DOCUMENT RESUME

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TITLE	Turboprop Propulsion Mechanic 2-8. Military Curriculum Materials for Vocational and Technical Education.
INSTITUTION	Chanute AFB Technical Training Center, Ill.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.
SPONS AGENCY	Office of Vocational and Adult Education (ED), Washington, D.C.
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DESCRIPTORS	*Aviation Mechanics; Behavioral Objectives; Engines; Equipment Maintenance; Equipment Utilization; Group Instruction; *Hydraulics; Individualized Instruction; Instructional Materials; Learning Activities; Lesson Plans; *Mechanics (Process); Military Training; Postsecondary Education; Power Technology; Safety; Secondary Education; Skilled Occupations; *Technical Education; *Vocational Education
IDENTIFIERS	*Military Aviation; Military Curriculum Project; Turboprop Engines

ABSTRACT

These military-developed curriculum materials for turboprop propulsion mechanics are targeted for use in grades 11-adult. Organized in five instructional blocks, the materials deal with the following topics: fundamentals of turboprop propulsion mechanics; engine and propeller systems operation; propeller maintenance; engine repair; and engine change, inspection, buildup, and rigging. Each unit contains lesson plans, programmed texts, a student workbook, and handouts. Also provided are statements of performance objectives and review exercises. For use in group as well as individualized instruction, these course materials train students to operate, remove, disassemble, inspect, test, and install hydraulically operated propellers, controls, and accessories. Also emphasized are ground safety practices, associated ground support equipment, and electrical fundamentals. Audio visual materials are recommended but not provided. (MN)

Military Curriculum Materials for Vocational and Technical Education

Turboprop Propulsion Mechanic 2-8

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY
1960 KENNY ROAD · COLUMBUS OHIO 43210

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL

Program Information Office
The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road, Columbus, Ohio 43210
Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

THE NATIONAL CENTER FOR RESEARCH IN VOCATIONAL EDUCATION

Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction Trades	Heating & Air Conditioning
Clerical Occupations	Machine Shop
Communications	Management & Supervision
Drafting	Meteorology & Navigation
Electronics	Photography
Engine Mechanics	Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

NORTHWEST
William Daniels
Director
Building 17
Airdustrial Park
Olympia, WA 98504
206/753-0879

MIDWEST
Robert Patton
Director
1515 West Sixth Ave.
Stillwater, OK 74704
405/377-2000

SOUTHEAST
James F. Shill, Ph.D.
Director
Mississippi State University
Drawer DX
Mississippi State, MS 39762
601/325-2510

NORTHEAST
Joseph F. Kelly, Ph.D.
Director
225 West State Street
Trenton, NJ 08625
609/292-6562

WESTERN
Lawrence F. H. Zane, Ph.D.
Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

TURBOPROP PROPULSION MECHANIC
3ABR42633

Classroom Course 2-8

Developed by:
United States Air Force

Development and Review Dates:
April 8, 1981

Occupational Area:
Aviation

Target Audiences:
Grades 11 - Adult

Print Pages:
899

Availability:
ERIC
National Center Clearinghouse

Contents:	Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Group Instruction:	Individualized:
BLOCK I -												
Fundamentals	.	.	.	.		x	.		.		.	.
BLOCK II -												
Engine and Propeller Systems Operation	.	.	.	.		x	.		.		.	.
BLOCK III -												
Propeller Maintenance	.	.	.	.		x	.		.		.	.
BLOCK IV -												
Engine Repair	.	.	.	.		x	.		.		.	.
BLOCK V -												
Engine Change, Inspection, Buildup, and Rigging	.	.	.	.		x	.		.		.	.

X Materials are recommended but not provided.

THE NATIONAL CENTER FOR RESEARCH IN VOCATIONAL EDUCATION
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210
(614) 486-3655

Course Description:

The course trains students to perform duties prescribed in AFR 39-1 for Turboprop Propulsion Mechanic. Training includes operation, removal, disassembly, inspection, repair, assembly, test and installation of hydraulically operated propellers, controls and accessories. Operating principles, engine change, adjustments and conditioning of turboprop engines and systems. Disassembly, inspection, repair, and assembly of turboprop engine. Emphasis in ground safety practices; associated ground support equipment, and electrical fundamentals.

TURBOPROP PROPULSION MECHANIC
3ABR42633

CLASSROOM COURSE

TABLE OF CONTENTS

POI C3ABR42633 000
(PDS Code ZNH)

PLAN OF INSTRUCTION

(Technical Training)

TURBOPROP PROPULSION MECHANIC

CHANUTE TECHNICAL TRAINING CENTER

8 April 1981 - Effective 8 April 1981 with class 810408

DEPARTMENT OF THE AIR FORCE
3330 Technical Training Wing (ATC)
Chanute Air Force Base, Illinois 61868

PLAN OF INSTRUCTION C3ABR42633 000
(PDS Code ZNH)
8 April 1981

FOREWORD

1. PURPOSE: This publication is the plan of instruction (POI) when the pages listed on page A are bound into a single volume. The POI contains the qualitative requirements for course C3ABR42633 000, Turboprop Propulsion Mechanic, in terms of criterion objectives for each unit of instruction and shows time, training standard correlation, and support materials and guidance. When separated into units of instruction, it becomes the lesson plan/Part I. This POI was developed according to AFR 50-8, Instructional System Development, and ATCR 52-6, Curriculum Documentation.

2. COURSE DESIGN/DESCRIPTION: The instructional design for this course is Group/Lock Step. The course trains airmen to perform duties prescribed in AFR 39-1 for Turboprop Propulsion Mechanic, AFSC 42633. Training includes operation, removal, disassembly, inspection, repair, assembly, test and installation of hydraulically operated propellers, controls and accessories. Operating principles, engine change, adjustments and conditioning of turboprop engines and systems. Disassembly, inspection, repair, and assembly of turboprop engine. Emphasis in ground safety practices; associated ground support equipment; electrical fundamentals; technical publications and familiarization with organizational and intermediate, maintenance forms, maintenance documentation, and man-hour accounting as applicable to engine and propeller maintenance. In addition, military training is provided on commander's calls and physical conditioning.

Note: Block training (instructional) sequence may vary so that cross utilization of equipment can be made.

3. TRAINING EQUIPMENT: The number shown in parentheses after equipment listed as Training Equipment under SUPPORT MATERIALS AND GUIDANCE is the planned number of students assigned to each equipment unit.

4. REFERENCES: This POI is based on Specialty Training Standard 426X3, December 1979, and Course Chart C3ABR42633 000, 15 December 1980.

FOR THE COMMANDER

GERALD B. LASCO, Colonel, USAF
Commander, 3350 Technical Training Group

Supersedes POI C3ABR42533 000, 30 October 1979.
OPR: 3350 Technical Training Group
DISTRIBUTION: Listed on Page A

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Fundamentals

1. COURSE CONTENT	2. TIME
2. Shop and Flight Line Safety	4

a. Without reference, correctly explain basic facts of accident prevention. STS: 3a Meas: W

b. Without reference, correctly explain basic facts of health hazards. STS: 3b Meas: W

c. Without reference, correctly explain basic facts of health protection. STS: 3b Meas: W

d. Without reference, correctly identify basic facts of shop and flight line safety practices. STS: 3c Meas: W

e. Without reference, correctly identify basic facts of the foreign object damage prevention program. STS: 3d Meas: W

Note: Portions of this course were deleted due to the military specificity of the material.

SUPERVISOR APPROVAL OF LESSON PLAN

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-102 (101), Ground Safety Practices
3ABR42633-WB-102, Shop and Flight Line Safety

Audio Visual Aids
Selected 35mm Slides: Accident Prevention Program
TS 299, The Six Million Dollar Screw
TF 5614, Foreign Object Damage

Training Methods
Lecture/Discussion (4 hrs)

Instructional Guidance
Discuss safety practices in shop and on the flight line. Point out danger areas of operating turboprop engines and the damage that can be caused by foreign objects. Discuss the fire prevention program by covering the classes of fires and the types of fire extinguishers. Conduct a class tour of the hangar area and have the students identify the elements of objectives 2a, 2b, 2c, 2d, and 2e. Have the students start SIT assignment on how to study. This will be started the last 2 hours of day 1. Make SIT assignment clear, understandable, when it will be turned in and how long it will take them to complete. This SIT assignment will take them 2 hours to complete. Tell the students they will be evaluated on this material. This satisfies the SIT requirement for PT 52-11.

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PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE

Fundamentals

1. COURSE CONTENT	2. TIME
4. Tools and Maintenance Materials	15
a. Using a trainer and handtools, correctly replace three nuts and bolts. STS: 9a Meas: P	(3)
b. Using a trainer and a torque wrench, correctly torque three bolts. STS: 9b Meas: P	(3)
c. Correctly explain facts relating to the use of engine hardware items. STS: 10a Meas: W	(3)
d. Using a trainer and handtools, correctly safety three assemblies. STS: 10b Meas: P	(3)
e. Using a micrometer, correctly measure the dimensions of three items. STS: 9b Meas: P	(3)

SUPERVISOR APPROVAL OF LESSON PLAN

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-104, Glossary
3ABR42633-PT-104, Mechanic's Handtools
3ABR42633-SG-104, 104A, 104B, 104C (102, 102A, 102B, 102C), Introduction to Common Handtools, Hardware, Measuring Devices, and Safety Wiring
3ABR42633-WB-104 (102D), Torque Wrenches
3ABR42633-WS-104A, Safety Devices
3ABR42633-WB-104B, Aircraft and Engine Hardware
3ABR42633-WB-104C, Micrometers

Audio Visual Aids
TFA 496a, Torquing Equipment and Usage - Breakaway Handles

Training Equipment
Trainer, 0182J, Handtool Identification (12)
Trainer, Identification and Lockwiring (1)
Handtools and Special Tools (2)
Selected Hardware (12)

Training Methods
Programmed Instruction (4 hrs)
Discussion/Demonstration (5 hrs)
Performance (6 hrs)

Multiple Instructor Requirements
Supervision, Equipment (2)

Instructional Guidance
Discuss the reasons why the students should be able to identify, use, and care for common handtools. Identify tool nomenclature using tools in the tool box. Demonstrate how to properly use and care for the breakaway torque wrench and discuss the importance of torque control. Demonstrate how to lockwire two bolts; then three bolts. Discuss the purpose of safety devices and techniques of lockwiring. Then have the students perform by lockwiring on the designated trainers. Point out selected hardware and have the students identify each. Distribute micrometers to each student. Monitor students closely as they take several readings with each micrometer. Have the students begin SIT assignment. Make SIT assignment clear, understandable, and when it will be completed and handed in. Inform the students that they will be evaluated on this material.

MIR: Two instructors are required for 6 hours of performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE Turboprop Propulsion Mechanic
BLOCK TITLE Fundamentals	

1. COURSE CONTENT	2. TIME
5. Aircraft and Engine Fundamentals	24 (22/2)
a. Without reference, correctly explain the meaning of aircraft designators. STS: 4a Meas: W	(1.5)
b. Without reference, correctly explain the meaning of engine designators. STS: 4a Meas: W	(1.5)
c. Without reference, correctly explain the basic principles of turboprop engine operation. STS: 11a Meas: W	(5)
d. Without reference, correctly identify the constructional features of the major sections of the T56 engine. STS: 11a, 11b(11), 11b(12) Meas: W	(3)
e. Without reference, correctly explain the constructional features of the main shaft bearings of T56 engine. STS: 11a Meas: W	(1)
f. Using TO 1C-130B-2-4, correctly state the location of the T56 starter system. STS: 11b(1) Meas: W	(1)
g. Using TOs 1C-130B-2-4 and 2J-T56-24, correctly state the location of the T56 ignition system. STS: 11b(2) Meas: W	(1)
h. Using TOs 1C-130B-2-4 and 2J-T56-24, correctly state the location of the T56 oil system. STS: 11b(3) Meas: W	(1.5)
i. Using TOs 1C-130B-2-4 and 2J-T56-24, correctly state the location of the T56 fuel system. STS: 11b(4) Meas: W	(1.5)
j. Using TO 2J-T56-24, correctly state the location of the T56 compressor airflow control system. STS: 11b(5) Meas: W	(1)
k. Using TOs 2J-T56-24 and 1C-130B-2-4, correctly state the location of the T56 anti-icing system. STS: 11b(6) Meas: W	(1)
l. Using TOs 1C-130B-1 and 2J-T56-24, correctly state the location of the T56 TIT indicating system. STS: 11b(7) Meas: W	(1)
m. Using TO 1C-130B-1, correctly state the location of the fire warning system. STS: 11b(8) Meas: W	(2)

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n. Using TO 1C-130B-1, correctly state the location of the RPM indicating system. STS: 11b(9) Meas: W (.5)

o. Using TO 1C-130B-1, correctly state the location of the torque indicating system. STS: 11b(9) Meas: W (.5)

p. Using TO 1C-130B-2-4, correctly state the location of the negative torque signal system. STS: 11b(10) Meas: W (1)

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-PT-105 (103), Technical Fundamentals of Turboprop Engines
3ABR42633-SG-105 (103), Aircraft and Engine Fundamentals
3ABR42633-WB-105 (103E), Jet Engine Theory
3ABR42633-WB-105A, Aircraft and Engine Designations
3ABR42633-WB-105B, T56 Engine Cases and Parts
3ABR42633-WB-105C, T56 Engine Engine Major Sections and Parts
3ABR42633-WB-105D, T56 Engine Main Bearings and Labyrinth Seals
3ABR42633-WB-105E, T56 Engine Systems and Parts
TO 1C-130B-1, Flight Manual
TO 1C-130B-2-4, Maintenance Instructions - Power Plant
TO 2J-T56-24, Illustrated Parts Breakdown - T56-A-7 Engine

Audio Visual Aids
Selected Charts, Aircraft and Engine Designations; Turboprop Engine Theory Engine Sections, Bearings, and Systems
TF 1-5364, An Introduction to Jet Engines

Training Equipment
T56 Engine (12)
Selected Engine System Parts (12)

Training Methods
Discussion/Demonstration (22 hrs)
SIT Assignment (2 hrs)

Instructional Guidance
Discuss aircraft and engine designators and have the students identify the designators as the instructor lists several of each on the chalkboard. Refer students to AFR 82-1 for a complete listing of aircraft designators. Discuss principles of turboprop operation. Tie in Newton's 3rd law of motion and Bernoulli's principle. Discuss the major sections of the T56 engine and have students identify and state the location of each major section. Discuss the T56 engine. Have students identify the location, type, and state the constructional features of each bearing. Discuss the the T56 engine systems and have the students identify the parts. Tour the hangar area and accident investigation room if time permits.

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PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Fundamentals

1. COURSE CONTENT	2. TIME
8. Engine Preservation and Storage	2 (0/2)
a. Using TOs 2J-1-18 and 2J-T56-26, correctly determine the procedures for removing and installing engines in shipping containers. STS: 15a Meas: W	
b. Using TOs 2J-1-18 and 2J-T56-26, correctly determine the procedures to preserve and depreserve engines. STS: 15b Meas: W	

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SW-108, Engine Preservation and Storage
TO 2J-1-18, Corrosion Control of Gas Turbine Engines
TO 2J-T56-26, Field Maintenance - T56-A-7 Engine

Training Methods
SIT Assignment (2 hrs)

Instructional Guidance
Make SIT assignment clear, understandable, and when it will be completed. Tell the students this assignment will take them 2 hours to complete. Inform the students they will be evaluated on this material. This satisfies the SIT assignment for preservation and storage.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
1. Starting System	1
a. Using TO 1C-130B-2-4, correctly explain the purpose and operation of the starting system. STS: 11b(1) Meas: W	

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-201/202 (205), Turboprop Engine Starter and Ignition Systems
3ABR42633-WB-201/202 (205), Turboprop Engine Starter and Ignition Systems
TO 1C-130B-2-4, Maintenance Instructions - Power Plant

Training Equipment
T56-A-7 Engine (12)
QEC Kit (12)

Training Methods
Lecture/Discussion (1 hr)

Instructional Guidance
Explain the purpose and operation of the starting system. Use the TOs and a T56 engine to trace the operation of the starting system. Stress management of defense energy resources and materials conservation throughout Block II. Stress safety throughout Block II.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
2. Ignition System	1
a. Using TO 1C-130B-2-4, correctly explain the purpose and operation of the ignition system. STS: 11b(2) Meas: W	

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-201/202 (205)
3ABR42633-WB-201/202 (205)
TO 1C-130B-2-4

Audio Visual Aids
Selected Charts, T56 Ignition System

Training Equipment
T56-A-7 Engine (12)

Training Methods
Lecture/Discussion (1 hr)

Instructional Guidance
Explain the purpose and operation of the ignition system. Use the TO and a T56 engine to trace the operation of the ignition system. The last 4 hours of day one will be used for removal, inspection, and installation of the starting and ignition system components. These 4 hours are taken from unit 12 of instruction covering remova, inspection, and installation of accessories.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsicn Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
3. Compressor Airflow Control System a. Using TO 1C-130B-2-4, correctly explain the purpose and operation of the compressor airflow control system. STS: 11b(5) Meas: W	2 (1/1)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-203 (207), Turboprop Compressor Bleed System
TO 1C-130B-2-4

Audio Visual Aids
Selected Charts, Compressor Bleed System

Training Equipment
T56-A-7 Engine (12)

Training Methods
Lecture/Discussion (1 hr)
SIT Assignment (1 hr)

Instructional Guidance
Explain the purpose and operation of the compressor bleed system. Use the TO and a T56 engine to trace the.operation of the compressor bleed system.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
4. RPM and Torque Indicating Systems	2 (1/1)
a. Using TOs 1C-130B-2-4 and 1C-130B-2-6, correctly explain the purpose and operation of the RPM indicating system. STS: 11b(9) Meas: W	
b. Using TOs 1C-130B-2-4 and 1C-130B-2-6, correctly explain the purpose and operation of the torque indicating system. STS: 11b(9) Meas: W	

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-WB-204, Turboprop Engine RPM and Torque Indicating Systems
TO 1C-130B-2-4
TO 1C-130B-2-6, Maintenance Instructions - Instruments

Audio Visual Aids
Selected Transparencies, RPM and Torque Indicating Systems

Training Equipment
T56-A-7 Engine (12)

Training Methods
Lecture/Discussion (1 hr)
SIT Assignment (1 hr)

Instructional Guidance
Explain the purpose and operation of the RPM and torque indicating systems. Use TOs, transparencies, and a T56 engine to trace the operation of the RPM and torque indicating systems.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE

Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
5. Anti-Icing System a. Using TO 1C-130B-1, correctly explain the purpose and operation of the anti-icing system. STS: 11b(6) Meas: W	1

SUPERVISOR APPROVAL OF LESSON PLAN

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-205/221 (214), Propeller and Engine Anti-Icing and Deicing Systems
TO 1C-130B-1, Flight Manual

Audio Visual Aids
Selected Charts, T56 Anti-Icing System

Training Equipment
T56-A-7 Engine (12)

Training Methods
Lecture/Discussion (1 hr)

Instructional Guidance
Explain the purpose and operation of the anti-icing system. Use the TO and charts to trace the operation of the anti-icing system. During the last 3 hours of day two, the students will perform removal, inspection, and installation of the compressor airflow control, RPM, torque indicating, and anti-icing systems on the T56 engine. These 3 hours are taken from unit 12 covering removal, inspection, and installation of accessories.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
6. Oil System a. Using TOs 1C-130B-2-4 and 2J-T56-26, correctly explain the purpose and operation of the oil system. STS: 11b(3) Meas: W b. Without reference, correctly identify the purpose and operation of the SOAP. STS: 12d Meas: W	8 (6/2)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-206 (201), Turboprop Engine Oil System
3ABR42633-WB-206 (201), Turboprop Engine Oil System
TO 1C-130B-2-4
TO 2J-T56-26, Field Maintenance

Audio Visual Aids
Selected Transparencies, T56 Oil System
Selected Charts, T56 Oil System

Training Equipment
T56-A-7 Engine (12)
QEC Kit (12)

Training Methods
Lecture/Discussion (6 hrs)
SIT Assignment (2 hrs)

Instructional Guidance
Explain the purpose and operation of the oil system. Use the TOs, charts, transparencies, and T56 engine to trace the operation of the oil system.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

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BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
7. Fuel System a. Using TO 1C-130B-2-4, correctly explain the purpose and operation of the fuel system. STS: 11b(4) Meas: W	8 (6/2)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-207 (203), Turboprop Engine Fuel System
3ABR42633-WB-207 (203), T56 Engine Fuel System
TO 1C-130B-2-4

Audio Visual Aids
Selected Charts, T56 Fuel System

Training Equipment
T56-A-7 Engine (12)
QEC Kit (12)

Training Methods
Lecture/Discussion (6 hrs)
SIT Assignment (2 hrs)

Instructional Guidance
Explain the purpose and operation of the fuel system. Use the charts, TO, and T56 engine to trace the operation of the fuel system.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
8. Temperature Datum System a. Using TO 1C-130B-2-4, correctly identify the purpose and operation of the temperature datum system. STS: 11b(13) Meas: W	5 (3/2)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-208 (217), Temperature Datum System
3ABR42633-WB-208 (217), Temperature Datum System
TO 1C-130B-2-4

Audio Visual Aids
Selected Charts, Temperature Datum System

Training Equipment
T56-A-7 Engine (12)
QEC Kit (12)

Training Methods
Lecture/Discussion (3 hrs)
SIT Assignment (2 hrs)

Instructional Guidance
Explain the purpose and operation of the temperature datum system. Use the TO, charts and T56 engine to trace the operation of the temperature datum system.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
9. TIT and Fire Warning Systems	2
a. Using TOs 1C-130B-2-4 and 2J-T56-26, correctly explain the purpose and operation of the TIT system. STS: 11b(7) Meas: W	
b. Using TO 1C-130B-1, correctly explain the purpose and operation of the fire warning system. STS: 11b(8) Meas: W	

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-WB-209 (202), Turboprop Engine TIT and Fire Warning System
TO 1C-130B-1
TO 1C-130B-2-4
TO 2J-T56-26

Audio Visual Aids
Selected Transparencies, TIT and Fire Warning Systems
Selected Charts, TIT System

Training Methods
Lecture/Discussion (2 hrs)

Instructional Guidance
Explain the purpose and operation of the TIT and fire warning systems. Use TOs, transparencies, and charts to trace the operation of the TIT and fire warning systems.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
10. Negative Torque Signal System	1
a. Using TO 1C-130B-2-4, correctly identify the purpose and operation of the negative torque signal system. STS: 11b(10) Meas: W	

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-210 (206), Negative Torque Signal System
TO 1C-130B-2-4

Audio Visual Aids
Selected Charts, Negative Torque Signal System

Training Equipment
T56-A-7 Engine (12)

Training Methods
Lecture/Discussion (1 hr)

Instructional Guidance
Explain the purpose and operation of the negative torque system. Use TOs and charts to trace the operation of the negative torque system.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
11. Maintenance Documentation a. Using TO 1C-130B-06, AFTO Forms 349 and/or 350, correctly document removal, inspection, and installation of selected engine accessories. STS: 8c Meas: P	4 (0/4)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-WB-211, Maintenance Documentation
TO 00-20-2-4, Maintenance Documentation for In-Shop Engine Maintenance
TO 1C-130A-06, Work Unit Code Manual
TO 1C-130B-2-4
TO 2J-T56-26
AFTO Forms 349 and 350

Training Methods
SIT Assignment (4 hrs)

Instructional Guidance
Students will complete documentation of removal, inspection, and installation of selected engine accessories. This will be done during SIT on days 6 and 7.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE

Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
12. Removal, Inspection, and Installation of Accessories	23
a. Using TOs 1C-130B-2-4 and 2J-T56-26, correctly remove, inspect, and install selected starter and ignition system components. STS: 13d(7) Meas: P	(4)
b. Using TOs 1C-130B-2-4 and 2J-T56-26, correctly remove, inspect, and install selected airflow control and anti-icing system components. STS: 13d(7) Meas: P	(3)
c. Using TOs 1C-130B-2-4 and 2J-T56-26, correctly remove, inspect, and install selected oil, fuel, and temperature datum system components. STS: 13d(7) Meas: P	(16)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
TO 1C-130B-2-4
TO 2J-T56-26

Training Equipment
T56-A-7 Engine (6)
Selected Handtools (6)

Training Methods
Performance (23 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities

Instructional Guidance
Objective 12a will be done on day 1. Objective 12b will be done on day 2. Objective 12c will be done on days 6, 7, and 8. During these periods, the students will remove, inspect, and install selected accessories using the applicable technical orders.

MIR: Two instructors are required for 23 hours during student performance.

13. Written Test and Critique 2

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
14. Propeller Technical Orders	3
a. Using TO 1C-130B-2-11, correctly locate specific information in the technical order. STS: 4b Meas: P	
b. Using TO 3H1-18-2, correctly locate specific information in the technical order. STS: 4b Meas: P	
c. Using TO 3H1-18-4, correctly locate specific information in the technical order. STS: 4b Meas: P	

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-214 (210), Propeller Technical Publications
3ABR42633-WB-214 (210), Propeller Technical Publications
TO 1C-130B-2-11, Maintenance Instructions - Propeller
TO 3H1-18-2, Field Maintenance Instructions - Variable Pitch Aircraft Propeller
TO 3H1-18-4, Illustrated Parts Breakdown - Variable Pitch Aircraft Propeller

Training Methods
Demonstration/Performance (3 hrs)

Instructional Guidance
Explain the importance of technical orders on the job and demonstrate how to use them. Students will then use the technical orders to complete WB-214.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
15. Propeller Fundamentals a. Without reference, correctly explain the propeller function and operating principles. STS: 20a Meas: W b. Without reference, correctly explain the operation of propellers on aircraft. STS: 20c Meas: W c. Using TOs 1C-130B-2-11 and 3H1-18-2, correctly explain the constructional features of the 54H60 propeller. STS: 20b Meas: W	8 (6/2)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-215 (209), Propeller Fundamentals
3ABR42633-WB-215 (209), Propeller Fundamentals

Training Equipment
Propeller Assembly (12)

Training Methods
Discussion/Demonstration (6 hrs)
SIT Assignment (2 hrs)

Instructional Guidance
Explain the basic operating principles of a propeller on and off an aircraft and the operating principles of the 54H60 propeller. Identify and explain the major parts and constructional features of the 54H60 propeller. Take students into the lab and have them identify the parts of the 54H60 propeller.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
16. Measuring Tools	4
a. Using a universal protractor, measure the angle of three propeller blades within 1 degree of the instructor's reading. STS: 9b Meas: P	
b. Using a PSM-37 multimeter and an electrical trainer, correctly trace three electrical circuits. STS: 19c Meas: P	

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-216 (215), Measuring Tools
3ABR42633-WB-216 (215), Measuring Tools

Training Equipment
Trainer, PSM-37 Multimeter (12)
Trainer, Universal Protractor (12)
PSM-37 Multimeter (2)
Universal Protractor (2)
54H60 Propeller (6)

Training Methods
Discussion/Demonstration (2 hrs)
Performance (2 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Demonstrate to the students how to use the PSM-37 multimeter and the universal protractor. Take the students into the lab and have them measure three different blade angles.

MIR: Two instructors are required for 2 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE

Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
17. Propeller Electrical Systems	7 (3/4)

a. Without reference, correctly identify the principles of basic electricity related to propeller electrical circuits. STS: 19a Meas: W

b. Without reference, correctly identify the hazards involved with working on propeller electrical systems. STS: 19a Meas: W

c. Without reference, correctly trace the condition lever feather circuit on the propeller electrical diagram. STS: 19b Meas: P

d. Without reference, correctly trace the emergency feather circuit on the propeller electrical diagram. STS: 19b Meas: P

e. Without reference, correctly trace the airstart circuit on the propeller electrical diagram. STS: 19b Meas: P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-217 (211), Propeller Feather and Air Start Control
3ABR42633-SG-217 (211), Electrical Safety and the Maintenance Man
3ABR42633-WB-217 (211), Propeller Electrical System
3ABR42633-SG-217A (211A), Fundamentals of AC and DC Electricity
3ABR42633-SG-217B (211B), Propeller Electrical System

Audio Visual Aids
Chart, Propeller Feather and Air Start Schematic

Training Methods
Lecture/Discussion (1 hr)
Demonstration/Performance (2 hrs)
SIT Assignment (4 hrs)

Instructional Guidance
Discuss with the students the fundamentals of AC and DC electricity. Go over the safety practices to be followed and the dangers that exist when working with electricity. Demonstrate to the students how to trace the condition lever feather, T-handle feather, and air start circuits. Have the students trace the above mentioned circuits on the propeller feather schematic diagram.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
18. Propeller Control System Construction Features a. Using TOs 1C-130B-2-11 and 3H1-18-2, correctly explain the constructional features of the propeller control assembly. STS: 21b Meas: W	8 (6/2)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-218, Propeller Control System
3ABR42633-WB-218, Propeller Control System
TO 1C-130B-2-11
TO 3H1-18-2

Audio Visual Aids
Selected Charts, 54H60 Propeller

Training Methods
Lecture/Discussion (6 hrs)
SIT Assignment (2 hrs)

Instructional Guidance
Explain the major parts and constructional features of the propeller control assembly.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
19. Propeller Control System Functions and Operating Principles	8 (6/2)
a. Using TOs 1C-130B-2-11 and 3H1-18-2, correctly explain the operating principles of the propeller control assembly. STS: 21a Meas: W	

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-219, Propeller Control System
3ABR42633-WB-219, Propeller Control System
TO 1C-130B-2-11
TO 3H1-18-2

Audic Visual Aids
Selected Charts, Propeller Hydraulic System

Training Methods
Demonstration/Performance (6 hrs)
SIT Assignment (2 hrs)

Instructional Guidance
Explain the operating principles of the propeller control assembly and show the oil flow through the components. Have the students trace the oil flow in WB-219.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
20. Propeller Modifications a. Without reference, correctly identify simple facts pertaining to the modification of propeller systems. STS: 20g Meas: W	1 (0/1)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-220 (209A), Modification of Propeller Systems

Training Methods
SIT Assignment (1 hr)

Instructional Guidance
Hand out SG-220 to the students. They will read this study guide and answer the questions at the end on a separate sheet of paper.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE

Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
21. Propeller Anti-Icing and Deicing a. Using TOs 1C-130B-2-11 and 3H1-18-2, correctly determine the procedure for the operation of the propeller anti-icing system. STS: 201 Meas: W b. Using TOs 1C-130B-2-11 and 3H1-18-2, correctly determine the procedure for the operation of the propeller deicing system. STS: 201 Meas: W	4 (3/1)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-205/221 (214)
3ABR42633-WB-221 (214), Propeller and Engine Anti-Icing and Deicing Systems
TO 1C-130B-2-11
TO 3H1-18-2

Audio Visual Aids
Selected Charts, Propeller Anti-Icing and Deicing Systems

Training Equipment
Trainer, 54H60 Propeller Anti-Icing (12)

Training Methods
Lecture/Discussion (2 hrs)
Demonstration (1 hr)
SIT Assignment (1 hr)

Instructional Guidance
Explain the purpose and operation of the propeller anti-icing and deicing systems. Use the TOs and charts to trace the operation of the systems. Take the students to the lab and demonstrate the operation of the two systems on the anti-icing and deicing trainer.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
22. Blade Repair a. Using TO 3H1-18-2, correctly repair one propeller blade. STS: 20f Meas: P	3

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-222 (216), Inspection and Blade Repair
3ABR42633-WB-222 (216), Inspection and Blade Repair
TO 3H1-18-2

Training Equipment
Aluminum Propeller Blades (4)
Dial Indicator (12)
Blade Repair Files (2)

Training Methods
Demonstration/Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Demonstrate how to repair a propeller blade. Take the students to the lab and have them repair a propeller blade.

MIR: Two instructors are required for 2 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
23. Propeller System Malfunctions a. Without reference, isolate minor malfunctions in propeller systems. STS: 20h Meas: P	2

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-223 (212), Trouble Analysis of Propeller Electrical Systems
3ABR42633-WB-223 (212), Trouble Analysis of Propell : Electrical Systems

Training Equipment
Trainer 1722J, Electrical System

Training Methods
Demonstration/Performance (2 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Have the students locate minor malfunctions in the electrical circuits.

MIR: Two instructors are required for 2 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine and Propeller Systems Operation

1. COURSE CONTENT	2. TIME
24. Soldering	4
a. Without reference, correctly identify the purpose of soldering. STS: 19d Meas: W	
b. Without reference, correctly identify the procedure for soldering. STS: 19d Meas: W	
c. Using the proper tools, correctly solder four electrical connections. STS: 19d Meas: P	

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-224 (213), Soldering Electrical Connections

Audio Visual Aids
FCC 42-9 thru 13; FCC 42-15 thru 16, Soldering

Training Equipment
Soldering Iron (1)

Training Methods
Lecture/Discussion (2 hrs)
Performance (2 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Discuss the purpose and procedures for soldering. Show film strip on how to solder. Take the students into the lab and have them solder four connections each.

MIR: Three instructors are required for 1 hour during student performance.

25. Military Training	6
a. Physical Conditioning	(6)
26. Written Test and Critique	2

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
1. Removal of Propeller Assembly	6

a. Using TO 1C-130B-2-11, locate procedures, safety practices, AGE data, FOD prevention, and special tools for propeller removal without error. STS: 4b, 20d Meas: W, P

b. With student assistance, remove the 54H60 propeller assembly from a T56 engine gearbox IAW TO 1C-130B-2-11. STS: 20d Meas: P

c. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-2, determine documentation procedures for AFTO Forms 349 and 350; using HO-300, determine the correct standard reporting designator, category of labor codes pertaining to propeller removal without error. STS: 4b, 8c Meas: W, P

d. Using TO 00-20-5, locate information pertaining to AFTO Form 95 entries for propeller removal and complete WB-301 without error. STS: 4b, 10e(1) Meas: W

SUPERVISOR APPROVAL OF LESSON PLAN

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404), Codes Needed on AFTO Forms 349 and 350
3ABR42633-SG-301 (302), Removal of Propeller Assembly
3ABR42633-WB-301 (302), Removal of Propeller Assembly
TO 00-20-2-2, On-Equipment Maintenance Documentation
TO 00-20-5, Aircraft, Drone and Air Launched Missile Inspections, Flight Reports, and Supporting Maintenance Documents
TO 1C-130A-06, Work Unit Code Manual
TO 1C-130B-2-11, Maintenance Instructions - Propeller

Training Equipment
Trainer, Propeller Change (6)
Handtools and Special Tools (6)
Applicable AGE (6)

Training Methods
Discussion/Demonstration (3 hrs)
Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Explain thoroughly the procedures for propeller removal in the TO and explain the importance of following the TO procedures while performing the task. Have the students complete SIT assignment PT-309, Final Assembly of Hub, Blades, Dome, and Oil Test, the last 2 hours of days 1, 2, 3, 4, and 6. This satisfies the SIT requirement for objective 9a. Make SIT assignments clear and understandable. Inform the students they will be evaluated on all SIT assignments in Block III. Stress management of defense energy resources and materials conservation throughout Block III. Stress safety throughout Block III.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
2. Removal of Control, Rear Spinner, and Deicing Contact Ring	6

a. Using TO 3H1-18-2, locate procedures, safety practices, FOD prevention, and special tools required for removal of control, rear spinner, and deicing contact ring without error. STS: 4b, 21c Meas: W, P

b. With student assistance, remove the control assembly from a 54H60 propeller IAW TO 3H1-18-2. STS: 21c Meas: P

c. With student assistance, remove the rear spinner and deicing contact ring assemblies from a 54H60 propeller IAW TO 3H1-18-2. STS: 21c Meas: P

d. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-10, determine documentation procedures for AFTO Forms 349 and 350; using HO-300, determine the correct standard reporting designator and category of labor codes pertaining to the removal of the control, rear spinner, and deicing contact ring and complete WB-302 without error. STS: 4b, 8c Meas: W, P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-302 (303), Removal of Rear Spinner and Deicing Contact Ring
3ABR42633-WB-302 (303), Removal of Rear Spinner and Deicing Contact Ring
TO 00-20-2-10, Documentation for Off-Equipment Maintenance
TO 1C-130A-06
TO 3H1-18-2, Field Maintenance Instructions - Variable Pitch Aircraft Propeller

Training Equipment
Propeller, Model 54H60 (6)

Training Methods
Discussion/Demonstration (3 hrs)
Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
The removal procedures are given in para 5-17 through 5-24 of TO 3H1-18-2. Divide the class into three for lab work.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
3. Installation of Rear Spinner, Deicing Contact Ring, and Control Assemblies	7

a. Using TO 1C-130B-2-11, locate procedures, torque limits, safety practices, FOD prevention, and special tools pertaining to installation of rear spinner, deicing contact ring, and control assemblies. STS: 4b, 20e Meas: W, P

b. With student assistance, install the 54H60 propeller rear spinner and deicing contact ring assemblies IAW TO 1C-130B-2-11. STS: 20e Meas: P

c. With student assistance, install the 54H60 propeller control assembly IAW TO 1C-130B-2-11. STS: 21c Meas: P

d. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-10, determine documentation procedures for AFTO Form 349; using HO-300, determine the correct standard reporting designator and category of labor codes pertaining to installation of the rear spinner, deicing contact ring, and control assemblies and complete WB-303 without error. STS: 4b, 8c Meas: W, P

e. Using TO 00-20-5, locate information pertaining to AFTO Form 95 entries for installation of the control assembly without error. STS: 4b, 10e(1) Meas: W

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-303 (304), Installation of Rear Spinner, Deicing Contact Ring and Control Assemblies
3ABR42633-WB-303 (304), Installation of Rear Spinner, Deicing Contact Ring and Contact Assemblies
TO 00-20-2-10
TO 00-20-5
TO 1C-130A-06
TO 1C-130B-2-11

Training Equipment
Propeller, Model 54H60 (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (2.5 hrs)
Performance (4.5 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Review the cautions applying to removal as well as installation of the control, spinner, and deicing contact assembly. Insure complete and correct application of all hardware and safety devices. Follow the procedures in TO 1C-130B-2-11.

MIR: Two instructors are required for 4.5 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
4. Installation of Propeller Assembly	7

a. Without reference, explain how to operate and maintain propeller dollies without error. STS: 22c Meas: W

b. Using TO 1C-130B-2-11, locate procedures, torque limits, safety practices, AGE data, FOD precautions, and special tools pertaining to propeller installation without error. STS: 4b, 20d Meas: W, P

c. With student assistance, install the 54H60 propeller assembly on a T56 engine gearbox IAW TO 1C-130B-2-11. STS: 20d Meas: P

d. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-2, determine documentation procedures for AFTO Form 349; using HO-300, determine the correct standard reporting designator, category of labor codes pertaining to propeller installation, and complete WB-304 without error. STS: 4b, 8c Meas: W, P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-304 (301), Installation of Propeller Assembly
3ABR42633-WB-304 (301), Installation of Propeller Assembly
TO 00-20-2-2
TO 1C-130A-06
TO 1C-130B-2-11

Training Equipment
Trainer, Propeller Change (6)
Handtools and Special Tools (6)
Applicable AGE (6)

Training Methods
Discussion/Demonstration (2.5 hrs)
Performance (4.5 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Point out areas that normally wear and the seals that commonly cause leakage. After the propeller is installed, conduct a discussion on key areas such as indexing pitch lock, safetying of propeller retaining nut, pitch lock, dome, dome cap, AN connectors, and linkage.

MIR: Two instructors are required for 4.5 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
5. Disassembly and Inspection of Hub and Blade Assembly	4

5. Disassembly and Inspection of Hub and Blade Assembly

a. Using TO 3H1-18-2, locate procedures, safety practices, FOD prevention, and special tools pertaining to the disassembly and inspection of a 54H60 propeller assembly without error. STS: 4b, 20e Meas: W, P

b. With student assistance, disassemble and inspect a 54H60 propeller assembly IAW TO 3H1-18-2. STS: 20e Meas: P

c. Using TO 1C-130A-06, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-10, determine documentation procedures for AFTO Forms 349 and 350; using HO-300, determine the correct standard reporting designator and category of labor codes pertaining to disassembly and inspection of the hub and blade assembly, and complete WB-305 without error. STS: 4b, 8c Meas: W, P

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-305, Disassembly and Inspection of Hub and Blade Assembly
3ABR42633-WB-305, Disassembly and Inspection of Hub and Blade Assembly
TO 00-20-2-10
TO 1C-130A-06
TO 3H1-18-2

Training Equipment
Propeller, Model 54H60 (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (2.5 hrs)
Performance (1.5 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Remind the students that the dome and blades are heavy and two people will be assigned to each unit when disassembling the propeller.
Instructor reference: TO 3H1-18-4.

MIR: Two instructors are required for 1.5 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
6. Assembly and Check of Hub and Blade Assembly	4.5

a. Using TO 3H1-18-2, locate procedures, torque limits, safety procedures, and FOD prevention procedures pertaining to assembly and check of the hub and blade assembly without error. STS: 4b, 20e Meas: W, P

b. With student assistance, assemble and check a 54H60 propeller assembly IAW TO 3H1-18-2. STS: 20e Meas: P

c. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-10, determine documentation procedures for AFTO Form 349, using HO-300, determine the correct standard reporting designator and category of labor codes pertaining to assembly and check of hub and blade assembly and complete WB-306 without error. STS: 4b, 20e Meas: W, P

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-306, Assembly and Check of the Hub and Blade Assembly
3ABR42633-WB-306, Assembly and Check of the Hub and Blade Assembly
TO 00-20-2-10
TO 1C-130A-06
TO 3H1-18-2
TO 3H1-18-4, Illustrated Parts Breakdown

Training Equipment
Propeller, Model 54H60 (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (1.5 hrs)
Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Remind the students that the dome and blades are heavy and that two people will be assigned to each unit when assembling the propeller.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
7. Disassembly and Assembly of Dome Assembly	4.5

a. Using TO 3H1-18-3, locate procedures, torque limits, safety procedures, and FOD prevention procedures for disassembly and assembly of the propeller dome assembly without error. STS: 4b, 20e Meas: W, P

b. With student assistance, disassemble and assemble a 54H60 propeller dome IAW TO 3H1-18-3. STS: 20e Meas: P

c. Using TO 1C-130A-06, locate informati in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-10, determine documentation procedures for AFTO Forms 349 and 350; using HO-300, determine the correct standard reporting designator and category of labor codes pertaining to disassembly and assembly of the dome assembly. STS: 4b, 8c Meas: W, P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-307, Disassembly and Assembly of Dome Assembly
3ABR42633-WB-307, Disassembly and Assembly of Dome Assambly
TO 00-20-2-10
TO 1C-130A-06
TO 3H1-18-3, Overhaul Instructions - Variable Pitch Aircraft Propeller

Training Equipment
Propeller Dome Assembly, Model 54H60 (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (2.5 hrs)
Performance (2 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
During disassembly and assembly, point out that it is easy to cut off a finger in the cam slots if proper safety is not practiced.

MIR: Two instructors are required for 2 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
8. Disassembly and Assembly of Low Pitch Stop Lever and Pitch Lock Regulator	6

a. Using TO 3H1-18-3, locate procedures, torque limits, safety practices, FOD prevention, and special tools pertaining to disassembly and assembly of low pitch stop lever and pitch lock regulator without error. STS: 4b, 20e Meas: W, P

b. With student assistance, disassemble and assemble a 54H60 propeller low pitch stop lever assembly IAW TO 3H1-18-3. STS: 20e Meas: P

c. With student assistance, disassemble and assemble a 54H60 propeller pitch lock regulator IAW TO 3H1-18-3. STS: 20e Meas: W, P

d. With student assistance, perform tests on low pitch stop assembly IAW TO 3H1-18-3. STS: 21e Meas: P

e. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-10, determine documentation procedures for AFTO Forms 349 and 350; using HO-300, determine the correct standard reporting designator and category of labor codes pertaining to disassembly and assembly of the low pitch stop lever and pitch lock regulator. STS: 4b, 8c Meas: W, P

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-308, Disassembly and Assembly of Low Pitch Stop and Pitch Lock Regulator
3ABR42633-WB-308, Disassembly and Assembly of Low Pitch Stop and Pitch Lock Regulator
TO 00-20-2-10
TO 1C-130A-06
TO 1C-130B-2-11
TO 3H1-18-3

Training Equipment
Low Pitch Stop Assembly, 54H60 Propeller (6)
Pitch Lock Regulator Assembly, 54H60 Propeller (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (3 hrs)
Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Have the students complete SIT assignment, PT-312, the last 2 hours of day 7 and day 8, and 1 hour of day 9. This satisfies the SIT requirement for objective 12a. Instructor reference - TO 3H1-18-3.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
9. Final Assembly, Balance, and Oil Test	15 (5/10)
a. Without reference, explain the purpose and procedures for oil test of the propeller assembly without error. STS: 20e, 20i, 22b Meas: W	(0/10)
b. Using TO 3H1-18-2, locate procedures, torque limits, safety practices, AGE data, FOD prevention, and special tools pertaining to final assembly, balance, and oil test without error. STS: 4b, 20e, 20i Meas: W	(.5)
c. With student assistance, perform the 54H60 propeller final assembly, and balance IAW TO 3H1-18-2. STS: 20e Meas: P	(1)
d. Given information by the instructor, correctly explain how to use and maintain test equipment. STS: 22b Meas: W	(.5)
e. Following instructions in TO 3H1-18-2, perform hydraulic tests on the 54H60 propeller. Must operate the tester and propeller to full feather, flight idle, and full reverse blade angles and state whether the propeller operates properly in two of the three checks. STS: 20i Meas: P	(2)
f. Working as a group, perform the 54H60 propeller pitch lock cam out and low blade angle tests. Must state the angles of cam out and low blade angle on the propeller within ± 1.0 degree. STS: 20i Meas: P	(1)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-309, Final Assembly, Balance, and Oil Test
3ABR42633-SW-309, Propeller Oil Test
3ABR42633-WB-309, Final Assembly, Balance, and Oil Test
TO 3H1-18-2

Training Equipment
Propeller Assembly, Model 54H60-91 (6)
Tester, Model GS-1221-M9 (12)
Tester, Fixture, HSP 1685 (12)
Marvel Balancer (12)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (2 hrs)
Performance (3 hrs)
SIT Assignment (10 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Demonstrate the procedure for operating the hydraulic tester. Explain that unless the valves are controlled properly, pressure surges can occur which will cause excessively high readings on the gages.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
10. Disassembly and Assembly of Propeller Control Assembly	4

a. Using TO 3H1-18-2, correctly determine the step-by-step procedure for testing propeller control system units. STS: 21e Meas: W

b. Using TO 3H1-18-2, locate procedures, torque limits, safety practices, FOD prevention, and special tools pertaining to disassembly and assembly of the propeller control assembly without error. STS: 4b Meas: W, P

c. With student assistance, disassemble and assemble a 54H60 propeller control assembly IAW TO 3H1-18-2. STS: 19e, 21d, 21f Meas: P

d. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-10, determine documentation procedures for AFTO Forms 349 and 350; using HO-300, determine the correct standard reporting designator, category of labor codes pertaining to disassembly and assembly of the propeller control assembly and complete WB-310 without error. STS: 4b, 8c Meas: W, P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-HO-300 (402/403/404)
3ABR42633-SG-310, Propeller Control Assembly
3ABR42633-WB-310, Propeller Control Assembly
TO 00-20-2-10
TO 1C-130A-06
TO 3H1-18-2

Training Equipment
54H60 Propeller Control Assembly (5)

Training Methods
Discussion/Demonstration (1 hr)
Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Use a partially disassembled control to teach the nomenclature and operating principles of the propeller and controls. Explain all operations of the control assembly using each hydraulic flow chart for an onspeed, underspeed, reverse, and feather condition. Have the students trace the diagrams. Use TO 3HA2-7-3 to show constructional features of the test equipment. Instructor references: TOs 1C-130B-2-11, 3HA2-7-3, and 3HA2-7-4.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
11. Valve Housing Maintenance and Adjustment	4

a. Using TO 1C-130B-211, locate procedures, torque limits, safety practices, FOD prevention, and special tools pertaining to valve housing maintenance and adjustment without error. STS: 4b, 21g Meas: W, P

b. With student assistance, remove and install the valve housing on a 54H60 propeller IAW TO 1C-130B-2-11. STS: 21g Meas: P

c. Working as a group, perform the operational checks and adjustments on a 54H60 propeller IAW TO 1C-130B-2-11. Must perform at least two adjustments without instructor assistance. STS: 19f, 20i, 20j Meas: P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-311, Valve Housing Maintenance and Adjustments
3ABR42633-WB-311, Valve Housing Maintenance and Adjustments
TO 1C-130B-2-11

Training Equipment
Trainer, Propeller Change (6)
54H60 Control Assembly (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (1.5 hrs)
Performance (2.5 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Students will remove and install the valve housing on the propeller. Using the propeller change trainer, check the 86 degree switch, feather valve switch, and its check switch.

MIR: Two instructors are required for 2.5 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Propeller Maintenance

1. COURSE CONTENT	2. TIME
12. Prepare Propeller/Propeller Units for Return to Supply a. Without reference, state the procedures for preparing propellers/propeller units for return to supply without error. STS: 20k Meas: W	5 (0/5)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-312, Prepare Propellers/Propeller Units for Return to Supply

Training Methods
SIT Assignment (5 hrs)

Instructional Guidance
This SIT assignment is to be passed out to the students on day 6 and completed on day 10.

13.	Military Training	5
	a. Physical Conditioning	(4)
	b. Commander's Call	(1)
14.	Written Test and Critique	2

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine Repair

1. COURSE CONTENT	2. TIME
1. Disassembly, Inspection, and Reassembly of Turbine and Combustion Section	56 (48/8)
a. Without reference, explain the constructional features and operating principles of the turbine and combustion sections of the T56 engine without error. STS: 11a Meas: W	(0/8)
b. Using TO 2J-T56-26, locate procedures, torque limits, safety procedures, AGE data, and FOD prevention procedures pertaining to disassembly, inspection, and reassembly of turbine and combustion sections of a T56 engine without error. STS: 13a Meas: W, P	(9)
c. Using TO 1C-130B-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-4, determine documentation procedures for AFTO Forms 349 and 350 and complete AFTO Forms 349 and 350 pertaining to in-shop engine maintenance without error. STS: 4b, 8c, 13b Meas: W, P	(3)
d. Using TO 2J-T56-26, with student assistance, remove, disassemble, inspect, reassemble, and install the turbine and combustion sections of a T56 engine and repair engine parts as required IAW applicable technical order. STS: 13b, 13c, 13d(1), 13d(3), 13d(4), 13d(5), 13d(6), 13d(8), 13d(9), 13d(10), 13d(11), 13e Meas: P	(36)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SW-401/402, T56 Constructional Features
3ABR42633-WB-401, Disassembly, Inspection, and Reassembly of Turbine and Combustion Section
TO 1C-130A-06, Aircraft Work Unit Code Manual
TO 00-20-2-4, Maintenance Documentation for In-Shop Engine Maintenance
TO 2J-T56-26, Field Maintenance

Training Equipment
T56-A-7 Engine (6)
Borescope (15)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (12 hrs)
Performance (36 hrs)
SIT Assignment (8 hrs)

Multiple Instructor Requirements
Equipment, Supervision, Safety (2)

Instructional Guidance
Explain fully the procedures in TO 2J-T56-26 for disassembly, inspection, and reassembly of the turbine and combustion sections. Explain TO 1C-130B-06 and TO 00-20-2-4 as they pertain to filling out AFTO Forms 349 and 350 for in-shop engine maintenance. The student will complete SIT assignment in PT-401/402 during the last 2 hours of days 1, 2, 3, 4, 6, 7, 8, and 9. Make the SIT assignments clear and understandable. Inform the students that they will be evaluated on all SIT assignments throughout Block IV. This satisfies the SIT requirement for objectives 1a and 2a. Stress management of defense energy resources and materials conservation throughout Block IV. Stress safety throughout Block IV.

MIR: Two instructors are required for 36 hours of student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine Repair

1. COURSE CONTENT	2. TIME
2. Removal and Installation of Reduction Gearbox Assembly and Disassembly, Inspection and Reassembly of Torquemeter	18 (10/8)
a. Without reference, explain the constructional features and operating principles of the reduction gearbox and torquemeter assembly without error. STS: 11b(11), 11b(12) Meas: W	(0/8)
b. Using TO 2J-T56-26, locate procedures, torque limits, safety procedures, AGE data, and FOD prevention procedures pertaining to reduction gearbox removal and installation and disassembly, inspection and reassembly of torquemeter without error. STS: 4b, 13a Meas: W	(3)
c. Using TO 2J-T56-26, with student assistance, remove a reduction gearbox from a T56 engine IAW applicable technical orders. STS: 13b, 13c, 13d(12) Meas: P	(1)
d. Using TO 2J-T56-26, with student assistance, remove, disassemble, inspect, reassemble, and install the torquemeter assembly on a T56 engine IAW applicable technical orders. STS: 13b, 13c, 13d(13) Meas: P	(4)
e. Using TO 2J-T56-26, with student assistance, install a reduction gearbox on a T56 engine IAW applicable technical orders. STS: 13b, 13c, 13d(12) Meas: P	(2)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SW-401/402
3ABR42633-WB-402, Removal and Installation of Reduction Gearbox Assembly and Disassembly, Inspection, and Reassembly of Torquemeter
TO 2J-T56-26

Training Equipment
T56-A-7 Engine (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (3 hrs)
Performance (7 hrs)
SIT Assignment (8 hrs)

Multiple Instructor Requirements
Equipment, Supervision, Safety (2)

Instructional Guidance
Explain fully the procedures in TO 2J-T56-26 for the removal and installation of reduction gearbox assembly and disassembly inspection and reassembly of the torquemeter.

MIR: Two instructors are required for 7 hours of student performance.

3.	Military Training	4
	a. Physical Conditioning	(4)
4.	Written Test and Critique	2

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine Change, Inspection, Buildup, and Rigging

1. COURSE CONTENT	2. TIME
1. Engine Buildup and Teardown	10
a. Without reference, define terms relevant to engine buildup and teardown, determine technical publications applicable to B-1 and B-2 accessories, use TO 2J-1-24 to identify B-1 accessories and identify the purpose and procedures for block testing the engine after buildup is complete without error. STS: 16a Meas: W	(1)
b. Using TO 1C-130B-10, identify introductory information, B-2 accessories installation instructions, safety procedures, FOD prevention, and locate part numbers for selected B-2 accessories without error. STS: 4b, 14b Meas: W, P	(2)
c. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, support general, and work unit codes applicable to equipment buildup and teardown; using TO 00-20-2-4, locate instructions pertaining to entries required on AFTO Forms 349 and 350 for in-shop maintenance; using TOs 00-20-2-4, 1C-130A-06, and 1C-130B-10, complete AFTO Forms 349 and/or 350 for engine buildup and teardown without error. STS: 4b, 8c Meas: W, P	(1)
d. Using a T56 engine and proper technical orders, with student assistance, teardown, inspect, document, and install selected B-2 accessories and hardware with proper torque, safety procedures, and FOD prevention IAW applicable technical orders. STS: 4b, 10a, 10b, 10d, 13d(2), 13d(7), 14b Meas: P	(6)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-501, Engine Buildup and Teardown
3ABR42633-WB-501, Engine Buildup and Teardown
TO 00-20-2-4, Maintenance Documentation for In-Shop Engine Maintenance
TO 1C-130A-06, Work Unit Code Manual
TO 1C-130B-10, Buildup Instructions - Aircraft Power Package
TO 2J-1-24, Equipment Comprising A Complete Basic Gas Turbine Engine

Training Equipment
T56-A-7 Engine (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (4 hrs)
Performance (6 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
The first 4 hours of engine buildup are classroom and the last 6 hours are lab time. Have the student complete SIT assignment PT-504, Engine and Propeller Rigging, the last 2 hours of day 1 and 2, and the last hour of day 3. Make SIT assignments clear and understandable. Inform the students that they will be evaluated on all SIT assignments in Block V. This satisfies the SIT requirement for objective 4a. Stress management of defense energy resources and materials conservation throughout Block . Stress safety throughout Block V.

MIR: Two instructors are required for 6 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine Change, Inspection, Buildup, and Rigging

1. COURSE CONTENT	2. TIME
2. Engine and Propeller Inspection	8

a. Using TO 00-20-1, explain information pertaining to the methods of inspection and maintenance, planned inspection and maintenance concept, description, and maintenance of inspection work cards without error. STS: 8b Meas: W

b. Using TO 00-20-5, locate information pertaining to the basic inspection concepts, description of scheduled inspections, and materiel deficiency reporting systems without error. STS: 8d Meas: W

c. Using TO 00-20-5, locate information pertaining to filling out AFTO Forms 44, 95, and 781 series without error. STS: 10e(1), 10e(2) Meas: W

d. Using TO 1C-130A-6WC-15, identify additional TOs and personnel needed to complete an inspection, list safety practices, accident prevention and FOD precautions, maintenance procedures, work areas, card time and item time, work unit codes, and how malfunctioned codes for selected work card items without error. STS: 8b Meas: W

e. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, support general, and work unit codes applicable to scheduled and special inspections; using TO 00-20-2-2, locate instructions pertaining to entries required on AFTO Forms 349 and 350 for on-equipment maintenance; using TOs 00-20-2-2 and 1C-130A-06, complete AFTO Forms 349 and/or 350 for a major inspection without error. STS: 4b, 8c Meas: W, P

f. With student assistance, perform an inspection on the T56 engine and propeller assemblies IAW applicable technical orders. Must find at least two discrepancies and make the appropriate entries on the AFTO Form 781A. STS: 8e, 12a, 20m Meas: P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-502, Engine and Propeller Inspection
3ABR42633-WB-502, Engine and Propeller Inspection
00-20 Series Technical Orders
TO 1C-130A-6WC-15, Aircraft Inspection Work Cards
TO 1C-130B-2-4, Maintenance Instructions - Power Plant
TO 1C-130B-2-11, Maintenance Instructions - Propeller

Audio Visual Aids
Selected Training Charts, AFTO Forms 349 and 350

Training Equipment
T56 Engine and Nacelle (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (5 hrs)
Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Explain the Dock and Inplace methods of inspection in TO 00-20-1 and what type of inspections are included under each. Explain the concepts of inspection in TO 00-20-5 and explain that the C-130 aircraft is under the Isochronal concept. When working in the lab, pass out selected tasks from the inspection work cards for the students to perform.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine Change, Inspection, Buildup, and Rigging

1. COURSE CONTENT	2. TIME
3. Engine Removal and Installation	12
a. Using TO 1C-130B-2-4, locate procedures, torque limits, safety procedures, AGE data, and FOD prevention procedures pertaining to aircraft engine removal and installation without error. STS: 4b, 14a Meas: W, P	(3)
b. Using TO 1C-130A-06, locate information in the preface, locate type maintenance, action taken, when discovered, how malfunctioned, and work unit codes; using TO 00-20-2-2, determine documentation procedures for AFTO Forms 349 and 350 pertaining to C-130 engine removal and installation without error. STS: 4b, 8c Meas: P	(3)
c. Using TO 1C-130B-2-4, with student assistance, remove and install a T56 engine on a C-130 engine pad, perform all maintenance, safety procedures, FOD prevention, and torque IAW applicable technical orders. STS: 10b, 14a, 22a(1), 22a(3) Meas: P	(5)
d. Without reference, correctly name simple facts pertaining to the performance of user maintenance of engine removal and transportation trailers. STS: 14d Meas: W	(1)

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SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-503, Engine Removal and Installation
3ABR42633-WB-503, Engine Removal and Installation
TO 00-20-2-2, On-Equipment Maintenance
TO 1C-130A-06
TO 1C-130B-2-4

Audio Visual Aids
Selected Training Charts, AFTO Forms 349 and 350

Training Equipment
T56 Engine and Nacelle (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (6 hrs)
Performance (6 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
The first day of engine removal and installation is classroom work, the second day is lab work.

MIR: Two instructors are required for 6 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine Change, Inspection, Buildup, and Rigging

1. COURSE CONTENT	2. TIME
4. Engine and Propeller Rigging	9
a. Without reference, explain the purpose, procedure, and tasks involved in rigging the propeller and engine without error. STS: 14c, 21h Meas: W	(4/5) (0/5)
b. Using TO 1C-130B-2-4, locate procedures for rigging the engine controls without error. STS: 14c Meas: W	(.5)
c. Using TO 1C-130B-2-11, locate procedures for rigging the propeller controls without error. STS: 21h Meas: W	(.5)
d. With student assistance, rig the engine and propeller control system IAW applicable technical orders. STS: 9b, 14c, 21h Meas: P	(3)

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-504, Engine and Propeller Rigging
3ABR42633-WB-504, Engine and Propeller Rigging
TO 1C-130B-2-4
TO 1C-130B-2-11

Training Equipment
T56 Engine and Nacelle (6)
Handtools and Special Tools (6)

Training Methods
Discussion/Demonstration (1 hr)
Performance (3 hrs)
SIT Assignment (5 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Explain the procedures in TOs 1C-130B-2-4 and 1C-130B-2-11 for engine and propeller rigging and insure the students can follow the procedures when working in the lab.

MIR: Two instructors are required for 3 hours during student performance.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Turboprop Propulsion Mechanic

BLOCK TITLE
Engine Change, Inspection, Buildup, and Rigging

1. COURSE CONTENT	2. TIME
5. Synchrophaser Theory, Operation, and Inspection	4

a. Using TO 3HA7-3-2, correctly explain synchrophaser theory and operation. STS: 21i Meas: W

b. Using a block diagram, trace the operation of the synchrophaser system. Must correctly trace seven of ten circuits listed. STS: 10c, 19b Meas: P

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COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
3ABR42633-SG-505, Synchrophaser Theory and Operation
3ABR42633-WB-505, Synchrophaser Theory and Operation
TO 3HA7-3-2, Field Maintenance - Aircraft Propeller Synchrophaser

Training Methods
Discussion/Demonstration (1 hr)
Performance (3 hrs)

Multiple Instructor Requirements
Safety, Equipment, Facilities (2)

Instructional Guidance
Explain to the students that before the synchrophaser is removed, the circuit breakers to the synchrophaser must be pulled. Explain the procedures for connecting the synchrophaser to the tester. Instructor reference - TO 1C-130B-2-11.

MIR: Two instructors are required for 3 hours during student performance.

6.	Military Training	9
	a. Physical Conditioning	(3)
	b. Commander's Call	(1)
	c. End-of-Course Appointments	(5)
7.	Measurement Test and Critique	2
8.	Course Critique and Graduation	2

STUDY GUIDE
3ABR31630T-SG-703
3ABR31632T-SG-703
3ABR42632-SG-101

Technical Training

Missile Systems Analyst Specialist (AGM-69A)
Missile Electronic Equipment Specialist (AGM-69A)
Jet Engine Mechanics

GROUND SAFETY PRACTICES

30 November 1976

USAF SCHOOL OF APPLIED AEROSPACE SCIENCES
3360th Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

GROUND SAFETY PRACTICES

OBJECTIVE

When you have completed this study guide you will be able to point out safety hazards and outline safety practices to observe in the shop, hangar and on the flight line.

INTRODUCTION

STOP! LOOK! LISTEN!

Your life is at stake. More than that, the lives of everybody with whom you come in contact are at stake. You are a potential H-bomb, waiting to explode. Your actions determine our future -- both yours and mine. It makes sense then, that safety is everybody's business. If your carelessness affects me, then your actions are my business -- enough my business for me to write about it. And it's your business to read about it and then do something about it.

Safety engineers have studied the records of large companies over a long period of time. They find startling facts hidden in the statistics. A relatively small number of people have the majority of accidents. If the records of these few people could be set aside, the accident rate would be mighty low.

Since it has been proven that some people are "accident prones," it follows that accidents have a direct relationship to our habits -- to our thinking -- and our actions. Let's investigate this angle a little more.

INFORMATION

Many of our normal activities during each day are filled with accidents waiting to happen. Most accidents can be prevented if we plan our habits and routines with safety in mind. So let's see what we individually can do to live a longer and less painful life. Perhaps the best place to start this study of safety is with housekeeping habits.

GOOD HOUSEKEEPING IS THE FIRST LAW OF ACCIDENT PREVENTION

Some people are recognized for their neatness. Everything they have is tidy. Everything they do is neat and orderly. Neatness is a part of them. On the other hand, some of us constantly look like we slept in our uniforms, like we were miles from the nearest barber, like our work area is an auto cemetery. How we appear to others and how we do things reflects our inner

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personalities. We have standards which are the result of our home environment. We carry such standards into every phase of life. All of our actions reflect our upbringing. Standards are adjustable -- they can be learned. In fact, that's just what we are attempting to do in this course you are taking -- teach you the acceptable standards for maintenance. Remember, lives will be in your hands.

PLAN YOUR WORK WITH SAFETY IN MIND

Before you start the job -- any job -- think it over. Ask yourself some questions about it. Lots of people talk to themselves nowadays. What am I trying to accomplish? How far do I tear the unit down? Where will I place my tools? Cleaning fluid? Parts? Do I have the right Technical Order for this model? What precautions are to be exercised in doing the job? What are the possibilities of fire? Explosion? Breakage of parts? Loss of parts? What can I do about these possibilities? Where is the nearest fire extinguisher? How do I use it? Where is the nearest exit? Alternate exit? Telephone? What number do I call? Where is the nearest power line? Air? Vacuum? These are but a few of the things we should ask ourselves before attempting to do a job. Many people, before spending the night in a hotel or a motel, hold a "mental fire drill" -- they carefully investigate all methods of escape to be ready, should they be startled by the cry of "FIRE" during the night. An alternative plan is often necessary. Before starting an aircraft repair job, we should hold such a conference with ourselves.

Good housekeeping must be carried through to the final clean-up. Some units you will disassemble will have small parts that can be easily lost, broken or mixed with other parts. Have "a place for everything and everything in its place." Since good housekeeping is so vitally important to safety, it is the concern of everyone -- you, your supervisor and your fellow workers. Keep the floor and area clean. Old parts should be promptly disposed of -- and not on the bench or floor. Thousands of fatal accidents have been caused by people tripping on rubbish, debris and needless materials. Place waste and trash in suitable containers. Put all items away that are not immediately connected with the job you are doing. If oil is spilled, clean it up immediately. Alert people for special hazards -- sharp corners, bolts, etc. Every shop should have a place for storing tool boxes when they are not in immediate use. Keep them in this place with the lid closed. Lots of shins have been painfully bruised through such carelessness. The Air Force attempts to warn people of special danger areas by painting propeller tips yellow, painting a red line on the fuselage at the place the propeller rotates, by warning signs in the area of danger, etc. Still, some people refuse to believe and heed. Good housekeeping has another effect on us. By keeping our work area clear, morale goes up because tools no longer get lost, equipment no longer damaged. As a result, the amount and quality of work increases and the accident rate goes down.

FIRE

Closely allied with good housekeeping, fire prevention is a requirement of safety. The best fire prevention system yet found is good housekeeping. Here are a few precautions that will cut down the fire loss in your place of work. Perhaps you can add a few to the list.

1. Don't allow oily rags to accumulate in open piles.

2. "NO SMOKING" signs are placed by regulations. They mean it is illegal to smoke.

3. If your clothing becomes saturated with fuel or oil, take them off as soon as possible. Fuel and oil cause irritation to the skin which is painful. Besides, you may get the urge to light up a cigarette.

4. NEVER store inflammables in open containers.

5. Make certain static lines are firmly grounded before working on the aircraft.

6. Use ash trays. NEVER toss cigarette butts or matches into a wastebasket.

Since we all have moments of carelessness, fires may result. If a fire should start in your area, it is up to you to act -- fast and correctly.

1. Know the telephone number of the base fire department -- from memory. At least know where you can find the number quickly. Call the fire department first.

2. Know where the nearest fire extinguisher is and how to use it. Once a fire starts, you won't have time for reading and interpreting the fine print on how to use it.

3. If alarm boxes are installed on your base, learn where the close ones are and how to use them.

4. Yell "FIRE" to warn others in the area and summon help.

If, in spite of all your precautions, a fire starts anyway, you must know how to stop it. Some fires can be more readily extinguished by one type of extinguisher than by others. Table I may be of some help.

Other rules for fire prevention include:

1. Don't smoke within 50 feet of a hangar, parked aircraft or place where inflammable material is stored.

Type	Vaporizing Liquid	Soda Acid	Foam	CO_2	Water	Dry Powder
Sizes	1 Qt to 20 Gal	2-1/2 Gal	2-1/2 Gal	2 to 100 lbs	2-1/2, 4, 5, gallons	2-1/2 to 30 lbs
Operation	Squeeze handle	Invert	Invert	Open valve	Pump air pressure	Squeeze handle
Conductor of Electricity	No	Yes	Yes	No	Yes	No
Range	Approximately 20 - 40 feet	Approx 30 feet	Approx 30 feet	Approx 8 feet	Approx 30 to 40 ft	Approx 6 to 8 ft
Time Required To Empty	Varies	Approx 1minute	Approx 1 minute	Approx 1 minute	1/2 to 2-1/2 Min	Approx 1 minute
Chemicals Used	CBM CB	Bicarb of soda sulphuric acid	Alum sulphate - bicarbonate of soda foaming agent	Liquid CO_2	Water	Chemically processed dry powder. Dry chemical has bicarbonate of soda
Need of Freezing Protection	No	Use in heated bldgs	Use in heated bldgs	When used below 0 F	Yes	No
Extinguishing Effect	Smothering cooling	Quenching cooling	Blanketing cooling	Smothering by cooling	Quenching cooling	Blanketing smothering
Use on burning wood & paper	Poor	Excellent	Fair	Poor	Excellent	Poor
Use on burning petroleum	Fair	Poor	Excellent	Good	Poor - should not be used	Excellent
Use on burning electrical equipment	Excellent	Poor - should not be used	Poor - should not be used	Excellent	Poor - should not be used	Good

Figure 1. Fire Extinguisher Characteristics.

2. Make certain all aircraft are grounded before working on them.

3. Don't drain fuel sumps in a hangar.

4. Use nonsparking tools whenever possible.

HANGAR HAZARDS

Accidents Don't Just Happen -- They're Caused

All accidents taking place on an Air Force Base or involving government owned equipment are thoroughly investigated. The cause is determined and remedies are planned to make certain that these accidents do not happen again. Studies of ground safety records clearly show the fundamental causes of accidents. They include:

Lack of Knowledge or Skill

Sometimes personnel think they can do the job, but they fail to understand that the equipment has slight modification from the model they worked on previously. Misunderstanding is costly. It is the job of the supervisor to make certain the mechanic knows the who, what and where of a job before sending him to do it. Misinformation, inexperience, not being convinced, lack of information; any of these are dangerous. Mighty dangerous. There is only one known method of combating these dangers - education. That's why you are in technical school now.

Always use the Technical Order procedure. Become acquainted with the Technical Order system, know it and use it. Technical Orders are your only assurance of doing the job correctly. Don't attempt to perform maintenance until you've read all about how to do it in the Technical Order. Aircraft mistakes are costly.

Here's a case that happened a few years back: Three airmen were assigned to dismount, mount and inflate aircraft tires. One man was in the process of inflating the first tire that had been remounted on a wheel rim when he noticed two nitrogen bottles nearby. He asked the other airmen if the bottles could be used for inflating tires and after some discussion, it was decided to "try" them. The filler hose on the nitrogen bottle was connected to a high pressure gauge which was attached to the valve stem on the tire. When approximately 200 psi was indicated on the delivery pressure gauge, one airman reached to remove the filler line and the explosion occurred. One airman lost his right hand and fractured his right arm. Another was struck on the head by the wheel flange and injured his ear drum. All three airmen went into shock. Causes were determined to be:

1. Not following the Technical Order procedure for inflating tires.

2. Lack of knowledge and experience.

3. Inadequate supervision.

4. Probable wheel rim failure since 200 psi is considered within the safe limits for inflation of the tire.

5. Failure to use a suitable wheel guard while inflating the tire (as prescribed by the Technical Order). Although this would not have prevented the accident, serious injuries could have been averted if the guard had been used.

This is but one of many examples of what happens when people attempt maintenance while lacking knowledge or skill.

Improper Attitude

Ground and flying safety reports are filled with accidents that have little reason for happening other than improper attitude. Improper attitude may be seen in any of its forms - laziness, recklessness, uncooperativeness, egoism, impatience, absent mindedness, excitability, intolerance - just mentally unsuited in general. One man with a bad attitude can (and usually will, if given the chance) do more harm than good. You've seen the type; everything he touches gets ruined. We all have days like that. Keep that kind of a man away from all equipment. Let's make doubly sure that man isn't you.

SHOP HAZARDS

Shop safety begins with shop layout. If your shop is set up properly, safety is built in. Plan the shop to save steps wherever possible. Records show that the less a man moves from his work area, the fewer the accidents. Shop accidents have resulted from tripping over pipe and tubing, from a soldering iron, torch, etc. A west coast base reports an accident as follows: The base electrical shop had a locally made conduit rack on one end which was constructed of angle iron. A civilian aircraft mechanic was selecting a piece of stock from the top shelf when a shelf brace broke loose from one end of the rack and dropped conduits of varying sizes on the man, splintering his foot, leg and knee. The accident causes were listed as:

1. Poor welding job on the rack.

2. Failure of the electrical shop to maintain an orderly rack. It was found that conduits of all sizes were on the top shelf. An orderly rack would have the heavy conduits on lower shelves and lighter conduits on top shelves.

Other dangers of shops include unintentionally hitting others with long objects - lumber, tubing, cable, etc, using improperly guarded machines, tripping over things on the floor and improper lifting.

Accident files are filled with cases. At an eastern base, one man had his eye put out by a cable. He was busy at his work area about eight feet from a man splicing a cable, when suddenly the cable snapped into his eye. Investigation showed that the man splicing the cable had a disorderly desk. As he turned the cable, it caught on some tools cluttering his work area. As he pulled on the cable, it sprang free and into the face of the injured man. Causes of the accident were listed as:

1. A cluttered work area.

2. Disregard for the safety of fellow employees while pulling the cable free.

3. Leaving the cable uncoiled while working.

A well planned shop will have the floors and aisles clean and uncluttered. Work areas should be self-supporting with individual electrical, air and vacuum lines overhead. Necessary tools and equipment should be included in the work area.

Grinders are a source of many eye accidents. By regulation, GOGGLES MUST BE WORN when grinding. Yet, some people still insist on grinding without them. It just isn't worth taking the chance in view of the injuries that may result.

Catch-all cabinets are booby traps. An overseas base reports an injury caused by opening a cabinet door. The cabinet was used to store spare parts (that's what a supply room is for) for aircraft engines. Upon opening the door, a part rolled off the shelf and onto the foot of the airman who opened the door. A painfully broken toe resulted.

A few ideas which can save you grief are:

1. Horseplay has no business in productive work areas. Many men have needlessly suffered and died because somebody else "needed" a laugh.

2. Keep fuels away from the shop. Fires are costly. Do your cleaning outside in the open air.

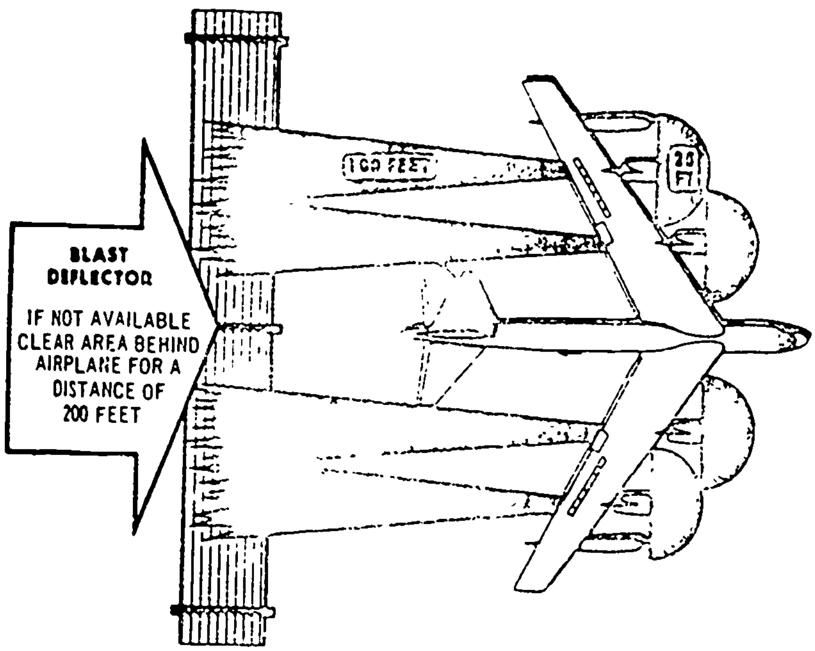
3. Keep tools and equipment orderly and clean.

4. Use safety equipment where recommended. Remember "Safety First."

FLIGHT LINE HAZARDS.

The history books of the Air Force relate gory tales concerning carelessness on and around the flight line. If you ever saw a man walk into a turning propeller, you'd be extra cautious around a flight line. Yet, this has happened many times in the past and people are still walking into them.

Just as dangerous and with equally fatal results, is walking near the intake area or exhaust area of jet engines. A few years ago, a student at Chanute was drawn into the intake duct as he tried to pass in front of an operating aircraft. Though quick thinking on the part of the instructor saved his life (the engine was shut down), but the airman was never the sam again. Stay clear of the area in front of the jet. The exhaust end of a jet is just as bad, only here the danger is from the hot gases which are expelled from the tailpipe



BLAST EFFECT

DISTANCE FEET	TEMPERATURE °F	VELOCITY KNOTS
25	350	415
50	225	210
75	150	105
100	100	45

NOTE
Turbine disintegration danger areas exist to the aft of engines in the blast area. Possibility of disintegration toward the side is remote.

Figure 1. Jet Engine Danger Areas.

There have been a few cases where the turbine wheel has disintegrated in operation. Should this happen with you standing in the plane of rotation, you would be cut to pieces by flying parts traveling far above the muzzle velocity of a rifle. For this reason, stand fore or aft of the plane of rotation when the engine is being run on the ground. Since daily inspections must be made of the wheel, necessitating that someone crawl up the tailpipe, assure yourself that someone else is in the cockpit to prevent the engine from being started.

Before even going near the engine, make certain that all switches are off. The chocks should be in place and the parking brakes on. Put someone in the cockpit who is qualified. Above all, don't put some "hangar pilot" in charge and rely on his judgment.

When starting aircraft engines, be certain that a qualified person is standing by with fire extinguishers which are ready for use - and which are of the correct type. No other person than the fireguard should stand under the wing or in front of the aircraft. Place the fireguard near the wing tip and to the rear, so that he has a full view of the exhaust cone and yet may be seen by the man in the cockpit.

If fire starts, the man in the cockpit should immediately:

1. Pull the throttle back to the "OFF" position, or close the stop cock if one is available.

2. Turn all the tank selector switches to "OFF."

3. Turn off the emergency fuel system.

4. Release the starter switch.

5. Turn off the battery switch.

SERVICING

Fuel

Fire is the primary hazard of servicing aircraft with fuel. Grounding prevents static charges from building up between units and ground and then sparking. Sparks are especially dangerous during fueling operations; soooooo GROUND THAT AIRCRAFT. Other troubles can develop during refueling though. For instance ---------

An F-86H aircraft was conveniently located on the ramp near the single point fuel servicing unit and the hose nozzle was inserted in the single point refueling receptacle. The ground servicing equipment was started and the refueling nozzle turned on. While refueling, a leak was discovered at the rear of the aircraft so the operator went to the left aft tank to determine the cause. As he removed the cover, the fuel tank cap blew off and jet fuel spurted from the filler pipe and struck the airman about the face and left ear. As a result the airman received burns on the face and the left ear was deafened.

Cause: 1. Failure to secure the fuel tank caps at the conclusion of the previous refueling.

2. Failure to check the caps before refueling.

108 Oxygen

Modern aircraft have liquid oxygen systems which present all the hazards of low pressure systems plus many more. Let's look at some of the precautions necessary when working around oxygen.

1. Keep all oxygen lines, fittings, clothes and equipment free from grease and oil. A combination of oil and oxygen creates fires.

2. Don't open an oxygen valve in the presence of fire. It's like adding gasoline.

3. Before removing any unit on the oxygen system, drain the system by opening the emergency knob on all regulators.

4. Use protective clothing when handling liquid oxygen. These items consist of rubber impregnated gloves and apron and a plastic face shield. Wearing them properly will prevent oxygen "burns" if the lines should rupture.

During World War II, a B-17, at a transition base in Ohio, was preparing for a high altitude flight. After taxiing to approximately 300 feet from the runway, the aircraft took its place at the end of the runway for a final check, when suddenly a blast blew the aircraft completely open from the nose section to the waist gun section and killed five crewmen. Investigation disclosed that the oxygen system of the aircraft had been charged with a mixture of hydrogen and oxygen. The tanks used to fill the aircraft had been of all colors and sizes. The service crew had used one red tank and one orange tank to make up their cart. The fitting on the red tank would not screw in, so the airmen cross threaded the fittings so as to connect them to the filler line. It is presumed that one of the crewmembers wanted to smoke while preflighting the oxygen system before take-off.

COCKPIT HAZARDS

In modern aircraft, the cockpit, like a cannon, is deadly in the hands of the inexperienced. Modern cockpits control explosive wing tip tanks, canopies, seats, and radar equipment. In addition to all that, it contains other killers such as landing gear controls and flap controls.

A B-47, on which some maintenance had been performed during an inspection, was being prepared for towing from a hangar. The aircraft canopy over the pilot's compartment was open and an A/1C was in the pilot's seat. External power had been left connected to the aircraft by a previous crew which had checked flaps and ailerons. The A/1C in the cockpit rose and talked with the mechanic on the floor, asking him for clearance to raise the flaps. After giving an OK, the airman on the floor walked toward the right rear wing to check the flaps. Observing no flap movement, he glanced to the cockpit and saw the A/1C wedged between the canopy and the windshield. The control lever had been accidently actuated, permitting the canopy to slam forward and crush the A/1C's neck. The medic was called but the airman was dead.

Causes: 1. The A/1C actuated the canopy control lever instead of the wing flap control lever.

2. Failure to lock the canopy in the open position with safety locks.

A base in the midwest had an F-104A, not assigned to that base, stop in for minor maintenance. The maintenance required removal of the ejection seat. Four men were working on the project -- two at the cockpit and two on the ground, to receive it when it dropped. The men at this base had removed ejection seats on several F-104's recently and it had been a while since any of them had read a Technical Order on seat removal. One of the men disconnected the ejection release, but didn't realize that this seat was different -- that it had a second ejection release. In preparing to drop the seat, it ejected, killing one man and cutting the legs off another.

Cause: Failure to keep abreast of Technical Order changes.

An extremely dangerous situation has developed recently in the USAF. Since maintenance men are required to crawl in and out of the cockpit in the performance of their duties, they recognize the consequences of accidently discharging the seat ejection mechanism, tip tanks, etc. As a result, they often disconnect the ejection system as a safety measure. That is fine. However, they must MAKE CERTAIN THE SEAT EJECTION SYSTEM IS RECONNECTED before signing off the maintenance.

On a recent inspection of transient F-104 aircraft, Wright-Patterson AFB discovered that, of 21 aircraft checked, 18 were found with the seat ejection system disconnected. Eighteen of twenty-one pilots had flown the aircraft from which, if necessary, it would have been impossible to eject. No one knows how many pilots have been killed because some careless maintenance man forgot to connect the seat ejection system.

Here are a few simple but effective rules to follow to make certain that cockpit accidents won't happen to you.

1. Once assigned to a base, learn the cockpit details of all aircraft on which you will be working. Know these details so well that you know exactly what each unit or lever does and how it does it, as well as being able to recognize non-standard equipment.

2. NEVER PULL A HANDLE OR FLIP A SWITCH if you are not certain of the results.

3. USE CAUTION when working in and around a cockpit so that you do not accidently lean against or brush against any handles, switches, or levers.

RADIATION.

Atomic

Modern aircraft and their crews are in the business of transporting atomic weapons to targets. As a result, they can easily become contaminated with radioactive dust. With this in mind, let's look at how contaminated aircraft are handled.

When aircraft, suspected of being contaminated, land, they are immediately sent to the "hot ramp" where they are placarded with the radiation warning placard, AFTO Form 9. A radiological medical service officer checks the aircraft daily to determine when it is safe to move it to the wash racks where it is scrubbed, rechecked and if necessary, scrubbed again until decontaminated.

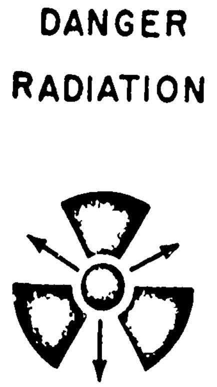


Figure 2. Radiation Symbol.

Personnel working in the vicinity of contaminated equipment will either carry a dosimeter in their pocket (which records the intensity) or a film badge (which records the amount of accumulated radiation). Exposure to small amounts over a period of time is as dangerous as a large dose.

Early effects of an over-amount of radiation include nausea, vomiting and a general run-down feeling. Should anyone suffer from these symptoms, he should see the medics immediately.

Electromagnetic

Since aircraft first began carrying electronic equipment -- radar, ECM, etc -- scientists have studied the effects of the transmitted signals on the human body. Until recently it was never a problem. However, modern equipment has increased the hazards. It is now recognized that two types of radiation result from operating high frequency electronic equipment -- X-rays and electromagnetic radiation.

X-rays are not recognized as being a great hazard because units are shielded in such a way as to hold the X-rays inside the shielding.

Electromagnetic radiation which comes from the antenna is the result of the frequency of the waves. The shorter the wave length and the higher the frequency, the greater the danger. These waves are dangerous because they burn the body beneath the skin. They may or may not cause a burning feeling before harm is done, depending on the parts of the body burned and the intensity of the radiation.

The danger to the human body from microwave radiation should not be under-emphasized. Cataracts have grown over eyes as a result of it. Internal burns have resulted. It is obvious then, that all radiation must be considered hazardous.

The normal danger area is a 50 feet radius from the center of the antenna cone. In tests however, flash bulbs and steel wool have been ignited at distances up to 350 feet. The burning of these materials is possible because the materials making them up are heated to incandescence when excited by the microwave beam.

HIGH INTENSITY SOUND,

With the arrival of jet aircraft, a new problem came to the attention of Air Force medical people. Noise has long been a nuisance around air bases. The noise from aircraft engines has been so continuous that some former Air Force men have lost their hearing. All this has happened during the days of reciprocating engines.

Since jet engines have become standard equipment, the danger to hearing has increased. Sounds are getting louder and higher. As a result, they wear upon the nervous systems of those who must work around engines. Also, the hazard of high intensity sound is increased as the length of the exposure is increased -- the more of it you are exposed to, the greater the probability of damage to the ear. The Air Force recognizes this and issues earplugs and/or earmuffs to men who work in the vicinity of such noise. When these plugs or muffs are used, it is still possible to carry on a conversation with others in the general area of the run-up.

The plugs issued by the USAF are made of a spongy rubber-like material. When correctly fitted (there are several sizes) and properly inserted, adequate protection is given. Keep the ear muffs and plugs clean. Just wash them gently with a mild soap. The important thing to remember is that earplugs don't protect anything while in their container. Wearing them will save you much discomfort, both at the time and later in life.

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ELECTRICAL HAZARDS.

Nearly everyone is cautious with electricity. Few enjoy an unexpected shock, no matter how small. It is a common impression that death is caused by high voltage; some "experts" claim that few deaths occur below 220 volts. Yet statistics tell a different story. Over 700 people die every year from voltages in the 110-220 volt range. A surprising number are caused by 110 volts. Look at the facts from a medical standpoint. Voltage alone does not kill. The guy in the side show electric chair takes 30 to 40 thousand volts with very low current. Sparks an inch long jump from his tongue or his fingers. How much current flows through his body? Very little. Three factors decide whether electricity is lethal.

1. The quantity of current flowing through the body.

2. The path followed by the current through the body. Naturally, if a vital organ lies in the path the chance of escaping injury is small.

3. The time that the current flows through the body. Electrical nerve impulses flow through innumerable relays or junctions, called synapses. A synapse, like a fuse, can take a slight overload for only a short time without failure. This "grace" time is very brief. Exceeding this time is very dangerous.

The voltage/current combination required to bring death depends a lot upon a person's physical condition and surroundings. A few cases will bring out this point. In Chicago, records show how 65 volts brought death. The victim was intoxicated and lying in a bathtub into which he had knocked a heating element. Analyze his case.

1. Alcohol had lowered his electrical resistance appreciably.

2. The body was immersed in water, which is a conductor.

3. An autopsy showed "fatty heart," any shock would have been dangerous.

In Cleveland a janitor sprinkled the inside of a boiler with water to settle dust. Then he carried an electric cord and light inside to do a repair job. His wife found his body several hours later. Damp surroundings, poor equipment, good "connections." . . .

This incident happened in the Instrument Course at Chanute Air Force Base. A student picked up a "live" 220 volt connection and proceeded to pull it apart, meanwhile holding it at eye level. It arced and the student suffered flash burns, and lost his eyelashes. All this could have been avoided if he had only "cut the power" before attempting the job. Poor equipment was also involved. In this case, the weakeness was not apparent to the naked eye.

Again, at Chanute, a student working on a trainer attempted to perform maintenance without turning the system power off. Somehow, he got "hung up" on 25 volts AC and froze in his shoes through shock. His alert partner turned the equipment off, but wasn't quick enough to catch the student as he fainted. This rather trivial accident could also have been avoided by simply throwing the switch to the "OFF" position before the work was started.

One should be careful about rings, watch chains, wrist watches, identification bracelets, etc; some tragic things happen because of them. In one case a worker was severely burned by a wrist watch. He was working around high frequency current and the watch came in contact with the energized circuit.

Keep outside of barriers; learn the believe in signs. At one overseas base a radar set was being repaired while it was in operation. A large condenser carrying over 30,000 volts was carefully placed in a wooden chair beside the radar set. All entrances to the room were well posted "DO NOT ENTER-HIGH VOLTAGE." An unbeliever wandered into the area; he pushed the metal door open and knocked over the chair. The discharge from the condenser into the metal door resulted in his death.

GENERAL SAFETY HINTS.

There are a number of little hints that may help keep you out of a hospital. Here are some of them.

Keep wing nuts on engine stands firmly tightened. A sudden release of the brakes might allow the engine to swing free and ruin you. Keep all maintenance stands clean and in good repair.

Keep your tools in your tool box. Loose tools, when left on stands, have caused fatal falls. Equally important, keep your tool box where it is not in your way and won't fall on anyone.

Before revolving an engine on a workstand, look around. Make certain no one is close enough to be hurt.

Never clean magnesium with abrasive material, steel wool or the like. These are the elements used in making magnesium flares.

Never walk under an aircraft unannounced.

Use crew chief stands to climb on and off the wings. DON'T JUMP.

Severe hand cuts may result from removing fuel tank caps. Use the special tools which have been designed for this purpose.

During installation, droppable fuel tanks are raised almost to position before making final line connections. Be extremely careful to avoid strains in handling such an awkward weight. Avoid crawling under or placing parts of your body under filled wing tanks.

When pressure testing the cockpit, safety straps made of canvas webbing should be used to fasten the canopy to the fuselage to prevent damage in case of failure of the mechanism. Don't ever raise the interior pressure more than specified lest the canopy rupture.

Century series aircraft wings have razor-sharp edges. Just walking into the wing's leading edge may give you a cut, even through your clothing.

From all the accidents we've heard involving bomb bay doors, we'd better pass the word on to you. They have cut more than one body in two. Before you go into a bomb bay, MAKE CERTAIN THE LOCKS ARE IN.

Aircraft surfaces are exceedingly slippery. This is especially true when wet or when gasoline has been spilled on them. NEVER walk on an uncovered airfoil surface. It will be marred. Many sharp edges exist around aircraft - - flaps, landing gear fairings, doors, ailerons, elevators and tabs. Slip-on pads will eliminate a lot of such trouble.

Some ailerons are operated by the control stick through a hydraulic booster which adds to the force supplied by the pilot. The pilot supplies only one-fifth of the total force required to move the surface. Keep your hands out of the aileron space. Nothing can save you from a terrible mutilation if the ailerons move. Fingers have been crushed when cockpit jockeys have moved controls while mechanics fingers were on them.

The tailpipe is wrapped in many layers of insulating material to protect the aircraft structure from the excessive operating temperatures. Don't damage these layers or the plane may suffer structural failure.

Remove all jewelry from your arms and fingers. Mechanics have received severe finger lacerations when rings became entangled in the aircraft.

FORM SAFE HABITS.

Since it has been shown that safety is the result of habits, perhaps it is well to consider what we can do to formulate safe habits.

1. For one complete week, think thoroughly of the possible consequences of each and every thing you do - - action, remark, etc, - - what could happen if you smoke in bed - - what could happen if you didn't check to make certain the match was out before you threw it away while in the barracks - - what could happen if you tripped the guy marching ahead of you - - what could result from wrestling with another airman, even a smaller airman than yourself? - - what could happen if you jacked an aircraft on a gusty day? - - what could happen if you drove on the left lane of a highway? These are things we do everyday without thinking twice. They are the things, however, that cause accidents. Since throwing burned matches away is a routine, maybe we should take an inventory on how we throw this match away. Do we always check to make certain the match is out? Do we always check to see that it lands in a suitable fireproof container? Do we make certain that nothing inflammable is in the butt can?

If we'll project these and several other questions to the other routine tasks (habits) that make up living, we'll soon recognize that most of us are potential destroyers.

2. Make it a habit to read all the details about accidents that happen in our area - - both "on duty" and "off duty" accidents, paying particular attention to the situations leading up to the accidents and the gory details that make up the hospital records and the obituary columns. A state patrolman recently made this remark, "If you'd have seen the bloody mess, you'd wonder why anybody would ever drink, much less drive while drunk." People can learn from the mistakes of others. Take time out to consider the possible results of driving while drinking.

3. Make a mental check list regarding the safe way of doing things- - our jobs, walking and driving habits, attitudes toward those little things we do. Consider the safe way, then follow it. Speed and carelessness kill. You are held responsible for your actions.

WORKBOOK

3ABR42633-WB-102

Technical Training

Turboprop Propulsion Mechanic

SHOP AND FLIGHT LINE SAFETY

1 July 1981

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

Do Not Use on the Job.

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-102

SHOP AND FLIGHT LINE SAFETY

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Identify the purpose of the accident prevention program.

2. Identify health and noise hazards.

3. Identify shop and flight line safety practices.

4. Identify and state procedures for the prevention of foreign object damage.

EQUIPMENT

	Basis of Issue
3ABR42633-SG-102	1/student

PROCEDURE

Use the information presented in the classroom presentation and study guide. Fill in the spaces provided with the correct information.

Section 1. ACCIDENT PREVENTION

1. Accident Prevention Program.

a. The purpose of the accident prevention program is to:

(1) prevent personal ____________________ .

(2) prevent damage to ____________________ .

(3) save time and ____________________ .

b. The first rule of accident prevention is ________________

____________________________________.

c. The title of AFR 127-101 is ____________ ________________

________________ ________________________.

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d. Part of your education and training in the accident prevention program is carried out through safety _______ and __________.

e. Safety is the ____________ of everyone.

2. Health Hazards.

a. Inflammation of the skin could result as ______________ remove natural fats and oils from the skin.

b. Inhaling fuel vapors may cause serious _________________.

c. Swallowing fuels will result in ______________________ injury and possible death.

3. Noise Hazards.

a. Use ear ______________ or ear _____________ when working around or near operating jet engines.

b. Extreme noise potentials may:

(1) be dangerous to your _____________________________.

(2) interfere with _________________ communication.

(3) lead to fatigue which leads to maintenance _________ which leads to ____________________.

c. High frequency sound produced by operating jet engines is one form of noise pollution which could cause ___________ damage.

4. Shop Safety.

a. Remove all _____________ before starting to work.

b. The type of clothing worn on the job is determined by the nature of the __________________.

c. Keep _____________ clean and clear from obstruction at all times.

d. Drips and spills should be __________ up immediately with rags or a nonflammable ________________.

e. Maintain a _____________ work area.

f. When manually lifting an object, you should remember to use your _____________ and ________________ keeping your back straight.

g. Some things to remember about mechanical handling and lifting devices are:

(1) They are used on __________ or bulky loads.

(2) All operations should be ______________.

(3) They should only be operated by ______________ personnel.

(4) Become familiar with __________ precautions.

(5) They must be tested and __________ periodically.

(6) Do not exceed ____________ capacitites.

h. When using work stands, the safety __________ and safety ________ should be installed and the wheels ____________.

5. Foreign Object Damage (FOD).

a. Foreign object damage can be defined as any __________ ____________ entering the engine from an external source.

b. ________ is the largest single cause for removal of gas turbine engines from aircraft - other than scheduled maintenance.

c. Some examples of foreign objects are:

(1) ____________________

(2) ____________________

(3) ____________________

d. Four rules for preventing FOD are:

(1) Checking tools against a _________ before and after each job.

(2) Removing all __________ from your person.

(3) Constant __________ of all areas.

(4) Become familiar with AFR __________ which covers the prevention of FOD.

6. Danger Areas of Operating Engines.

a. Danger areas include the engine _______ and _________.

b. _______ feet from the inlet, and _______ feet to the side and rearward is considered a safe distance from the inlet.

c. The minimum safe distance of a turboprop propeller exhaust is:

(1) _______ feet wake velocity is 128 KTS.

(2) _______ feet wake velocity is 107 KTS.

d. Rotating starters and turbine wheels have danger areas called the ______________ of rotation.

e. Red line or lines around the fuselage or cowling identifies the ___________ of ______________.

7. Fire Prevention.

a. The friction of two unlike materials can cause a buildup of electrical energy known as _____________ _________________________.

b. Static electricity cannot be eliminated but can be controlled by _______________ and ______________________________________.

c. The strap that electrically connects your automobile engine to the body would be an example of _____________________.

d. The disposal of combustible materials should be made in a __________ marked metal container with a _________________ closing lid.

e. Combustible materials should be ______________ at the end of each day.

f. The disposal of ____________ materials should be made in a metal container plainly marked.

g. No smoking is permitted unless designated by the base

_________________ _________________________.

h. The three fire classifications are:

(1) Class __________ - wood, paper, rags, trash.

(2) Class __________ - flammable liquids.

(3) Class __________ - electrical.

i. The purpose of fire extinguishers is to produce a

______________ or ___________________________ effect on the fire.

j. Pressurized water extinguishers can only be used on class __________ fires.

k. Pressurized water extinguishers create a ______________ effect on fires.

l. Foam type extinguishers can be used on class __________ and __________ fires.

m. Carbon dioxide (CO_2) extinguishers can be used on ______________ classes of fires.

n. Dry chemical extinguishers can be used on ______________ classes of fires.

o. The foam, CO_2, and dry chemical extinguishers all create a ______________ effect on the fire.

p. Fire extinguishers should be inspected for ____________ safeties and/or ______________________ in place.

Section 2. CAPTION TO PHOTO MATCHING

PROCEDURES

Write the proper captions, from those listed below, under figures 1 through 15, and fill in the blanks to complete the accompanying statements.

Jet engine foreign object damage (FOD).

Dry chemical extinguisher.

Personnel maintenance stand.

Turboprop engine danger areas.

Pressurized water extinguisher.

Hydraulic lifting jack.

Aircraft grounding.

Turboprop engine maintenance stand.

Carbon dioxide (CO_2) extinguisher.

Protective clothing.

Safety toe, nonsparking shoes.

Mechanical lifting device.

Combustible waste containers.

Wrong and right manual lifting.

Self-closing metal container.

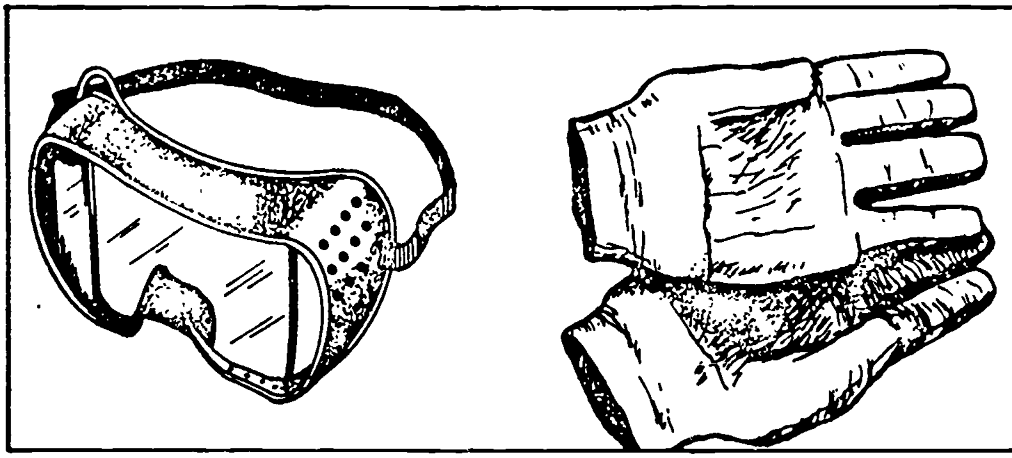

Figure 1.

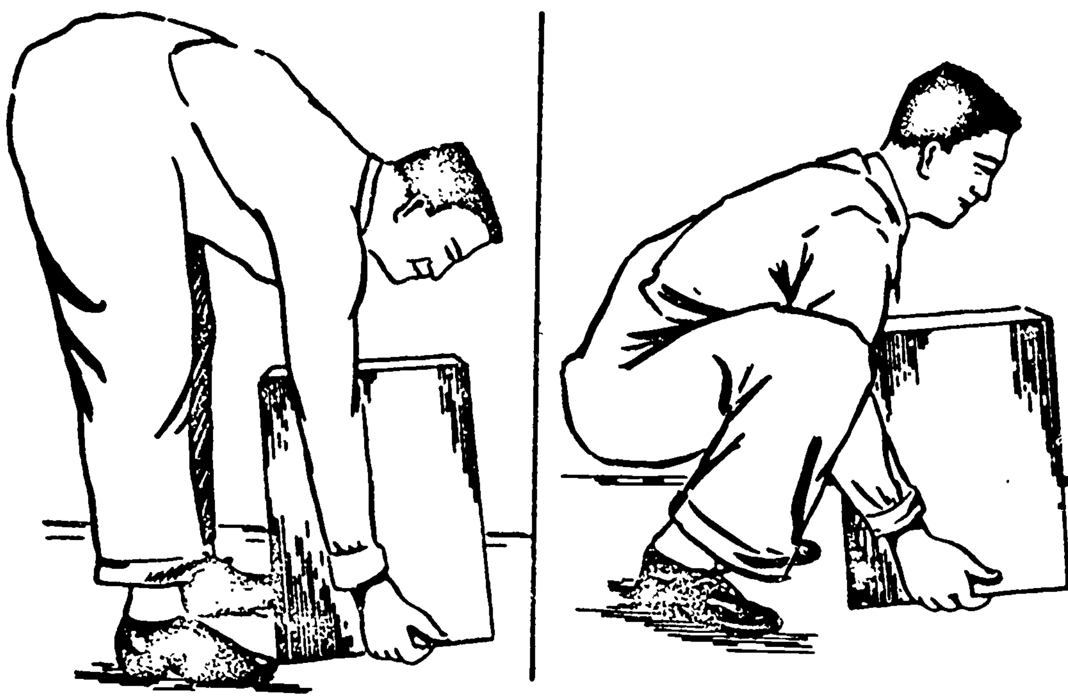

Figure 2.

123

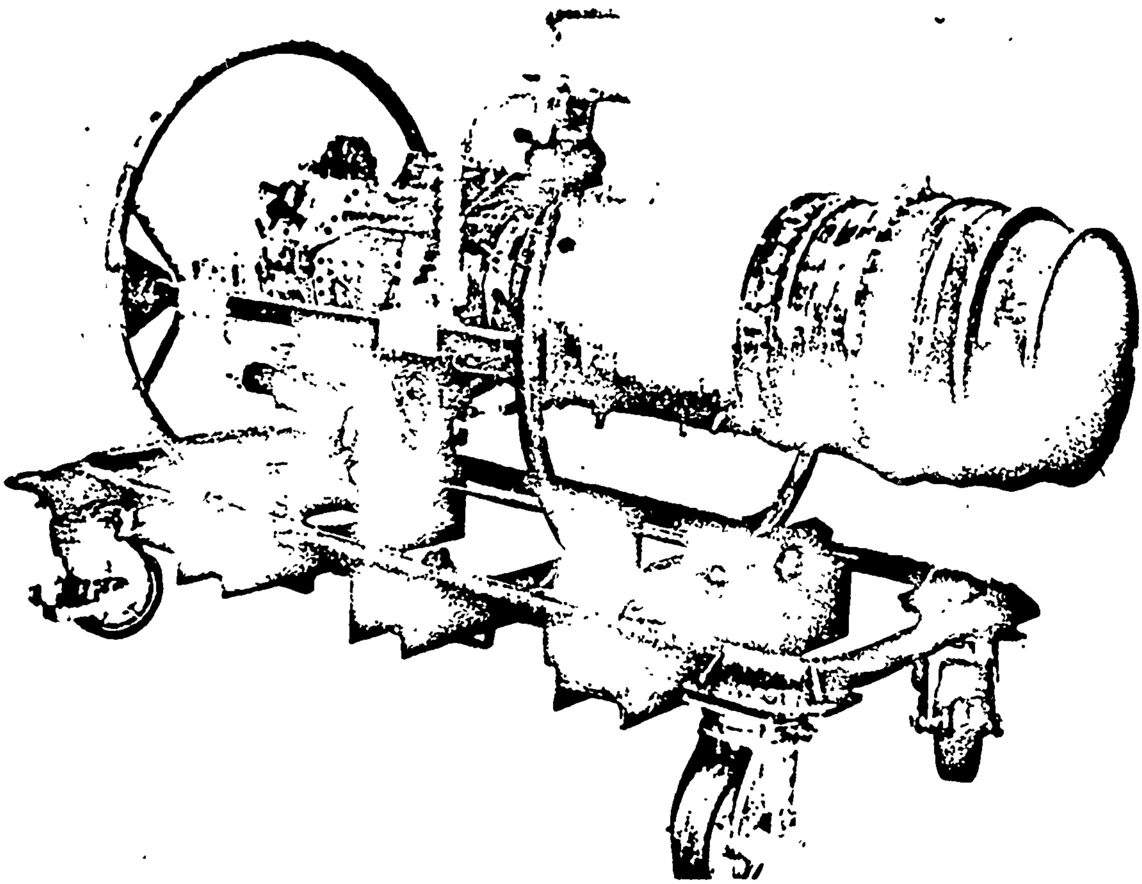

Figure 3.

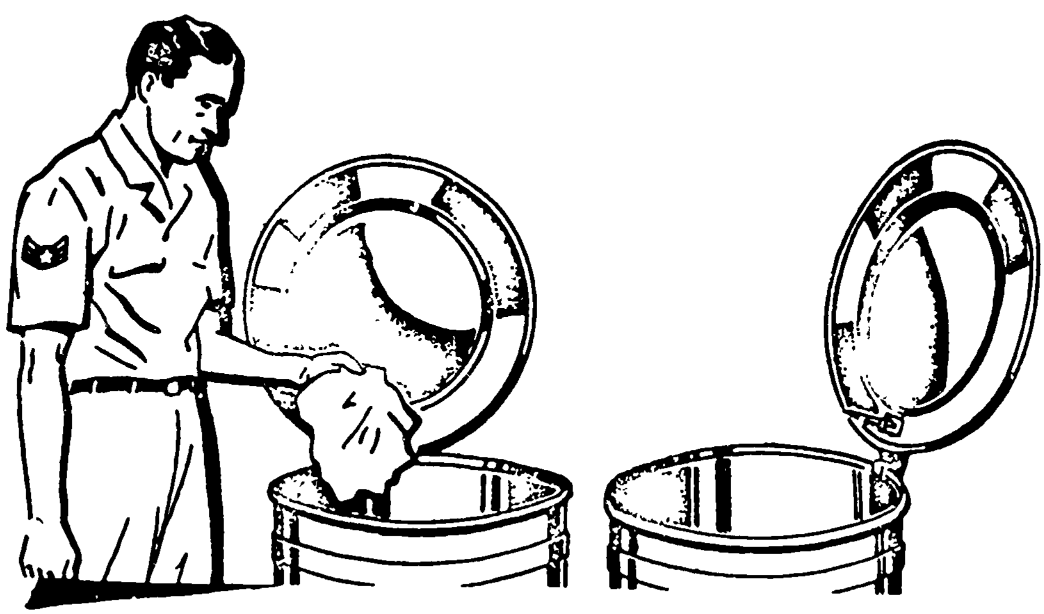

Figure 4.

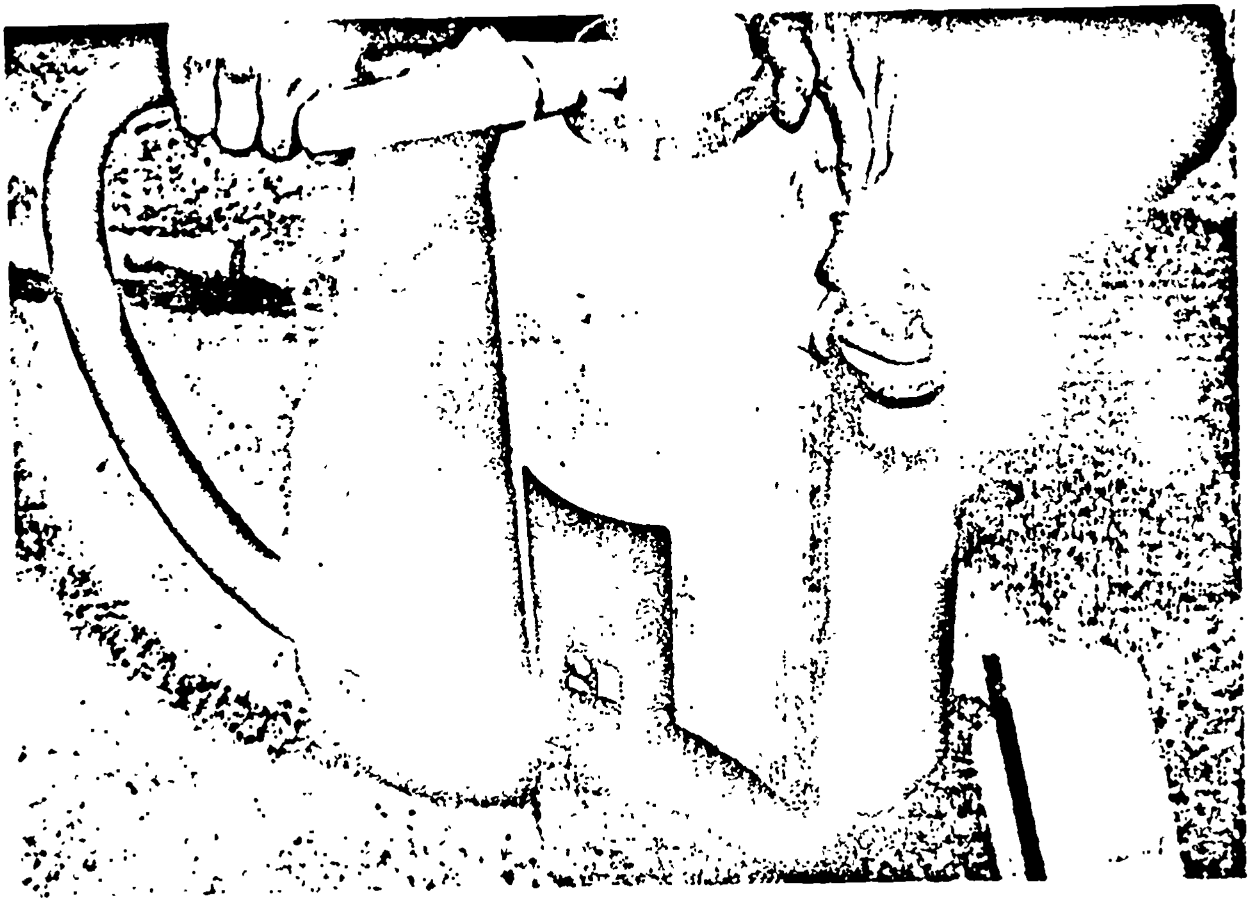

Figure 5.

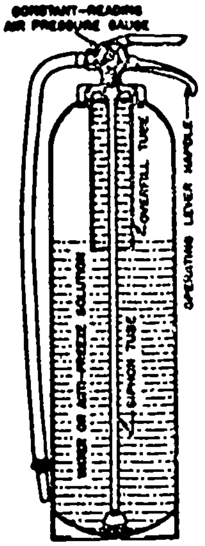

Figure 6.

125

This extinguisher is used only on class ______________ fires.

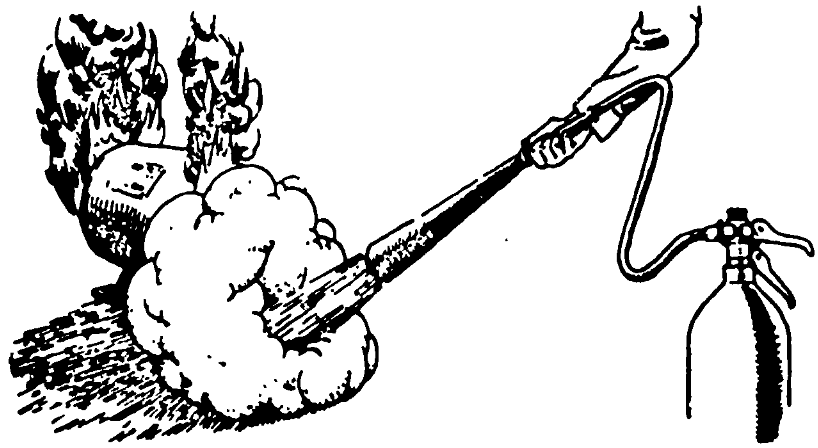

Figure 7.

This is an illustration of a class __________ (electrical) fire being extinguished by a ______________________ extinguisher.

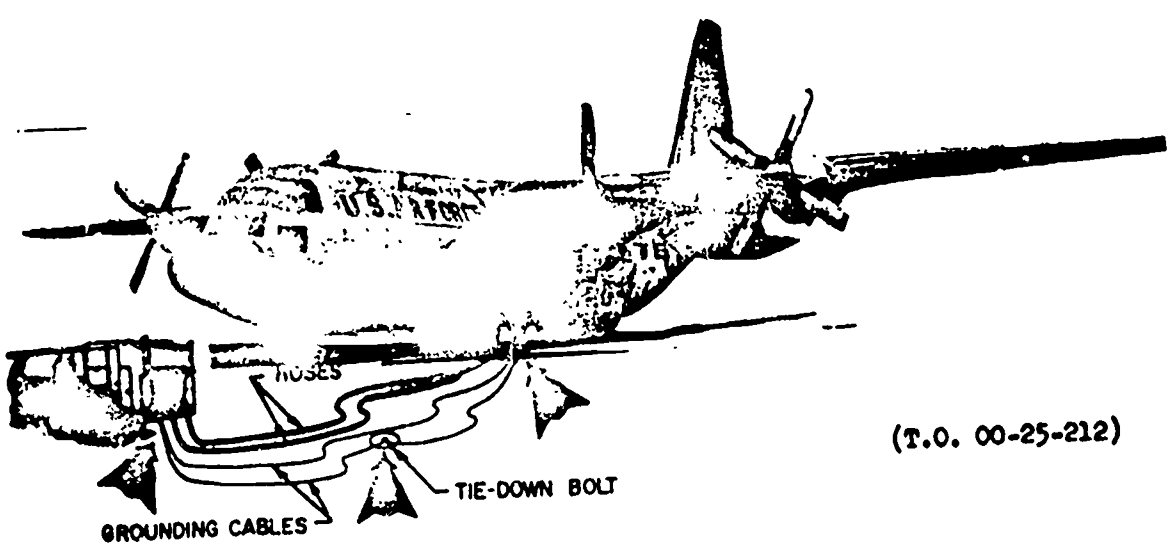

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Figure 8.

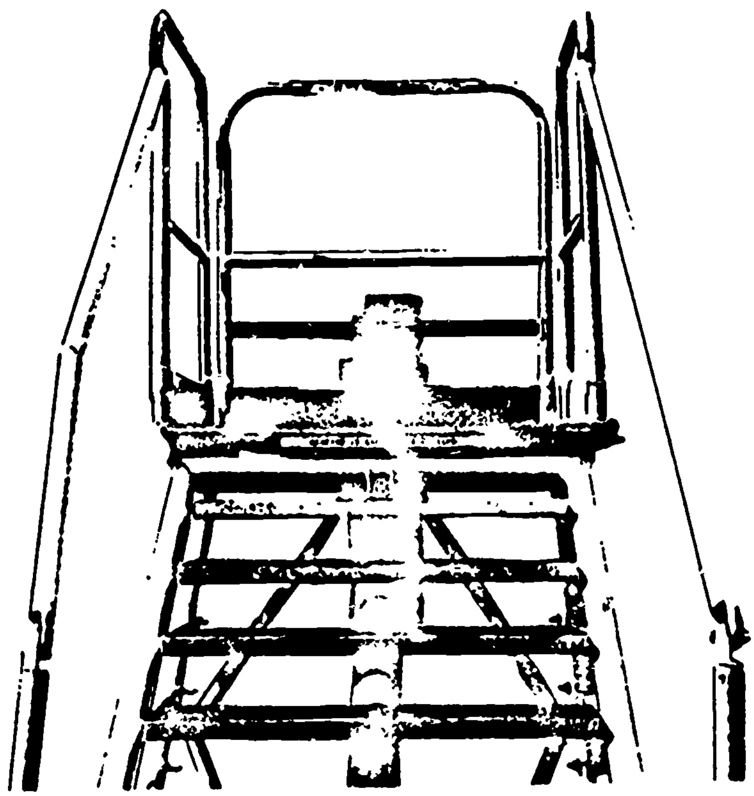


Figure 9.

with the safety ______________________ installed.

127

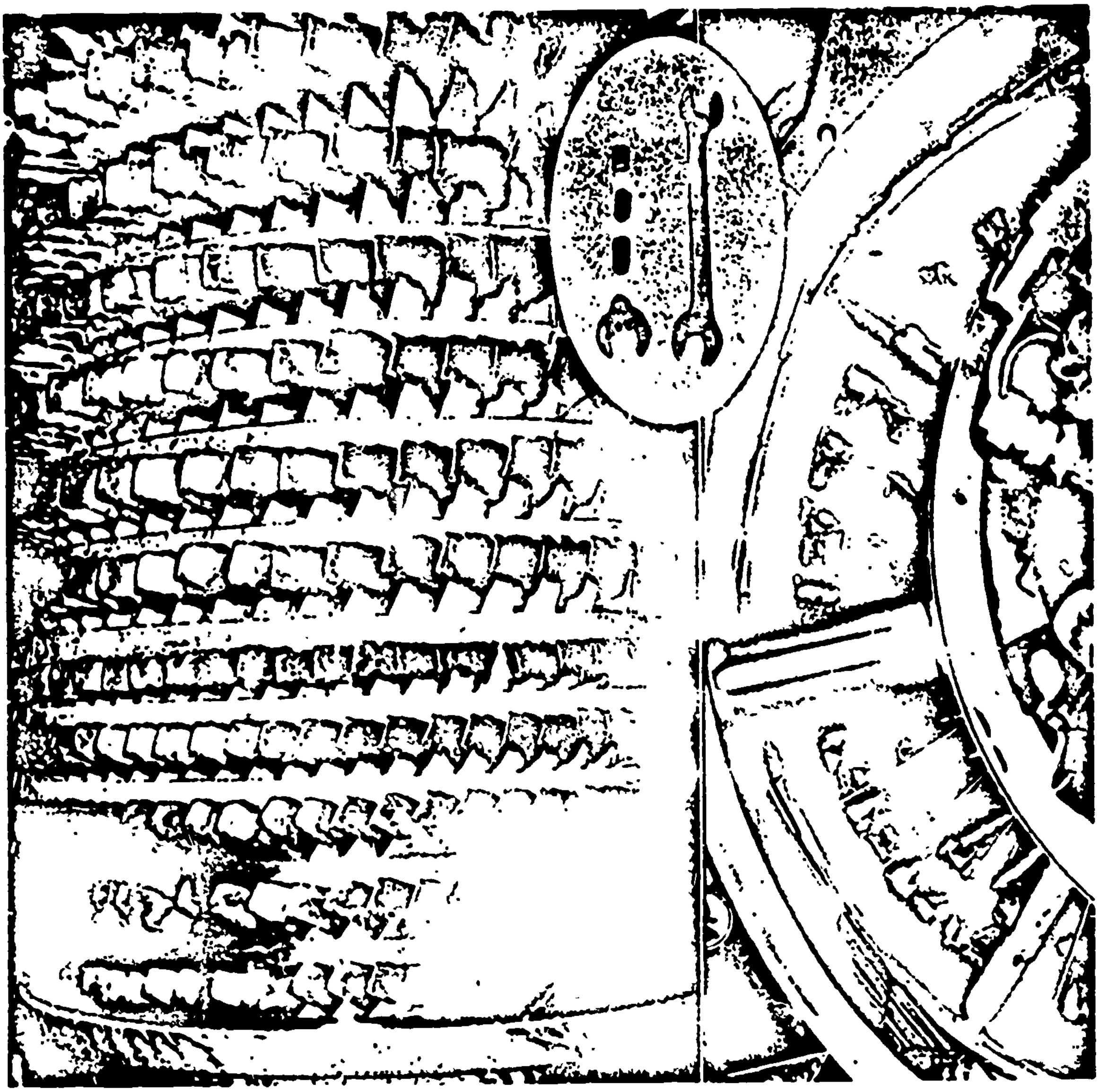


Figure 10.

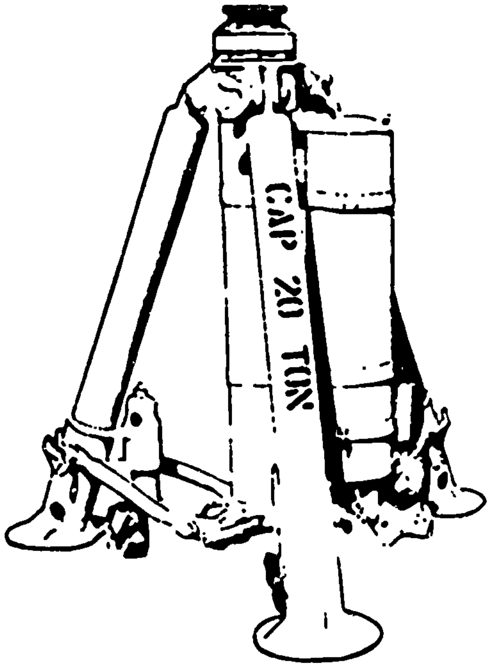
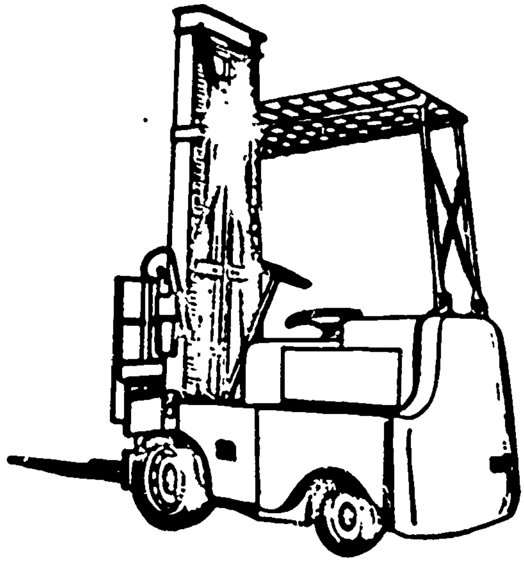


Figure 11.



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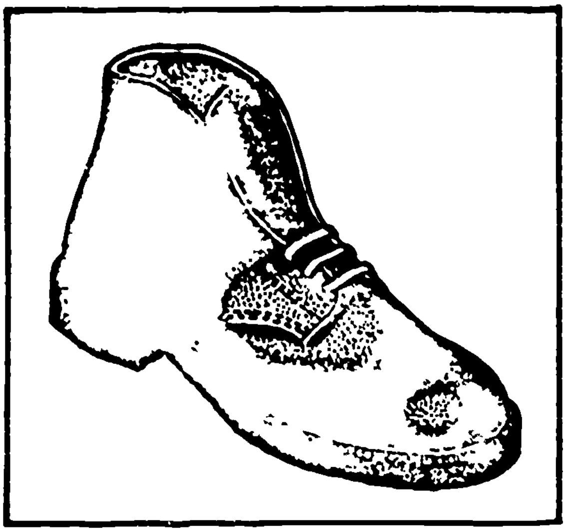


Figure 13.

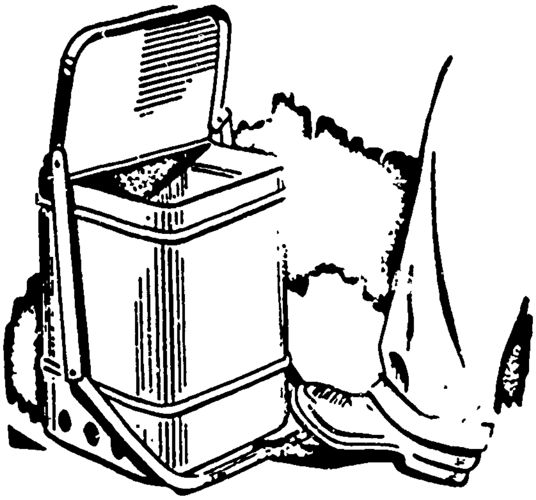
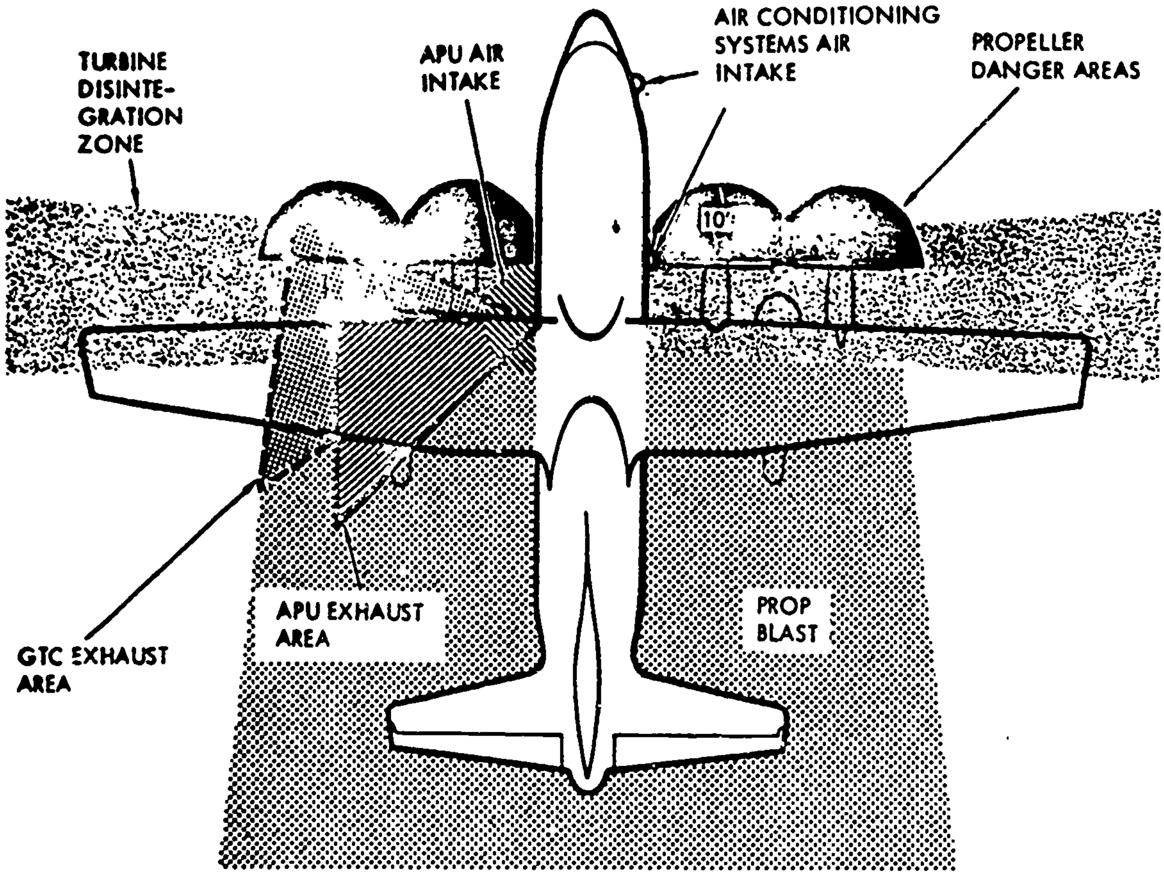


Figure 14.

danger areas



MAXIMUM POWER, NO WIND

DISTANCE AFT OF PROPS - FEET	100	200	300	400	500
WAKE VELOCITY - KNOTS	128	107	92	80	69

Figure 15.

Stay at least _______ feet from the propeller and _______ feet from exhausts of operating aircraft engines at wake velocity of 69 knots.

REVIEW QUESTIONS

1. The purpose of the accident prevention program is to prevent personal ________, damage to ________, and save time and ___________.

2. AFR _______ is titled Ground Accident Prevention Handbook.

3. "Good housekeeping" or a place for ________ and everything in its place plays an important part in reducing shop ____________.

4. The first thing you should do before starting to work on any piece of equipment is to remove all ______________.

5. When lifting objects, be sure to use your _____________ and _____________ and not your back.

6. Lifting heavy weights that exceed the limits prescribed in AFR 127-101 over a period of time may cause back ___________.

7. Mechanical handling and lifting devices should be ___________ and ____________ periodically.

8. Remember not to exceed ___________ capacities when using equipment such as jacks and hoists.

9. Three things that should be done when using workstands are:

a. Safety _____________ installed.

b. Safety _____________ installed.

c. Wheels __________.

10. Foreign object damage can result from ____________ being where its not supposed to be.

11. The publication that deals with FOD is AFR ______________.

12. Always use a checklist to check your tools _________ and ____________ each job.

13. __________ is the largest single cause for __________ removal other than scheduled maintenance.

14. A list of danger areas of operating jet engines could include the _________, ___________, and plane of _________________.

15. The high frequency sound of operating jet engines could cause possible ear ____________.

16. The minimum safe distance from the exhaust of an operating jet engine's wake velocity of 107 knots is _________ feet.

17. The plane of rotation on jet engines is identified by _________ line or lines around the ________________ or cowling.

18. Static electricity can be controlled by ___________ and ________________.

19. When several fuel drums are lined up together, they all should be ___________ together and then all connected to a common ____________.

20. Two fire extinguishers that can be used on all three classes of fires are the ___________ and ______________.

HANDOUT

3ABR42632-HO-101
3ABR42633-HO-104

Technical Training

Jet Engine Mechanic
Turboprop Propulsion Mechanic

GLOSSARY

17 September 1979

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

Do Not Use on the Job.

RGL: N/A

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42632-HO-101
3ABR42633-HO-104

GLOSSARY

INTRODUCTION

This handout consists of words and terms used in this course. Use this glossary for the meaning of words and terms you don't understand as you read the study guide assignments.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

ABORT -- To stop or fail in the early stages. To turn back without completion.

ACCELERATION -- The rate of change in velocity (a change in speed).

AIR START -- Engine start made in flight using ram air to rotate the engine compressors.

AMBIENT AIR -- Air surrounding all sides of an engine, air available for consumption.

ANNEALING -- A process of heat treating to soften metal.

ANTI FRICTION -- Reducing friction; having rolling contact instead of sliding contact (ball bearing).

ANTI-ICING -- Prevention of ice formation.

ATOMIZED -- To reduce to fine particles or spray.

AXIAL FLOW -- Refers to the path of air as it passes along the axis (or shaft) of engine rotating assembly.

AXIALLY -- Extending in a direction essentially parallel to the main axis of the engine.

BAFFLE -- An obstruction designed to control the flow of air or fluids. Something for deflecting, checking, or otherwise regulating flow.

BLENDING -- To mix or fuse thoroughly so parts are no longer distinct.

BOWING -- Curving or gradual deviation from original line or plane usually caused by lateral force and/or heat.

BRINNELLING -- Indentations sometimes found on surface of ball or roller bearing parts.

BURRS -- A rough edge or a sharp projection on the edge of surface of the parent material.

BYPASS -- A pipe between two points that avoids or is auxiliary to the main way.

BYPASS VALVE -- A valve that allows oil to go around a filter that is clogged.

CAGE -- A frame for holding bearing in place around in shaft journal.

CATEGORY -- A Classification division in any field or knowledge.

CENTRIFUGAL -- Moving or directed outward from the center.

CHAFFING -- A rubbing action between two parts having limited relative motion, which will cause wear.

CLOGGED -- To become stopped up (such as a fuel line becoming blocked).

CLUSTER -- A number of things of the same sort gathered or growing together; bunch (a slucter or a bunch of fuel nozzles such as six (6) nozzle for each of the eight (8) combustion chamber in a J57 engine)

COMPRESSOR BLADE (ROTOR) -- A rotating airfoil shaped component which moves the air along.

COMPRESSOR VANE (STATOR) -- A stationary airfoil - shaped component which raises pressure.

COMPRISED -- To include, sum up.

CONFIGURATION -- Form contour or structure as determined by the arrangement of parts.

CONFINED -- To keep within limits; to keep shut up.

CONTAMINATION -- To make impure, pollute, dirty (such as a dirty oil filter)

CONVERGENT -- To tend to meet in a point on a line. Incline toward each other.

CONVERGENT DUCT -- Becoming continuously smaller in the direction of flow.

DAMPENED -- To moisten; to deaden; depress, reduce or lessen.

DEAERATOR -- A unit that removes air from the oil.

DEENERGIZE -- To check the flow of current through (an electrical device).

DEGREASING -- To remove grease or oil from metals with hot or cold chemicals.

DEMAGNETIZE -- The purpose is to eliminate the residual magnetism which would cause particles to adhere to the bearing.

DEMINERALIZED -- To remove the mineral matter from (as water).

DEPRESERVATION -- The act of removing the barrier so that the engine could be put into use.

DISCARDED -- To get rid of; to throw away.

DIVERGENT -- Pertaining to a condition brought about by a net flow of air from a given region or air moving in different directions from a common point.

DIVERGENT DUCT -- Becoming continuously larger in the direction of flow.

DRONE -- A pilotless airplane directed by remote control.

DUCT -- A passage which contains and controls the flow of gases in motion.

DUEL -- Meaning two (2).

DUET -- A composition for two voices or instruments.

DUPLEX (OR DOUBLE) BEARING -- Two independent bearings paried up and acting as one.

ENERGIZE -- To give energy to. To apply a source of voltage or current to.

FACILITATE -- To make easier or less difficult.

FAILURES -- The act, fact, failing, falling short, not doing or succeeding in passing a test or part not operating their normal times.

FERRULE -- To give added strength to metal. Enclosing the end of a tool. Handle or similar object to strengthen it or prevent spilling and wearing.

FIRMLY -- Not yielding easily under; solid; steady.

FLANGE -- A rim or edge (as on a shaft or a pipefitting) projecting at right angles to provide strength or means of attachment to another part.

FLUORESCENT -- To make cracks readly visible when viewed under ultra-violet light.

FLUORESCENT PENETRANT -- Is a nondestructive means of inspecting materials and parts for surface cracks or discontinuities.

FLUSH -- Making an even line or plane, even with a margin or edge, so as to be level or in alignment.

FRAGILE -- Easily broken, damaged or destroyed, frail, delicate.

GALLING -- A transfer of metal by rubbing one surface to another. To wear away by friction.

GASKET -- A piece or ring of rubber metal, etc., placed around a piston or joint to make it leakproof.

HUB -- The center part of a wheel. The central part of a motor - driven fan to which the blades are attached.

INGESTION -- To take as by swallowing or absorbing. Foreign object that may be swallowed by a jet engine which would cause damage.

INTERMEDIATE -- Lying or being in the middle place, coming in between. J57 engine has what is called intermediate front bearing (no. 2) and intermediate rear bearing (no. 3) which is between the front and rear compressors.

JAMMED -- To squeeze into or through a confined space. To become wedged or stuck fast.

JOURNAL -- A machined surface on which the inner ring of anti-friction bearing is mounted.

LEAKAGE -- An act or instance of leaking; the amount that leaks in or out of an area.

LUG -- An earlike projection by which a thing is held or supported. A projection on a casting to which a bolt or another part may be fitted.

MATING SPLINES -- The act of matching splines (a series of projecting keys and fitting into an internal groved cylindrical member).

MATTER -- The substance of which physical object consist of or are composed of. Found in three states; solid, liquid and gas.

MISCELLANEOUS -- Consisting of various kinds, mixed hardware, such as nuts, bolts, studs and etc.

MULTI -- A word element meaning "many" (such as three or more).

NACELLE -- The enclosed part of an airplane in which the engine is housed.

NOMENCLATURE -- Technical name or description of an item.

NOZZLE -- A duct of varying cross-section, used in discharging liquids or gases, in which the velocity of the fluid or gas is increased.

OBSTRUCTION -- Something to block or make difficult the passage or aisle to the nearest exit.

ORIFICE -- An opening or mouth as of a tube.

OXIDATION -- The state or result of being oxidized (to combine with oxygen or with more oxygen).

PENETRANT -- To pass into or through; to enter or go through by overcoming resistance. Discover the inner contents. Recognize the precise nature of the metals.

PERPENDICULAR -- Meeting a given line or surface at right angles. Air flow is at right angles to the axis.

PINION -- A gear with a small number of teeth designed to mesh (mate) with a larger gear.

PNEUMATIC -- Relating to air or air pressure.

POSITIVE DISPLACEMENT -- A pump that will displace the same amount of liquid in any one cycle.

PRESERVATION -- To prevent corrosion by placing a barrier between critical metal surfaces and moisture during the time the engine is idle.

PRESSURIZE -- To keep nearly normal air pressure inside of (an airplane, space suit) as at high altitudes. To subject to high pressure.

PROBE -- A small diameter sensing element extending into the air or gas stream to measure pressure, temperature, or velocity. To examine or investigate thoroughly, to search.

QUADRANT -- Something shaped like a quarter of a circle, as a part of machine. Placed in the cockpit where the throttle is they are used to control the fuel flow to the engine.

RACE -- A groove for the balls in a ball bearing or rollers in a roller bearing.

RADIAL -- Branching outward in all directions from a common center.

RAM AIR -- The pressure buildup at the engine inlet, created by the forward motion of the aircraft.

RELAXED -- To rest or give rest to, from work, worry.

RESPECTIVE -- As relates to indivudally to each of two or more. Noticing with attention. Regardful of particular persons or things.

RETAINING -- To keep in one's mind.

RIGID -- Not bending or flexible: stiff.

SCAVENGE -- To return all to the tank from the sump. To remove residue. To remove dirt, waste, or other impurities from a space (sump).

SCHEMATIC -- Pertaining to or of the nature of a plan or drawing.

SCORING -- Deep scratches made during engine operation by sharp edges or foreign particles; elongated gouges.

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SCRIBE -- To mark by cutting or scratching a line with a pointed instrument.

SEAL -- A tight or perfect closure as against the passage of air. To close completely as to make airtight.

SEGMENT -- Any of the parts which something is separated. To divine into parts.

SELF SUSTAINING RPM -- Is the RPM the compressor must attain before it can supply the volume of compressor air needed to support the combustion required to furnish the power to turn the compressor.

SERRATIONS -- The condition of being serrated. A single tooth or notch in a serrate edge (having sawlike notches along the edge) A formation resembling the toothed edge of a saw.

SHUTTLE -- To move rapidly back and forth.

SHEARED -- Dividing a body by cutting action, division of a body so as to cause the parts to slide relative to each other in a direction parallel to their plane of contact.

SHEARED -- To break under a twist stress.

SIGNIFICANT -- Having or expressing a meaning; full of meaning, important fact.

SKIDDING -- Sliding without rotating. Failing to grip the roadway.

SLING -- A looped or hanging band, strap used in raising or lowering a heavy object.

SLUDGE -- Any heavy, slimy deposit, as the waste resulting from oil refining, the sediment in a crankcase. A muddy deposit.

SMEARED -- To cover or soil with something greasy, sticky.

SNAP -- A catch or fastening that closes or locks with a click (as one provided with a spring or with parts that fit tightly into each other.)

SPHERICAL -- Shaped like a globe. Having the form of a sphere (an ideal globe) or one of its segments.

SPLINES -- A flat, rectangular piece cut or key fitted into a groove.

STARVATION -- To die from lack of food. To freeze up from the lack of oil.

STRESS -- When used in describing the cause of failure of machine parts.

STRETCH -- To reach out. To extend over a given space, distance, or time.

SUMP -- A low place where fluid (oil) will collect.

SWIRL -- To move with a whirling motion.

SWIRL CUP -- A device that is built into a dome of a combustion chamber to move the air with whirling motion as it mixes with the fuel from the nozzles.

SYNTHETIC -- Not real or genuine, artificial, manmade. Produced by artificial process. Something produced by putting together elements so as to form a whole.

TAPPED -- To make a hole for drawing off liquid. Make or open holes.

TERMED -- Limited ended. Such as a limited or definite extent of time.

THERMOCOUPLE -- A temperature sensing device. A device for measuring temperature in which two electrical conductors of dissimilar (not alike) metals are joined at the point where heat is to be applied and the free ends are connected to an electrical measuring instrument (as an ammeter).

TIE ROD BOLTS -- A bolt used as a connecting member of a compressor (as in a J57 engine) along a bolt ties all rotating members (disc) of the front compressor.

TORQUE -- A force that will produce rotation.

TOXIC -- Poisonous or injurious to respiratory organs.

TRANSDUCER -- A device that transmits energy from one system to another.

VENTILATED -- To circulate fresh air in a room. To let air or gas to escape overboard from the aircraft.

WARPAGE -- A distortion to become bent or twisted out of shape. The action, process, or the result of bending or twisting out of shape.

WELD -- To unite (pieces of metal) by heating until molten and fused or until soft enough to hammer or press together.

PROGRAMMED TEXT
3ABR42632-PT-104

Technical Training

Jet Engine Mechanic

MECHANIC'S HANDTOOLS

17 June 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

RGL: 9.4

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VALIDATION

This programmed text is designed for students in the C3ABR42632, Jet Engine Mechanic Course. Tryout of the learning format and technical information was conducted using students with no prior exposure to the subject material. More than 90 percent of the 34 students used to validate the material surpassed the criteria specified in the objectives approved by Air Training Command. The average time required to complete this programmed text was 2 hours.

OBJECTIVES

Upon completion of this programmed text, you will be able to:

1. State the factors to consider in the selection of handtools for a job.

2. State the procedures for proper use and care of handtools.

INTRODUCTION

This text discusses the selection, care, and use of common handtools that will be used daily during your training as a jet engine mechanic.

As you progress through this programmed text, you will understand the importance of choosing and using the correct tools to do a job correctly.

INSTRUCTIONS

This program is presented in steps called "frames." As a part of each step you are asked to respond by selecting the correct answer from multiple answers, choose either TRUE or FALSE, or match descriptions to nomenclatures. These answers which you are required to furnish were taught in that or previous frames of this text.

To use this text, use a piece of paper or a card as a mask to cover the printed material. Slide this mask down the page until the top of a row of slashes (//////////) is exposed. One step or frame is now exposed. Read the material presented and make your response or selection by selecting the letter, or choosing TRUE or FALSE for the questions asked. Then slide the mask down and compare your answer with the correct one found just below the slashes. If your answer is correct, go on to the next frame; if you are wrong, read the frame again and see how the correct response was derived.

Supersedes 3ABR42632-PT-105, 20 February 1979.
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 3000; TTVSA - 1

FRAME 1. SAFETY PRECAUTIONS, USE, AND CARE OF HANDTOOLS

Proper care and use of handtools go hand in hand with safety. Improper care and use of tools are violations of safety precautions and may lead to serious harm to yourself or a fellow airman. They may even cause the loss of an aircraft and crew. The following list of statements pertains to proper care, use, and safety precautions concerning your handtools.

a. Do not carry tools in your pocket.

b. Keep all tools clean, free of rust, corrosion, grease, and other foreign matter.

c. Check tools for defects prior to use.

d. Turn in defective tools for new ones.

e. Oil the moving parts of tools. Use oil SAE No. 10.

f. Inventory your tools before and after each job to prevent foreign object damage.

g. Use solvent for cleaning tools. Never use gasoline or JP-4.

h. Always use the right tool for the job.

i. Use an authorized tool storage area for storing your toolbox.

j. Your toolbox will be locked when it is to be left unattended.

k. Do not horseplay with tools.

l. Do not use the toolbox to store special tools.

m. Mechanics are financially responsible for their tools.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ______ When removing grease or oil from handtools, it is permissible to use unleaded gasoline.

2. ______ Tools should be inventoried only before the job is started.

3. ______ Financial responsibility for handtools rests with the individual.

//////////////////////

1. False. Gasoline will not be used for any type of cleaning.

2. False. You should inventory your tools before and after each job.

3. True. Financial responsibility rests with the individual.

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FRAME 2. WRENCHES

Wrenches are tools used for tightening or removing nuts or bolts. They are generally classified as socket sets, adjustable or nonadjustable wrenches.

Use and Care of Wrenches

a. Never use a wrench that does not fit the nut or bolt exactly. Use only the correct size wrench.

b. Use adjustable jaw wrenches so the pulling force is on the stationary jaw.

c. Always pull on a wrench -- don't push. The nut or bolt may break loose unexpectedly.

d. Do not use a pipe on the handle of a wrench. Use a wrench with a longer handle.

e. Use solvent to clean wrenches.

f. Use oil (SAE 10) to lubricate the moving parts of wrenches and other handtools.

Mark the following statements as either true (T) or false (F) in the space provided.

1. _______ Use pulling force when using a wrench.

2. _______ A wrench should fit a nut or bolt exactly.

3. _______ It is permissible to use JP-4 to clean wrenches.

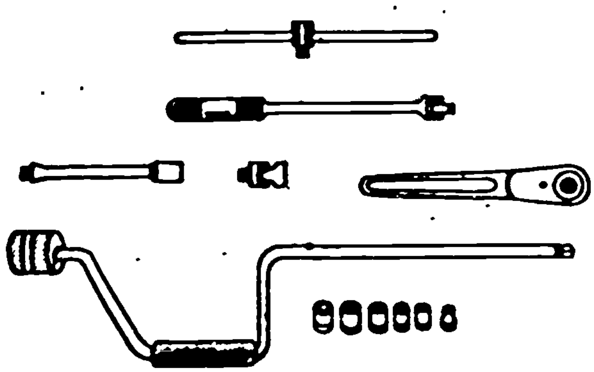
/ /

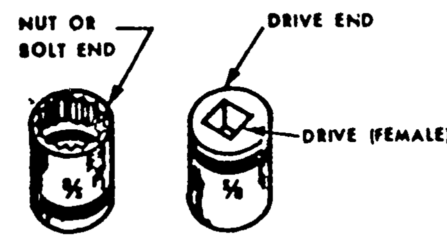
1. True. Pulling on a wrench gives you better control.

2. True. There is a wrench made for each type of nut or bolt.

3. False. Read Frame 1, paragraph g.

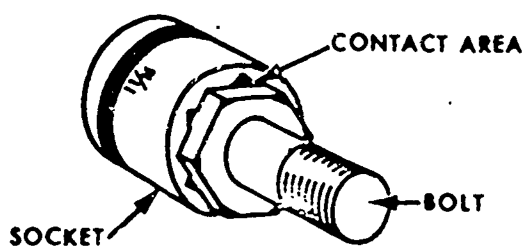
FRAME 3. SOCKET (WRENCH) SET

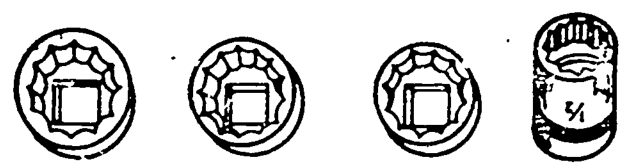




Socket sets, because of their versatility* and speed, are considered the mechanics' first choice of wrenches. They consist of various types of sockets, handles, and attachments which can provide the ideal wrench combination for almost any maintenance job. Socket sets are identified by the size of their (square) drives. Some common socket set sizes are the 1/4 size, 3/8 size, and 1/2 inch.

*Defined as variable, adaptable, reversible, and ease of turning.





SHALLOW SOCKETS

Sockets are made to fit the nut or bolt on all corners and are provided in all needed sizes. The size is stamped on the side of the socket and indicates the wrench size of the nut or bolt which it will fit. There are three types of sockets: shallow, deep well, and universal. Shallow sockets (shown above) are used for most normal work. Individual sockets are sized according to the size of the drive and the size of the nut or bolt end.

Mark the following statements as either true (T) or false (F) in the space provided.

1. _______ One reason that mechanics select the socket set as their first choice of wrenches is because of their versatility.

2. _______ Individual sockets are sized by the size of the drive.

3. _______ The size stamped on the socket identifies the size of the drive.

/ /

1. True. The many types of handles and sockets make them ideal for mechanic's use.
2. False.
3. False. The size stamped on the socket is the size of the socket.

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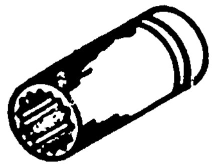
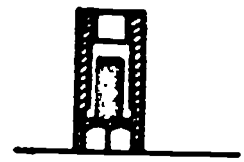
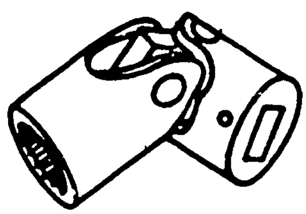
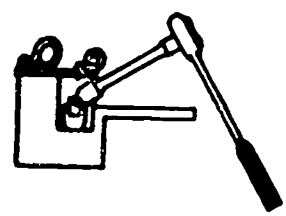
FRAME 4. SOCKET (WRENCH) SET continued





In some installations, the threaded part of a bolt or stud may extend thru the nut to the extent that a shallow socket will not reach the nut. This is a job for the deep well socket. It is used where socket depth is needed. In some cases, it is possible to avoid the use of an extention by using a deep well socket.





The universal socket is used in areas where there is not a straight approach to a nut or bolt. The universal part of this socket permits it to be used at an angle.

Mark the following two statements as either true (T) or false (F) in the space provided.

1. _______ A deep well socket is used where space is needed above a nut to clear the threaded portion of a bolt.

2. _______ Where there is an angular approach to a nut, it may be removed by using a universal socket.

Circle the letter of the correct answer.

3. The size of a socket set is determined by the

   a. socket size.

   b. size of the drive.

   c. deep well of the socket.

   d. size stamped on the socket.

/ /

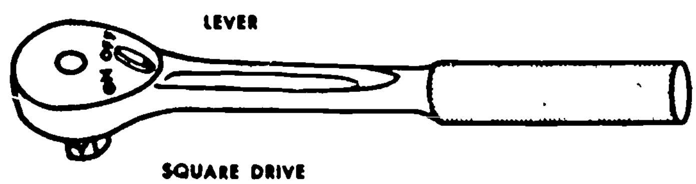
1. True. A deep well socket would be used in order to provide a clearance above the top of the nut.

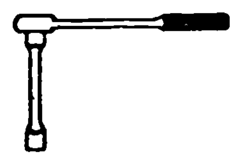
2. True. A universal socket can be used at an angle.

3. b. size of the drive.

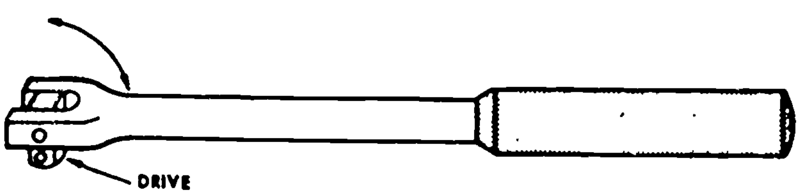
FRAME 5. SOCKET (WRENCH) SET continued

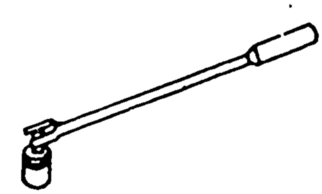
Handles. Since sockets are detachable, a variety of handles may be used for different kinds of work. These add to the versatility of the socket set. The four types of handles used with the socket set are ratchet, "T", speed, and hinge handles.



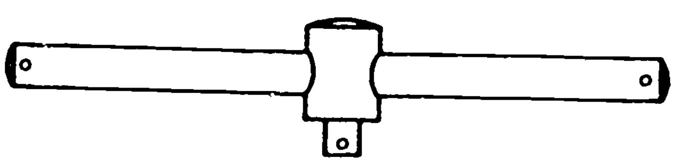


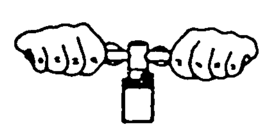
a. The ratchet handle ratchets (slips) in one direction when loosening a nut or bolt and in the other direction when tightening a nut or bolt. There is a lever on the ratchet head that is used to change the direction of the ratchet action. The ratchet is useful where the swing arc is restricted. This handle should not be used for high torque, such as breaking loose a tight nut or bolt.





b. The hinge handle is used to break loose nuts or bolts. To loosen a tight nut or bolt, the handle can be used at a right angle to the socket to give the greatest usable leverage. Then, if the fastener is sufficiently loosened, the handle can be hinged to the vertical position where it may be turned with the fingers.





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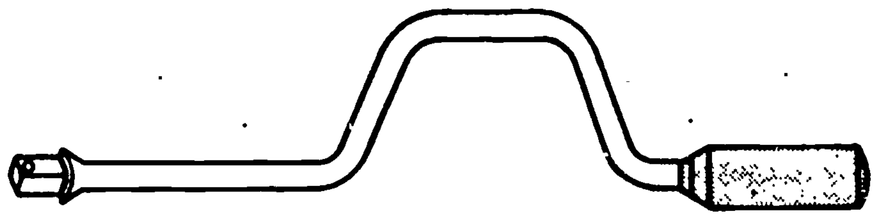
c. The "T" handle is another of the various handles used for driving sockets. The "T" shape makes it possible to apply equal force with both hands because the drive is in the center. The drive may be moved to one end of the bar for more leverage.



d. The speed handle is a rapid means of turning a socket. It is usually used where there are many nuts or bolts and the swing arc is not restricted.

Match the items in column B to the statements in column A.

Column A	Column B
1. ___ Used when fast removal or installation of nuts or bolts is required and the swing arc <u>is not</u> restricted.	a. "T" handle.
2. ___ Used to break loose a tight nut or bolt.	b. Ratchet handle.
3. ___ To tighten or loosen a nut or bolt without having to remove or position the socket, when the swing arc is restricted.	c. Speed handle.
4. ___ Used to apply equal force with both hands when the drive is positioned in the center.	d. Hinge handle.

Mark the following statements as either true (T) or false (F) in the space provided.

5. ___ The hinge handle can be used at a right angle to the socket for a straight pull for greatest leverage.

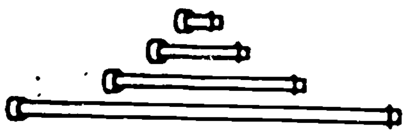
6. ___ Nuts or bolts should be broken loose with a hinge handle.

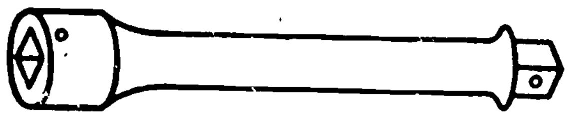
/ /

1. c 2. d 3. b 4. a 5. true 6. true

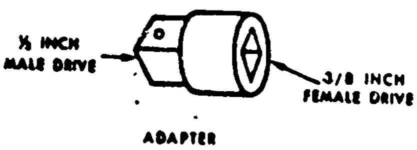
FRAME 6. SOCKET (WRENCH) SET continued

Attachments are used to change the drive size, angle, or length.



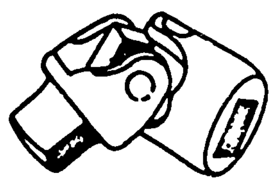


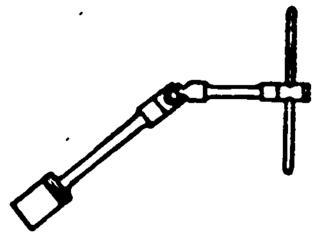
a. An extension is used to extend a socket into hard-to-reach places. Extensions are provided in many different lengths.



DOWN Can Be Adapted To Drive Sockets in This Drive Size	Originating Drive Size	UP Can Be Adapted To Drive Sockets in This Drive Size
-	1/4	3/8
1/4	3/8	1/2
3/8	1/2	3/4
1/2	3/4	1

b. An adapter provides the means for changing the drive size. 1/4" to 3/8", 3/8" to 1/2", etc.





c. A universal joint is used to change the angle of a drive when there is not a straight approach to a nut or bolt. It may be used on handles, extensions, and sockets.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ___ An extension is used to change the angle of the drive.

2. ___ An adapter is used to change a 1/2" drive to a 3/8" drive.

3. ___ The parts of a socket set which are used to change the sizes, angles, or lengths of drives are called attachments.

/ / / / / / / / / / / / / / / / / / / /

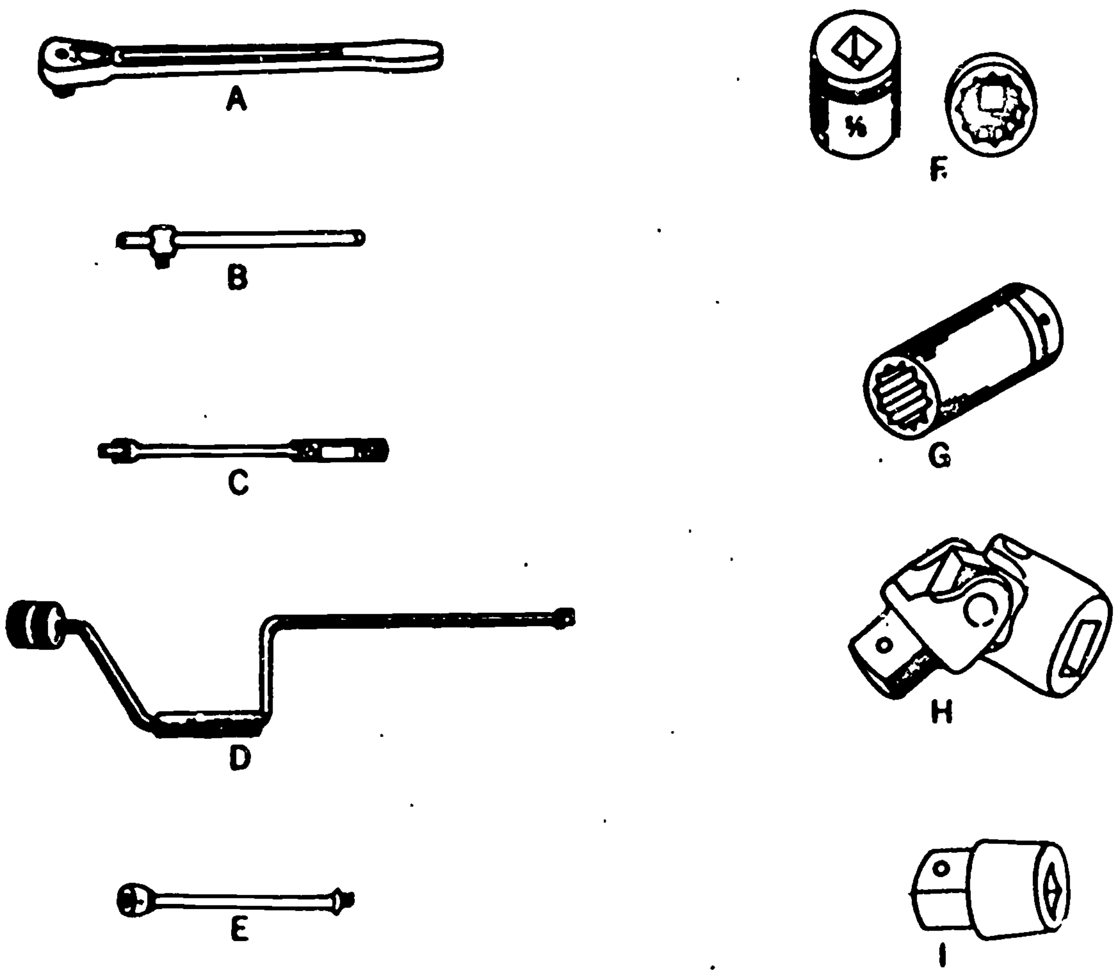
150

1. False. An extension lengthens the drive.

2. True. Adapters permit the use of handles on more than one set of sockets.

3. True. Attachments alter the drive for more handle versatility.

FRAME 7. REVIEW FOR SOCKET (WRENCH) SET



Match the items illustrated above with the statements listed below.

1. ___ Changes drive angle.

2. ___ A handle that provides speed for tightening many nuts or bolts.

3. ___ A handle used to tighten or loosen nuts or bolts in a restricted area.

4. ___ A shallow socket, used for most normal "nut and bolt" jobs.

5. ____ A handle used to apply force with both hands when the drive is in the center.

6. ____ A handle used to break loose nuts or bolts.

7. ____ Used to extend sockets into hard-to-reach places.

8. ____ A socket, used where the threaded part of a bolt extends a considerable distance above the nut. May be used also to eliminate the use of a short extension.

9. ____ Used to change the size of the drive.

/ /

1. H - 2. D 3. A 4. F 5. B 6. C 7. E 8. G
9. I

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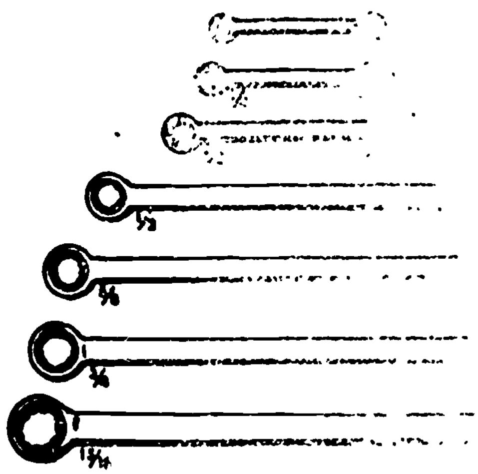
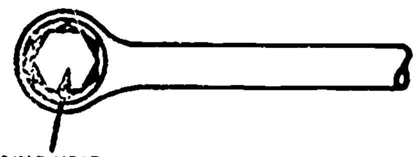
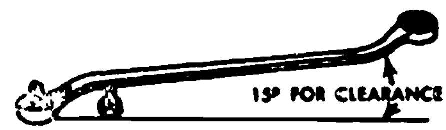
FRAME 8. BOX END WRENCHES







Box end wrenches are [illegible] [illegible]nics' second choice of wrenches. They are given the [illegible] they box (surround) the nut or bolt head. [illegible] where there are close quarters, and to "break [illegible]. The main disadvantage of the box end is [illegible] bolt and repositioned each time [illegible] end wrenches are offset 15°, as shown [illegible] is to provide hand and wrench clearance.

Circle the [illegible]

1. If the [illegible] [illegible]nics' second choice of wrenches [illegible]

   a. [illegible] [illegible] handle.

   b. [illegible] [illegible] handle.

2. The [illegible]

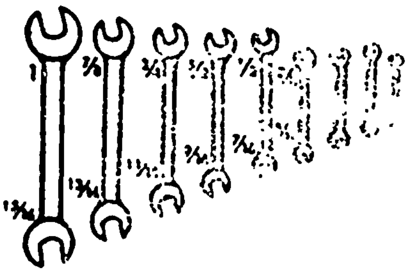
   a. [illegible] [illegible] bolt.

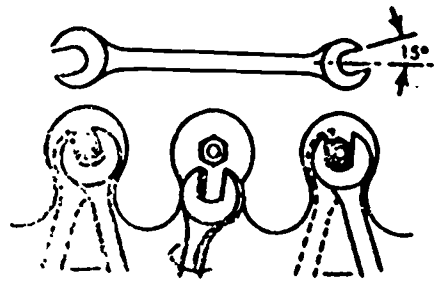
   b. [illegible]

/ / / / / / / / / /

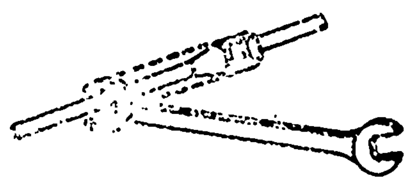
1. [illegible] 2. b

FRAME 9. OPEN END WRENCHES





Open end wrenches are light, strong and convenient to use. Each wrench normally has two different wrench sizes, one on each end of the handle. The jaws of open end wrenches are set at a 15° angle so that in restricted swing space, the wrench may be "flopped" over each time for a new grip on the nut or bolt. CAUTION: The jaws may spread under heavy torque.



Because of the open end, this [illegible] used to loosen or tighten nuts which secure hose assembl[illegible] as illustrated above.

Mark the following statements [illegible] or false (F) in the space provided.

1. ___ Open end wrenches are [illegible] nuts which secure hose assemblies and tubing.

2. ___ The jaws [illegible] wrench can be flopped over and a new [illegible].

3. ___ Open end wrenches [illegible] per handle.

/ / [illegible] / / / / / / / / /

1. True. [illegible] not fit over these nuts.

2. True. [illegible] could not fit the flats [illegible].

3. False. Open end [illegible] are [illegible] manufactured with two sizes [illegible].

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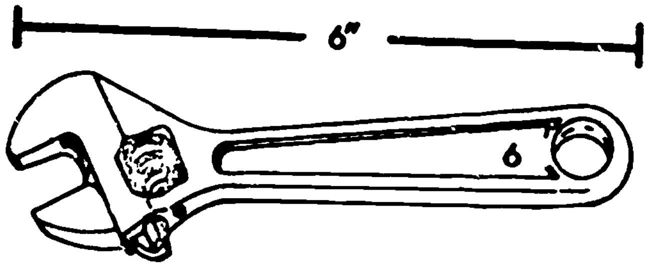
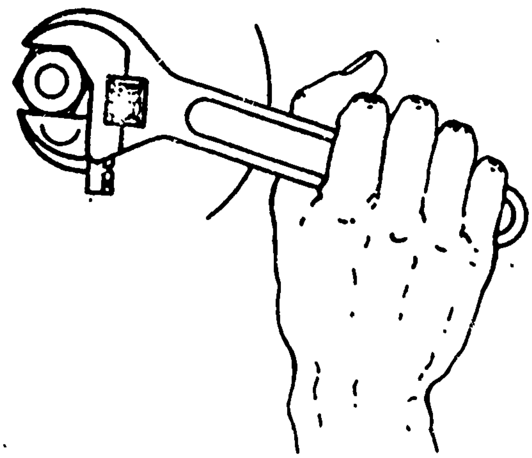
FRAME 10. ADJUSTABLE JAW WRENCH



An open end wrench is sometimes required but the correct size is not available. An adjustable jaw wrench would be used as a last resort for these jobs. The size of an adjustable jaw wrench is usually stamped on the handle and is determined by the overall length of the wrench.



Accidents and rounding off the corners of nuts and bolts usually result from the misuse of this tool. The wrench should be pulled with the force being applied to the stationary (solid) jaw. The adjustable jaw should always point in the direction of rotation.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ___ The adjustable jaw wrench would be used as a last resort.

2. ___ Force is applied to the stationary jaw.

3. ____ The size of the adjustable jaw wrench is determined by the width of the jaws.

/ /

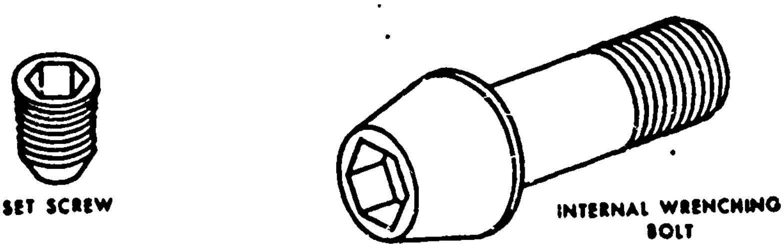
1. True. Because misuse is easy and accidents can occur from misuse.

2. True. The adjustable jaw will point in the direction of rotation.

3. False. The size is determined by the overall length and is stamped on the handle.

FRAME 11

The wrench pictured above is commonly called an "Allen wrench. hex head, or internal wreuching wrench.



These wrenches are six-sided "L" shaped keys used in internal wrenching bolts and set screws.

Circle the letter/letters of the correct answer.

1. The allen wrench is also called

   a. key set.

   b. hex head.

   c. internal wrenching wrench.

   d. all of the above.

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2. Allen wrenches are used to install and remove. (Two responses.)

a. set screws.

b. common screws.

c. hex head bolts.

d. internal wrenching bolts.

//////////////////////

1. both b and c   2. a, d

FRAME 12. REVIEW FOR WRENCHES

Match the items illustrated below with the following statements.

1. ___ One detachable part of a socket set.

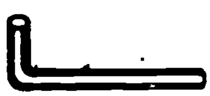
2. ___ An "L" shaped wrench that is used in tightening or loosening internal wrenching bolts or set screws.

3. ___ A nonadjustable wrench that fits the nut on all corners and is offset 15° to allow wrench and hand clearance.

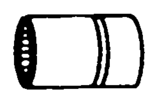
4. ___ A wrench that is used as a last resort and the size is determined by the overall length of the wrench.

5. ___ A nonadjustable wrench that is used to tighten or loosen nuts on hose assemblies and tubing.

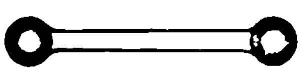
6. ___ Illustrates the correct use of an adjustable jaw wrench.



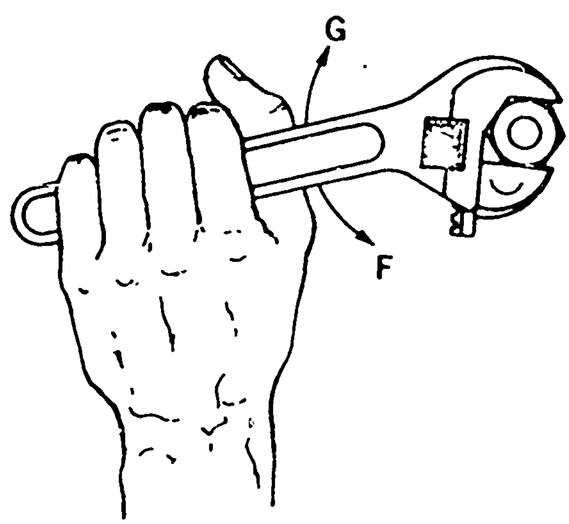
A

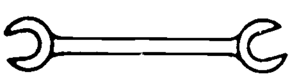


E



B





C

D

/ /

1. E 2. A 3. B 4. D 5. C 6. F

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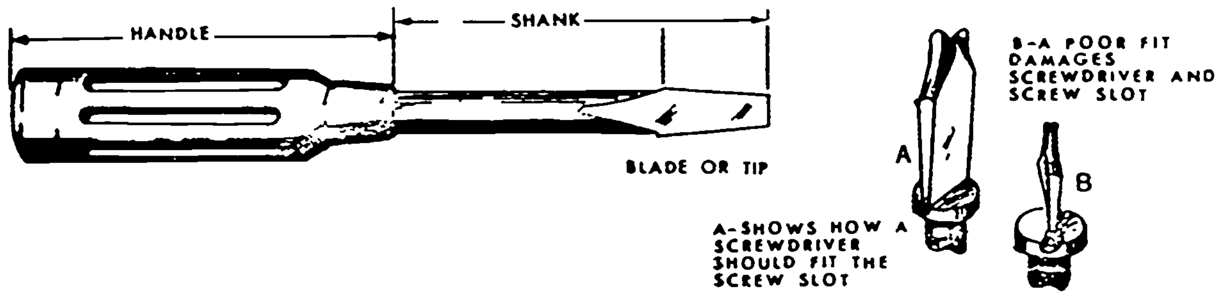
FRAME 13. SCREWDRIVERS

Screwdrivers are used to drive (turn) slotted head or cross head screws in threaded holes. A screwdriver consists of three parts: handle, shank, and blade or tip. The blade must fill the slot of the screw, both in width and depth, and should also fill most of the length of the slot



Use and Care of Screwdrivers

a. Never use a screwdriver as a chisel.

b. Do not use a screwdriver as a pry bar.

c. Use Reed and Prince screwdrivers in Reed and Prince screws.

d. Use Phillips screwdrivers in Phillips screws.

e. Clean and oil the blade to prevent corrosion.

f. Clean the handle of all grease or oil before using.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ____ A screwdriver consists of a handle, shank, and blade or tip.

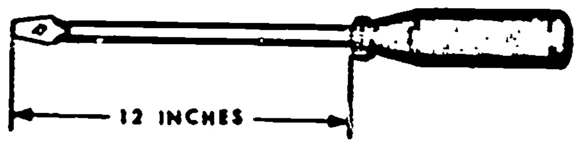
2. ____ The blade of a screwdriver should be 1/2 the width of the slot.

/ /

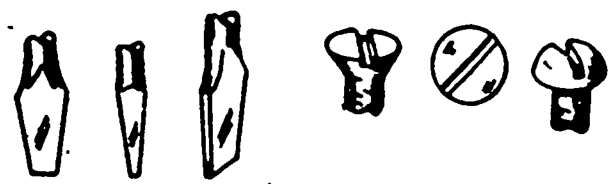
1. True. See picture above.

2. False. To prevent damage to the screwdriver blade or screw slot, the screwdriver tip should fill the slot.

FRAME 14. SCREWDRIVERS continued.



The size of a screwdriver is determined by the length of the shank and blade in inches.



The common or standard screwdrivers have flat blades and are used to drive slotted head screws. When selecting a common screwdriver for a job, you should use one that has the proper size of blade.

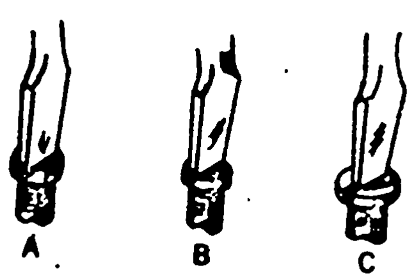
Mark the following statements as either true (T) or false (F) in the space provided.

1. ___ The size of a common screwdriver is determined by the width of the blade or tip.

2. ___ The common screwdriver is used to drive slotted head screws.

Select from the drawings below the one that shows the proper fit of the blade in the screw slot. Place the letter in the space provided.

3. ___



/////////////////////////////

1.	False.	The length is measured from the tip to the bottom of the handle.
2.	True.	See picture above.
3.	B.	

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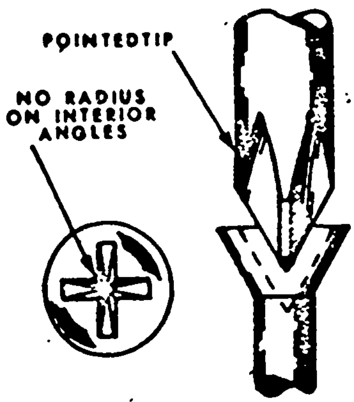
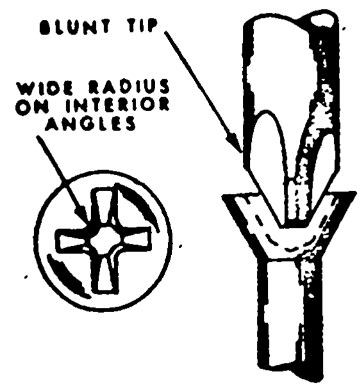
FRAME 15. SCREWDRIVERS continued

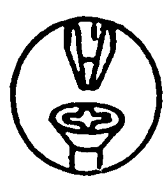


A. REED & PRINCE TYPE

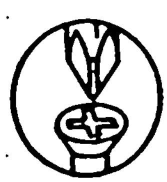


B. PHILLIPS TYPE

Two types of crosspoint screwdrivers in use by the Air Force are the Reed and Prince (picture A above) and the Phillips (picture B above). The correct screwdriver must be used to avoid damage to the screw head and screwdriver.



Phillips screwdrivers have blunt tips and are used in cross slot screws that have rounded corners. See picture above.



Reed and Prince screwdrivers have pointed tips and are used in cross slot screws that have square corners. See picture above.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ___ A Phillips screwdriver has a pointed tip.

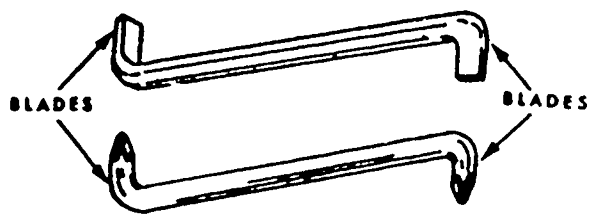
2. ___ Reed and Prince screwdrivers are used in screw slots that have square corners.

/ /

1. False. See picture on preceding page.

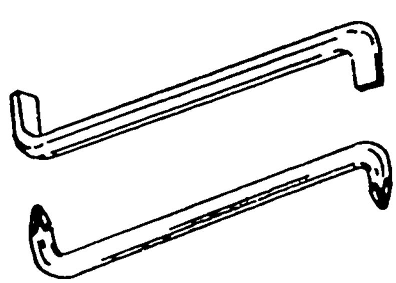
2. True. See picture on preceding page.

FRAME 16. SCREWDRIVERS continued



Offset screwdrivers may have either standard or cross point blades. They are used when working in spaces where there is not enough room to use a regular screwdriver. Blades of offset screwdrivers are set 90° from the shank and handle.

Label the screwdrivers below with their proper name.



1. ______________________

____

2. ______________________

____

/ /

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1. Common or standard offset.

2. Cross point offset.

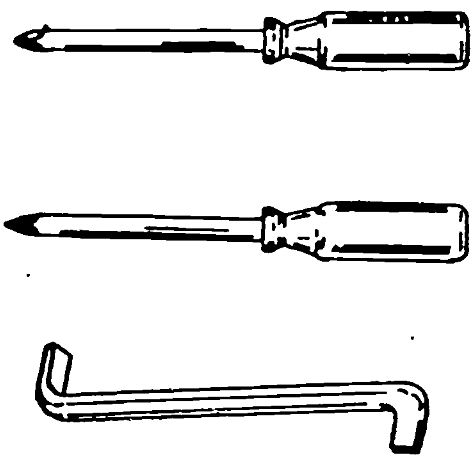
FRAME 17. REVIEW FOR SCREWDRIVERS

Write the name of the three kinds of screwdrivers in the spaces provided.

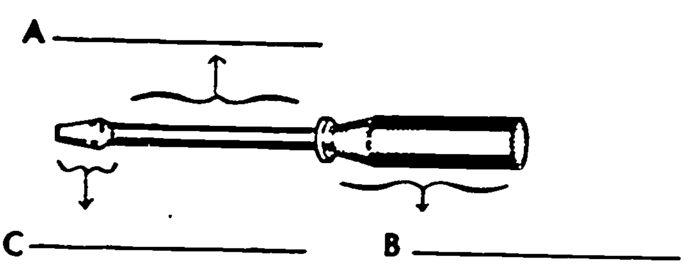
1. ______________________

2. ______________________

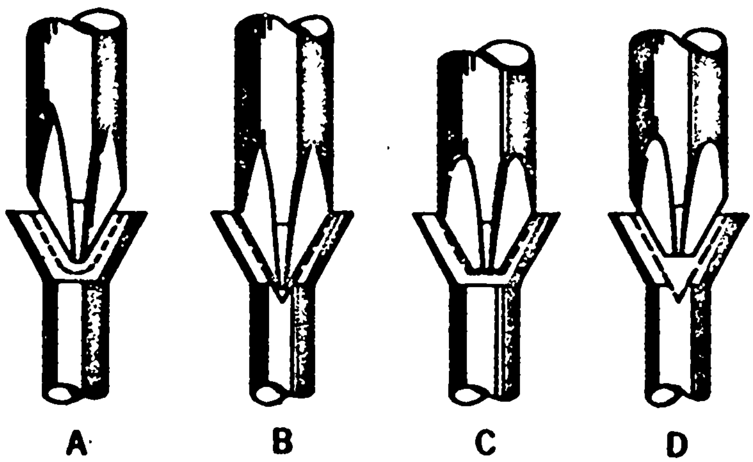
3. ______________________



4. Write the name of each part of the screwdriver in the picture below.



Study the drawing below and place the letters of the two cross point screwdrivers which are being used correctly in the space provided.



5. ________

6. ________

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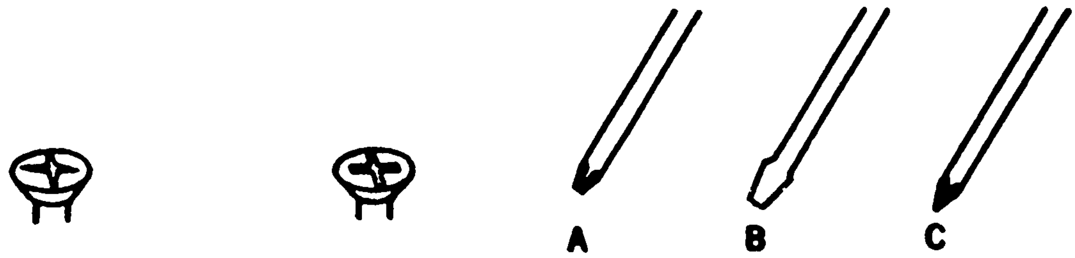
FRAME 18. REVIEW SCREWDRIVERS continued

Match the screws illustrated on the left with the letter of the correct screwdriver on the right.



7. ____________________ 8. ____________________

/ /

1. Phillips crosspoint.
2. Reed and Prince crosspoint.
3. **Standard offset.**
4. a. shank b. handle c. blade or tip.
5. B.
6. C.
7. A.
8. C.

If you have answered all the questions on this section of the programmed text correctly, go on to the next frame. Raise your hand if additional information or clarification is needed.

FRAME 19. HAMMERS

A hammer is a tool consisting of a head and a handle. The good mechanic learns to select the correct hammer for the particular work at hand. Hammers are generally classified as "hard face" or "soft face" hammers. Each hammer has its own special use. Hard face hammers are made of steel. Soft face hammers have a face made of lead, plastic, leather, or rubber.

Use and Care of Hammers

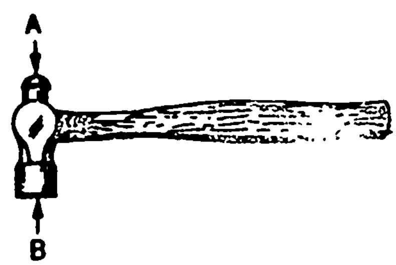
a. Do not use a hammer or mallet with a loose head.

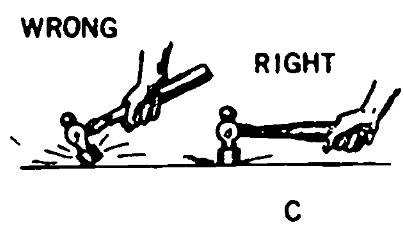
b. Replace worn handles.

c. Do not use the handle as a pry bar.

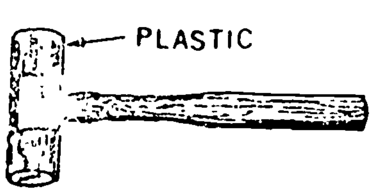
d. Use linseed oil to clean wood handles.

e. Use a solvent to clean the heads of steel hammers. (Prevents rust.)





The ball peen hammer is the type most used by aircraft mechanics. It has a flat surface (B) on one end called the face and a round surface on the other end called the ball (A). Remember to grip the end of the handle and strike with the center of the face, as shown in (C). Hammers are used in areas where dents in the metal are not important and to provide the driving force for chisels and punches. They are sized according to the weight of the head and range from four ounces to 20 pounds in size.



A mallet usually has a replaceable soft face or tip made of lead, leather, rubber or plastic. Mallets are used where the finished product must be smooth (no nicks or dents in the metal). The size of a mallet is determined by the diameter of the face.

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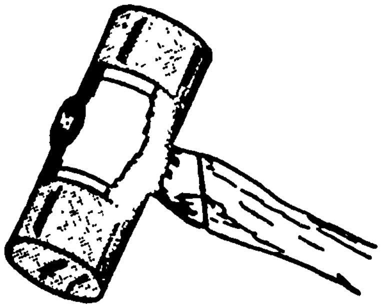
FRAME 20. HAMMERS continued



A

B

Match the hammers shown above to the nomenclatures below.

1. ___ Hammer, hand, machinist, ball peen.

2. ___ Hammer, hand, screw-in replaceable plastic face.

Mark each of the following statements as either true (T) or false (F) in the space provided.

3. ____ The size of the ball peen hammer is determined by the weight of the head.

4. ____ Hard face hammers are made of material such as leather, lead, plastic, or rubber.

//////////////////////

1. B

2. A

3. True.

4. False. Hard face hammers are made of steel.

FRAME 21. PLIERS

Pliers are available in various types and sizes. They are primarily an extension to your hand and are used to hold material which the hand is not strong enough to grasp tightly. Pliers come in two types, adjustable and nonadjustable. They are not used as a replacement for wrenches. The adjustable pliers include slipjoint pliers and vise grips. Nonadjustable pliers include chain long nose, flatnose, and diagonal side cutters.

Use and Care of Pliers

a. Do not use pliers to loosen nuts or bolts. Use only proper size wrenches.

b. Do not use plier handles as a pry bar.

c. Cover or hold the ends of safety wire or cotter pins when cutting.

d. Clean and oil pliers frequently.

Mark the following statements either true (T) or false (F) in the space provided.

1. ___ If a wrench is not available, it is permissible to use pliers.

2. ___ An accident can be avoided by covering or holding the ends of cotter pins or safety wire when cutting them.

3. ___ Pliers are divided into two general types.

/ /

1. False. Pliers will round off the corners on nuts and bolts.

2. True. The ends might hit someone in the eye when cut or cause "foreign object damage."

3. True. They are divided into adjustable and nonadjustable jaws.

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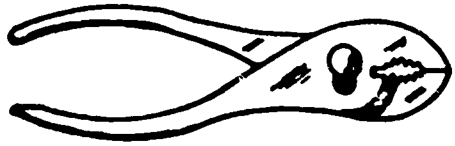
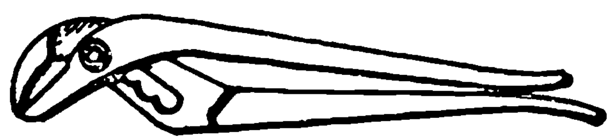
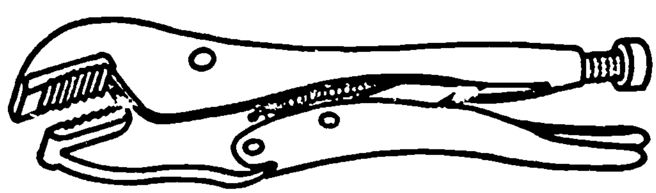
FRAME 22. ADJUSTABLE PLIERS



The most commonly used pliers are the slipjoint pliers, usually called "common pliers". They are used as a general purpose holding tool, and for bending pieces of metal or wire.



Water pump pliers were originally designed to tighten water pump packing gland nuts on cars in the 1920s. They are no longer needed for that purpose, but they are very effective as a "large capacity" holding tool.



Vise grip pliers have a locking device on one jaw. Once adjusted and locked, it is like putting an object in a small vise. This leaves your hands free for other work.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ___ Common pliers are used for general purpose tasks, such as holding and bending pieces of metal or wire.

2. ___ Vise grip pliers can be used to hold two pieces of sheet metal together in preparation for drilling.

3. ___ Water pump pliers are used for holding large objects, such as pipes.

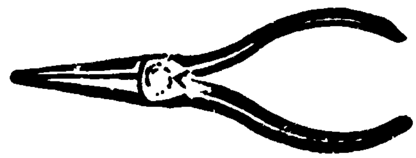
/ /

1. True.

2. True.

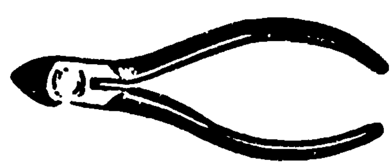
3. True.

FRAME 23. NON-ADJUSTABLE PLIERS



Chain long nose pliers, commonly called "needle nose pliers" have long jaws that come to a point. They are used for grasping small items in tight places where the fingers cannot reach, and to make delicate bends in thin pieces of metal.

Duck bill pliers have long, flat jaws and are designed to be used for pulling and twisting safety wire.



Diagonal side cutting pliers, commonly called "dikes" have jaws with sharp edges and are used for cutting safety wire or removing cotter pins.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ____ Dikes are pliers that have sharp cutting jaws and are used for cutting small diameter wire (safety wire) and for cutting and pulling cotter pins.

2. ____ Needle nose pliers have long, slender jaws and are designed to reach into tight places where the fingers cannot be used.

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3. ____ Duck bill pliers have long flat jaws and are designed for twisting and pulling safety wire.

//////////////////////

1. True.

2. True.

3. True.

FRAME 24. PUNCHES AND CHISELS

Chisels and punches are made in a variety of shapes to suit many different types of work. They are made from tempered steel and require care and precautions like other tools.

Use and Care of Punches and Chisels.

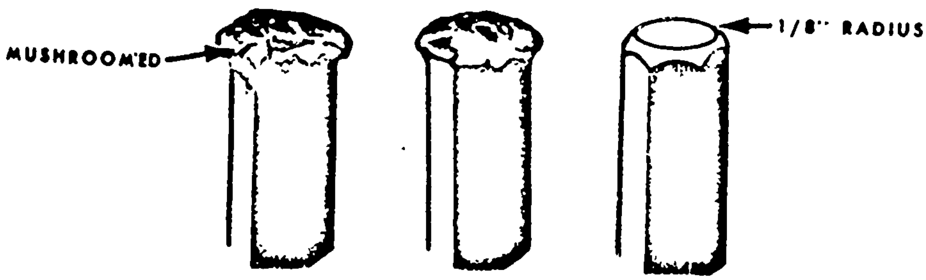
a. Do not use a dull chisel.

b. Use the correct punch when doing a job.

c. During sharpening, use safety apparel (face shield or goggles).

d. Use solvent for cleaning all tools, including punches and chisels.

e. Never use a chisel or punch that has a mushroom head.



The head on the left is badly mushroomed. The one in the center is slightly mushroomed. Both should be dressed until they are in the condition shown at the right.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ___ It is proper to use a dull chisel to remove a nut.

2. ___ When sharpening a chisel, use a face shield or goggles.

3. ___ Mushroom headed chisels or punches should not be used.

/ / / / / / / / / / / / / / / / / / / /

1. False. A dull chisel will cause chips to fly and possibly injure someone.

2. True. When you sharpen a chisel, use a face shield or goggles.

3. True. A chisel or punch in this condition should not be used because the bent edges are likely to break off and injure someone or cause 'foreign object damage."

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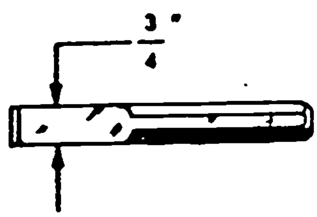
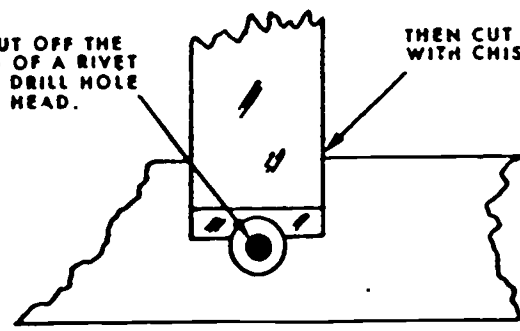
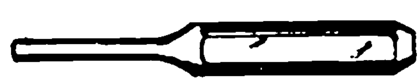
FRAME 25. PUNCHES AND CHISELS continued

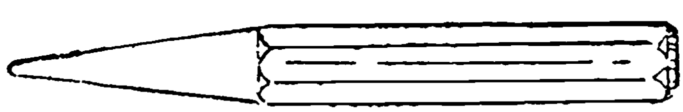




The size of a cold chisel is identified by the width of the blade. The cold chisel derives its name from the fact that it can be used to cut "cold metal". That is without first softening the metal by heating. They are ideally suited for removing the heads from rivets or cutting off stubborn bolts. The cold chisel is sometimes called a flat chisel.



The pin punch has a straight shank and is used to finish the job of driving rivets, bolts, or pins out of holes.



The drive or drift punch is used to start rivets, bolts, or pins out of holes.

Mark the following statements as either true (T) or false (F) in the space provided.

1. ___ The size of a cold chisel is identified by the width of the blade.

2. ___ The pin punch has a thick tapered shank and is used to enlarge holes.

3. ___ The drift punch is used to finish driving rivets or pins out of holes.

//////////////////////

1. True. 2. False. 3. False

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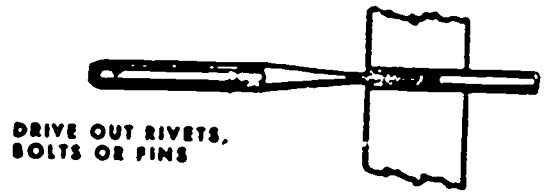
FRAME 26. REVIEW PUNCHES AND CHISELS.

Match the item listed in column B with the correct use in Column A.

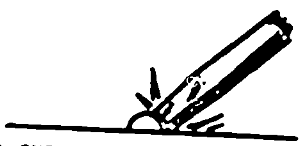
COLUMN A

COLUMN B



1. ____________________

a. Chisel



2. ____________________

b. Pin punch

c. Drive punch

/ / / / / / / / / / / / / / / /

1. b 2. a

FRAME 27. MEASURING TOOLS

The Air Force has many types of measuring tools. Each type has a specific job. We will cover a few of the more common types used by the mechanic.

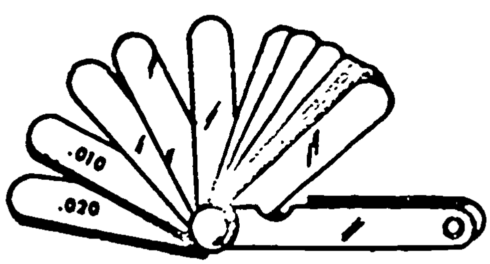
Use and Care of Measuring Devices

a. Keep all measuring tools clean. Oil lightly.

b. Turn in all tools that are not in good condition.

The simplest tool is the steel rule. Steel rules are made in various lengths, usually six or twelve inches. The smallest graduation on a steel rule will be 64ths of an inch.

Another type of measuring device is the steel tape. They extend to 6, 8, 10 or 12 feet.



A thickness gage is used to measure the clearance (space) between two parts that fit very closely together. Each leaf of the thickness gage is marked to show its thickness in thousandths of an inch.

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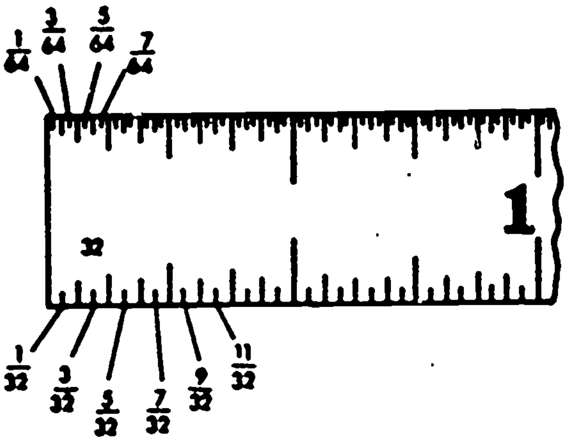
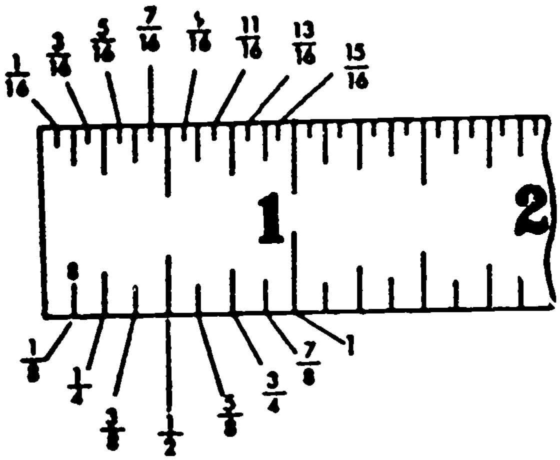
FRAME 28. REVIEW FOR MEASURING TOOLS





Using the above views, answer the following questions in the space provided.

1. ___ How many 64ths in 1/2 inch?

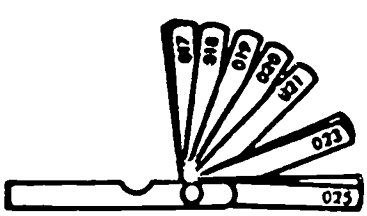
2. ___ How many 8ths in 3/4 inch?

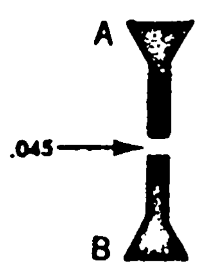
3. ___ How many 16th in 3/8 inch?

4. ___ How many 32nds in 1/4 inch?

If you had to check the clearance below, which two leaves of the thickness gauge would you use?

5. ________ ________





/ / / / / / / / / / / / / / / / / / / /

1. 32 2. 6 3. 6 4. 8 5. .022 and .023

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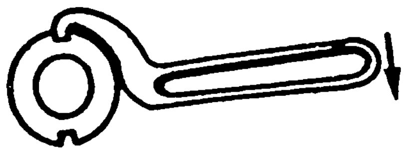
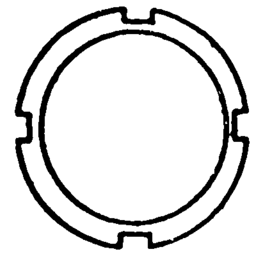
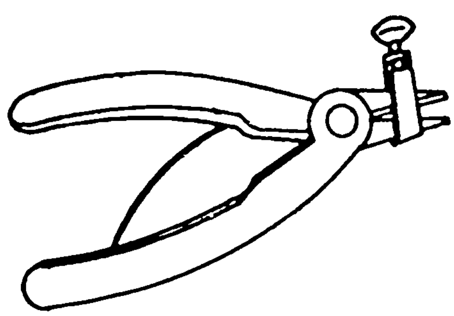
FRAME 29. SPECIAL HANDTOOLS

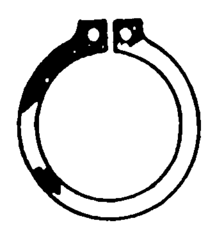
Special tools are designed for specific purposes and can be checked out from the special tool section of your base.





The spanner wrench (external) is made to fit round packing or gland type retaining nuts with lugs or slots in the outer surface, as shown above.





Snap ring extractors are made to slip into the holes in the ends of a snap ring and expand it to remove it, as shown above.

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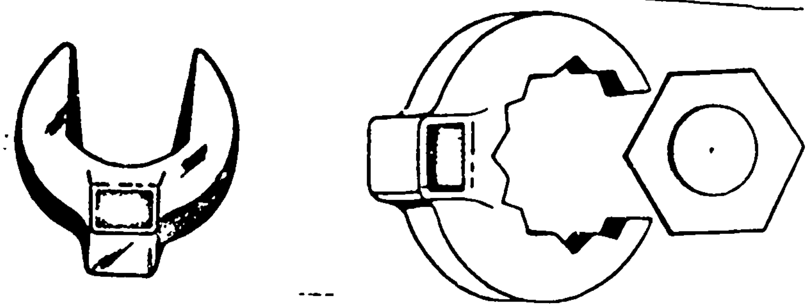
FRAME 30. MISCELLANEOUS HANDTOOLS

Miscellaneous handtools may or may not be issued as part of the mechanics' toolbox.



Another handy wrench for hard-to-reach places is the "crow's foot". This wrench has a female drive on one end and the same handles used with socket sets can be used. The crow's foot may be open end or box end type and is used to torque tubing nuts.

NO RESPONSE REQUIRED

FRAME 31. REVIEW

From memory, write the name of each tool in the space provided..

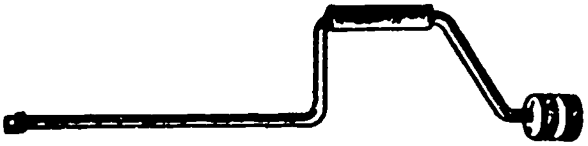
1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________



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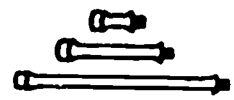
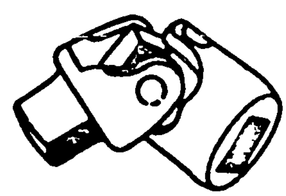
6. ____________________

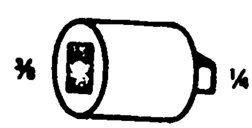
7. ____________________



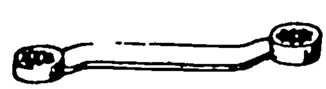
8. ____________________



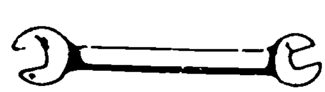
9. ____________________



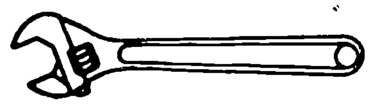
10. ____________________



11. ____________________



12. ______________________________



13. ______________________________

14. ______________________________

15. ______________________________

16. ______________________________

17. ______________________________

18. ______________________________

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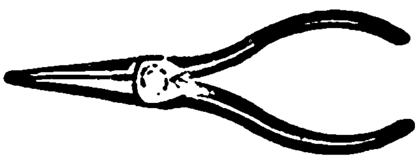
19. ______________________________

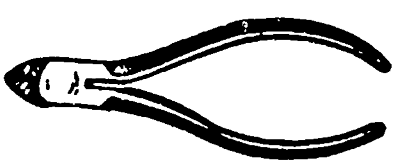
20. ______________________________

21. ______________________________

22. ______________________________



23. ______________________________

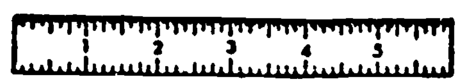


24. ______________________________

25. ______________________________

26. ______________________________

27. ______________________________



28. ______________________________

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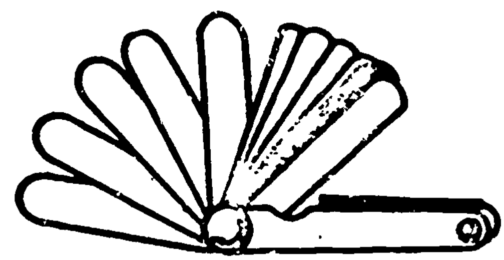
29. ______________________



Mark the following statements as either true (T) or false (F) in the space provided.

30. ___ Before and after each job, the mechanic should inventory his tools.

31. ___ The mechanic is responsible for keeping his tools oiled and clean.

32. ___ Rags and excess parts should not be stored in the mechanic's toolbox.

33. ___ Aircraft mechanics are financially responsible for their tools.

34. ___ The three groups of components that make up a socket set are attachments, handles, and sockets.

35. ___ The term mushroom head applies to punches and chisels.

36. ___ Box end wrenches are offset 15° to prevent injury to your hand.

37. ___ The tool used for measuring clearance is the thickness gauge.

38. ___ The mechanic's first choice of wrenches would be the socket set.

39. ___ The hammer best suited to drive a chisel would be the ball peen.

40. ___ The Phillips screwdriver is used in cross slot screws having round corners.

41. ___ The open end wrench is used to remove nuts from tubing and hose assemblies.

42. ___ The adjustable jaw of the adjustable wrench should point in the direction of rotation.

43. ___ The hammer used for shaping metal, where metal damage would be critical, is the mallet.

44. ___ Duckbill pliers are used for twisting safety wire.

45. ___ The hinge handle is best used for breaking loose tight nuts and bolts.

46. ___ Diagonal side cutters are used to cut wire and remove cotter pins.

47. ___ Solvent is used to clean grease and dirt from handtools.

48. ___ Lost or missing tools may cause foreign object damage.

49. ___ The socket head setscrew wrench is used in internal wrenching bolts.

50. ___ The Reed and Prince screwdriver is used in screws having cross slots with square corners.

/ / / / / / / / / / / / / / / / /

1. Deep well socket.
2. Shallow socket.
3. Ratchet handle.
4. Hinge handle.
5. Speed handle.
6. "T" handle.
7. Extension.
8. Universal.
9. Adapter.
10. Box end wrench.
11. Open end wrench.
12. Adjustsble jaw wrench.
13. Allen or hex head.
14. Phillips screwdriver.
15. Standard (common) screwdriver.
16. Reed and Prince screwdriver.
17. Crosspoint offset screwdriver.
18. Standard (common) offset screwdriver.
19. Channel lock pliers.

20. Slipjoint (common) pliers.

21. Flat nose (duckbill) pliers.

22. Chain long nose (needle nose) pliers.

23. Diagonal cutting pliers (dikes).

24. Vise grips.

25. Ball peen hammer.

26. Mallet.

27. Six inch steel rule.

28. Steel tape.

29. Thickness gauge.

Questions 30 through 50 are all true.

If all of your answers in the last three frames are correct, you have completed the Programmed Text portion of this lesson. Raise your hand to let the instructor know you are finished.

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STUDY GUIDE

3ABR42633-SG-104/104A/104B/104C

Technical Training

Jet Engine Mechanic
Turboprop Propulsion Mechanic

INTRODUCTION TO COMMON HANDTOOLS, HARDWARE, MEASURING DEVICES, AND SAFETY WIRING

11 April 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.
Do Not Use on the Job.

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-104/104A/104B/104C

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OPR: 3350 TCHTG
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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-104

COMMON HANDTOOLS

OBJECTIVES

After you have completed this study guide and your classroom instruction, you will be able to:

1. Select common handtools.
2. Care for common handtools.
3. Use common handtools on trainers.

INTRODUCTION

Technical Order 32-1-101, Maintenance and Care of Handtools, lists many common types of handtools. This study guide will also list some of the more commonly used handtools. As a jet engine mechanic, you will have handtools in your tool box or otherwise available if you should need them.

INFORMATION

FILES AND RASPS

Files and rasps are used to remove burrs from rough metal, tubing ends, and to smooth rough areas and edges on sheet metal. Figure 1 shows the construction of files and also shows examples of the more common types of files.

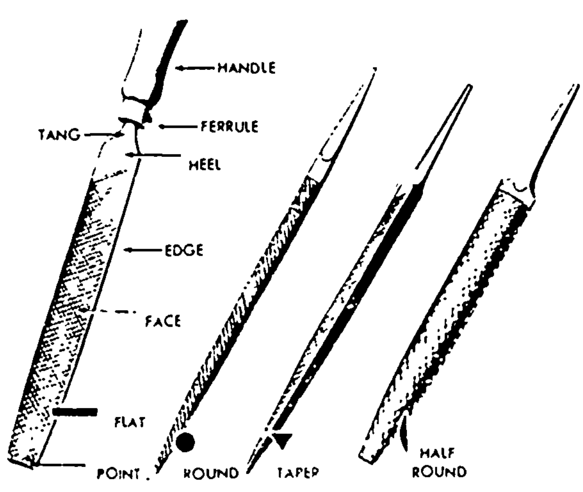

Figure 1. Files.

A file should always have an appropriate handle. The handle permits you to use the file with greater ease and safety.

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A file can be cleaned with a file brush or soft metal cleaning pin.

The file is designed to cut on the forward stroke; however, the file should not be forced down by applying pressure on the point, figure 2.

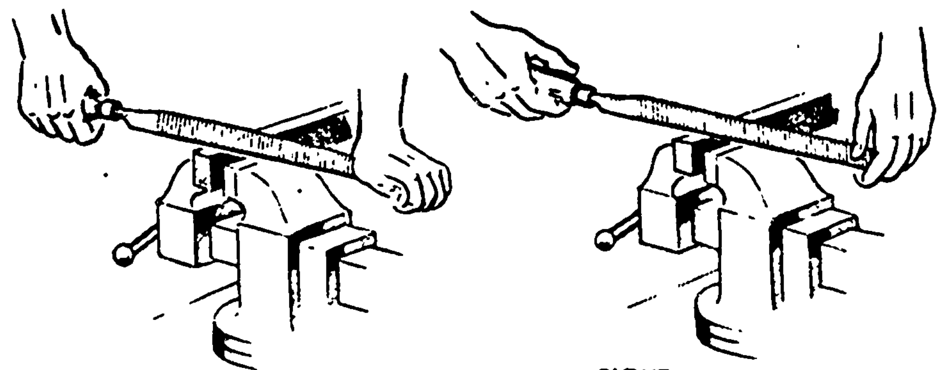

Figure 2. Use of Files.

HAMMERS, MALLETS, MAULS, AND SLEDGES

Hammers, mallets, mauls and sledges should be kept clean, free of grease and dirt. Grease and dirt on these tools create an additional safety hazard for persons using the tools; also, other persons in the immediate area will be subjected to increased danger.

Different types of hammers are shown in figure 3. They are quite varied for use on different jobs and materials. The rawhide mallet, for example, has a hard head which will allow a firm sharp head which will allow a firm sharp blow to metal and produce very little surface damage to the metal. The rounded ball portion of the ball-peen hammer can be used for bending or reshaping metals or rivets.

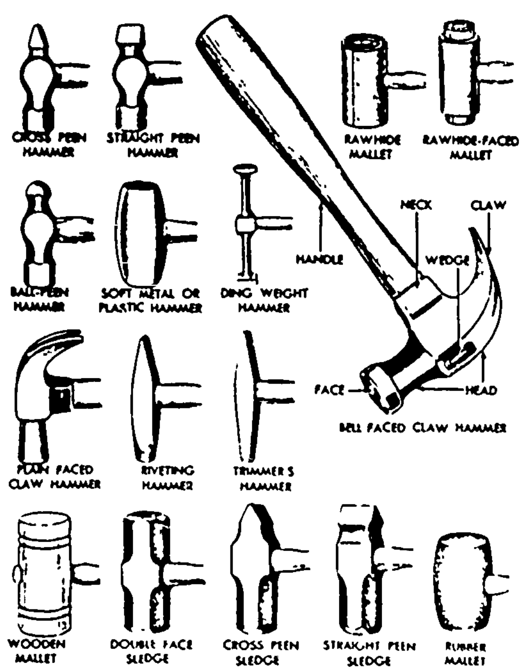

Figure 3. Hammers, Mallets, Mauls and Sledges.

CAUTION: A LOOSE HAMMER HEAD SHOULD BE TIGHTENED WITH A METAL WEDGE; THE HAMMER SHOULD NOT BE USED IF THE HEAD IS LOOSE ON THE HANDLE OR IF THE HANDLE IS CRACKED.

PLIERS

Pliers are used as an extension for the mechanic's fingers, for holding, bending and cutting metals, and materials when performing maintenance tasks. Figure 4 shows examples of pliers the mechanic may use.

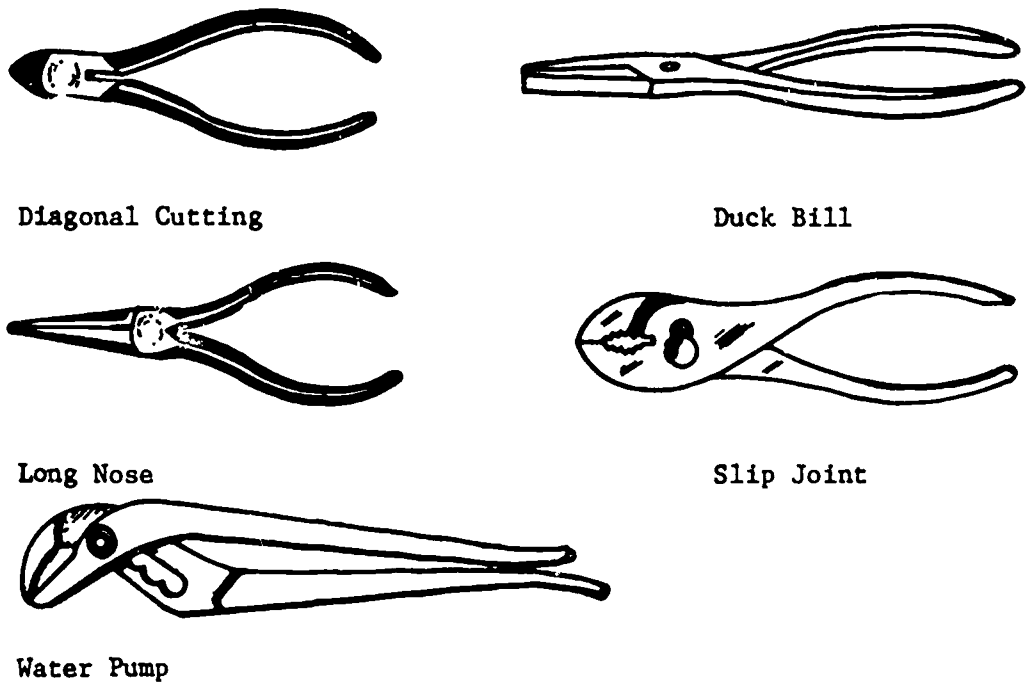

Figure 4. Pliers.

Diagonal side cutting pliers, commonly called "dikes," are used for cutting safety wire or removing cotter pins.

Long nose pliers, commonly called "needle-nose pliers," are used for grasping small items in tight places where fingers cannot reach.

Slip-joint pliers, usually called "common pliers," are used as a general purpose holding tool for bending pieces of metal or wire.

Water-pump pliers are very effective as a large capacity holding tool.

Duck bill pliers are used for pulling and twisting safety wire.

CAUTION: PLIERS SHOULD NOT BE USED TO APPLY TORQUE TO NUTS OR BOLTS; THIS WILL DAMAGE THE TOOL AND ALSO THE HARDWARE.

PUNCHES

Punches have many uses, the prick punch is used to make fine marks and to pierce thin sheet metal, figure 5.

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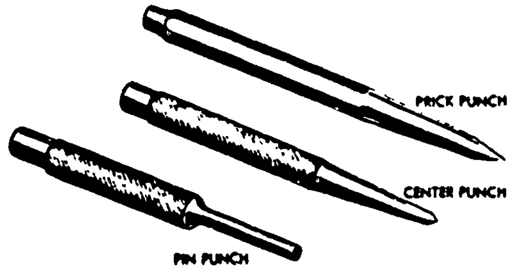

Figure 5. Punches.

The center punch is used to mark metal for drilling holes.

The pin punch is used to help drive rivets from holes after the rivet is loosened.

Note: The screwdriver should NOT be used as a punch.

SCREWDRIVERS

Screwdrivers are used to tighten or loosen screws. There are several different types of screwdrivers to fit different types of screws, figure 6.

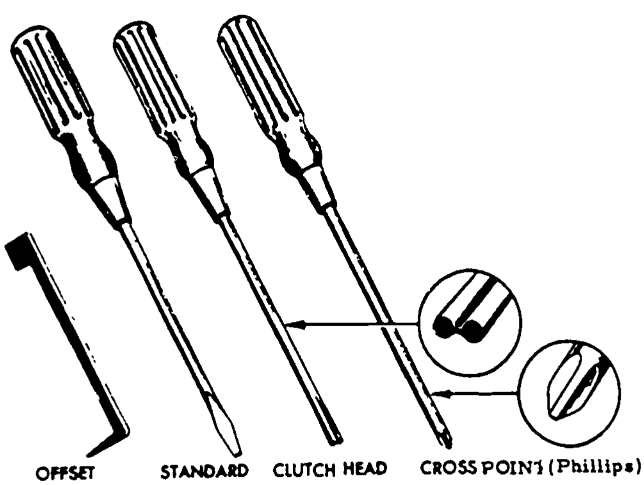

Figure 6. Screwdrivers.

The common standard screwdriver is used frequently by most mechanics.

The cross point screwdrivers, used on cross point screws, are the Phillips and the Reed and Prince.

The off-set screwdriver is ideal to use on screws that are located in a close or difficult position.

The clutch head screwdriver is to be used on screws of this particular head design.

CAUTION: USE THE SCREWDRIVER FOR THE PURPOSE AND IN THE MANNER IT WAS DESIGNED TO BE USED. DO NOT USE THE SCREWDRIVER TO PRY, TO SCRAPE, TO PUNCH, TO CHISEL OR AS A LEVER. DO NOT USE PLIERS ON THE SHANK OF THE SCREWDRIVER TO GAIN EXTRA LEVERAGE, FIGURE 7.

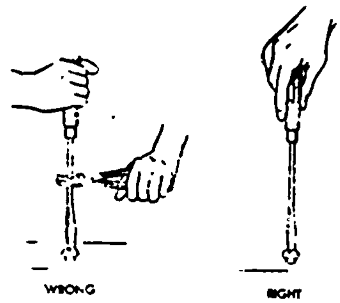

Figure 7. Use of the Screwdriver.

WRENCHES

Wrenches are used tc apply a tightening force or, on the other hand, is used to loosen nuts, bolts and lines.

The mechanic on the job, will use socket wrenches, open end wrenches, box wrenches and adjustable wrenches, figure 8.

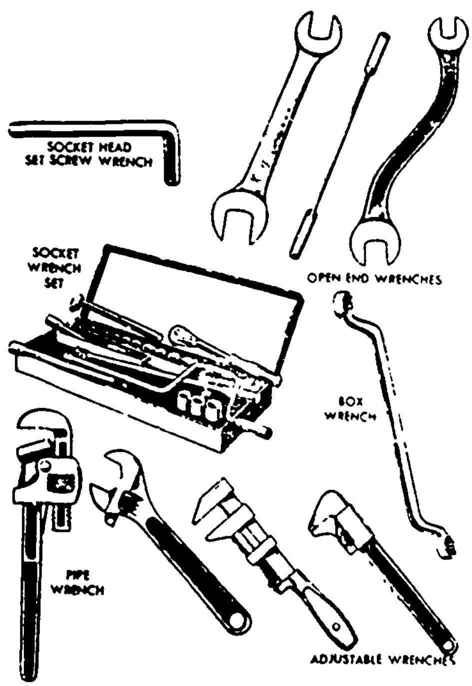

Figure 8. Wrenches.

Note: Safety, speed, and application are important aspects to remember when selecting a wrench. That is, the mechanic should select and use the wrench that is the most practical and safe, for a particular job of tighening or loosening parts on an engine. The wrong application of the adjustable wrench can be hazardous and also may damage engine parts, figure 9.

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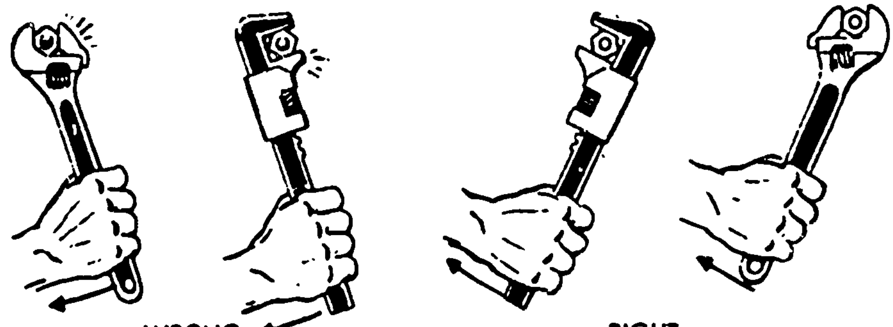

Figure 9. Use of the Adjustable Wrench.

CAUTION: DO NOT USE PIPE OR OTHER EXTENSIONS TO INCREASE THE LEVERAGE ON A WRENCH. THE USE OF AN EXTENSION WILL USUALLY DAMAGE THE EQUIPMENT AND MAY ALSO CAUSE INJURY TO THE PERSON USING THE TOOL, FIGURE 10.

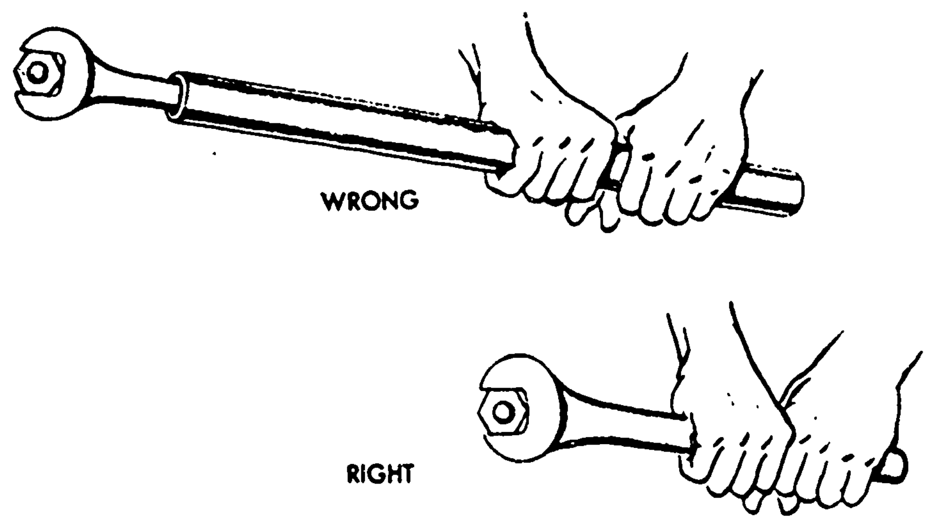

Figure 10. Use of the Wrench.

QUESTIONS

1. What is used to clean a file?

2. Name three types of hammers.

3. Why are pliers used?

4. Name three types of punches.

5. Name two types of cross-point screwdrivers.

6. What are three important things to remember when selecting wrenches?

Jet Engine Branch
Chanute AFB, Illinois

HARDWARE

OBJECTIVES

After you have completed this study guide and your classroom instruction, you will be able to:

1. State the purpose of hardware.

2. Identify the types of hardware.

INTRODUCTION

The purpose of this study guide is to introduce some of the aerospace hardware that you may use as a mechanic. Because of the small size of some hardware, its importance is sometimes overlooked. This study guide is designed to cover only a portion of aircraft and engine hardware. The information is general; for more current data refer to TO 1-1A-8 on aircraft hardware, also the TO pertaining to your specific equipment.

INFORMATION

SCREWS

The screw is the most common type of threaded fastener used on aircraft. They are similar to other types of threaded fasteners, but usually have a lower material strength or loose thread fit. Each type screw requires a particular type screwdriver. There are four main groups of screws, the structural screw, machine screw, self-tapping screw, and set screw.

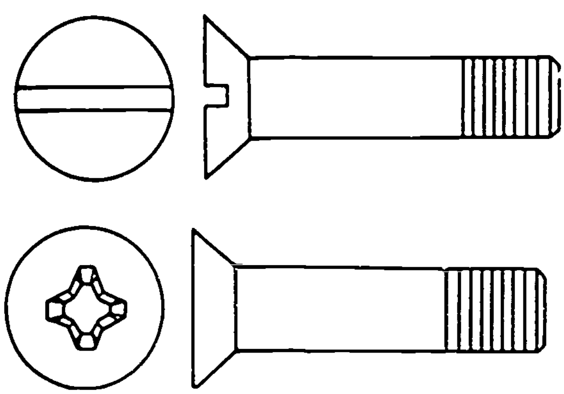

Figure 11. Structural Screw.

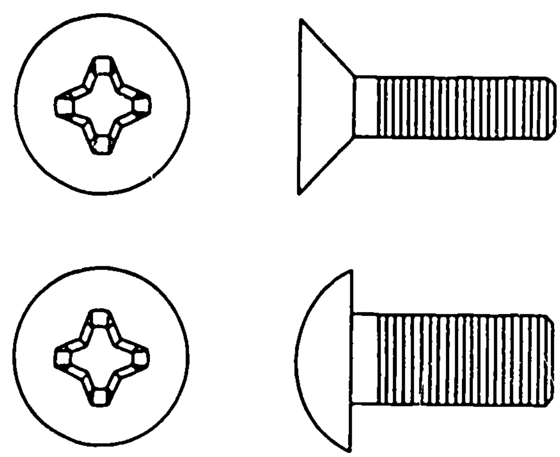

Figure 12. Machine Screw (Flathead and Roundhead).

The structural screw is used in the primary structure of the aircraft as are rivets or bolts, figure 11.

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The machine screw is widely used and there are many varied types and designs, for example, the flathead, roundhead, fillister head, socket head, pan and truss head, figure 12.

Self-tapping screws tap their own threads as they bore into the materials. Examples of the self-tapping screws are wood screws and sheetmetal screws, figure 13.

Set screws are used to secure or position units such as gears or pulleys on shafts, figure 14.

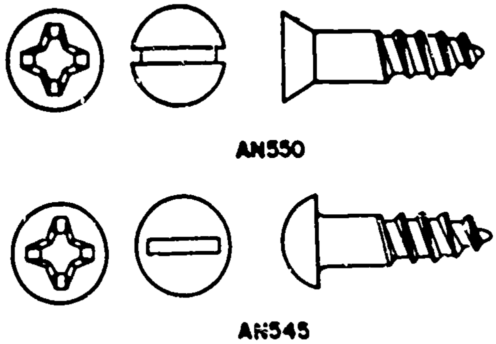

Figure 13. Self-Tapping Screws.

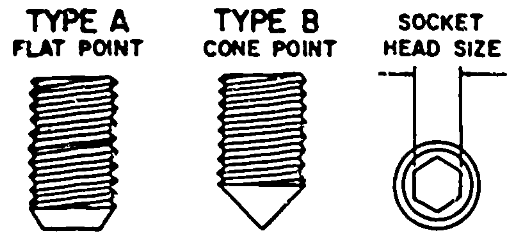

Figure 14. Set Screws.

BOLTS

Most bolts used for the aircraft structure are general purpose, internal wrenching, or close-tolerance bolts. Some bolts are designed for a particular purpose and application, these should always be replaced with like items. These special bolts are usually designed by the manufacturer and marked on the head with a stamped letter "S," for special. Before any bolt is tightened or replaced the equipment TO should always be checked for proper hardware identification and replacement information. Standard aircraft bolts are designed for general applications that involve certain tension or shearing loads. The size of the bolt is determined by the three size readings, figure 15. The length of the shank (a), the diameter of the shank (b), and the number of threads per inch (c).

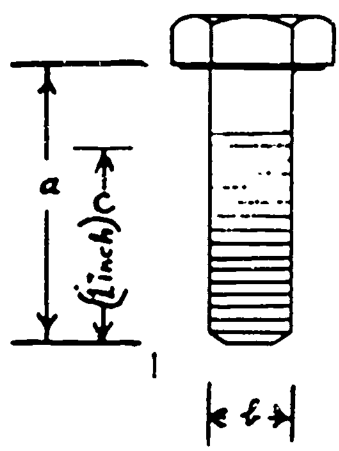

Figure 15. Determining Bolt Size.

The standard aircraft bolt head will be in the shape of a hexagon design, figure 16. A special head such as an internal wrenching, figure 17, a 12 point external wrenching, figure 18, or an eye bolt, figure 19, will be used as specified by the TO.

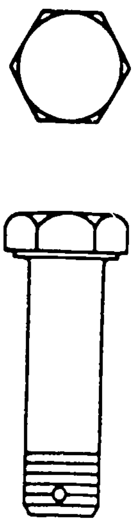

Figure 16. Standard Aircraft Bolt.

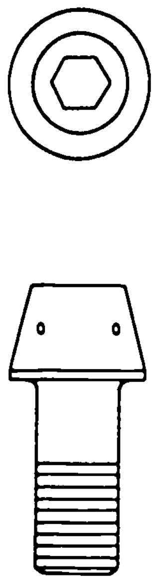

Figure 17. Internal Wrenching.

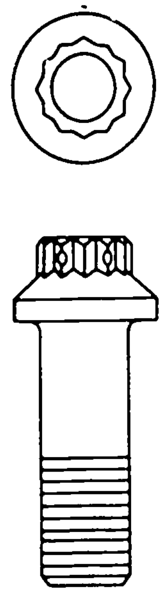

Figure 18 12-Point External Wrenching.

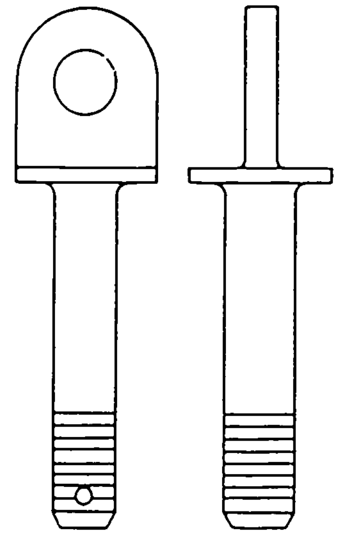

Figure 19 Eye Bolt.

Note: The holes in the bolt heads are for lockwire; and, in the shank end the holes are used for lockwire or cotter pins.

Bolt heads are stamped (coded) to show the physical characteristics of a particular bolt, figure 20.

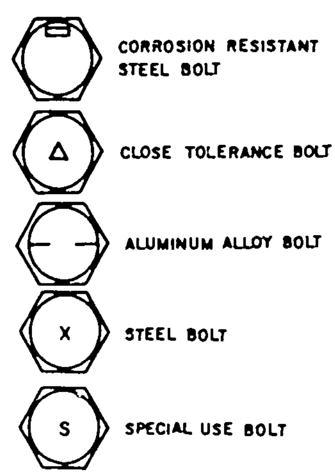

Figure 20. Stamped (Coded) Bolt Heads.

Note: Other letters or numbers used to code bolts are explained in TO 1-1A-8, Aircraft Structural Hardware. When the TO specifies a steel bolt is to be used it cannot be replaced with bolts made of aluminum or other materials. The markings or codes on the bolts make the identification and selection of the correct bolt easy and saves time.

STUDS

Studs are used in soft metals or materials where damage could result if bolts used to fasten parts were removed and installed repeatedly. The stud is installed in the unit and a nut is used on the exposed end of the stud to secure the part or accessory.

There are many types of studs; the most common types are the straight and stepped, figures 21 and 22.

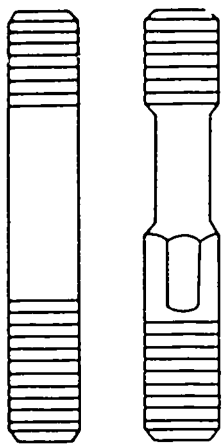

Figure 21.
Straight Studs.

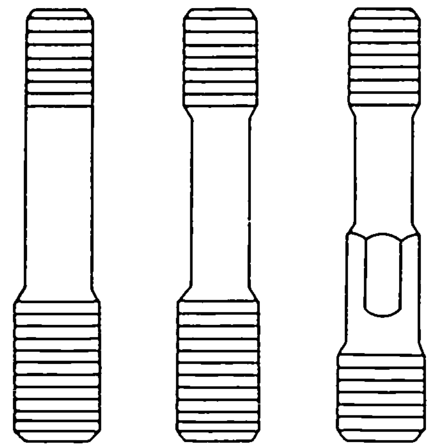

Figure 22.
Stepped Studs.

NUTS

The nut is threaded internally to mate with the threads on a bolt or screw. The primary function of a nut (fastener) is to apply tension to the bolt or stud. This tension holds the joined members together. Before torquing any nut or bolt, check the TO for proper torque to apply on any specific item of equipment.

There are many types of nuts used on Air Force equipment and the military standard nuts are of one piece construction. An exception to the one piece construction, is the nonmetallic inserted nut.

Self-locking nuts provide a tight connection which will not loosen because of vibration. The two major types of self-locking nuts are the torque type and free-spinning nuts. The torque type nut requires the use of a wrench throughout the entire tightening cycle after the bolt or screw threads have been engaged. An example of the torque nut is the nonmetallic inserted (fiber) nut. This nut has a nylon locking section which grips the bolt or screw thread and prevents the nut loosening. This nut is not used where it would be subjected to temperatures above 250°F.

Note: No self-locking nut is to be used at a joint or aircraft structure that is subjected to rotational movement in relation to the bolt.

Nonself-locking nuts vary in design and purpose. Examples are the plain, check, wing and castle nuts.

Plain Nut

The plain nut, figure 23, is used to a very limited extent on the aircraft. It must be locked, usually with a check nut or lock washer.

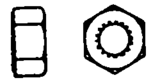

Figure 23. Plain Nut.

Check Nut

The check nut, figure 24, is used for a locking device for plain nuts, set screws, threaded rod ends and other devices.

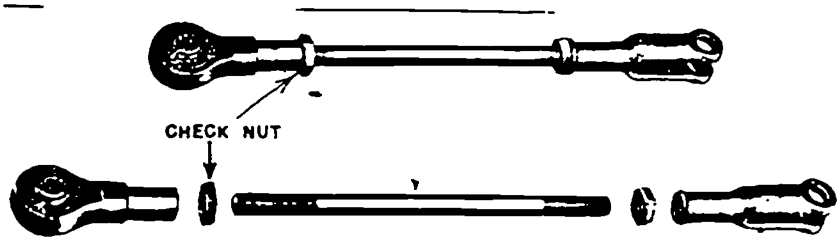

Figure 24. Check Nut.

Wing Nut

The wing nut, figure 25, is used where the desired torque is to be applied by the use of the fingers.

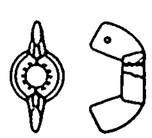

Figure 25. Wing Nut.

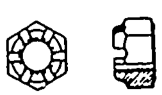

Figure 26. Castle Nut.

Castle Nut

The castle nut, figure 26, is used on a drilled bolt or screw and is secured by a cotter pin.

WASHERS

Washers: The most commonly used washers on an aircraft are the plain washers, lock washers and special washers.

Plain washers, figure 27, are used under nuts and bolts to provide a smooth surface and protect the surface from crushing damage when the nut is tightened. Aluminum or aluminum alloy plain washers are used under bolts and nuts on magnesium units to prevent corrosion.

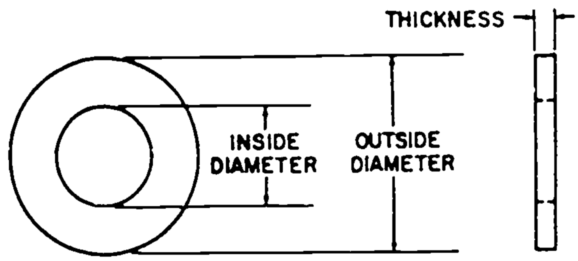

Figure 27. Plain Washers.

Lockwashers, figure 28, provide a spring pressure under the nut to prevent loosening. It is used only if the equipment TO specifies its use. When used on soft surfaces a plain washer must be used under the lockwasher to prevent damage to the soft materials.

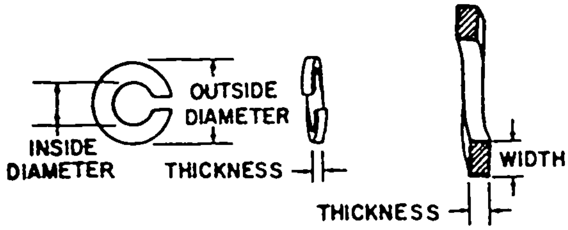

Figure 28. Lockwashers.

Special washers, figures 29 and 30, are designed to be used in special locations for special jobs; the TO shows where and when to use special washers.

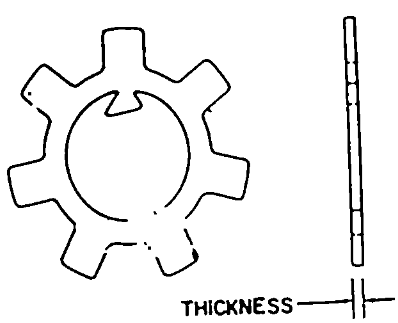

Figure 29. Special Washer.

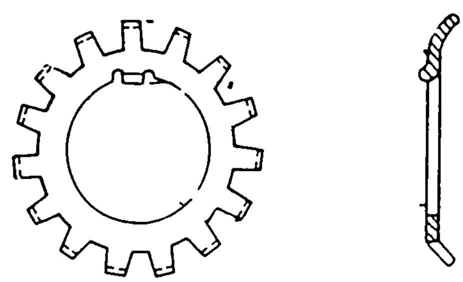

Figure 30. Special Washer.

PINS

Pins are used to secure aircraft hardware items or units. There are many types of pins, such as tapered pins, flat pins, cotter pins, spring pins and quick release pins.

Tapered pins, figure 31, are used in joints that carry shear loads and where the absence of clearance is essential.

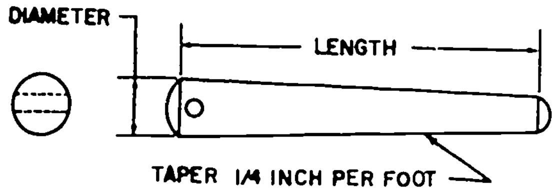

Figure 31. Tapered Pin.

Flat head pins, figure 32, are used with tie rod terminals or secondary controls. The flat head pin is secured with a cotter pin.

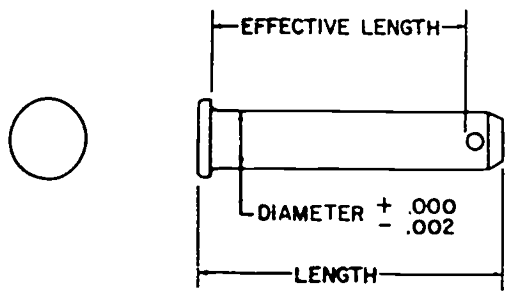

Figure 32. Flat Head Pin.

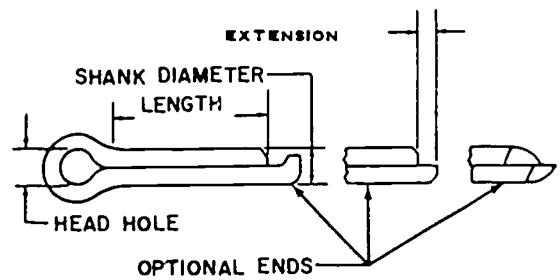

Figure 33. Cotter Pin.

Cotter pins, figure 33, are used to secure bolts, nuts, screws, and pins where necessary. Cotter pins are used one time and should never be reused, but should be replaced with a new pin.

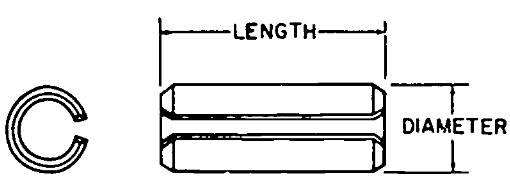

Figure 34. Spring Pin.

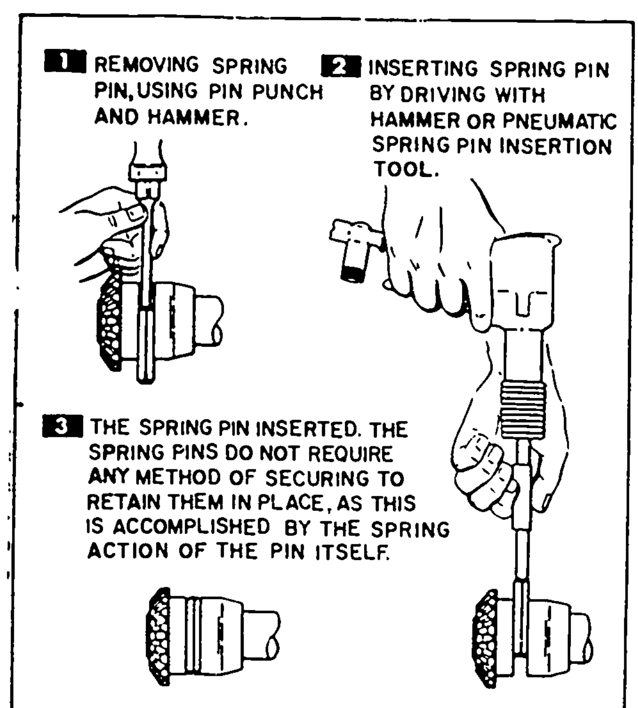

Figure 35. Spring Pin, Removal and Installation.

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Spring pins, figures 34 and 35, are heat treated to obtain maximum strength and toughness in the pins. The outside diameter of a pin is greater than the hole the pin is installed in, therefore, a steady pressure is exerted by the spring pin after it is installed.

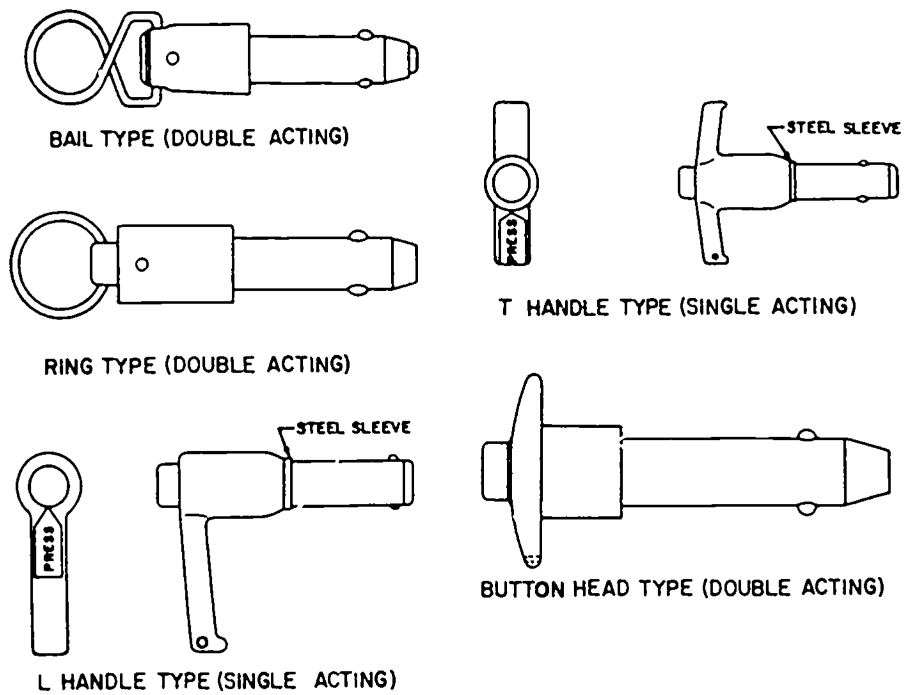


Figure 36. Quick Release Pins.

Quick release pins, figure 36, sometimes referred to as "pip" pins, where rapid removal and replacement of equipment is necessary.

THREADED INSERTS

Threaded inserts are commonly used in aircraft, engines and accessories to protect and strengthen tapped threads in light materials, metals and plastics, particularly in locations or on parts that require frequent assembly and disassembly. The three types of threaded inserts are the lock ring, clinch nut and the one-piece threaded insert.

The lock ring threaded insert of the standard or self-tapping type, figure 37, can be placed in any material that can be drilled and tapped. The lock ring threaded insert is constructed of strong steel and bolts, studs, or screws will not cause damage to its internal teeth. The lock ring, installed by pressure, prevents the insert from coming loose because of vibration or removal of the bolt.

The clinch nut type threaded insert, figure 38, provides a permanent fastener where a nut is to remain in place. This allows for simplicity and speed in removal and reassembly of the unit.

One piece threaded inserts, figure 39, are precision formed coils of diamond-shaped wire and are used as screw thread bushings. The one piece threaded inserts are available in various diameters and thread sizes. They are used in some instances with steel studs and bolts.

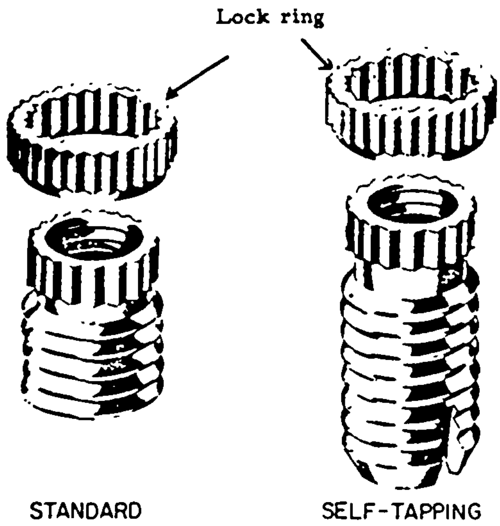


Figure 37.
Lock Ring Threaded Inserts.

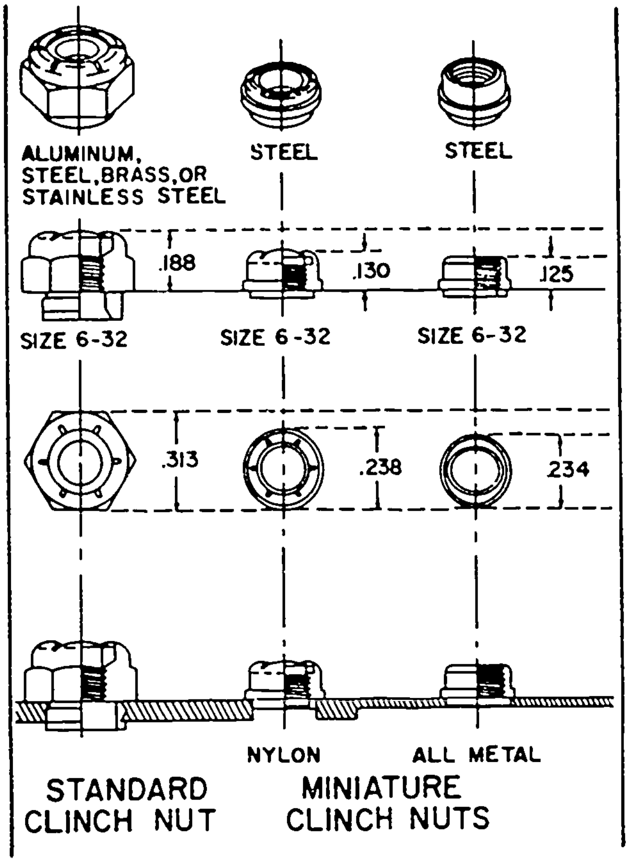


Figure 38. Clinch Nut Type Threaded Inserts.

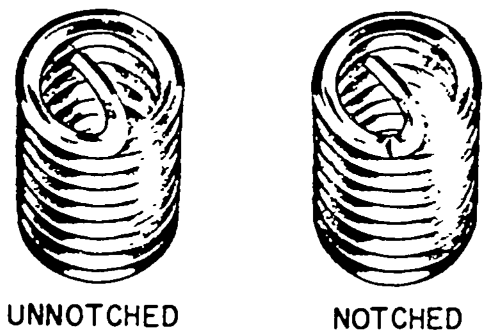


Figure 39. One-Piece Threaded Inserts.

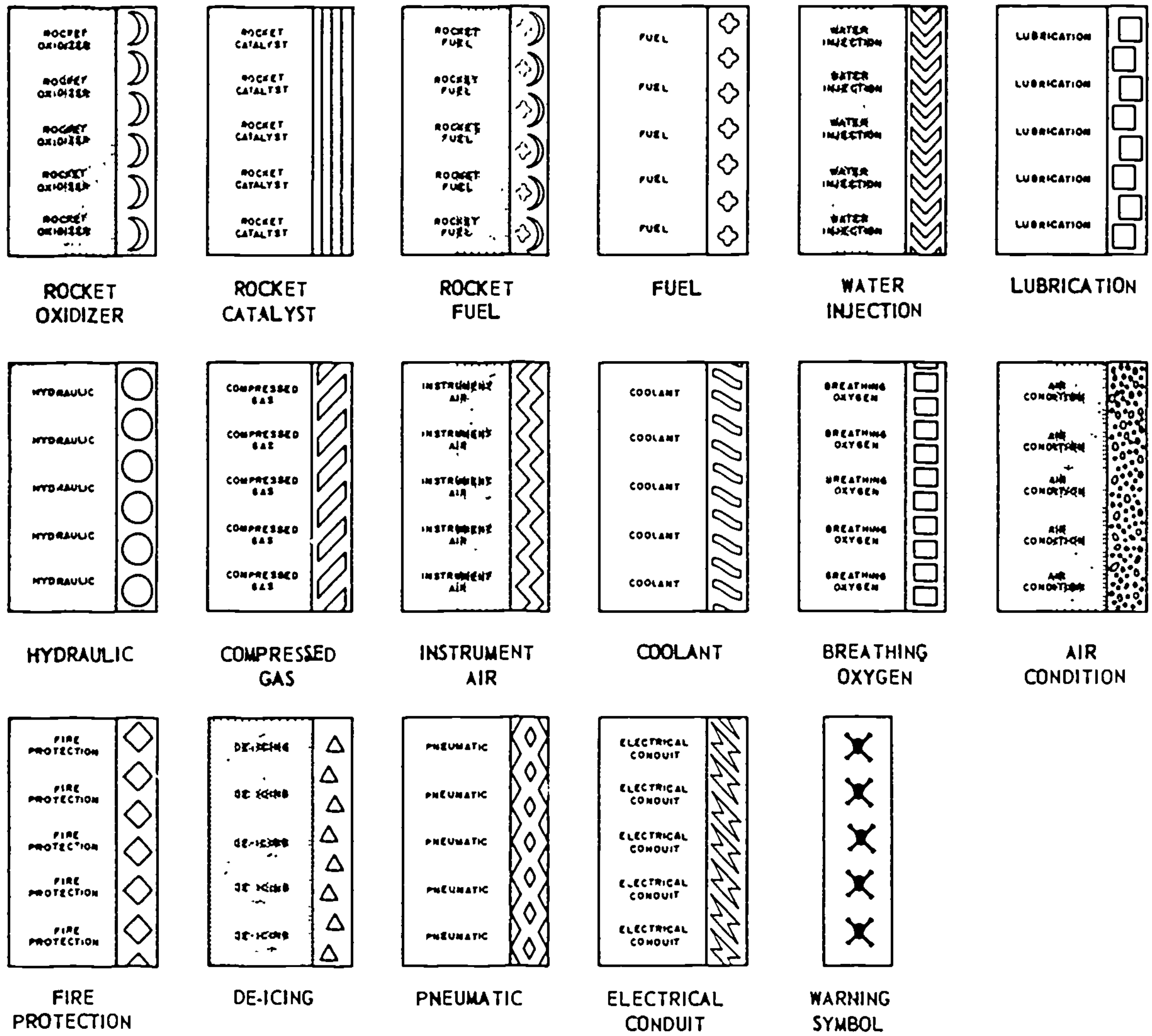
TUBING AND SYSTEM IDENTIFICATION

Tubing such as stainless steel and aluminum alloy are used to carry fluids and gases in the various systems. The color coded tape, figure 40, is used to aid in rapid and accurate identification of the tubes (lines) of the various systems.

Stainless steel tubing is corrosion resistant and used in high pressure systems. This tubing will withstand as much as 3000 psi, such as is used in hydraulic system for landing gear, wing flaps and brakes.

Aluminum alloy tubing is used for geneal purpose lines and conduits for low fluid pressures. This tubing is used for instrument lines, electrical and ven lating conduits and drain lines.

Note: All tubing should be handled carefully to prevent sharp bends, kinks, nicks, or scratches on the tubing.



THE ABOVE COLOR CODES REPRESENT DESIGNATION FOR SYSTEMS ONLY. FOR CODING LINES WHICH DO NOT FALL INTO ONE OF THESE SYSTEMS THE CONTENTS SHALL BE DESIGNATED BY BLACK LETTERING ON A WHITE TAPE.

SUBSIDIARY FUNCTIONS OR IDENTIFICATION OF LINE CONTENT MAY BE INDICATED BY THE USE OF ADDITIONAL WORDS OR ABBREVIATIONS WHICH SHALL BE CARRIED ON A SECOND TAPE ADJACENT TO THE FIRST OR ALTERNATIVELY, INTERPOSED BETWEEN THE WORDS DESCRIPTIVE OF THE MAIN FUNCTION.

WARNING SYMBOL TAPES, 3/8-INCH WIDE, SHALL BE APPLIED TO THOSE LINES WHOSE CONTENTS ARE CONSIDERED TO BE DANGEROUS TO MAINTENANCE PERSONNEL. WARNING TAPES ARE TO BE PLACED ADJACENT TO SYSTEM IDENTIFICATION TAPES.

ONE BAND SHALL BE LOCATED ON EACH TUBE SEGMENT, 24 INCHES OR SHORTER. ONE BAND SHALL BE LOCATED AT EACH END OF EACH TUBE SEGMENT LONGER THAN 24 INCHES. ADDITIONAL BANDS SHALL BE APPLIED WHEN THE TUBE SEGMENT PASSES THROUGH MORE THAN ONE COMPARTMENT OR BULKHEAD. AT LEAST ONE BAND SHALL BE VISIBLE IN EACH COMPARTMENT OR ON EACH SIDE OF THE BULKHEAD.

PRESSURE TRANSMITTER LINES SHALL BE IDENTIFIED BY THE SAME COLORS AS THE LINES FROM WHICH THE PRESSURE IS BEING TRANSMITTED

FILLER LINES, VENT LINES AND DRAIN LINES OF A SYSTEM SHALL BE IDENTIFIED BY THE SAME COLORS AS THE RELATED SYSTEM.

TAPES SHALL NOT BE USED ON FLUID LINES IN THE ENGINE COMPARTMENT WHERE THERE IS A POSSIBILITY OF THE TAPE BEING DRAWN INTO THE ENGINE INTAKE. FOR SUCH LOCATIONS, SUITABLE PAINTS, CONFORMING TO THIS COLOR CODE, AND WHICH HAVE NO DELETERIOUS EFFECT ON THE MATERIAL USED FOR THE LINES, SHALL BE USED FOR IDENTIFICATION PURPOSES. IN THESE CASES THE GEOMETRICAL SYMBOLS MAY BE OMITTED.

Figure 40. Color Coding for Tubing and Hoses.

QUESTIONS

1. Name four types of screws.
2. Name four types of bolts.
3. Name two types of studs.
4. When are plain washers used?
5. When are castle nuts used?
6. Name two types of pins.
7. Name three types of threaded inserts.
8. Name two types of tubing.
9. What is the color code for fuel lines or hoses?
10. What is the color code for hydraulic lines or hoses?

MEASURING DEVICES

OBJECTIVES

After you have completed this study guide and your classroom instruction, you will be able to:

1. Identify types of measuring devices.

2. Use measuring devices on simple projects.

INTRODUCTION

The work of a mechanic is no more accurate than the measurements he may make. It is important, therefore, that he learns to hold, use, and read the measuring device correctly and accurately. There are many different types and kinds of measuring devices; each device is designed to be used for a specific purpose. Examples of measuring devices are: a 6-inch steel rule, thickness gage, screwpitch gage, calipers, and micrometers.

MICROMETER

The micrometer is the most accurate of the adjustable measuring instruments. It is used to measure to within one-thousandth (0.001) of an inch. If it is equipped with a vernier scale, it will measure to within one ten-thousandth (0.0001) of an inch. An outside micrometer is shown in figure 41. The principle parts of an outside micrometer are the anvil, spindle, frame, barrel and thimble. Some micrometers are equipped with a lock and ratchet stop.

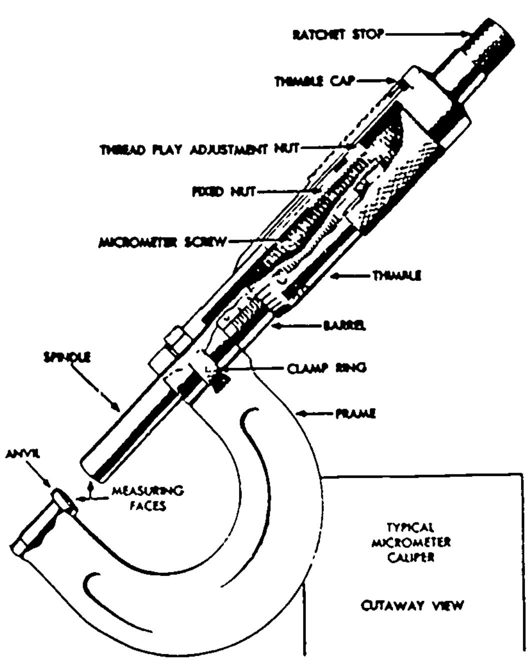


Figure 41. Outside Micrometer.

The anvil is one of the two measuring faces between which the work is measured. The anvil is mounted in the frame opposite the spindle face, figure 41.

The spindle is the other of the two measuring faces of the micrometer. A clockwise rotation of the thimble will cause the spindle to move toward the anvil, while a counterclockwise rotation of the thimble will cause the spindle to move away from the anvil.

The frame, figure 42, holds the anvil in place, and is also held in the mechanic's hand when he is measuring or working with the micrometer.

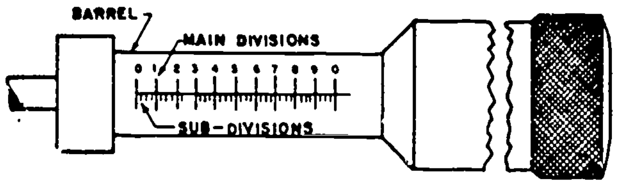


Figure 42. Main and Subdivision on the Barrel.

The barrel of a micrometer that has a range of one inch is divided into ten main divisions, each division equaling one-hundred thousandths of an inch (0.100). Each main division of the barrel is then subdivided into four equal subdivisions of twenty-five thousandths (0.025) of an inch, figures 42 and 43.

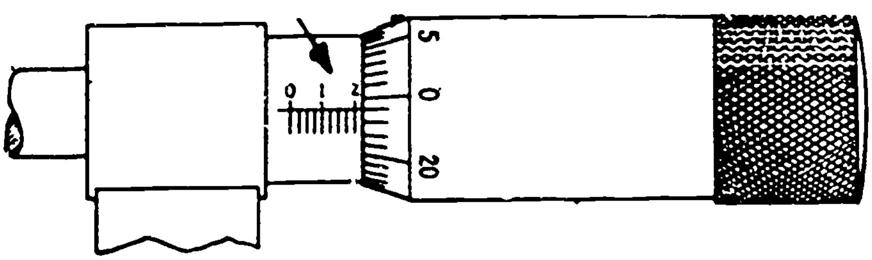


Figure 43. Micrometer Readings.

The thimble has a beveled edge which is divided into 25 equal divisions, each of these divisions equals one thousandths of an inch (0.001). These divisions are marked, for convenience, at every five spaces by 0, 5, 10, 15 and 20. One complete turn of the thimble will move the spindle twenty-five thousandths (0.025) of an inch, figure 43.

Different types of micrometers are used for different types of measurements, mainly outside measurements, inside measurements and depth measurements. The principles, of use and operation of all types of micrometers is about the same.

An inside micrometer, figure 44, is used to measure the inside diameter of cylinders, the width of recesses and other similar inside dimensions.

A depth micrometer, figure 45, is used to measure the depth of a recess or hole.

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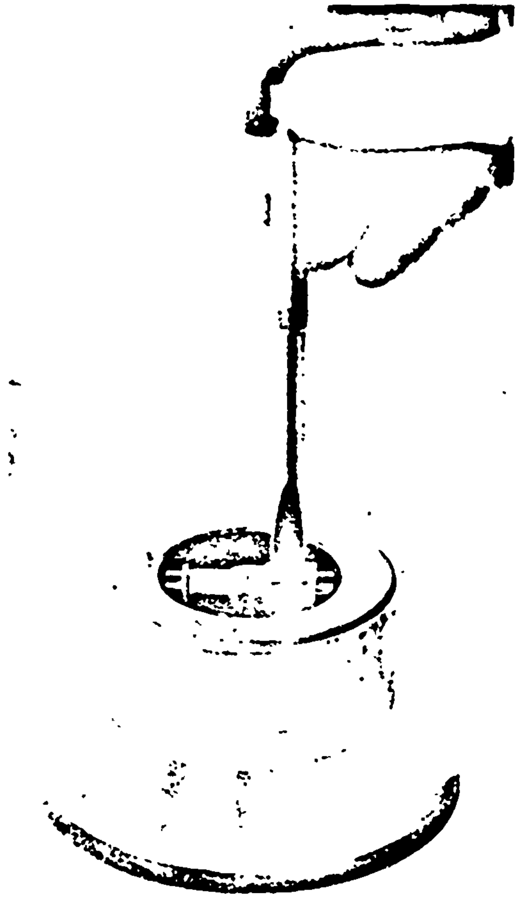

Figure 44. *Measuring with an Inside Micrometer.*

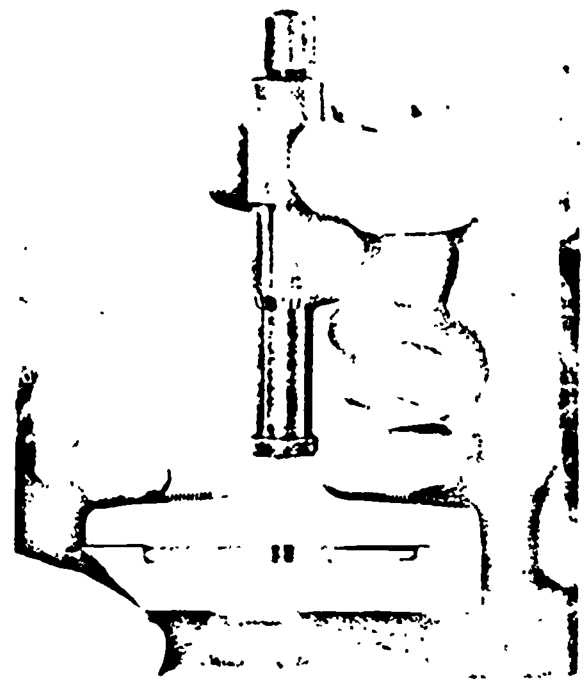

Figure 45. *Using a Depth Micrometer.*

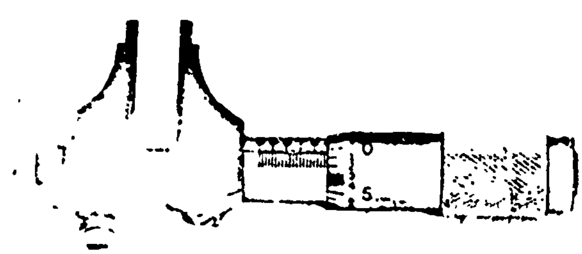

Figure 46. Inside Micrometer Caliper.

An inside micrometer caliper, figure 46, is another form of micrometer that is designed for inside measurements such as small diameters and narrow slots.

The first step in learning to use a micrometer is to hold it correctly, figure 47. The thumb and first finger are used to turn the thimble until the anvil and spindle just touch the material. Only a very slight tension should be applied, and it should be the same every time the micrometer is used. Many micrometers have a ratchet on the end of the thimble which will slip when tension becomes too great and will prevent overtightening.

The spindle of the micrometer should always be perpendicular to the material being measured. If it is not, the micrometer reading will be slightly greater than the actual size of the material.

Figure 47. Correct Way to Hold a Small Outside Micrometer.

The micrometer is a most delicate measuring instrument, rough handling or misuse will reduce its accuracy or cause it to be inoperable. When the micrometer is not being used, place it gently on a smooth clean surface. Do not bump or drop the micrometer. Place a light film of clean oil on the surface of the micrometer. Never use dirty oil, or permit dirt particles, to touch or accumulate on the micrometer -- KEEP IT CLEAN. Do not tighten the thimble, but use a very light touch when adjusting the micrometer for measurements.

CALIPERS

Calipers are used for measuring or transferring diameters and distances or comparing distances and sizes. They are classified as <u>sliding</u> or <u>spring</u> calipers, and either classification may be used for inside or outside measurements. Measurements taken with calipers are considered more accurate than those taken with a rule. They can be used to take measurements to within one thousandth (0.001) of an inch.

The caliper rule, figure 48, has a fixed jaw at the end of a bar and a movable jaw fastened to a frame which slides on this bar. The bar has a scale on it and the frame has two index marks labeled IN and OUT. One side of the jaw is used to take outside measurements and the other side of the jaw is used to take inside measurements.

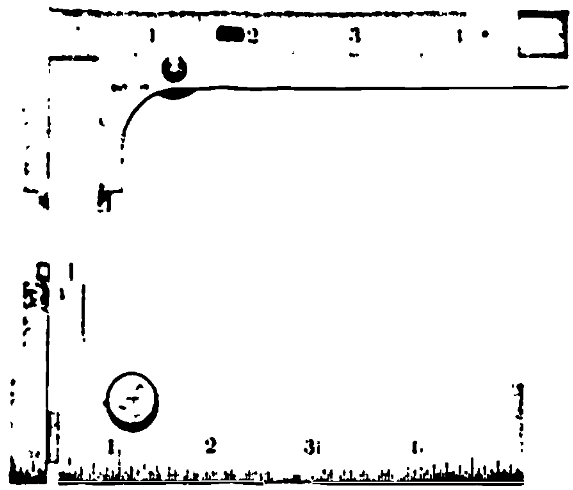

Figure 48. Two Views of a Simple Caliper Rule.

Spring calipers, figures 49 and 50, have no scale and are used mainly to transfer dimensions. They are used to take the inside or outside dimensions of a piece of material.

Figure 49. Three Types of Outside Calipers.

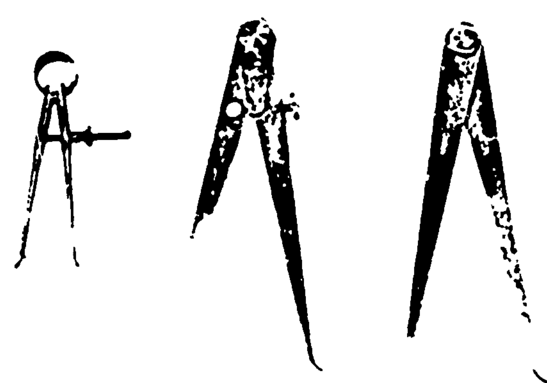

Figure 50. Three Types of Inside Calipers.

Sliding calipers should be kept clean and oiled. They should never be jammed tightly on the material, this may spring the jaws and damage the calipers.

Spring calipers should not be used when material is moving, nor should the calipers be forced on the material. They may not be damaged, but they will spring slightly and give an inaccurate measurement.

SCREW PITCH GAGE

This gage is sometimes referred to as a thread pitch gage. It is similar in appearance to the thickness gage; however, all the leaves have about the same thickness. The edge of each leaf has a different number of teeth per inch cut in it, figure 51. The screw pitch gage is used to determine the number of threads per inch on a screw, bolt, or other threaded units. The number of threads per inch on a threaded object may be determined by trying various leaves of the gage until one fits perfectly. The number stamped into the leaf indicates the number of threads per inch (TPI), figure 52.

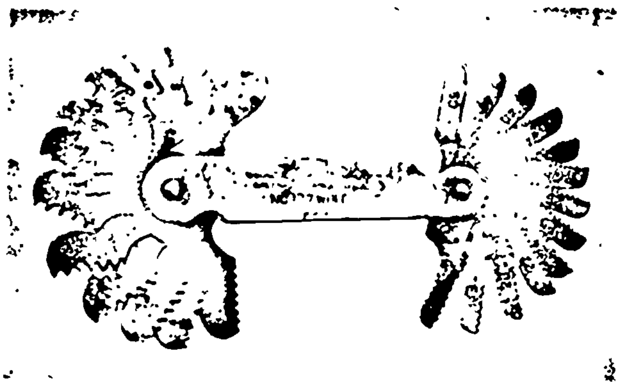

Figure 51. Thread Pitch Gage.

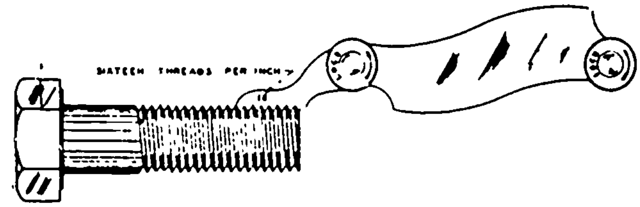

Figure 52. Use of Screw Pitch Gage.

THICKNESS GAGE

The thickness gage consists of thin leaves of hard steel, figure 53. Each leaf is precision ground to a definite thickness. The leaves are usually in sets, with one end of the leaf fastened in a case. A set usually includes 26 leaves that range in size from fifteen ten-thousandths (0.0015) to twenty-five thousandths (0.025) of an inch.

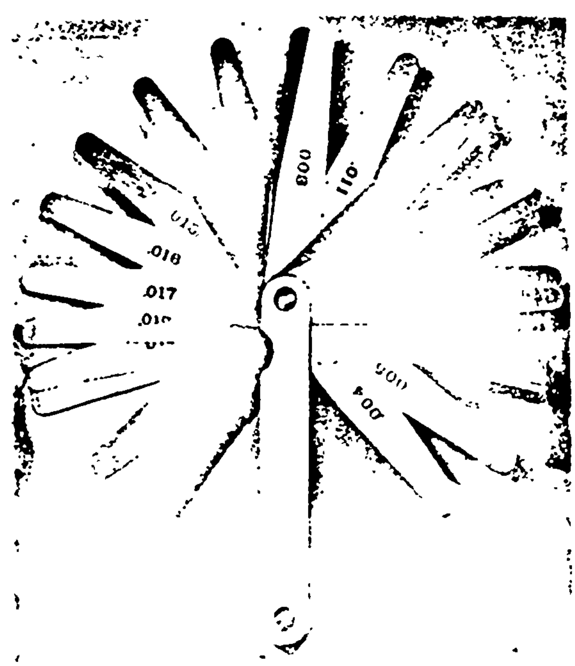

Figure 53. Typical Thickness Gage.

Thickness gages are used to measure the clearance between two parts. One leaf at a time is tried until the leaf which will enter the opening is found. The thickness of that leaf is then read and the clearance determined. The leaf should be wiped off before trying to insert it

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between two parts. It should never be forced! Only a light pressure should be applied. If the leaf is forced, it may spread the opening slightly, thus giving an inaccurate indication of size. There is danger also of kinking and damaging the leaf. If a leaf of the proper thickness is not available, two leaves may be wiped clean and used together.

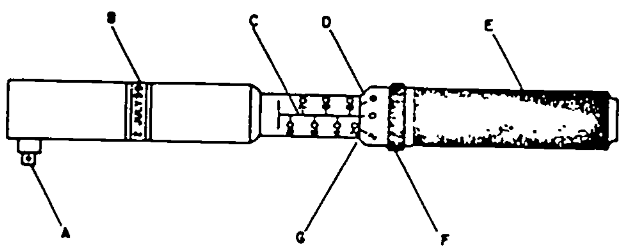
STEEL RULES

Rules are usually made of steel and are 4, 6, or 12 inches in length. The largest unit of measurement common to these rules is the inch. The inch may be divided into smaller parts known as fractional parts of an inch. There are four graduations on a steel rule. They are 1/8, 1/16, 1/32 and 1/64 of an inch.

The rule is a measuring instrument. It is not a screwdriver, a pry, a scraper, or a putty knife. The rule should never be used for one of these tools.

TORQUE WRENCHES

A torque wrench consists of a torque handle and a socket. It enables a mechanic to tighten a nut or bolt with exactly the proper amount of tightness. Two different types of torque handles used in the Air Force are the automatic release or breakaway and ratchet "T" handle, figure 54.



IDENTIFICATION CODE

- A SQUARE DRIVE
- B COLOR CODE
- C SHAFT SCALE
- D GRIP MARKINGS
- E GRIP
- F GRIP LOCK
- G GRIP END

Figure 54. Automatic Release or Breakaway Torque Handle.

The automatic release of breakaway type torque handle is designed in such a way that when the set amount of torque is reached the handle will automatically release or "break." When the handle releases, it will have approximately fifteen to twenty degrees of free travel. The desired torque setting is accomplished by turning the grip (E) section of the handle clockwise to raise the torque and counterclockwise to lower the torque. The numbers on the shaft scale (C) and grip markings (D) represent foot pounds or inch pounds, according to the size of the handle being used. When the grip lock (F) is unlocked, the grip (E) can be turned to any given setting within the range of the scale. As the grip is turned it moves along the shaft scale. One revolution of the grip moves the grip end through a 10 inch pound range or from one number to the next. The grip markings (D) are used to obtain a setting which falls between two consecutive numbers on the scale. Two reference lines must be considered when setting the handle to a given torque. First, the grip end is the reference line for reading numbers on the shaft scale. Second, the shaft scale line (C) is the reference line the reading numbers on the grip end. If it is desired to set the torque indicating handle to 20 inch pounds, turn the grip until the grip is on the 20 mark and the 0 on the grip end is in line with the shaft scale line (C).

The "T" handle torque wrench, figure 55, is shaped like a "T," as the name implies. It has a preset torque and cannot be adjusted like the other torque wrenches. When a nut or hose clamp has been tightened to the set torque, the handle will ratchet, if the handle is turned further it will not tighten the nut any more.

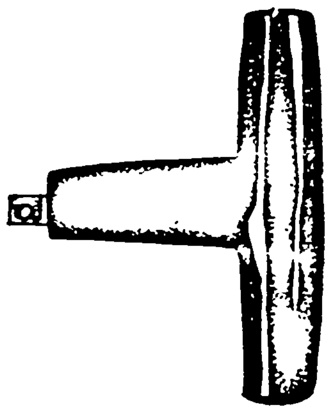


Figure 55. "T" Handle Torque Wrench.

The purpose of tightening a screw or a nut on a stud is to place the screw or stud under tension. The amount of tension is very critical in some assemblies. If a nut is left too loose, it does not hold securely. If it is tightened too tight, it may pull the bolt, strip the threads, or put an unnecessary and possibly dangerous strain on the members being held together. If a set of nuts on a unit are not all tightened with the same torque, internal stresses will be set up in the unit. These stresses may cause eventual failure of the unit. Check after check has shown that structural failure and rapid wear have been caused by improper tightening of nuts and bolts.

Torque exerted by the mechanic while using the torque wrench, is an approximate measure of the tension. However, torque as a measure of screw or stud tension is approximately accurate, only, if proper technique is used while the torque wrench is being used.

When the torque wrench is being used and the specified torque is approached, keep the nut or screw moving with a steady, slow, sweep of the wrench until the specified torque is reached.

Note: A fast or jerky motion will result in an improperly torqued or damaged fastener.

In all torque requirements, the desired torque value is predetermined and may be found in the appropriate technical order.

Torque wrenches should be calibrated every 60 days or more often depending upon how much the handle is used. A strip of color code tape and the day, month and year, will be placed on the handle to indicate when the handle is next due. Treat a torque wrench as a delicate instrument. A torque wrench cannot be treated as carelessly as a box wrench or screwdriver without losing its accuracy. If the torque wrench is dropped, it must be calibrated before using it again.

QUESTIONS

1. Name the four principle parts of an outside micrometer.

2. The barrel of a micrometer is divided into how many main divisions?

3. Name three types of micrometers.

4. When are calipers used?

5. What is the purpose of a screwpitch gage?

6. What is the purpose of a torque wrench?

7. How often are torque handles calibrated?

8. Where are all torque requirements found?

SAFETY WIRE (LOCKWIRING)

OBJECTIVES

After you have completed this study guide and your classroom instruction, you will be able to use safetywire correctly by lockwiring three bolts together.

INTRODUCTION

Safetywire is used to secure aircraft and engine hardware items such as nuts, bolts, lines, and caps. After the hardware item has been tightened properly, safetywire is installed to prevent the items from loosening because of vibration or strain.

BASIC RULES OF LOCKWIRING

Lockwire must be tight after installation to prevent failure due to rubbing or vibration.

Lockwire must be installed in a manner that tends to tighten and keep the part locked in place, thus counteracting the natural tendency of a part to loosen.

Lockwire must not be overstressed, it will break under vibration if twisted too tightly. Lockwire must be taut when it is being twisted, but shall have minimum tension, if any, when secured.

Lockwire ends must be bent toward the engine or part, to avoid sharp or projecting ends which might present a safety hazard or vibrate in the air stream.

Internal wiring must not cross over or obstruct a flow passage when an alternate method can be used.

The applicable TO should be consulted before using lockwire on any piece of equipment.

Always apply the correct torque to nuts and bolts before installing the safety wire.

TWISTING THE LOCKWIRE

To prevent mutilation of the twisted section of the wire when using pliers, grasp the wire at the ends or at a point where the wire will not be twisted. Lockwire must not be nicked, kinked or mutilated. Never twist or break the wire ends off with pliers. When cutting off the wire ends, leave at least three complete turns after the loop; also, exercise extreme care to prevent wire ends from falling into the engine. The strength of the lockwire holes in nuts and bolts is marginal, never twist the wire off with the pliers. In the event the original lockwire hole is damaged on the nuts, an additional hole may be drilled on the opposite side of the nut.

Caution: Remove burrs and sharp edges from the damaged lockwire holes.

Methods of lockwiring include the double twist method and the single strand method. Refer to the TO on specific equipment for the preferred method to use on lockwiring.

The double twist method is done two different ways, the over the head method and around the head method.

LOCKWIRING PROCEDURES

Figures 56, 57, and 58 illustrate typical lockwiring procedures. There are many lockwiring procedures performed on the engines, and practically all of the procedures are derived from the basic examples shown in these figures.

QUESTIONS

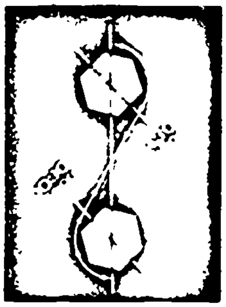
1. Name four basic rules of lockwiring.

2. Name two methods of lockwiring.

3. How many turns (twists) should be left on the end of lockwire?

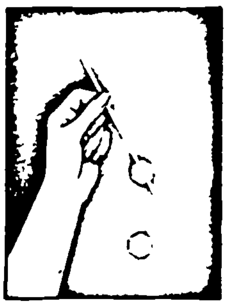
4. Name two ways the double twist method can be done.

5. On specific equipment, what method of lockwiring should be used?



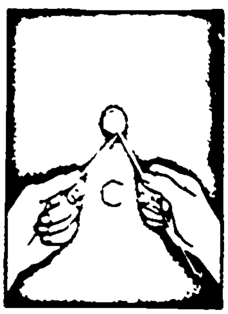
1

Position the holes



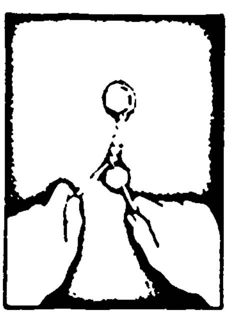
2

Insert proper gage wire. To determine the proper wire to be used in conjunction with a particular tightening operation refer to the correspondingly designated engine parts catalog or illustrated parts breakdown. Lockwire which is specially treated for 982°C (1800°F) applications has a dark gray to black color.



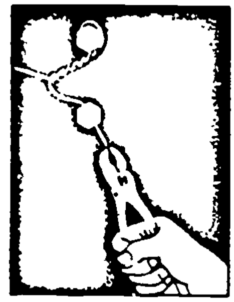
3

Grasp upper end of the wire and bend it around the head of the bolt; then under the other end of the wire. Be sure wire is tight around head.



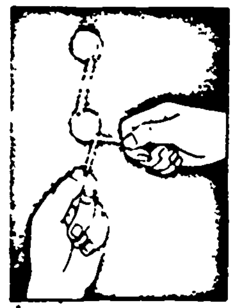
4

Twist wire until wire is just short of hole in the second bolt.



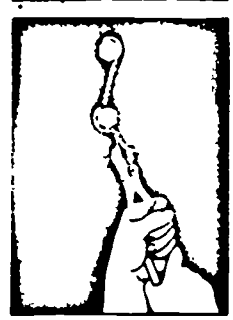
5

Insert the uppermost wire, which points towards the second bolt, through the hole which lies between the nine and twelve o'clock position. Grasp the end of the wire with a pair of pliers and pull the wire tight.



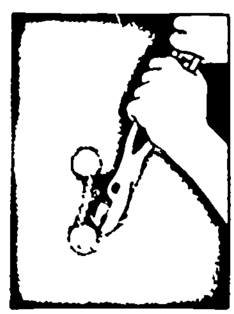
6

Bring the free end of the wire around the bolt head in a counterclockwise direction and under the end protruding from the bolt hole. Twist the wire in a counterclockwise direction.



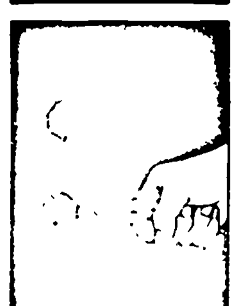
7

Grasp the wire beyond the twisted portion and twist the wire ends counterclockwise until tight.



8

During the final twisting motion of the pliers, bend the wire down and under the head of the bolt.



9

Cut off excess wire with diagonal cutters.

L-5254

Figure 56. Lockwiring Procedures.

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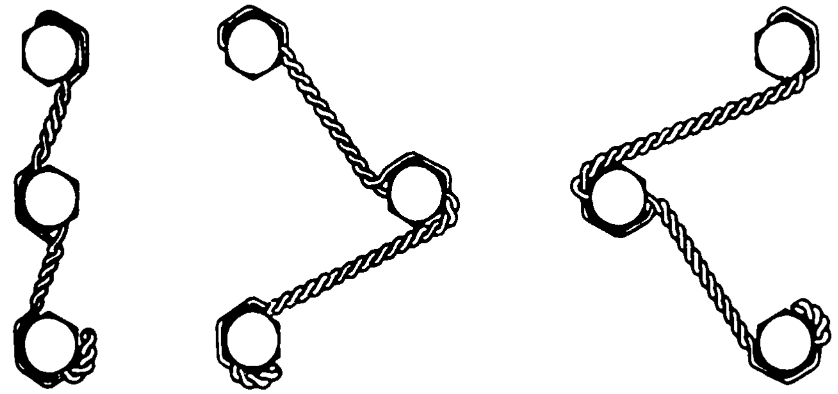
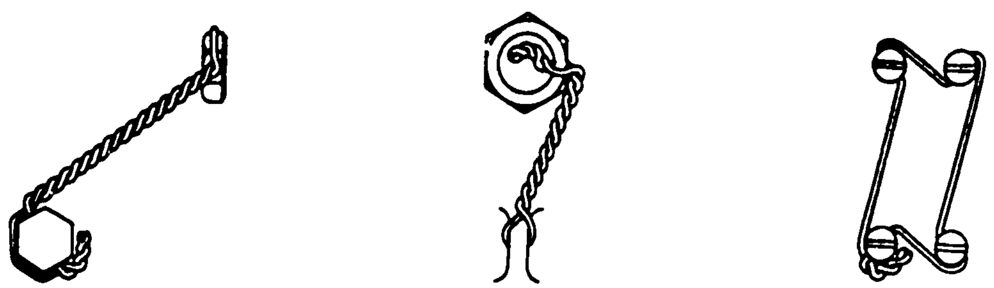


EXAMPLE 1 EXAMPLE 2 EXAMPLE 3 EXAMPLE 4

Examples 1, 2, 3, and 4 apply to all types of bolts, fillister head screws, square head plugs, and other similar parts which are wired so that the loosening tendency of either part is counteracted by tightening of the other part. The direction of twist — from the second to the third unit is counterclockwise to keep the loop in position against the head of the bolt. The wire entering the hole in the third unit will be the lower wire and by making a counterclockwise twist after it leaves the hole, the loop will be secured in place around the head of that bolt.

EXAMPLE 5 EXAMPLE 6 EXAMPLE 7 EXAMPLE 8

Examples 5, 6, 7 & 8 show methods for wiring various standard items. Note: Wire may be wrapped over the unit rather than around it when wiring castellated nuts or on other items when there is a clearance problem.



EXAMPLE 9

Example 9 shows the method for wiring bolts in different planes. Note that wire should always be applied so that tension is in the tightening direction.

EXAMPLE 10

Hollow head plugs shall be wired as shown with the tab bent inside the hole to avoid snags and possible injury to personnel working on the engine.

EXAMPLE 11

Correct application of single wire to closely spaced multiple group.

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Figure 57. Lockwiring.

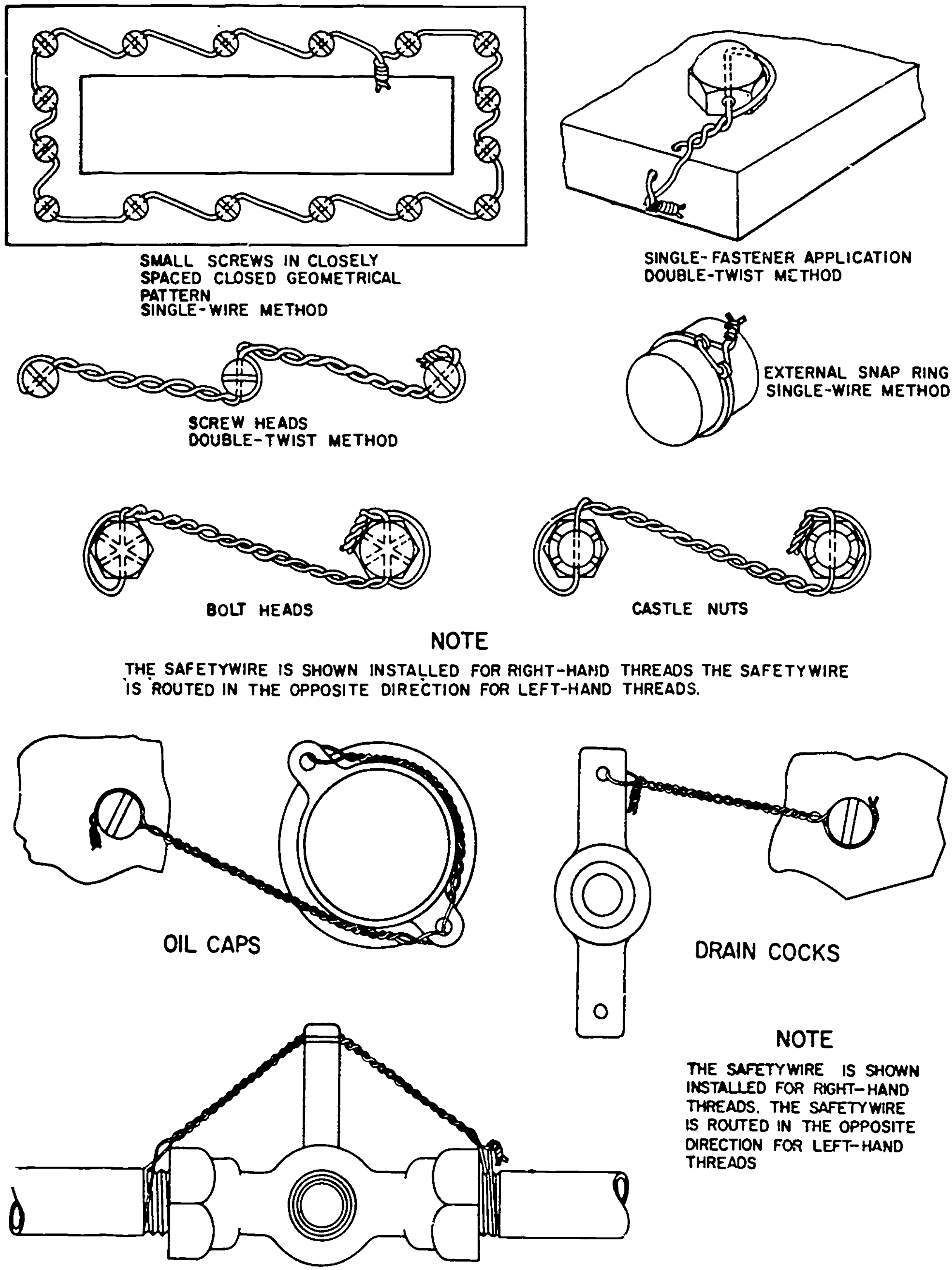

Figure 58. Lockwiring.

77-47069

Jet Engine Branch
Chanute AFB, Illinois

3ABR43230-WB-102D
19 November 1974

TORQUE WRENCHES

OBJECTIVES

When you have completed this workbook, you will be able to:

1. State the purpose and proper use of torque wrenches.

2. State the method used for torque conversion.

EQUIPMENT

	Basis of Issue
3ABR43230-SG-103B	1/student

PROCEDURE

Use the information presented in the classroom presentation, discussion, study guide, and aid from the instructor. Fill in the spaces provided with the correct information.

1. Torque wrenches are used to obtain a predetermined ______________ value as prescribed in the technical orders and manuals.

2. Torque Conversions: 12 inch-pounds equal ______________ foot-pound.

a. To change:

(1) Foot-pounds to inch-pounds, you __________ by 12.

(2) Inch-pounds to foot-pounds, you __________ by 12.

b. Work the following problems:

(1) 60 foot-pounds equals __________ inch-pounds.

(2) 216 inch-pounds equals __________ foot-pounds.

(3) 576 inch-pounds equals __________ foot-pounds.

(4) 75 foot-pounds equals __________ inch-pounds.

This supersedes 3ABR43230-WS-102D, 21 March 1973. RGL: N/A
OPR: TAR
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Designed for ATC Course Use. Do Not Use on the Job.

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Choose from these words to complete items 3 through 20.

bolts	fast	smooth
breakaway	jerky	steady
capacity	lock	techniques
color code tape	lowest	sixty
common tools	memory	torque
date	nuts	torque control
extension	overtorque	verified
smooth	release	overtorque

3. The most common type of torque wrench used in the Air Force is the ______________ type.

4. When the torque reaches a preset value, the handle will ______________ or breakaway approximately 15 degrees travel.

5. When the mechanic feels the handle release, he knows the proper ______________ has been reached.

6. Once the torque wrench has released DO NOT PULL AGAIN, not even to recheck the torque, as this will ______________ the bolt.

7. Unlock and rotate the grip to the desired torque setting on the shaft, then ______________ the grip in place.

8. Torque should be applied in a ______________ and ______________ motion to prevent overtightening.

9. With a ______________ or ______________ pull, you might not feel the breakaway action of the torque wrench and could easily ______________ the bolt or nut.

10. Torque control, as it is called, is the ability to apply torque in a ______________, steady motion.

11. Proper tightening of aircraft hardware is called ______________ ______________.

12. A good mechanic will not take torque control lightly, and will be familiar with correct torque application ______________ and procedures.

13. Torque wrenches are precision instruments and are not to be used as ______________ ______________.

14. NEVER back off ______________ or ______________ with a torque wrench.

15. Don't use a torque wrench to apply more force than the rated ______________ of the tool.

16. NEVER use an ______________ on the handle or grip end.

17. Before storing the torque wrench, return the handle to the ______________ setting on the shaft.

18. Torque wrenches should be ______________ every ______________ days or when dropped, and recalibrated if necessary.

19. Each time a torque wrench is verified, the ______________ and ______________ ______________ ______________ will be placed on the shaft.

20. Always check the technical order for correct torque values, NEVER RELY ON ______________.

QUESTIONS

1. You multiply by 12 to change __________ - __________ to __________ - __________.

2. Convert 780 inch-pounds to foot-pounds. Ans: __________

3. One foot-pound equals ______________ inch-pounds.

4. Convert 55 foot-pounds to inch-pounds. Ans: __________

5. The ______________ torque wrench releases when the torque reaches the setting on the wrench.

6. Never recheck ______________ as this will cause overtightening.

7. Torque should be applied in a ______________, ______________ motion.

8. Correct torque application techniques and procedures are called ______________ ______________.

9. Torque wrenches are precision instruments and are not to be used as common ______________.

10. Never go beyond the ______________ action of a torque wrench.

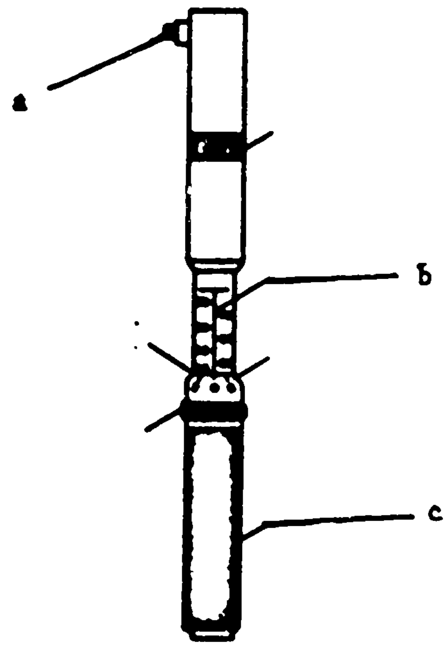
11. ______________ re not to be used on the handle or grip end.

12. Return the ______________ to the lowest setting before storing.

13. Torque wrenches should be calibrated or verified every ______________ days or when ______________.

14. What is placed on the shaft of torque wrenches to indicate when the next due date is for verification or calibration? Ans: ______________ and ______________ ______________ ______________

15. ______________ ______________ will always specify correct torque values.



16. Identify the three basic parts of the torque wrench.

a. ______________

b. ______________

c. ______________

WORKBOOK

3ABR42632-WB-104A

Technical Training

Jet Engine Mechanic

SAFETY DEVICES

14 August 1979

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

RGL: N/A

225

Jet Engine Branch
Chanute AFB, Illinois

3ABR42632-WB-104A

SAFETY DEVICES

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to identify safety devices used on aircraft engines.

EQUIPMENT

	Basis of Issue
3ABR42632-SG-104A, 104C	1/student

PROCEDURE

Use the information presented in the classroom discussion, study guides, and aid from the instructor. Fill in the spaces provided with the correct information.

Use the following list of words to complete item 1.

external teeth	keyed	spacer	tab	spring
internal teeth	lock	split	tech order	

1. Washers

a. Types of washers

(1) Plain

(a) Used under ____________ washers to prevent damage to soft metals.

(b) Used as a ___________ for adjustments, like aligning a castellated nut to match a drilled hole in a bolt.

(2) Lockwashers

(a) There are many types of lockwashers but the three that are most commonly used are:

1 _________

2 _________ _________

3 _________ _________

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OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 2400; TTVSA - 1

(b) Lockwashers are used with plain nuts and have ________ action.

(3) Special

(a) There are many different shapes and varieties of special washers and two of the most commonly used are the ____________ and ____________.

(b) Be sure to check the ________ _________ to see where special washers can be used.

Use the following list of words to complete item 2.

cotter pins   quick release   castle

2. Pins

a. Types of Pins

(1) ________ ________ are used to secure such items as nuts, bolts, screws, pins, and shafts. Cotter pins are used with drilled shank bolts, studs, and ___________ nuts.

(2) _________________ pins are used where rapid removal is necessary. (Example: Jet engine maintenance stands.)

Use the following list of words and numbers to complete item 3.

2	confused	jewelry	tech order
3	copper	lug	tighten
4	cut	mutilated	together
6	dikes	overstressed	tools
24	duckbills	per inch	torque
across the head	end	size	twist
aluminum	FOD	size	twist
annealed	geometrical	strand	wire
around the head	hardware	strip	zinc

3. Safety Wire (Lockwire)

a. Safety wire is used to secure aircraft ______________ that has no other locking device.

b. Types of lockwire.

(1) _________ coated, soft steel wire is used on drilled head bolts, fillister screws, snap rings, and other similar items.

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(2) ________ corrosion-resistant steel wire is used in the hot section of the engine. Most widely used type.

(3) ________ or ________ wire is very thin and is used as a seal to secure such things as safety switches and fire extinguishers.

Note: Steel and aluminum wire should not be ________.

c. Two methods of safety wiring.

(1) Double __________ methods.

(a) There are ________ ways of doing the double twist method.

(b) The two ways are:

1 __________ __________ __________, where the wire is wrapped around the head of the bolt or screw.

2 __________ __________ __________, where the wire is laid over the head of the bolt or screw.

(2) Single __________ method.

(a) Use single strand only where specified in the __________ __________.

(b) Bolts are usually in a __________ pattern.

d. Lockwiring electrical coupling nuts (cannon plugs).

(1) Properly __________ cannon plugs.

(2) Use double __________ method for lockwiring cannon plugs.

(a) Cannon plugs can be lockwired to a wire __________.

(b) Two cannon plugs can be lockwired __________.

(3) Be careful not to __________ out lockwire hole in cannon plug.

(4) Check tech order for proper lockwire __________, procedures and illustrations.

e. Lockwire procedure.

(1) Remove all __________.

(2) Select proper tools - they are ___________ and ___________.

(3) Maximum or ________ units wired together.

(4) Maximum span of lockwire between tension points is __________ inches.

(5) Wire length not to exceed _________ inches.

(6) Check tech order for proper wire ___________.

(7) Lockwire must not be nicked, kinked, or ___________.

(8) Duckbills to be used on the _____________ of the wire only.

(9) Lockwire must tend to ______________ at all times.

(10) Wire must be tight but not ____________________.

(11) 7 to 10 twists ___________ ____________ between the bolts.

(12) Pigtail should have at least ________ full turns and bent down or under.

(13) Place hand over _____________ when cutting.

(14) Always ____________ lockwire, never twist off.

(15) Place ____________ in proper container.

(16) Replace ___________ in tool box.

REVIEW QUESTIONS

1. The three types of washers are ___________, ___________, and ___________.

2. Plain washers are used under _____________ washers to prevent damage to soft metals.

3. ____________ washers may be used as spacers for adjustments when necessary.

4. ____________ washers use spring action as its locking feature.

5. Two types of special washers are _________ and _____________.

6. Quick release pins are used where __________ __________ is necessary.

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7. ______________ pins are used to secure such items as bolts, nuts, screws, pins, and shafts.

8. ______________ is used to secure hardware items that have no other locking device.

9. List the three types of lockwire.

a. ________________________________

b. ________________________________

c. ________________________________

10. The two methods of lockwiring are ___________ _____________ and ____________ ______________.

11. Two ways of doing the double twist method is _______________ and ________________.

12. The _____________ ____________ method is used only where specified in the tech order.

13. Use the double twist method for lockwiring ______________ plugs.

14. Cannon plugs may be lockwired ____________ or to a wire __________.

15. Be very careful when lockwiring cannon plugs as not to strip out the lockwire ____________.

16. A maximum of ___________ units should be lockwired together.

17. Lockwire must not be ___________, _________, or _____________.

18. Lockwire should be tight but not _______________________.

19. The maximum length of safety wire you can use is _________ inches.

20. Seven to ten __________ ___________ ___________ is the desired number of twists between the bolts.

21. Steel and ____________ wire look very much alike and should not be confused.

22. Always check the __________ ____________ to find out what size lockwire the job requires.

23. _____________ wire is sometimes used instead of copper wire for safetying fire extinguishers, first aid kits, and other emergency equipment.

24. Care should be taken not to confuse __________ with aluminum wire.

25. Maximum ____________ of lockwire between tension points is 6 inches.

26. Always ____________ lockwire, never twist off.

27. ______________ should have at least 3 full turns and ____________ down or under.

28. Place your ____________ over the lockwire when cutting.

29. Remove all ____________ before starting to work.

30. The proper pliers to use for lockwiring is the ____________ and ______________.

31. Lockwire must ____________ to ___________ at all times.

32. ______________ pliers should be used on the end of the wire only.

33. Place FOD in proper _______________.

Use the following list of words to identify figures 1 through 12.

around the head	keyed washer	single strand method
across the head	external teeth	split washer
cotter pin	plain washer	spool of lockwire
double twist method	quick release pin	tab washer
internal teeth		

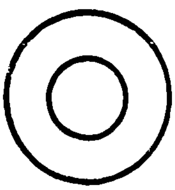

Figure 1.

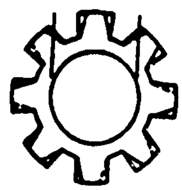

Figure 2.

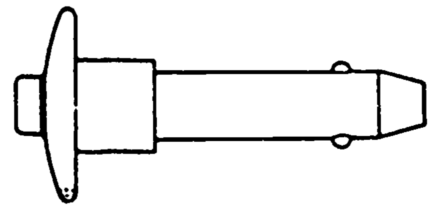

Figure 3.

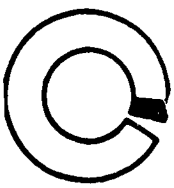

Figure 4.

Figure 5.

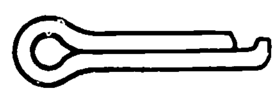

Figure 6.

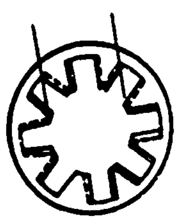

Figure 7.

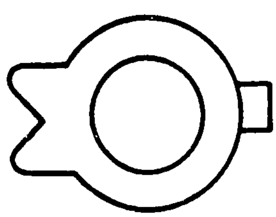

Figure 8.

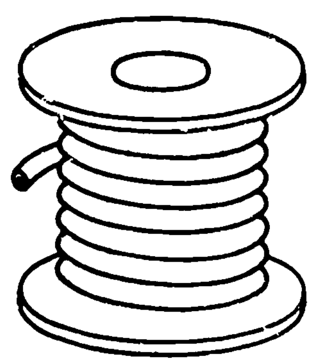

Figure 9.

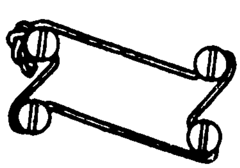

Figure 10.

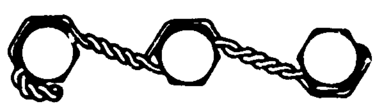

Figure 11.

Figure 12.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42632-WB-104B
3ABR42633-WB-104B
7 April 1980

AIRCRAFT AND ENGINE HARDWARE

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to identify and state the purpose of selected hardware items.

EQUIPMENT

	Basis of Issue
3ABR42632-SG-104A/3ABR42633-SG-104A	1/student

PROCEDURE

Use the information presented in the classroom presentation, discussion, study guide, and aid from the instructor. Fill in the spaces provided with the correct information.

1. Screws

a. A screw has a lower material strength than a

______________________.

b. Generally speaking if you can use a ______________ or Allen wrench on it, its called a screw.

c. Four main groups of screws

(1) ______________ - Found in the framework of the aircraft.

(2) ______________ - Used where high material strength is not important.

(3) ______________ - Cut their own threads in the material.

(4) ______________ - Used to hold pulleys or gears on shafts.

Supersedes 3ABR43230-WB-102F, 1 November 1972.
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 3,300; TTVSA - 1

Designed for ATC Course Use. Do Not Use on the Job.

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2. Bolts

a. Bolts are stronger than __________________.

b. Available in many special designs as well as

__________________ shapes and designs.

c. Types of bolts used

(1) __________________________________ -
Used throughout the aircraft frame and engine.

(2) __________________________________ -
The wrench goes inside the head of the bolt.

(3) __________________________________ -
Fits the hole very tightly and used where there is vibration or load reversals.

(4) __________________________________ -
Made for special applications.

d. When removing and replacing bolts it is important

that you use ______________________ bolts.

e. Identification markings

(1) Bolts are marked with a code to identify their

physical _____________________.

(2) Some examples of markings on bolts are:

(a) + ______________ ______________

(b) - ______________ ______________

(c) - - ______________ ______________

(3) Many bolts are marked with ________________

____________ which indicates specific metals and alloys.

f. Bolt size is determined by:

(1) ______________

(2) ______________

(3) ______________ ______________ ______________

3. Nuts

a. Nuts are used to properly ________________ the bolted assembly.

b. Identification markings on nuts are the same as ________________.

c. Tightening of nuts and bolts

(1) Check the specific TO for proper ________________ value.

(2) Always use proper ________________ procedures when tightening nuts and bolts.

4. Studs

a. Studs are used to ________________ removable parts to castings made of soft metals.

b. Types of studs used are:

(1) ________________

(2) ________________

c. Studs can be ________________ or ________________ on the nut end.

5. Hoses

a. Hoses are used for making ________________ that move or subject to vibration.

b. Hoses will ________________ so the movement will not do any harm.

6. Tubing

a. Tubing is used to carry ________________ and ________________.

b. Types of tubing

(1) ________________ ________________ - Used in high pressure systems.

(2) ________________ ________________ - Used in low pressure systems.

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c. Color coding for tubing

(1) Color coding on tubing aids in ________________ identification.

(2) Most common colors used are:

(a) Red = ______________

(b) Yellow = ______________

(c) Blue & Yellow = ______________

(d) Red - Grey - Red = ______________ ______________

REVIEW QUESTIONS

1. Name the four main groups of screws

2. Which type of screw is used to secure a pulley to a shaft?

3. A sheetmetal screw is an example of a ____________ ____________ screw.

4. If you can use a screwdriver or an ______________ ______________ on the head, its generally called a screw.

5. Name the four types of bolts. ____________________

____

____

6. ________________ have a higher material strength than a screw.

7. Which type of bolt is used where there is vibration or load reversals?

8. When you remove and replace a bolt make sure the replacement bolt is a like ____________________.

9. Allen wrenches are used on ______________ ______________ bolts.

10. Steel alloy bolts are marked with a ______________.

11. Aluminum alloy bolts are marked with a ______________.

12. Corrosion resistant steel bolts are marked with a

________________.

13. The size of a bolt is determined by the ______________,

________________, and ________________ ________________

________________.

14. Always check the TO for proper ________________ value on nuts and bolts.

15. Two types of studs used on engines are ______________

and ________________.

16. Connections that move or subject to vibration are joined

by ________________.

17. Two types of tubing used is ______________ ______________

and ________________ ________________.

18. Color coding on tubing is used for rapid ______________.

19. Red color coding designates ________________ lines.

20. Blue and yellow color coding designates ________________ lines.

WORKBOOK

3ABR42632-WB-104C
3ABR42633-WB-104C

Technical Training

Jet Engine Mechanic
Turboprop Propulsion Mechanic

MICROMETERS

18 March 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42632-WB-104C
3ABR42633-WB-104C

MICROMETERS

OBJECTIVES

After you have completed this workbook and your classroom instruction, you will be able to:

1. Identify types of measuring devices.

2. Use measuring devices on simple projects.

EQUIPMENT

	Basis of Issue
Micrometers	1/student
3ABR42632/3-SG-104B	1/student

Supersedes 3ABR42632-SW-302, 28 September 1978.
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 3300; TTVSA - 1

SECTION 1

PROCEDURE

Using the information presented in the classroom presentation, discussion, study guide, and aid from the instructor, fill in the spaces provided with the correct information.

Choose from these words and figures to complete items 1 through 3.

anvil	depth	inside	spindle	0.0001
barrel	frame	outside	thimble	0.001

1. Micrometers are used to measure tolerances within __________ of an inch; with a vernier scale it will measure within ______________ of an inch.

2. Three basic types of micrometers are:

   a. ____________________ - Measures inside diameters.

   b. ____________________ - Measures the depth of a hole or recess.

   c. ____________________ - Measures outside diameters.

3. Parts of the OUTSIDE micrometer.

   a. C-shaped ____________________.

   b. __________ and __________ material is measured between these two parts.

   c. The ________________________ is divided into 10 equal main divisions.

   d. The beveled edge of the _________________ is divided into 25 equal divisions.

Choose from these words to complete item 4.

barrel base ratchet spindles thimble

4. Parts of the DEPTH micrometer.

a. The flat surface is called the ________________, which is a measuring surface.

b. Several extensions of various lengths are called

__________________.

c. The __________________ is divided into 10 equal main divisions.

d. The beveled edge of the __________________ is divided into 25 equal divisions.

e. The _______________ is used to control the correct amount of contact pressure.

5. Reading the OUTSIDE micrometer.

a. Barrel.

(1) The barrel is divided into __________ equal main

divisions. Each of the main divisions on the barrel equals __________ of an inch.

(2) Each main division is divided into _________ equal

subdivisions. Each subdivisions equals ____________ of an inch.

b. Thimble.

(1) The beveled edge of the thimble is divided into

_____________ equal divisions. Each of these divisions equals ______ of an inch.

(2) One complete turn of the thimble would equal

_________________ of an inch.

c. Final Reading (using the example below).

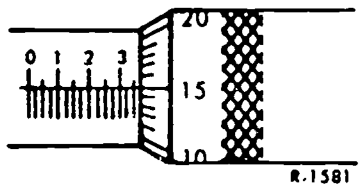

Figure 8.

(1) The number of main divisions shown on the barrel is __________, which equals _____________ of an inch.

(2) The number of subdivisions after the number 3 is __________, which equals _______________ of an inch.

(3) The number of divisions shown on the thimble is __________, which equals ______________ of an inch.

(4) Now ADD these three readings together and your answer is _____________ of an inch.

6. Reading the DEPTH Micrometer.

a. The barrel and thimble on the depth micrometer is marked the same way as the outside micrometer. The only difference is that the numbers are in reverse order. That is, instead of the numbers on the barrel going 0 1 2 3 4 5 6 7 8 9 0, they are 0 9 8 7 6 5 4 3 2 1 0.

b. For a quick review, let's go over them again.

(1) The barrel is divided into __________ equal main divisions. Each main division equals __________ of an inch.

(2) Each main division on the barrel is divided into ________ equal subdivisions. Each subdivision equals __________ of an inch.

(3) The beveled edge of the thimble is divided into ___________ equal divisions. Each of these divisions equals ________ of an inch.

(4) One complete turn of the thimble would equal __________ of an inch.

c. Final Reading (using the example below).

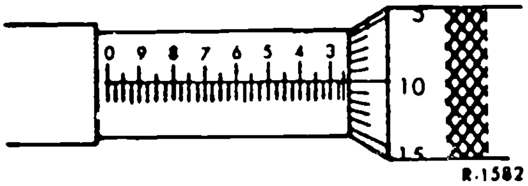

Figure 9.

(1) The number of main divisions that are covered by the thimble is __________, which equals ________________ of an inch.

(2) The number of subdivisions covered by the thimble is __________, which equals _______________ of an inch.

(3) The number of divisions shown on the thimble is __________, which equals ______________ of an inch.

(4) Now ADD these three readings together, and your answer is ____________ of an inch.

Choose from these words to complete item 7.

anvil	damage	hands	spindle	year
box	damaged	micrometer	spindles	anvil
clean	dropped	precision	tension	spindle

7. Use and Care of the Micrometer.

a. Keep ________________ and lightly oiled.

b. Clean your ____________ before using the ___________ to keep dirt and perspiration off the instrument.

c. Store in a ______________ to prevent _____________ to the micrometer.

d. Store the OUTSIDE micrometer with a space between the ______________ and ______________ to prevent corrosion between the two parts.

e. Hold correctly and apply only a slight ___________ on the thimble.

f. When using the outside micrometer, the _________ and ____________ should be wiped clean before each use.

g. A micrometer should NEVER be used as a C-clamp, as the frame and screw could be ____________ by the pressure.

h. The depth micrometer has interchangeable lengths called ________________.

i. Calibrate every ______________ or when _____________.

j. Micrometers are one of the most accurate measuring instruments and should be treated as ________________ instruments.

REVIEW QUESTIONS

1. Most micrometers will measure tolerances within _______ of an inch.

2. Micrometers that have vernier scales will measure within ____________ of an inch.

3. The __________ micrometer is used to measure outside diameters.

4. To measure the cylinder walls in your automobile you would use an ________________ micrometer.

5. The ____________ micrometer uses interchangeable spindle lengths.

6. Measurements are taken between the __________ and __________ on the outside micrometer.

7. Readings are taken from the ____________ and ____________.

8. The flat surface or base on the depth micrometer is the __________________ surface.

9. The distance between each ____________ division on the barrel of the micrometer is 0.100 of an inch.

10. Each main division on the barrel is divided into four equal ____________.

11. Each subdivision on the barrel equals _________ of an inch.

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12. One complete turn of the ________ equals 0.025 of an inch.

13. Micrometers can only measure a maximum of __________ inch.

14. A piece of stock 5-1/2 inches in diameter would have to be measured by a __________ to __________ inch outside micrometer.

15. Using the dollar and cent system, how many quarters would it take to make up one main division on the barrel? Answer: ________

____

16. Using the dollar and cent system, how many pennies are there on the thimble? Answer: ______________________________

17. The best way to keep a micrometer clean is to not allow it to get ________________.

18. One way to ruin a micrometer is to use it as a ________ -clamp.

19. Micrometers should be calibrated every _________ or when __________.

20. How many turns of the thimble would it take to move the spindle 1/2 inch? Answer: ______________________________

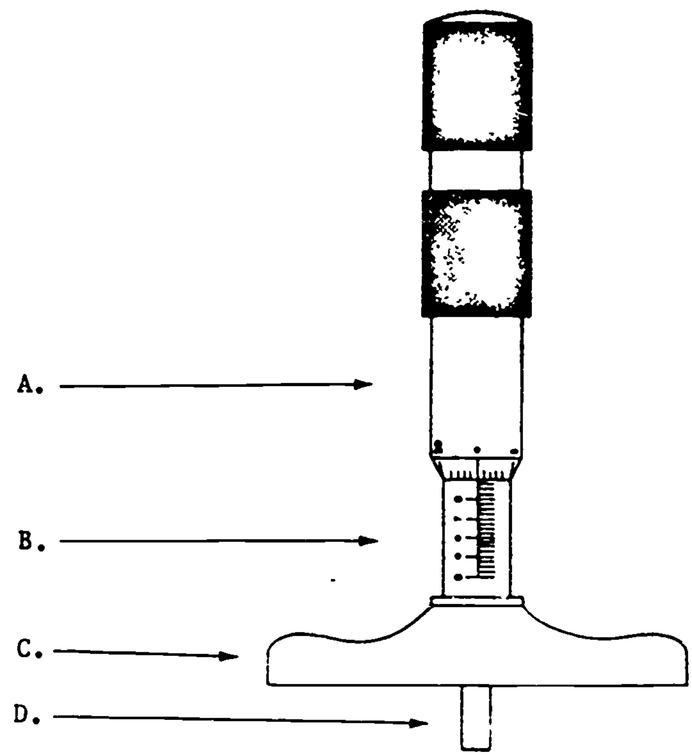
21. Identify the four basic parts of the depth micrometer.

A. ____________

B. ____________

C. ____________

D. ____________



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22. Identify the five basic parts of the outside micrometer.

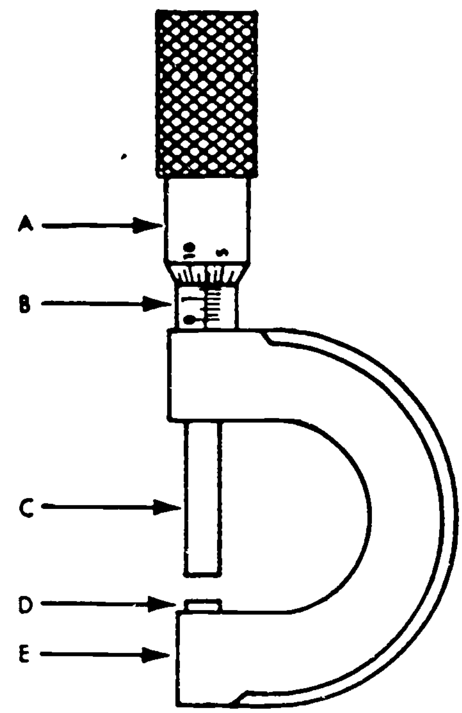
A ______________________________

B ______________________________

C ______________________________

D ______________________________

E ______________________________



23. Provide the readings for each of the following micrometer settings.

1 ________

2 ________

3 ________

4 ________

5 ________

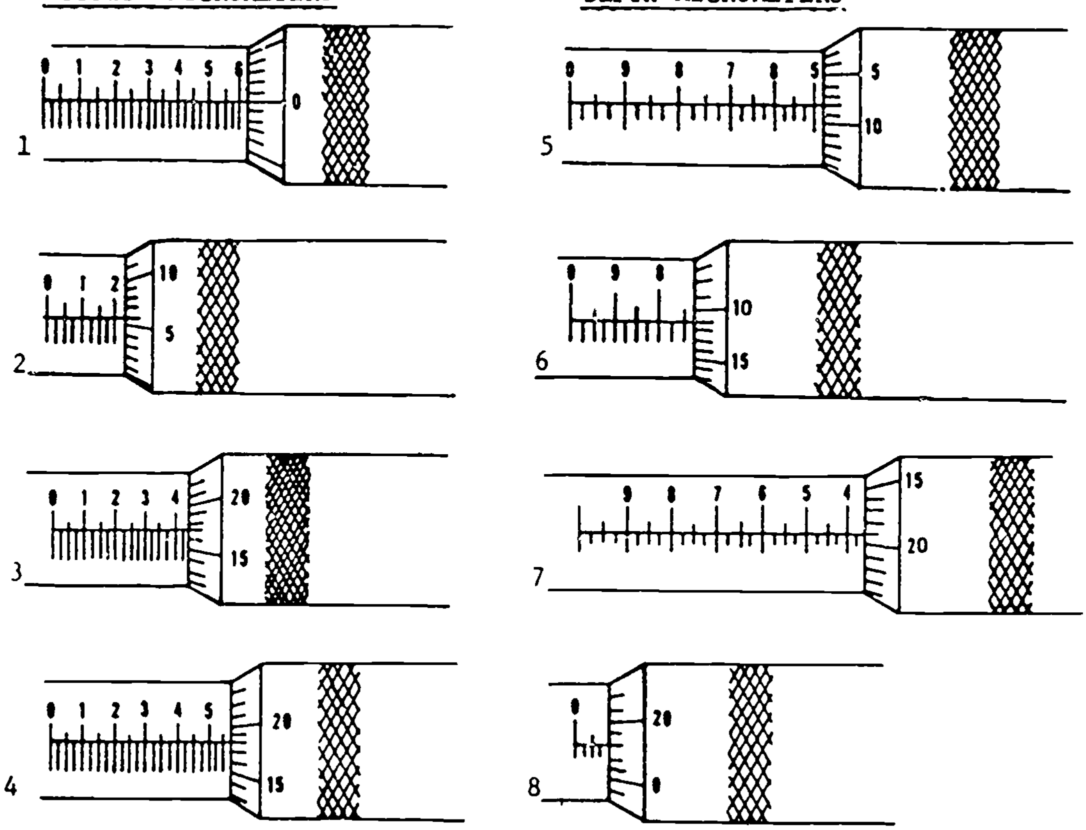
6 ________

7 ________

8 ________

OUTSIDE MICROMETERS

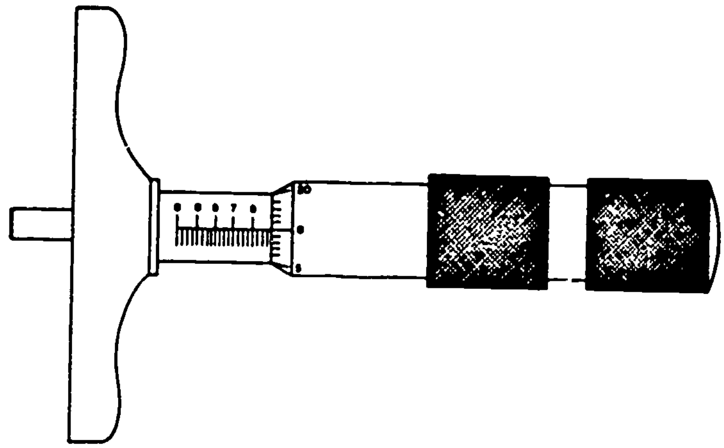
DEPTH MICROMETERS



SECTION 2

PROCEDURE

Determine the correct reading in each case and enter the answer in the appropriate numbered space under the heading "Micrometer Readings."



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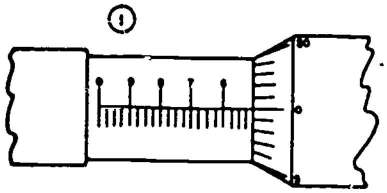

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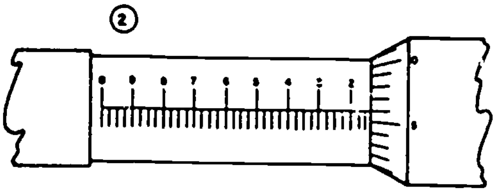

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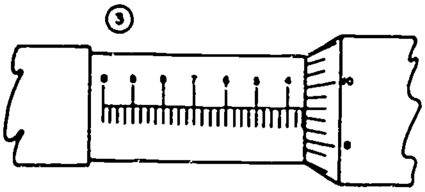

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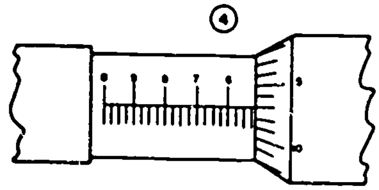

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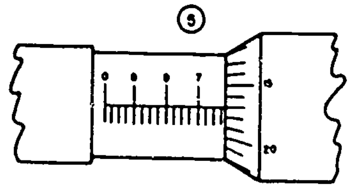

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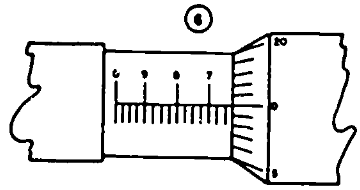
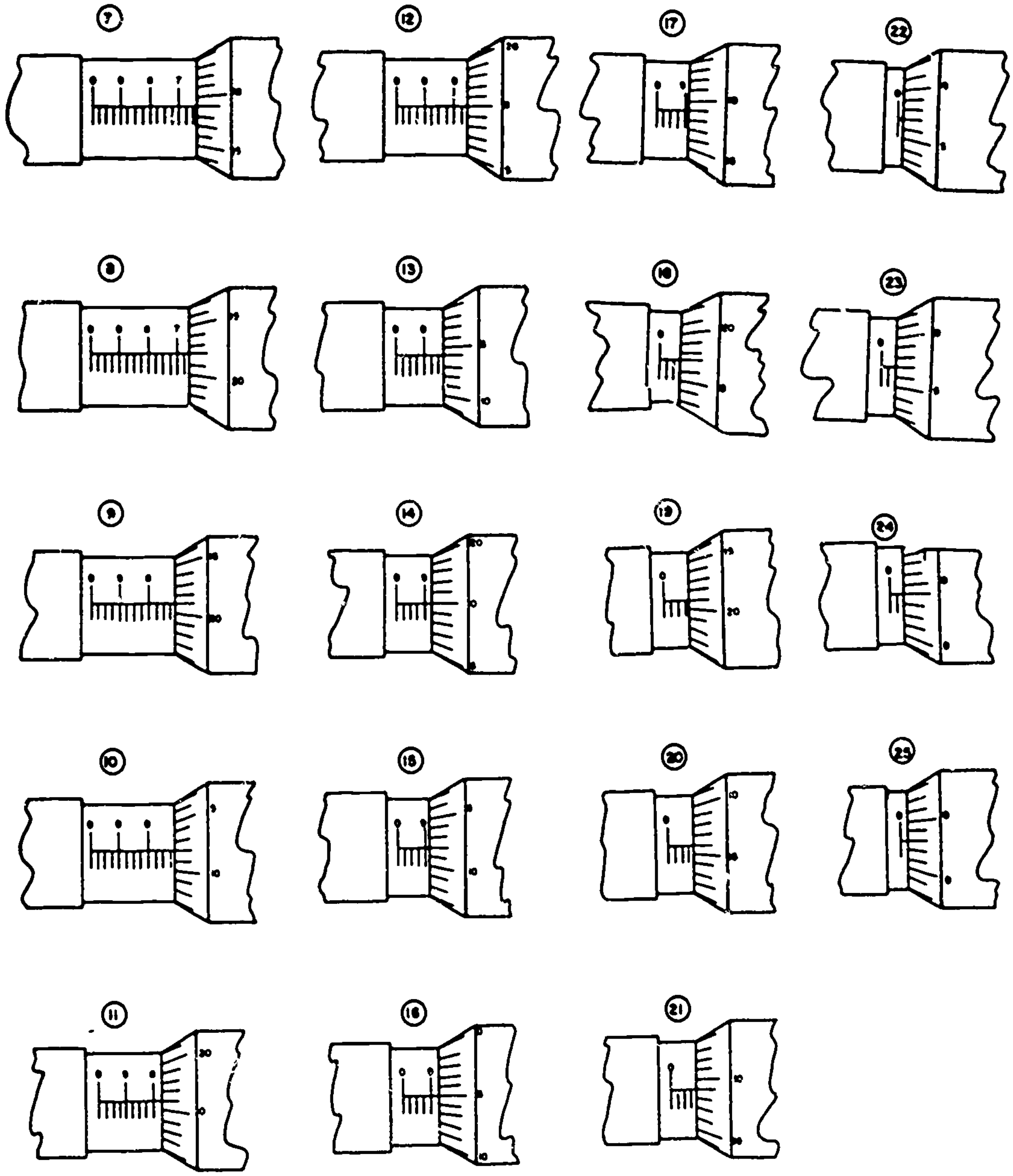




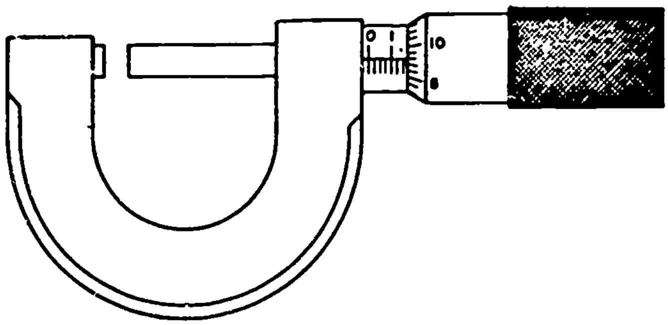
MICROMETER READINGS

1		8		14		20	
2		9		15		21	
3		10		16		22	
4		11		17		23	
5		12		18		24	
6		13		19		25	
7							

SECTION 3

PROCEDURE

1. Determine the correct reading in each case and enter the answer in the appropriate space under each reading.



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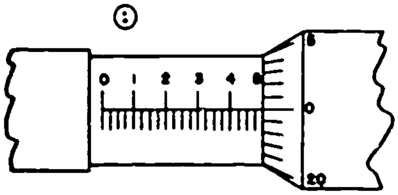

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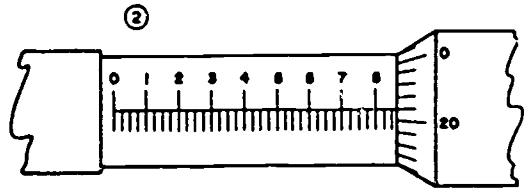

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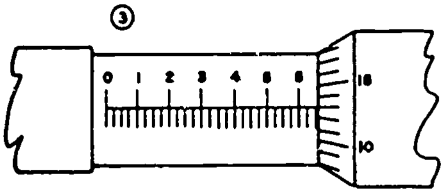

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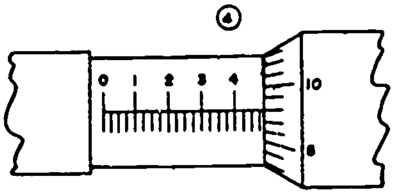

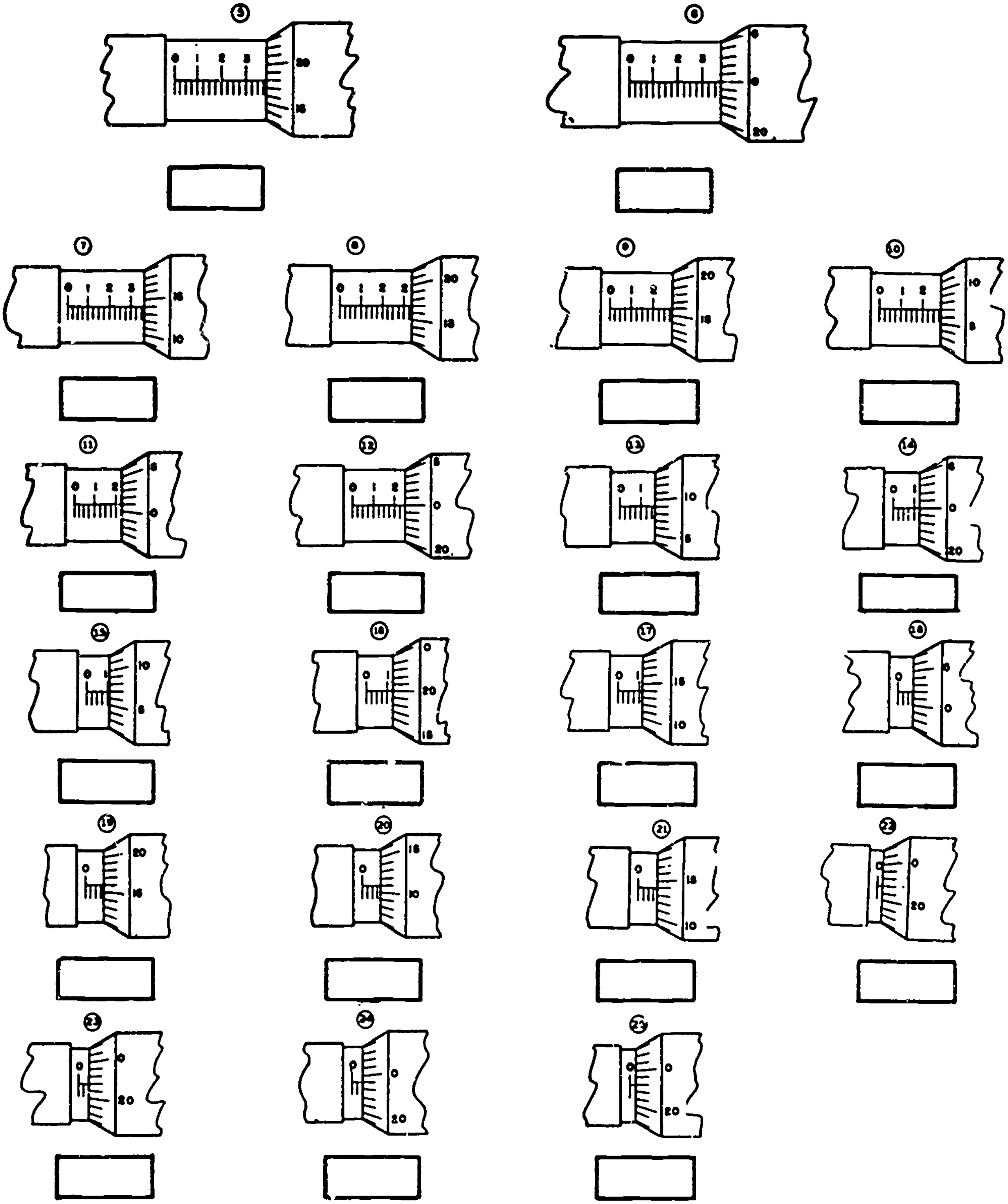

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PROGRAMMED TEXT
3ABR42632-PT-103

Technical Training

Jet Engine Mechanic

TECHNICAL FUNDAMENTALS OF TURBOJET ENGINES
(JET ENGINE OPERATING PRINCIPLES)

25 January 1978

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

RGL: N/A

TECHNICAL FUNDAMENTALS OF TURBOJET ENGINES
(Jet Engine Operating Principles)

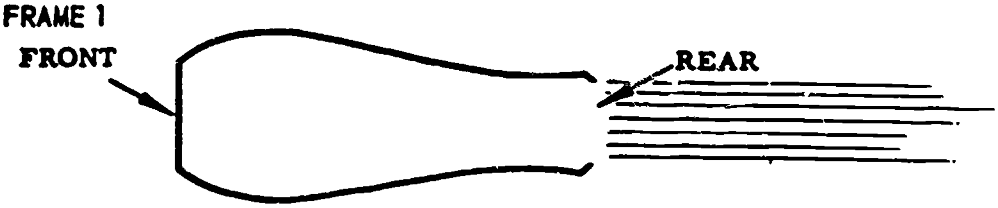
INTRODUCTION

During the next two days you are going to learn how a jet engine develops its power. You are, also, going to learn how it is constructed and will be able to describe the purposes of its subassemblies and parts. This study guide will prepare you for this instruction by showing the basic design of turbojet engines and the fundamentals of their operation.

PROCEDURE

This is an unusual study guide. It is made up of many small steps called FRAMES. Each frame contains a statement with one or more words omitted. Your job is to write in the missing words. Many of the frames contain drawings which you should study before writing in the words that have been omitted. Study FRAME 1 below and write in the missing word.

FRAME 1



A JET ENGINE TAKES IN AIR AT THE FRONT AND SHOOTS HOT EXHAUST GASES OUT THE ______________________.

You wrote the word "rear," didn't you? The correct words are always shown on the back of the page. Look at the TOP of the back of this page.

Supersedes 3ABR43131E-PT-118, 4 March 1976.
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 2,400; TTVSA

1A

REAR

There is your answer.

Now go on to FRAME 2

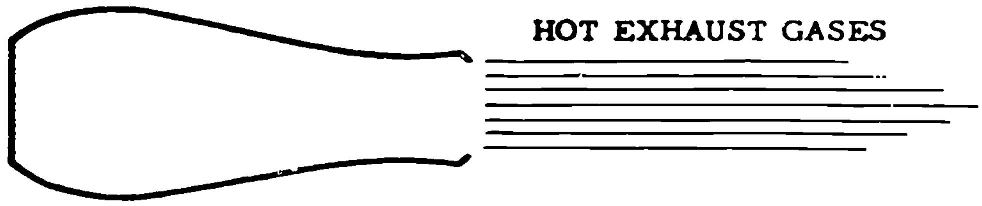
right over there ⟶

IGNORE EVERYTHING BELOW THIS LINE

TURN YOUR BOOK AND FOLLOW ARROW TO FRAME 70

FRAME 70 ⟶

FRAME 2



All jet engines force hot ____________ ____________ out the ____________

LOOK AT THE TOP OF THE BACK SIDE OF THIS PAGE TO SEE IF YOU WROTE THE RIGHT WORDS.

IGNORE EVERYTHING BELOW THIS LINE.

B

A

V69

FRAME 70

The thrust of a turbojet depends on how fast the exhaust gases are accelerated. Thrust, also, depends on the amount of ____________ drawn in by the ____________.

255

2A

EXHAUST GASES

REAR

If you were right, go on. If you missed the answer go back and write in the right words.

FRAME 3 ⟶

IGNORE EVERYTHING BELOW THIS LINE

FRAME 69

Check all the true statements below:

a. ☐ An increase in rotor rpm will increase thrust.

b. ☐ An increase in EGT will increase thrust.

c. ☐ There is no danger to the engine when maximum EGT and rpm limits are exceeded.

70A

Air

Compressor

(4)

FRAME 3

When a jet aircraft flies over, you can hear the hot __________ __________ being forced out the ________________ of the jet engine.

NO RESPONSE REQUIRED.

68A

FRAME 71

The two engine factors that affect thrust are EGT and rpm.

- ☐ True
- ☐ False

257

3A

EXHAUST GASES

REAR

Let's see what causes jet engines to shoot hot exhaust gases out the rear.

FRAME 4 →

FRAME 68

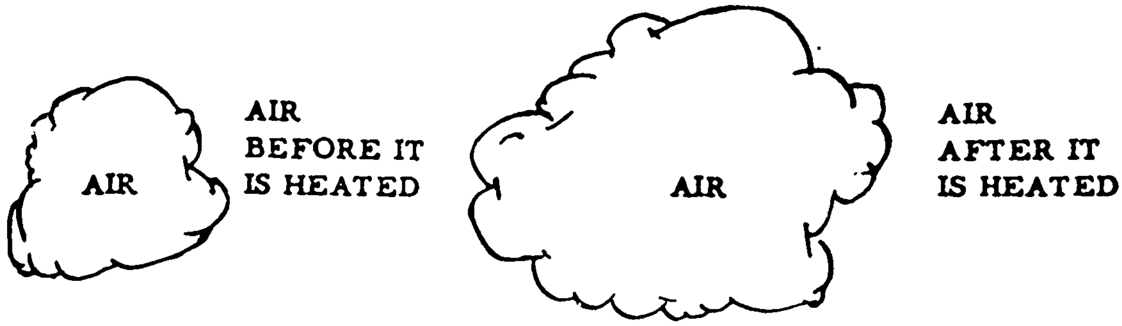
Some compressor and turbine rotors turn more than 9,000 rpm. There is a maximum limit, however, to the rpm that the rotors can turn. Beyond this maximum the engine would be seriously damaged.

71A

True

FRAME 4

When air is heated, it instantly expands in all directions.



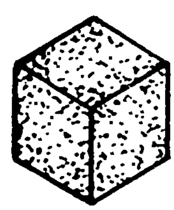
The air at the right was expanded by_______________.

NO RESPONSE REQUIRED.

67A

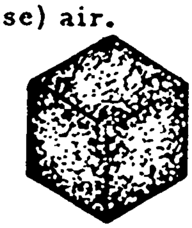
FRAME 72

This is a cubic yard of thin air.



A

This is a cubic yard of thick (dense) air.



B

Which would be heavier? __________

4A

HEAT

FRAME 5 →

FRAME 67

The power of the turbine rotor depends on the force and velocity of the exhaust gases striking the turbine blades. Force of the exhaust gases can be increased by increasing the amount of fuel for more combustion. The more fuel that is burned, the faster the compressor rotor will turn.

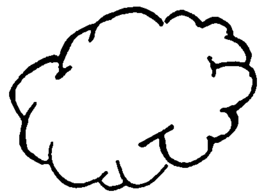
72A

B

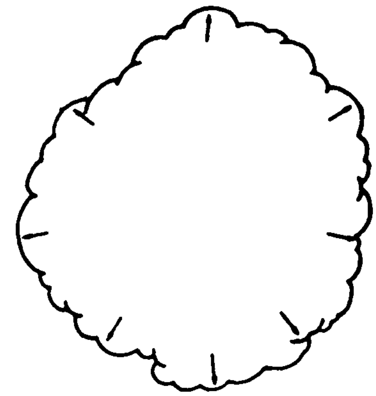
(8)

FRAME 5

Air before it is heated



Air expanding in all directions

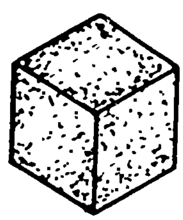


When air is __________, it expands in all __________.

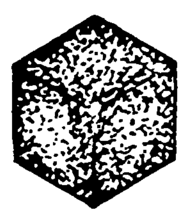
Turbine

66A

FRAME 73



A



B

The air in B is more dense than the air in A. The air in B would be heavier because it is more __________.

5A

HEATED

DIRECTIONS

FRAME 66

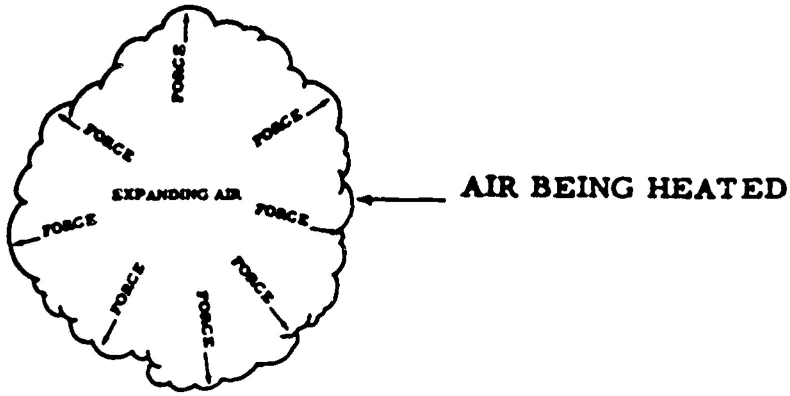
Compressor rotor rpm depends on the power applied to it by the ________ rotor.

73A

Dense

(10)

FRAME 6



When air is expanded by ______________, it exerts ____________ in all ________________.

r p m

Revolutions Per Minute

65A

FRAME 74

The weight of a volume of air depends on its density. One cubic foot of air may weigh more than another cubic foot of air depending on its ___________.

6A

HEATED

FORCE

DIRECTIONS

FRAME 65

The speed of a compressor rotor is measured in revolutions per minute (rpm).

Write the words for the abbreviation "rpm."

r ____________

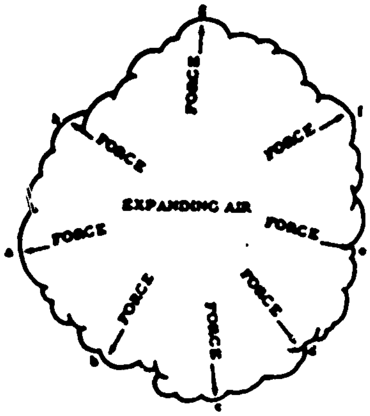
p ____________

m ____________

74A

Density

FRAME 7



When air is heated, it exerts equal force in all directions. The forces at points a, b, c, d, e, f, g and h are all_____________.

MORE AIR

64A

FRAME 75

The weight of a volume of air depends on its_____________________.

265

7A

EQUAL

FRAME 64

At top speed, some compressors can force more than 2,000 cubic feet of air into an engine within a 1-second period. The faster the compressor rotor is turned the __________ __________ is forced into the engine.

75A

DENSITY

FRAME 8

One way to heat air is to mix a little fuel with it and light a match to it. The fuel in the mixture of ____________ and ____________ will burn very hot.

NO RESPONSE REQUIRED.

63A

FRAME 76

A compressor turning at a certain rpm will always draw in the same volume of air. However, the weight of the air at a certain rpm will depend on the ____________ of the air.

8A

FUEL AND AIR

FRAME 63

You have learned that one way to increase thrust is to increase acceleration of exhaust gases by more heat of combustion. Let us look at another way for increasing thrust.

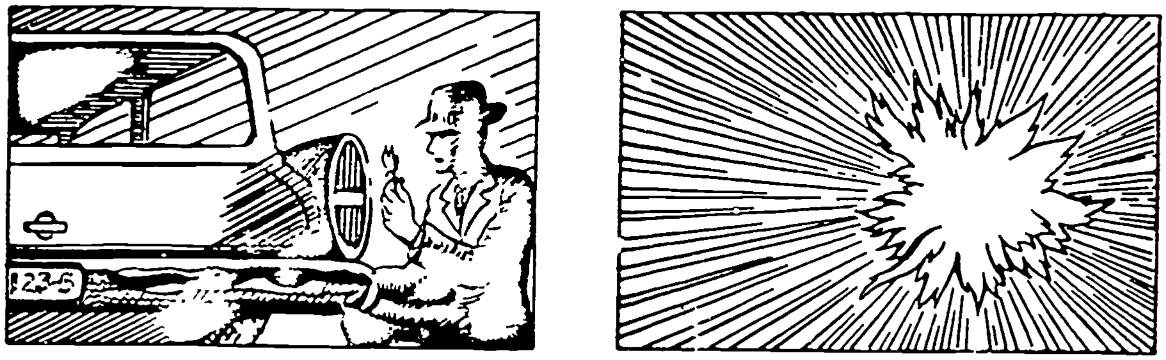
76A

DENSITY

(16)

FRAME 9

This is Joe Blow lighting a match to a car's fuel tank.

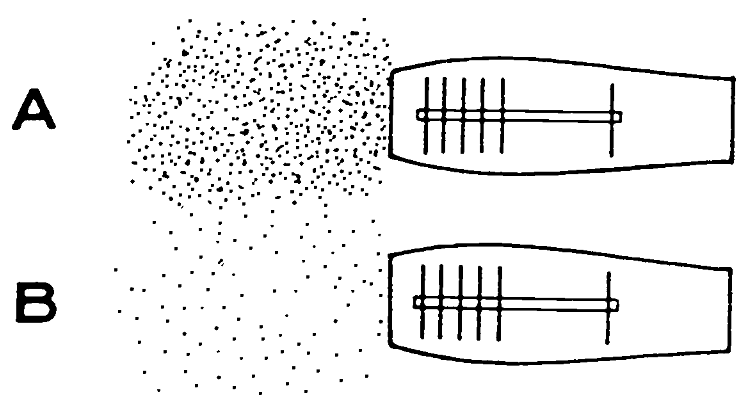


Joe was blown sky high because the heat caused the fuel/air mixture to suddenly expand and exert a ________________ in all directions.

DAMAGED

62A

FRAME 77



Engine A is operating in air that is more dense than engine B: therefore, engine A will have ________________ thrust.

9A

FORCE

FRAME 62

If EGT is allowed to become too high, the engine will be ____________.

77A

MORE

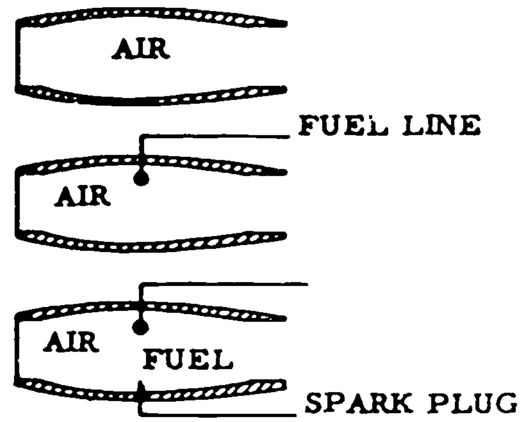
(18)

FRAME 10

This jet engine has air inside.

This engine has air and fuel inside.

This engine has air, fuel and a spark plug



Now, if someone will fire that spark plug, we should have some fast activity.

INCREASED

61A

FRAME 78

A turbojet engine operating in dense air will have ________________
(more)   (less)

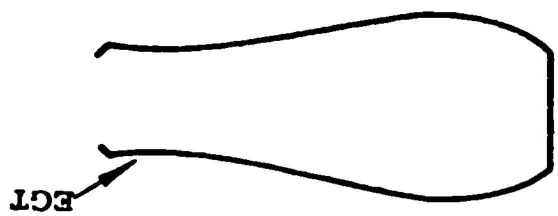
thrust than one operating in less dense air.

10A

NO RESPONSE REQUIRED.
GO ON TO THE NEXT FRAME.

FRAME 61

EGT is measured in the exhaust section.

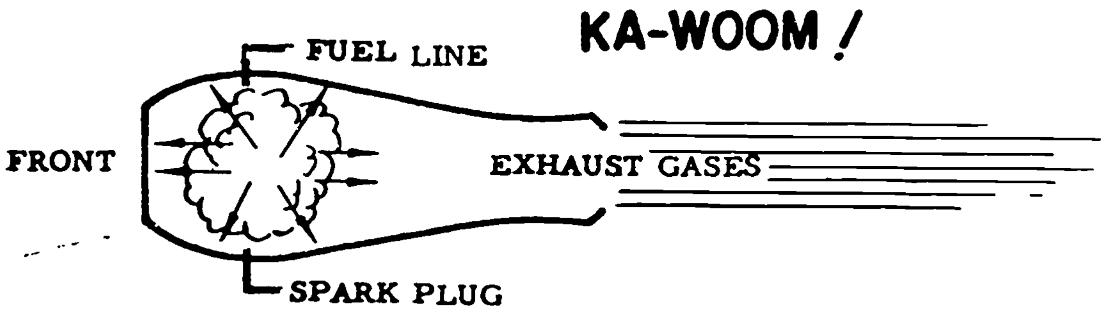


If EGT is increased, acceleration of the exhaust gases will be ____________

78A

MORE

FRAME 11



The fuel in the mixture of ____________ and ____________ was ignited and the sudden heat expansion caused a strong ____________ in all directions.

EXHAUST GAS TEMPERATURE

V09

FRAME 79

The greater the air density, the ________________ ____________________ a turbojet will develop.

Let us see what makes air more or less dense.

11A

FUEL

AIR

FORCE

FRAME 60

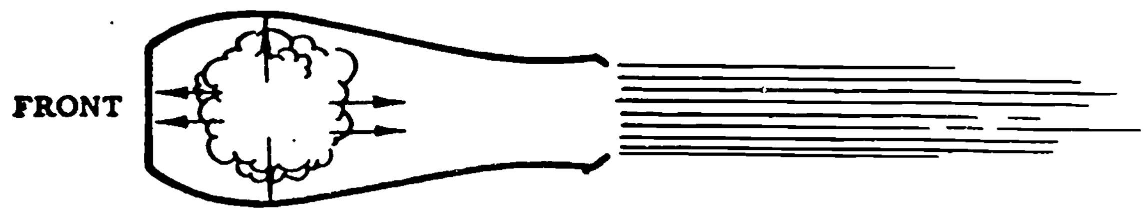
EGT means ______________________________

79A

MORE

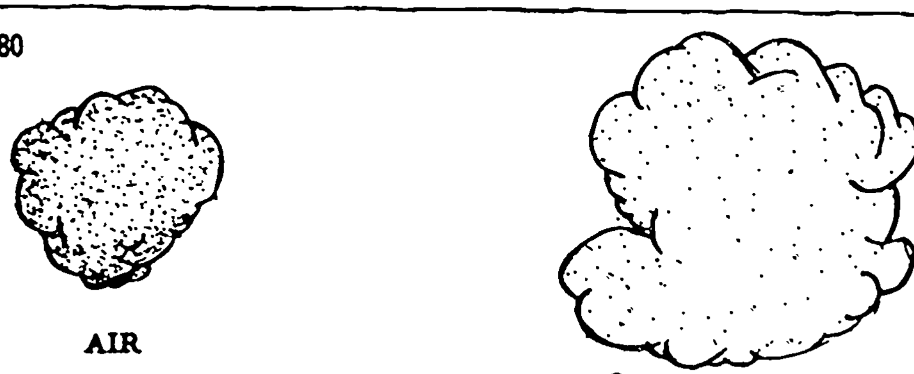
THRUST

FRAME 12



The force toward the front of the engine is equal to the __________ toward the __________ of the engine.

FRAME 80



When air is heated, it spreads out and becomes __________ dense.
(more) (less)

12A

FORCE

REAR

FRAME 59

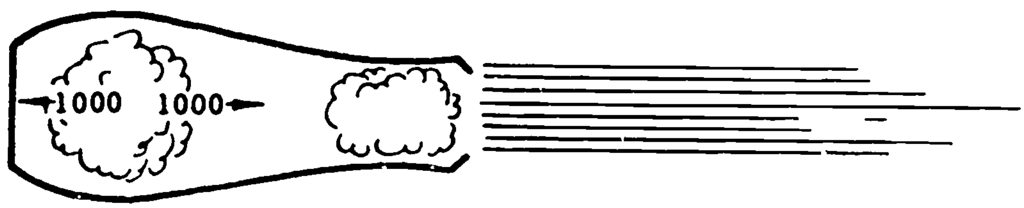
Write the abbreviation for Exhaust Gas Temperature.

____

80A

LESS

FRAME 13

FRONT 

If the force toward the rear is 1,000 pounds, then the force toward the front

s __________ _______________.

58A

EXHAUST — E

GAS — G

TEMPERATURE — T

FRAME 81

If air becomes less dense when it is heated, it will become _______________

_________________ when it is cooled.

277

13A

1,000

POUNDS

FRAME 58

One way to increase acceleration is to burn more fuel and increase the expansion forces of combustion. However, there is a limit to the temperature that an engine can stand. The Exhaust Gas Temperature (EGT) must not exceed a maximum limit. Write the words for the abbreviation EGT.

E ______________________

G ______________________

T ______________________

81A

MORE

DENSE

FRAME 14

The forces toward the front and rear of a jet engine are ________________.

57A

FAST AIR

MORE

FRAME 82

Cold air is ________________ dense than warm air.
(more) (less)

279

14A

EQUAL

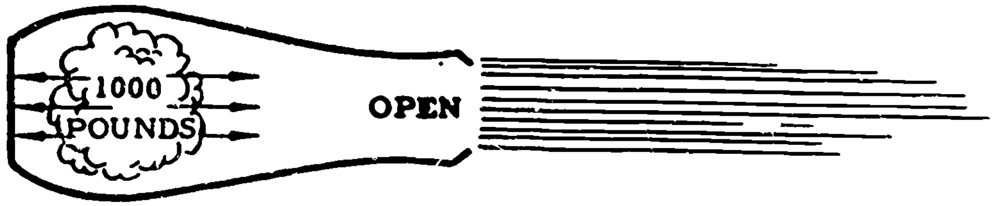
FRAME 57

One of the two factors that affect thrust of a jet engine is how ________ the ________ is accelerated. The faster the air is accelerated, the ________ thrust will be developed.

82A

MORE

FRAME 15



The forward and rearward expansion forces are equal, but the force toward the front is pushing against the engine, while the ______________ toward the ________________ (is, is not) ______________ pushing against the engine.

NO RESPONSE REQUIRED.

56A

FRAME 83

Since cold air is more dense than warm air, a turbojet will develop more thrust in ________________ air than in ________________ air.

281

15A

FORCE

REAR

IS NOT

FRAME 56

In the next few frames, you will learn about factors that affect thrust of a turbojet engine. Basically there are only two conditions that affect thrust. One is the weight of the air being accelerated and the other is how fast the air is accelerated.

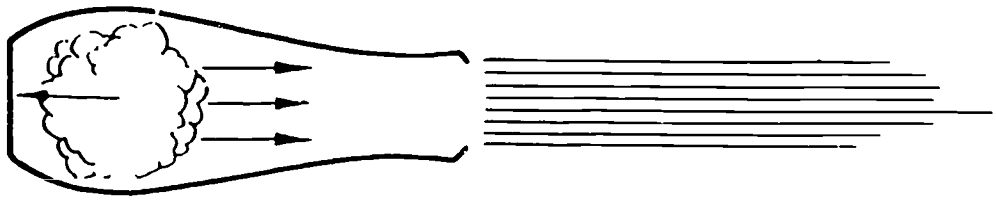
83A

COLD

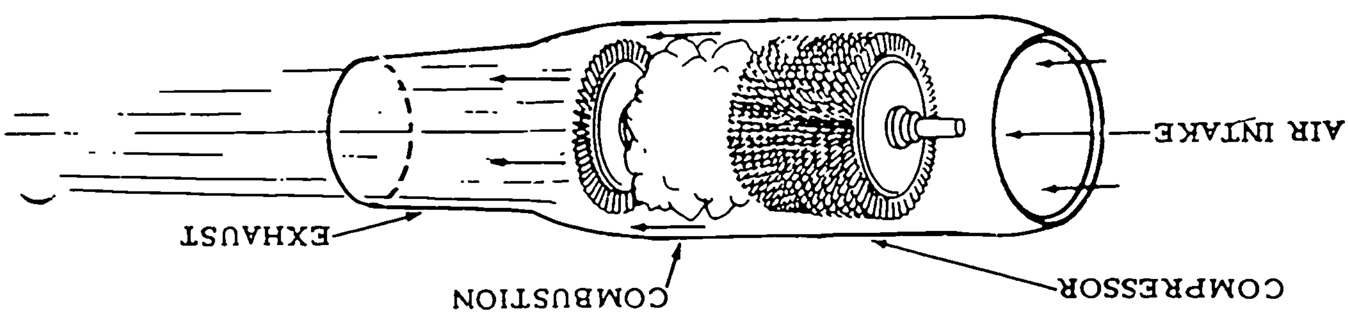
WARM

FRAME 16

If the expanding force toward the rear does not push against the engine, what does it push against?



According to the above drawing the rearward force is against ____________.



FRAME 84

A jet engine operating on a cold day would have ________________ thrust than when operating on a warm day.

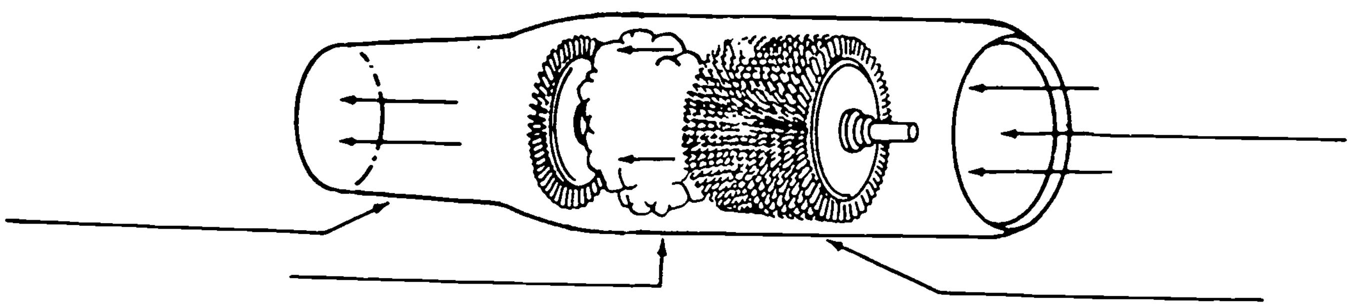
Let us look at another factor that effects air density.

283

16A

NOTHING.

FRAME 55



Write the name of each section on the appropriate arrows above.

84A

MORE

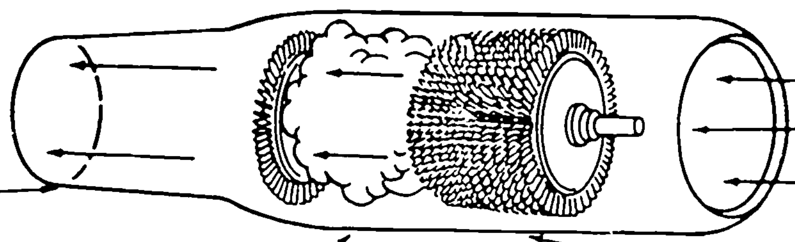
(32)

FRAME 17

Now, wait a minute!! It doesn't take much force to move air--or does it?

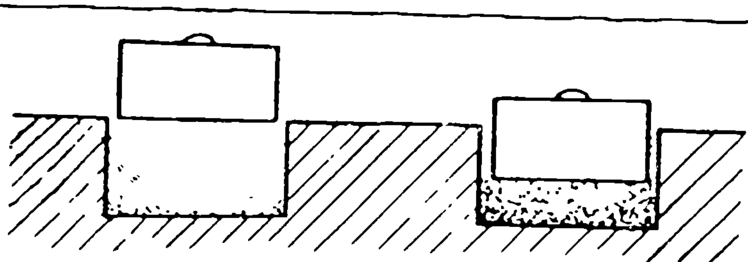
Let's try an experiment.

1. Set your lips as if you were going to say the word "when."
2. Gently exhale. Note that very little force was required to push the air out.
3. Set your lips again, inhale and blow out the air as fast as possible. Note that this time you exerted much more force.



54A

FRAME 85



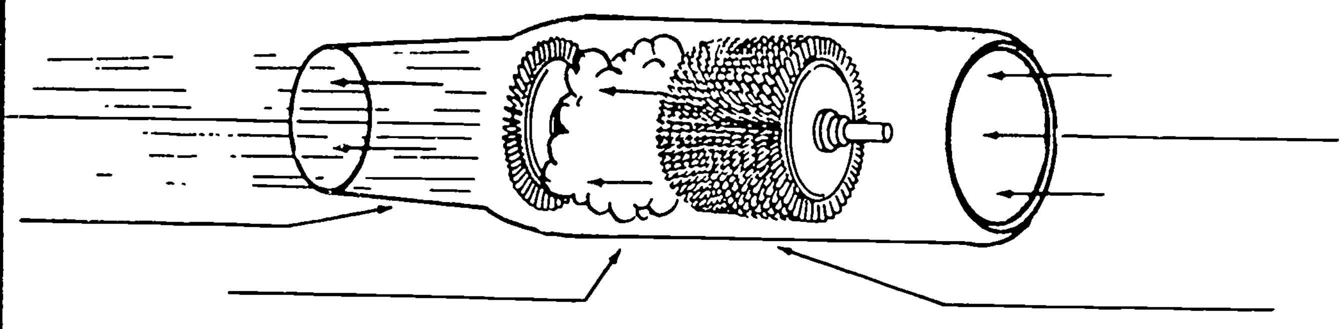
Pressure has caused the air particles in B to be squeezed together. Air becomes more dense when it is under ______________________:

285

17A

NO RESPONSE REQUIRED.

FRAME 54



The four main sections of the turbojet above are Air Intake, Compressor, Combustion, and Exhaust. Write the name of each section on the appropriate arrows above.

85A

PRESSURE

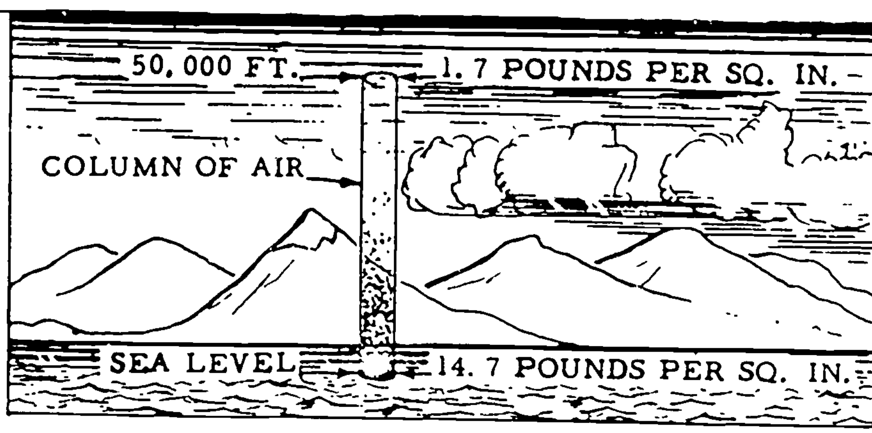
FRAME 18

When you blew the first time you probably accelerated the air from zero to about 2 feet per second. The next time you blew, you probably accelerated the air to about 8 feet per second. In the second case ______________ force was
(more) (less)
required to ______________ the air.

TURBOJET

53A

FRAME 86



AIR PRESSURE IN THE ATMOSPHERE

The lower the altitude the more pressure there will be on the air; therefore, at low altitude the air is ______________ dense.
(more) (less)

18A

MORE

ACCELERATE

FRAME 53

Because the compressor rotor is driven by the turbine, this type jet engine is called a "turbojet." A jet engine whose compressor rotor is driven by a turbine is called a ____________.

86A

MORE

FRAME 19

A jet engine can accelerate air to over 2,000 feet per second. This requires a tremendous ________________.

52A

DRIVE

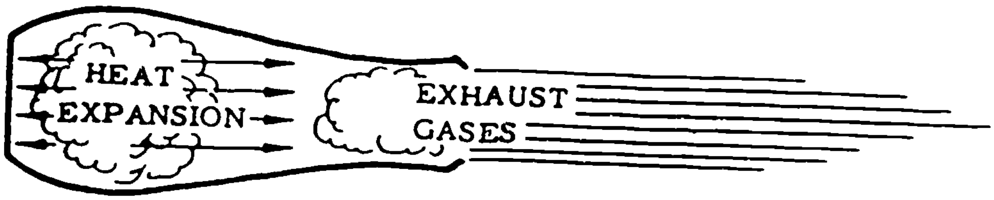
COMPRESSOR

FRAME 87

The higher the altitude the ________________ dense air becomes.

FRAME 20

A jet engine does not actually accelerate pure air. Gases from the fuel that is burned will be mixed with the air. We call the mixture exhaust gases.



EXHAUST GASES AS THEY RUSH REARWARD

51A

FRAME 88

At low altitude a turbojet will develop ______________ thrust than
(more) (less)

at high altitude because the air is ______________ dense.

AUGMENTATION

THRUST

119A

291

20A

NO RESPONSE REQUIRED.

FRAME 51

Where does the power come from to turn the turbine rotor?

____

____

____

88A

MORE

MORE

FRAME 119

Increasing thrust by use of an afterburner is called _______________.

FRAME 21

FRONT

In the above engine, suppose 1,200 pounds of force is exerted toward the front of the engine. How many pounds of force will be exerted toward the rear of the engine? ____________

TURBINE ROTOR

50A

FRAME 89

At high altitude, a turbojet will have ______________ thrust
(more) (less)

ACCELERATING

HIGHER
(Greater)

118A

(41)

293

21A

1,200

The unit that drives the compressor is the ______ ______.

FRAME 50

89A

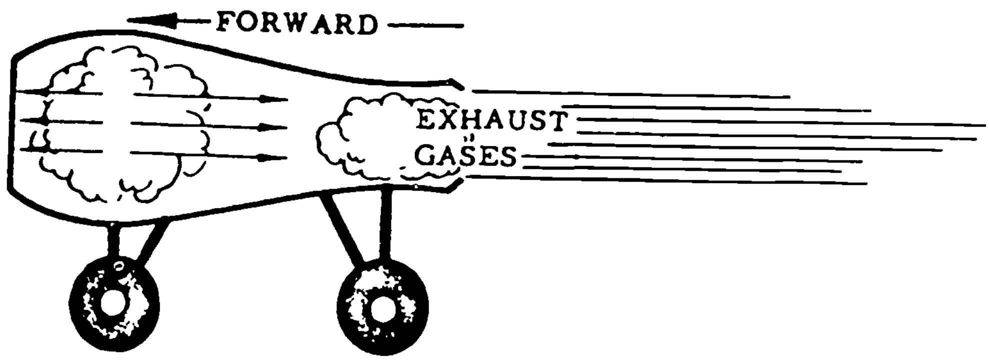
LESS

The afterburner augments thrust by ______ the exhaust to a ______ velocity.

FRAME 118

FRAME 22

Let's set an engine on wheels and see what happens.



When the engine is fired, the exhaust gases go rearward and the ________ goes________.

CONTINUOUS

49A

FRAME 90

Weather affects atmospheric pressure. Normally, the pressure at sea level is 29.92 inches of mercury. If sea level pressure increases to 30.00 a turbojet will have ____________ ____________.

EXHAUST GASES

117A

295

22A

ENGINE

FORWARD

FRAME 49

While the engine is operating, the flows of air and fuel are continuous. The fuel needs to be ignited only at the start and will continue to burn because the flow of air and fuel is ________.

90A

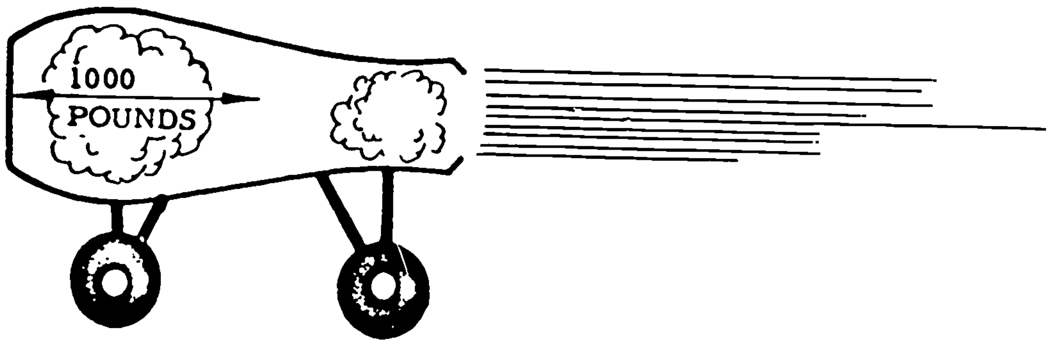
MORE

THRUST

FRAME 117

The afterburner does not cause the engine to draw in more air. It augments thrust by accelerating the ________ ________ ________ to a higher velocity.

FRAME 23



When fired, this engine will have a forward pushing force called thrust.

This particular engine has 1,000 pounds of ____________.

CONTINUOUS

48A

FRAME 91

The thrust of a turbojet will vary with sea level pressure. If the pressure drops below normal, a turbojet will have ________ ____________.

There is another factor which affects thrust. Let's see what it is.

rpm

EGT

116A

297

23A

THRUST

FRAME 48

The compressor supplies a continuous flow of air to the combustion section. Once the fuel is ignited, combustion is continuous without need for further ignition. In a jet engine air flow and combustion are ______________.

91A

LESS

THRUST

FRAME 116

An afterburner provides a means for thrust augmentation without exceeding the engine ______________ or ______________ limits.

FRAME 24

It is estimated 1,000 pounds of thrust is enough to push 3 cars. Some jet engines have as much as 20,000 ____________ of ____________.

COMBUSTION SECTION

47A

FRAME 92

You would think that air containing water vapor would be heavier than dry air. The opposite is true. Water in a vapor form is lighter than other particles of air; therefore, humid air is actually lighter than dry air at the same pressure. When air is humid, a turbojet will develop __________ thrust.

rpm

EGT

115A

299

24A

POUNDS OF THRUST

FRAME 47

The force of heat expansion takes place in the ______ ______ of the engine.

92A

LESS

FRAME 115

Since combustion in the A/B heats the exhaust gases after they have passed through the turbine area of the engine, the A/B will not cause the engine ______ or ______ to exceed maximum limits.

FRAME 25

Automobile engines are rated in horsepower but jet engines are rated in

__________________ of ______________.

COMBUSTION SECTION

46A

FRAME 93

When the atmosphere is humid, a turbojet will develop __________________

thrust.

DOES NOT

114A

301

25A.

POUNDS OF THRUST

FRAME 46

Burning of fuel in the fuel air mixture takes place in the ________ of the engine.

93A

LESS

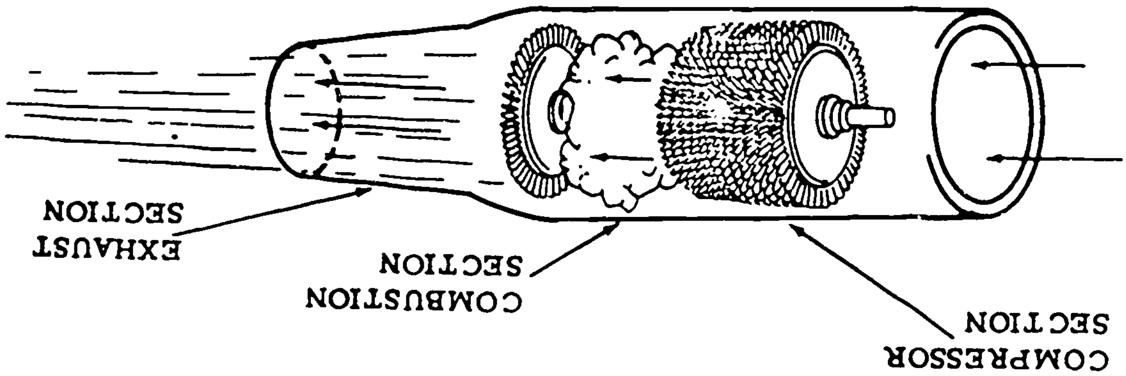
FRAME 114

Since combustion in the A/B heats the exhaust gases after they have passed through the turbine rotor, the A/B ________ affect EGT in the turbine area of the engine.

(does) (does not)

FRAME 26

Jet engines develop thrust from the force of rapidly expanding ______________.



45A

FRAME 94

Let's review atmospheric factors which affect thrust. Think carefully now.

a. A turbojet has more thrust when the air is ______________.
(cold) (warm)

b. A turbojet has more thrust at ____________ altitude than at ____________ altitude.

c. A turbojet has more thrust when the atmosphere ______________ humid.
(is) (is not)

DAMAGE

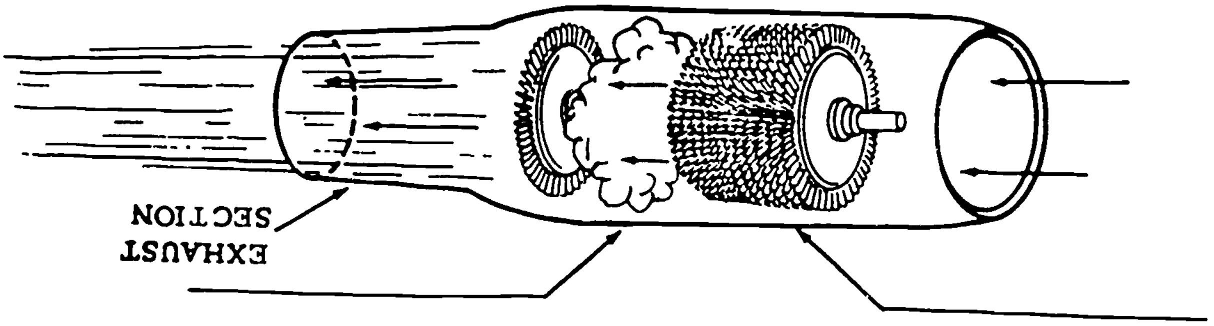
113A

303

26A

GASES

The compressor forces a huge mass of air into the combustion section of the engine. Label the combustion section and the compressor in the above drawing.



FRAME 45

94A

a. Cold

b. Low
High

c. Is Not

Since the A/B has no effect on engine rpm, operation of the A/B will not cause ____________ to the engine.

FRAME 113

FRAME 27

Inside a jet engine, expanding gases exert equal ____________ in all ____________

TURBINE ROTOR

44A

FRAME 95

Be careful now! Don't get confused.

a. A turbojet has less thrust on a ____________ day.
(cold) (warm)

b. A turbojet has less thrust at ____________ altitude than at ____________ altitude.

c. A turbojet has less thrust when the atmosphere ____________ humid.
(is) (is not)

112A

DOES NOT

TURBINE
or
COMPRESSOR

305

27A

FORCE

DIRECTIONS

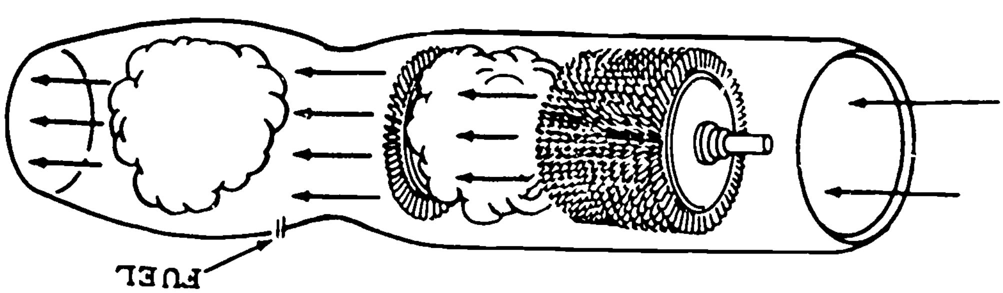
FRAME 44

In one second the compressor rotor, at top speed, will turn about 150 times. Each rotor blade will travel a distance of about 4 average city blocks in 1 second. Power for turning the compressor rotor at such high speed comes from the __________ __________.

95A

a. Warm
b. High
   Low
c. Is

FRAME 112



Combustion in the A/B (afterburner) takes place behind the turbine rotor and therefore __________ affect the rpm of the __________.
(does) (does not)

FRAME 28

The forward force of expanding gases is against the ____________.

TURBINE ROTOR

43A

FRAME 96

The forward force of expanding gases is against the ____________.

Let's think about how much fuel a jet engine will burn. Only about one fifth of the air that enters a turbojet is used to burn the fuel. If all the air were used there would be so much heat that the engine would burn up in a matter of seconds. The unused air mixes with the results of fuel combustion before it reaches the turbine rotor and prevents overheating of the engine.

111A

THRUST

AUGMENTATION

28A

ENGINE

FRAME 43

The unit that drives the compressor rotor with a large shaft is the ______ ______.

96A

NO RESPONSE REQUIRED

FRAME 111

Increasing thrust by the use of an afterburner is called ______ ______.

FRAME 29

Here is how a jet engine develops thrust.

a. The fuel in a mixture of __________ and __________ is ignited by spark plug.

b. There is a sudden terrific expansion of the mixture due to __________.

c. The forward and rearward expansion forces are __________.
(equal) (unequal)

d. The forward force pushes against the __________.

e. The power of a jet engine is rated in __________ of __________.

TURBINE ROTOR

42A

FRAME 97

Only about one fifth of the air that enters a turbojet is used. If an engine takes in 150 pounds of air per second only __________ pounds would be used for combustion.

AUGMENTATION

110A

29A

a. fuel and air
b. heat
c. equal
d. engine
e. pounds of thrust

FRAME 42

As the exhaust gases rush toward the rear of the engine, they turn the ______________ ______________.

97A

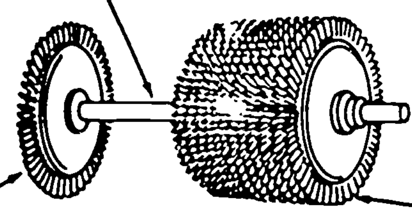
30

FRAME 110

You need to get used to a new technical term called thrust augmentation. Augment means to increase or add to. When the afterburner increases thrust it is called thrust ______________.

FRAME 30

Combustion is another name for burning. When we ignite the fuel in a fuel/air mixture, ____________ or burning occurs.



41A

FRAME 98

For proper combustion, about 1 pound of fuel is mixed with each 15 pounds of air. If an engine takes in 150 pounds of air per second, it would use about 30 pounds of air. How much fuel would be mixed with the 30 pounds of air to get proper combustion? ____________ pounds.

SHORT

109A

FRAME 31

The fuel in a fuel/air mixture is very combustible, but it must be ignited for burning for ____________ to occur.

40A

EXHAUST GASES

REAR

FRAME 99

The greater the mass of air drawn into an engine, the ________________ fuel will be used. On a cold day a turbojet will use ________________ fuel and will develop ________________ thrust.

(more) (less)

108A

AFTERBURNER

OFF

31A

COMBUSTION

FRAME 40

The turbine rotor is turned by the ______ ______ as they rush toward the ______ of the engine.

99A

MORE

MORE

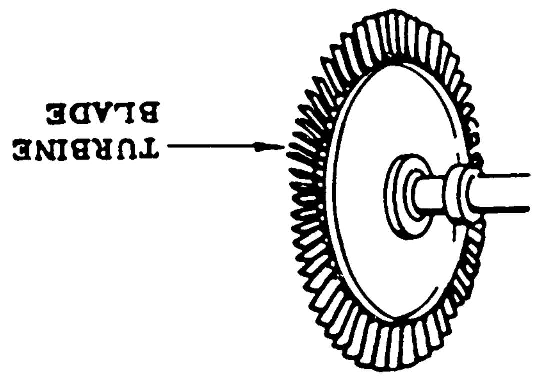
MORE

FRAME 108

The afterburner is operated only when additional thrust is needed, such as during takeoff. When the pilot needs extra thrust, he can turn the ______ on and when not needed he can turn it ______.

FRAME 32

If the fuel in a fuel/air mixture is ignited, ____________ will occur.



39A

FRAME 100

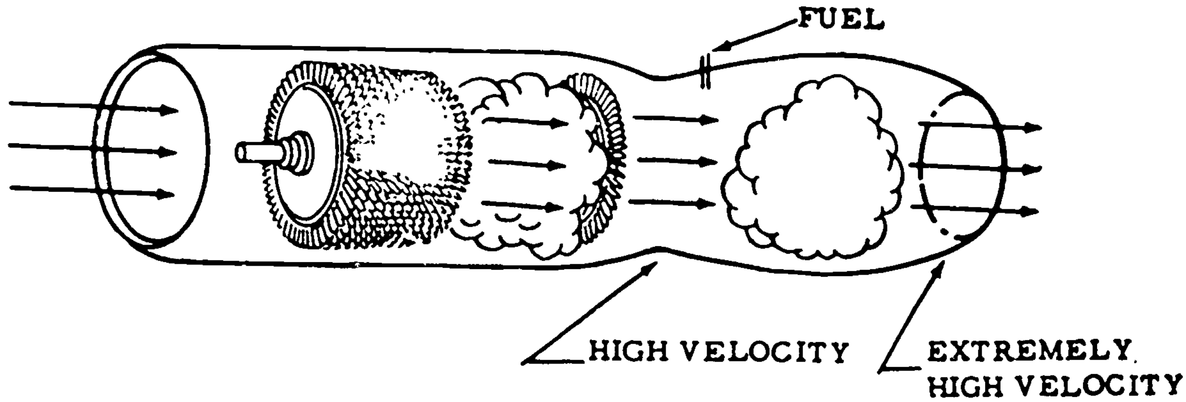
At high altitude a turbojet has ____________ air to use so it will use ____________ fuel.

MORE

107A

(64)

FRAME 107

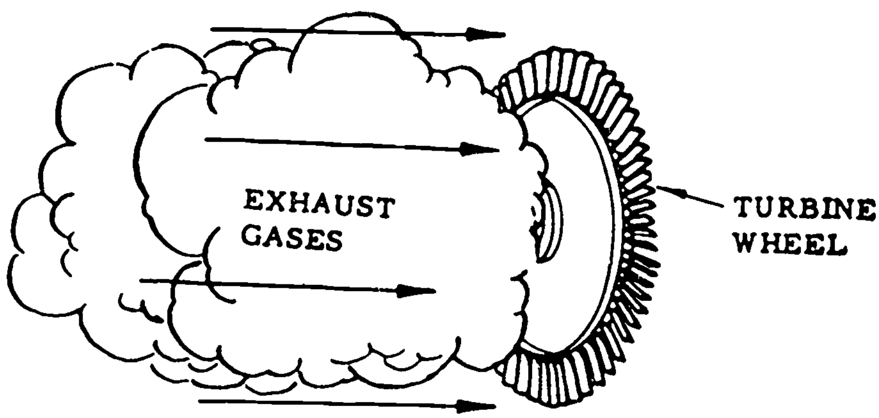


An afterburner gives added acceleration to the exhaust gases. The more the exhaust gases in an engine are accelerated, the ______________ thrust will be developed.
(more) (less)

LESS
LESS

100A

FRAME 39

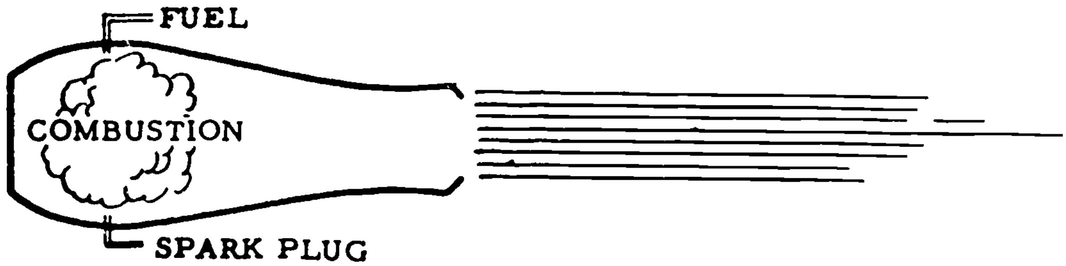


The turbine drives the compressor, but what drives the turbine? On their way out of the engine, the high speed exhaust gases strike the blades on the turbine wheel causing it to rotate at a high speed. Draw an arrow to one of the turbine blades and write in its name.

COMBUSTION

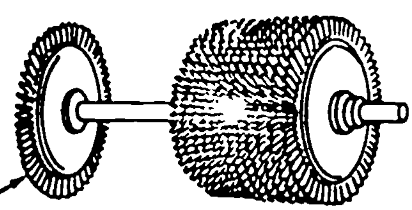
32A

FRAME 33



In all the time we have been studying this engine, we have fired it only once, and that won't take us very far. Combustion burned all the fuel. We must have a fresh supply of ____________ and ____________ for combustion to occur again.

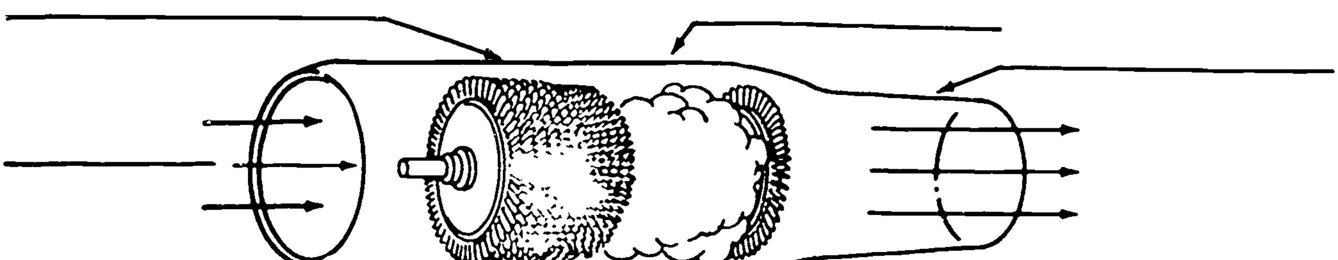
Let's see how we get air into the engine.



38A

FRAME 101

Label the sections of the engine below.



NO RESPONSE REQUIRED.

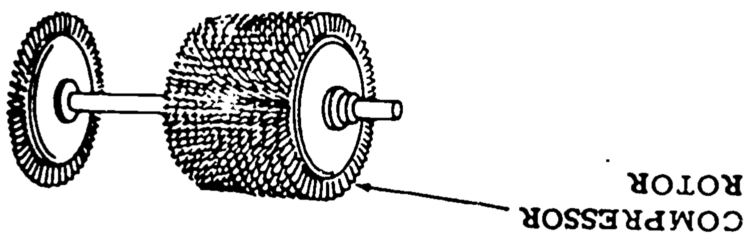
106A

317

33A

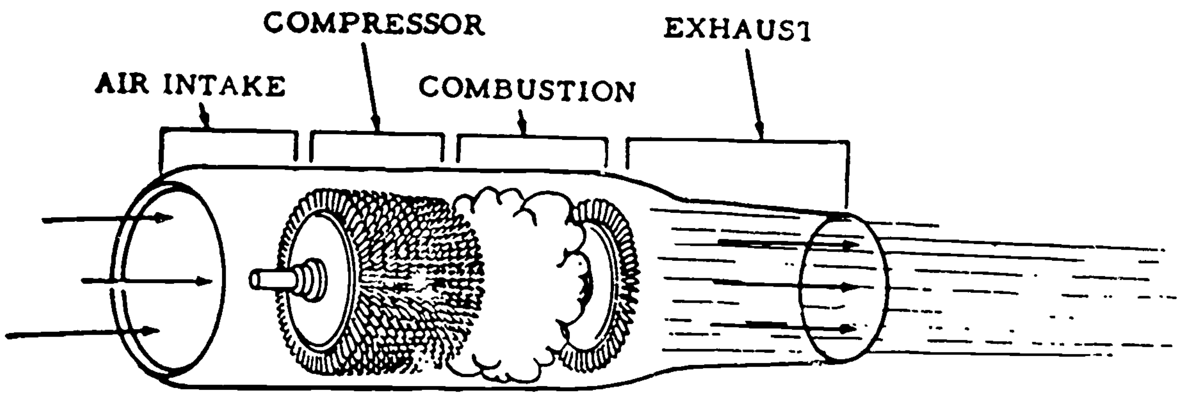
FUEL AND AIR

FRAME 38

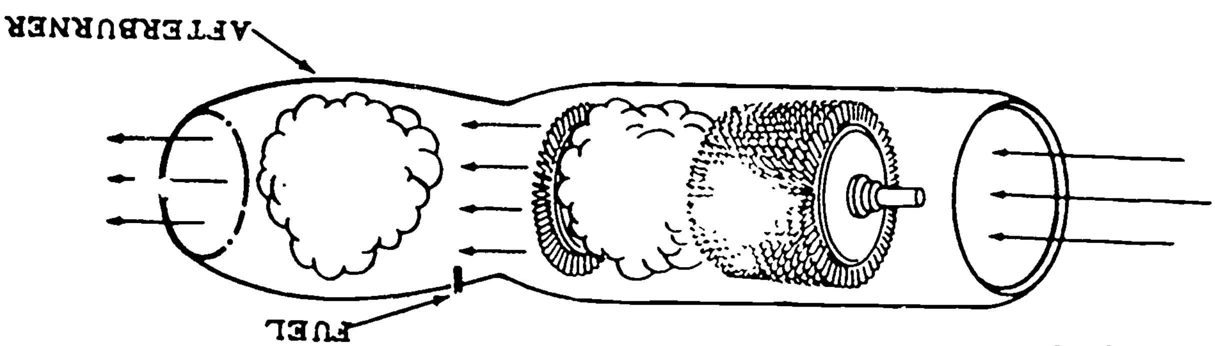


It takes a lot of power to turn the compressor rotor. This power is supplied by a turbine which is connected to the rear end of the compressor rotor by a shaft. In the illustration above, draw an arrow to the turbine and write in its name.

101A



FRAME 106



In place of an exhaust section, some engines have a section called an <u>after-burner</u>. It operates like a huge combustion chamber. Fuel is <u>sprayed into</u> the exhaust gases (4/5 unused air) as they pass through the afterburner. The resulting combustion adds a terrific force to the exhaust gases causing them to be accelerated to an extremely high velocity.

FRAME 34

Jet engines have a means for cramming or compressing a huge amount of air into themselves. If an engine has more air to accelerate, it can develop ________________ thrust.

37A

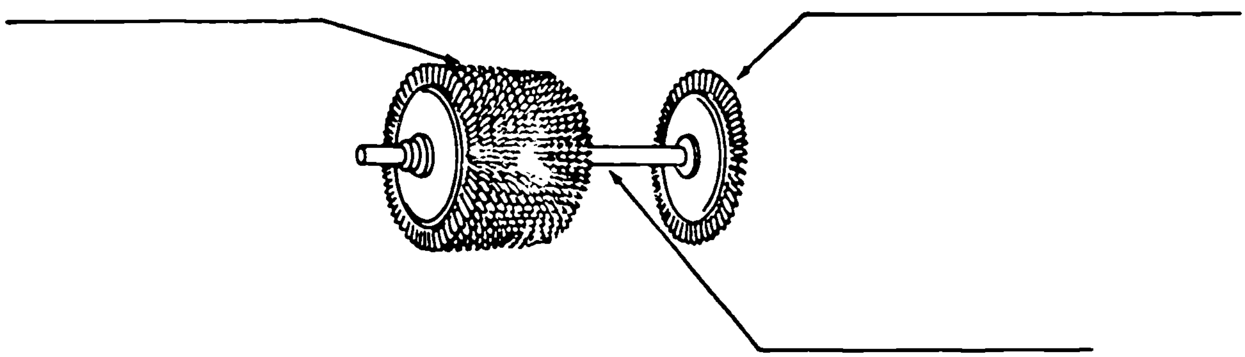
COMPRESSOR

LARGE

AIR

FRAME 102

Label the units in the figure below:



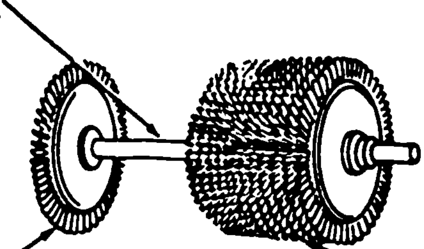
105A

TURBINE

EXHAUST GASES

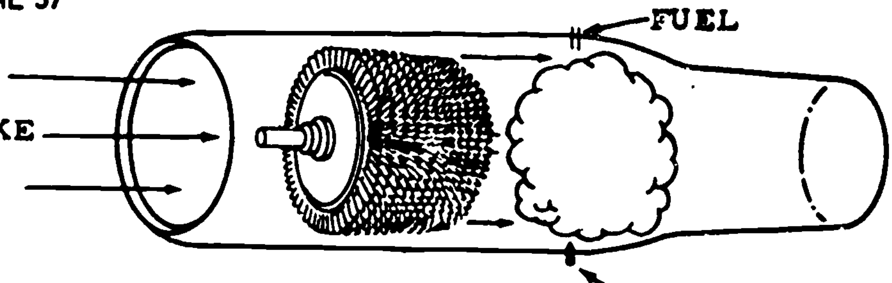
FRAME 105

The compressor rotor is driven by the ______________ rotor which is turned by the __________ ______________ as they rush toward the rear of the engine.



102A

FRAME 37



At top speed, the compressor will draw in over 100 pounds of air per second. One hundred pounds of air is enough to fill an average size room. The ____________________ draws in a very ______________ mass of ____________________.

MORE

34A

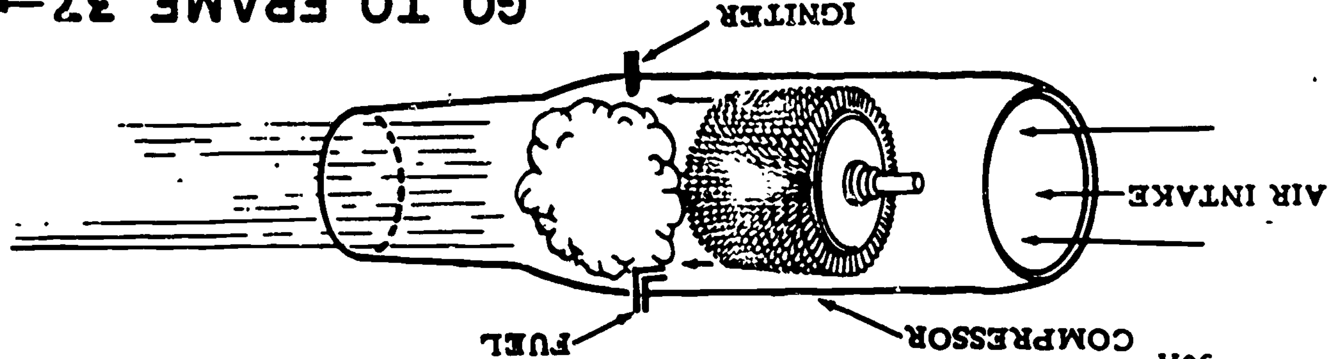
319

FRAME 35

The unit which draws in air and compresses it into the engine is called a

compressor.

GO TO FRAME 37



36A

FRAME 103

Here is how a turbojet engine develops thrust.

a. The compressor turns at a high speed and draws in a huge mass of ____________.

b. When the air reaches the combustion section about one fifth of it is mixed with ____________ as the fuel is burned.

c. Combustion creates ____________ which causes the air to ____________ and exert forces in all ____________.

d. Force toward the front of the engine is ____________ to the force toward the rear.

ENGINE

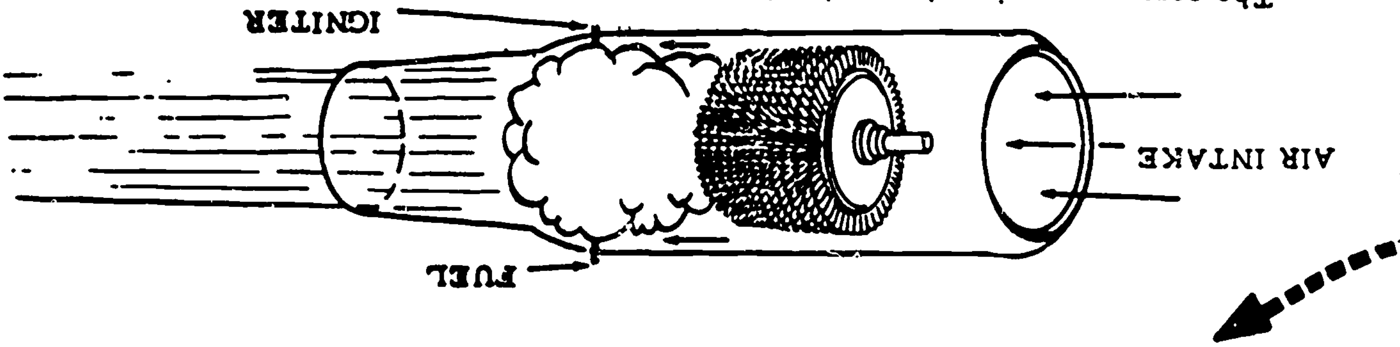
104A

321

35A

NO RESPONSE REQUIRED.

FRAME 36



The compressor in a jet engine is like a series of many bladed fans, mounted one behind the other. In the above illustration, draw an arrow to the compressor and write in its name.

103A

a. air

b. fuel

c. heat
expands
directions

d. equal

FRAME 104

CONTINUED

e. Force toward the front is against the ______

ROTATE YOUR BOOK ONE-HALF TURN AND FOLLOW THIS ARROW

NOW GO ON TO
FRAME 36

YOU ARE GOING TO HAVE TO ROTATE THIS BOOK AGAIN.

FOLLOW THE ARROW TO FRAME 104

COMING
104

STUDY GUIDE

3ABR42633-SG-105

Technical Training

Jet Engine Mechanic

AIRCRAFT AND ENGINE FUNDAMENTALS

26 March 1981

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AIRCRAFT AND ENGINE FUNDAMENTALS

OBJECTIVES

After you have completed this study guide and your classroom instruction, you will be able to:

1. State the principles of jet engine operation.

2. State how a jet engine develops thrust and the atmospheric conditions that affect thrust.

3. State the meanings of aircraft and engine designations.

4. Name the major sections and parts of a T56 engine and state its principles of operation.

5. State the purpose and location of the T56 engine systems and parts.

INTRODUCTION

An understanding of how a jet engine develops thrust is essential to troubleshooting of gas turbine engines. This study guide is devoted to an introductory discussion of jet propulsion and jet engines. It has been simplified to establish an easy understanding upon which the following lessons can be built. There is a glossary at the back of this study guide. You can find the meaning of many new technical terms in this glossary.

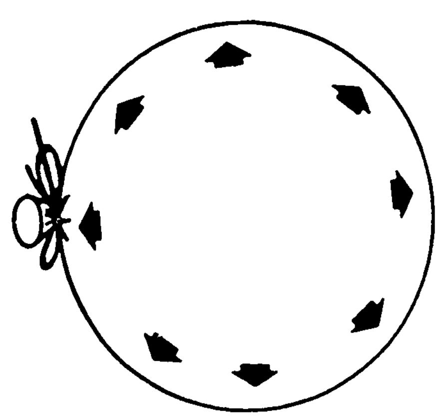

Figure 1. Equal Pressure in all Directions.

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INFORMATION

JET ENGINE THEORY

If a toy ballon is blown up and the stem released, it will travel at a high rate of speed until the air is exhausted. When a balloon is inflated, the inside air pressure is greater than the outside pressure. With the stem tied closed, this inside pressure pushes with equal force in all direction, figure 1. The balloon remains stationary.

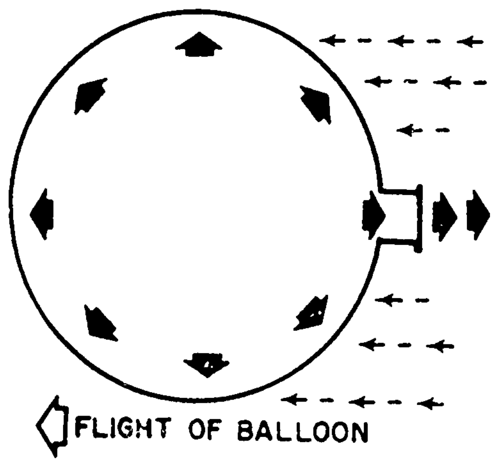

Figure 2. Unequal Pressure Causes Moving Force.

Releasing the tie on the balloon stem causes the balloon to move away from the stem, figure 2. What causes this to happen? With the stem open, that section of the balloon that air pressure was pushing against has been removed. The air pressure, however, continues to push on the side opposite the stem. It is this unequal pressure that causes the balloon to move in the direction opposite the stem. A jet engine operates on the same principle.

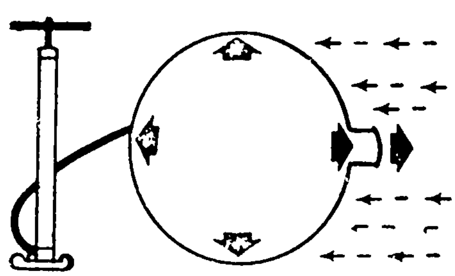

Figure 3. Maintaining Pressure in the Balloon.

The flight of the balloon is short because the air pressure is soon exhausted. This can be overcome by maintaining air pressure in the balloon with a tire pump, figure 3.

To change this machine into a jet engine, the tire pump is replaced with a rotary pump or compressor, figure 4. Now, by turning the compressor at a high rate of speed, large volumes of air will pass through

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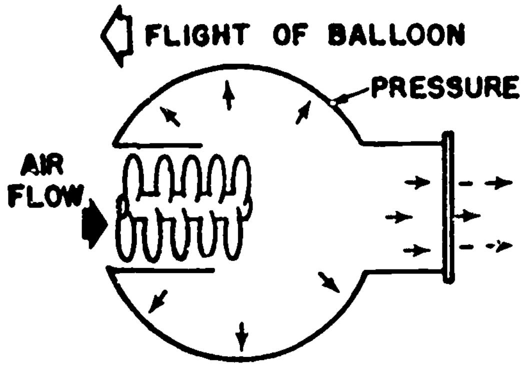

Figure 4. Replaces Tire Pump with Rotary Pump.

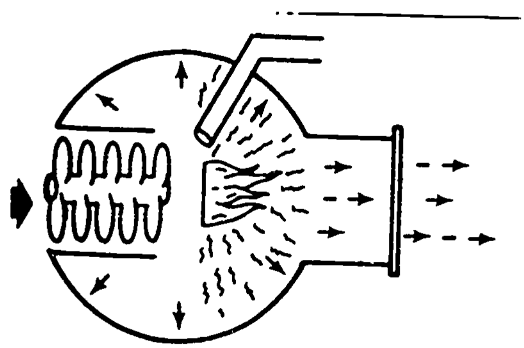

Figure 5. Fuel is Burned in the Airstream.

the balloon while continuing to hold a high pressure inside. To produce energy, fuel is introduced and burned in the airstream behind the compressor, figure 5. Burning the fuel expands the air, greatly increasing the pressure within the "engine" and the velocity of the air through the opening.

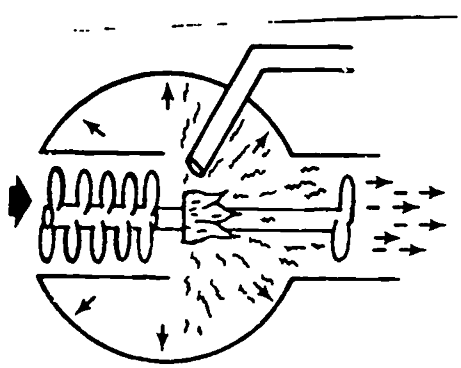

Figure 6. Add Turbine to Drive Compressor.

Now, the only requirement necessary to complete the engine is some internal means of operating the compressor. Figure 6 shows how this is done. A turbine wheel is placed in the path of the heated gases with a connecting shaft to the compressor. Some of the hot gas energy is used to turn the turbine wheel, which, in turn, drives the compressor. Most of the remaining gas energy is expended through the exhaust nozzle, creating thrust.

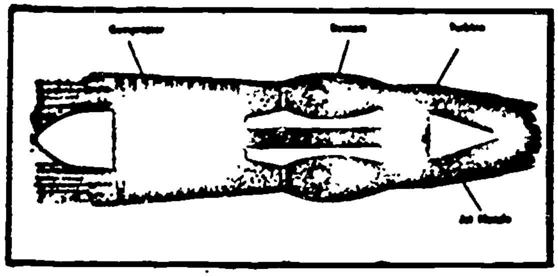

Figure 7. A Typical Turbojet Engine.

This simplified jet engine can now be compared with a typical turbojet engine, figure 7. Its operation is a continuous cycle that will operate as long as it receives fuel.

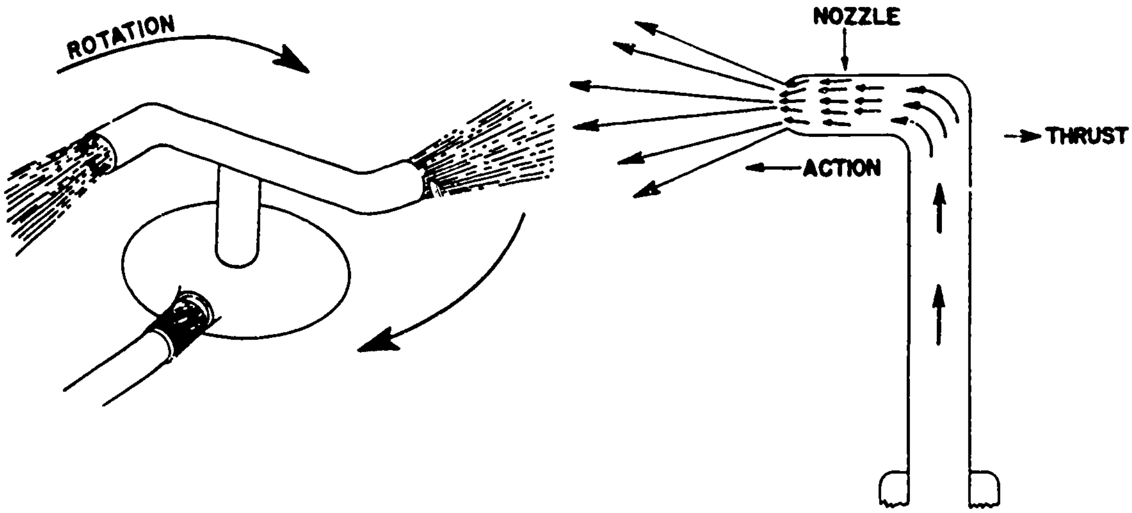

Figure 8. Water Sprinkler, Action and Reaction.

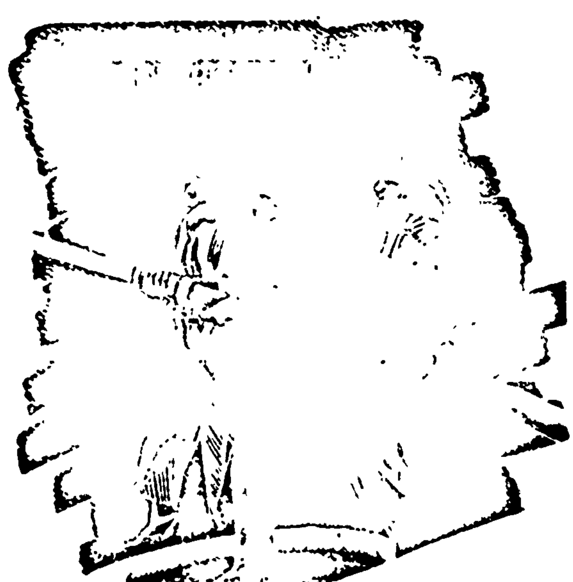

Figure 9. Fire Hose, Action and Reaction.

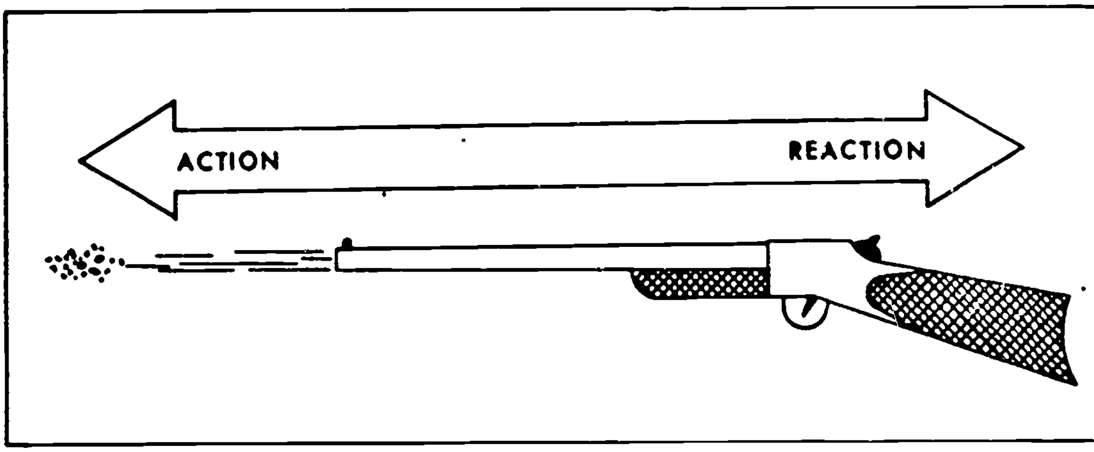

Figure 10. Gun, Action-Reaction.

The principles of jet propulsion involve basic laws which are easier to understand if explained with common everyday examples. A jet engine is defined as a reactionary device which develops forward thrust by the acceleration of a mass rearward through a jet or nozzle. The thrust forward and mass accelerated rearward can best be explained using Newton's 3rd law of motion. Newton states, "To every action there is an equal and opposite reaction." This is important in understanding the term "reactionary device." Devices that can be used to illustrate this principle are shown in figures 8, 9, and 10. The water sprinkler, figure 8, uses water forced through a nozzle as an action. The resulting reaction (thrust) is the rotation of the sprinkler head around its base. Figure 9, illustrated by a fire hose, is also the result of a water mass exiting in one direction. The reaction is in the opposite direction, which requires the firemen to hold the hose. You may experience this on a smaller scale when you water a garden or wash your car. How about when you fired a gun while hunting or target shooting? The "kick" is also an example of action - reaction, figure 10. The weapon produces an action by accelerating the bullet in one direction. The reaction is the recoil felt on your shoulder. The larger the caliber or gauge, the greater the reaction of "kick" as the mass leaves the weapon.

The idea of expelling a mass through a jet or nozzle in the definition of a jet engine is better explained using Bernoulli's principle. Bernoulli's principle may be stated as follows: When the same amount of fluid leaves as enters a pipe, but the cross sectional diameter of the pipe varies, the pressure will be the highest where the cross section is the largest and the velocity will be the lowest.

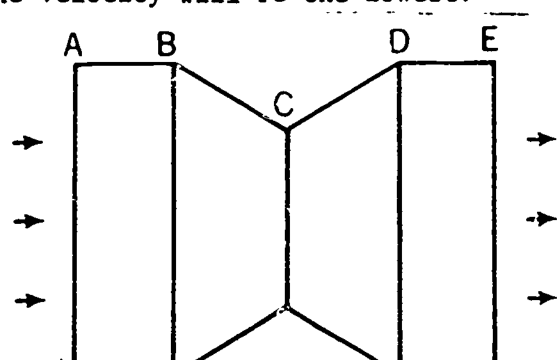

Figure 11. Bernoulli's Principle.

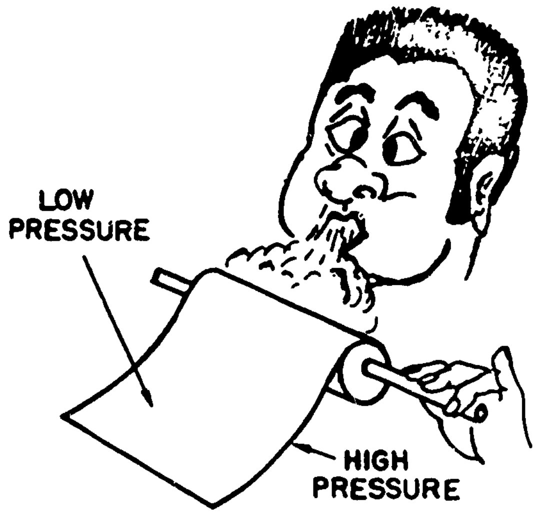

Figure 12. Creating Lift.

Figure 11 shows a duct with several different diameters. According to Bernoulli's principle, the pressure at points A, B, D and E is higher than at point C. Larger diameters create higher pressures. Pressure drops from point B to point C, and velocity increases. This reverses as it passes from point C to point D. The pressure begins to increase at point C and the velocity begins to decrease. Figure 12 shows how Bernoulli's principle can be applied to a sheet of paper to create lift. The velocity over the top of the paper increases and the pressure drops, so the pressure underneath is slightly higher which tends to lift the sheet of paper. Just remember, when the velocity increases, the pressure decreases.

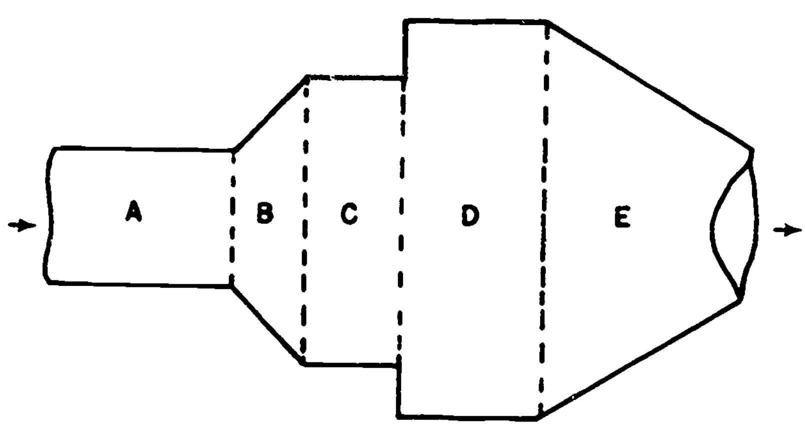

Figure 13. Pipe, Varying Diameters.

In figure 13, as the fluid moves through the pipe, the pressure increases through sections B, C, and D because the diameters are larger than section A. Remember, that as the pressure increases, the velocity will decrease.

In order to accelerate a gas through a jet or nozzle, the diameter of the duct must converge, or get smaller. The speed of velocity of the gas will increase. This is what happens through section E.

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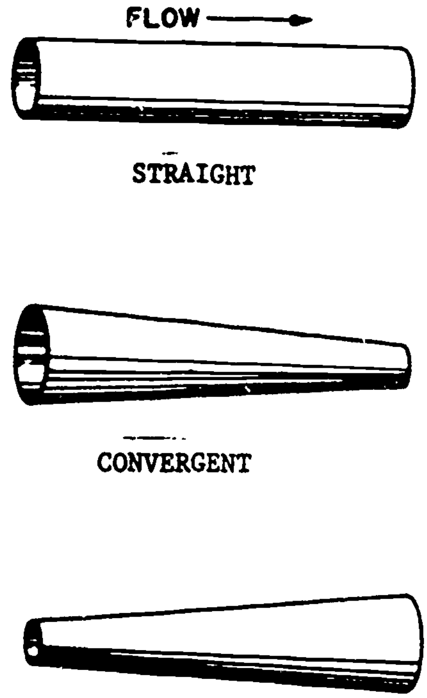

Figure 14. Types of Ducts.

Simply stated, to increase velocity you decrease the duct size. This duct is called a convergent duct. To increase pressure, you must increase the diameter of the duct. This duct is called a divergent duct. If pressure and velocity remain the same through a duct it is called a straight duct. Examples of these ducts are shown in figure 14.

TERMS USED IN REFERENCE TO JET ENGINES

Matter

Matter exists in three states: solid, liquid, and gas. Liquids and gases are grouped together as fluids since they have many characteristics in common. Everything is made of matter, even air.

Mass

Mass is a quantity of matter. One pound and one kilogram are measures of mass.

Density

This is the amount of mass in a given space or mass per unit volume. Imagine two boxes the same size, one filled with feathers and the other with bricks, figure 15. There is more mass in the box of bricks. Since the bricks weigh more than the feathers, the bricks have more mass in the same volume. Therefore, they are denser than the feathers.

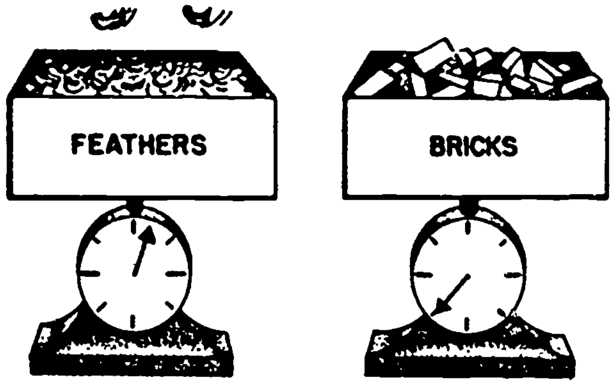

Figure 15. Density.

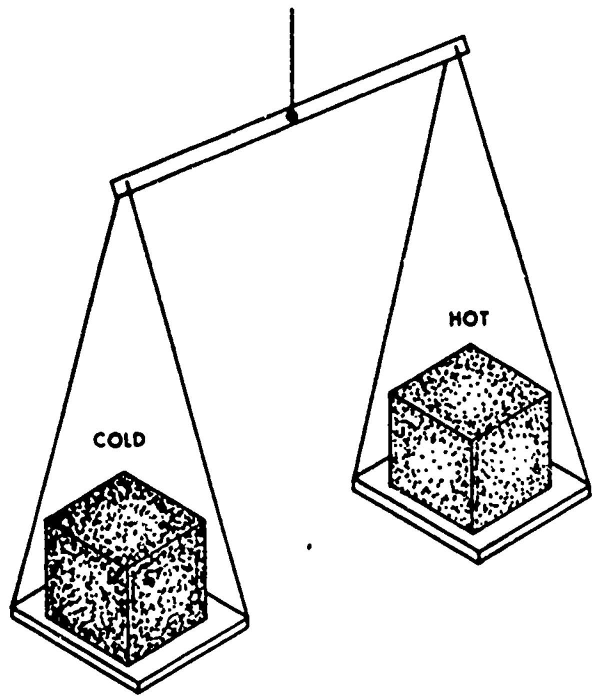

Figure 16. Air Density.

In figure 16, we see a cube of cold air and a cube of hot air. As temperature increases air becomes less dense; therefore, a cube of cold air has a greater density and will weigh more.

Velocity

Velocity is the rate of change of position in relation to time. Velocity is almost the same as speed, except that velocity also includes direction. So 35 miles per hour south is a measure of velocity.

Acceleration

Acceleration can be positive or negative. Acceleration includes your zero to 60 time for your car, as well as the 60 to zero time that

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you might think of as your braking time. Acceleration is a change in velocity, whether it be positive or negative.

Force

Force is the total push or pull on matter, as the result of something pushing on an object or the pull of gravity. Force is the cause of motion.

Pressure

Pressure is the intensity of the force exerted against an opposing body. For example, the water in a tank has weight or force (F) of 100 pounds, and the area (A) of the bottom of the tank is 10 square inches. The pressure (P) on the bottom of the tank is 10 pounds per square inch (psi).

$$F = 100 \text{ lb}$$

$$A = 10 \text{ sq in}$$

$$P = \frac{F}{A} = \frac{100}{10} = 10 \text{ psi}$$

Atmosphere

The earth is attended by a gaseous sea of air called the atmosphere. Because it is invisible, we frequently remain unconscious of it. Air is necessary for combustion and to transmit sound. The atmosphere furnishes a highway for aircraft. An aircraft moves through the air as a submarine moves through the water. The atmosphere is a mixture of gases, primarily nitrogen and oxygen.

Atmospheric Pressure

The atmosphere is piled on the earth's surface like hay in a haystack. The bottom layers are packed down more compactly, due to the weight of the hay above. They are more dense than the layers near the top where the hay is loose. You can also understand atmospheric pressure if you compare it with a water tank. The pressure is greatest at the bottom. Since everything is attracted to the earth by gravity, atmospheric pressure is the weight of the air above that level where the pressure is measured.

Pressure is expressed in units of weight (force) per unit area or psi (pounds per square inch). We say that the atmospheric pressure is 14.7 psi at sea level. This means that a 1 inch square column of air would weigh 14.7 pounds if it reached to the top of the atmosphere.

Barometer

Atmospheric pressure is measured by a barometer and is usually expressed in inches or centimeters of mercury, figure 17. If a glass tube closed at one end, and 30 inches or more in length, is filled with mercury and inverted in a bowl of mercury, the mercury will stand in

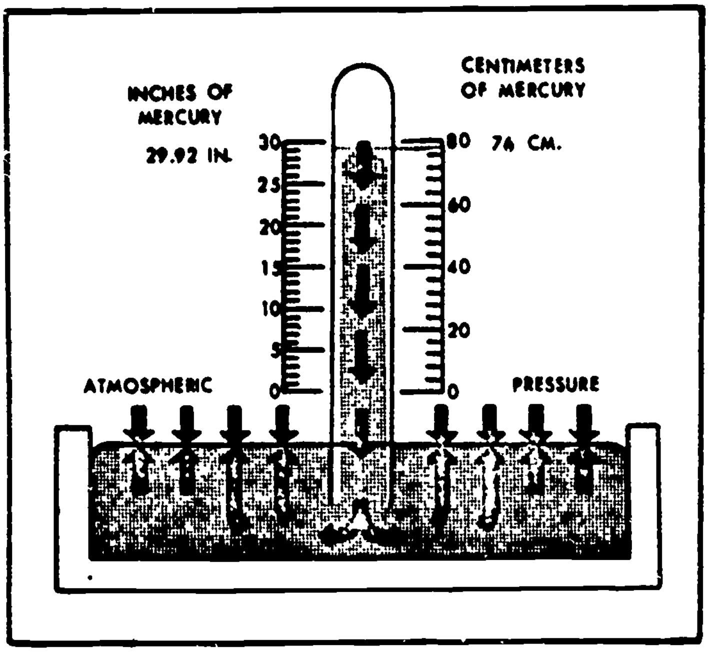

Figure 17. The Mercury Barometer.

the tube to a height of about 30 inches. Note in figure 17 the weight of the column of mercury will be exactly the same as atmospheric pressure. Naturally, if the atmospheric pressure is lowered, the level of mercury in the tube will be lowered, and vice versa.

Temperature

This is the degree of hot or cold of anything, usually measured with a thermometer. The term ambient temperature refers to the temperature around or surrounding the area where the reading was taken.

Humidity

Humidity is a term used to express the presence of water vapor in the air. Relative humidity is the actual amount of water vapor in the air compared to the maximum amount of vapor the air can hold at that temperature. For example, if water vapor could make up 4% of the total volume of the atmosphere at the present temperature without condensing. If only 2% of the atmosphere is actually water vapor, the relative humidity is 50% or half of what the air is capable of holding at that temperature.

ATMOSPHERIC CONDITIONS AFFECTING JET ENGINE THRUST

Formula for Computing Thrust

Thrust (force) = mass (M) times acceleration (A) (T = M x A), is from Newton's second law of motion.

Pressure

When the pressure increases, it will compress more air molecules (mass) into the jet engine, increasing the jet engine thrust.

Temperature

When the temperature increases, the air will expand, reducing the mass being taken into the jet engine. This reduces the jet engine thrust.

Humidity

When the humidity increases, the water vapor displaces the heavier molecules of air. The thrust will decrease because of the reduced mass being taken into the jet engine.

Standard Day Conditions

These conditions are used to compute the jet engine thrust using Air Force technical orders and specially designed tables. Standard day temperature is 59°F, humidity 0%, and barometric pressure 29.92 inches of mercury (Hg).

QUESTIONS

1. State Newton's third law of motion.

2. List and explain two examples of Newton's third law of motion.

3. What are three atmospheric conditions which affect jet engine thrust?

4. What are the standard day settings used to compute thrust?

5. What is humidity?

6. What are the three kinds of ducts and what are their effects on pressure and velocity?

7. Does a jet engine have to push against something (like the atmosphere) to move? Why or why not?

8. What is acceleration? Does it have anything to do with thrust?

9. Which is denser, hot or cold air?

CHARACTERISTICS OF JET PROPULSION POWER PLANTS

Jet propulsion power plants may be divided into two general classes, air breathing and non-air breathing engines.

Rockets are non-air breathing and, therefore, are self-contained. That is, all of the materials necessary for operation are contained within the rockets. The operation is independent of the atmosphere because they carry their own supply of oxygen. Rockets are further classified according to the type of propellants used, which may be either liquid or solid.

Air breathing power plants use the surrounding atmosphere to support combustion for the necessary addition of heat. They can operate only where air (oxygen) exists.

where air (oxygen) exists. Included in this group are the ramjet and turbojet engines.

Types of Jet Engines

RAMJET. A ramjet engine gets its name from the ram action which makes possible its operation. Theoretically, the speed that can be attained by a ramjet engine is unlimited. Actually, the faster it moves the better it runs and the more thrust it develops.

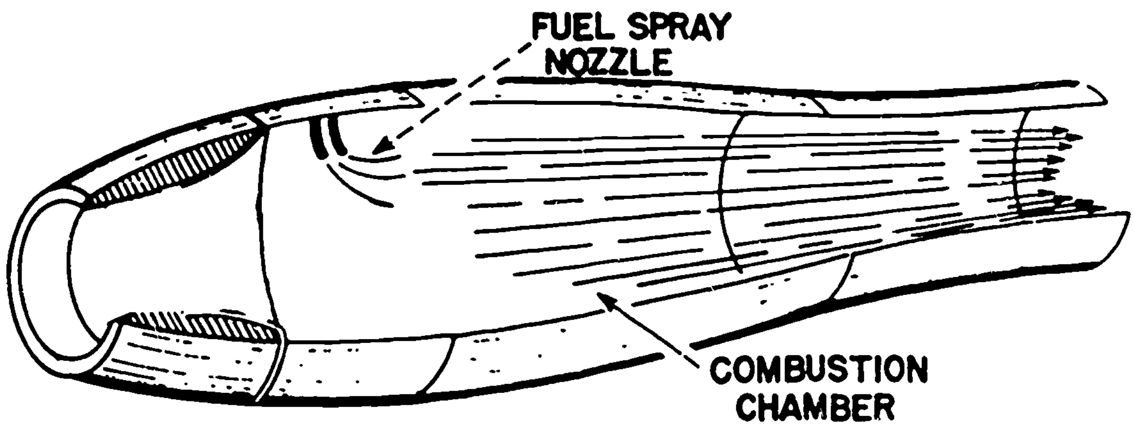

Figure 18. Ramjet Engine.

The major disadvantage of a ramjet is that it cannot accelerate from rest; therefore, it cannot take off under its own power. If a ramjet were operated at rest, high-pressure combustion gases would escape out of the front as well as the rear, since the ramjet engine, figure 18, has no mechanical compressor.

This engine must be brought up to high speed by some outside means so the forward motion will be high enough to compress the air. Then fuel is introduced into the combustion chamber by a fuel spray nozzle and ignited with a spark plug after the forward speed is high enough to sustain operation.

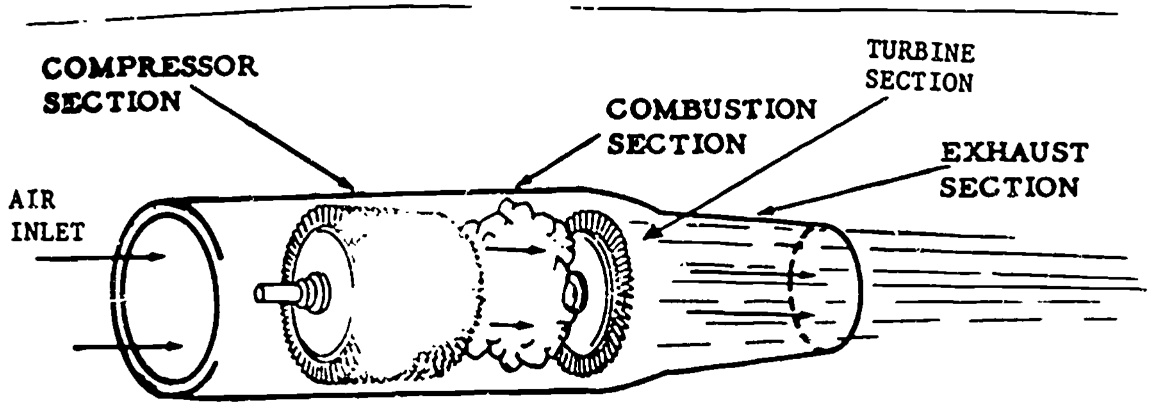

Figure 19. Turbojet Engine.

TURBOJET. A turbojet engine is an air-breathing, jet-propulsion device that gets its name from its design. This means that it uses an exhaust-gas-driven turbine wheel to drive its compressor. The same events occur in a turbojet as in the conventional four cycle piston engine. In the turbojet engine, a separate section is devoted to each function. All functions occur at the same time and without interruption. These sections are the compressor section, combustion section, turbine section, and exhaust section, as shown in figure 19.

In operation, the compressor brings in and compresses air. Fuel is then injected into the combustion area and burned. The heated air expands through the turbine and drives the compressor. The remaining gas energy is expended in accelerating the exhaust gas through a jet nozzle and produces thrust.

A turbojet engine is a complete power plant. This is true of any type of turbojet engine, whether it is large or small, simple or complex. All of the engines work on the few simple laws you have learned. It would be very simple if the Air Force used only one type of engine. This is impossible, because of the different missions for which aircraft are designed, new ideas, design changes, and manufacturers competing with each other to develop more powerful and more efficient engines.

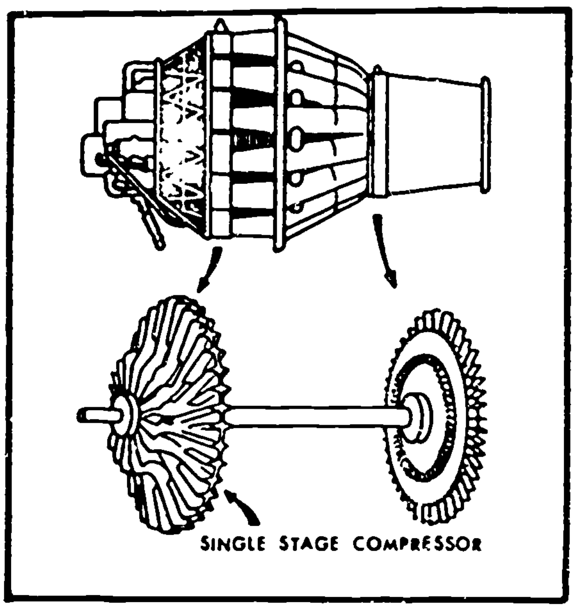

Figure 20. Centrifugal Flow Compressor.

When the Air Force became interested in turbojet engines, the first compressor design was the centrifugal flow, single stage compressor, shown in figure 20. Engine speed was limited in this type of engine. Some of these types are still in use. The axial flow, multistage compressor, shown in figure 21, allows straight-through airflow. The axial flow compressor allows higher compression ratios with less frontal area. So it became the accepted design in general use throughout the Air Force.

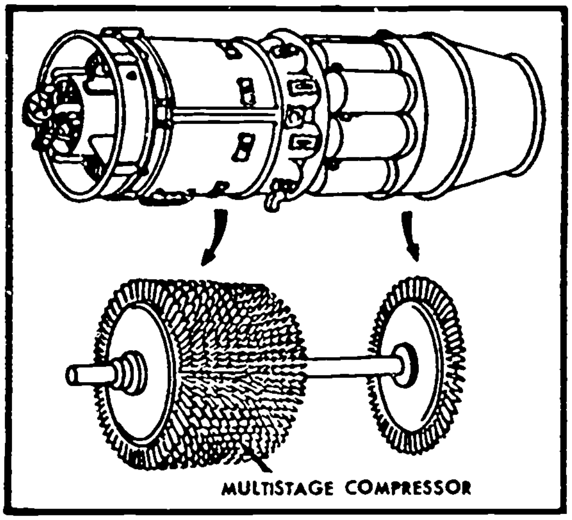

Figure 21. Axial Flow Compressor.

TURBOPROP. The need for aircraft of greater size, carrying capacity, range and speed created a demand for more powerful engines. The turbojet engine with its high power-to-weight ratio supplied the power but without some of the desirable features of propeller-equipped engines. It follows, then, that the most desirable engine would combine the best characteristics of the turbojet and propeller-equipped engines.

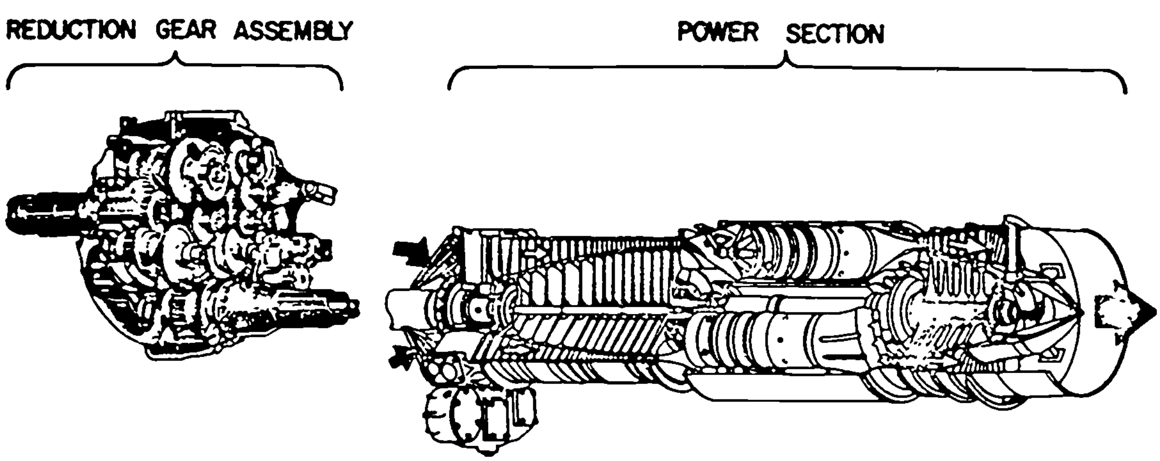

Figure 22. Turboprop Engine (Cutaway).

In an attempt to combine into one engine the best characteristics of each type, the turboprop engine, shown in figure 22, was developed. This type of engine is currently installed in production aircraft. It offers several advantages; economical operation, little vibration, the propeller for takeoffs and landings on moderate sized airstrips, and high power with low weight.

The turboprop is not a conventional jet engine, although they use jet reaction as an additional source of power. The power developed by the gas turbine power section drives a propeller through a reduction gear assembly, shown in figure 22.

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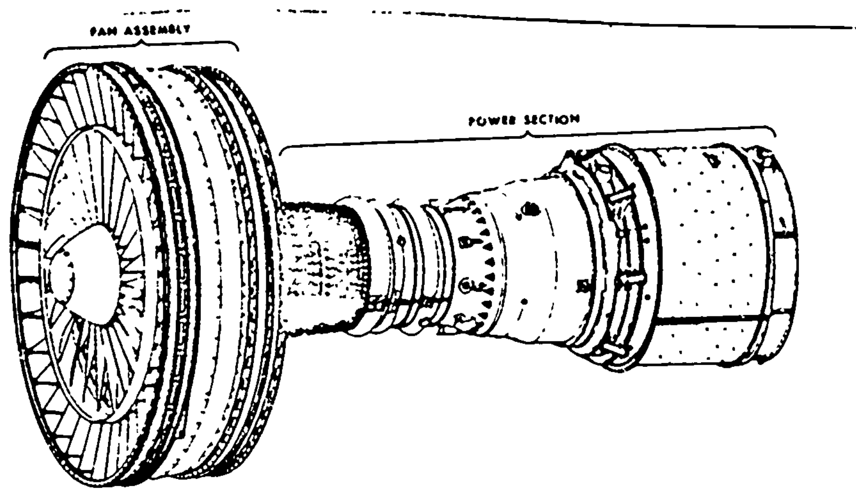

Figure 23. Axial-Flow Fan.

TURBOFAN. In principle, the turbofan gas turbine engine is the same as the turboprop except that the geared propeller is replaced by an axial-flow fan that is driven at engine speed. See figure 23. Secondary air is the air passing through the outer part of the fan, but not through the power section. The ratio of secondary to primary airflow is greater than 1.

Directional References

Directional references is the term used to describe the standard method for labeling and locating parts of an engine or aircraft. This is done as if you are standing at the rear looking forward. Also, the location of any item would be given in clock positions. An example of this would be if some unit was on the right-hand side, it would be labeled as the 3 o'clock position. Study figure 24.

DESIGNATIONS

Aircraft Designations

BASIC MISSION AND TYPE SYMBOL. This is a letter used to indicate the primary function or capability of an aircraft. Modified mission symbols are used with "type symbols" (such as "H" for helicopter) to determine what the aircraft is being used for. Some examples are:

Letter	Title
A	Attack
B	Bomber
C	Cargo/Transport
F	Fighter
*H	Helicopter
L	Observation
T	Trainer
U	Utility
X	Research

*Type symbol

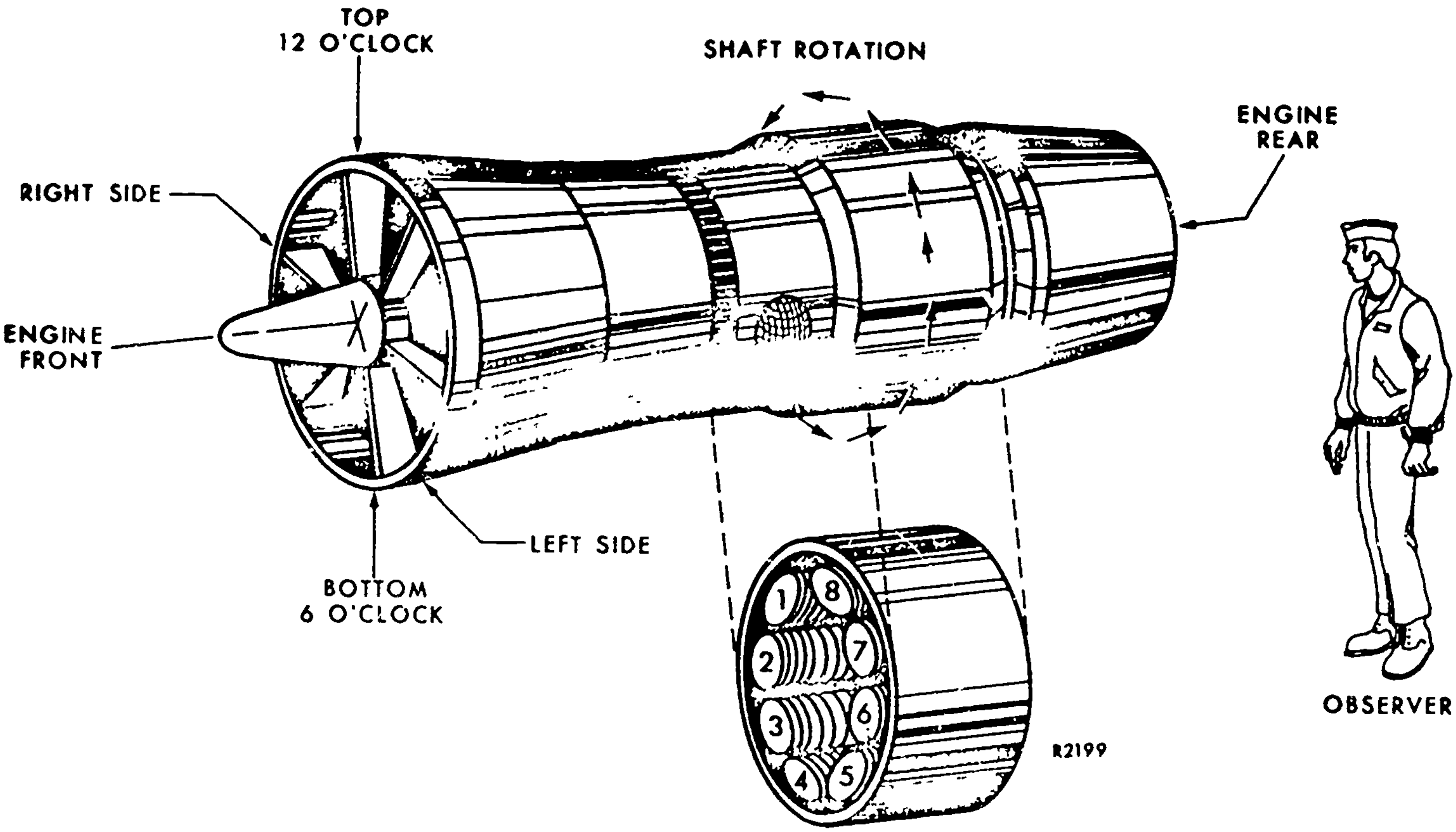

Figure 24. Directional References (Rear Looking Forward).

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MODIFIED MISSION SYMBOL (PREFIX LETTER). This is used to show the present use of an aircraft when it is so modified that its original function is no longer possible or is restricted in capability. Only one modified mission symbol can be placed to the left (prefix) of any basic mission symbol. Example: The KC-135 aircraft was designed to carry cargo but has been modified to a tanker for refueling use.

Modified mission symbols include:

Letter	Title
A	Attack
C	Cargo/Transport
E	Special Electronic Installation
H	Search Rescue
K	Tanker
R	Reconnaissance
T	Trainer
U	Utility
V	Staff
W	Weather

DESIGN NUMBER. This is a sequenced number following the basic mission symbol for each new design of the same type of aircraft. Some are never mass produced. After the numbers got too high in value, the Air Force started counting from 1 again. Hence the C-5 and the F-4 and F-15.

Below are examples of aircraft chosen at random from those put into production.

B-52	C-5
B-57	F-100
B-66	F-101
C-119	F-104
C-121	F-105
C-124	F-111
C-130	F-4
C-135	F-15
C-141	

SERIES LETTER. The series letter is used to show changes in aircraft that affect logistic or support requirements. Series letters start with "A" but do not include "I" or "O" to eliminate confusion with numerals.

Examples of some series changes would be the installation of different engines, extra fuel tanks, electronic equipment, etc. The C-130, for instance, has several series changes, such as C-130B, C-130E, and so on to C-130H.

STATUS PREFIX SYMBOL (CLASSIFICATION LETTER). When a status prefix letter is used on an aircraft, it shows use for experimentation, or special or service test. The status prefix letter is placed to the left of the basic mission symbol or the modified mission symbol.

Some examples are:

Letter	Title
G	Permanently Grounded
J	Special Test, Temporary
N	Special Test, Permanent
X	Experimental
Y	Prototype
Z	Planning

Engine Designation

TYPE LETTER. Type letters are used to identify different types of power plants.

Some examples are:

Letter	Title
R	Reciprocating
J	Turbojet
RJ	Ramjet
TF or F	Turbofan
T	Turboprop
K	Rocket

MODEL NUMBER. Model numbers are used to show the model of the engine. Numbers are used with the letters to identify specific engines in a type. These numbers start with 30 for each type of power plant and progress in sequence. Even numbers, such as 30, 32, 34, 36, etc., are used for engines which are developed for the Navy. Odd numbers, such as 31, 33, 57, 79, etc., are used for engines which are developed for the Air Force.

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For example, the J33 is the second turbojet engine developed for the Air Force, and the T34 is the third turboprop engine developed for the Navy.

Examples of design numbers with type letters are:

Air Force	J33, TF39, J57, F101
Navy	TF30, J48, T56, T400

MANUFACTURER'S CODE LETTERS. The manufacturer's code letter is used to indicate who manufactured the engine. More than one manufacturer could build the same type and model engine.

Examples:

T56-A	Built by Allison
J79-GE	Built by General Electric
J75-F	Built by Ford

Other manufacturer code letters are:

R - Fairchild	NA - North American
T - Continental	ST - Studebaker
L - Lycoming	W - Wright Aeronautical

SERIAL NUMBER. The series number is used to indicate the major changes to the model and to indicate who is using the engine. The Air Force uses odd numbers (1, 3, 5, 9, etc). The Navy uses the even numbers (2, 4, 6, etc).

Examples:

J57-P-6	designed for the Air Force and being used by the Navy
T56-A-7	designed for the Navy and being used by the Air Force

Higher series numbers indicate more recent changes to the engine model.

SERIES MODIFICATION LETTER. Series modification letters are used to show factory changes to the series. These changes are used to show improvements or modifications to the series. These letters are added only with the manufacturer's authorization.

Some examples of series modification letters are:

T56-A-7A

T56-A-7B

T56-A-9A

T56-A-9B

CLASSIFICATION LETTER. Classification letters are used to show the status of the engine.

Examples:

Letter	Title
X	Experimental
Y	Prototype

QUESTIONS

1. List the types of jet engines discussed in this study guide.

2. Explain the designation KC-97L.

3. For a flight to the moon a turbojet would be of little use. Why?

4. What type of jet engine is designated "TF"? "J"? "T"?

5. Explain the directional reference of a jet engine.

6. Explain the engine designation YT56-A-7B.

CHARACTERISTICS AND MAJOR SECTIONS OF THE T56 ENGINE

The T56 engine is an axial flow, continuous-burning turboprop engine. It is rated at 4,050 equivalent shaft horsepower. Its length is 13 feet, with the power section taking up 8 feet of that. It is 2 feet in diameter, and weighs 1845 pounds. It develops 2.2 horsepower per pound of engine weight.

The T56 engine is made up of three sections, shown in figure 25. The power section, the torquemeter and tie struts, and the reduction gearbox. The power section is divided into four assemblies. The compressor, the combustion, the turbine, and the accessory gearbox. These will be described in the following paragraphs.

Power Section

COMPRESSOR ASSEMBLY. The purpose of the compressor assembly is to deliver air to the combustion assembly and the other air operated parts, under high pressure and moderate velocity. The compressor assembly is

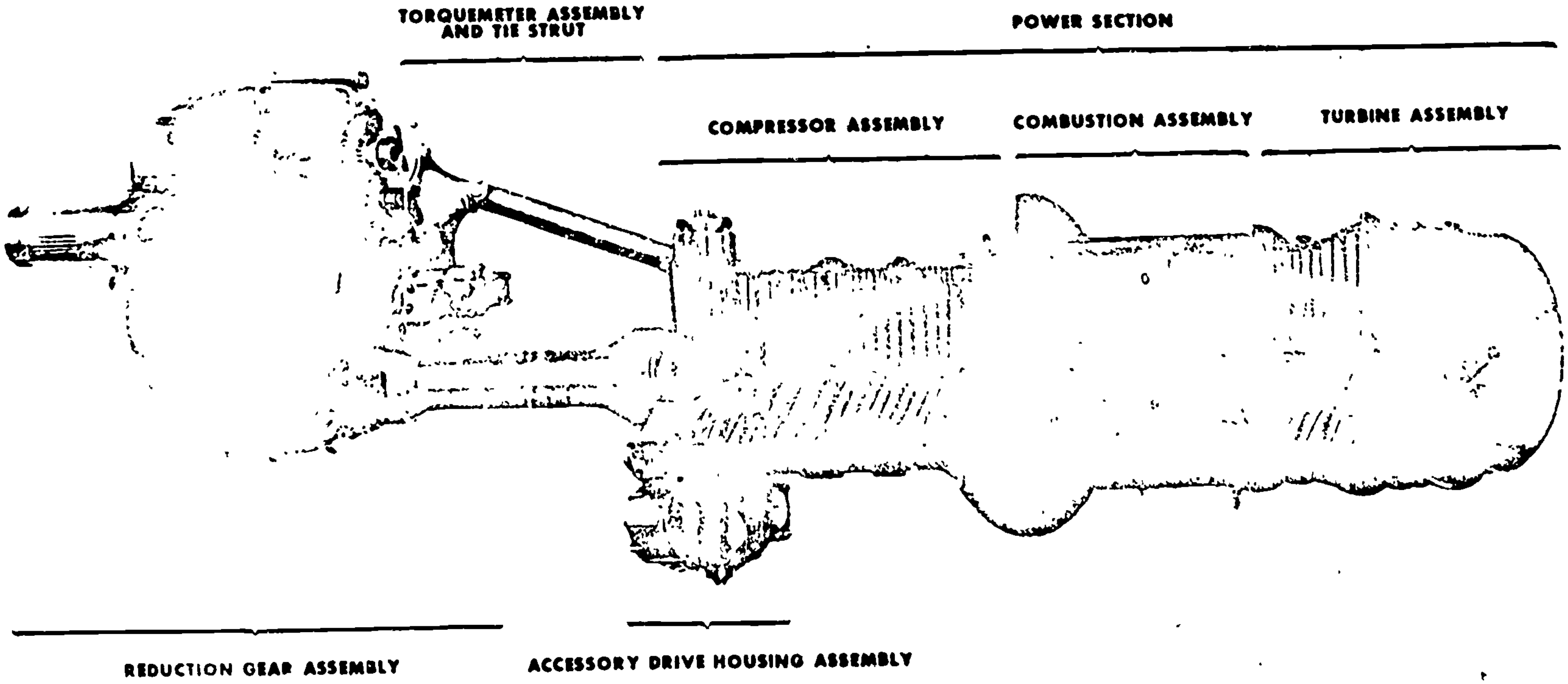

Figure 25. Major Engine Assemblies.

made up of four main parts. The air inlet housing, compressor rotor, compressor case, and compressor diffuser.

The air inlet housing is used to direct the air into the compressor. It has eight hollow support struts to allow flow of anti-icing 14th stage air. It also houses the compressor extension shaft which connects the torquemeter to the compressor, and the No. 1 bearing.

The compressor rotor consists of 14 stages of compressor blades, which are separated by stator vanes. The rotor is supported on each end by an antifriction bearing.

The compressor case houses the compressor rotor, and is the part that the stator vanes are mounted to. The case is made of four 90 degree segments, which are bolted together.

The compressor diffuser is located at the rear of the compressor assembly and is used to prepare the air for entry into the combustion assembly. It is a divergent type duct which will increase the pressure and decrease the velocity. Housed inside the diffuser is the No. 2 bearing. It is a ball type bearing, and is used to support the rear of the compressor rotor. It is also used to prevent axial movement of the compressor rotor and turbine rotor. Also attached to the diffuser are six fuel nozzles at the 2, 4, 6, 8, 10, and 12 clock positions, extending into the combustion chamber liners.

COMBUSTION ASSEMBLY. The purpose of the combustion assembly is to provide an area where fuel and air can be mixed together and burned. Approximately 25% of the air supplied by the compressor assembly is used for combustion, while the remaining 75% is used for cooling of the engine turbine assembly.

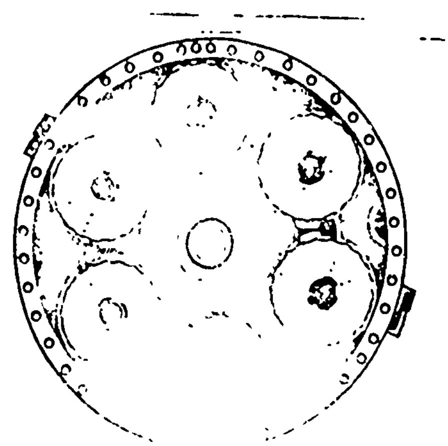

Figure 26. Canannular Combustion Section.

The combustion assembly is of the canannular type. This is shown in figure 26. This type uses a set of combustion liners around an inner combustion case and is surrounded by an outer combustion case. This combines the "burner can" efficiency of the individual chamber, with the strength and increased airflow of the annular type or single burner can.

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The major parts of the combustion assembly are the, six combustion chamber liners, the combustion outer case, and the combustion inner case.

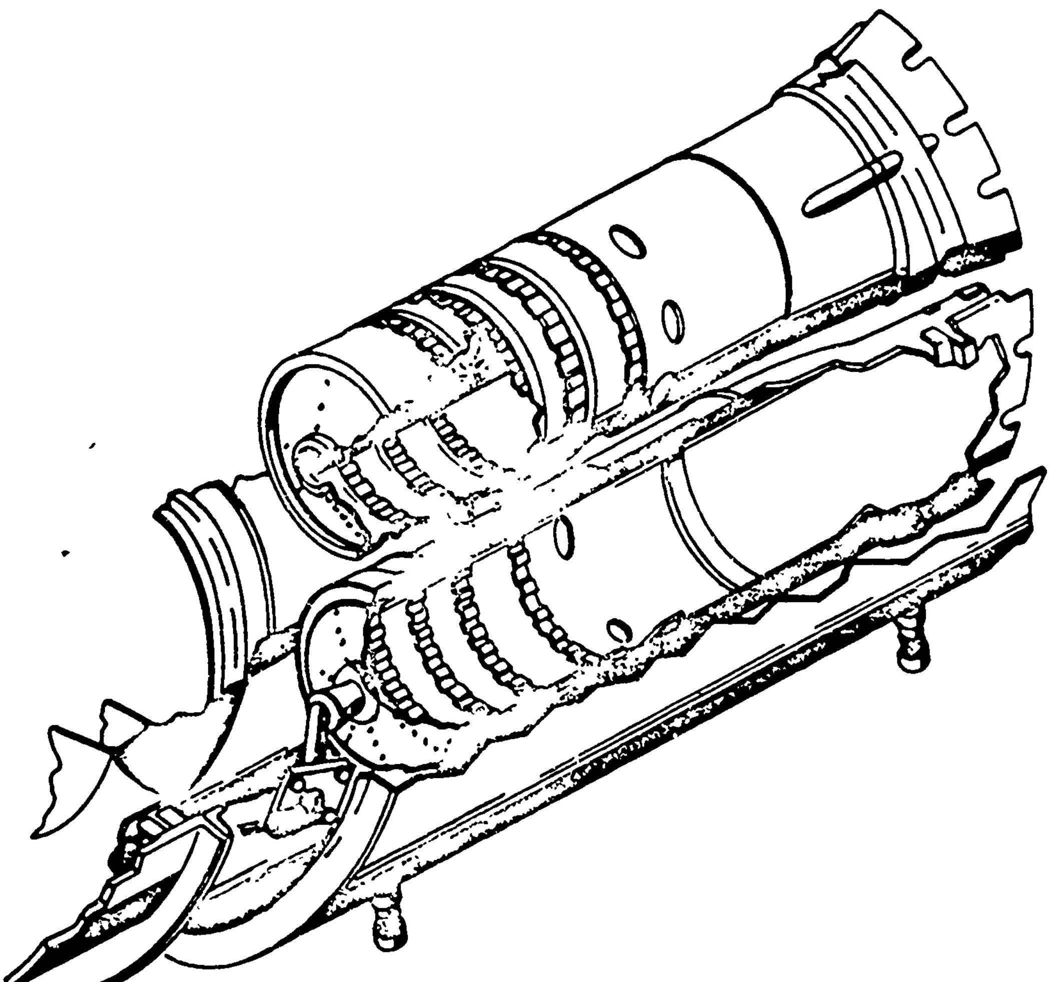

Figure 27. Combustion Chambers.

The six combustion chamber liners are located at the even clock positions around the inner combustion case, see figures 26 and 27. They provide an area where fuel and air can be mixed and burned efficiently. The combustion is started by use of two igniter plugs that extend into the number two and five chambers. Flame is spread to the remaining chambers by use of flame crossover tubes.

The combustion outer case makes up the outer wall of the combustion assembly, see figure 28. It surrounds the six combustion chamber liners and contains the extra 75% cooling air.

The combustion inner case makes up the inner wall of the combustion assembly. Housed inside are the inner case liner, two oil lines, and the turbine coupling shaft. Insulation for these parts is provided by the dead air space between the inner combustion case and the inner combustion case liner.

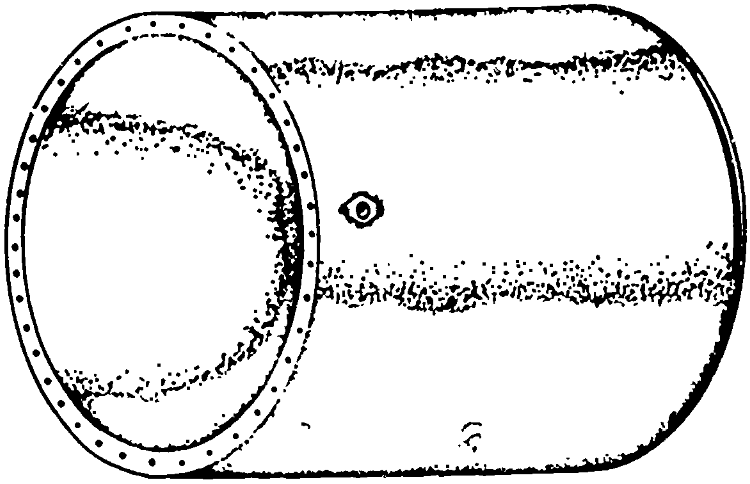

Figure 28. Outer Combustion Casing.

TURBINE ASSEMBLY. The purpose of the turbine assembly is to extract energy from the combustion gases and convert it to mechanical energy to drive the compressor and the engine driven accessories. The major parts of the turbine assembly are the turbine inlet case, the turbine vane case, the turbine rotor, and the rear bearing support.

The turbine inlet case is used to direct the gases into the turbine assembly. It houses the first stage of the turbine nozzle vanes and 18 thermocouple assemblies. The No. 3 bearing is also housed in the turbine inlet case.

The turbine vane casing forms the outer wall around the turbine rotor and vane assembly. It houses the second, third, and fourth stage turbine nozzle vanes, and the first, second, and third stages of the turbine rotor.

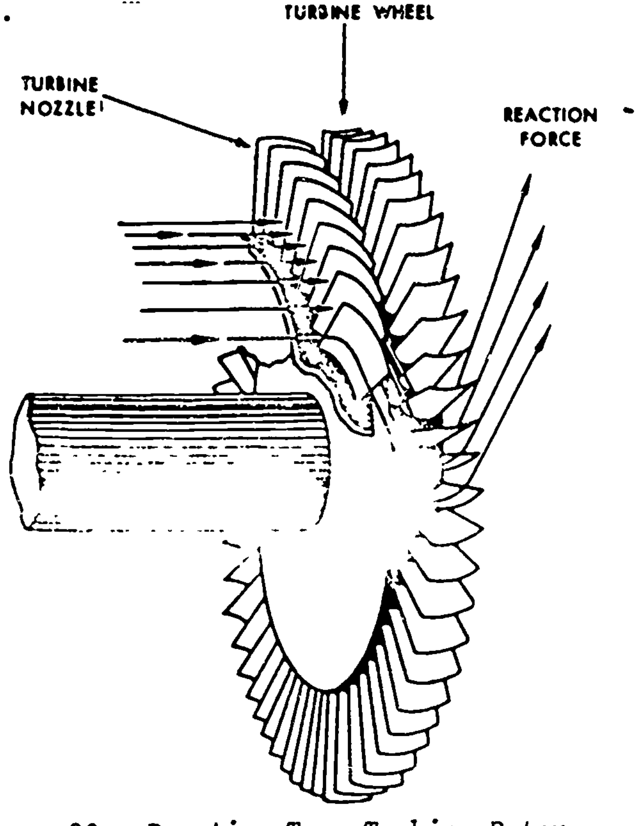

Figure 29. Reaction-Type Turbine Rotor.

The turbine rotor is of a four-stage, reaction-type, see figure 29. The four stages are needed to extract enough energy to drive the compressor, accessories, and propeller. It is supported at each end by an antifriction bearing to provide ease of rotation. It is attached to the compressor by means of a turbine coupling shaft and a turbine tie bolt. The tie bolt passes through the turbine rotor and the coupling shaft and threads into the rear of the compressor. This prevents axial movement of the turbine rotor.

ACCESSORY DRIVE ASSEMBLY. The purpose of the accessory drive assembly is to provide a place to mount and drive accessories to maintain operation of the engine. The accessory drive housing is located at the bottom of the air inlet housing. The power needed to drive the accessory drive housing is taken off the compressor extension shaft. This is by use of a side gear and a vertical drive shaft which passes through the 6 o'clock strut in the air inlet housing.

The parts that are mounted to the accessory drive housing are the:

1. Speed Sensitive Valve - On the outer, left hand, front side.
2. Speed Sensitive Control - On the inner, left hand, front side.
3. Oil Pump - On the inner, right hand, front side.
4. Oil Filter - On the outer, right hand, front side.
5. Fuel Control - On the left hand, rear side.
6. Fuel Pump - On the right hand, rear side.
7. External Scavenge Pump - On the center, rear side.

Torquemeter and Tie Struts

The torquemeter assembly is used to connect the power section to the reduction gearbox and to transfer all the torque developed by the power section to the reduction gearbox. It also provides a means of measuring the torque. This will be discussed in a later section.

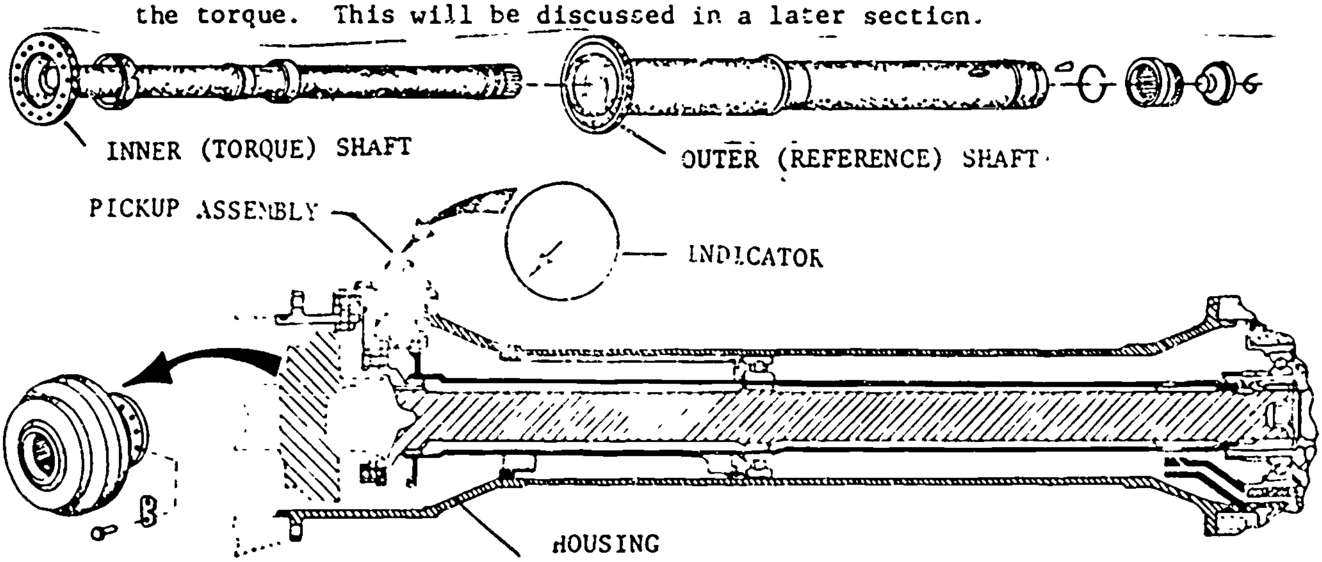

Figure 30. Torquemeter Assembly.

The torquemeter itself is made up of two separate shafts, see figure 30, an inner (torque) shaft and an outer (reference) shaft. Both shafts are attached together at the rear, but remain separate everywhere else. It is splined to the compressor extension shaft at the rear, and bolted to the safety coupling in the reduction gearbox at the front.

The torquemeter is housed in the torquemeter housing, which is bolted to the reduction gearbox (RGB) in the front and to the air inlet housing in the rear. The torquemeter housing provides most of the support between the RGB and the power section.

The tie struts are bolted to the top of the air inlet housing at the 2 and 10 o'clock positions at the rear, and the 2 and 10 o'clock positions of the rear side of the RGB at the front. These provide additional support between the RGB and power section and help stabilize the RGB.

Reduction Gearbox

The reduction gearbox is used to reduce the engine rpm to a safe rpm which can be used by the propeller. It does this by means of a two stage gear reduction process, providing an overall reduction rate of 13.54 : 1.

There are four major cases to the RGB. They are the front case, rear case, bearing diaphragm, and rear case inner diaphragm.

The front case houses and supports the forward parts of the RGB. Some of these parts are the propeller shaft, main scavenge pump, nose scavenge pump, negative torque signal system parts, thrust plate, and two magnetic drain plugs.

The rear case supports and houses the rear parts. Some of the accessories and parts on the rear case are the starter, hydraulic pump generator, oil pressure pump, and tachometer generator.

The bearing diaphragm is located between the front case and the rear case and is the midstructural member for the RGB. It supports the front of the pinion gear and the rear of the planetary gear carrier.

The rear case inner diaphragm is used to support the front of the gears used to drive the accessories.

The gear reduction consists of two stages. The parts of the first stage of reduction consists of the pinion gear and the main drive gear. These gears provide a gear ratio of 3.125 : 1. The parts of the second stage of gear reduction consists of the sun gear, planetary gears, and the ring gear. These gears provide a gear ratio of 4.333 : 1.

The reduction gearbox also has three safety features; the propeller brake, safety couplings, and negative torque signal system.

The propeller brake is located in the rear case of the starter drive pad. It is used to prevent windmilling of the propeller while in flight when in the feather position. It also aids in stopping the rotation of the propeller during normal engine shutdown.

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The safety coupling is located at the bottom rear of the RGB. It is bolted to the pinion gear. It is used to disengage the power section from the reduction gearbox in case of excessive negative torque. If the safety coupling disengages, the engine must be shut down because it will not reengage.

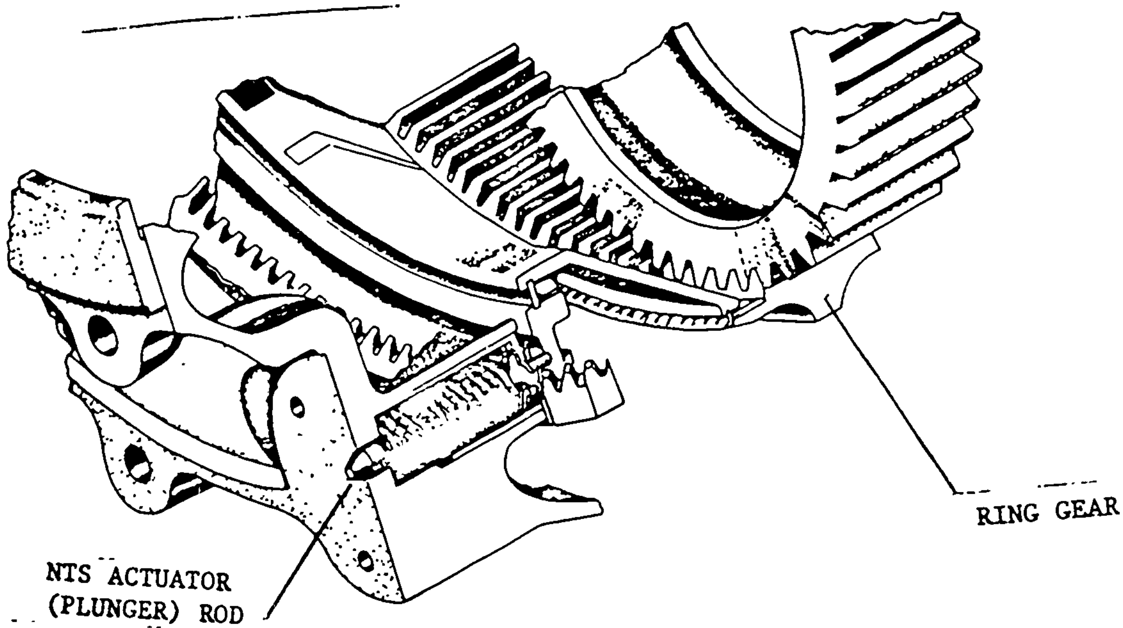

Figure 31. Negative Torque Signal System.

The Negative Torque Signal (NTS) System, shown in figure 31, is located in the upper portion of the RGB front case. It is used to prevent the propeller from driving the engine. It does this by means of a ring gear, plunger, and bracket. These will signal the propeller control assembly to increase the blade angle when negative torque exists. This will create more drag on the propeller, allowing the engine to, once again, drive the propeller.

QUESTIONS

1. What are the three major sections of the T56 engine?
2. What are the four major assemblies of the power section?
3. What is the purpose of the reduction gearbox?
4. What is the purpose of the torquemeter and tie struts?
5. What is the purpose of the power section?

T56 ENGINE SYSTEMS

The turboprop engine is designed to drive a prop to drive the aircraft through the air. But the engine cannot do this on its own. It needs other systems to allow it to operate correctly at all altitudes and power settings. Just like a car engine needs its systems, such as the cooling, ignition, starting, and other systems to operate efficiently.

Some of the systems used on the T56 are the starting, ignition, compressor bleed, fuel, oil, rpm and torque indicating, turbine inlet temperature indicating, negative torque signal system, anti-icing, and fire warning. A description of their parts and locations will be given in the following paragraphs.

Starting System

The purpose of the starting system is to turn the engine compressor to a self-sustaining rpm. "Self-sustaining" is the speed which the compressor must reach before the engine will keep running. The compressor will then be able to supply the needed amount of air to support combustion and cooling.

Parts of the starting system consists of the following:

1. Starter.

   a. Type - Pneumatic.

   b. Location - The center rear side of the RGB.

   c. Purpose - To convert kinetic energy from an air source to mechanical energy to bring the engine to a self-sustaining rpm.

2. Starter control valve.

   a. Type - Butterfly.

   b. Location - The upper right-hand side of the nacelle.

   c. Purpose - To regulate and control the air to the starter.

Ignition System

The purpose of the ignition system is to provide a high voltage, high energy spark to ignite the fuel/air mixture. This high energy spark is needed to blast away any deposits that may be on the spark igniters. These deposits occur because the ignition system operates only during the starting phase of engine operation. Unlike an automobile engine, whose ignition system operates continuously.

Parts of the ignition system consists of the following:

1. Speed Sensitive Control.

   a. Purpose - To energize the ignition relay at 16% rpm and de-energize the ignition relay at 65% rpm.

   b. Location - The inner left-hand front side of the accessory drive housing.

2. Ignition Relay.

   a. Purpose - To complete the circuit and send the voltage to the ignition exciters.

b. Location - At the 11 o'clock forward position of the compressor case.

3. Ignition Exciter.

a. Purpose - To step-up the voltage received from the ignition relay and convert 28 VDC to 20,000 - 25,000 VDC.

b. Location - At the 1 - 3 o'clock forward position of the compressor case.

c. Type - Capacitor discharge.

4. Igniter Plugs.

a. Purpose - To provide an air gap for the ignition of the fuel/air mixture.

b. Location - Is bolted to the outer combustion case at the 2 and 8 o'clock positions, extending into the number 2 and 5 combustion chamber liners.

c. Type - Self-gapping, nonadjustable (creepage).

Oil System

The purpose of the oil system is to clean, cool, and lubricate all bearings and moving parts of the engine. There are two basic types of oil systems, wet sump and dry sump. The T56 engine uses the dry sump type, which means the oil is stored outside of the engine in an external oil tank. Engines with wet sump systems have the oil contained within the engine, such as an automobile engine.

The type oil used in the T56 engine oil system is of the synthetic base instead of petroleum base. The military specification is MIL-L-23699. Although MIL-L-7808 can be used for emergencies.

Parts of the oil system consists of the following:

1. Oil Tank.

a. Purpose - To provide an area to store the engine oil.

b. Location - The upper portion of the nacelle, above the compressor.

c. Capacity - 12 gallons of oil.

7.5 gallons of air for oil expansion.

19.5 gallons total capacity.

2. Oil Tank Pressurizing Valve.

a. Purpose - To maintain 3.5 psi of air pressure in the oil tank.

b. Location - The upper forward side of the oil tank.

3. Oil Quantity Tank Unit.

a. Purpose - To send an indication of the amount of oil in the oil tank to the cockpit.

b. Location - The left-hand side of the oil tank.

4. Scupper-Filler.

a. Purpose - To provide an area for servicing of the oil tank and a way of catching the overflow oil.

b. Location - The right-hand side of the oil tank.

5. Oil Tank Sump.

a. Purpose - To provide an area for the sediment to settle and also for draining the oil tank.

b. Location - The bottom of the oil tank.

6. Oil Tank Shut-Off Valve.

a. Purpose - To provide a means of shutting off the engine oil supply in case of an emergency.

b. Location - Is attached to the right-hand side of the oil tank sump.

c. Type - Gate type.

7. Oil Temperature Bulb.

a. Purpose - To send an indication of the oil temperature to the cockpit.

b. Location - In the oil tank outlet line.

8. Pressure Pumps.

a. Power Section.

(1) Location - The center front side of the accessory drive housing.

(2) Purpose - To supply pressurized oil to all bearings and moving parts of the power section.

b. Reduction Gearbox.

(1) Purpose - To supply pressurized oil for all bearings and moving parts of the RGB.

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(2) Location - The right-hand rear side of the RGB.

9. Oil Filters.

a. Power Section.

(1) Purpose - Filter the contaminants from the power section oil system.

(2) Location - On the outer right-hand front side of the accessory drive housing.

b. Reduction Gearbox.

(1) Purpose - Filter the contaminants from the RGB oil system.

(2) Location - On the RGB oil pump housing.

10. Oil Scavenge Pumps.

a. Purpose - To return the oil from the bearing areas to the oil tank.

b. Power Section Locations.

(1) Main Scavenge Pump - The inner right-hand front side of the accessory drive housing, behind the pressure pump.

(2) External Scavenge Pump - The center rear side of the accessory drive housing.

(3) Rear Turbine Scavenge Pump - Inside the exhaust cone, in the rear bearing support.

c. Reduction Gearbox Locations.

(1) Main Scavenge Pump - The bottom of the front case of the reduction gearbox.

(2) Nose Scavenge Pump - Beneath the propeller shaft, inside the front case of the reduction gearbox.

11. Fuel Heater Strainer.

a. Purpose - Uses hot scavenge oil to heat the fuel and prevent ice from forming in the fuel.

b. Location - Right-hand side of the nacelle.

12. Oil Cooler.

a. Purpose - To cool the oil after the engine warms up.

b. Location - The lower part of the nacelle.

c. Type - Air/oil type.

13. Oil Cooler Flap.

a. Purpose - To control the amount of air passing through the air cooler.

b. Location - In the lower part of the nacelle, behind the oil cooler flap.

14. Oil Cooler Flap Actuator.

a. Purpose - To position the oil cooler flap for control of the oil temperature.

b. Location - Inside the nacelle, above the oil cooler flap.

15. Oil Temperature Control Thermostat.

a. Purpose - Signal the flap actuator when to open or close the oil cooler flap according to the oil temperature.

b. Location - The upper left-hand side of the nacelle, behind the oil tank.

Fuel System

The purpose of the fuel system is to supply the engine with the correct amount of fuel, for combustion, during all engine operating conditions. The correct operation of this system is necessary in order to control the engine temperature and the rate of acceleration and deceleration to prevent flameout of the engine.

The T56 engine fuel system consists of a fuel heater strainer, an engine driven fuel pump, fuel filters, a hydromechanical fuel control, fuel enrichment valve, electronic temperature datum valve, fuel manifold drain valve, fuel manifold, six fuel nozzles, and two burner drain valves.

Parts of the fuel system consists of the following:

1. Fuel Heater Strainer - Is the same as in the oil system.

2. Fuel Pump.

a. Purpose - To pressurize and deliver fuel to the rest of the system parts.

b. Location - The right-hand rear side of the accessory drive housing.

c. Type - Dual, centrifugal boost, with spur-gear type secondary and primary pumps.

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3. Low Pressure Fuel Filter.

a. Purpose - To filter the fuel after it leaves the centrifugal boost pump and sends it to the secondary pump.

b. Location - The right-hand side of the engine, next to the fuel pump.

c. Type - Paper throw-away.

4. High Pressure Fuel Filter.

a. Purpose - To filter the fuel as it leaves the primary pump.

b. Location - The bottom of the fuel pump.

c. Type - Waifer air maze.

5. Fuel Control.

a. Purpose - To meter fuel for combustion according to atmospheric and mechanical variables.

b. Location - On the left-hand rear side of the accessory drive housing.

c. Type - Hydromechanical.

6. Enrichment Valve.

a. Purpose - To provide additional unmetered fuel for starting the engine during cold weather.

b. Location - Mounted to the back of the external scavenge pump.

7. Temperature Datum Valve.

a. Purpose - To meter the fuel according to the signals received from the temperature datum control.

b. Location - The bottom of the compressor case, behind the fuel pump.

8. Fuel Manifold Drain Valve.

a. Purpose - To drain the fuel in the fuel manifold after engine shutdown.

b. Location - The bottom of the compressor case, behind the fuel control.

9. Fuel Manifold.

   a. Purpose - To distribute the fuel to the six fuel nozzles.

   b. Location - Around the compressor diffuser.

10. Fuel Nozzles.

   a. Purpose - To atomize the fuel for more efficient combustion.

   b. Location - At the even clock positions on the compressor diffuser.

11. Burner Drain Valves.

   a. Purpose - To drain the fuel from the outer combustion case in the event of an unsuccessful start.

   b. Location - At the forward and rear positions of the outer combustion case, at the 6 o'clock position.

Compressor Bleed System

The compressor bleed system provides an automatic means of controlling the compressor airflow. Its purpose is to reduce or prevent compressor surges and stalls.

During low speed operation, the compressor provides more air than the combustion section can handle or use. Therefore, the compressor bleed system must discharge this extra air overboard to prevent surges and stalls.

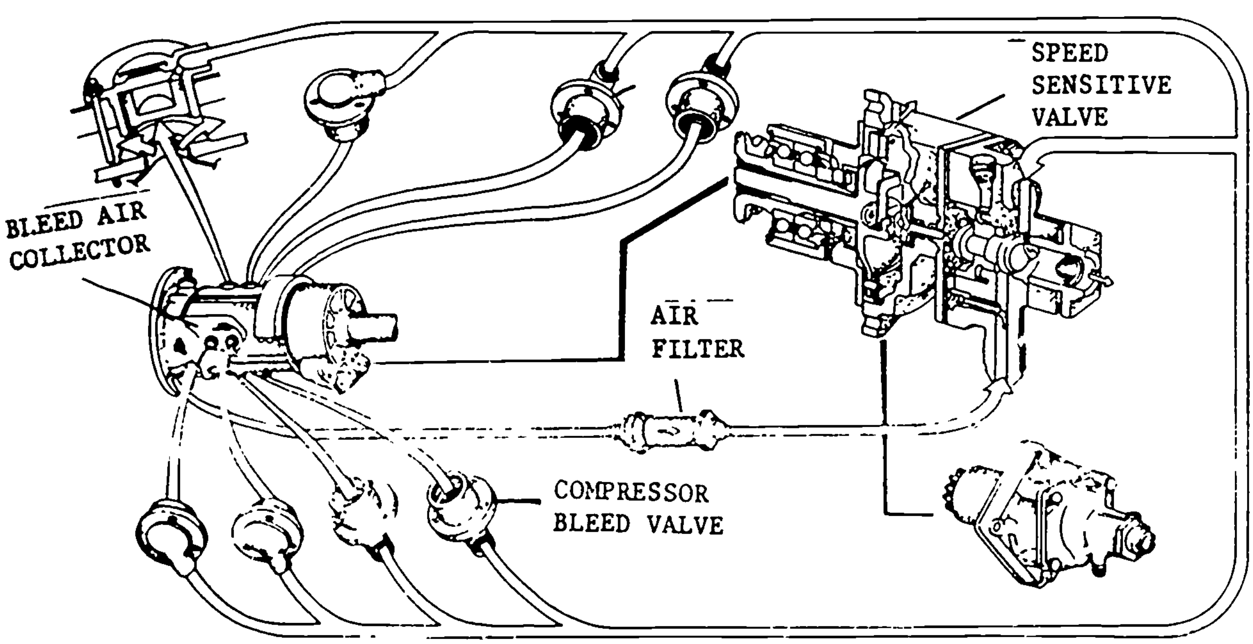

Figure 32. Compressor Bleed System.

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The parts of the compressor bleed system, shown in figure 32, are the speed sensitive valve, eight compressor bleed valves, and the bleed air collectors.

1. Speed Sensitive Valve.

a. Purpose - To control the operation of the compressor bleed valves.

b. Location - On the outer left-hand front side of the accessory drive housing.

2. Compressor Bleed Valves.

a. Purpose - To bleed excess air from the compressor to prevent surges and stalls.

b. Location - Two each at the 3, 6, 9, and 12 o'clock positions, over the 5th and 10th stage of compression.

3. Bleed Air Collectors.

a. Purpose - To act as air ducts to route the compressor bleed air overboard.

b. Location - At the 3 and 9 o'clock positions on the compressor.

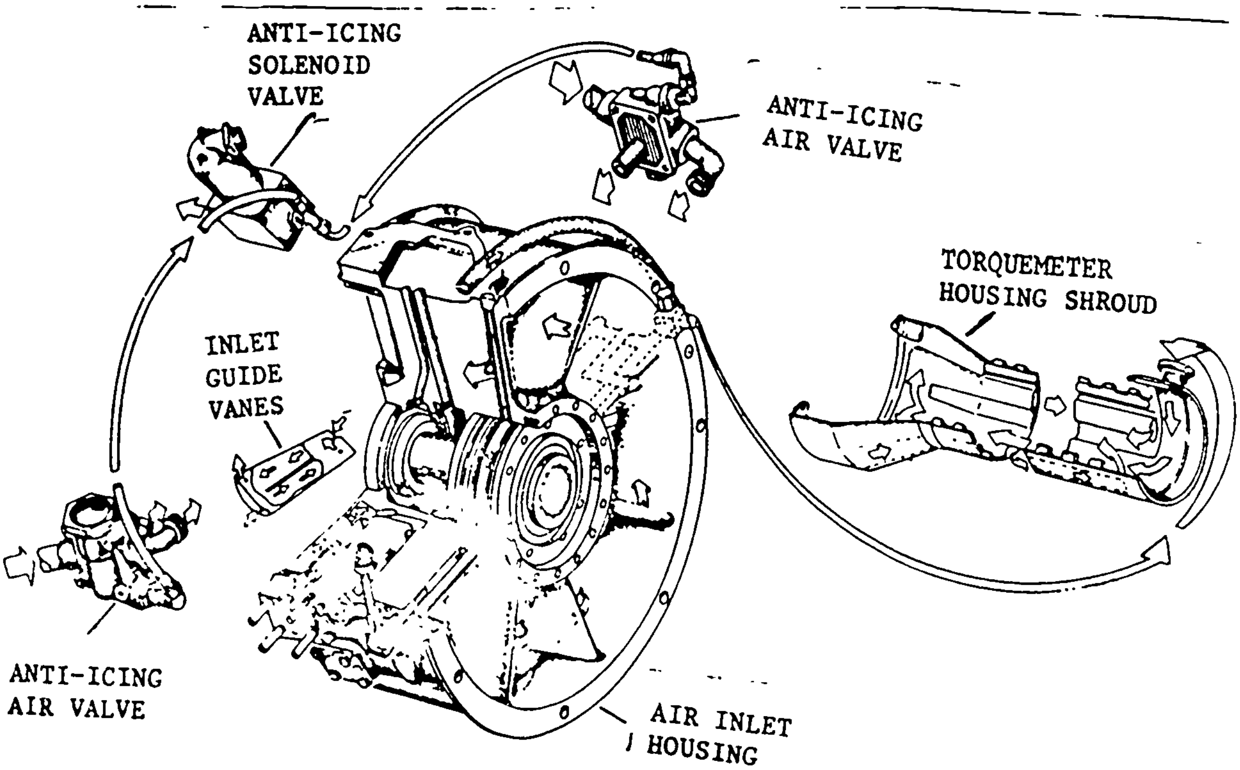

Figure 33. Anti-Icing System.

Anti-Icing System

The purpose of the anti-icing system, shown in figure 33, is to prevent ice from forming on the engine in its air inlet area. Heat for anti-icing is provided by routing hot 14th stage compressor air to the inlet area. There it is routed through hollow struts and ducts to prevent ice from forming. After heating the inlet area, the hot 14th stage air is then discharged into the front of the compressor.

The items of the engine that are anti-iced are the air inlet housing, inlet guide vanes, and the lower half of the torquemeter housing shroud.

The parts of the anti-icing system are the anti-icing master switch, anti-icing solenoid valve, and two anti-icing air valves.

1. Master Switch.

   a. Purpose - Provides control over the anti-icing systems on the aircraft.

   b. Location - On the anti-icing control panel in the cockpit.

2. Anti-Icing Solenoid Valve.

   a. Purpose - Provides primary control of the engine anti-icing system.

   b. Location - At the 11 o'clock forward position on the compressor case.

3. Anti-Icing Air Valves.

   a. Purpose - To control the flow of anti-icing air to the air inlet housing.

   b. Location - Bolted to the air inlet housing at the 3 and 9 o'clock position.

4. Anti-Icing Air Lines.

   a. Purpose - To route hot 14th stage air from the diffuser to the anti-icing air valves.

   b. Location - Between the anti-icing system parts.

TIT Indicating System

The purpose of the TIT indicating system, shown in figure 34, is to monitor the temperature of the combustion gases at the turbine inlet and send an indication to the gage in the cockpit. The temperature of the engine must be monitored and controlled to prevent the engine from getting too hot. This could lead to quick deterioration of the turbine section which could cause an engine failure and change.

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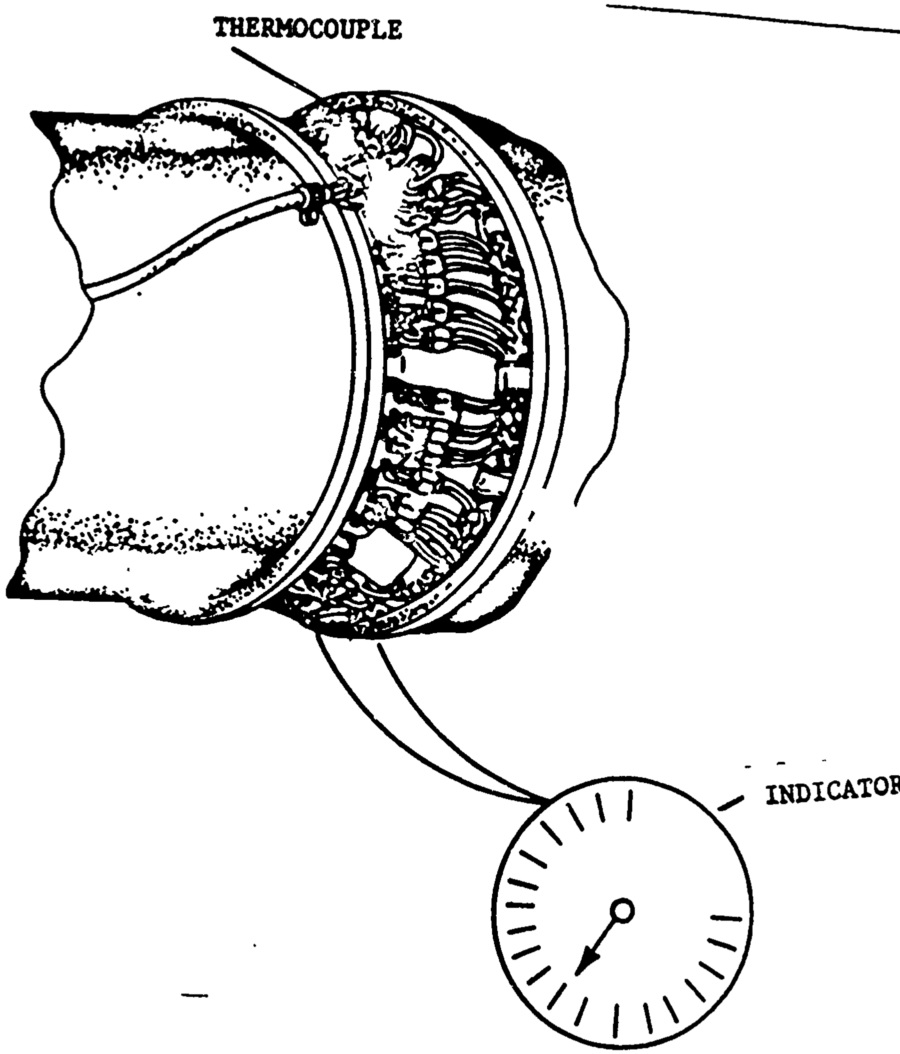

Figure 34. TIT System.

The parts of the TIT indicating system are:

1. Thermocouples.

a. Purpose - To measure the temperature of the combustion gases at the turbine inlet.

b. Location - Around the turbine inlet case.

c. Type - Alumel, chromel.

Indicator.

a. Purpose - To indicate, to the engine operator, the tempe…ure of the turbine inlet gases, in degrees Celsius.

b. Location - On the engine instrument panel in the cockpit.

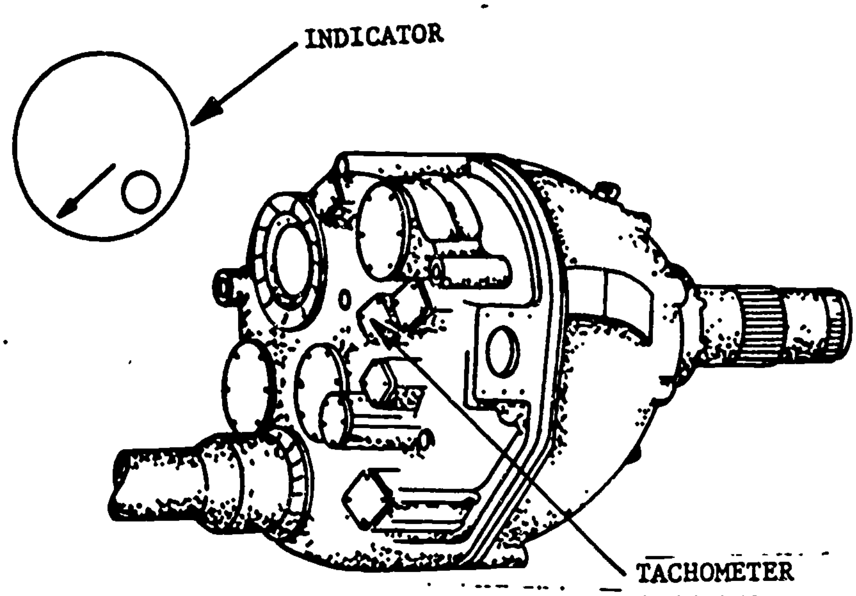

Figure 35. RPM Indicating System.

RPM Indicating System

The purpose of the rpm indicating system, shown in figure 35, is to give an indication to the pilot of the speed of the compressor. This indication will be in percent of the maximum rpm. For example, when the indicator shows 100% the actual rpm is 13,820 and when the indicator shows 94%, the actual rpm is 13,000.

It is important to monitor the rpm, because if the turbine is allowed to overspeed, the blades could stretch due to the excessive centrifugal force. This could cause the turbines to drag or rub against the case, which could cause an engine failure.

The rpm indicating system consists of the following parts:

1. Tachometer Generator.

   a. Purpose - To send a variable voltage signal to the indicator, for measuring rpm.

   b. Location - On the right-hand rear side of the RGB.

2. Tachometer Indicator.

   a. Purpose - To indicate, to the pilot, the speed of the compressor in percent of maximum rpm.

   b. Location - On the engine instrument panel in the cockpit.

Torque Indicating System

The purpose of the torque indicating system, shown in figure 30, is to provide a way of measuring the torque produced by the power section. The torque reading will be in inch-pounds of torque.

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The monitoring of the torque produced is important so as not to overstress the drive parts and the propeller. Too much excessive torque could even cause the torquemeter shaft to shear or break. This would cause an engine shutdown and possible an aborted mission.

The torque indicating system parts consists of the indicator, torquemeter pickup, and the torquemeter.

1. Indicator.

a. Purpose - To indicate to the pilot the amount of torque being produced by the engine power section in inch-pounds.

b. Location - In the engine instrument panel in the cockpit.

2. Torquemeter Pickup.

a. Purpose - To measure the amount of twist in the torquemeter shaft and send an electrical signal to the indicator.

b. Location - The left-hand forward side of the torquemeter housing.

3. Torquemeter.

a. Purpose - To transfer the torque produced by the power section of the engine to the RGB and provide a unit from which the torque can be measured.

b. Location - Inside the torquemeter housing, between the power section and the RGB.

Negative Torque Signal (NTS) System

The NTS system, shown in figure 31, is used to keep the prop from driving the engine. This occurs when negative torque exists. It does this by signalling the propeller control to increase the blade angle. This will put more drag on the prop and thereby remove the negative torque condition.

The negative torque signal system consists of the following:

1. Ring Gear.

a. Purpose - Acts as a sensing device and will move forward to move the NTS plunger forward when a negative torque condition exists.

b. Location - In the front case of the RGB.

2. NTS Plunger.

a. Purpose - To transmit ring gear movement to the NTS bracket.

b. Location - At the 1 o'clock position on the front case of the RGB.

3. NTS Bracket.

a. Purpose - Acts as the final linkage to transmit the ring gear movement to the propeller control assembly.

b. Location - At the 1 o'clock position in front of the NTS plunger on the front case of the RGB.

Fire Warning and Overheat Warning Systems

While the previous systems are required for proper operation of the engine, the overheat and fire warning systems are not. Instead, they are used to signal the pilot when the engine is malfunctioning. To be more specific, to tell him when it is on fire or overheating.

There are three systems that will do this. The fire warning, turbine overheat warning, and nacelle overheat warning systems.

The fire warning systems is used to detect a fire in one of the five engines (four main and one GTC). The turbine overheat warning system is used to detect an overheat condition in the turbine area of the four main engines. The nacelle overheat warning system is used to detect an overheat condition in the four engine nacelles.

Parts of the fire warning and overheat warning systems consists of the following:

1. Fire Warning System.

a. Master Light.

(1) Purpose - To indicate to the pilot when there is a fire in one of the five engines.

(2) Location - On the pilot's instrument panel.

b. Fire Handles (T-Handles) (5).

(1) Purpose - To indicate which engine the fire is in.

(2) Location - Emergency fire control panel.

2. Turbine Overheat Warning System.

a. Master Light.

(1) Purpose - To indicate to the pilot when an overheat condition exists in one of the four main engines.

(2) Location - On the pilot's instrument panel.

b. Turbine Overheat Warning Lights (4).

(1) Purpose - To indicate which one of the four main engines is in a turbine overheat.

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(2) Location - In the four main engine T-handles on the emergency fire control panel.

3. Nacelle Overheat Warning System.

a. Overheat Warning Lights (4).

(1) Purpose - To indicate an overheat condition in one of the four engine nacelles.

(2) Location - In the copilot's instrument panel.

QUESTIONS

1. What is the purpose of the engine systems used on the T56?

2. What system prevents surges and stalls of the compressor?

3. What are the parts used in the ignition system?

4. What systems provide performance data of the engine and propeller?

5. What system monitors the temperature of the engine?

6. What are the parts used in the starter system?

7. What is the purpose of the engine oil system?

8. What system prevents ice from forming on the engine?

9. What is the purpose of the fuel system?

10. What is the purpose of the negative torque signal system?

11. What is the purpose of the fire and overheat warning system?

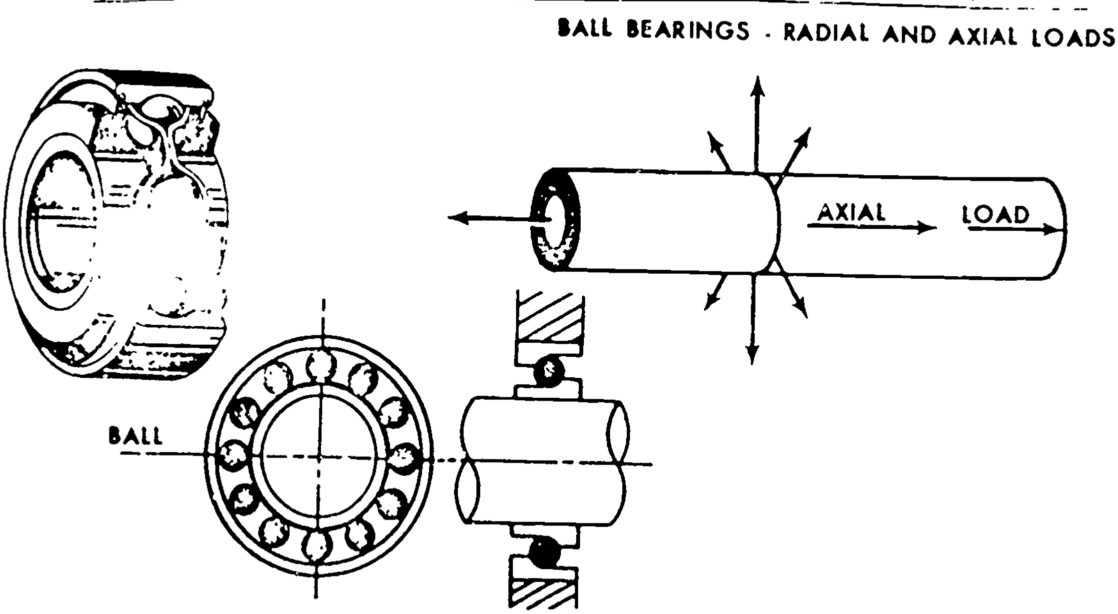

Figure 36. Ball Bearings.

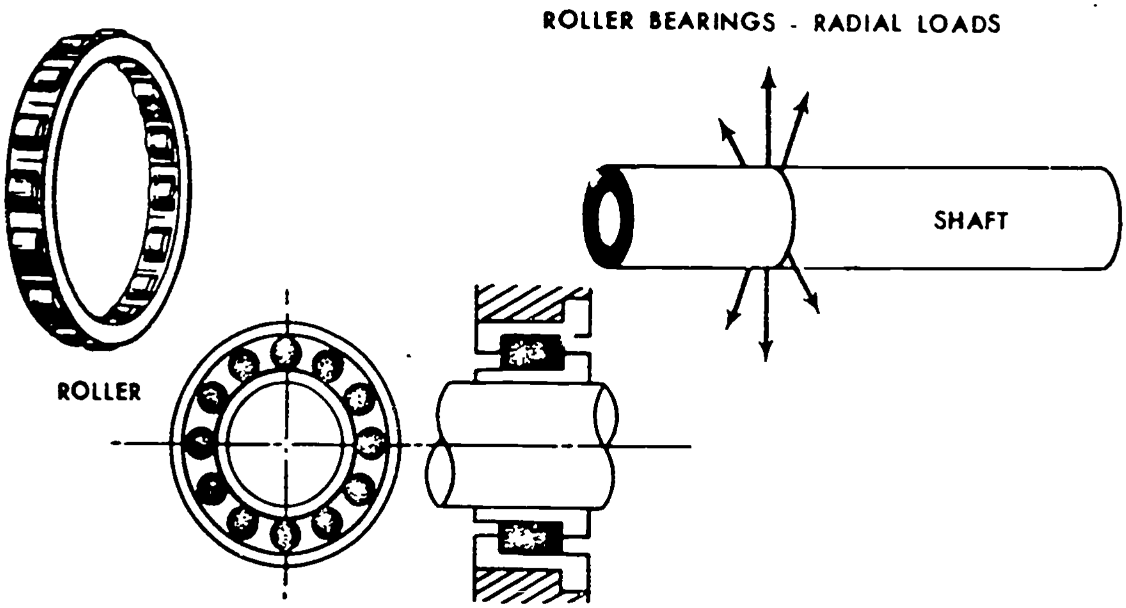

Figure 37. Roller Bearings.

T56 MAIN BEARINGS AND SEALS

The T56 engine uses four main shaft bearings. One is a ball bearing and three are roller bearings, see figures 36 and 37. Ball bearings are used to take up both radial and axial loads, whereas roller bearings take up radial loads only. Ball bearings are sometimes called thrust bearings. In a T56, the compressor rear (No. 2) bearing is the thrust bearing.

The compressor front bearing, or No. 1 bearing, is located in the air inlet housing. The No. 1 bearing is a roller type bearing and supports the radial load at the front of the compressor.

The compressor rear bearing, or No. 2 bearing, is located in the compressor diffuser. The No. 2 bearing is a ball bearing and supports the radial and axial load of the compressor.

The turbine front bearing, or No. 3 bearing, is located in the turbine inlet housing. The No. 3 bearing supports the radial load at the front of the turbine.

The turbine rear bearing, or No. 4 bearing, is located in the rear bearing support. The No. 4 bearing supports the radial load at the rear of the turbine.

These bearings need to be lubricated to operate properly. But this lubricating oil cannot be allowed to leak into the engine. Therefore, the T56 engine uses "labyrinth seals" to keep the oil from leaking out of the bearing areas. The labyrinth seals use a series of baffles where 6th or 14th stage air is used to prevent the oil from leaking over them. These labyrinth seals are used in each bearing area for a total of four seal assemblies.

QUESTIONS

1. How many main bearings are used on a T56 engine?
2. How many ball (thrust) bearings are used in a T56 engine?
3. What prevents oil from leaking out of the bearing cavities?
4. What is used to pressurize the labyrinth seals?
5. What type of bearings are used in a T56 engine?

GLOSSARY

ACCELERATION - The rate of change in velocity (a change in speed).

ACTUATOR - Something which transmits motion.

AIR START - Engine start made in flight, using ram air to rotate the engine compressors or propeller.

AMBIENT AIR - Air surrounding all sides of an engine, air available for consumption.

ANNEALING - A process of heat treating to soften metal.

ANTI-ICING - Prevention of ice formation.

AXIAL - Along an axis.

AXIAL FLOW - Refers to the path of air, as it passes along the axis (or shaft) of engine rotating assembly.

BAFFLE - An obstruction designed to control the flow of air or fluids.

COMBUSTION CHAMBER - A place where fuel and air are mixed and the fuel burned.

COMPRESSOR BLADE (ROTOR) - A rotating airfoil-shaped component which moves air.

COMPRESSOR VANE (STATOR) - A stationary airfoil-shaped component which raises pressure.

COMPRESSOR STAGE - One row of rotating blades (rotor) plus one row of stationary vanes (stators).

COMPRESSOR SURGE - A disturbance of normal airflow, sometimes known as a stall.

DIFFUSER - A rapidly expanding area where air from the compressor is directed to the combustion section and to other internal and external takeoffs. Used to increase pressure and decrease velocity.

DUCT - A passage which contains and controls the flow of gases in motion.

CONVERGENCE DUCT - Becoming continuously smaller in the direction of flow.

DIVERGENT DUCT - Becoming continuously larger in the direction of flow.

ENERGY - The ability to do work.

FLAMEOUT - Unintentional flame stoppage.

MANIFOLD - A connecting pipe which may take any of various forms.

NOMENCLATURE - Technical name or description of an item.

NOZZLE - A duct of varying cross-section, used in discharging liquids or gases, in which the velocity of the fluid or gas is increased.

OVERTEMP - An EGT in excess of the maximum allowable for a given condition.

PNEUMATIC - Relating to air or air pressure.

PROBE - A small diameter sensing element extending into the air or gas stream to measure pressure, temperature, or velocity.

RADIAL - Branching outward from the common center.

RAM AIR - The pressure buildup at the engine inlet, created by the forward motion of the aircraft.

SCAVENGE - Remove residue.

STANDARD DAY - A set of theoretical atmospheric conditions, used as a reference in making TO charts which are used for making engine adjustments and computing thrust.

STATIC - Not moving.

START - To successfully bring the engine into operation.

SUMP - A low place where fluid will collect.

TACHOMETER - A device which shows the rotational speed of a shaft.

TECHNICAL ORDERS (TOs) - Printed and detailed information concerning operation, maintenance, inspection, and repair of Air Force equipment.

TORQUE - A force that will produce rotation.

TORQUE VALUE - The amount of force applied; common units are inch-pounds or foot-pounds.

TOXIC - Poisonous or injurious to respirator organs.

TRIM - To adjust properly.

TRIM CHARTS - Reference charts consulted while making adjustments on the engine (found in equipment technical orders).

THERMO - Relating to heat.

THERMOCOUPLE - A temperature sensing device.

THRUST - The forward force produced in reaction by the escaping gases in jet propulsion. Formula: Thrust = Mass times Acceleration (T = M x A).

THRUST AUGMENTATION - Any method of temporarily increasing thrust.

TURBULENCE - A disturbed pattern of airflow.

WELDMENT - A welded assembly.

WORKBOOK

3ABR42632-WB-103E

Technical Training

Jet Engine Mechanic

JET ENGINE THEORY

9 June 1978

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

RGL: N/A

Jet Engine Branch
Chanute AFB, Illinois

3ABR42632-WB-103E

JET ENGINE THEORY

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to:

1. Define the terms and state the principles of jet engine operation.

2. State the application of Newton's third law of motion.

3. State the application of Bernoulli's principle.

EQUIPMENT

	Basis of Issue
3ABR42632-SG-103	1/student

PROCEDURE

Using the information presented in the classroom presentation, discussion, study guide, and aid from the instructor, fill in the spaces provided with the correct information.

1. Given the meaning of each term.

   a. Mass - ____________________

   b. Acceleration - ____________________

   c. Density - ____________________

   d. Velocity - ____________________

   e. Pressure - ____________________

   f. Humidity - ____________________

   g. Thrust - ____________________

2. Newton's third law of __________ states that for every __________ there is an __________ and __________ reaction.

   a. Name two examples that would illustrate Newton's third law of motion.

   (1) ____________________

   (2) ____________________

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3. Bernoulli's principle states that when gases or __________ flow through a pipe whose cross sectional diameter varies, __________ will be the greatest where the cross section is the greatest, and the __________ will be the least.

a. Simply stated, __________ and __________ vary inversely with each other in Bernoulli's principle.

b. List the three types of ducts below.

(1) ____________________

(2) ____________________

(3) ____________________

c. Explain what happens to PRESSURE and VELOCITY in each of these ducts.

(1) ______________________________

(2) ______________________________

(3) ______________________________

4. The engine manufacturer uses standard day conditions to make comparisons for engine __________ and computing __________.

a. What are the three standard day (atmospheric) conditions that affect thrust?

(1) ____________________

(2) ____________________

(3) ____________________

b. What happens to thrust in the following atmospheric conditions?

(1) Temp increases, thrust __________.

(2) Humidity increases, thrust __________.

(3) Pressure increases, thrust __________.

5. Jet Engine

a. Definition - a __________ device which develops forward thrust by accelerating a __________ rearward through a jet or nozzle.

b. Types of jet engines.

(1) Ramjet

(a) The abbreviation for ramjet is ______________.

(b) The ramjet is the ____________ type of jet engine.

(c) The ramjet cannot ______________from rest.

(2) Turbojet

(a) The abbreviation for turbojet is _____________.

(b) Most ______________ used type of jet engine.

(c) The turbojet can create thrust from rest because it has a ______________ and ______________ wheel.

(3) Turboprop

(a) The abbreviation for turboprop is ____________.

(b) The turboprop engine has reduction gears to keep the ______________ speed within practical limits.

(4) Turbofan

(a) The abbreviation for turbofam is _____________.

(b) The turbofam produces a ______________ air-
tream of high velocity which greatly increases thrust.

6. Classification of Turbojet Engines

a. Classification of turbojet engines is determined by the type of ______________.

b. Turbojet engines have two types of compressors. They are called ______________ and ______________ flow.

c. Centrifugal flow is when the airflow through the engine is ______________ to the axis of the engine.

d. Axial flow is when the airflow through the engine is ______________ to the axis of the engine.

e. In an axial flow engine one row of ______________ blades and one row of ______________ vanes makes one stage of compression.

f. Remember that ______________ blades accelerate air and ______________ vanes compress air.

7. Directions in reference to a turbojet engine

   a. Stand at the ____________ facing engine.

   b. The numbering of units is ________ from the rear.

REVIEW QUESTIONS

1. Definitions

   a. The rate of change of position in relation to time is defined as ____________.

   b. ____________ is defined as a force exerted against an opposing body.

   c. The forward force produced by exhaust gases escaping rearward is ____________.

   d. Simply stated, Bernoulli's principle says that ____________ and ____________ vary inversely with each other.

   e. Newton's third law of motion states that ____________ ____.

   f. A change in velocity, either positive or negative, is defined as ______________________________.

   g. __________________ is water vapor in the air.

   h. Mass per unit of volume is defined as ____________.

2. Bernoulli's Principle

   a. Velocity increases; pressure decreases in a ____________ duct.

   b. Making water squirt farther from a water hose is an example of increasing ____________________.

   c. Pressure and velocity will ________________ in a straight duct.

   d. Velocity will _______________ in a convergent duct.

   e. Velocity decreases and pressure increases in a ____________ duct.

3. Newton's Third Law of Motion

   a. Newton's third law of motion states for every action there is an ________________ and ________________ reaction.

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b. The kick you get from firing a shotgun is the ____________.

c. The action of the exhaust gases being expelled rearward from a jet engine is the ______________, the aircraft being propelled forward is the ____________________.

d. If the rearward force of a jet engine is 1000 pounds, the forward force will be ____________________ pounds.

4. Jet Engines

a. Name the type of jet engine designated by each of the following symbols:

RJ ________________________

TF ________________________

J ________________________

T ________________________

b. Two types of compressors used in turbojet engines are ________________ and ________________.

c. When airflow is parallel to the axis of the engine, the compressor is known as an ________________________ flow compressor.

d. The ________________ does not have a compressor or turbine, and therefore, is unable to accelerate from rest.

e. Which jet engine produces a secondary airstream rearward at a high velocity? ________________________

f. __________________ engines have a capability of taking off and landing on short runways.

g. An attempt to fly to the moon using a turbojet engine would be of little use. Why? ____.

5. Standard Day Conditions

a. List the standard day settings used to compute thrust.

____

____

____

b. List the three atmospheric conditions which will affect jet engine thrust.

____

____

____

c. If there is an increase in barometric pressure, thrust will ____________________.

d. A decrease in humidity would ________________ thrust.

e. If temperature increases and pressure decreases, thrust will ________________________.

f. More thrust is developed by a jet engine on a (cool) or (hot) day. ____________________

g. More thrust is developed by a jet engine on a (wet) or (dry) day. ____________________

6. Fill in the blanks under the following illustrations.

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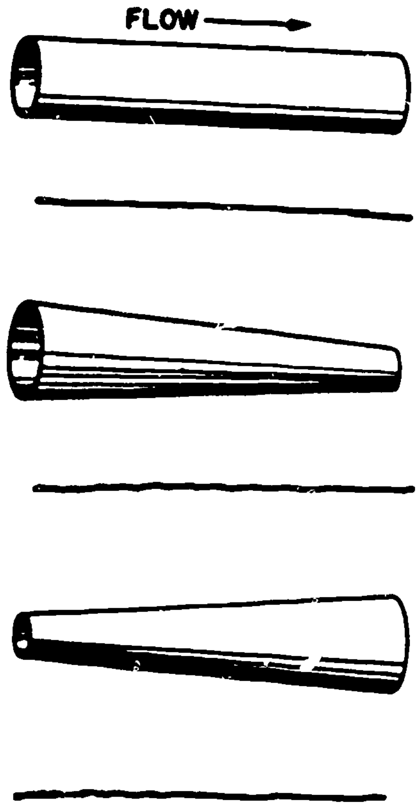

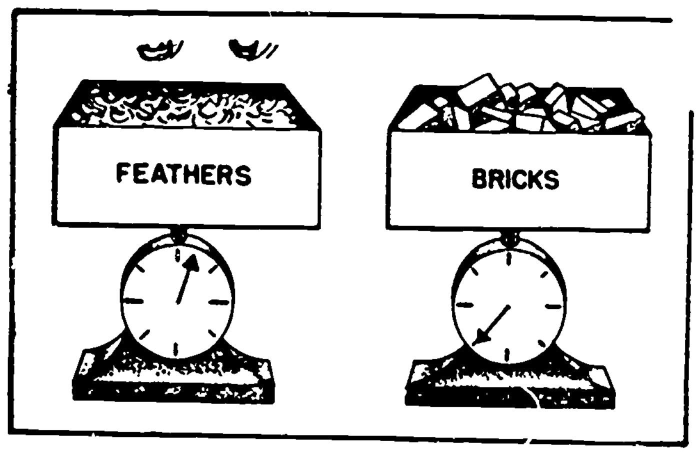

Figure 2 Illustrates the Difference Between Mass and ________________.

Figure 1 Illustrates the 3 Types of Ducts Applying ________ Principle. Label Each Duct.

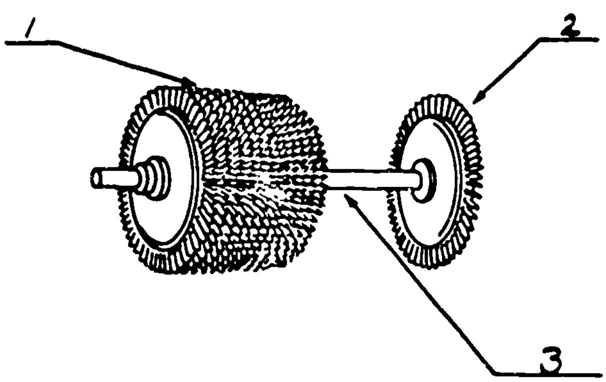

Figure 3 Illustrates the Major ________________ Assembly of a Turbojet Engine. It Consists of the (1) ________________, (2) ____________, and (3) ____________________.

Figure 4 Illustrates ________________ 3rd Law, The Law of ________.

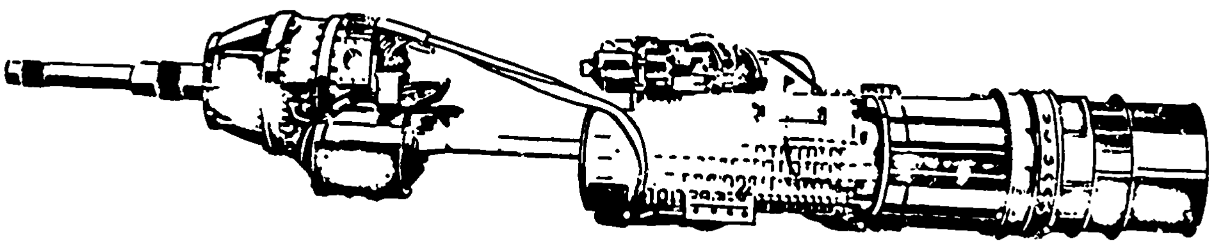

Figure 5 hows a ______________________________ Jet Engine.

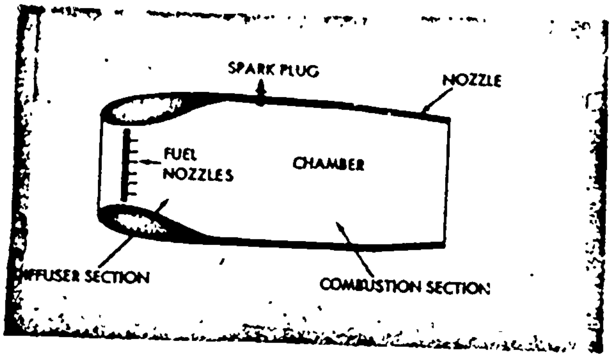

Figure 6 shows a ______________________________ Jet Engine.

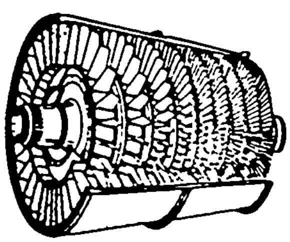

Figure 7 Illustrates the ______________ Section of a Turbojet Engine.

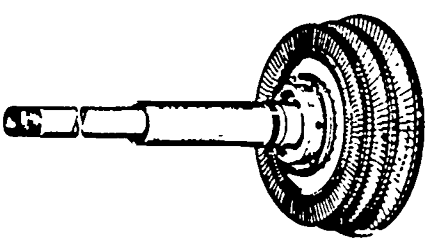

Figure 8 Illustrates the ________ Section of a Turbojet Engine.

WORKBOOK
3ABR42632-WB-107A
3ABR42633-WB-105A

Technical Training

Jet Engine Mechanic

Turboprop Propulsion Mechanic

AIRCRAFT AND ENGINE DESIGNATIONS

23 March 1981

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

DO NOT USE ON THE JOB

RGL: N/A

ATC FORM 214 (JAN 76) OBSOLETES ATC FORMS 214, MAY 69, 522, NOV 63 AND 523, MAY 71. STANDARD COVERSHEET

380

Jet Engine Branch
Chanute AFB, Illinois

3ABR42632-WB-107A
3ABR42633-WB-105A

AIRCRAFT AND ENGINE DESIGNATIONS

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to identify the meaning of each part of aircraft and engine designations.

EQUIPMENT

None

PROCEDURE

Using the information presented in the classroom discussion, and aid from the instructor, fill in the spaces with the correct information.

Section 1. ·AIRCRAFT DESIGNATION

1. Basic Mission Symbol. (B-52D)

a. The ________________ ________________ ______________ is used to indicate the primary intended function of the aircraft.

b. Examples of some Basic Mission Symbols are:

B = ______________________

C = ______________________

F = ______________________

T = ______________________

2. Design Number. (B-52D)

a. The ______________ ____________________ designates the general design of the aircraft.

b. Using the aircraft designation shown in paragraph 2, the "52" would indicate the ____________________ design number.

3. Series Letter. (B-52D)

a. The ______________ ________________ indicates the number of major changes to the aircraft structure or to its equipment. (After "A" series)

Supersedes 3ABR43230-WS-103A, 1 July 1971; 3ABR42632-WB-103I, 7 April 1976.
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 2500; DAV - 1

b. The first production B-52 was the _______ series. Along came a major change and we had the __________ series.

c. The letter "D" in the aircraft designation B-52D indicates the ____________ major change to the B-52 aircraft.

4. Modified Mission Symbol. (KC-135A)

a. The __________ ______________ ___________ indicates "present use" of the aircraft.

b. Some examples of the modified mission symbols are:

K = ________________

R = ________________

V = ________________

W = ________________

c. Using the aircraft designation in paragraph 4, the letter "C" would indicate the aircraft was originally designed to be a _______. but is now being used as a _____________ aircraft.

5. Status Prefix Letter. (XB-70A)

a. The __________ ______________ _______________, when used, identifies the status of the aircraft when it is not in normal everyday use.

b. There are six status prefix letters in all, but the two most familiar are:

X = ____________ - aircraft in a developmental stage. but not for service use.

Y = ____________ - aircraft that are obtained in limited quantities for service test.

In case you are interested, the others are:

G = Permanently Grounded

J = Special Test, Temporary

N = Special Test, Permanent

Z = Planning

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c. Using the aircraft designation as shown in paragraph 5, the status prefix letter is ______________ and would signify ________.

6. Write the description and meaning of each letter and number in the aircraft designation below.

YRB-58B

Y = ____________________ ____________________

R = ____________________ ____________________

B = ____________________ ____________________

58 = ____________________ ____________________

B = ____________________ ____________________

Section 2. ENGINE DESIGNATION

1. Type Letter. (J57-P-19W)

a. The ______________ ______________ designates the type of engine.

b. Some examples of engine type letters are:

RJ = ____________________

J = ____________________

T = ____________________

F/TF = ____________________

2. Model Number (J57-P-19W)

a. The ____________ ____________ identifies a specific engine within a type.

b. Even model numbers are assigned to engines designed for the ____________.

c. Odd model numbers are assigned to engines designed for the ____________.

3. Manufacturer's Code Letter. (J57-P-19W)

a. The ____________ ____________ ____________ identifies the manufacturer of the engine.

b. The _________ ____________ ____________ will always be between the two numbers in the designation.

c. Some manufacturer's code letters are:

P = ________________

F = ________________

GE = ________________

A = ________________

d. Using the designation shown in paragraph 3, the manufacturer of this engine is ______________________.

4. Series Number. (J57-P-19W)

a. The _______________ _________________ identifies the series of engine.

b. If the series number is _____________ the engine is being used by the Air Force.

c. If the series number is _____________ the engine is being used by the Navy.

d. Using the designation T56-A-9, complete the following:

Engine type ______________________

Designed for the ______________________

Manufactured by ______________________

Used by the ______________________

5. Series Modification Letter. (J57-P-19W)

a. The ___________ _____________ _______________ indicates a minor change to the series.

b. The "W" in the designation in paragraph 5, indicates

______________ ________________.

6. Classification Letters. (XJ57-P-19W)

a. The _____________ ________________ indicates the status of the engine when it is not in normal use.

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b. Two of the most frequently used classification letters are:

X = ______________

Y = ______________

7. Write the description and meaning of each letter and number in the engine designation below.

YJ33-F-1W

Y = ______________ ______________

J = ______________ ______________

33 = ______________ ______________

F = ______________ ______________

1 = ______________ ______________

W = ______________ ______________

REVIEW QUESTIONS

1. Aircraft Designation.

a. What does the Modified Mission Symbol indicate?

b. What is the meaning of the Basic Mission Symbol?

c. Define the following Basic Mission Symbols.

F = ______________

T = ______________

B = ______________

C = ______________

d. Define the following Modified Mission Symbols.

R = ______________

K = ______________

W = ______________

V = ______________

e. What is the purpose of the Series letter?

f. In the designation F-100F, how many changes have there been to the aircraft? ______________.

g. What is the meaning of the Status Prefix Letter?

h. What do the following Status Prefix Letters indicate?

X = ______________

Y = ______________

i. Which status prefix letter indicates those aircraft that are obtained in limited quantities for service test? ______________.

j. Write the description and meaning of each letter and number in the aircraft designation VC-137E.

V = ______________ ______________

C = ______________ ______________

137 = ______________ ______________

E = ______________ ______________

k. Fill in the blanks using the aircraft designation XB-70A.

Design Number ______________

Basic Mission Symbol ______________

Series Letter ______________

Status Prefix Letter ______________

l. Write the description and meaning of each letter and number in the aircraft designation XWB-66D.

X = ______________ ______________

W = ______________ ______________

B = ______________ ______________

66 = ______________ ______________

D = ______________ ______________

2. Engine Designation.

a. What is the meaning of the Type letter?

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b. Circle the Type letter in this engine designation.

YJ79-GE-5A

c. What is the meaning of the Classification letter?

d. Circle the Classification letter in this engine designation.

XJ60-P-1A

e. Which part of the engine designation indicates which branch of service is using the engine? ____________________

f. The manufacturer code letter for Pratt and Whitney is ______.

g. The manufacturer code letter is between the ______________ and ____________________.

h. The engine type letter for a turboprop engine is __________.

i. The classification letter "Y" means ____________________

____.

j. Circle the engine series number in this designation.

TF33-P-3A

k. A minor change to the engine series is the ______________

________________________ ____________________.

l. Circle the series modification letter in this designation.

T34-P-9W

m. The engine type letter meaning turbojet is ______________.

n. Write the description and meaning of each letter and number in the engine designation YJ79-GE-5A.

Y = ____________________ ____________________

J = ____________________ ____________________

79 = ____________________ ____________________

GE = ____________________ ____________________

5 = ____________________ ____________________

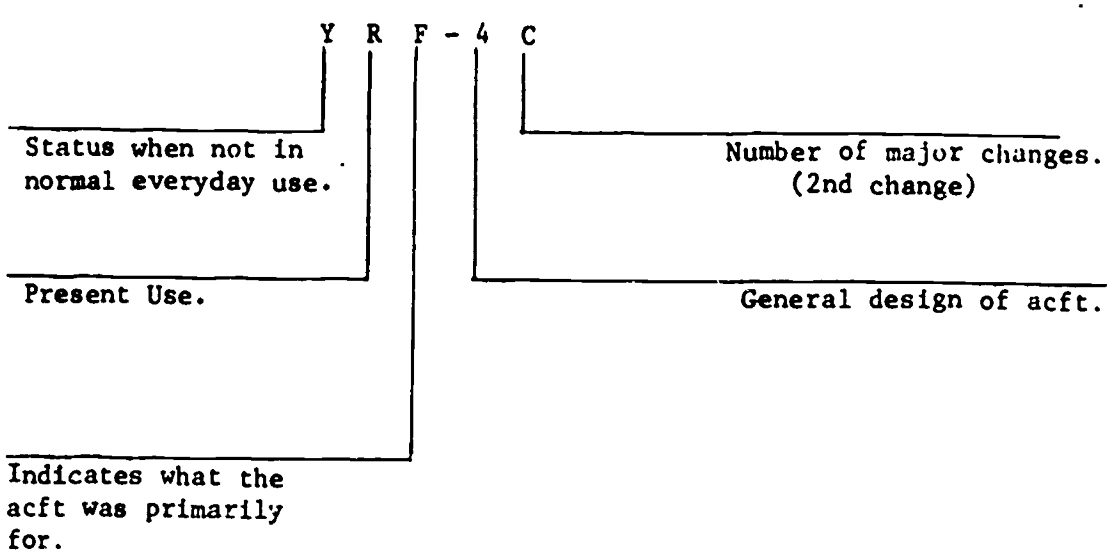
A = ____________________ ____________________

o. Fill in the blanks using the engine designation XJ57-F-59W.

Series Modification Letter	____________
Manufacturer Code Letter	____________
Classification Letter	____________
Series Number	____________
Model Number	____________
Type Letter	____________

p. An easy way to tell the difference between an aircraft and engine designation is to remember that the engine designation has ________ (sets) of numbers and the aircraft designation has ________ (set) of numbers.

3. Write the meaning of each letter and number in the aircraft designation as shown in the example below.



4. Write the meaning of each letter and number in the engine designation as shown in the example below.

X J 57 - P - 29 W

Status when not in normal everyday use.

Designates the kind of engine.

____

Engine was designed for:

Odd numbers = __________

Even numbers = __________

Minor change to the series.

____

Engine being used by:

Even numbers = __________

Odd numbers = __________

____

Manufacturer

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-105B
10 March 1980

T56 ENGINE CASES AND PARTS

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to identify and locate the T56 engine cases and parts.

EQUIPMENT

	Basis of Issue
T56 engine	1/15 students
Selected bearings and system parts	1/15 students

PROCEDURE

Use the information given in the classroom presentation, discussion, and aid from the instructor. Fill in the spaces provided under the illustration with the information from the list below that correctly identifies each item in the figure.

REDUCTION GEAR ASSEMBLY	INNER COMBUSTION CASING
TORQUEMETER ASSEMBLY AND TIE STRUT	COMBUSTION LINERS
ACCESSORY DRIVE HOUSING ASSEMBLY	TURBINE ROTOR
	REAR BEARING SUPPORT
COMPRESSOR ASSEMBLY	FUEL NOZZLE
TURBINE ASSEMBLY	BREATHER ANTI-ICING
POWER SECTION	REAR SCAVENGE PUMP
PROPELLER SHAFT	NUMBER 4 BEARING
COMPRESSOR AIR INLET HOUSING	NUMBER 3 BEARING
COMPRESSOR DIFFUSER	NUMBER 2 BEARING
OUTER COMBUSTION CASING	NUMBER 1 BEARING
COMPRESSOR CASE	TAILPIPE

OPR: 3350 TCHTC
DISTRIBUTION: X
3350 TCHTC/TTCU-J - 600; TTVSA - 1

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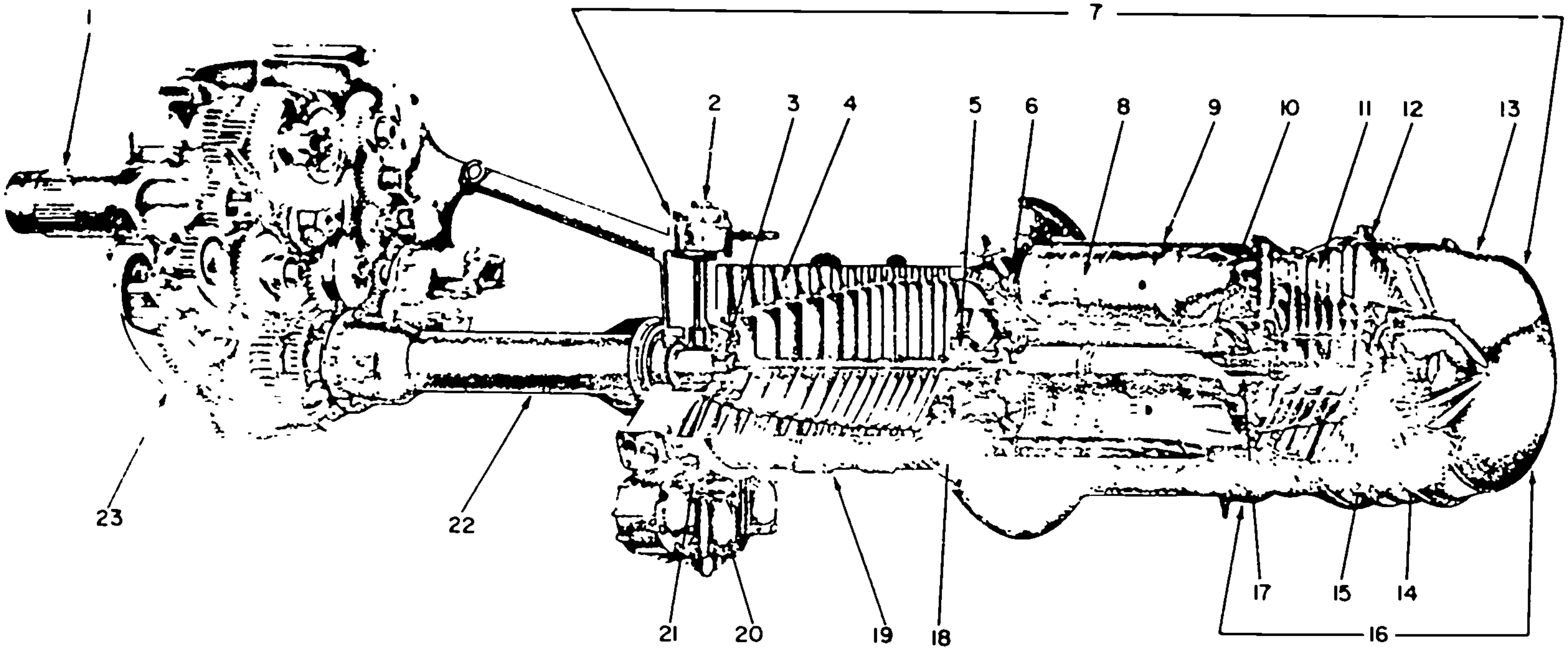

2

1. ______________________

2. ______________________

3. ______________________

4. ______________________

5. ______________________

6. ______________________

7. ______________________

8. ______________________

9. ______________________

397 10. ______________________

11. ______________________

12. ______________________

13. ______________________

14. ______________________

15. ______________________

16. ______________________

17. ______________________

18. ______________________

19. ______________________

20. ______________________

21. ______________________

22. ______________________

23. ______________________

WORKBOOK

3ABR42633-WB-105C

Technical Training

Turboprop Propulsion Mechanic

T56 ENGINE MAJOR SECTIONS AND PARTS

31 December 1979

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.
Do Not Use on the Job.

RGL: N/A

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-105C

T56 ENGINE MAJOR SECTIONS AND PARTS

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to identify and locate the major sections and parts of a T56 engine.

EQUIPMENT

	Basis of Issue
T56 engine	1/15 students
Selected bearings and system parts	1/15 students

PROCEDURE

Use the information presented in the classroom presentation, discussion, and aid from the instructor. Fill in the spaces provided with the correct information.

1. Compressor Section (Figure 1)

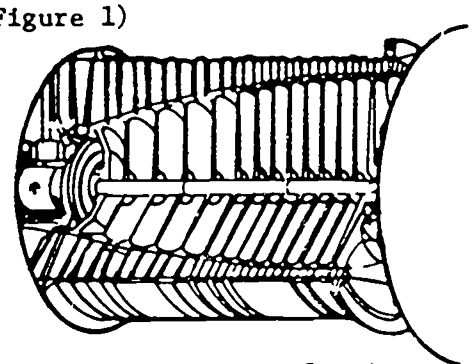

Figure 1. Compressor Section.

a. The purpose of the compressor section is to:

(1) Deliver air to the _______________ __________________ under pressure.

(2) Create a ________________ ____________________ area in front of the combustion chambers.

(3) Supply air for all ________________________ operated units.

b. Type of compressor section.

(1) Dual ____________________, axial ________________________.

(a) The T56 has (one) (two) compressors.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

(b) Airflow through the engine is ______________ to the axis of the engine.

(2) Has ________________________ stages of compression.

(a) One row of ____________ blades and one row of ___________ vanes, equal one stage of ________________________.

(b) __________________ vanes do not move, but _________ blades do.

c. Compressor Air Inlet Housing (Figure 2)

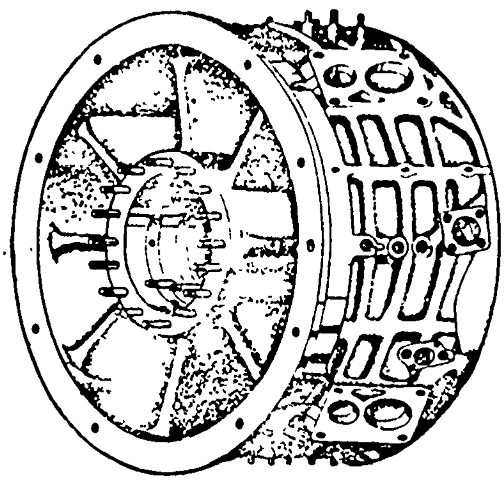

Figure 2. Compressor Air Inlet Housing.

(1) Contains ______________ hollow struts.

(2) Supports _____________bearings.

(3) Anti-iced by _________________ stage air.

d. Compressor inlet guide vanes (Figure 3)

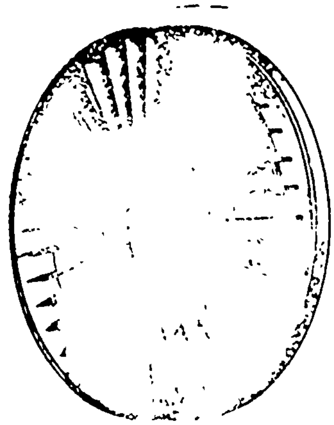

Figure 3. Inlet Guide Vanes.

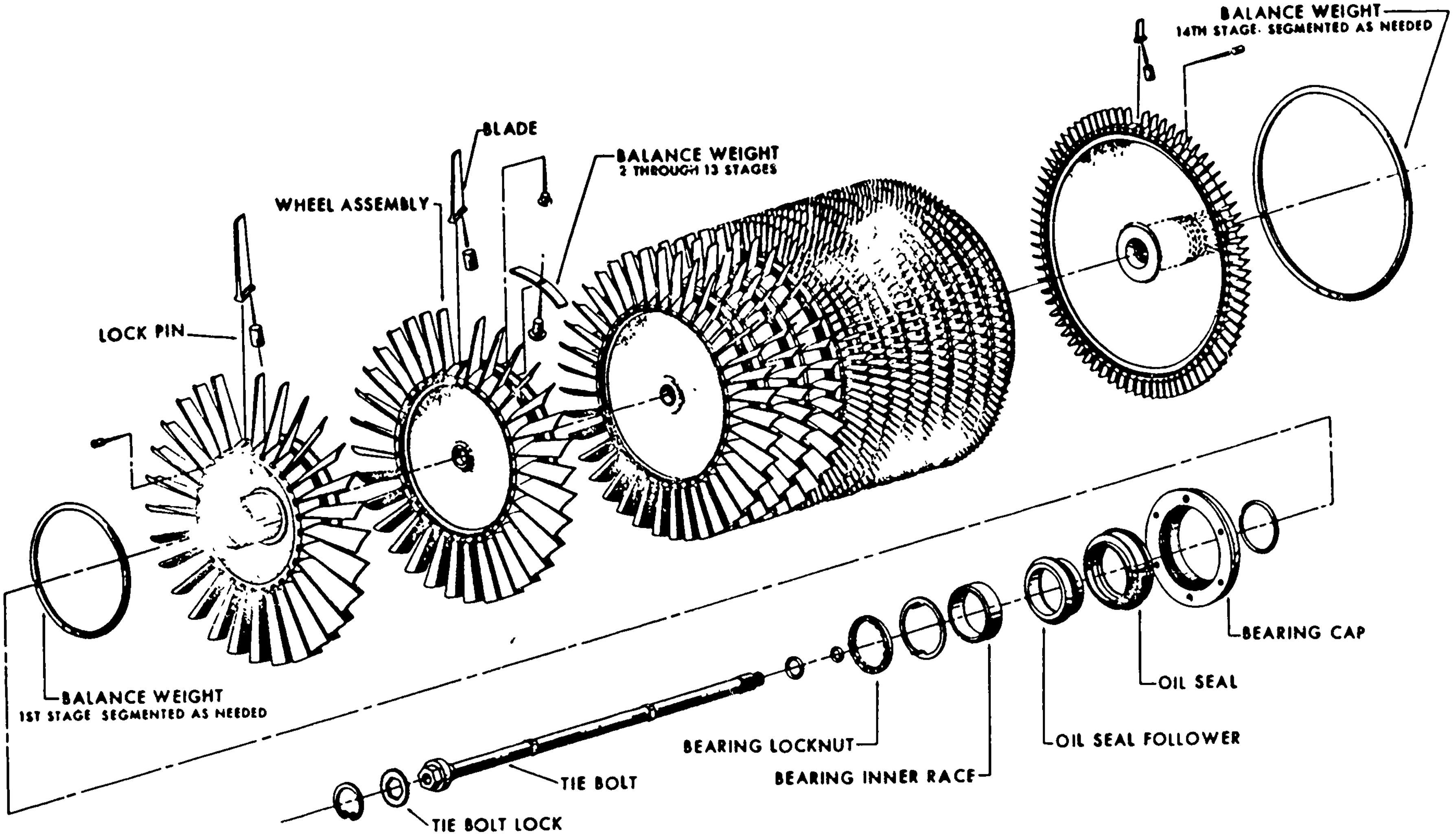

Figure 4. Compressor Rotor.

(1) Secured to the rear face of the ____________ ____________

________________ housing.

(2) Consists of 26 vanes which guide the ___________ flow

into the ___________________ compressor.

(3) Anti-iced by ___________________ stage air.

e. Compressor (Figure 4)

(1) The purpose of the compressor is to furnish a large

mass of air under moderate pressure to the _______________ diffuser.

(2) Has __________________ stages of compression.

(3) Driven by the _____________ turbine.

f. Diffuser case (Figure 5)

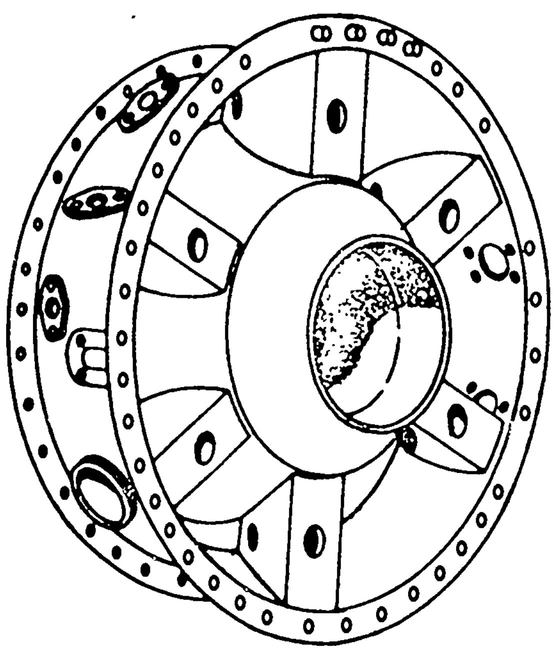

Figure 5. Diffuser Case.

(1) The diffuser case is a ______________ duct, which

__________ pressure in front of the combustion section.

(2) The diffuser prepares the air for entry into the

_________________ chambers by converting velocity into ______________.

(3) 14th stage air is taken off the _______________ case for
anti-icing and for air operated units.

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2. Combustion Section (Figures 6, 7)

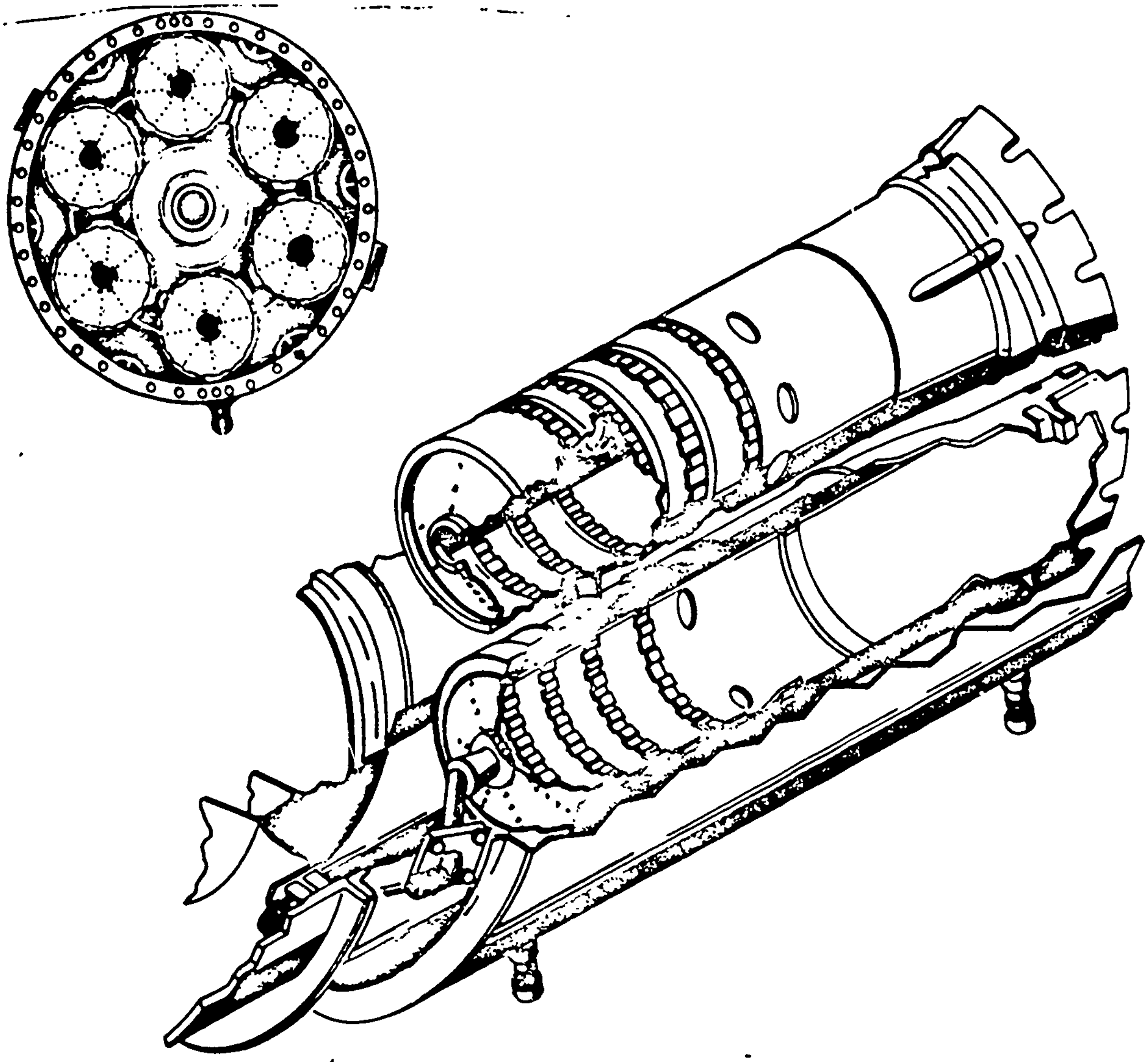

Figure 6. Combstion Chambers.

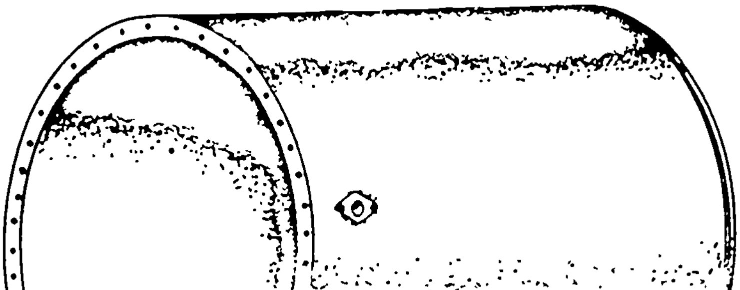

Figure 7. Outer Combustion Casing.

a. Purpose: To provide a place where air, under pressure, is mixed with fuel for ______________________.

b. Type of combustion section

(1) The T56 engine has a ____________________ combustion section.

(2) By canannular, we mean that the ____________ ______________ (Figure 6) are located between an inner and outer case.

(3) The INNER CASE is called the ______________________ ____________________ bearing support.

(4) The OUTER CASE (Figure 7) is called the ____________________ _________________ outer casing.

(5) There are _________ combustion liners numbered clockwise around the engine, starting with number one at the ________ o'clock position.

(6) The combustion ____________ are housed in the combustion outer outer _________________ casing (Figure 7).

c. Approximately ________________ percent of the air is used for cooling and ______________ percent for combustion.

d. The ______________________ are used to carry the flame from one combustion liner to another.

e. The spark igniters are mounted in the _______________ case and extended in numbers __________ and __________ combustion liners at the 5 and 7 o'clock position.

3. Turbine Section

a. Purpose: Converts _____________ energy into ___________ energy to drive the ______________ and accessories.

b. Type of turbine section in the T56 engine is __________________, multirotor.

c. Turbine nozzles (Figure 8)

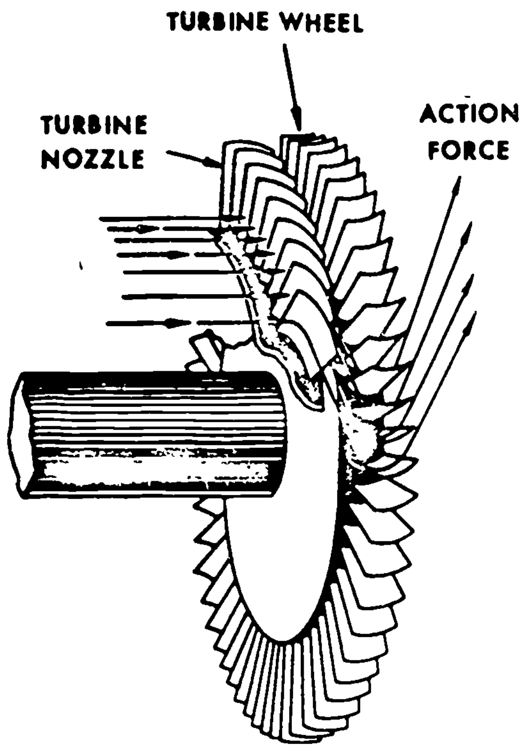

Figure 8. Turbine Nozzle Wheel.

(1) Purpose: Increases velocity and directs the exhaust gases onto the ______________ ______________ at the most effective angle.

(2) There is one turbine nozzle in ____________ of each turbine wheel.

(3) The turbine rotor assembly is housed in the __________________ _______________ vane casting.

d. Major rotating assembly (Figure 8)

(1) The two major parts that rotate and make up one major rotating assembly are the:

(a) __________________

(b) __________________

(2) A T56 engine has __________ major rotating assemblies. (Figure 8A)

e. Cooling air for the turbine rotors.

(1) All of the turbine rotors are cooled by _________________ stage air.

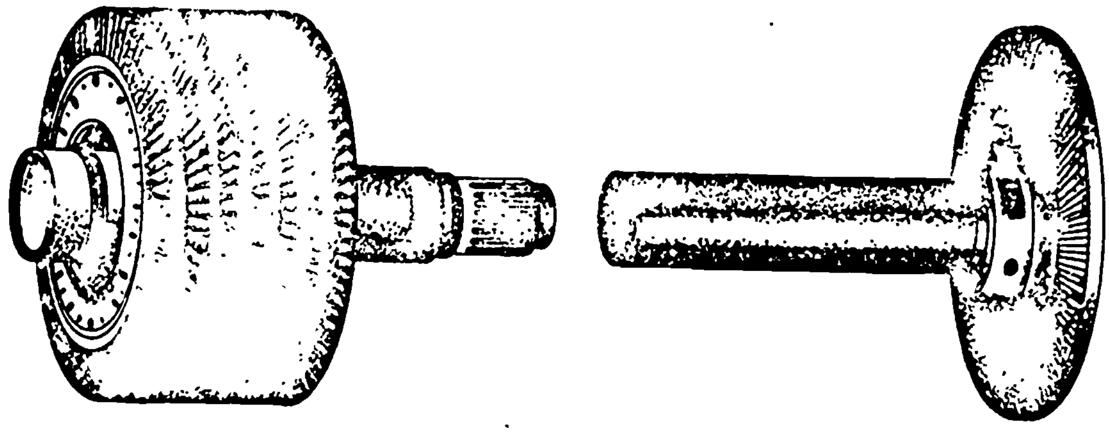

Figure 8A. Major Rotating Assembly.

4. Exhaust Section (Figure 9)

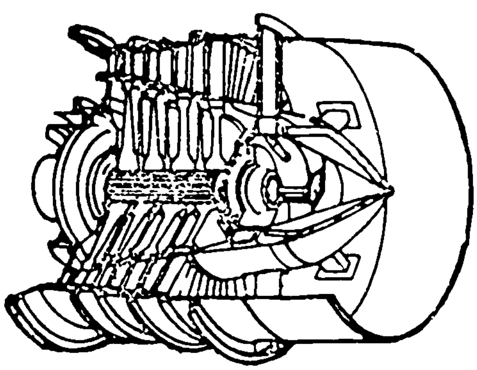

Figure 9. Turbine Bearing Support and Tailpipe.

a. The purpose of the exhaust section is to:

(1) Reduce ________________ and increases ____________________ of the exhaust gases.

(2) Provides a __________________ exit path of the exhaust gases.

(3) Creates a nozzle through which the mass is accelerated to produce ________________.

b. Parts of the exhaust section:

(1) Exhaust struts: Aids in keeping the gases in a ________________ airflow pattern.

(2) Exhaust cone (Figure 9): Aids in controlling the ____________ ______________ ______________.

(3) Exhaust nozzle area (Figure 9): The area formed by the exhaust cone and ______________________. This area creates a nozzle through which the mass is accelerated to produce ______________.

5. Accessory Section (Figure 10)

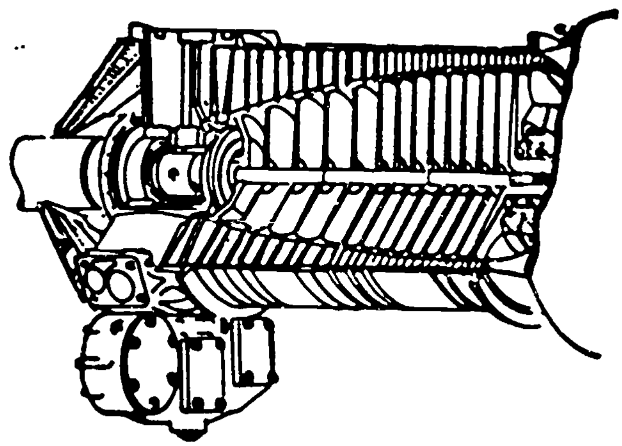

Figure 10. Accessory Case.

a. Purpose: Provides a mounting place and a means of driving the ______________________.

b. The T56 engine has an accessory drive housing called the ____________ ______________ (Z1).

c. Power to drive the accessories is taken from the compressor ____________ ________________.

d. List three engine accessories.

(1) ________________________________

(2) ________________________________

(3) ________________________________

REVIEW QUESTIONS

1. Compressor Section

a. State the purpose of the compressor section.

____.

b. What type of compressor does the T56 engine have?

____.

c. What does it take to equal one stage of compression?

____.

d. The compressor has ________ stages of compression.

e. Which engine case houses the compressor? ______________

____

f. What is the purpose of the difffuser case? ______________

____.

g. The diffuser case increases ________ and decreases ________.

2. Combustion Section

a. State the purpose of the combustion section. ______________

____.

b. What type of combustion section does the T56 engine have?

____.

c. The spark igniters are mounted in the __________ case at the __________ and __________o'clock position and extend into the number __________ and ______________ combustion liners.

d. How does the flame spread from one combustion liner to the other? ______________________________________.

e. The T56 engine has ______________ individual combustion liners.

f. Approximately 75% of the air is used for __________ 25% for __________.

g. Once the fuel is ignited, the burning continues until the ______________ is shut off.

3. Turbine Section

a. State the purpose of the turbine section. ______________

____.

b. What type of turbine section does the T56 engine have?

____.

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c. What is the purpose of the turbine nozzles? ______________

____.

d. The compressor, turbine rotors, and turbine shaft are referred to as the ______________________________.

e. Which turbine rotor(s) are cooled by 14th stage air?

____.

f. Where are the turbine wheels housed? ______________

____.

4. Exhaust Section

a. State the purpose of the exhaust section. ______________

____.

b. Name the part of the exhaust section described in the following:

(1) Creates a nozzle through which the mass is accelerated to produce thrust. ______________________________

(2) Aids in controlling the exhaust gas temperature.

____

(3) Aids in keeping the exhaust gases in a straight air flow pattern. ______________________________

c. The exhaust gases escaping rearward produce a reacting force forward called. ____________

5. Accessory Section

a. State the purpose of the accessory section. ______________

____.

b. The fuel pump, fuel control, and speed sensitive control are a few of the accessories located on the ______________________.

c. The accessories are driven by a vertical drive shaft from a gear on the compressor ______________________________.

d. The _______ is located just under the ______________ case.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-105D
25 January 1980

T56 ENGINE MAIN BEARINGS AND LABYRINTH SEALS

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to identify and locate the main bearings on a T56 engine.

EQUIPMENT

	Basis of Issue
3ABR42633-SG-105	1/student
T56 engine	1/15 students
Selected bearings and engine parts	1/15 students

PROCEDURE

Use the information presented in the classroom, study guide, engine, and aid from the instructor. Fill in the spaces in this workbook and chart with the correct information.

1. Type of Bearings.

a. Roller - Absorbs only ________________ loads.

b. Ball or thrust - Absorbs both ________________ and ________________ loads.

2. Labyrinth Seals.

a. Purpose: Used to form an air seal around the bearing to prevent ________________ from leaking from the bearing compartments.

b. A labyrinth seal must have ________________ against it to seal.

3. Main Bearings.

a. Front compressor bearing.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

Designed for ATC Course Use. Do Not Use on the Job.

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(1) Purpose: Supports the front of the __________ compressor.

(2) Type load - __________

(3) Type bearing - __________

(4) Location - __________

b. Rear compressor bearing.

(1) Purpose: Supports the __________ load of the compressor.

(2) Type load - __________ and __________

(3) Type bearing - __________ or thrust.

(4) Location - __________

c. Turbine front bearing.

(1) Purpose: Supports the front of the __________ compressor.

(2) Type load - __________

(3) Type bearing - __________

(4) Location - __________

d. Turbine rear bearing.

(1) Purpose: Supports the __________ load of the rear compressor and the __________ load of the turbine rotor assembly.

(2) Type load - __________ and __________

(3) Type bearing - Ball or __________.

(4) Labyrinth seals pressurized by - __________

(5) Location - __________

NUMBER OF BEARING	NAME OF BEARING	TYPE LOAD	TYPE BEARING	LABYRINTH SEALS PRESSURIZED BY	LOCATION

Chart 1. T56 Engine Bearings and Labyrinth Seals.

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REVIEW QUESTIONS

1. Roller bearings take up ________________ loads.

2. Another name for a ball bearing is _______________ bearing.

3. Ball bearings take up _____________ and ______________ loads.

4. Labyrinth seals are pressurized by _________________________.

5. What is the purpose of the labyrinth seals? ______________

____

6. What is the name of the number 1 bearing? _________________

7. How are the number 1 and number 2 labyrinth seals pressurized?

____

8. The number 1 bearing is located in the _______________________ of the air inlet housing.

9. The wave washer is considered to be __________________ pressure.

10. Which bearings are thrust bearings? __________________________

11. The rear compressor bearing is the number _______ bearing.

12. The rear compressor bearing is located in the ___________ case.

13. What is the name of the number 4 bearing? _____________________

14. The number 4 bearing is located between the _____________ shafts.

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WORKBOOK

3ABR42633-WB-105E

Technical Training

Turboprop Propulsion Mechanic

T56 ENGINE SYSTEMS AND PARTS

31 January 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-105E

T56 ENGINE SYSTEMS AND PARTS

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to identify basic engine systems and parts.

EQUIPMENT

	Basis of Issue
T56 Engine	1/15 students
Selected bearings and system parts	1/15 students

PROCEDURE

Use the information presented in the classroom, discussion and with aid from the instructor. Identify the parts of each system by placing the number from the figure in the space provided by the name of the part. Complete the incomplete statements.

1. Starter System.

a. Purpose: Rotates the engine rotor to sufficient ______________ for starting.

b. Types used on T56 engine.

(1) Pneumatic.

(a) Most ______________ used.

(b) Requires ______________ air supply.

(c) Rotates the ______________ compressor.

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DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

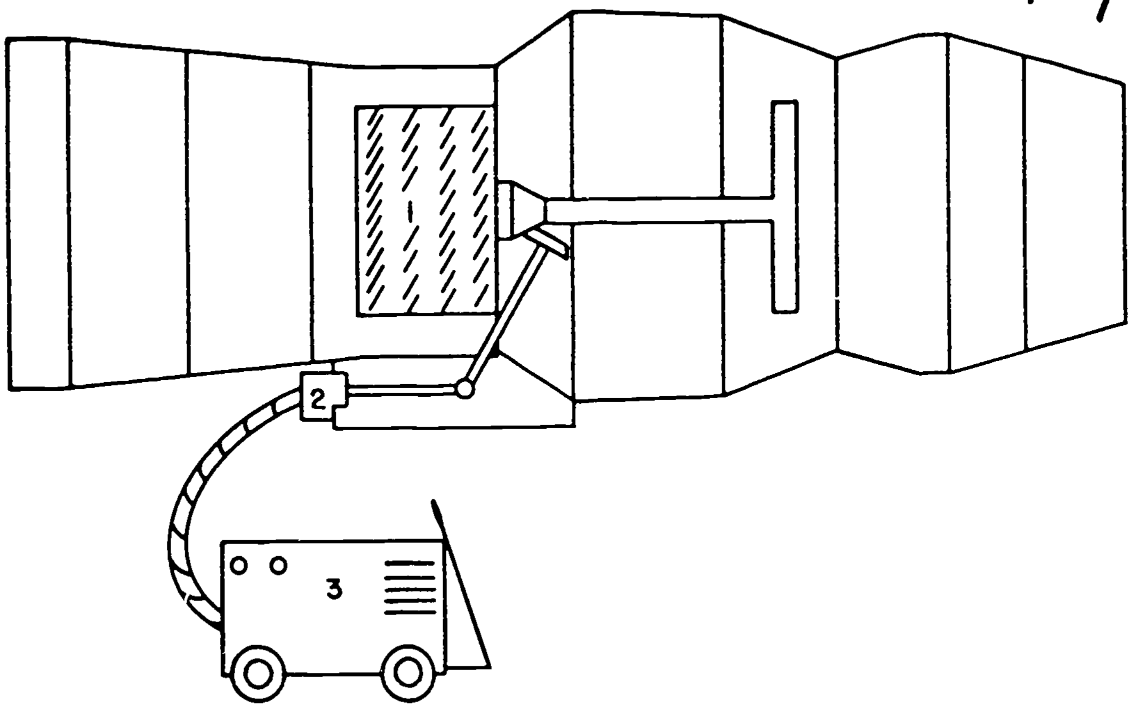

Figure 1. Starter System.

Starter System

a. ________ Air compressor

b. ________ Pneumatic starter

c. ________ Compressor

2. Ignition System.

a. Purpose: Provides a high energy spark for ____________ the fuel/air mixture in the combustion chamber.

b. Types of ignition systems.

(1) High energy ______________ type.

(a) Most ______________ used.

(b) Used for ______________ only.

(c) Parts of high energy capacitor type.

1 Two ______________ units where the electrical charge is stored for a sudden release.

2 Two ______________ leads that carry the electrical current from the exciter units to the spark igniters.

3 Two ______________ which ignite the fuel/air mixture in number ______________ and ______________ combustion chambers.

(2) Other types include ____________ and ____________.

c. Caution: Always ground the ____________ ____________ before working on the ignition system.

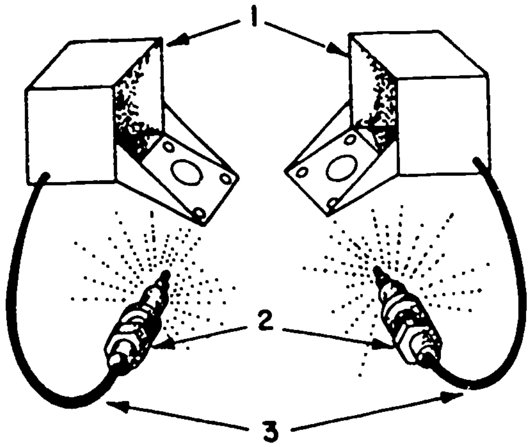

Figure 2. Ignition System.

Ignition System

a. ________ Exciters

b. ________ Leads

c. ________ Igniters

d. The spark igniters project into the No. _____ and No. _____ combustion chambers.

3. Oil System.

a. Purpose: __________, ____________, and ___________ bearings and gears.

b. Types of oil systems.

(1) ____________ sump.

(a) Oil stored in an _________ tank.

(b) Used on the ____________ engine.

(2) ____________ sump.

(a) Oil stored ____________ the engine.

(b) Has no external oil ____________.

c. Parts of the oil system.

(1) Tank - A place where the _________ is stored.

(2) Pressure pump - Delivers oil under pressure to all parts requiring _____________.

(3) Oil filter or strainer - Filters out ____________ particles from the oil.

(4) Pressure relief valve - Regulates ______________ pressure.

(5) Oil jets - Sprays the oil onto the ____________ and ____________.

(6) Scavenge pump - Pumps the oil through or around the oil cooler and back to the _____________.

(7) Oil cooler - ______________ the oil before it returns to the tank.

(a) The type of oil cooler used on the T56 engine is _____________.

(b) The type oil used in the T56 engine is _____________ (synthetic base).

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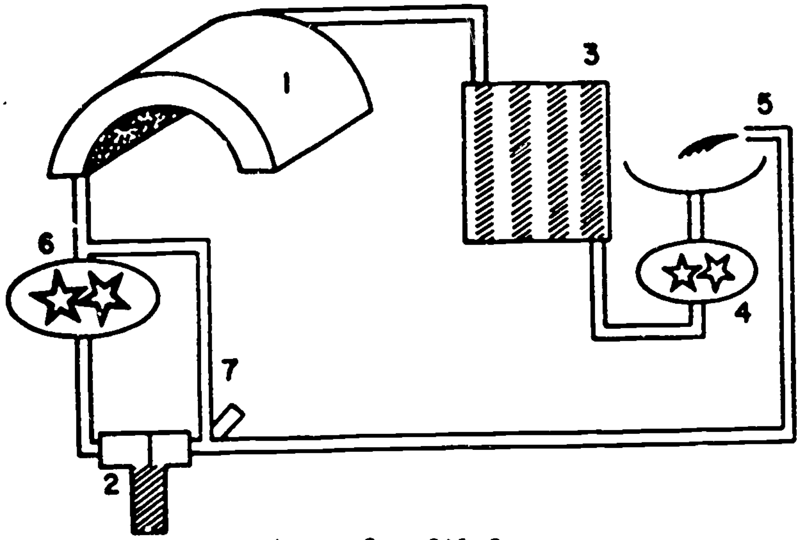

Figure 3. Oil System.

Oil System

a. ________ Tank

b. ________ Pressure pump

c. ________ Filter

d. ________ Relief valve

e. ________ Oil nozzle

f. ________ Scavenge pump

g. ________ Cooler

4. Fuel System.

a. Purpose: Supplies ____________ to the engine under pressure during all engine operating conditions.

b. Parts of the fuel system.

(1) Tank - Mounted in the ______________.

(2) Fuel filter - Filters out foreign ____________ before they reach the fuel system.

(3) Fuel pump - Delivers fuel under pressure to the ______________ ______________.

(4) Fuel control - ______________ fuel to the temperature datum valve.

(5) Fuel flow transmitter - Transmits the amount of ______________ the engine is using to the indicator in the cockpit.

(6) One manifold drain valve and two burner drain valves - Allow the fuel to be ______________ overboard upon engine shutdown.

(7) Fuel manifold - Distributes fuel to the ______________ ______________.

(8) Fuel nozzles - Sprays atomized fuel into the ______________ ______________.

(9) Temperature datum valve - ______________ fuel to the fuel manifold.

(10) Pressure switch - Senses ______________ fuel pressure.

(11) Primer valve - Allows ______________ to bypass the metering section of the fuel control.

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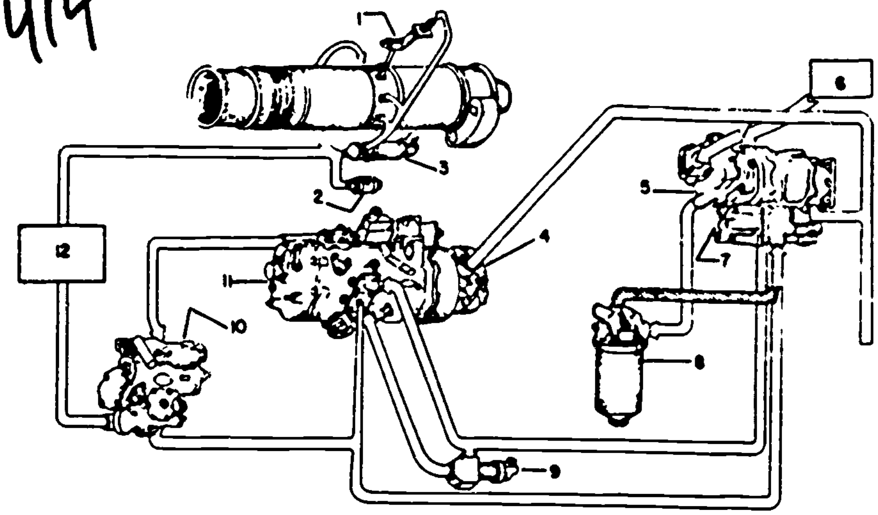

Figure 4. Fuel System.

Fuel System

a. _______ Tank (aircraft mounted)

b. _______ Low pressure filter

c. _______ High pressure filter

d. _______ Fuel nozzle

e. _______ Manifold drain valve (drip valve)

f. _______ Fuel pump

g. _______ Temperature datum valve

h. _______ Fuel control

i. _______ Pressure switch

j. _______ Enrichment (primer) valve

k. _______ Quick disconenct flange

l. _______ Flow meter (aircraft furnished)

5. Compressor Bleed System.

a. Purpose: Aids in the prevention of _______________ and _______________ by bleeding some of the _____th stage and _____th stage air overboard.

b. Surges and stalls can be defined as a breakdown of airflow through a few _______________ of compression.

c. Parts of the compressor bleed system.

(1) The _________ _________ _________ sends air under pressure to the bleed valves.

(2) The _________ _________ filters the air from the diffuser.

(3) The _________ _________ bleeds excess air from the compressor.

d. Surges and stalls usually occur during ___________ and ___________.

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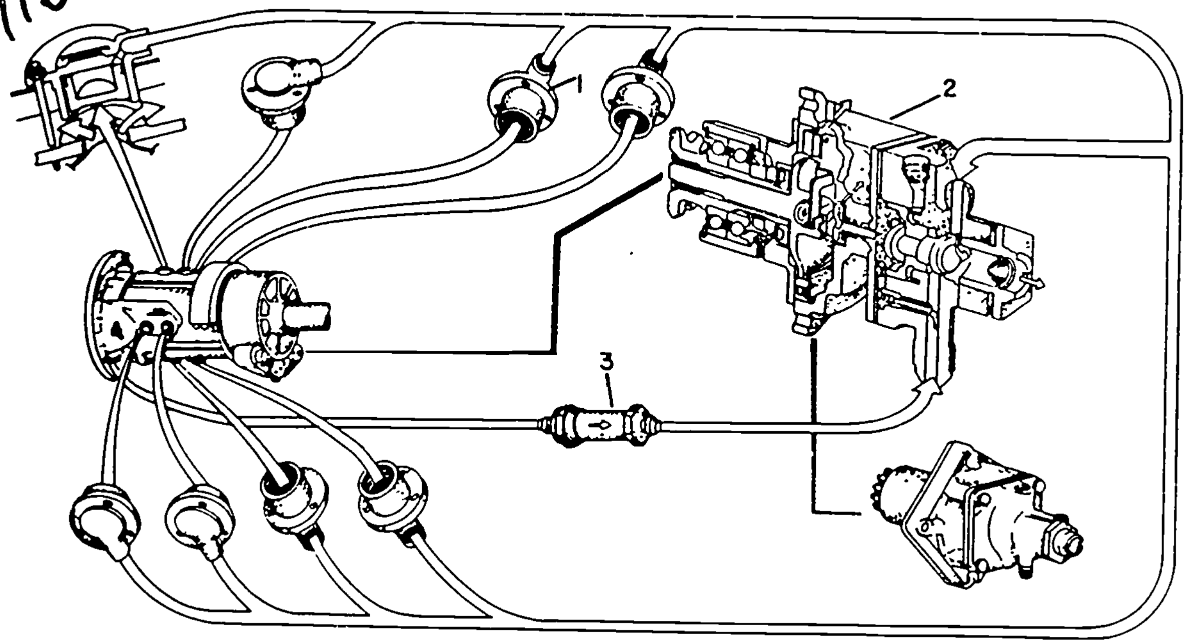

Figure 5. Compressor Bleed System.

Compressor Bleed System

a. _______ Speed sensitive valve

b. _______ Bleed valve

c. _______ Air filter

d. The compressor bleed valve will usually bleed off 5th and 10th stage air during ______________ and ______________.

6. Anti-Icing System

a. Purpose: To prevent ice from forming on the ______________ section.

b. _____th stage air is directed to the inlet section from the ______________ case.

c. Parts of the anti-icing system.

(1) ______________ ______________ turns anti-icing air off and on.

(2) ______________ automatically controls the air flow.

(3) ______________ ______________ ______________ provides a place where moisture can be drained from the inlet area.

d. Indications of ice forming on inlet:

(1) ____________________.

(2) ____________________.

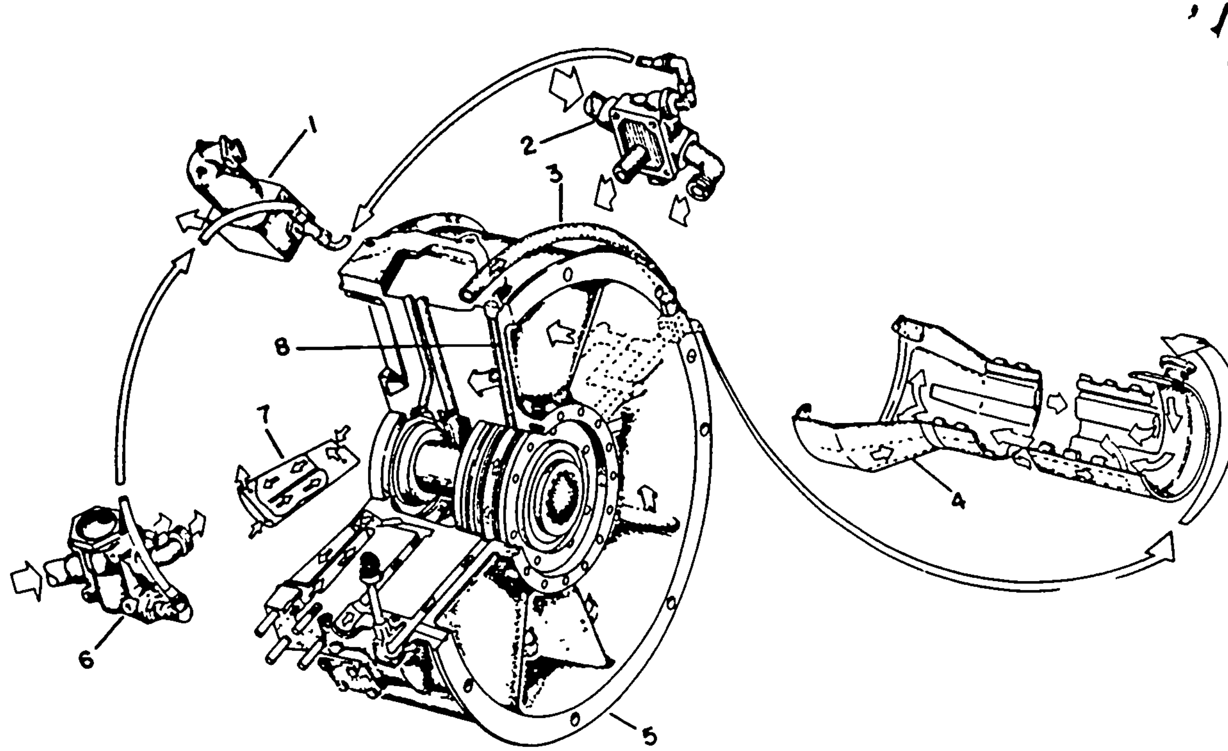

Figure 6. Anti-Icing System.

Anti-Icing System

a. _______ Anti-icing air valve

b. _______ Anti-icing solenoid valve

c. _______ Compressor inlet housing

d. _______ Torquemeter anti-icing shroud

e. _______ Anti-icing vane

f. _______ Balance line

g. _______ 14th stage air

h. _______ Anti-icing air distribution tube

7. Turbine Inlet Temperature Indicating System.

a. Purpose: Indicates the turbine inlet temeprature (TIT) of the _______________.

b. The TIT is taken at the rear of the _______________ section.

c. The _______________ sense heat and send an electrical signal to the TIT in the cockpit.

d. The TIT gauges are calibrated in degrees _______________.

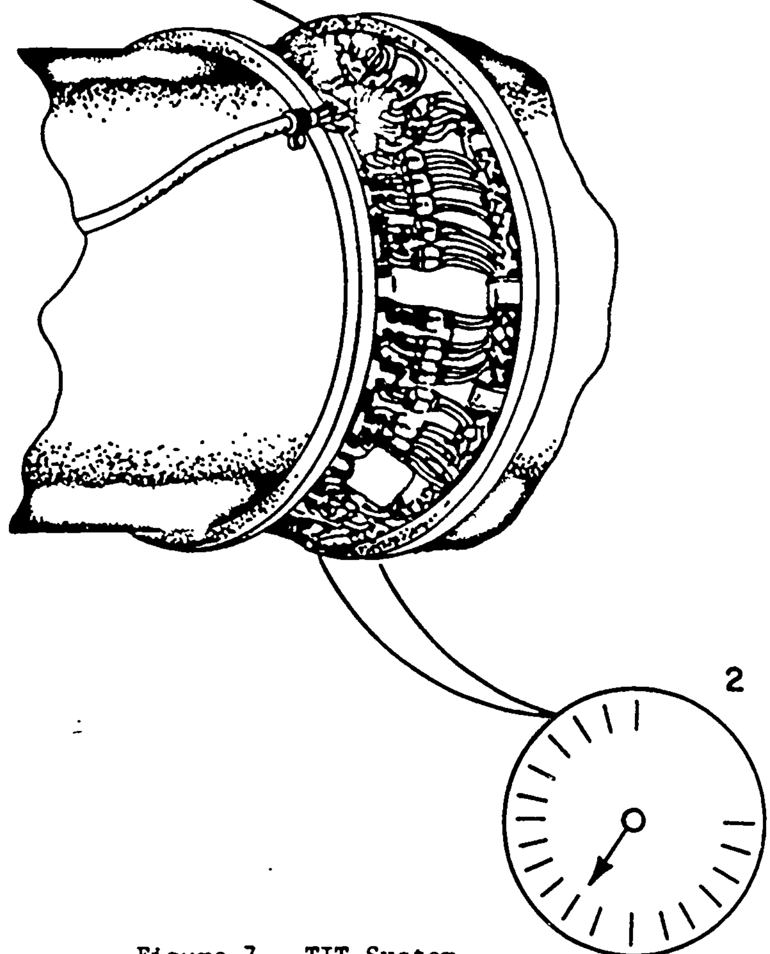

Figure 7. TIT System.

TIT System

a. _______ Thermocouple

b. _______ Indicator

c. TIT is read in degrees _________.

8. Fire Warning System.

a. Purpose: Indicates an _____________ condition in the engine area.

b. Parts of the fire warning system.

(1) _____________ _____________ are located around the engine area sensing overheat conditions.

(2) _____________ _____________ _____________ in the cockpit warns the pilot of an overheat condition.

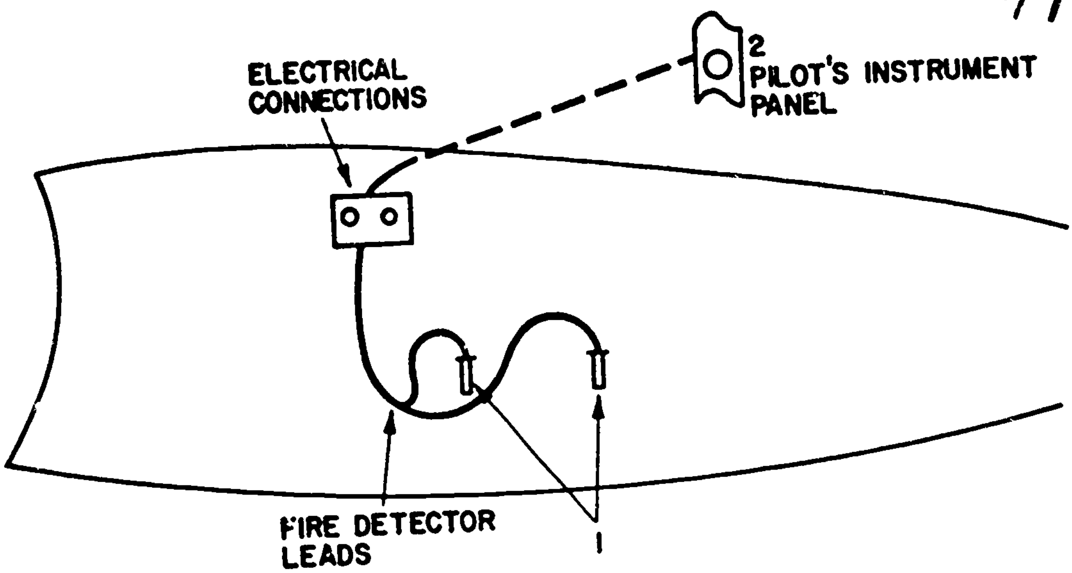

Figure 8. Fire Warning System.

Fire Warning System

a. _______ Fire detectors

b. _______ Fire warning light

9. RPM Indicating System.

a. Purpose: Indicates the rpm of the _______________ compressor.

b. A _______________ generator, located on the reduction gearbox, sends an electrical signal to the cockpit to drive the rpm indicator.

c. The rpm indicator indicates the engine rpm in __________.

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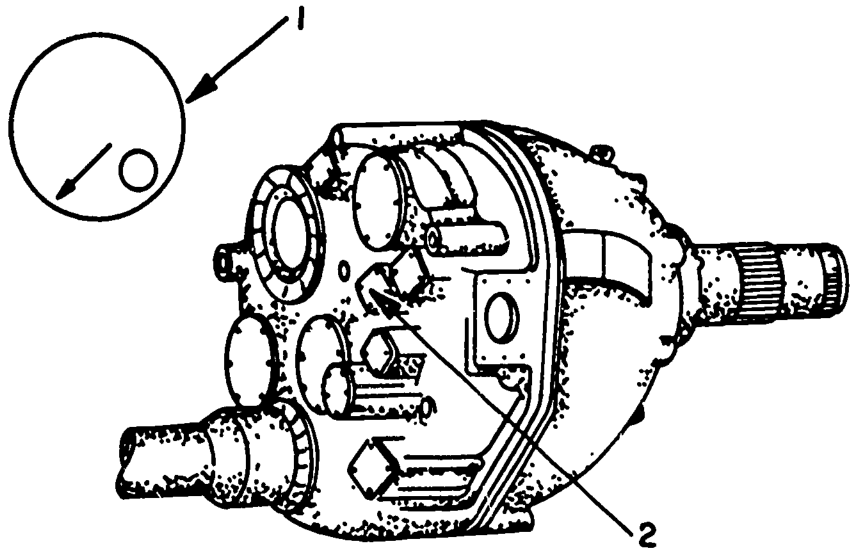

Figure 9. RPM System.

RPM System

a. _______ Indicator

b. _______ Tachometer generator

c. The rpm indicator reads in _____________.

10. Torque Indicating System.

a. Purpose: Indicates to the pilot how much _____________ the engine is producing.

b. The torquemeter magnetic pickup senses the offset teeth caused by the twisting shaft and is called _______________.

c. The torquemeter magnetic pickup sends an electrical signal to the _______________ in the cockpit.

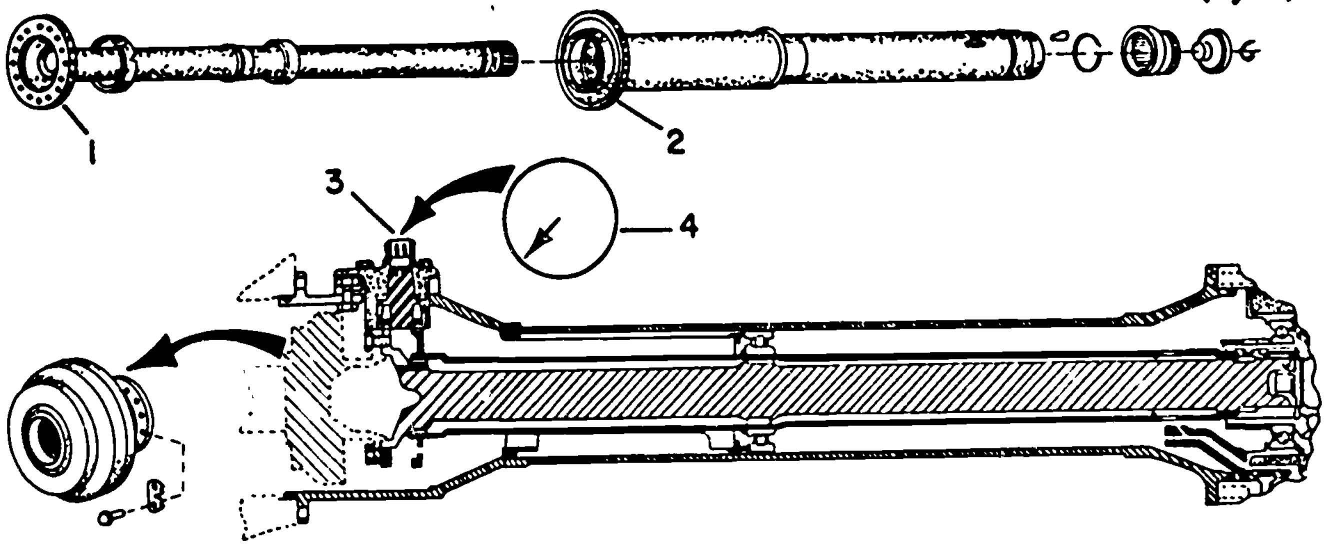

Figure 10. Torque Indicating System.

Torque Indicating System

a. _______ Torquemeter indicator

b. _______ Torquemeter pickup assembly

c. _______ Inner shaft exciter wheel

d. _______ Outer shaft exciter wheel

11. Negative Torque System (NTS).

a. Purpose: To prevent the propeller from ____________.

b. The NTS actuator (plunger) rod is mounted in the ______________.

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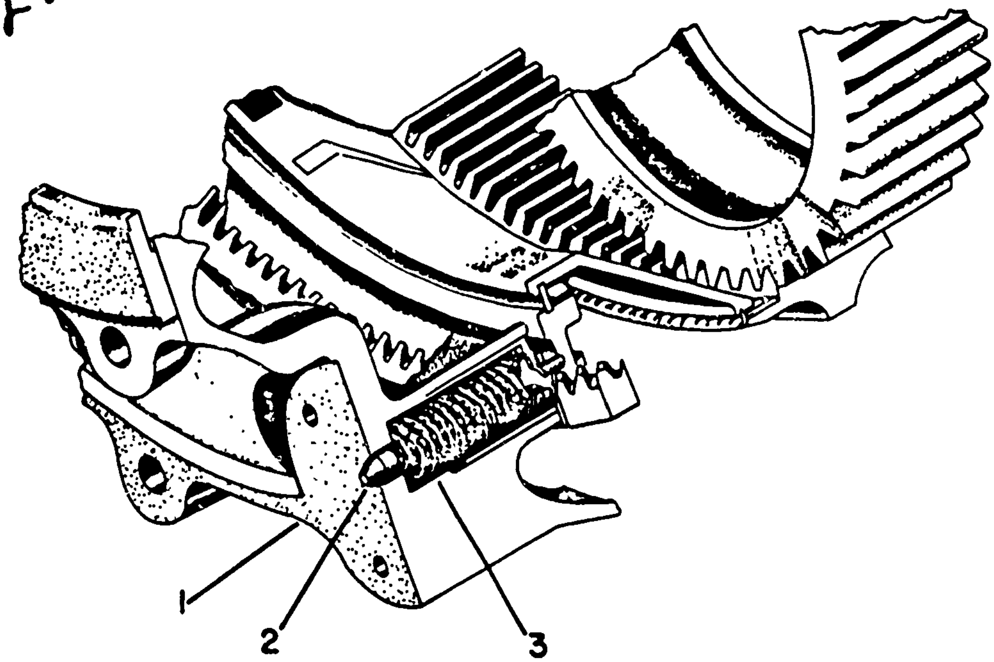

Figure 11. Negative Torque System.

Negative Torque System (NTS)

a. _______ Gearbox

b. _______ NTS actuator (plunger) rod

c. _______ Spring

REVIEW QUESTIONS

1. Which type starter is used when no air supply is available? ______________________________

2. The ______________ starter is the most widely used type.

3. Which system provides a high energy spark to ignite the fuel in the combustion chamber? ______________________________

4. The spark igniters are located in number ______ and ______ combustion chambers.

5. The T56 engine uses the ____________ ____________ ____________ type ignition system.

6. Name two types of oil systems. ______________ and ______________

7. Which oil system is used in the T56 engine? ______________

8. State the purpose of the oil system. ______________________________

9. What type of oil is used in the T56 engine? ______________

10. The fuel control ______________ fuel to the fuel manifold.

11. Which part of the fuel system distributes fuel to the fuel nozzles? ______________________________

12. Excess air from the ______________ compressor is bled overboard to prevent surges and stalls.

13. Define surges and stalls. ______________________________

14. What stage air is used for the anti-icing system? ______________________________

15. The anti-icing system prevents ______________ from forming on the inlet area of the engine.

16. TIT is the abbreviation for ____________ ____________ ____________.

17. Which engine system indicates an overheat condition in the engine area? ______________

424 18. The rpm indicator receives its power from the ____________

____

19. The rpm indicating system indicates the speed of the

____________.

20. Which engine system gives the pilot an indication of the power output of the engine? ______________

21. What is the purpose of the reduction gearbox? __________

____

22. The reduction gearbox is installed in ______________ of the engine.

80-58920

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-108
26 May 1981

ENGINE PRESERVATION AND STORAGE

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to determine:

1. Types of corrosion.

2. Procedures for removing and installing engines in shipping containers.

3. Procedures for preserving and depreserving engines.

4. Why corrosion prevention and storage are necessary.

5. The applicable historical records or fo s used in aircraft engine preservation and depreservation.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-4	1/student
TO 2J-1-18	1/student

PROJECT 1

PROCEDURE

Use the sections of TO 2J-1-18 as indicated to answer the following questions and fill in the correct information.

Section I

1. What is the paragraph reference covering the theory of preservation of aircraft engines? ________

2. What three objectives are covered by this theory?

a. ____

____

b. ____

____

c. ____

____

Supersedes 3ABR42633-SW-108, 23 January 1980. RGL: N/A
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3350 TCHTG/TTGU-J - 400; DAV - 1
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3. What are the two basic types of corrosion?

a. ______________________

b. ______________________

4. What is humidity? ______________________

5. What should be done with dehydrating agents removed from a preserved engine? ______________________

Section II

1. What are the four AFTO forms which are used to keep a historical record of preservation of an engine? ______________________

2. What TO is used for proper marking of an engine shipping container? ______________________

Section III

1. What is the title of this section? ______________________

____

2. If an engine is given preservative treatment, does it have to be depreserved after 35 days storage? ________

Section IV

1. What type of solvent is used for cleaning the propeller shaft?

____

Section V

1. Is it necessary to remove the top of the metal engine container?

____

Section VII

1. What color will the humidity indicator be if the moisture content in the engine container is satisfactory? ________

Section VIII

1. What does the first "flag word" on page 8-2 refer to?

____

Section IX

1. What table lists the amount of desiccant used in engine containers? ________

PROJECT 2

PROCEDURE

Using TO 1C-130B-2-4, answer the following questions:

1. What section covers preservation and depreservation of the engine?

______

2. What paragraph covers preservation of the engine lubrication system? ______

3. On what page can the renewal of engine preservation be found?

______

4. What are the Allison part numbers for the engine container?

____

5. What figure shows the power section lifting sling? ______

6. What page shows the power section shipping parts? ______

7. What paragraph covers the removal of the power section from the shipping container? ______

8. Who will depreserve an inoperable engine? ______

ATC PROGRAMMED TEXT 52-1, VOLUME II

Prepared by Chanute AFB

TECHNICAL TRAINING

MAINTENANCE MANAGEMENT

VOLUME II—AIRCRAFT INSPECTION AND MAINTENANCE SYSTEM

SEPTEMBER 1977

AIR TRAINING COMMAND

Designed For ATC Course Use
DO NOT USE ON THE JOB

Volume II

AIRCRAFT INSPECTION AND MAINTENANCE SYSTEM

TO 00-20-1 (15 April 1977)
TO 00-20-5 (15 August 1976)

CONTENTS

INTRODUCTION

Have you ever had the experience of your car breaking down while on a trip? If you have, you know the inconvenience it causes. When an aircraft breaks down while on "a trip" it can be disastrous. Every precaution must be taken to prevent an aircraft from breaking down while on "a trip." To keep aircraft as safe as humanly possible the Air Force has developed a system of maintenance and inspection that is generally considered to be the finest in the world. The system is continually developing and undergoing improvement. The aircraft is not only examined for sources of possible malfunctions; in addition, discrepancies which are detected are immediately repaired. Records are kept and analyzed to provide data for further improvement of the system. You are about to embark on a study of this inspection and maintenance system. We believe you will find the information in this text useful and interesting.

OBJECTIVES

1. When you complete this volume you will be able to select the correct response to multiple choice questions that:

a. define the levels of maintenance.

b. identify the three authorized inspection concepts and the scheduled maintenance inspections performed under each concept.

c. recall the methods used to perform the scheduled maintenance inspections.

d. identify the management tools of the planned inspection concept.

e. define the purpose and meaning of maintenance record symbols.

2. Use technical manuals to locate correct abbreviations for maintenance terms.

3. Make entries in AFTO Form 781A facsimiles in the correct format.

INSTRUCTIONS

This is volume II of three study volumes. This volume should be studied in sequence if the complete course is to be taken. It is possible to use this volume alone or in any sequence if you desire to do so.

This may be your first exposure to a programmed text, or to this particular style of programming. In such a case, a few words of explanation on the booklet and its use are in order.

This volume is programmed using a modified style of intrinsic programming. Everything needed to meet the objectives is contained in this text except Technical Order references. (Necessary Technical Order references are provided in Volume IV, *Reference Materials*, of the ATCPT 52-1 package.) The information is presented in logical segments followed by questions and/or problems requiring a response, followed by the correct answers (confirmation). To meet the objectives you should read all the information, do the questions or problems in each segment, then "test" your understanding of the material by answering the questions or working the problems. Then check your answers by reading the answer sets. Be sure to read the answer pages because, in addition to providing confirmation and reinforcement, many of the answers will give you additional information on the subject. You will need the following materials for reference and use:

1. Volume IV which contains extracts from Technical Orders 00-20-1 and 00-20-5.

2. Volume V, Student Response Booklet.

3. An ordinary lead pencil and a red lead pencil.

NOTE: The technical information contained herein is sufficient for this text only. For comprehensive and indepth coverage of the inspection and maintenance system refer to the appropriate 00-20 series Technical Order and AFM 66-1.

NOTE: To conserve instructional materials do NOT write in this volume. Use the Student Response Booklet, Volume V, when answering questions and completing exercises.

LEVELS OF MAINTENANCE

The three levels of maintenance from lowest to highest are: Organizational, Intermediate, and Depot. The overall maintenance and inspection policies are formulated by Air Force Logistics Command (AFLC). To support all Air Force organizations AFLC has established air logistics centers that are charged with depot class maintenance.

The major commands engaged in actual flight-line operations are divided into numbered Air Forces and divisions. An air division is further divided into wings, which are normally the smallest self-sufficient units.

Organizational Maintenance

Organizational Maintenance is limited in scope. This level of maintenance includes routine inspections, replacement of some components, minor structural repairs, and servicing with fuel, oil, etc. Organizational maintenance may also perform technical order modification that can be performed with the facilities available at the organizational level.

It is of the utmost importance that technicians at organizational level discover indications of equipment failure soon enough to prevent major component failure. Failure to discover these indications results in an increase in the workload of other levels of maintenance. This may result in disruption of maintenance schedules not to mention in-flight failure with the possibility of loss of life and equipment.

Intermediate Maintenance

Closely supporting the organizational level of maintenance is the intermediate level of maintenance. Personnel in the field maintenance activity, usually a field maintenance squadron (FMS), perform maintenance at the intermediate level. The FMS usually has the highest concentration of skilled specialists and costly equipment in the maintenance organization. You will find such shops as engines, fuel systems, electrical, pneudraulics, and egress, just to name a few, at this level. The actual number will depend on the size of the mission of the organization, in other words *need.* If the DCM decides that there is a need for a function (shop) then the organization will make a provision for it.

The support provided by this echelon (level of maintenance) consists primarily of furnishing specialist assistance to organizational line maintenance, performing bench checks of equipment, and maintenance repair that is beyond the capacity of the organizational unit. When the capabilities of the maintenance activity at the intermediate level are exceeded, the problem becomes a matter for depot level maintenance.

Depot Maintenance

The highest level of maintenance requires extensive equipment to perform major repair and overhaul. The chief function of a depot is the performance of major modifications on aircraft and all aircraft components. All systems are "inspected and repaired as necessary." Depots also supply spare parts, aerospace ground equipment, and Technical Order Compliance kits (TOC) to organizational and field maintenance units through normal supply channels.

Depot maintenance is usually performed at specifically designated bases in the states and in some overseas areas.

Question Set I

Select the correct response for each of the following questions and record your answer in the appropriate section of your Student Response Booklet, Volume V. Verify your responses with the answers at the end of this question set.

1. Look at section 1 of TO 00-20-5 contained in ATCPT 52-1, Volume IV. The purpose of this publication is to prescribe the inspection and maintenance system and the

a. preventive maintenance program, general requirements and procedures.

b. maintenance processing of reparable property and the repair cycle asset control system and related test equipment.

c. maintenance documentation for inshop maintenance.

d. requirements and procedures for the preventive maintenance of aircraft, drones, and air-launched missiles, the use of maintenance documents and collection of flight data.

2. When an organization performs minor maintenance on its assigned aircraft, the level of maintenance would be

a. depot.

b. organizational.

c. intermediate.

d. organizational and intermediate.

3. Field maintenance shops perform

a. depot maintenance.

b. intermediate maintenance.

c. organizational maintenance.

d. both depot and organizational maintenance.

4. The three levels of maintenance from lowest to highest are

a. organizational, intermediate, and depot.

b. depot, intermediate, and organizational.

c. intermediate, depot, organizational.

d. organizational, depot, intermediate.

5. Specifically designated bases which accomplish the complete overhaul of aircraft perform

a. depot maintenance.

b. intermediate maintenance.

c. organizational maintenance.

d. the lowest level of maintenance.

6. The level of maintenance that performs routine inspections, servicing with oil, fuel, etc., and is performed by the using organization is

a. organizational maintenance.

b. intermediate maintenance.

c. depot maintenance.

d. intermediate and depot maintenance.

7. The level of maintenance that is authorized to completely overhaul aircraft is

a. organizational maintenance.

b. intermediate maintenance.

c. depot maintenance.

d. intermediate and organizational maintenance.

8. The level of maintenance that provides most of the specialist in the maintenance organization and provides direct support to the using organization is

a. depot maintenance.

b. organizational maintenance.

c. intermediate maintenance.

d. depot and organizational maintenance.

Answers to Question Set I

1. The answer is **d.** The purpose of the 00-20-5 Technical Order is to prescribe requirements and procedures for the preventive maintenance of aircraft, drones and air-launched missiles, the use of maintenance documents, and collection of flight data.

2. The answer is **b.** Organizational maintenance would perform minor maintenance on assigned aircraft and equipment as well as most of the servicing required.

3. The answer is **b.** Field maintenance activities would perform intermediate level maintenance, or the maintenance that is too involved for organizational maintenance but is not sufficient to warrant depot maintenance.

4. The answer is **a.** The three levels of maintenance from lowest to highest are: organizational, intermediate, and depot.

5. The answer is **a.** Specifically designated bases which accomplish complete overhaul of aircraft perform depot level maintenance, which is the highest level of maintenance.

6. The answer is **a.** Routine inspections, maintenance and servicing is performed by organizational maintenance.

7. The answer is c. Depot maintenance is authorized and equipped to completely overhaul aircraft.

8. The answer is c. The level of maintenance that has most of the assigned specialist and provides direct support to the using organizations is intermediate maintenance which is usually performed by the field maintenance squadron in the maintenance organization.

SCHEDULED MAINTENANCE INSPECTIONS

Routine scheduled maintenance inspections intervals are found in Technical Order 00-20-5, *Aircraft, Drone, and Air-Launched Missile Flight Reports and Supporting Maintenance Documents*. These intervals are also found in applicable aircraft inspection manual (-6) technical order. Scheduled maintenance inspections are the responsibility of organizational maintenance and field maintenance activities.

There are three authorized scheduled inspection concepts used by the Air Force. These are periodic, phased, and isochronal. The sub-elements for each concept are listed below. We will discuss each of the different sub-elements in turn.

a. Periodic Concept

(1) Preflight (PR)

(2) End-of-Runway (EOR)

(3) Thruflight (TH)

(4) Basic postflight (BPO)

(5) Hourly postflight (HPO)

(6) Periodic (PE)

b. Phased Concept

(1) Preflight

(2) End-of-Runway

(3) Thruflight

(4) Basic postflight

(5) Phased (PH)

c. Isochronal Concept

(1) Preflight

(2) End-of-Runway

(3) Thruflight

(4) Home Station Check (HSC)

(5) Minor (MIN)

(6) Maj (MAJ)

(Isochronal is a term meaning of equal term or occurring at regular intervals.)

Preflight Inspection

The Preflight Inspection, as the name implies, is basically a flight preparedness check. As such this inspection is performed before resuming flying activity after the aircraft has been inactive for a period of time. On this basis the preflight inspection is required prior to the first flight of the day. The inspection is a thorough visual inspection and operational check of certain systems and components to ensure that no defects exist that could cause accidents or mission aborts.

Aircraft on alert status will have a complete preflight inspection accomplished prior to going on alert status and again before flight after completion of the alert period. Continuous surveillance by the aircrew and accomplishment in alert and scramble checklist should ensure that the aircraft is airworthy.

End-of-Runway Inspection

The EOR Inspection is a final visual and/or operational check of designated aircraft systems and components. The inspection is performed immediately prior to takeoff at a designated location usually near the end of the runway. The purpose of the inspection is to detect critical defects which may have developed or have become apparent during ground operation of the aircraft.

Thruflight Inspection

The Thruflight Inspection was designed for use on cargo aircraft utilized for regular airline type operations. It is however, applicable to any aircraft where an immediate turnaround or a continuation flight is scheduled. This inspection will be performed prior to takeoff at intermediate stops. The aircraft is visually checked to see if there are any defects which could impair safety of flight. The scope of the thruflight will be governed by the inspection concept under which that particular weapon system is being operated.

Basic Postflight Inspection

The Basic Postflight Inspection will be accomplished after the last flight of the flying period. This inspection consists of checking the aircraft to determine if it is suitable for another flight by performing a visual examination of certain systems and components to ensure that no defects exist which would be detrimental to further flight.

Maintenance is not obligated to perform the basic postflight until the aircraft is released by operations. If an aircraft lands to change pilots or other crewmembers, or if an aircraft makes a brief stop with the crew staying in the immediate area of the aircraft, the basic postflight need not be performed, since the aircraft has not been released by operations. The basic postflight inspection is a more thorough check than the preflight or the thruflight inspections.

Hourly Postflight

The Hourly Postflight is accomplished after a specified number of flying hours have accumulated. It consists of checking certain components areas and systems of the aircraft to make sure that no conditions exist which could result in failure of the component before the next scheduled inspection. This inspection augments the basic postflight. In fact, the basic postflight is often accomplished at the same time. For example, if an aircraft has flown and has also accumulated the specified number of hours for the hourly postflight then the hourly postflight and basic postflight will be accomplished at the same time.

Periodic Inspection

The Periodic Inspection is a thorough and searching inspection of the entire aircraft, more extensive than the hourly postflight or basic postflight inspections. In addition to the recurring inspection items, some of which are required at the hourly postflight inspections, the periodic inspection includes certain components, areas and systems of the aircraft that require less frequent inspection (because of their function) than the hourly postflight or the basic postflight.

The periodic inspection is considered due when the specified number of flying hours or calendar period has expired. As is the case of the hourly postflight, the aircraft should not be scheduled for flight if the mission will over extend the inspection by too great a margin.

Phased Inspection

The Phased Inspection concept is actually a combination of the basic postflight and/or hourly postflight and periodic inspection requirements into small packages. These packages have approximately the same work content and clock hours. Lumping these three inspections into one would make an inspection that requires an extremely long time to complete. Therefore, this inspection is broken into parts or phases. The amount of flying time accrued between phases depends upon the aircraft and its use. For example, the B-52G phased inspection consists of 12 phases. Phase 1 is at 50 hours, phase 2 at 100 hours, phase 3 at 150 hours, etc., with phase 12 at 600 hours. At 650 hours the sequence would start again with phase 1, and the cycle would repeat itself indefinitely.

One of the main objectives of the phased concept is to reduce the time the aircraft is out of commission for any given inspection. The phases are arranged in such a manner that each requires approximately the same number of man-hours. This arrangement permits all inspection requirements to be met with a short out-of-commission time for any one phase.

Figure 1 shows a sample card from a set of workcards for a phased inspection. The headings at the top of the card provide some rather important information. By reading the information in the heading blocks we know the card number, the work area, the publication number and date, the type mechanic required to perform the work, and whether or not the electrical power must be on or off. Also, we can tell which phase or phases these particular items must be inspected.

Isochronal (ISO) Inspection

The Isochronal Inspection concept is designed to translate flying-hour utilization rates into

CARD NO	WORK AREA(S)	TYPE MECH REQ	MECH NO	CARD TIME	PUBLICATION NUMBER AND DATE
B-044	3	ACFT MECH			1B-52B-6WC-2 1 MAY 71

MAN-MINUTES	WORK AREA	WORK UNIT CODE SYS	SUB-SYS AND COMP	2ND PH — INSPECTION REQUIREMENTS	ELECTRICAL POWER: OFF	SERVICE	B-044
				ENGINES 5 AND 6			
002	3	23	HAP	1. FUEL CONTROL BURNER PRESSURE SENSING TUBE MOISTURE TRAPS FOR ACCUMULATED MOISTURE. DRAIN HOLES FOR OBSTRUCTIONS.			
002	3	23	HAH	2. FUEL FLOW TRANSMITTER LINE TO P AND D VALVE FOR LEAKS, CHAFING, CRACKS, AND BROKEN OR MISSING LOCKWIRE.			
002	3	23	HRH	3. FUEL CONTROL TO FUEL FLOW TRANSMITTER LINE FOR LEAKS, CHAFING, CRACKS AND BROKEN LOCKWIRE.			
002	3	23	HAH	4. FUEL CONTROL TO P AND D VALVE SENSING LINE FOR LEAKS, CHAFING, CRACKS AND BROKEN OR MISSING LOCKWIRE.			
002	3	23	HQM	5. MAIN FUEL SUPPLY HOSE FROM AIRCRAFT TO FUEL FILTERS FOR LEAKS, CHAFING, CRACKS, AND BROKEN OR MISSING LOCKWIRE.			
002	3	23	HRC	6. FUEL STRAINER OUTLET LINE FOR LEAKS, CHAFING, CRACKS, AND LOOSE OR MISSING LOCKWIRE.			
002	3	23	LAA	7. COMPRESSOR BLEED VALVES FOR BROKEN OR MISSING WIRE. VALVES FOR STATIC CONDITION. (B-52B-E, OPEN.			

CARD NO	WORK AREA(S)	TYPE MECH REQ	MECH NO	CARD TIME	PUBLICATION NUMBER AND DATE
B-044	3	ACFT MECH			1B-52B-6WC-2 1 MAY 71

Figure 1

calendar periods, usually expressed in days. The system manager is responsible for ensuring the calendar period is properly established to meet maintenance and engineering requirements, and that it is adjusted when basic utilization rates change.

The scheduling program should be constructed to allow for the time that an aircraft is programmed to be in inspection status. For example, if an aircraft is programmed to be in inspection status for 3 days and the calendar inspection period based on the utilization rate is 70 days, the inspection would be scheduled each 73 days. This should be established as the inspection interval for this particular aircraft and the schedule based on the programmed input date for the first inspection.

Home Station Check Inspection

The Home Station Check (HSC) Inspection consists of requirements that are a combination of former basic postflight and hourly postflight items. These items are arranged and designed for accomplishment at the home station when the aircraft returns from a long-range mission or upon expiration of a specified short-term calendar interval. This inspection will become due and will be performed at the calendar interval specified in the -6 inspection workcards. This inspection will also be accomplished in conjunction with minor and major inspections.

Minor Inspection

The Minor Inspection will become due upon the accrual of the number of calendar days specified in the applicable -6 inspection manual and -6 workcards. This inspection consists of checking certain components areas, or systems of the aircraft to determine that no conditions exist which could result in failure prior to the next scheduled inspections.

Aircraft should not be scheduled for a mission of a duration that will exceed the specified limitation to the extent that safety of flight would be jeopardized.

Major Inspection

This inspection is a thorough and searching inspection of the entire aircraft or weapon system. Individual requirements may be more extensive in scope than previous inspection items. The major inspection will become due when the number of calendar days specified in the applicable -6 inspection manual and workcards have accumulated. The inspection will include certain components, areas, and systems of the aircraft or weapon system which, due to their function, required less frequent inspection than that required by other inspections.

Because of the length of time normally required to complete a major or minor inspection, it is inadvisable to include preflight inspection requirements as part of the major or minor inspection. Therefore, a separate preflight inspection will be required before the aircraft is released for flight.

CALENDAR INSPECTIONS

When an aircraft does not fly or is out of commission for more than 30 consecutive days, a basic postflight or home station check inspection will be required before the aircraft can be released for flight. This will be considered as a minimum 30-day calendar inspection.

When an aircraft is idle for more than 90 consecutive days; an hourly postflight inspection or home station check, plus performance of an operational check of all functional aircraft systems (excluding landing gear retraction) and accomplishment of all periodic or minor lubrication requirements will be required before the aircraft is returned to operational status. As is the case for the 30-day calendar inspection, this will be considered a minimum 90-day inspection. In both the 30- and 90-day inspections, the local commander and the maintenance officer will determine whether additional inspection or maintenance is required.

Question Set II

Select the correct response for each of the following questions and record your answer in the appropriate section of your Student Response Booklet, Volume V. Verify your responses with the answers at the end of this question set.

1. Which of the publications listed below *describe* routine scheduled maintenance inspections?

a. TO 00-20-3.

b. TO 00-20-5.

c. TO 00-20-11.

d. AFM 66-1, Volume I.

2. The performance of the scheduled maintenance inspections is the responsibility of

a. depot, field, and organizational maintenance activities.

b. field and depot maintenance activities.

c. depot maintenance activities.

d. organizational maintenance and field maintenance activities.

3. The three authorized inspections concepts are

a. periodic, phased and isochronal.

b. phased, minor, and major.

c. periodic, minor, and major.

d. minor, major, and isochronal.

4. Preflight inspection is best described as

a. a visual check.

b. an operational check.

c. a flight preparedness check.

d. a visual check accomplished after each flight.

5. The basic postflight inspection is a check to

a. prepare the aircraft for the first flight of the day.

b. determine if the aircraft is suitable for another flight.

c. determine the in-flight condition of the aircraft.

d. determine the preflight condition of the aircraft.

6. Maintenance is not obligated to perform the basic postflight until

a. just before the aircraft is scheduled to fly again.

b. the aircraft has accumulated a specified number of flying hours.

c. the aircraft has been released by operations.

d. a specified calendar period has elapsed.

7. The hourly postflight is accomplished

a. after the last flight of the day.

b. upon accrual of a specified number of calendar days.

c. as a thorough and searching inspection of the entire aircraft.

d. after the flight in which a specified number of flying hours is accrued.

8. The hourly postflight inspection augments the basic postflight inspection and

a. is a combination of periodic and phased inspection requirements.

b. is accomplished after the accrual of a specified number of flying hours.

c. is considered due when the specified calendar period has expired.

d. is specifically designed for cargo-type aircraft.

9. The periodic inspection is performed upon accrual of a specified number of

a. flights.

b. landings.

c. malfunction in any one aircraft system.

d. flying hours.

10. Select the statement which best describes the periodic inspection.

a. The periodic inspection is made up of only the basic and hourly postflight inspection requirements.

b. The periodic inspection is a thorough and searching inspection of the entire aircraft.

c. The periodic inspection is a quick look-see inspection performed periodically.

d. The periodic inspection is a thorough inspection of only a few of the aircraft systems.

11. The inspection which is designed to reduce aircraft out-of-commission time is the

a. thruflight inspection.

b. basic postflight inspection.

c. hourly postflight inspection.

d. phased inspection.

12. The phased inspection is

a. actually a lumping together of the preflight and postflight inspections.

b. performed when a specified number of calendar days have accumulated.

c. actually a combination of the hourly postflight and basic postflight, and periodic, broken into equal time-phased inspections.

d. a combination of isochronal and periodic inspection concepts.

13. The thruflight inspection is a check

a. to prepare the aircraft for the first flight of the day.

b. to determine if the aircraft is ready to *continue* the flight.

c. which is a thorough and searching inspection of the aircraft.

d. of the aircraft during flight.

14. The three inspections requirements *not* used in the periodic or phased concepts are the

a. home station check, hourly postflight, and minor.

b. minor, basic postflight, and thruflight.

c. preflight, periodic, and major.

d. home station check, minor, and major.

15. For practical purposes the home station check is a combination of the

a. basic postflight and thruflight.

b. basic postflight and phased.

c. hourly postflight and periodic.

d. basic postflight and hourly postflight.

16. The inspection which is performed at specific intervals and *concurrently* with the minor and major inspections is the

a. periodic.

b. home station check.

c. phased.

d. hourly postflight.

17. Minor and major inspections are required upon accrual of a specified number of

a. flying hours.

b. flying days.

c. calendar days.

d. calendar hours.

18. When an aircraft is out of commission for more than 30 consecutive days, what type inspection is required?

a. Preflight, periodic, phased, and postflight.

b. Basic postflight, or home station check (which is actually a calendar inspection).

c. Thruflight and postflight.

d. Phased and a preflight.

19. When an aircraft is idle for more than 90 consecutive days what type inspection should be performed?

a. A complete depot inspection performed at the factory.

b. Three 30-day calendar inspections.

c. None, because if an aircraft is idle for 90 days or more it must be taken out of commission permanently.

d. An hourly postflight or home station check plus operational check of all functional aircraft systems (excluding landing gear retraction) and accomplishment of all periodic or minor lubrications requirements. This is actually a 90-day calendar inspection.

Using TO 00-25-5 in Volume IV, *Reference Materials*, answer the following questions.

20. For aircraft that are preflighted and do not fly, their preflight will remain valid for a period of time not to exceed a

a. 20-hour period.

b. 24-hour period.

c. 36-hour period.

d. 48-hour period.

21. When will the thruflight inspection be accomplished?

a. Prior to takeoff at intermediate stops.

b. Prior to takeoff on the first flight of the day.

c. Immediately after the last flight of the day.

d. After a specified calendar period has passed.

22. When will the basic postflight be accomplished?

a. Prior to takeoff at intermediate stops.

b. Prior to takeoff on the first flight of the day.

c. The basic postflight will be accomplished after the last flight of a flying period.

d. After each flight in a flying period.

23. What inspection would you be performing if it is a final visual and/or operational check of designated aircraft systems and components?

a. Preflight.

b. Thruflgiht.

c. Basic postflight.

d. End-of-Runway.

24. What inspection concept is designed to translate flying-hour utilization rates into calendar periods?

a. Calendar.

b. Isochronal.

c. Periodic.

d. Phased.

Answers to Question Set II

1. The answer is **b**, TO 00-20-5, *Aircraft, Drones, and Air-Launched Missile Flight Reports and Supporting Maintenance Records.* Actually, there is a whole series of 00-20 technical orders that covers various maintenance management areas.

2. The answer is **d**, organizational maintenance and field maintenance activities. Scheduled maintenance should be accomplished at the lowest echelon. This normally means organizational maintenance with the necessary assistance from field maintenance activities.

3. The answer is **a**, periodic, phased, and isochronal. The other answers list various individual inspections which are a part of one or more of the three inspection concepts.

4. The answer is **c**. The preflight inspection is basically a flight preparedness check, although it is performed visually and may, at times, involve an operational check of some aircraft systems.

5. The answer is **b**. The basic postflight is a check to determine the fitness of the aircraft for another flight.

6. The answer is **c**. Maintenance is not authorized to accomplish the basic postflight inspection until the aircraft has been released by operations.

7. The answer is **d**. The hourly postflight is accomplished after the flight in which a specified number of flying hours have accumulated.

8. The answer is **b**. The hourly postflight inspection augments, or enlarges the basic postflight inspection. It is accomplished after the accrual of a specified number of flying hours.

9. The answer is **d**. The periodic inspection is accomplished when a specified number of flying hours have accumulated. In some instances a periodic may be required on a calendar day basis when required by local authority.

10. The answer is **b**. The complete periodic inspection will include the requirements of the basic postflight and hourly postflight. In addition, certain systems and components are included which because of their function required less frequent inspection than the hourly postflight or the basic postflight inspections.

11. The answer is **d**. The phased inspection is actually a combination of the basic postflight, hourly postflight, and periodic inspections, divided into equally timed parts or phases. Thus, all inspection requirements are met when the inspection cycles are complete and the aircraft is not out-of-commission for any extended period.

12. The answer is **c**. The explanation for the answer is covered in the answer to question 11.

13. The answer is **b**. The thruflight is an inspection made at intermediate stops. This type inspection is used extensively with aircraft assigned to airline-type missions.

14. The answer is **d**. While there is an element of truth in the other answers, the home station check, minor, and major are *not* contained in the periodic or phased concept—they are considered part of the isocrhonal concept.

15. The answer is **d**. The home station check combines the requirements of the basic postflight and hourly postflight items. This inspection may be accomplished at the home station when the aircraft has returned from a long-range mission or at the expiration of a specified calendar period.

16. The answer is **b**. The home station check is accomplished in conjunction with the minor and major inspections.

17. The answer is **c**. Both the minor and major inspections are required when a specified number of calendar days have expired.

18. The answer is **b**. A basic postflight or home station check is considered the minimum calendar inspection for an aircraft that has been idle for 30 days or more.

19. The answer is **d.** Ninety days is a long time for an aircraft to sit idle; so it is necessary that the inspection should be thorough and include lubrication and functional check of aircraft systems.

20. The answer is **d.** The preflight inspection is normally good for a 48-hour period.

21. The answer is **a.** The thruflight inspection is accomplished prior to takeoff at intermediate stops.

22. The answer is **c.** The basic postflight will be accomplished after the last flight of a flying period.

23. The answer is **d.** The End-of-Runway inspection is the final check before the aircraft launches.

24. The answer is **b.** The phased and periodic concept is based on hours flown. The calendar inspection is based on days not flown.

METHODS OF INSPECTION

The two methods of inspection currently used are the INPLACE METHOD and DOCK METHOD. The inspection crews are supported by specialists dispatched from the various shops.

A maintenance unit may use one or both methods of inspection. The local or major command will decide which method best meets their mission requirements.

Inplace Method

The Inplace Method is used when maintenance and operational requirements dictate that inspections and maintenance must be performed at the equipment location.

If the inplace system is used on aircraft, it may take the form of one or more assigned ground crews assigned or dispatched to a particular aircraft. The highest ranking member of the crew is usually designated as the crew chief. He supervises all operations performed by the crew.

Dock Method

The Dock Method is used when maintenance and operational requirements dictate that the equipment be moved to a fixed station or site for accomplishment of inspection and maintenance. The required maintenance crews may be permanently assigned to such stations or sites under the supervision of a dock chief.

Dock structures may be designated to hold an aircraft, or at least the major portion of the aircraft, so that working personnel are protected from the elements. When small aircraft are involved, a dock may be a designated area inside a large maintenance hangar. The dock facilities include items constantly being required, such as compressed air, an aircraft power supply, lights, heat, as well as necessary bench stock (nuts, bolts, screws, etc.). These items are needed to save man-hours that would be required to supply them on a recurring basis.

Latrine facilities, built-in workstands, and an office equipped with a telephone and intercom increase efficiency. Efficiency is further increased by preplanning. Jobs are plotted on a sequence chart so that each specialist and mechanic are scheduled to perform maintenance tasks with minimum interference with each other. (We will discuss the sequence chart in more detail in the next section.) Supplies, parts, and replacements that are know[illegible] be needed are procured in advance and prepositioned in the dock.

Question Set III

Select the correct response for each of the following questions and record your answer in the appropriate section of your Student Response Booklet, Volume V. Verify your response with the answers at the end of this question set.

1. Which of the following statements best describe the inplace method of inspection?

a. An assigned or dispatched crew performs scheduled inspection and maintenance on weapon systems at the equipment location.

b. The aircraft is brought to a fixed site for scheduled inspections and maintenance.

c. Mechanics are assigned to a specific work station to accomplish maintenance and inspections.

d. A crew is dispatched from the dock area to perform depot type inspections.

2. The highest ranking member of an aircraft maintenance inplace crew will normally supervise all work accomplished by his crew. This individual's title is usually

a. shop chief.

b. maintenance chief.

c. line chief.

d. crew chief.

3. Which one of the statements listed below *best* describe the dock method of inspection?

a. The aircraft is brought to a fixed site for maintenance.

b. Crews are assigned to an aircraft under the supervision of a crew chief.

c. The mechanics are assigned to various work stations on the aircraft under the supervision of a dock chief.

d. Both a and c.

4. The supervisor of an aircraft maintenance dock would probably be called a

a. crew chief.

b. branch chief.

c. shop chief.

d. dock chief.

5. Dock structures may be equipped with

a. inspection workcards and required technical orders.

b. latrine facilities and lights.

c. permanent and portable workstands.

d. all the items listed in a, b, and c.

Answers to Question Set III

1. The answer is a.

2. The answer is d. "Crew chief" is a designation that is almost universally used throughout the Air Force for the individual that is assigned the responsibility for maintaining an aircraft. A "line chief" on the other hand, may have several crew chiefs working for him.

3. The answer is d. The aircraft is brought to a fixed site or dock where mechanics or teams of mechanics are assigned to various areas or work stations to perform inspection and maintenance.

4. The answer is d. The supervisor of an aircraft dock is called "dock chief." The "branch chief" is in charge of an entire maintenance section. A "crew chief" is in charge of an individual aircraft and ground crew, and a "shop chief" is in charge of an individual shop such as the engine shop, sheet metal shop, etc.

5. The answer is d. Not only should the dock area be equipped with all the items listed but any additional equipment that will increase the efficiency of the dock operations.

MANAGEMENT TOOLS OF THE PLANNED INSPECTION CONCEPT

Over the years the Air Force has developed many techniques and tools to make the maintenance system more efficient. We will discuss three of these management tools that have evolved and have proved highly successful. They are the inspection workcards, sequence chart, and the data collection forms (AFTO Forms 349 and 350).

Inspection Workcards

Figure 1 shows an example of an inspection workcard for a B-52B aircraft. For some aircraft a complete set may contain a hundred or more cards. They may be maintained in looseleaf binders or covered with plastic. Cards are prepared for all the scheduled inspections, preflight, postflight, major, periodic, etc. In the example shown the type inspection is phased. An aircraft mechanic is needed to accomplish the items on this particular inspection.

The inspection workcards provide the minimum inspection requirements necessary to accomplish the prescribed inspection. The mechanic uses the cards to guide him during his visual inspection. The workcards usually give most of the tolerances and specify any adjustments that must be made.

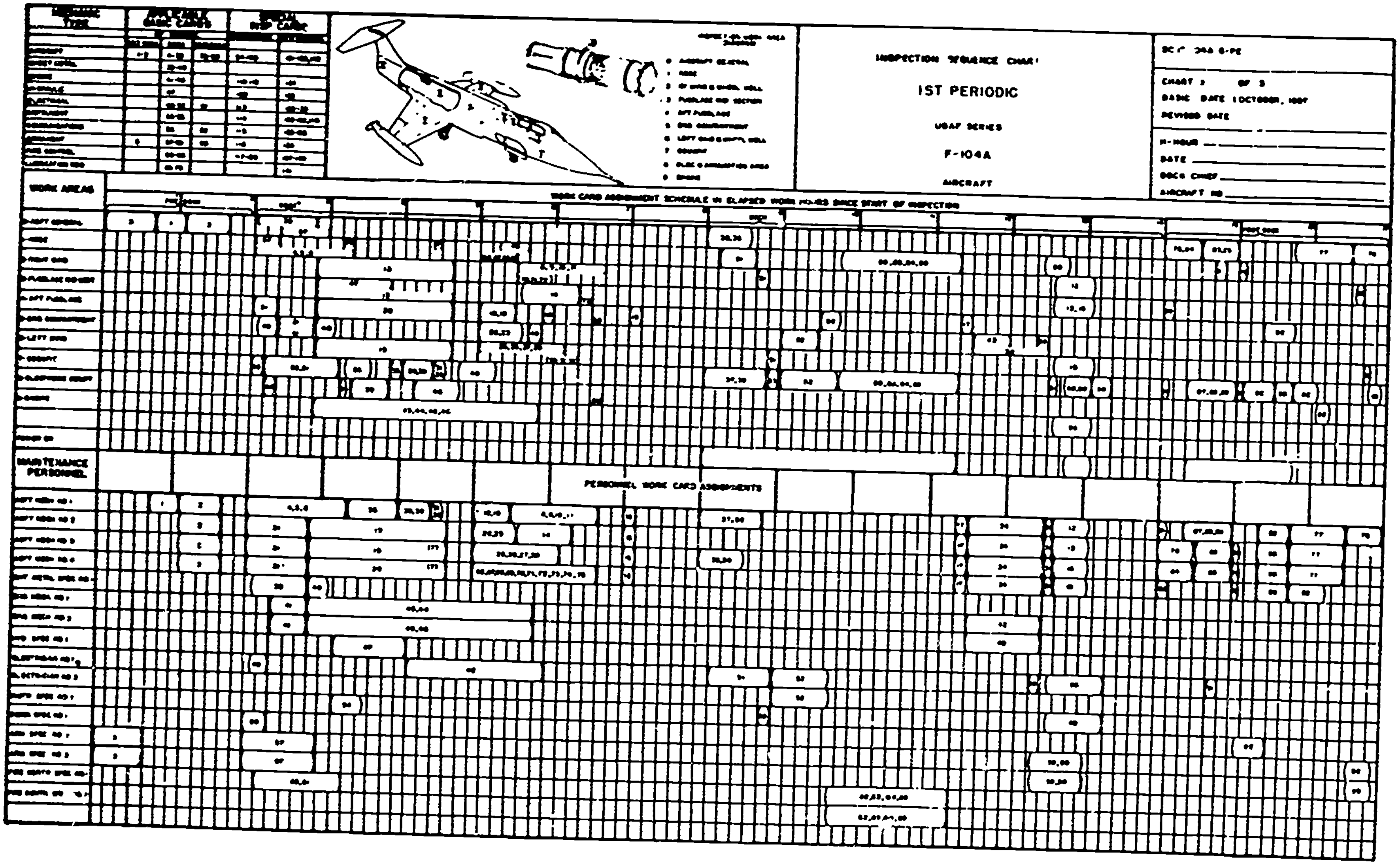

INSPECTION SEQUENCE CHART
1ST PERIODIC
USAF SERIES
F-104A
AIRCRAFT
WORK AREAS
MAINTENANCE PERSONNEL
PERSONNEL WORK CARD ASSIGNMENTS

Figure 2

Sequence Chart

A Sequence Chart (see fig 2) is actually a flexible timetable for scheduling jobs during a dock inspection. These charts are furnished in published form for specific aircraft or they are available in blank forms that may be adapted to fit the particular aircraft. The charts serve as a guide in preparing the actual work schedules. They also serve as a means of controlling the assignment of work during an inspection. Properly maintained the charts serve as a ready reference for determining the progress of the inspection.

The chart for a large aircraft may measure several feet in length and perhaps 2 to 3 feet in width. The sequence chart shown in figure 2 is divided into 1-hour increments. Each hour is subdivided into 10-minute increments. As each portion of the inspection is completed, it is marked off on the chart. A plastic overlay and colored grease pencils may be used for this purpose.

We have stated that the sequence chart is a flexible time table. It is also a time-based arrangement of the workcards. The chart shows the starting time, elapsed time, and work area required for each workcard. H hour is the starting time, which may be any time of day, and all subsequent times are computed in H plus hours. The chart is designed to allow time to perform each task and keep a maximum number of tasks in progress with minimum interference with each other. The sequence chart and inspection workcards are classified as technical publications and must be maintained in accordance with the Technical Order directives.

AFTO Forms 349 and 350

Information concerning maintenance actions must be recorded on "something." We must also have a systematic way of collecting this information. Two important forms that have been developed for recording maintenance information are the AFTO Forms 349 and 350. The system to collect this information and deliver it to statistical services is known as the data collection system. This system is discussed in greater detail in Volume III, but we want to introduce the AFTO Forms 349 and 350 here because they are also a kind of management tool.

AFTO Form 349. Figure 3 shows a sample AFTO Form 349. As you can see the form contains several numbered blocks, some of which are divided into a number of smaller sections. The 00-20-2 technical orders contain the detailed instructions as to which blocks must be filled in for any maintenance performed.

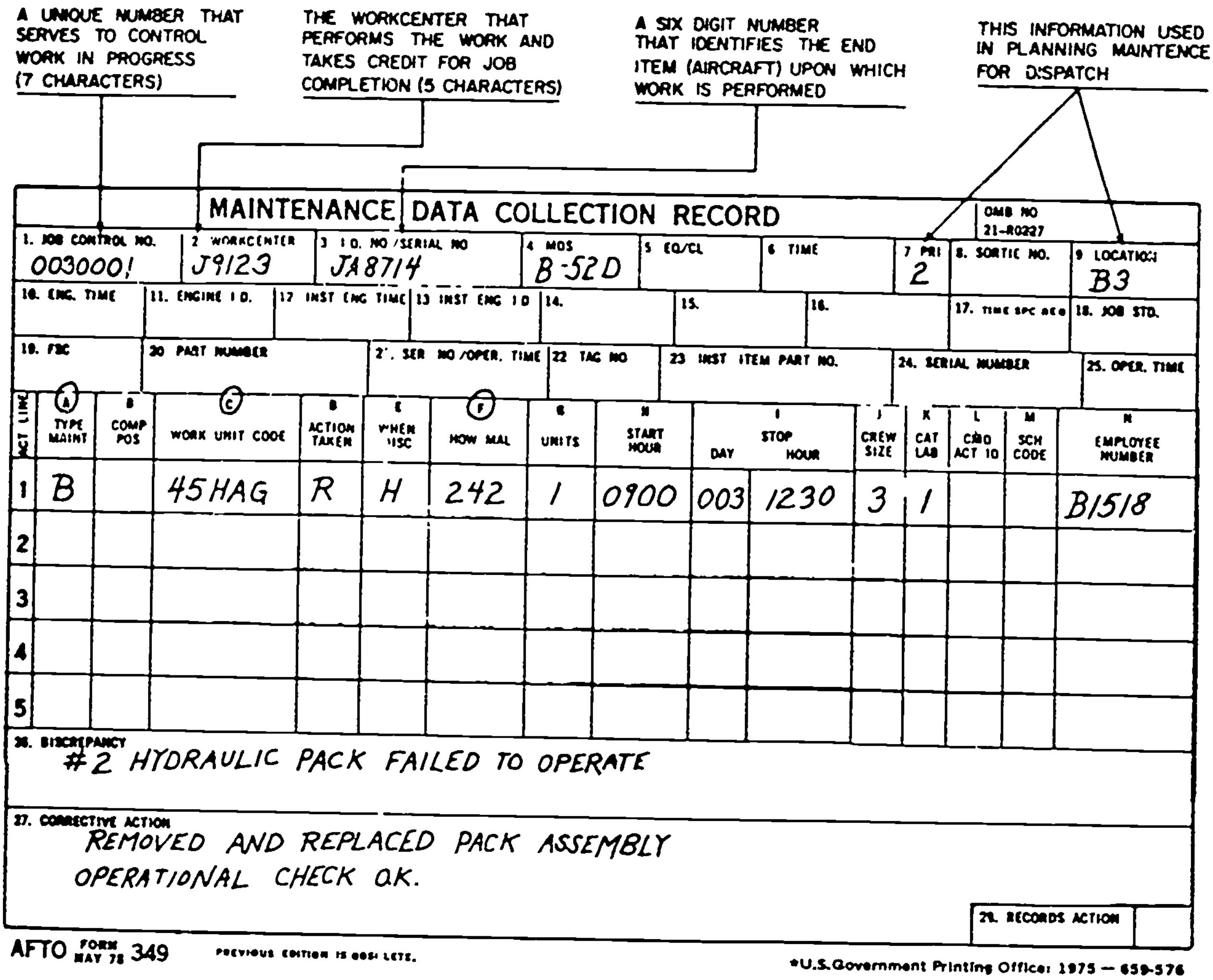
The AFTO Form 349 is used as a dispatch form and as a maintenance form. When the AFTO Form 349 is completed it is turned in to statistical services. Here, along with countless other 349s, it becomes a very important source of information for maintenance management. The mechanic may initiate the 349 to record actions taken or he may be dispatched with a partially filled out 349 to do a certain job or task. In this case he will complete the 349 by entering the necessary data for the job he has completed.

AFTO Form 350. Figure 4 shows an AFTO Form 350. This form is the reparable tag for on- and off-base processing. The AFTO Form 350 is a two-part form. Part 1 is the processing document and part 2 is for Reparable Processing Center (RPC). Use of this tag is essential. It ensures that the status of reparable items is always identified, and provides a source document for information required in completing other maintenance data documents. This form also provides a means of controlling items flowing to and from maintenance shops. In practice the 349 and 350 forms are often used together.

In figure 3 codes shown in columns A and C through F have been taken from the -06 Work Unit Code Manual for the B-52B aircraft. These statistical codes convert verbal descriptions of maintenance performed into computerized language which lends itself to the machine accounting system, used in the Maintenance Data Collection System.

Notice the code shown in column C (45HAG), this describes the number 2 Hydraulic Pack of the B-52B aircraft. The code (242) shown in column F translates to the verbal description of "Failed to Operate," thus columns F and C state that the number 2 Hydraulic Pack failed to operate.

For example, if a reparable item is removed from an aircraft, the mechanic would initiate



A UNIQUE NUMBER THAT SERVES TO CONTROL WORK IN PROGRESS (7 CHARACTERS)

THE WORKCENTER THAT PERFORMS THE WORK AND TAKES CREDIT FOR JOB COMPLETION (5 CHARACTERS)

A SIX DIGIT NUMBER THAT IDENTIFIES THE END ITEM (AIRCRAFT) UPON WHICH WORK IS PERFORMED

THIS INFORMATION USED IN PLANNING MAINTENCE FOR DISPATCH

MAINTENANCE DATA COLLECTION RECORD — OMB NO 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO/SERIAL NO	4. MDS	5. EQ/CL	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION
0030001	J9123	JA8714	B-52D			2		B3

10. ENG. TIME | 11. ENGINE I.D. | 12. INST ENG TIME | 13. INST ENG I.D. | 14. | 15. | 16. | 17. TIME SPC ACQ | 18. JOB STD.

19. FSC | 20. PART NUMBER | 21. SER NO/OPER. TIME | 22. TAG NO | 23. INST ITEM PART NO. | 24. SERIAL NUMBER | 25. OPER. TIME

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1	B		45HAG	R	H	242	1	0900	003	1230	3	1			B1518
2															
3															
4															
5															

26. DISCREPANCY
#2 HYDRAULIC PACK FAILED TO OPERATE

27. CORRECTIVE ACTION
REMOVED AND REPLACED PACK ASSEMBLY
OPERATIONAL CHECK OK.

28. RECORDS ACTION

AFTO FORM MAY 73 349 PREVIOUS EDITION IS OBSOLETE.

*U.S. Government Printing Office: 1975 — 659-576

Figure 3

both a 349 and 350. The 349 would be used to document the action taken and time expended. The 350 would be initiated and attached to the equipment (part) to expedite and control the equipment through the repair cycle and back into the normal supply channels.

All entries on these forms with the exception of personal signatures will be typed or printed. Signatures may also be typed or printed if copied by an individual other than the original signer. The handscribed entries should be made in black pencil, unless otherwise specified, to ensure neatness and to permit correction of minor errors.

The entries required on these forms are covered in detail in Volume III of the ATCPT 52-1. For the time being you should consider the 349 and 350 as management tools used to increase the efficiency of the planned inspection concept.

AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU NO. 21-R0227

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO	2. ID / SERIAL NO	3. TM	3A. SRD	4 WHEN DISC
0380004	JA8714	P	ABD	M

5. HOW MAL	6. MDS	7. WORK UNIT CODE	8. ITEM OPER TIME	9. QTY.
242		13115		1

10. FSC	11. PART NUMBER
4705	49735-31

12. SERIAL NUMBER

13. SUPPLY DOCUMENT NUMBER

14. DISCREPANCY

LEFT MAIN LANDING GEAR BOX FAILED TO OPERATE

15. SHOP USE ONLY

15A. CMD / ACT ID

TAG NO. 939570 AFTC 350 PT. I

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE

18. PART NUMBER

19. NSN

20 ACTION TAKEN	21. QTY.	22. RPC. USE ONLY

TAG NO. 939570 AFTO 350 PT. II

☆ U. S. GOVERNMENT PRINTING OFFICE: 1977-758-426

WARNING

Unauthorized persons removing, defacing, or destroying this tag (or label) may be subject to a fine of not more than $1,000 or imprisonment for not more than one year or both.
(18 USC 1 36 1)

REPAIR CYCLE DATA

23 NSN

24. SRAN CODE

25. TRANSPORTATION CONTROL NUMBER

STATUS CHANGED TO

26. SERVICEABLE

27. CONDEMNED

28. SUPPLY INSPECTOR'S STAMP

29.

BASE REPAIR CYCLE DATA		MO.	DAY	YR.	TIME
DATE REMOVED 7 FEB 77	REC D BY RPC				AWM
TO:					
TO					AWP
TO·					
TO:					
TO:					
DATE COMPLETED					

Figure 4

Question Set IV

Select the correct response for each of the following questions and record your answer in the appropriate section of your Student Response Booklet, Volume V. Verify your responses with the answers at the end of this question set.

1. Which of the items listed below are examples of management tools?

a. Workcards.

b. Sequence charts.

c. AFTO Forms 349 and 350.

d. All of the above.

2. Which of the items listed below contain the minimum inspection requirements?

a. Sequence charts.

b. Workcards.

c. AFTO Forms 349 and 350.

d. Sequence charts and workcards.

3. The sequence chart is used

a. as a checklist.

b. to provide a means of documenting maintenance actions.

c. in place of inspection workcards.

d. for the assignment of and control of work while the aircraft is in the dock.

4. Maintenance work accomplished during an inspection is recorded on

a. the sequence chart and workcards.

b. inspection workcards.

c. a special tablet.

d. data collection forms.

5. Which of the items listed below would be used by the mechanic as a guide for performing a thorough inspection?

a. Sequence chart and data forms.

b. Workcards.

c. Data collection forms.

d. Technical chart.

Answers to Question Set IV

1. The answer is d. Workcards, sequence charts, AFTO Forms 349 and 350 are three examples of management tools. There are others. We described the three that are the most often used or initiated by maintenance personnel.

2. The answer is b. The workcards contain the minimum inspection requirements; they may also contain operating limits for some systems, tolerances, necessary adjustments, and lubrication charts.

3. The answer is d. The sequence chart is a time based flexible timetable. It shows the start time, elapsed time and work area for each job. Therefore, the sequence chart provides a graphic picture of how the inspection is progressing.

4. The answer is d. Maintenance work is recorded on data collection Forms 349 and 350. These forms are only two examples of maintenance data collection forms. Start and completion times may be noted on a sequence chart, if it is used.

5. The answer is b. Inspection workcards serve as a guide to perform an inspection. The cards contain, in some cases, many specifics or detailed information to help the mechanic. Should the mechanic require still more information he can always go to the basic technical order from which the workcards were extracted.

Checklists may also be extracted from the basic Tehnical Order. Checklists differ from workcards in that a checklist provides information that should be accomplished in certain *sequences*.

MAINTENANCE SYMBOLS

Symbols, or special characters, are used on maintenance forms to make important information instantly apparent and to save space on maintenance forms. We will study five of the more commonly used maintenance symbols. These symbols are explained in greater detail in TO 00-20-1 and TO 00-20-5. (Portions of these TOs are printed in ATCPT 52-1, Volume IV.)

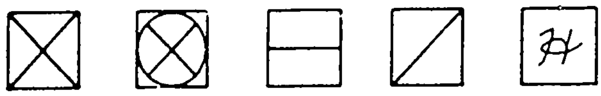


Figure 5. Maintenance Symbols. From left to right, red X, circled red X, red dash, red diagonal, and black last name initial.

In figure 5 you can see the five symbols we will discuss. Four are red in color and indicate that an unsatisfactory condition exists. The red X and circled red X are the most serious and indicate that the aircraft or equipment can not be used until the defect has been corrected.

Red X

The Red X symbol is the most serious and indicates that an aircraft or a piece of equipment is unsafe and may not be used. An aircraft is grounded or a piece of equipment is restricted from use until the unsafe condition has been cleared. A red X symbol is entered on the maintenance forms for the following conditions:

- A major discrepancy.
- A safety of flight condition. (Work being done on a critical part of the aircraft.)
- A piece of equipment is unsafe or unfit for use.
- Upon receipt of an immediate action technical order.

After a red X condition is corrected, it must be inspected by a qualified inspector who will then clear the symbol by placing his last name initial over it and writing his minimum signature in the "Inspected by" block.

Circled Red X

The Circled Red X symbol is used *only* for Urgent Action Time Compliance Technical Orders (TCTO). It is the second most serious symbol and is used to ground the aircraft (aircraft is not allowed to fly) when work has begun on, or the time limit has expired on an Urgent Action Time Compliance Technical Order. An example of a TCTO can be seen in Volume V of ATCPT 52-1, *Reference Materials.* A circled red X condition must also be signed off by a qualified inspector. After the defect has been corrected the inspector places his last name initial over the symbol and signs the form in the "Inspected by" block (see figure 6). He will use the *minimum* signature, that is, first name initial and last name.

Red Dash

The Red Dash symbol is the third symbol. It indicates the condition of the equipment is unknown (a *scheduled* inspection is due or overdue on an aircraft or piece of equipment). A red dash also indicates that an accessory replacement, operational checkout, special inspection, or functional check flight, although due, has not been completed.

Red Diagonal

The Red Diagonal symbol is the least serious of the red symbols. It indicates that an unsatisfactory condition exists, but is not serious or dangerous enough to prevent using the aircraft or equipment. A red diagonal symbol is entered on the maintenance forms to indicate a minor discrepancy. The red dash and red diagonal symbols can be signed off by the mechanic who corrects the defect.

Black Last Name Initial

The last symbol shown in figure 5 is the "Black Last Name Initial." This symbol when entered in the aircraft maintenance forms *by itself* indicates that the aircraft or equipment has no discrepancies. When it is entered over a red symbol it indicates that the person whose name appears in the "Corrected by" block has accomplished the required maintenance or inspected the equipment or system and finds its condition satisfactory, which clears the symbol.

Other Red Symbols

The red letters N, B, and C inside a red circle indicate that the aircraft may be contaminated with a nuclear, biological, or chemical agent.

N (Nuclear)

B (Biological)

C (Chemical)

Question Set V

Select the correct response for each of the following questions and record your answer in the appropriate section of your Student Response Booklet, Volume V. Verify you responses with the answers at the end of this question set.

1. The purpose of maintenance symbols is to

a. save space on maintenance forms.

b. make important information instantly apparent.

c. indicate the status and condition of equipment.

d. all of the above.

2. Two screws not tightened in the cockpit area. They do not affect the flight of the aircraft. The symbol used on the aircraft maintenance forms would be the

a. red X.

b. red diagonal.

c. circled red X.

d. black last name initial.

3. Work has begun on an Urgent Action Time Compliance Technical Order. The symbol used on the aircraft maintenance forms would be a

a. red X.

b. circled red X.

c. red diagonal.

d. in black ink.

4. A qualified inspector has inspected and cleared a major discrepancy. How would he indicate that the defect had been inspected and cleared?

a. He would enter a red X on the forms.

b. He would enter a red dash on the forms.

c. He would enter a red diagonal on the forms.

d. He would place his last name initial over the symbol and sign the "Inspected by" block.

5. The symbol that is used to show that an aircraft is completely free of discrepancies is a

a. red X.

b. red diagonal.

c. red dash.

d. black last name initial.

Answers to Question Set V

1. The answer is d. The purpose of maintenance symbols is to save space on maintenance forms, make important information instantly apparent and indicate status and condition of equipment.

2. The answer is b. If the safety of flight is in no way affected then the symbol, a red diagonal, is used to indicate the least serious condition.

3. The answer is b. A circled red X is entered on the aircraft forms when work is being accomplished on an urgent action TCTO.

4. The answer is d. A major discrepancy indicates a red X or a circled red X condition. The inspector, and he must be a qualified inspector authorized to sign off major discrepancies, would place his last name initial over the symbol and sign the "Inspected by" block.

5. The answer is d. The black last name initial when entered *by itself* indicates that the aircraft is free of discrepancies.

ABBREVIATIONS

The use of abbreviations in Air Force communications should be kept to a minimum. However, experience has shown that the use of certain abbreviations can be useful. They save space on maintenance forms and they reduce the typing and printing chores. Also, some of the abbreviations have been used so long that they are more familiar in maintenance jargon than the terms for which they stand. Therefore, you should learn some of the abbreviations that are used frequently. You will be introduced to a few of these abbreviations in the following exercise.

Exercise I

Using Volume IV of ATCPT 52-1, *Reference Materials*, turn to TO 00-20-1 and write the authorized abbreviations for the terms listed below in the appropriate section of your Student Response Booklet, Volume V. Do not write in this volume II. Note that the abbreviations are printed in capital letters. Lower case letters are not authorized.

1. Time Compliance Technical Order ____________
2. Minor Inspection ____________
3. Major Inspection ____________
4. Home Station Check ____________
5. Basic Postflight ____________
6. Preflight ____________
7. Thruflight ____________
8. Not Applicable ____________
9. Periodic ____________
10. Complied With ____________
11. Carried Forward ____________
12. Previously Complied With ____________
13. Not Complied With ____________
14. Not Reparable This Station ____________
15. Technical Order ____________

Answers to Exercise I

1. Time Compliance Technical Order	**TCTO**
2. Minor Inspection	**MIN**
3. Major Inspection	**MAJ**
4. Home Station Check	**HSC**
5. Basic Postflight	**BPO**
6. Preflight	**PR**
7. Thruflight	**TH**
8. Not Applicable	**NA**
9. Periodic	**PE**
10. Complied With	**CW**
11. Carried Forward	**CF**
12. Previously Complied With	**PCW**
13. Not Complied With	**NCW**
14. Not Reparable This Station	**NRTS**
15. Technical Order	**TO**

Question Set VI

Select the correct response to the following question and record your answer in the appropriate section of your Student Response Booklet, Volume V. Verify your response with the answer at the end of this question set.

1. TO 00-20-1 states that the entries on maintenance records will preferably be

a. in ink.

b. in pencil.

c. in pencil but an occasional pen-and-ink entry is acceptable.

d. entered in red.

Answers to Question Set VI

1. The answer is c. (ATCPT 52-1, Volume IV)

AFTO 781 SERIES FORMS

A set of 781 series forms, *Aircraft Flight Report and Maintenance Records,* is maintained for each aircraft in the Air Force inventory. These forms are maintained in a looseleaf binder that is kept in the aircraft.

The 781 series forms have gone through many changes and revisions. This is understandable, since the purpose is to design a set of forms that will present a "clear picture" of the status and condition of the aircraft.

Entries are made by several different persons in varying capacities. The flight crew, crew chief, mechanics and specialists are all authorized to make entries on one or more of the 781 series forms.

The crew chief or his alternate will ensure that enough copies of the AFTO Forms 781 are aboard the aircraft. The aircraft commander will ensure that the forms properly reflect pertinent flight data and the flying time for all personnel who are authorized to participate in the flight.

The AFTO Form 781 series of aircraft records consists of the following forms:

- AFTO Form 781F, *Aerospace Vehicle Flight Report and Maintenance Document.*
- AFTO Form 781, *Aerospace Flight Data Document.*
- AFTO Form 781H, *Aerospace Vehicle Flight Status and Maintenance Document.*
- AFTO Form 781A, *Maintenance Discrepancy and Work Document.*
- AFTO Form 781J, *Aerospace Vehicle-Engine Flight Document.*
- AFTO Form 781K, *Aerospace Vehicle Inspection, Engine Data, Calendar Item Inspection and Delayed Discrepancy Document.*
- AFTO Form 781C, *Avionics Configuration and Load Status Document.*
- AFTO Form 781D, *Calendar and Hourly Item Inspection Document.*
- AFTO Form 781E, *Accessory Replacement Document.*
- AFTO Form 781M, *Status Symbols and Functional System Codes.*
- AFTO Form 781G, *General Mission Classifications—Mission Symbols.*

ENTRIES ON THE AFTO FORM 781A

The AFTO Form 781A is used to document each discrepancy discovered by the pilot or maintenance personnel. As stated previously, the crew chief or his alternate will be responsible for ensuring that enough copies of the AFTO Form 781A are available for the entire mission. Also, he will remove forms from the binder, transcribe open writeups to a new AFTO Form 781A and forward the removed forms to the maintenance officer. After review by the maintenance supervisor the AFTO Form 781A will be forwarded to the documentation activity for filing.

If you are assigned to a maintenance organization, sometime during your career you will have to accomplish most of the 781 series forms. As a three level you should be able to make entries on the 781A which has to do with maintenance discrepancies and work. (You might have known if there was any work to be done they would have you there.)

The AFTO Form 781A is basically a simple form and almost self-explanatory. However, some information is necessary since this is

PAGE 1 OF 1 PAGES

DATE FROM 01/05/7 TO 02/05/7 | CREW CHIEF M.GRIFFIN SSgt | ORGN 60th MAW | LOCATION TRAVIS AFB, CA | MDS C-141A | SERIAL NO. 61-0164

SYM X | DATE DISCO 01/05/7 | WOC D | JCN 1210021 | TAG NO | CF TO 781A P I DATED / / | TRANSFERRED TO 781K DATE / / | TRANSFERRED BY

DISCREPANCY
FLT No. 1, No. 1 THROTTLE OUT OF ALIGNMENT

CORRECTIVE ACTION
THROTTLE LINKAGE ADJUSTED. OPERATIONAL CHECKED OK.

DATE CORRECTED 01/05/7

ON | DISCOVERED BY | CORRECTED BY J. Ray Sgt. R2125 | INSPECTED BY

SYM D | DATE DISCO 01/05/7 | WOC D | JCN 1210022 | TAG NO 857692 | CF TO 781A P I DATED / / | TRANSFERRED TO 781K DATE / / | TRANSFERRED BY

DISCREPANCY
FLT No. 1 PILOTS MIKE BUTTON STICKS

CORRECTIVE ACTION
REMOVED AND REPLACED PILOTS MIKE BUTTON. OPERATIONAL CHECKED OK.

DATE CORRECTED 01/05/7

ON X103FL71210135 | DISCOVERED BY | CORRECTED BY P. Dunn Sgt. D1113 | INSPECTED BY

SYM X | DATE DISCO 01/05/7 | WOC D | JCN 1210023 | TAG NO 857697 | CF TO 781A P I DATED / / | TRANSFERRED TO 781K DATE / / | TRANSFERRED BY

DISCREPANCY
FLT No. 1 LOST FUEL FLOW No. 1 ENGINE T.O. PLUS 1 HR. ALL OTHER INSTRUMENTS NORMAL

CORRECTIVE ACTION
REMOVED AND REPLACED No. 1 ENGINE FUEL FLOW TRANSMITTER SYSTEM CHECKED OK. IAW TO 1C-141A-2-4

DATE CORRECTED 01/05/7

ON X103FL71210188 | DISCOVERED BY B. Jones Capt. | CORRECTED BY C. Kay SSgt. K4152 | INSPECTED BY A. Smith MSgt.

SYM | DATE DISCO / / | WOC | JCN | TAG NO | CF TO 781A P I DATED / / | TRANSFERRED TO 781K DATE / / | TRANSFERRED BY

DISCREPANCY

CORRECTIVE ACTION

DATE CORRECTED / /

ON | DISCOVERED BY | CORRECTED BY | INSPECTED BY

AFTO FORM MAY 73 781A MAINTENANCE DISCREPANCY AND WORK DOCUMENT PREVIOUS EDITION IS OBSOLETE

Figure 6

your first introduction to this form. The information that follows has been condensed from TO 00-20-5. It is meant to supply sufficient information to complete this text and is not complete in all details. Always remember to check the latest 00-20-5 and related technical orders when using this form in an actual maintenance situation. Refer to figure 6 as you read the following information.

Page ____ of ____ Pages. Enter the page number. *Example:* page 1 of 3 pages. The front and back of the form will be considered as separate pages and will be numbered accordingly.

Date. Enter the dates to indicate the elapsed period covered by the form. *Example:* from 01/05/7 to 02/05/7. The "FROM" date on a new form will be the same as the "TO" date on the closed out form.

Crew Chief. Enter the first name initial, last name, and grade of the assigned crew chief. *Example:* M. Griffin, SSgt.

Orgn Enter the organization to which the aerospace vehicle is assigned. *Example:* 60th MAW.

Location. Enter the base where the organization is located. *Example:* Travis AFB, California. Overseas organizations will enter their APO number in this block.

MDS. Enter the aerospace vehicle mission, design, and series designator. *Example:* C-141A.

Serial No. Enter the aerospace vehicle serial number. *Example:* 61-0164.

Sym Block. Enter the proper symbol for each discrepancy (red X, red dash, etc.). When a discrepancy is corrected, an initial will be placed over the symbol. Red dash and red diagonal symbols will be initialed over by the individual who performs the corrective action. If the defect carried a red X or circled red X symbol, *the corrective action must be inspected and signed off by an inspector or supervisor designated to clear red X symbols.* Specific instructions for clearing red X symbols are contained in TO 00-20-1.

NOTE: Never erase a symbol entered in error. If a symbol is entered in error, make the following applicable statement in the corrective action block: "Symbol entered in error, discrepancy and correct symbol entered below," or "Symbol entered in error, no discrepancy exists." Then sign the "Corrected by" block and initial over the erroneous symbol. If the erroneous symbol is a red X, the erroneous symbol must be verified by an individual authorized to clear red X symbols.

Date Disc WDC, JCN, Tag No., Discrepancy and DN. The person entering the defect will print the date discovered, when discovered code, and a description of the defect. If a pilot makes the entry, he will enter the number of his flight on the first vacant line in the discrepancy block. *Example:* Flt No. 1. The crew chief will enter the job control number (when assigned) and the supply document number if parts are ordered.

Only one discrepancy will be entered for each discrepancy block. However, as many discrepancy blocks as necessary may be used to complete a single discrepancy.

The pilot or aircrew member will enter their signature and grade in the "DISCOVERED BY" block of his last entry. Maintenance personnel will enter their signature and grade in the "DISCOVERED BY" block for each discrepancy they enter.

When a part is returned to supply or routed through the Reparable Processing Center (RPC) the individual removing the item will enter the tag number of the AFTO Form 350 (Reparable Item Processing Tag) in the appropriate block.

Corrected Action. When a defect is corrected, a brief description of the corrective action will be documented in the "Corrective Action" block and the date will be entered in the "DATE CORRECTED" block.

CF to 781A, Transferred to 781K, Transferred By. When a new AFTO Form 781A is initiated, any uncorrected discrepancies may be transferred to the new form and the page number, item number, and date of the new form entered in the "CF TO 781A" block. The signature of the person who carried the entry forward is placed in the "TRANSFERRED BY" block. If red X or circled red X discrepancies are not involved, the discrepancy may be transferred to the AFTO Form 781K after which the date of transfer is entered in the

"TRANSFERRED TO 781K" block, and the minimum signature and grade of the person making the transfer is entered in the "TRANSFERRED BY" block.

An initial will not be placed over the symbol for discrepancies that are carried forward or transferred to another form.

Exercise II

Use the following information to make entries in the AFTO Form 781A shown in Exercise II of your Student Response Booklet, Volume V. Verify your work with the Answer to Exercise II shown on the next even number page (figure 8).

A1C H. Jones found a red diagonal condition consisting of an oil leak at the oil cooler inlet tube on number one engine on 1 July 1977.

Using the following information make the necessary entries on the 781A in the Student Response Booklet to clear the discrepancy.

The required symbol is a red diagonal.

The When Discovered Code (WDC) is "F."

The Job Control Number (JCN) is 1830066.

The discrepancy was corrected by replacing an "O" ring seal and the pressure check was O.K.

The discrepancy was corrected by Sgt E. Ward, Employee Number W0153 on the same day it was discoverd (1 July 1977).

Do *not* make entries in the AFTO Form 781A shown in figure 7. Use the AFTO Form 781A in Student Response Booklet, Volume V, which is identical.

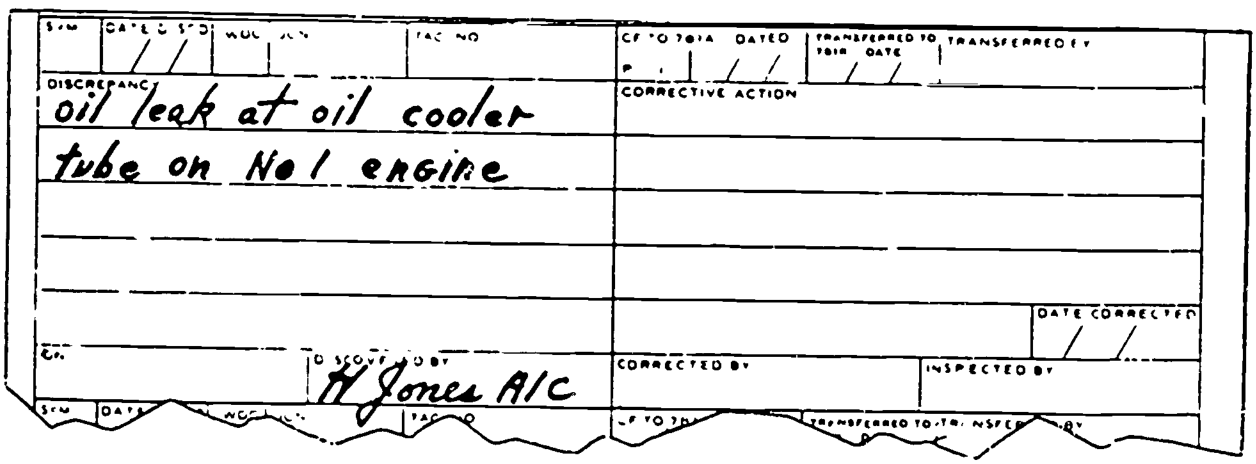

DISCREPANCY
oil leak at oil cooler
tube on No 1 engine
CORRECTIVE ACTION
DATE CORRECTED
CORRECTED BY
INSPECTED BY
H Jones A1C

Figure 7

Exercise III

Use the following information to make entries in the AFTO Form 781A shown in Exercise III of your Student Response Booklet, Volume V. Verify your work with the Answer to Exercise III shown on the next even numbered page (figure 10).

On 28 January 1977, 1st Lt V. Bock discovered the exhaust gas temperature (EGT) fluctuated intermittently on number one engine.

Use the following information; make the necessary entries on the 781A in the Student Response Booklet to clear the discrepancy.

The required symbol is a red diagonal.

The When Discovered Code (WDC) is "D."

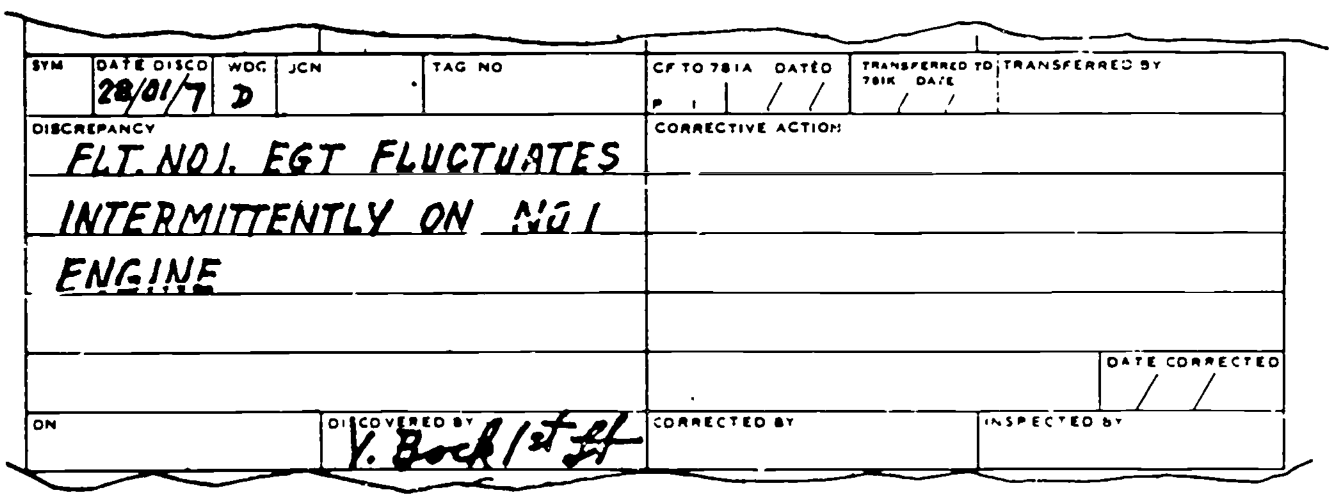
The Job Control Number (JCN) is 0280081.

The Document Number (DN) is X103FL70280125.

The discrepancy was corrected by replacing the thermocouple harness. An operational check proved the system was O.K.

You did the corrective work.

Do *not* make entries in the AFTO Form 781A shown in figure 9. Use the AFTO Form 781A in Student Response Booklet, Volume V. The two forms are identical



SYM	DATE DISCO	WDC	JCN	TAG NO	CF TO 781A DATED	TRANSFERRED TO 781K DATE	TRANSFERRED BY
	28/01/7	D			P / /	/ /	

DISCREPANCY
FLT. NO 1. EGT FLUCTUATES INTERMITTENTLY ON NO 1 ENGINE

CORRECTIVE ACTION

DATE CORRECTED / /

ON

DISCOVERED BY V. Bock / 1st Lt

CORRECTED BY

INSPECTED BY

Figure 9

SYM	DATE DISCOVERED	WUC	JCN	IAC NO	CF TO 781A DATED	TRANSFERRED TO 781K DATE	TRANSFERRED BY
W	01/07/7	F	1820066		P / /	/ /	

DISCREPANCY	CORRECTIVE ACTION
OIL LEAK AT OIL COOLER	REPLACED "O" RING SEAL.
TUBE ON No. 1 ENGINE	PRESSURE CHECKED OK.
	DATE CORRECTED 01/07/7

ON	DISCOVERED BY	CORRECTED BY	INSPECTED BY
	H. Jones A1C	E. Ward Sgt. W0153	

Figure 8

Student's last name initial should be entered over the symbol

SYM	DATE DISCOVERED	WUC	JCN	IAC NO	CF TO 781A DATED	TRANSFERRED TO 781K DATE	TRANSFERRED BY
S	28/01/7	D	0280081		P / /	/ /	

DISCREPANCY	CORRECTIVE ACTION
FLT No. 1 EGT FLUCTUATES	THERMOCOUPLE HARNESS
INTERMITTENTLY ON No. 1	REPLACED. OPERATIONAL
ENGINE	CHECK OK.
	DATE CORRECTED 28/01/7

ON	DISCOVERED BY	CORRECTED BY	INSPECTED BY
X103FL70280125	V. Bock 1st Lt.	B. Student Sgt. S8000	

Student's first name initial, last name, grade, last name initial and last four digits of social security number should be here

Figure 10

Exercise IV

Use the following information to make entries in the AFTO Form 781A shown in Exercise IV of your Student Response Booklet, Volume V. Verify your work with the Answer to Exercise IV shown on the next even numbered page (figure 12).

During a flight on 23 June 1977, Capt K. Deniston, who was flying copilot, was very annoyed because the microphone button kept sticking. He entered this defect on the AFTO Form 781A.

Using the following information make the necessary entries on the 781A in the Student Response Booklet to clear the discrepancy.

The required symbol is a red diagonal.

The When Discovered Code (WDC) is "D."

The Job Control Number (JCN) is 1740041.

The Document Number (DN) is X103FL71740135.

The discrepancy was corrected by replacing the copilot's mike switch.

You did the corrective work on the same day that the defect was found.

Do *not* make entries on the AFTO Form 781A shown in figure 11. Use the AFTO Form 781A in the Student Response Booklet, Volume V. The two forms are identical.

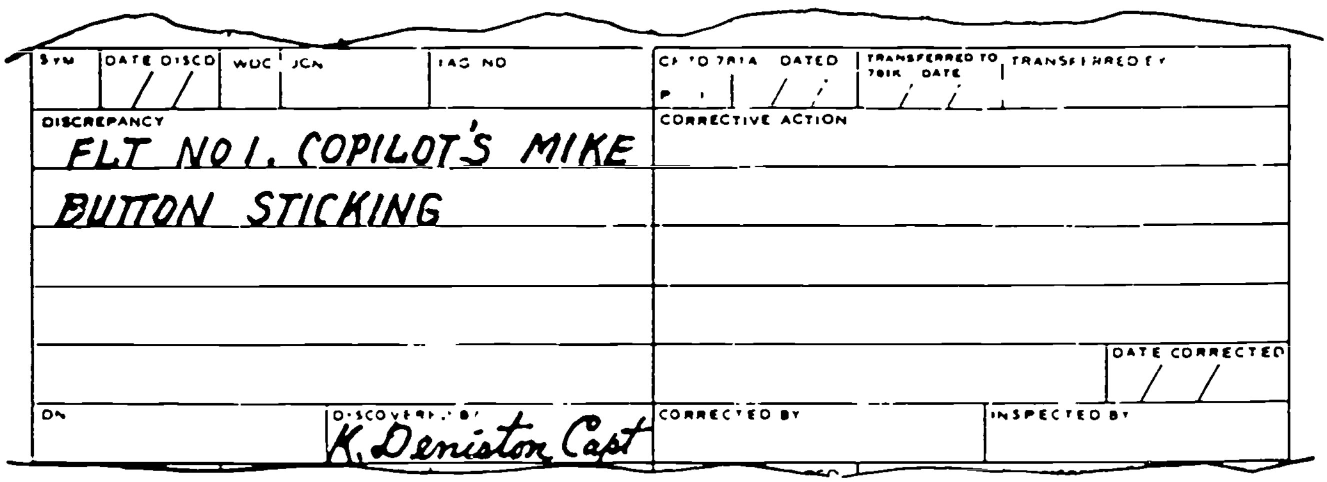
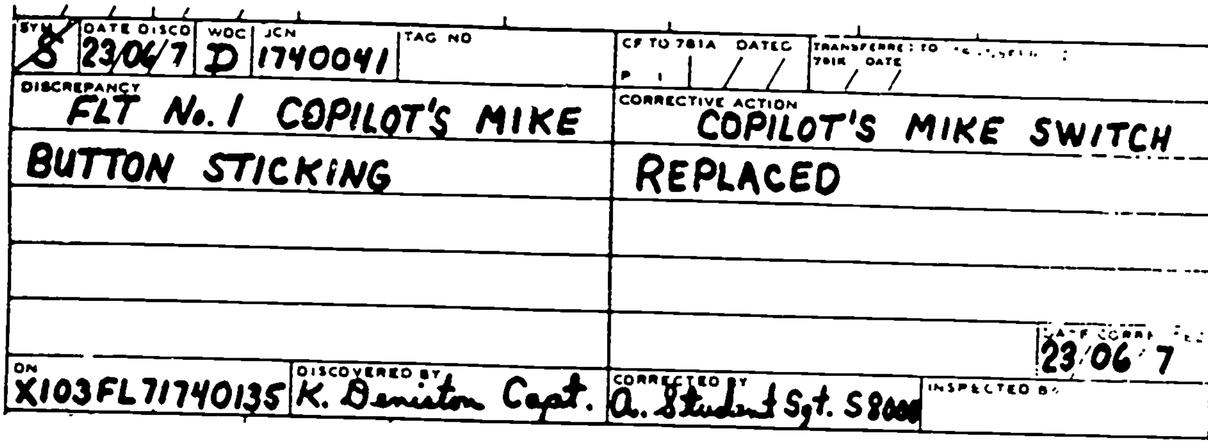

SYM
DATE DISCD
WDC
JCN
TAG NO
DATED
TRANSFERRED TO 781K DATE
DISCREPANCY
FLT NO 1. COPILOT'S MIKE BUTTON STICKING
CORRECTIVE ACTION
DATE CORRECTED
DN
DISCOVERED BY
K. Deniston Capt
CORRECTED BY
INSPECTED BY

Figure 11

Student's last name initial should be entered over the symbol



SYM: S | DATE DISCD: 23/06/7 | WDC: D | JCN: 1740041 | TAG NO | CF TO 781A | DATE | TRANSFERRED TO 781K DATE

DISCREPANCY: FLT No. 1 COPILOT'S MIKE BUTTON STICKING

CORRECTIVE ACTION: COPILOT'S MIKE SWITCH REPLACED

DATE CORRECTED: 23 06 7

ON: X103FL71740135 | DISCOVERED BY: K. Deniston Capt. | CORRECTED BY: A. Student Sgt. S8000 | INSPECTED BY

Student's first name initial, last name, grade, last name initial and last four digits of social security number should be here

Figure 12

Question Set VII

Select the correct response for each of the following questions and record your answer in the appropriate section of your Student Response Booklet, Volume V. Verify your responses with the answers at the end of this question set.

1. The aircraft flight and maintenance record is recorded on

a. sequence charts.

b. AFTO Form 349.

c. AFTO 781 series forms.

d. workcards.

2. Which of the following names, if written, would be a minimum signature?

a. Kenneth Deniston.

b. Edward Wojick.

c. Ralph W. Hayes.

d. R. Hayes, MSgt.

3. Which of the following statements concerning the AFTO 781 series forms are true?

a. They are kept in a looseleaf binder.

b. They are kept in the aircraft.

c. A set is maintained for each aircraft.

d. All of the above statements are true.

4. The "Maintenance Discrepancy and Work Document," in which discrepancies and the work that is done to correct the discrepancies is documented, is the AFTO Form.

a. 349.

b. 350.

c. 781A.

d. 781H.

5. To find current information concerning the 781 series forms always refer to the latest

a. AFM 66-1.

b. 00-20 series TOs.

c. TO 00-5-1.

d. 00-35 series TOs.

6. If you enter a red symbol in error on the AFTO Forms 781A, the correct thing to do is to

a. erase the symbol.

b. write in the "Corrected Action" block, "Symbol entered in error, discrepancy and correct symbol reentered below" or "Symbol entered in error no discrepancy exists."

c. sign the "Corrected by" block and initial over the symbol.

d. both b and c are correct.

Answers to Question Set VII

1. The answer is c, AFTO 781 series forms. The sequence chart and workcards are used in the inspection system. The 349 is used to record discrepancies found during inspection.

2. The answer is d. The first name initial and the last name spelled out followed by your rank is considered the minimum signature for use on the 781 maintenance forms.

3. All answers are true. A set of 781 series forms must be maintained for each aircraft, they are kept in the aircraft in a looseleaf binder. Some individual forms may not be used on every aircraft because of mission requirements but a set of 781 forms must be maintained on each aircraft. Answer d is the most complete answer.

4. The answer is c. The 781A, *Maintenance Discrepancy Work Document*, is used to record discrepancies and the corrective actions necessary to clear the discrepancy. The 781H is used to record maintenance status and servicing information.

5. The answer is b. Specifically, TO 00-20-5 Most of the material for this text was taken from this TO.

6. The answer is d. TO 00-20-1 states that a red symbol will never be erased and directs that the procedure be followed as given in b and c unless the symbol is a red X or circled red X in which case an inspector must sign off and initial over the symbol.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-205
4 January 1980

TURBOPROP ENGINE STARTER AND IGNITION SYSTEMS

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to explain the purpose, operation, and arrangement of the engine starter and ignition systems.

INTRODUCTION

Like the automobile engine, the aircraft engine has a starter and ignition system. The air turbine starter is geared to the engine to rotate the engine compressor during the starting cycle. The starter can be operated with compressed air supplied from the gas turbine compressor (GTC), another operating engine on the aircraft, or an external source of air. Once the engine is energized and supplied with a fuel-air mixture, ignition is necessary. The ignition system ignites the fuel-air mixture in the combustion chambers and shuts off automatically when the engine accelerates to a predetermined speed (RPM).

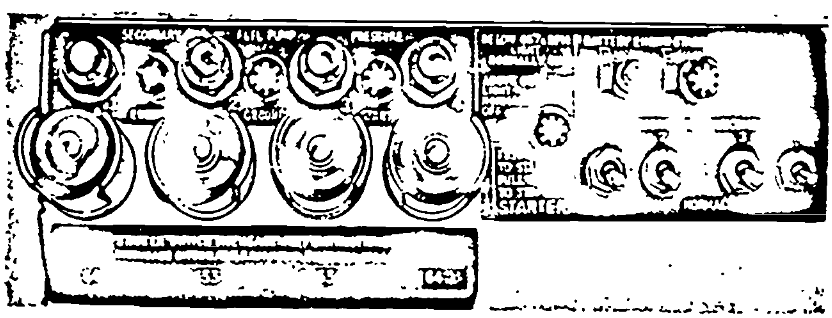


Figure 1. Engine Start Panel.

INFORMATION

STARTER SYSTEM

Starter Switches

The engine ground start switches (see figure 1) are located on the engine starting panel on the overhead control panel. Each switch is used to open the starter control valve to permit operation of the starter. The switch button is pushed in manually, then a holding coil holds the button in. At the same time, the starter control valve is energized open. A red light in the button glows as long as the button is held in. When the engine accelerates to a preset speed, the centrifugal cutout switch in the starter is actuated open to

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cause the starter control valve to close and the starter switch (button) to be released, causing the light to go out. The button can be pulled manually at any time to discontinue starter operation.

Starter

Each engine is equipped with a pneumatic starting system. The starter (see figure 2) is designed to rotate the compressor fast enough to provide sufficient air to support combustion and to cool the engine. The starter is geared to the engine through the reduction gear assembly and obtains air through the bleed air manifold. Air may be supplied to the bleed air manifold by the gas turbine compressor, another operating engine or an external air source (MA-1A).

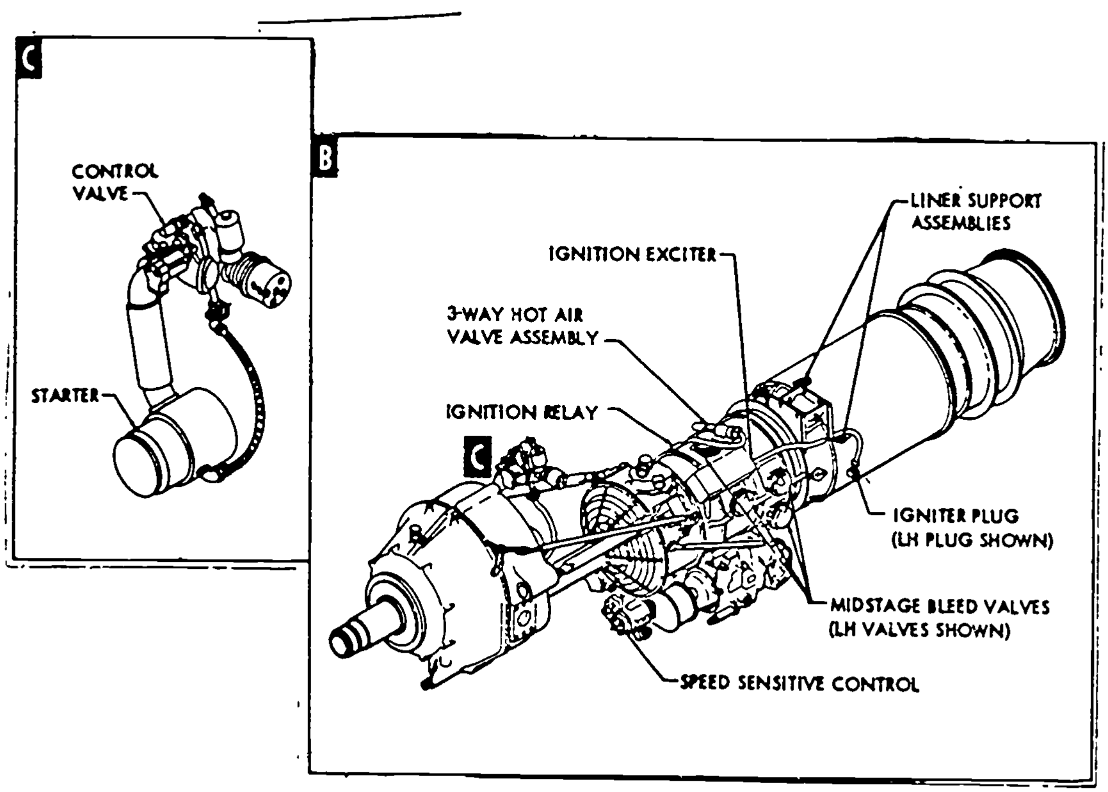

Figure 2. Engine Starting System Components Locations.

Starter Control Valve

The starter control valve controls the flow of bleed air to the starter (see figure 2). It is a combination air shutoff and regulator valve. This valve is located in the starter air inlet duct. This valve is energized open during the engine starting cycle and is deenergized closed automatically by the centrifugal cutout switch or manually by pulling the starter switch (button).

Three-Way Hot Air Valve Assembly

A three-way, solenoid-operated valve is provided to control the closing of the compressor midstage bleed valves. The valve is mounted to the top of the engine compressor section. It receives air pressure from the compressor's 14th stage. The solenoid is energized during the engine starting cycle to close the three-way hot air valve. This cuts off the supply of air from the 14th stage and permits the midstage valve to open (see figure 2).

IGNITION SYSTEM

The purpose of the ignition system is to supply a current which fires the spark igniters in the combustion chambers. Ignition occurs automatically during the starting cycle and continues until the engine is turning fast enough to sustain combustion of the fuel. The ignition system is a high voltage, condenser-discharge type. Units of the system consist of an ignition relay, a speed sensitive control, an ignition exciter, and two spark igniters (see figure 2).

Ignition Relay

The ignition relay is a normally open relay mounted on the upper compressor housing. It is energized by the speed sensitive control during the starting cycle when the engine reaches 16% rpm. It is deenergized by the speed sensitive control when the engine reaches 65% rpm. When energized, it completes circuits to the ignition exciter, which fires the spark igniters; to the fuel manifold drain valve solenoid, which closes the drain valve; to the paralleling valve, which parallels the fuel pumps; and to the fuel enrichment relay, which energizes the fuel enrichment valve solenoid (providing the fuel enrichment switch on the engine start panel is in the normal position). When deenergized, the ignition relay breaks these circuits and they return to their deenergized condition (see figure 2).

Igniter Exciter

The ignition exciter receives 28-volts DC from the ignition relay and steps it up to high voltage required by the spark igniters to ignite the fuel air mixture during the engine start cycle (see figure 2).

Spark Igniters

The engine uses only two spark igniters. They are located in combustion chambers two and five. Flame is supplied to the four other chambers by crossover tubes (see figure 2).

SUMMARY

Compressed air causes the starter to rotate the compressor rotor bringing air into the engine. The engine-driven fuel pump sends fuel under pressure to the manifold. At a predetermined speed, the drip valve closes and fuel enters the combustion chambers. At this same instant, the ignition relay closes and the spark ignites the fuel-air mixture in the combustion chambers; the mass expands and turns the turbine wheels on its way out of the engine. The energy derived from the hot gases rotating the turbine wheels assists the starter in turning the compressor rotor faster. At a predetermined engine speed, the starter and ignition systems are cut off by the engine speed sensing control and the engine is started.

QUESTIONS

1. What is the indication when the engine ground start switches are energized?

2. Where is the pneumatic starter located?

3. What controls the bleed air to the pneumatic starter?

4. Where does the pneumatic starter obtain its air source?

5. What component completes the circuit to the igniter exciter?

6. Where are the spark igniters located?

7. How are the combustion chambers without igniter plugs fired?

8. Where is the ignition relay located?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-205
12 December 1980

TURBOPROP ENGINE STARTER AND IGNITION SYSTEMS

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Explain the purpose, operation, and arrangement of the starter system.

2. Explain the purpose, operation, and arrangement of the ignition system.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-4	1/student

PROCEDURE

Using TO 1C-130B-2-4 and the information presented in the classroom, fill in the spaces provided with the correct information.

Project 1. STARTER SYSTEM

1. The purpose of the starter system is to rotate the engine to a ___________-sustaining RPM.

2. The purpose of the starter control valve is to ______________ the pressure of the air flowing to the __________________.

3. The starter is mounted to the ____________ face of the reduction gearbox.

4. The starter _____________ automatically disengages the starter from the engine.

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DISTRIBUTION: X
3350 TCHTG/TTGU-J - 300; TTVSA - 1

RGL: N/A

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5. The starter duty cycle is ________ minute ON, ________ OFF, ________ minute ON, ________ minute OFF, ________ minute ON, ________ minutes OFF.

6. The oil quantity must be maintained at its normal level to prevent ________ to the starter.

7. The starting cycle is controlled by the ________ ________ panel.

8. At ________ percent the starter button is released.

Project 2. IGNITION SYSTEM

1. The purpose of the speed sensitive control is to ________ the fuel pumps and supply ________ to the engine.

2. At approximately ________ percent the ________ ________ control places the fuel pumps in ________ operation.

3. The ________ ________ supplies high voltage to the igniter plugs for ignition of engine fuel.

4. There are ________ leads that connect the ________ ________ to the ________ ________.

5. The ignition exciter is mounted on the ________ case ________ ________ side.

6. The igniter plugs are mounted in the ________ ________ case.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-207
4 January 1980

TURBOPROP COMPRESSOR BLEED SYSTEM

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to state the purpose, units, location, and operating principles of the T56 engine compressor bleed system.

INTRODUCTION

There are two types of bleed air systems used on C-130 aircraft. One is the pneumatic bleed air system which is used to supply air to the various systems on the aircraft that require an air supply. The other is the compressor bleed system used to prevent surges and stalls during acceleration of the engine. This system is sometimes referred to as the acceleration bleed system.

INFORMATION

PNEUMATIC BLEED AIR SYSTEMS

The engine bleed air system consists of high pressure ducts and valves which conduct compressed air to pneumatically operated systems of the aircraft.

Three different sources are provided for a supply of compressed air to the pneumatic systems. When any or all of the engines are running, the supply of bleed air is taken from the compressor diffuser section of the engine. When on the ground with the engines shut down, the supply may come from the onboard gas turbine compressor (GTC) or from an external source. A more detailed description can be found in TO 1C-130B-2-10, C-130B Utility Systems. The power plant related penumatically operated systems on the C-130 aircraft which use bleed air are:

1. Engine starting system
2. Nacelle preheat system
3. Engine air inlet and oil cooler scoop anti-icing system

COMPRESSOR STALLS

When designing a compressor, engineers must consider a condition known as a "compressor stall." A compressor stall occurs when the airflow through the compressor breaks down or is interrupted. A compressor surge is a stage of stall. The severity of a stall depends upon the area involved - whether one stage, several stages, or the entire compressor is involved.

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DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1
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During a stall, the rotor blades cannot move sufficient air rearward to support combustion. Stalls are most likely to occur during rapid acceleration, as during a start. Then, the amount of air needed is more than the compressor output. Extra fuel is added to accelerate the turbine. Should the fuel be added too rapidly, the pressure in the combustion chambers will exceed compressor discharge pressure, thus causing the air to reverse flow momentarily. If this flow reversal is momentary, a surge results, or if the reversal is prolonged, a stall will result. Failure to stop a surge or stall by retarding the throttle may severely damage an engine.

Several methods are in use which help prevent stalls and surges. On the T56 engine, compressor bleed valves are used. The use of these bleed valves allows the engine to accelerate more rapidly. These valves open above 16% engine rpm and remain open until 94% engine rpm, allowing a more stable airflow through the engine, which permits the addition of more fuel during acceleration. Since the T56 engine is a constant speed engine, once it reaches design speed (13,820 rpm), it is not subject to acceleration stalls.

COMPRESSOR BLEED SYSTEM

Acceleration bleed valves are installed on the 5th and 10th stages of the compressor. These valves unload excess air from the compressor during starting and acceleration and in this way help prevent compressor stalls.

The eight valves discharge the air into sheet metal collectors which duct the bleed air aft of the engine firewall. This hot bleed air is a fire hazard so it must be vented to a fireproof area. These bleed valves open above 16% rpm and close above 94% rpm. A speed sensitive valve, mounted on the front of the accessory case, controls the opening of the acceleration bleed valves. This speed sensitive valve is controlled by flyweights. Below 13,000 rpm, the top sides of the bleed valves are vented to atmosphere through the speed sensitive valve. Since atmospheric pressure is less than 5th and 10th stage air pressure, the greater pressure holds the valves open. Above 13,000 rpm, the flyweights will move the speed sensitive, closing the vent to atmosphere and opening the top sides of the bleed valves to 14th stage pressure. This 14th stage air is carried from the diffuser to the speed sensitive valve by an external line.

QUESTIONS

1. What are the two types of bleed air systems used on C-130 aircraft?

2. Where is bleed air taken from the engine to supply air to the aircraft pneumatic systems?

3. What is a compressor stall?

4. What is the difference between a stall and a surge?

5. What is used on the T56 engine to help prevent stalls?

6. What controls the opening of the compressor bleed valves?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-204
10 December 1980

TURBOPROP ENGINE RPM AND TORQUE INDICATING SYSTEMS

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. State the purpose, operation, and arrangement of the turboprop engine RPM system.

2. State the purpose, operation, and arrangement of the turboprop engine torque system.

EQUIPMENT

	Basis of Issue
TO 1C-130B-1	1/student

PROCEDURE

Using TO 1C-130B-1 and the information presented in the classroom presentation, fill in the spaces provided with the correct information.

Project 1. RPM INDICATING SYSTEM

1. The purpose of the RPM indicating systems is to provide the operator with an indication of _______________ RPM.

2. The _________ _______________ is mounted on the _____________ face of the reduction gearbox.

. The tachometer generator sends an electrical signal to the _________________ in the cockpit.

4. The tachometer indicator indicates engine RPM in _____________ maximum RPM.

5. The RPM indicating _______________ provides _______________ performance data.

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RGL: N/A

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Project 2. TORQUE INDICATING SYSTEM

1. The purpose of the torque indicating system is to provide the engine operator with an indication of ______________ being produced by each engine.

2. The ______________ pickup senses the torque shaft ______________ wheel teeth are out of phase with the ______________ shaft exciter wheel teeth.

3. The torquemeter ______________ receives the electrical signal from the torquemeter pickup in inch pounds.

4. The torquemeter pickup is mounted to the torquemeter ______________.

5. There are ______________ shafts in the torquemeter assembly.

6. The torque indicator is located on the __________ _____ _____ instrument panel.

STUDY GUIDE

3ABR42633-SG-201

Technical Training

Turboprop Propulsion Mechanic

TURBOPROP ENGINE OIL SYSTEM

3 January 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

Do Not Use on the Job.

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TURBOPROP ENGINE OIL SYSTEM

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to state the purpose, units, location, and operating principles of the T56 engine oil system.

INTRODUCTION

The purpose of the oil system is to cool, lubricate, and clean the oil wetted parts of the engine. The T56 engine oil system has parts located in the aircraft nacelle as well as on the engine. It is a dry sump type oil system with the oil tank being located in the aircraft nacelle.

INFORMATION

The T56 power section and reduction gear assembly have separate and independent oil systems which use a common airframe furnished oil tank. The power section contains an independent lubrication system with the exception of airframe furnished parts which are common to both the power section and reduction gear assembly.

PRESSURE OIL SYSTEM

Aircraft Mounted Major Units

Refer to figure 1 for the aircraft mounted major units. Although some of the items in figure 1 are not discussed in this study guide, study them so you will be able to identify them by their names.

OIL TANK. A stainless steel, nonself-sealing engine oil tank is located above the engine in the forward section of the nacelle. The tank is serviced through a scupper type filler, which has an overflow drain to direct excess oil overboard during servicing. A calibrated oil level bayonet gage is attached to the screw-type filler cap. Each oil tank has an oil capacity of 12 gallons, plus an additional 7.5 gallon air space, and provides for removal of air from the returned engine oil. The oil tank sump is located at the bottom of the tank. A drain valve in the bottom of the sump aids in draining the sump and engine oil tank.

OIL TANK PRESSURIZING VALVE. An engine oil tank pressurizing valve is used to pressurize the oil tank by controlling the flow of oil released air from the tank. The valve contains an air-operated poppet valve and a vacuum relief feature. The purpose of the oil tank pressurizing valve is to keep the oil in the tank under pressure to ensure a continuous flow of oil to the power section and gearbox. The oil tank pressurizing valve vents into the overboard drain.

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DISTRIBUTION: X
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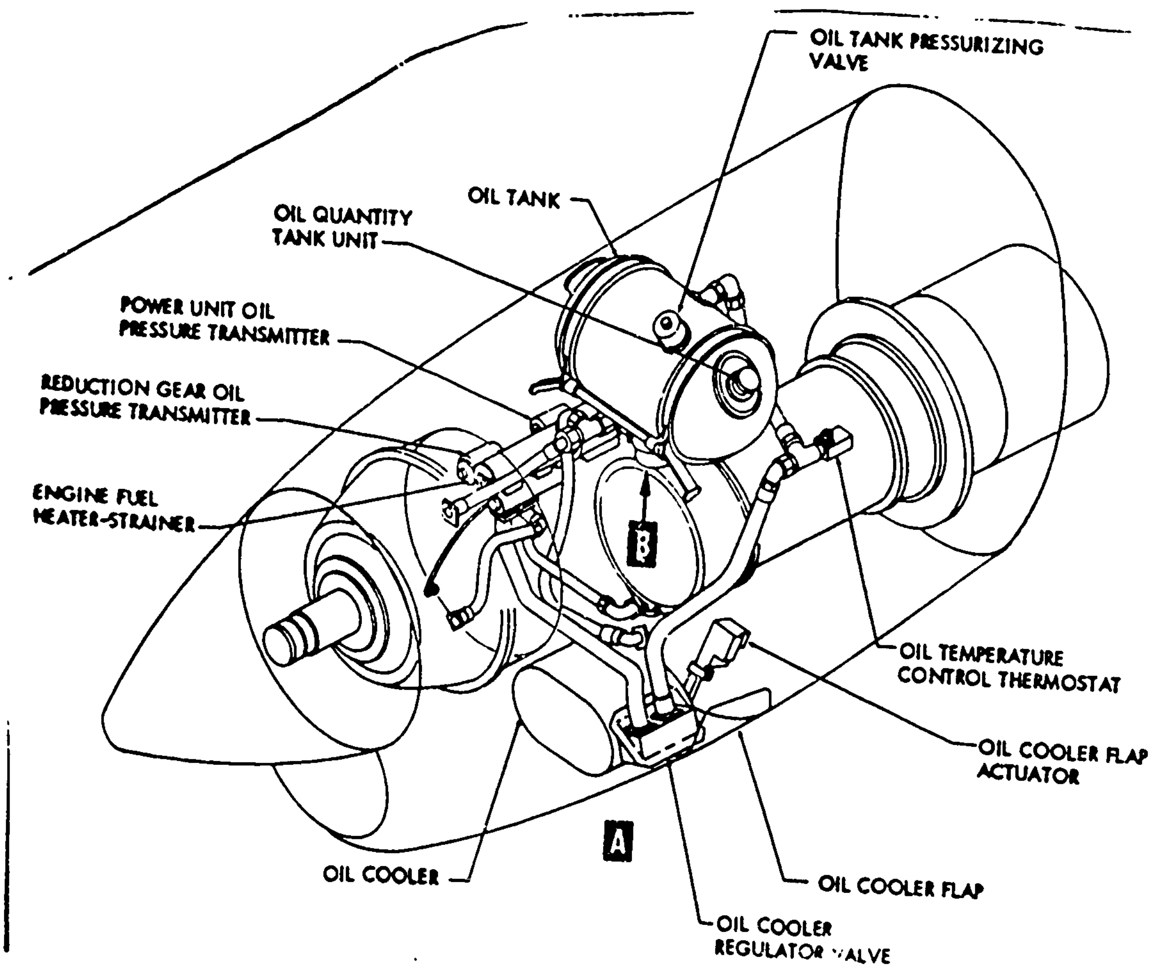

Figure 1. Engine Oil System Components Locations.

OIL SHUTOFF VALVE. A motor-operated oil tank sump gate type valve is attached to the oil sump. The valve is an energize-to-open, energize-to-close type with a manual override for servicing the valve. The open and closed positions are indicated on the valve. The valve receives power from the essential DC bus. Power passes through the normally closed contacts of the fire emergency handle to drive the oil shutoff valve motor and open the valve. When the fire emergency handle is pulled, power will drive the motor to close the oil shutoff valve.

OIL TEMPERATURE BULB. One resistance type oil temperature bulb is located in the engine oil tank outlet line on each of the four engines. The four oil temperature indicators on the engine instrument panel receive their power from the essential DC bus. One circuit breaker on the co-pilot's side circuit breaker panel protects each system.

ENGINE FUEL HEATER AND STRAINER. An engine fuel heater and strainer transfers engine oil heat to the fuel being supplied to the engine, to prevent icing of the fuel system parts. A thermostatically controlled bypass valve is located on the oil side of the heater core. It limits the temperature of the fuel to the engine by directing the oil supply either through or around the fuel heater.

OIL COOLER. The oil cooler is mounted in the lower portion of the engine nacelle and can be reached through the oil cooler access panel. The oil cooler radiator is elliptical in shape. It is made of aluminum alloy, a welded and braced shell assembly with a core equipped with tubes, heater plates and baffles which direct the flow of oil through the cooler, and a bypass jacket to serve as a warmup passage for the oil. The cooler has a bypass and cooler inlet port, a bypass outlet port, and a cooler outlet port. The cooling capacity of the oil cooler is governed by the flow of air through the core tubes. The flow is controlled by the position of the oil cooler flap. The oil cooler mounts the oil cooler regulator valve, which thermostatically regulates the temperature of the oil leaving the oil cooler and also provides high pressure surge protection of the cooler. The oil cooler drain can be reached by removing the oil cooler drain access cover. Two strap assemblies secure the oil cooler in position in the air duct.

OIL PRESSURE TRANSMITTER. Two oil pressure transmitters are located on each engine. A dual oil pressure indicator is located on the main instrument panel in the flight station to show transmitted pressures. One transmitter is connected to the reduction gear section of the engine and the other transmitter is connected to the power section.

Engine Mounted Major Units

Refer to figure 2 for the engine mounted major units of the oil system. Although some of the items in figure 2 are not discussed in this study guide, study them so you will be able to identify them by their names.

MAIN OIL PUMP. The main oil pump is mounted on the front of the accessory drive housing cover. The pressure element supplies all pressure oil to the power section and the scavenge element scavenges oil from the accessory drive housing. It is a two-element pump, (pressure element and scavenge element) driven by a common shaft. Both elements are spur gear type pumps with a capacity of 7 gallons per minute at 100% rpm.

PRESSURE REGULATING VALVE. The pressure regulating valve is located in the body of the main oil pump. Its purpose is to bypass oil from the filter outlet back to the pressure element inlet, and regulates filter outlet oil pressure to 50-60 psi. It is a poppet type valve which is always bypassing a certain amount of oil. It can be field adjusted to regulate filter outlet oil pressure to 50-60 psi.

OIL FILTER. The oil filter is housed in the cover of the accessory drive housing on the front right-hand side. The oil filter is an 11 wafer stack, 117 micron element. One micron is equal to .000039 millionths of an inch.

Reduction Gearbox Mounted Major Units

Refer to figure 3 for the reduction gearbox mounted major units. Although some of the items in figure 3 are not discussed in this study guide, study them so you will be able to identify them by their names.

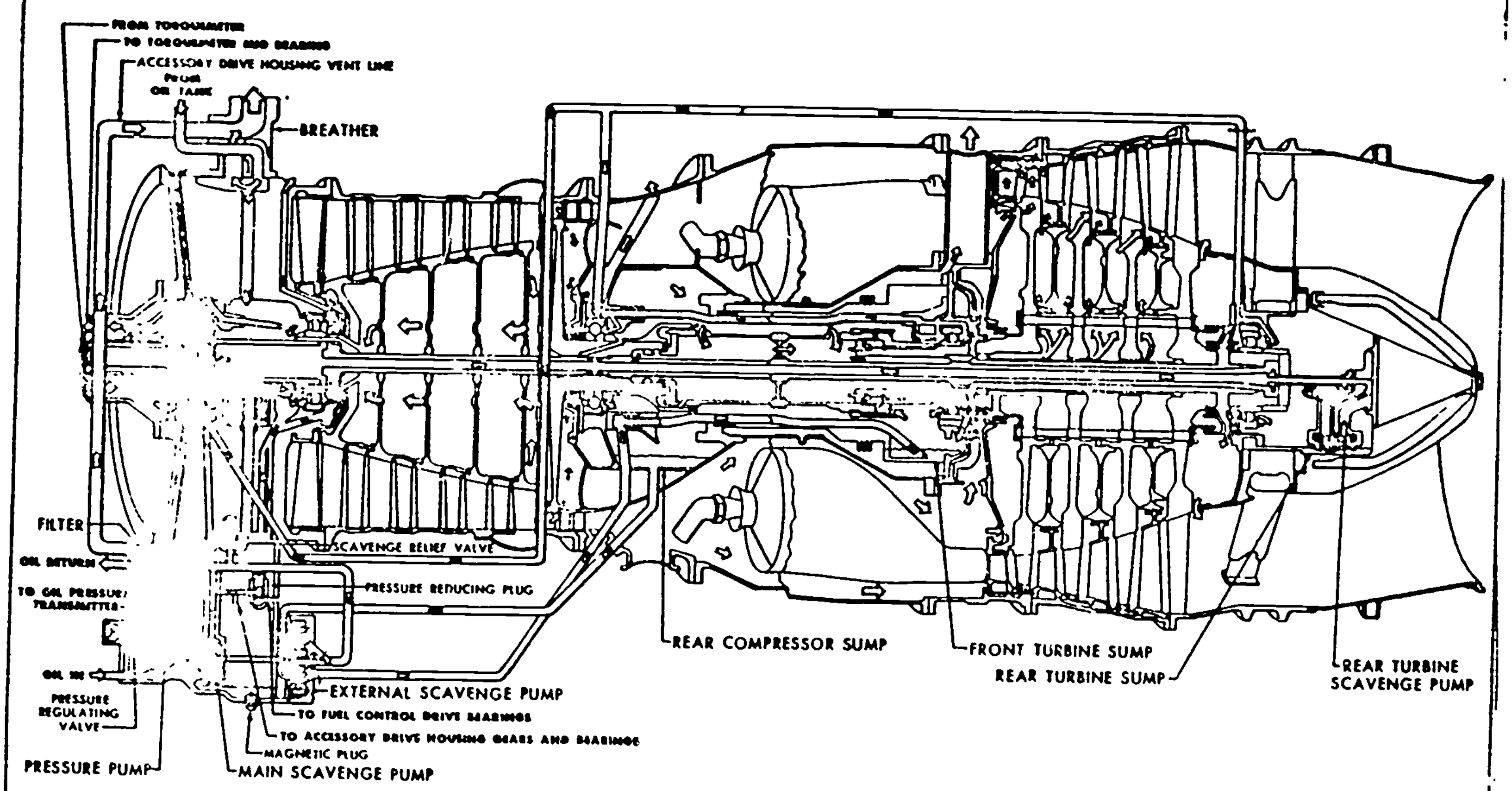

Figure 2. Power Section Oil System Schematic T-56 - A-7 and T56-A15.

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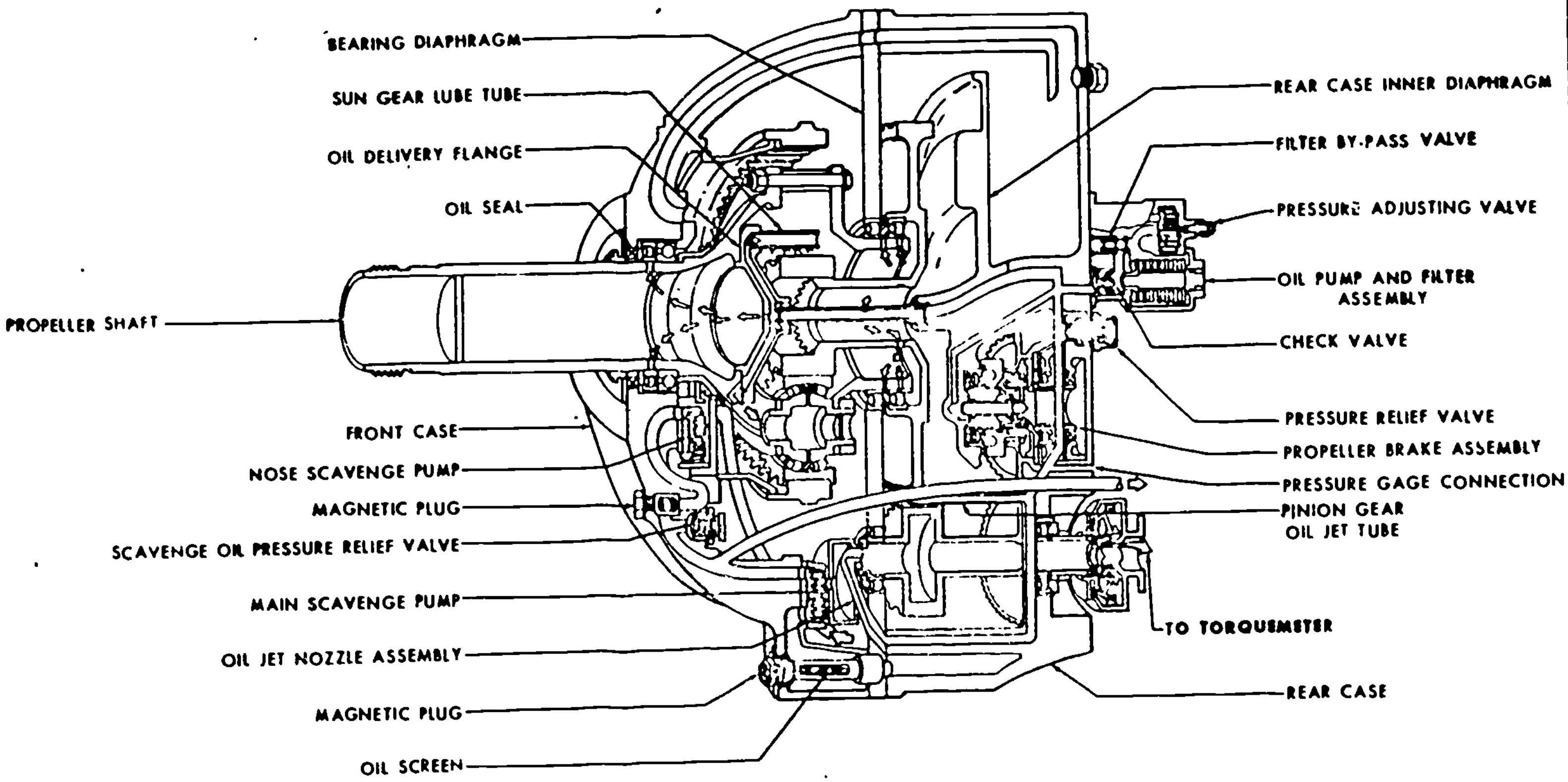

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Figure 3. Reduction Gear Oil System Schematic for T56-A-7, -15 Engines (There are minor differences in -9 engines).

PRESSURE PUMP AND FILTER ASSEMBLY. The pressure pump and filter assembly is located on the upper side of the rear case. The pump is the spur gear type and the output capacity is 17.5 gallons per minute. The filter is a 13 wafer stack, 117 micron element, and incorporates a bypass valve set at 300 psid which functions if the filter becomes clogged.

SCAVENGE OIL SYSTEM

Refer to figures two and three as you study the following text.

Major Units

TURBINE REAR SCAVENGE PUMP. The turbine rear scavenge pump is mounted in the turbine scavenge oil pump support. Its purpose is to scavenge turbine rear bearing oil. It is the spur gear type driven by the bevel gear and the side gear on the rear scavenge oil pump drive gear shaft. The rear scavenge oil pump drive gear shaft splines into the turbine scavenge pump drive shaft coupling which furnishes the drive for the pump.

EXTERNAL SCAVENGE PUMP. The external scavenge pump is mounted on the center rear pad of the accessory drive housing and its purpose is to scavenge oil from the diffuser sump, combustion inner casing, and the turbine front bearing oil sump. It is the spur gear type; three gears and two elements. It picks up oil from the sump area by two tubes, one connected to each element. The external scavenge pump discharges into the scavenge discharge of the main pressure and scavenge pump mounted on front of accessory drive housing.

REDUCTION GEARBOX NOSE SCAVENGE PUMP. The nose scavenge pump is secured to the nose bearing plate and it scavenges oil during the nose-down flight attitude. The outlet of the nose scavenge pump has passageways that connects in with the outlet of the reduction gearbox main scavenge pump.

REDUCTION GEARBOX MAIN SCAVENGE PUMP. The main scavenge pump is secured to the forward case of the reduction gearbox. It scavenges oil during any normal flight attitude except nose-down. It is a spur gear type pump.

OIL FLOW

Refer to figures 1, 2, and 3 as you study the following text. Oil flow is gravity fed from the oil tank to the oil pumps on the engine and the gearbox. After the oil leaves the engine oil pump it passes through the filter. Once the oil leaves the filter it lubricates the necessary parts of the accessory housing and then on into the air inlet housing through a passage in the bottom vertical strut of the air inlet housing. The oil then passes through oil jets to lubricate the front compressor bearing, mid-torque bearing, and torque-to-reference shaft sleeve bearing. From the air inlet housing, oil passes through a drilled passage to an external compressor pressure oil tube assembly. Oil flows rearward through the compressor pressure oil tube and a "T" fitting divides the oil flow at the diffuser. A part of the oil will flow into the diffuser oil tube connection. At the 1 o'clock position of the diffuser, to an oil jet which sprays some of the oil onto the rear compressor bearing and some will be used to lubricate the turbine front bearing. The remainder of the oil will flow into the pressure oil tube aft of the spray shield to a tube mounting pad on the turbine rear bearing support through a double wall tube, which is threaded into the rear bearing oil seal. Oil flows through drilled passages in the oil seal, bearing support, and bearing cap.

The oil that is gravity fed to the oil pump of the reduction gearbox passes through the filter and on to lubricate the gears and bearings in the reduction gearbox.

Once the oil passes over the bearings and gears it has to be picked up and returned to the oil tank. This is the job of the scavenge oil system. This scavenge oil is picked up by the different scavenge pumps located in the engine and gearbox. Before the oil gets to the tank it passes through the fuel/oil heater to prevent icing of the fuel system. This oil is very hot from the friction created by the bearings and gears. This is the reason it passes through the oil cooler before being returned to the tank.

QUESTIONS

1. The purpose of the oil system is to ______________, ___________ and _______________ the oil-wetted parts of the engine.

2. The T56 engine oil system is a ________________ sump type.

3. The capacity of the oil tank is _________ gallons, plus an additional ______________ gallons of air space.

4. The purpose of the fuel heater and strainer is to prevent _______ of the fuel system parts.

5. There are _______ oil pressure transmitters located on each engine.

6. The main oil pump is mounted on the _________ of the ____________ ____________ ______________ cover.

7. The oil pressure regulating valve can be field adjusted to regulate filter outlet oil pressure to ____________ psi.

8. The ___________ ____________ pump scavenges oil from the diffuser sump, combustion inner casing, and the turbine front bearing oil sump.

9. The reduction gearbox oil pressure pump is the ____________ __________ type.

10. The oil is fed to the oil pumps by _____________.

WORKBOOK

3ABR42633-WB-201

Technical Training

Turboprop Propulsion Mechanic

TURBOPROP ENGINE OIL SYSTEM

13 February 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-201

TURBOPROP ENGINE OIL SYSTEM

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to state the purpose, operation, and arrangement of the T56 engine oil system and its parts.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-4	1/student

PROCEDURE

Follow the instructions given for each section in this workbook.

Section 1

INSTRUCTIONS

Follow the classroom presentations nd fill in the blank spaces with the appropriate information to complete each statement.

1. The purpose of the engine oil system is to clean, ____________, and _________ the bearings and other _________ parts of the engine.

2. The T56 engine oil system is of the high-speed, _______-________ type, and is designed to lubricate both the __________ ______________ and ____________ _______________.

3. Oil System Components,

a. Oil tank.

(1) Purpose: To store the engine oil supply, ____________ or _________________.

(2) Location: Above the engine in the _________ section of the _____________.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

(3) Servicing of the oil tank is accomplished through a _______-_______ filler which is located on the right hand side of the _______.

b. Oil tank shutoff valve.

(1) Purpose: To _______ the flow of oil to the _______ and _______ when the fire emergency handle is pulled.

(2) Operation: The valve is of the energize-to-open, energize-to-close type with a _______ _______ to allow for servicing of the valve.

(3) Location: The oil tank shutoff valve is attached to the _______ _______ beneath the tank.

c. Oil tank pressurizing valve.

(1) Purpose: To pressurize the _______ _______ by controlling the flow of _______-_______ air from the tank.

(2) Operation: The valve is controlled by an air operated _______ valve which maintains a _______ oil tank pressure.

(3) Location: Attached to the _______ left hand portion of the _______ _______.

d. Oil quantity tank unit.

(1) Purpose: To indicate a low engine oil quantity to the _______.

(2) Operation: When oil quantity drops below _______ gallons, the _______ _______ _______ _______ warning light will _______ in the cockpit.

(3) Location: Mounted _______ through the left end of the _______ _______.

e. External scavenge oil filter.

(1) Purpose: Prevents ________-________ ________ of the ________ and reduction gearbox (RGB).

(2) Location: Mounted ________ on the right side of the quick engine change (QEC) kit.

f. Oil cooler.

(1) Purpose: Maintains the engine oil temperature during all ________ ________.

(2) Location: In the ________ portion of the ________ ________.

g. Engine oil pumps.

(1) Purpose: To provide the oil flow to the ________ and ________ ________ under all operating conditions.

(2) Oil pressure pump.

(a) Operation: ________-________, spur gear type.

(b) Location: On the ________ ________ face of the ________ drive housing.

(3) Oil scavenge section: Fill in the blocks on the chart below from the projected transparency.

PUMP NUMBER	LOCATION	ELEMENT	AREA SCAVENGED	DRIVEN BY

h. RGB oil pumps.

(1) Pressure oil pump

(a) Purpose: To supply pressurized oil to all ________ ____________ in the reduction gearbox.

(b) Operation: Spur gear type driven by ________ ______________.

(c) Location: Externally mounted on the right ________ face of the ________ ____________ in the same housing with the ____________ assembly.

(2) Scavenge oil pumps (2 each)

(a) Purpose: Provides adequate oil scavenging at all ____________ and ______________.

(b) Operation: Nose scavenge pump: Picks up oil which collects in the ________ casing of the reduction gearbox. Main scavenge pump: Scavenges oil which collects in the bottom of the ________ casing and ________ the oil to the engine ________ ________.

(c) Location: Both the ________ and __________ scavenge pumps are located _______ within the reduction gearbox.

i. Pressure oil filters.

(1) Purpose: Filters engine and reduction gearbox oil as it __________ the ________ pressure oil pumps.

(2) Location: Power unit: Forward left side of ________ ________ __________. Reduction gearbox: Mounted on _______ case of __________ ____________ in same ____________ with main oil pump assembly.

j. Filter bypass valves.

(1) Purpose: Allows oil to bypass the filter in case of excessive ____________.

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(2) Operation: Power section: Valve will open when ________ ________ reaches psid. Reduction gearbox: Valve will operate at ________ psid.

(3) Location: Power unit scavenge pump oil pressure bypass valve: In the ________ ________. Power unit pressure filter by-pass valve: Between the ________ ________ leading into and out of the ________. Reduction gearbox bypass valve: In the upper portion of the ________ ________ and ________ housing.

k. Oil filter check valve.

(1) Purpose: Prevents ________ flow of oil from the ________ when the engine is ________ ________.

(2) Location: Engine check valve: At filter ________. Reduction gearbox check valve: Mounted in ________ housing at filter ________.

l. Pressure regulating valve (engine only).

(1) Purpose: To maintain a ____-____ psi filter ________ oil pressure.

(2) Operation: A certain amount of oil is allowed to ____-____ by way of a ________ type valve.

(3) The pressure regulating valve can be ________ adjusted if necessary to maintain proper ________.

(4) Location: Mounted on ________ face of the main ________ ________ housing.

m. Reduction gearbox relief valves.

(1) Oil pressure relief valve.

(a) Operation: Valve is ____-____ to ________ when pressure reaches 250 psi.

(b) Valve ________ be field adjusted.

(c) Location: Lower right hand side of reduction gearbox ___________ case.

(2) Scavenge pressure relief valve.

(a) Purpose: Prevent high pressure _______________, primarily during engine __________ when the ____________ is cold.

(b) Operation: Spring loaded ___________ valve which begins to ____________ when oil pressure reaches ___________ psi.

(c) Location: Internally mounted in oil scavenge passageway of __________ case.

n. Engine fuel heater and strainer.

(1) Purpose: Transfers engine oil __________ to the fuel being supplied to the engine.

(2) Location: Mounted to the _________ hand side of the ____________ QEC kit.

o. Oil cooler flap.

(1) Purpose: ___________ cooling air flow through ___________ _____________ _____________.

(2) Operation: Controlled by oil cooler flap temperature ____________ ________________.

(3) Location: In engine _____________, aft of _________ _______________.

4. Engine Oil Instrumentation System.

a. Oil pressure indication system.

(1) Purpose: Provides an __________ of ___________ and __________ ______________ lub oil pressure.

(2) Operation: Operates on power from the ____________ _____________ and fuel control bus.

(3) Location: Indicator gages are located on ____________ ____________ panel in the cockpit.

b. Oil cooler flap position indicator.

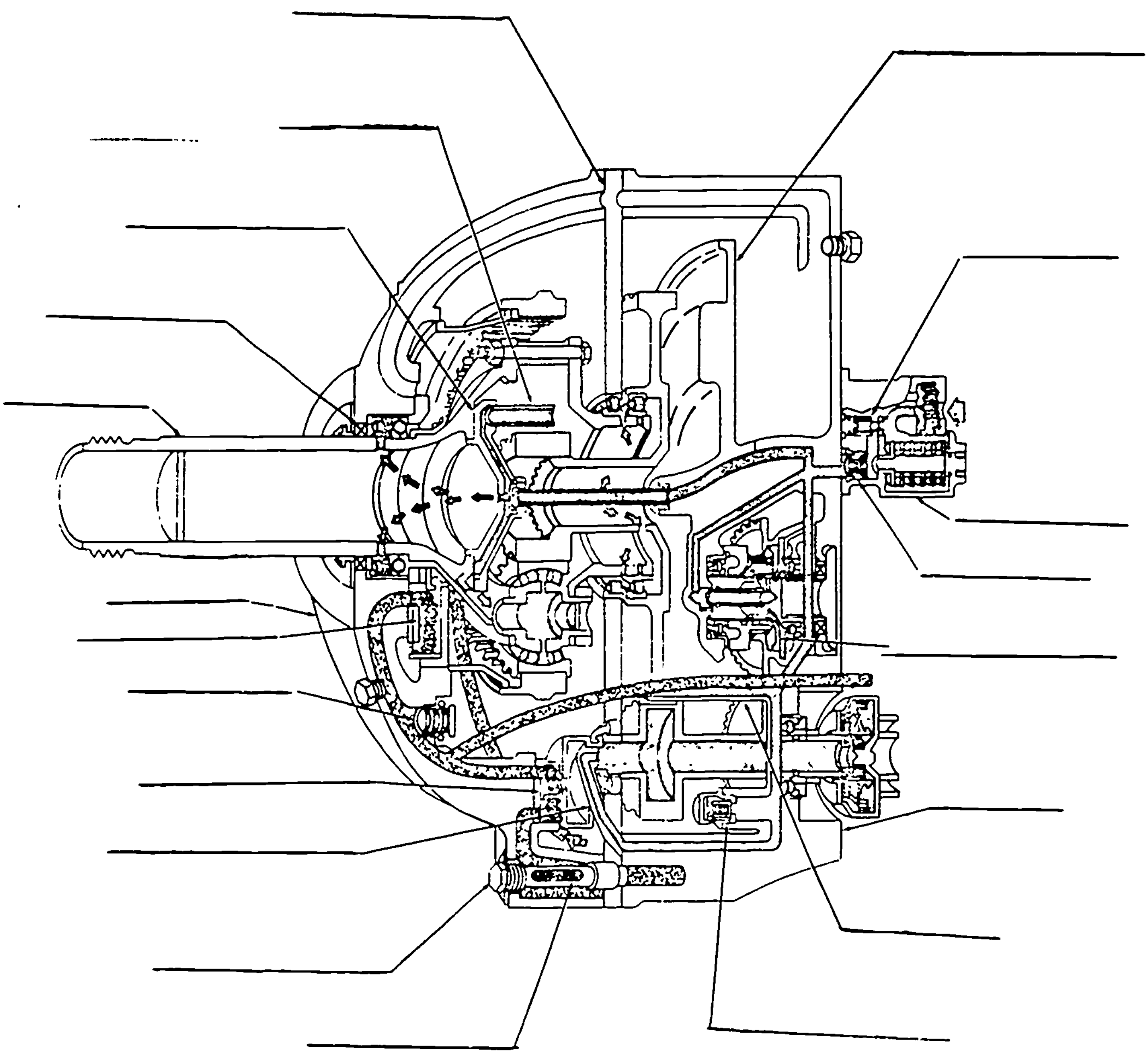
(1) Purpose: Allows cockpit personnel to ____________ how far the oil cooler flap is ____________.

(2) Location: Position indicators: In the ____________, on the ____________ ____________ panel.

Section 2

INSTRUCTIONS

Using TO 1C-130B-2-4, locate and fill in the blanks in figure 1 with the correct name of each part.



PRESSURE OIL SCAVENGE OIL

Figure 1. Reduction Gear Oil System Schematic Diagram.

Section 3

INSTRUCTIONS

Using information given during the classroom presentation, correctly fill in the blocks in figure 2 from the names listed below:

Nose Scavenge Pump

Oil Temperature Bulb

Pressure Oil Pump (Power Unit)

Oil Tank

Oil Temperature Control Thermostat

Shutoff Valve

RGB Transmitter

Power Unit Filter

Main Scavenge Pump (RGB)

Pressure Adjusting Valve

Pressure Regulator Valve

Power Unit Scavenge Pumps

Sump

Oil Quantity Tank Unit

Power Unit Transmitter

Filler Port and Dipstick

Power Unit Bypass Valve

RGB Bypass Valve

Oil Tank Pressurizing Valve

RGB Pressure Oil Pump

RGB Filter

Oil Cooler Regulator Valve

Fuel Heater and Strainer

Oil Cooler

External Scavenge Filter

Oil Cooler Flap Actuator

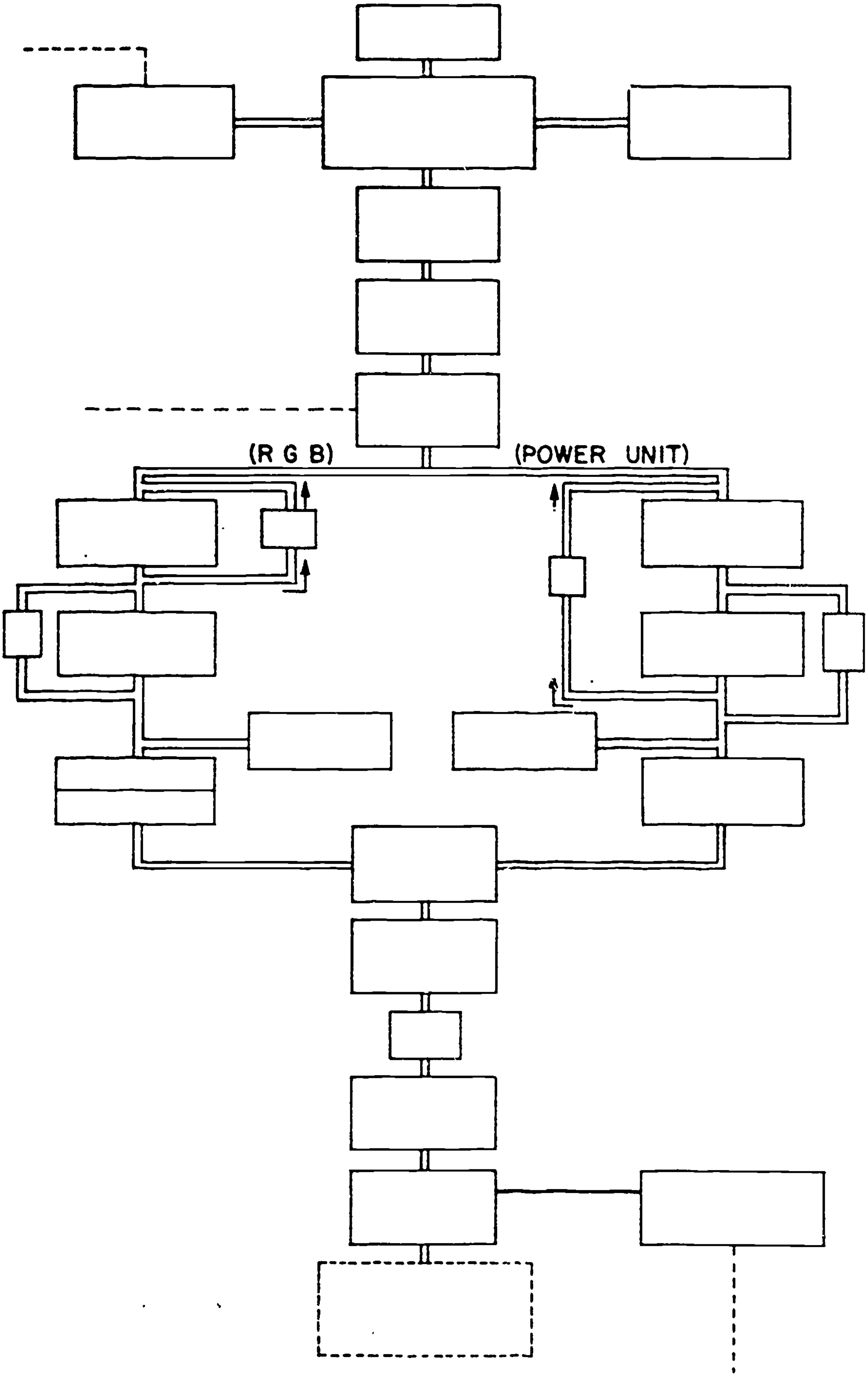


Figure 2. T56 Oil Flow Schematic.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-203
4 January 1980

TURBOPROP ENGINE FUEL SYSTEM

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to state the purpose, units, location, and operating principles of the T56 engine fuel system.

INTRODUCTION

MAJOR UNITS OF THE FUEL SYSTEM

A separate fuel system is provided for each engine. The major units of the fuel system are a starting fuel enrichment system, dual fuel pump, low-pressure paper-element filter assembly, high pressure fuel filter assembly, fuel control, coordinator, electronic temperature datum control, temperature datum valve, fuel manifold and nozzles, and two burner drain valves. The fuel is delivered to the engine fuel systems in the nacelles by the fuel supply system within the aircraft wings.

OPERATION OF THE FUEL SYSTEM

Fuel is supplied by the aircraft fuel system to the inlet of the engine-driven fuel pump assembly. The fuel pump assembly consists of a boost pump and two spur gear type pumps. The gear type pumps may be placed in either series or parallel by an electrically operated paralleling valve located in the high pressure fuel filter assembly. The boost pump output is delivered to the low pressure fuel filter assembly which filters the fuel and delivers it to the high pressure fuel filter assembly, where it is directed to the inlets of the two gear type pumps. The output of the two gear pumps is filtered by the high pressure fuel filter. A pressure switch in the high pressure fuel filter assembly completes an electrical circuit to the fuel pump light in the cockpit to give a warning of a primary gear pump failure. Fuel leaving the high pressure fuel filter takes two paths. One path enters the fuel control and flows through the fuel metering section. Here the fuel volume is corrected to 120% of engine demand. This correction is for RPM, throttle, and air density variations. The second path enters the fuel control through the enrichment valve and bypasses the metering section. The latter path is used only during the initial phase of the starting cycle when the use of the enrichment system is selected by a manually positioned cockpit enrichment switch.

The fuel control delivers metered fuel to the temperature datum valve which provides further correction to the fuel flow. The

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1
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temperature datum valve is a part of the electronic fuel trimming system and the fuel flow correction made by the temperature datum control. The electronic fuel trimming system compensates for variations in fuel density and BTU content. The temperature datum valve receives more fuel from the fuel control than it delivers to the fuel manifold and is always bypassing fuel. The amount of fuel bypassed is determined by the position of a bypass control needle which varies in response to an electrical signal from the temperature datum control amplifier. The amplifier determines this electrical signal by comparing a desired turbine inlet temperature signal to the actual turbine inlet temperature signal provided by a parallel circuit of 18 thermocouples located in the turbine inlet.

Fuel flow from the temperature datum valve is delivered to the fuel manifold through an aircraft furnished flowmeter. The fuel manifold distributes the fuel to six fuel nozzles which atomize and inject the fuel into the forward end of the six combustion liners. A drip valve located at the lowest point of the fuel manifold is used to drain the fuel manifold at engine shutdown. During the starting cycle, a solenoid is energized to close the drip valve. Fuel pressure holds the drip valve closed during normal operation. At engine shutdown, a spring opens the drip valve.

During an engine start, it is desirable to fill the fuel manifold rapidly so that an initial high pressure to the fuel nozzles will allow the nozzles to better atomize the fuel. This insures a better light-off during engine starts. The secondary and primary fuel pumps are placed in parallel during a start to insure sufficient fuel flow to fill the fuel manifold rapidly. If a start is not successful, additional fuel can be delivered to the fuel manifold on the next starting attempt by using the enrichment system. The enrichment system must be "armed" by the cockpit enrichment switch. If the enrichment system is "armed," the enrichment valve will open at 2200 rpm due to the speed sensitive control and ignition relay operation. When the pressure in the fuel manifold exceeds approximately 50 psi, a pressure switch connected to the fuel manifold opens an electrical circuit which will cause the enrichment valve to close. When the enrichment valve is open, fuel will flow through the enrichment valve to the upstream side of the fuel control cutoff valve. Functionally, the enrichment valve is in parallel with the metering section of the fuel control.

Fuel bypassed by the fuel control and temperature datum valve is returned to the fuel pump assembly by way of the high pressure fuel filter assembly. Any fuel leakage past the seals of the fuel pump assembly and fuel control is drained overboard through a common manifold.

QUESTIONS

1. What are the main units of the fuel system?

2. To what is the boost pump output fuel delivered to on the engine?

3. What completes an electrical circuit to the fuel pump light in the cockpit to give a warning of a primary gear pump failure?

4. What does the fuel control deliver fuel to?

5. What determines the amount of fuel bypassed by the temperature datum valve?

6. How many fuel nozzles and combustion liners are there on the T56 engine?

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Chanute AFB, Illinois

3ABR42633-WB-203
21 November 1980

T56 ENGINE FUEL SYSTEM

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to locate information about the fuel system in the technical order and explain the purpose, operation, and location of the fuel system and its parts.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-4	1/student

PROCEDURE

Complete the following projects according to the instructions given for each.

Project 1

INSTRUCTIONS

Using TO 1C-130B-2-4 and information received in your classroom instruction, complete the following statements by filling in the spaces with the correct word(s).

1. Fuel heater strainer

    a. Purpose - Prevents __________ formation in the fuel.

    b. Location - On the __________ -hand side of the engine nacelle.

    c. Operation - Uses hot scavenge __________ to heat the fuel.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 300; TTVSA - 1

RGL: N/A

2. Main fuel pump

a. Purpose - To pressurize and supply _________ of the needed amount of _________ for combustion.

b. Type - A _________ element, dual type pump; centrifugal type _________; _________ type secondary; and gear type _________.

c. Location - On _________ -hand rear side of the _________ drive housing.

d. Operation

(1) Series - From 0% rpm to _____ rpm and _____ rpm to 100% rpm.

(2) Parallel - From 16% rpm to _____ rpm.

3. Low pressure fuel filter

a. Purpose - To filter the _________ as it leaves the centrifugal _________ pump.

b. Location - On right-hand _________ of the _________ case.

c. Operation - Uses a 25 micron _________ throwaway filter with an 8 psid _________ valve in case the filter becomes clogged.

4. Paralleling valve

a. Purpose - To control the _________ of the fuel pumps.

b. Location - On the bottom of the fuel pump in the _________ pressure fuel _________ housing.

c. Operation - Is energized _________ by the 16% rpm switch in the speed sensitive control. Is deenergized (spring loaded) _________ by the 65% rpm switch in the speed sensitive control.

5. High pressure fuel filter

a. Purpose - To _________ the fuel after it leaves the _________ fuel pump.

b. Location - At the bottom of the fuel __________ housing.

c. Operation - Uses a 33 micron, 17 __________ air maze filter with a 125 psid bypass valve in case the filter becomes __________.

6. Fuel enrichment (primer) valve

a. Purpose - Provides unmetered extra __________ for starting in extreme __________ weather (below 32°F).

b. Location - Is mounted to the __________ side of the external scavenge __________.

c. Operation -

(1) Is __________ open (if selected by the pilot) by the 16% rpm switch in the speed sensitive control.

(2) Is deenergized (spring loaded) __________ by the fuel manifold pressure switch when fuel pressure in the manifold reaches __________ psi.

7. Fuel control

a. Purpose - To supply __________ (120% of the needed amount) fuel to the temperature datum __________ and bypass the extra fuel (80%) back to the secondary fuel pump __________.

b. Location - On the __________ -hand rear side of the accessory __________ housing.

c. Operation - Meters __________ according to the mechanical and atmospheric variables.

(1) Compressor __________ temperature.

(2) __________ inlet pressure.

(3) Throttle __________ angle.

(4) Compressor rotor __________.

8. Fuel control shutoff valve

a. Prevents __________ flow to shut down the engine.

b. Location - On the top of the fuel ________.

c. Operation

(1) Is opened ________ by the 16% rpm switch in the speed sensitive ________.

(2) Is closed by activating one of the following:

(a) Emergency ________ handle.

(b) Condition lever to ________.

(c) Condition ________ to ground stop.

9. Temperature datum valve

a. Purpose - To supply ________ fuel flow (100%) to the fuel ________ and bypass the extra fuel (20%) back to the ________ of the secondary fuel pump.

b. Location - Mounted to the compressor case ________ the fuel pump.

c. Operation - Meters the fuel according to TIT signals received from the temperature datum ________.

10. Fuel manifold drain valve

a. Purpose - Drains fuel from the fuel ________ during engine shutdown.

b. Location - At the bottom of the fuel ________.

c. Operation

(1) Is energized closed by the ____% rpm switch in the speed sensitive control.

(2) Is deenergized by the ____% rpm switch in the speed sensitive control but held closed by ________ pressure in the line.

(3) Is spring-loaded ________ when the ________ pressure decreases during engine shutdown.

11. Fuel manifold

a. Purpose - Distributes fuel to the fuel _________.

b. Location - Around the _________ case.

12. Fuel manifold pressure switch

a. Purpose - Used to _________ fuel enrichment when fuel pressure in the _________ reaches 50 psi.

b. Location - On the compressor case at the _____ o'clock position; connected to the No. _________ fuel nozzle.

c. Operation - Is spring loaded _________, fuel pressure _________.

13. Fuel nozzles

a. Purpose - To _________ the fuel for efficient combustion.

b. Location - Mounted to the _________ at the even clock positions and extending into the _________ chamber liners.

c. Type - Single _________ duplex.

14. Burner drain valves

a. Purpose - To drain excess _________ in the outer combustion case during an _________ start.

b. Location - On forward and rear ends of the combustion case at the _____ o'clock position.

c. Operation - Is _________ loaded open; air pressure _________.

Project 2

INSTRUCTIONS

Complete the following names of fuel system parts by selecting the correct word(s) from the list given below. Each response is used only once.

burner	filter	manifold	enrichment
control	fuel	pressure	high
datum	fuel	shutoff	valve
drain	heater	switch	

1. Fuel __________ strainer.
2. Main __________ pump.
3. Low __________ fuel filter.
4. Paralleling __________.
5. __________ pressure fuel __________.
6. Fuel __________ valve.
7. Main fuel __________.
8. Fuel control __________ valve.
9. Temperature __________ valve.
10. Fuel manifold __________ valve.
11. Fuel __________.
12. Fuel manifold pressure __________.
13. __________ nozzles.
14. __________ drain valves.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-217
10 December 1980

TEMPERATURE DATUM SYSTEM

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to correctly identify the purpose, operation, and arrangement of the temperature datum system.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-4	1/student

PROCEDURE

Using TO 1C-130B-2-4 and the information presented in the classroom, fill in the spaces provided with the correct information pertaining to the temperature datum system.

1. The purpose of the temperature datum system is to sense differences between the __________ and the ____________ turbine inlet temperatures.

2. The temperature datum control ____________ is located in the power package above the engine, just aft of the oil tank.

3. The purpose of the temperature datum control is to sense the differences between the __________ and _____________ turbine inlet temperature at various ______________ settings.

4. The temperature datum control valve is located on the bottom of the ______________ case.

5. The temperature datum control valve has a three position toggle switch; the switch positions are _____________, _____________, and _______________.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 300; TTVSA - 1

RGL: N/A

6. When the switch is in the "AUTO" position the fuel trimming system may operate in either the ____________ or ____________ mode.

7. When the switch is in the "NULL" position, the temperature datum control is ____________.

8. If the temperature datum control valve ____________ is not placed in the "LOCKED" position before moving the throttle below ____________ degrees, the temperature control system will be transferred from temperature ____________ to temperature ______________, and the temperature datum ____________ will return to its ____________ or no-signal position.

9. The temperature datum control valve switches are located on the ____________ pedestal.

10. The 20 percent take solenoid is mounted on the temperature datum ________________.

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Chanute AFB, Illinois

3ABR42633-WB-202
5 February 1980

TURBOPROP ENGINE TIT AND FIRE WARNING SYSTEMS

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to:

1. State the purpose of the turbine inlet temperature TIT and fire warning systems and their parts.

2. Locate TIT and fire warning systems parts on the engine and describe their operation.

PROCEDURE

Follow the classroom presentation for each section of this workbook and fill in the blank spaces with the appropriate information to complete each statement.

Section 1

1. The purpose of the TIT indicating system is to measure the temperature of the _________ ______________.

2. A thermocouple assembly consists of ______ thermocouples that go to the ________ ___________ and ___________.

3. There are ____ ___ thermocouples wired in ____________.

4. There are two types of thermocouples in use, they are the __________ top and __________ top.

5. Thermocouples must not be sprayed with liquid cleaning solvents because it will leave a ____________ containing __________ which will cause a low-resistance to ground.

6. The TIT indicator is located on the __________ instrument panel.

OPR: 3350 TCHTG
RGL: N/A
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

7. The TIT indicating system receives its power from the ________ ____________________.

8. On C-130B and HC-130B aircraft, the amplifiers are mounted on overhead rack in the ____________. On the C-130E and C-130H aircraft, they are located on the ______________________.

Section 2

1. The purpose of the nacelle overheat warning system is to warn of an __________ condition in the area around the engine __________ ______________.

2. The nacelle overheat warning system consists of ________ detectors in each nacelle.

3. Detector contacts are closed by _________ of an outer shell when the shell is heated to a temperature of _________ degrees.

4. There are four numbered nacelle overheat warning lights located on the _________ _________ ______________.

5. The test switch _________ checks detector continuity or operation.

6. How is a nacelle overheat condition indicated to the pilot? ______________________________________.

Section 3

1. The turbine overheat warning system is a __________ __________ - ____________ type.

2. A turbine overheat condition is indicated by ____________ ______________________________________.

3. The system operates when turbine temperature rises to _______ degrees and causes one of the detectors to close.

Section 4

1. The purpose of the fire warning system is ____________________ ____________________.

2. The fire detection system consists of _______ separate systems with _________ common test system.

3. Each of the five engine detection systems consist of a __________, ____________, and ______________ in the fire emergency handle for each engine.

4. The sensing element consists of an ____________ that encloses a wire imbedded in a special ____________ core.

5. The __________ ______________ of the ceramic core decreases as the temperature increases, permitting a small _________ ____________ between the wire and the outer grounded section of the Inconel tube.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-206
10 December 1980

TURBOPROP NEGATIVE TORQUE SIGNAL SYSTEM

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to identify the purpose, operation and arrangement of the negative torque signal system.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-4	1/student

PROCEDURE

Using TO 1C-130B-2-4 and the information presented in the classroom, fill in the spaces provided with the correct information pertaining to the negative torque signal system.

1. The purpose of the negative torque signal system protects the engine and propeller from ____________________.

2. The __________ ______________ provides a rapid method of breaking the power unit from the __________ __________________.

3. The safety coupling is mounted between the ____________ and the ____________ _________________.

4. The purpose of the propeller brake is to prevent ____________ when the propeller is feathered.

5. The three positions of the propeller brake are ______________, _________________, and _________________.

6. During starting, the propeller is initially released by starter torque after ______________ percent.

7. When the blade angle is 92.5° the propeller brake is in the ______________ position.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 300; TTVSA - 1

RGL: N/A

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8. The propeller brake is mounted under the ______________ pad.

9. When engine RPM drops below __________ percent, the propeller brake is applied by ________________ pressure.

10. Negative torque is sensed by the forward movement of a ________________ gear in the nose of the reduction gear assembly.

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Chanute AFB, Illinois

3ABR42633-SG-210
1 April 1980

PROPELLER TECHNICAL PUBLICATIONS

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to identify specific information of propeller technical orders.

INTRODUCTION

The knowledge of the proper use of technical orders is a must within the turboprop system. The propeller is a very important part of an aircraft. Failure to follow the information or instructions contained in the many different propeller technical orders could result in extensive damage to this expensive equipment.

INFORMATION

This study guide contains information for proper use of propeller technical orders. We will be using these propeller technical orders to determine which specific technical order contains the procedures for the propeller hub and blade assemblies, low pitch stop lever assembly, pitch lock assembly, hub mounted bulkhead assembly, deicer contact ring holder assembly, spinner assemblies, propeller control assembly, and other associated parts of the propeller.

GENERAL TECHNICAL ORDERS

The technical order (TO) index for all propellers in general is TO 0-1-3. It contains general information concerning all types of propellers. It will list the specific technical orders for the different types of propellers, and the associated equipment. The next general technical order for the propeller assembly is TO 3-1-1. This technical order will list the types of aircraft that use propellers, and what specific kind of propeller that aircraft has installed on the engine.

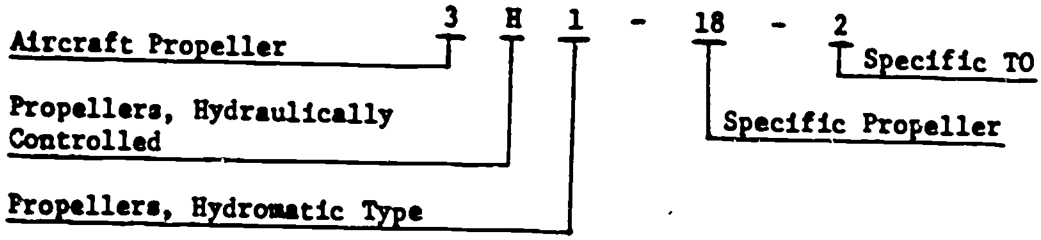
The Hamilton Standard turbopropeller, model 54H60-63, 54H60-91, and 54H60-117, is the only propeller system that is taught in this technical school. We will be using only the technical orders that pertain to the 54H60 propeller and the associated equipment for this propeller. The technical order which covers procedures for operating a propeller with a known

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 100; TTVSA - 1

propeller malfunction is TO 3-1-6. This technical order lists the specific information and procedures for operating a propeller with a known malfunction.

SPECIFIC TECHNICAL ORDERS

The 54H60 propeller assembly has many different types of technical orders. In order for you to understand what these technical orders contain, you will have to know the basic construction of the propeller technical order system. In order for you to identify a certain type of propeller technical order, and what information those technical orders contain, we will cover the numbering system for the propeller.



The specific propeller technical order which starts with 3H1 will contain all the information concerning hydraulic controlled propellers and their parts. Most of these technical orders contain general information about the specific propeller in that technical order on these hydraulic controlled propellers. To identify a specific type of hydraulic controlled propeller a second set of numbers is added to the 3H1. The two digit number that identifies the 54H60 propeller is 18. This technical order will identify the main parts of this propeller and its main units. The last number identifies the specific type of technical order of the hydraulic controlled propeller. The number two (2) on the end of numbering system identifies that technical order as Field Maintenance Repair Instructions. The number three (3) will identify that technical order as a Depot Level Maintenance technical order and the number four (4) is the Illustrated Parts Breakdown (IPB) for that specific propeller. You will be using the following technical orders here at school and the remainder of your Air Force career: TOs 3H1-18-2, 3H1-18-3, and 3H1-18-4.

There are other specific propeller technical orders which contain information concerning the associated equipment used on the propeller system. These technical orders are easily identified by the first section of the numbering system. All of these technical orders start with the category number 3HA. You will learn that these technical orders are divided into major groups of associated propeller equipment, and are used to repair and order parts for the specific type of associated parts. These major categories are listed on the next page for your information, so you will be able to identify the individual major category of the associated equipment.

3HA2 - Propeller Integral Oil Controls
3HA4 - Propeller Governors
3HA5 - Propeller Oil Control Pumps
3HA6 - Propeller Spinner Assemblies
3HA7 - Propeller Synchrophasers

SUMMARY

You must remember that technical orders are the only official publication authorized for operating, inspecting, and maintaining the aircraft propellers or engines, and that they are written orders. The more you use and understand the procedures in a technical order, the result of this knowledge will be an outstanding job completed, and error free work. On the other hand, failure to follow the procedures in a technical order is inexcusable. This has resulted in damage or loss of equipment. Accidents resulting in injury or death to personnel have been caused by maintenance personnel either not using or failing to follow the instructions of a technical order.

QUESTIONS

1. What technical order index covers all propellers in general?

2. What does the 3H1 mean in a technical order number?

3. What technical order number covers depot level maintenance instructions?

4. What specific technical order contains information on the 54H60 propeller?

5. What category of technical orders contains information concerning propeller associated equipment?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-210
1 April 1980

PROPELLER TECHNICAL PUBLICATIONS

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to locate specific information in propeller technical publications, list the part number, figure and index number, units per assembly, usable on-code, and identify specific parts in the propeller illustrated parts breakdown publication.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-11	1/student
TO 3H1-18-2	1/student
TO 3H1-18-4	1/student

PROCEDURE

Complete the three projects following the directions given for each project.

Project 1

DIRECTIONS

Using TO 1C-130B-2-11, locate and list the technical order page and paragraph number for specific maintenance, servicing, and operating information.

1. What page and paragraph number will list the procedures for propeller anti-icing and deicing system operation? ______________________________

2. What page and paragraph number will list the procedures for troubleshooting the propeller system? ____________________

3. What page and paragraph number will list the procedures for removing the propeller assembly from an aircraft? ______________________________

4. What page and paragraph number lists the oil servicing procedures for the propeller? ____________________

OPR: 3350 TCHTG
RGL: N/A
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 300; TTVSA - 1

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Project 2

DIRECTIONS

Using TO 3H1-18-4, locate the part number, figure and index, units per assembly, and usable on-code for the parts listed in column A.

COLUMN A	P/N	FIGURE AND INDEX	UNITS PER ASSEMBLY	USABLE ON-CODE
1. Low pitch stop				
2. Dome assembly				
3. Pitch lock assembly				
4. Deicing contact ring				
5. Retaining nut				
6. Propeller blade				

Project 3

DIRECTIONS

Using TO 3H1-18-2, locate specific information concerning maintenance on a propeller assembly.

1. What is the paragraph number for the procedures of tightening the eight barrel bolts? ______________

2. What is the paragraph number that lists the procedures for rear spinner installation? ____________________

3. What is the paragraph number that lists the procedures for blade damage repair? ____________________

4. What paragraph lists the procedures for oil testing the propeller assembly? ____________________

5. What section of the technical order lists the propeller constructional differences? ____________________

STUDY GUIDE
3ABR42633-SG-209

Technical Training

Turboprop Propulsion Mechanic

PROPELLER FUNDAMENTALS

5 February 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

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Chanute AFB, Illinois

3ABR42633-SG-209

PROPELLER FUNDAMENTALS

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to explain basic facts about propeller constructional features, operating principles, and functions.

INTRODUCTION

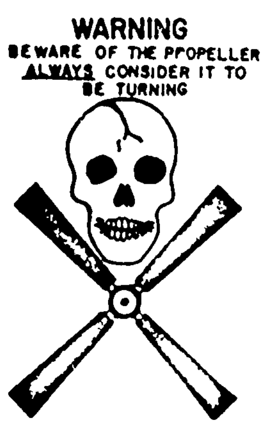
Early airplanes used fixed pitch propellers. Then, with the passing of time, adjustable propellers were developed. Some of the propellers had to be adjusted on the ground. Others had a hydraulic or electrical system which allowed the pilot to change the blade angles in flight.

The changing of blade angles is to keep with such changes as air density and aircraft attitude. This allows the engine to operate more efficiently.

Next the constant speed propeller was developed. This type of propeller could sense an off speed condition of the engine. An off speed is when the engine drives the propeller too fast or when the propeller drives the engine. It would then automatically change the blade angles to keep the engine rpm constant.

Today's turbopropeller is more accurate and sensitive than propellers have been. This is necessary because of the close control that must be maintained on the high speed turboprop engines.

As you can see, the propeller has evolved from a fixed pitch to a complicated device. It takes well trained men to repair and maintain these propellers.



PURPOSE OF A PROPELLER

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1

Propeller blade tips are required to be painted so the mechanic can identify the plane of rotation. One good safety practice to observe is to stay clear of the turning propeller. Always consider the area in front as well as the rear of the propeller as a danger area.

The purpose of the propeller is to convert engine power into forward or reverse thrust. It must also load the engine and thus control its speed. The propeller blades can be considered a series of rotating airfoils.

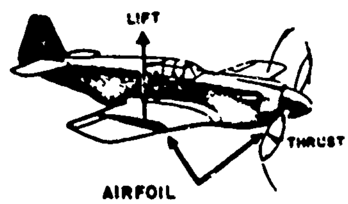


Figure 1. Airfoils.

The thrust of a propeller is developed in the same manner as lift on a wing. In fact, propeller thrust is nothing more than lift directed forward rather than upward. See figure 1.

The propeller blades are held at the center of rotation by a hub. The hub is attached to the propeller shaft. As the shaft is driven by the engine, the propeller turns and thrust is developed.

As an airfoil passes through the air, air pressures are present and acting on the airfoil.

Bernoulli's principle explains how these air pressures behave. Bernoulli was an Italian who performed many experiments dealing with velocity and pressure of fluid which includes air. Through his experiments, Bernoulli proved the following principle:

As a velocity of a fluid across a surface increases, pressure on that surface decreases. As velocity decreases, pressure increases. Now, let's apply this principle to a moving airfoil.

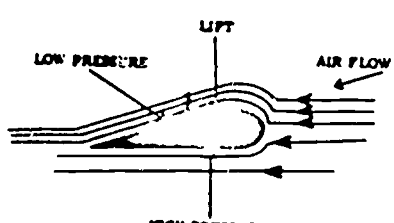


Figure 2. Airflow Over an Airfoil.

Refer to figure 2. You can see that as the air flows over the airfoil the flow over the curved or cambered portion must travel farther and faster than the flow across the flat portion. This increase in velocity causes a decrease in pressure on the curved portion. As a result, the airfoil moves toward the low pressure area. In the case of the wing, it would be up (lift), and on the propeller blade it would be forward (thrust).

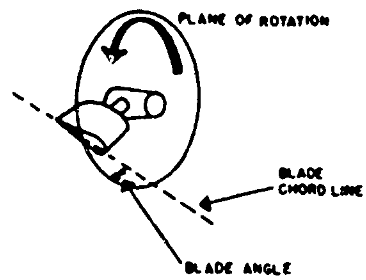


Figure 3. Blade Angle.

For a propeller to produce a desired amount of thrust the blades must be set at a specific angle. This blade angle is the angle between the chord of the blade and the plane of rotation. See figure 3.

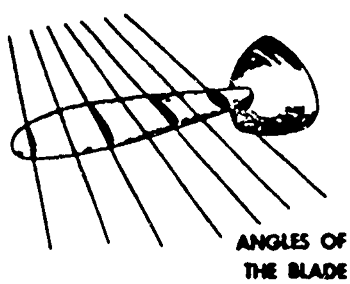


Figure 4. Variation in Blade Angles.

In order for the propeller to operate properly, the blade angle must vary along the length of the blade. See figure 4. The reason for this variation is that the propeller operates like a screw. It advances at the same time that it rotates. These two motions acting upon any section of the blade cause that point to follow a spiral path through the air. See figure 5. That is, a point on a section near the tip of the blade will trace a large spiral. A point on a section near the shank of the blade will trace a smaller spiral. If these spiral paths are to be traced with the various propeller blade sections at their most effective angle, then each individual airfoil section must be designed and constructed so that their angles become gradually less toward the tip of the blade and greater toward the shank of the blade. This gradual change of the blade angles is called a pitch distribution.

NOMENCLATURE AND TERMS

You will be required to know certain terms and theory that pertain to propellers. It is also necessary that you know the names of various parts of a propeller. The following is a list of propeller terms and nomenclature.

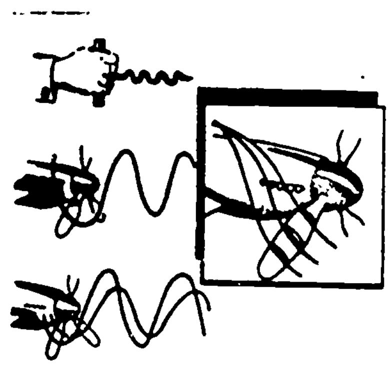


Figure 5. Action of Propeller Blade.

Propeller Hub - That part of the propeller that retains the blades.

Pitch Change Mechanism - Provides the force required to accomplish blade angle change.

Blade Angle - The angle between the chord line of the blade and the plane of rotation.

Chord Line of Blade - An imaginary line drawn through the blade from the leading edge to the trailing edge. It is perpendicular to the center of the blade.

Center Line of Blade - An imaginary line drawn through the center of a blade from tip to butt. It is used when laying off blade stations. It is the longitudinal axis of the blades.

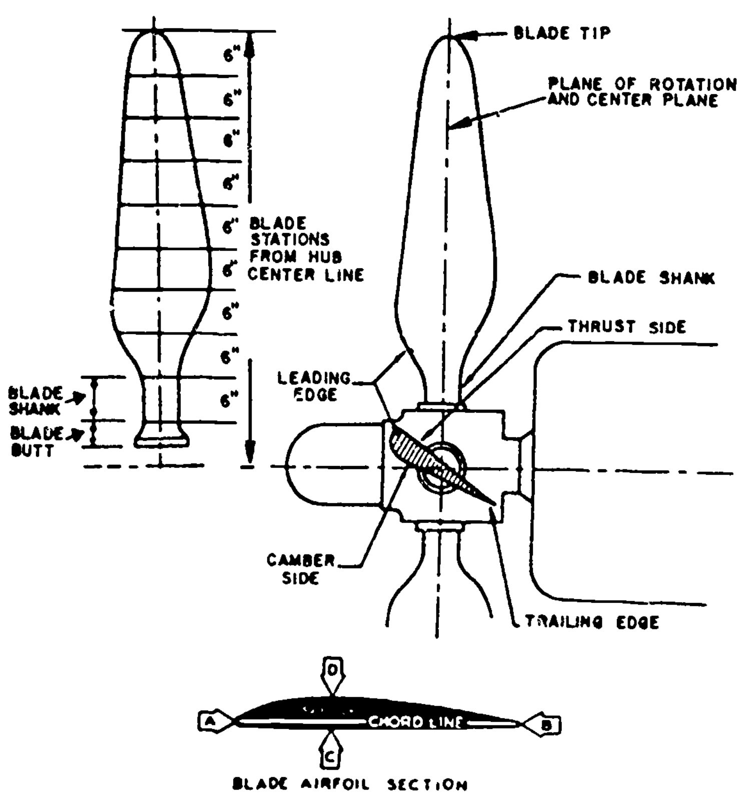


Figure 6. Blade Terms.

Blade Stations - Designated distance on the blade as measured from the hub center. It is common practice to designate these stations at 6-inch intervals. See figure 6.

Blade Track - When similar points on all blades of a propeller follow in the same plane of rotation.

Blade Data - Contains blade drawing number; serial number: high angle; low angle; feather angle; reverse blade angle; reference station for measuring blade angle. This information is located on the cambered side of the blade between the 12-24 inch station.

Revolutions Per Minute (RPM) - The number of complete turns an object makes in one minute of time.

Thrust Side - The side of a propeller blade which is usually flat or nearly so.

Camber Side - The curved side of a propeller blade.

Leading Edge - The edge of the blade that strikes the air first.

Trailing Edge - The edge of the propeller blade opposite the leading edge.

Blade Shank - The thick rounded part of the blade.

Blade Butt - The portion of the blade that extends into the hub or barrel.

Blade Tip - The outer extremity of the blade.

Blade Cuff (Fairing) - A molding placed on the blade shank to extend the blade airfoil to the propeller hub.

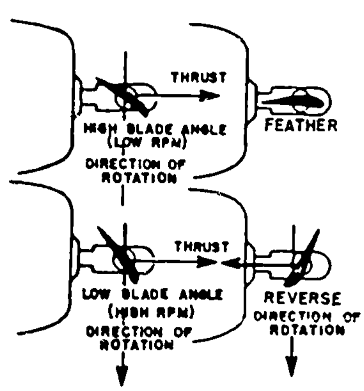


Figure 7. Position of Propeller Blade at Different Angles.

Low blade angle is the lowest angle that the blades of a propeller can be set and still effectively produce forward thrust for a given aircraft. See figure 7.

High blade angle is the highest angle that the blades of a propeller are set to operate in the automatic constant speed operations. See figure 7.

Feathered blade angle is the angle at which the blades are streamlined to the line of flight. This will prevent propeller windmilling and reduce drag on the aircraft. See figure 7.

Reverse blade angle is the position the blades assume for reverse thrust. This will slow the aircraft down after it has landed. See figure 7.

TYPES OF PROPELLERS

There are two general types of propellers; noncontrollable and controllable.

Noncontrollable Propellers

The noncontrollable propeller cannot change blade angle during flight. On some of the noncontrollable propellers the blade angle can be changed on the ground. This type of propeller is used on low horsepower engines.

Controllable Propellers

These propeller blade angles can be changed during flight. They are used on medium or high horsepower engines. Controllable propellers can be broken down into two categories; two position propellers and automatically controlled propellers.

Two Position. These propellers have a mechanical device whereby the pilot can select either a high or a low blade angle.

Automatically Controlled. These propellers are fully automatic and are controlled by a governing device. The blades of these propellers will automatically change angle to maintain the selected rpm of the engine. This is the most widely used propeller in the Air Force today.

The turboprop is one of the most recent developments in propellers. As you learned in the first part of this study guide, the turboprop is used on a turboprop engine.

PROPELLER FORCES AND STRESSES

Equally important in blade design are the stresses set up within the rotating propeller by the forces acting on it. When the propeller is rotating at high speeds, it is subject to three general types of stresses; tensile, torsional, and bending.

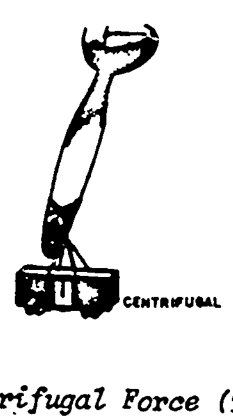


Figure 8. Centrifugal Force (Tensile).

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Tensile: Tensile stresses are created by centrifugal force acting on the propeller blade as shown in figure 8. To make this clearer, suppose a weight is whirled at the end of a string. The pull on the weight outward supplies what is known as centrifugal force created by the whirling motion of the propellers has a tendency to pull the blades from the hub. This force or pull is equal to approximately 50 tons per blade on a medium size propeller.

Figure 9. Centrifugal Twisting Moment.

Torsional: Torsional stress is caused by a force called Centrifugal Twisting Moment (CTM). This force constantly tries to twist the blades to a zero blade angle or flat pitch. CTM is present at all times during propeller rotation. See figure 9.

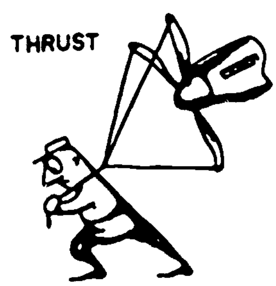

Figure 10. Bending Stress.

Bending: Bending stress is created by thrust. The forward pull of the propeller tends to bend the blades forward as shown in figure 10. This stress is counteracted by centrifugal force acting on the blades. The thrust face tends to bend the blades forward. The tremendous centrifugal force pulling out on each blade tends to hold it straight.

PROPELLER MODEL NUMBERS

Propellers are identified by their model numbers. Each character or designator that makes up the model numbers represents specific information. The chart in figure 11 shows a Hamilton (the manufacturer of the propeller) propeller model number and the meaning of each of the designators.

	5	4	H	60	91			
54H60-91	New Series of Propeller (Turboprop) & Major Modifications	Number of Blades	Blade Shank Size and Type of Blade Metal	Propeller Shaft Size (Size 60)	Minor Modifications			

Figure 11. Propeller Model Numbers.

BLADE DRAWING NUMBERS

As in the propeller model numbers, the blades are also identified by a number. This number is called a blade drawing number.

Hamilton

A	7111	C	2
Blade has a molded cuff on the shank	Represents the basic design of the blade	Blade has all parts such as deicing heater, bushing, slip ring.	Number of inches removed from original diameter.

Figure 12. Propeller Blade Designations (Blade Drawing Number).

The chart illustrated in figure 12 lists a typical propeller blade drawing number. It also shows the meaning of each of the designators.

SUMMARY

In this study guide a brief mention was made of the fundamental theory that applies to propellers. Terms such as leading edge, blade angle, blade tip, etc., are very important. You would do well to learn these terms and know what they mean.

Also listed were some of the stresses that are constantly acting on the rotating propeller. These forces have a definite affect on the propeller operation.

The types of propellers listed gives you an idea of the progress made in the development of the propeller. The turbopropeller is now the latest type and more information on it will be given to you later on in the course.

QUESTIONS

1. What does the number 60 represent in the propeller model number 54H60-91?

2. What is the purpose of the propeller?

3. Define the term "blade angle."

4. Define Bernoulli's principle.

5. Name two general types of propellers.

6. What is meant by torsional stress?

7. Name three forces that act on a rotating propeller.

8. What is the purpose of the pitch change mechanism?

9. When and why is the reversing operation of a propeller used?

10. Why is the blade angle at the tip less than the angle midway of the blade?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-209
5 February 1980

PROPELLER FUNDAMENTALS

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to identify fundamental propeller terms.

EQUIPMENT

	Basis of Issue
3ABR42633-SG-209	1/student

PROCEDURE

Complete the five tasks following the directions for each task. You may use SG-209 to assist you.

1. Using figure 1, match the circled numbers on the drawing with the correct name listed below.

NAME	NUMBER
a. Hub	_____
b. Blade	_____
c. Pitch changing mechanism	_____
d. Plane of rotation	_____
e. Axis of rotation	_____

2. Using figure 1, match the circled numbers on the drawing with the correct name listed below.

NAME	NUMBER
a. Blade tip	_____
b. Blade butt	_____
c. Blade shank	_____
d. Blade centerline	_____
e. Blade reference station	_____
f. Blade chord line	_____
g. Blade angle	_____
h. Thrust side	_____
i. Camber side	_____
j. Leading edge	_____
k. Trailing edge	_____

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RC.: N/A

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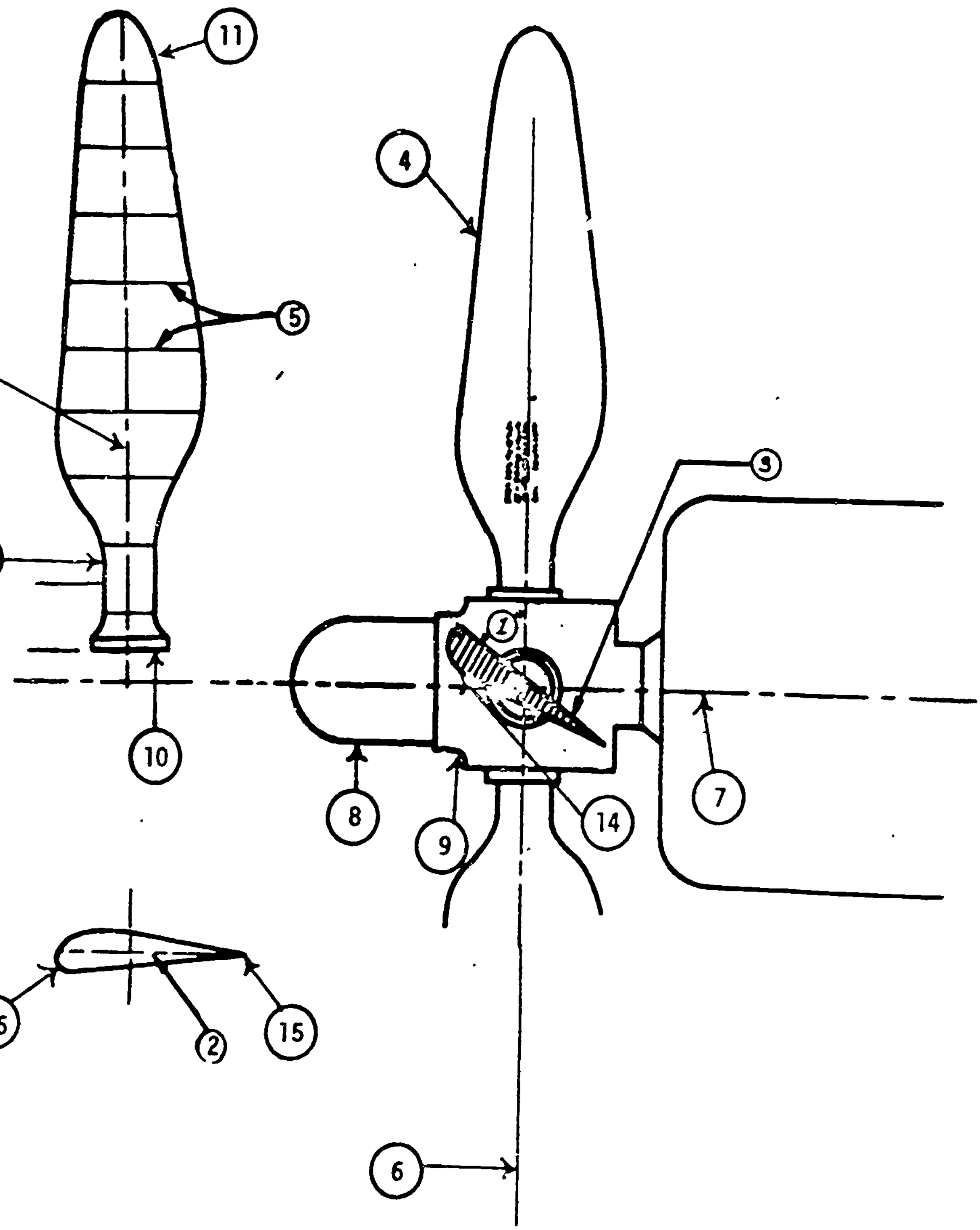

Figure 1.

3. Select the description for each stress listed and place the corresponding letter in the blank provided.

_____ Torsional

_____ Tensile

_____ Bending

a. Tends to pull the blade out of its socket.

b. Causes the rpm to rise.

c. Tends to turn the blade to a lower angle.

d. Causes the blade tip to lead the blade shank slightly.

4. Select, from the column of information, the items that explain the meaning of each of the characters in the following PROPELLER MODEL numbers. Place the correct information in the blank spaces provided at each model number.

a.

5 4 H 60- 91

(1) Propeller manufacturer

(2) Number of blades

(3) Major modifications

(4) Shaft size

(5) Minor modifications

(6) Shank size/type of blade material

(7) Length of blade

(8) Propeller can be Feathered

(9) Propeller can be Reversed

5. Select from the column of information the items that explain the meaning of each of the characters in the following BLADE DRAWING numbers. Place the correct information in the blank spaces provided at each blade drawing number.

a. Hamilton Blade drawing numbers

A 7111 C 2

(1) Basic blade design

(2) Complete blade assembly

(3) Blade material

(4) Inches propeller is reduced from original diameter

(5) Shank size

(6) Blade has a molded cuff

(7) Direction of rotation

(8) Major changes

(9) Blade belongs to a matched set

(10) Minor changes

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PROGRAMMED TEXT

3ABR42633-PT-216

Technical Training

Turboprop Propulsion Mechanic

MULTIMETERS
(PSM-37)

25 March 1981

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

Do Not Use on the Job.

RGL: 9.6

FOREWORD

This programmed text was prepared for use in Course 3ABR42633, Turboprop Propulsion Mechanic. The material has been validated with thirty (30) students from the subject course. Ninety percent of the students achieved the objectives as stated. The average time to complete this programmed text was 5 hours and 30 minutes.

OBJECTIVES

After completing this program test, you will be able to identify the parts of the PSM-37 multimeter, and the correct procedures for using it.

INSTRUCTIONS

This programmed text presents information in small steps called "frames." Carefully study the written material and/or diagram in each frame until you are satisfied that you understand its contents. Each frame requires you to respond to the information in some way. For example, you may be required to select the true statements or insert a correct answer. Specific instructions are provided in each frame. After you have made your response, compare your answers with the answers given two frames over. The answers will be located at the bottom of the page. If you are correct, go on to the next frame. If you are incorrect, study the frame again and correct your mistakes before continuing. If you still can't understand your mistake, ask your instructor for assistance. Read carefully, select the correct answer and DO NOT HURRY.

INTRODUCTION

In the inspection, maintenance, and operation of aircraft electrical equipment you will often have to measure voltages, currents, and resistance. In electrical work, one or more of the following methods are commonly used to determine if the circuits on an aircraft are operating properly:

1. Measure the amount of current flowing in a circuit.

2. Determine the difference in potential between two points in a circuit.

3. Measure circuit continuity and total or partial circuit resistance.

The multimeter has been designed as a multipurpose instrument that can measure AC/DC voltages, resistances, and DC current flow. There are a number of multimeters in use by the Air Force. You will learn to use the PSM-37 multimeters in this PT.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 400; DAV - 1

Frame 1

This frame summarizes the safety precautions that must be observed when using the PSM-37 to test circuits.

1. The PSM-37 should never be handled carelessly. Aside from being expensive, it is sensitive and delicate. Don't abuse it.

2. When measuring voltage and current, start your check with the range switch set on "1000". Then move it to a lower setting if necessary. Then turn it to a range higher than that applied to the circuit after making the check. This way the meter will be ready for the next check.

3. Never connect the ohmmeter to a circuit that has power on it.

4. When used as a voltmeter, connect it in "parallel" with the voltage drop being checked.

5. When measuring DC voltage and current, be sure to observe polarity when connecting the meter to the circuit. Note if the meter needle moves left on the scale, either reverse meter leads on the circuit or turn the polarity switch to the other DC position.

6. When used as an ammeter, connect it in "series" with the portion of the circuit being checked.

7. Before connecting the meter to a circuit, make sure it is set up for the values to be measured. (AC or DC volts and amps, or ohms)

8. Periodically check the strength of the internal battery. Accomplish this by zeroing the ohmmeter on each of the range switch settings. If it does not zero on all settings, the battery needs to be replaced.

9. Store the meter with the switches in the following positions: POLARITY switch "OFF", RANGE switch "1,000", and FUNCTION switch VOLTS 20 KΩ/V. These positions give the meter some protection if the next person forgets to check the meter before placing it in a circuit.

NO RESPONSE REQUIRED, GO ON TO THE NEXT FRAME.

Frame 2

The multimeter taught in this PT is the PSM-37 multimeter. The PSM-37 can be used to check alternating current (AC), direct current (DC), AC and DC voltage, and resistance. The maximum value of each that this meter can measure is given in the chart shown below.

Units	Without A Lead Adapter	With Adapter
Voltage	0-1000 Volts	0-5000 volts
Current	0-1 amp	0-10 amps
Resistance	0-100 Megohms	No Adapter

List the Five Functions of the PSM-37

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

In order for you to make volts, amps and ohms tests with the PSM-37 multimeter, you must know where all of the controls are found and what they do. We will tell you about each of them in the next few frames. As we talk of them, find them on your meter to check your knowledge of their location.

NO RESPONSE REQUIRED

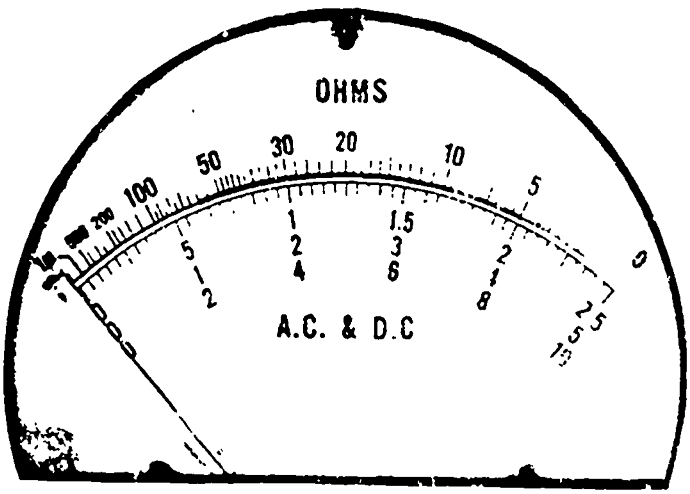
Frame 4

The meter face shows the values that you are measuring. It is made up of two scales, OHMS and AC and DC.

The green OHMs scale is used when you make a resistance test. It is read from right to left. Look at your meter; you will see a wide green area on the OHMS scale from 5-60. The reason for this is to show the part of the scale where the <u>most accurate readings</u> can be made. In later frames you will find it extremely important to take readings in this wide green area for the most accurate range.

The black AC & DC scale is used when you make a voltage or current test of circuits. The values of the scales will be volts when measuring voltage and milliamperes (MA) when you test for current. By now you should have seen that there are three sets of numbers below the black scale. You will be told more about these later.

The meter needle (pointer) points to the value of volts, milliamperes or ohms being measured.



Match the statement or function in Column B with the names to which they relate in Column A by placing the letter of the Column B items beside the numbers of the Column A items.

Column A

____1. OHMS scale

____2. AC & DC scale

____3. Needle

____4. Most accurate ohms

Column B

a. Read left to right and evenly marked.

b. Moves to indicate the valued being measured.

c. Ranges from zero (0) to infinity (∞)

d. Displays the values being measured.

e. 0 to 60.

f. 5 to 60.

Answers to Frame 2:

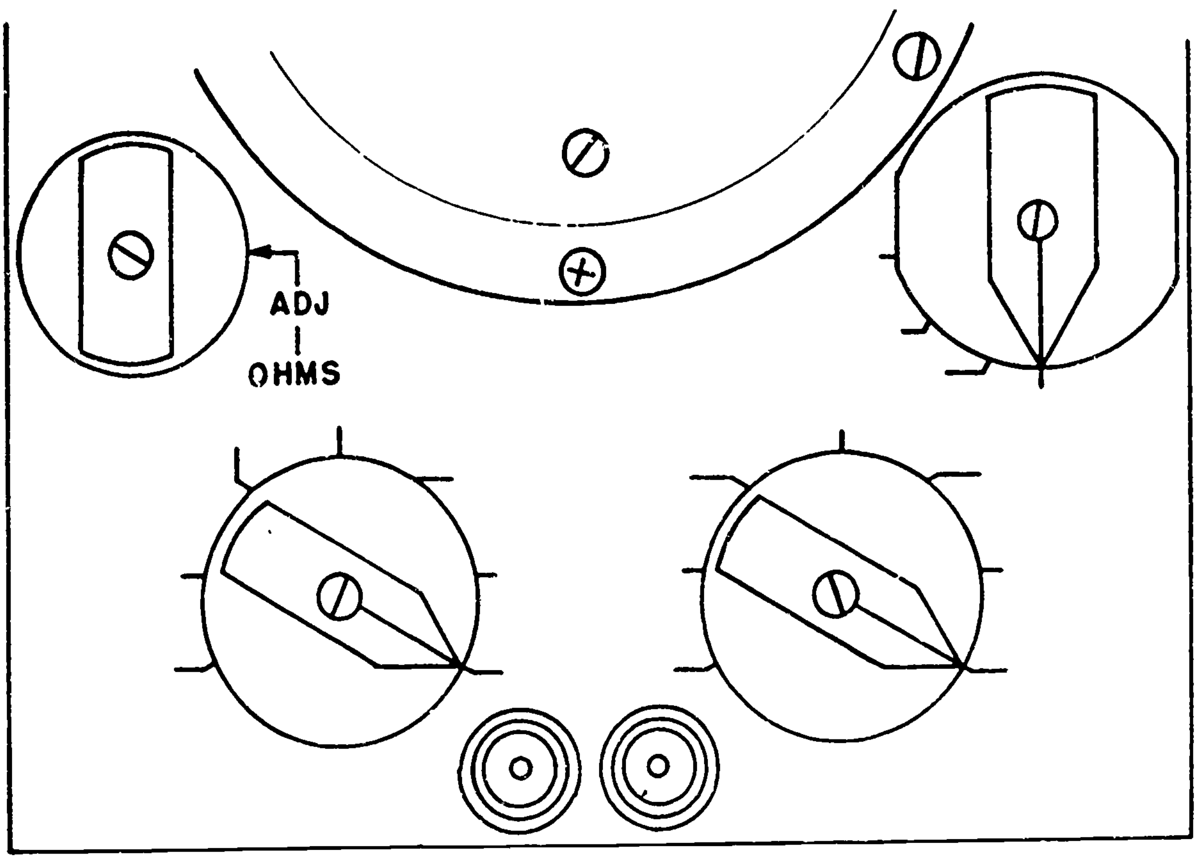
1. AC voltage, 2. DC voltage, 3. AC current, 4. DC current

5. Resistance. (Answers may be given in any order.)

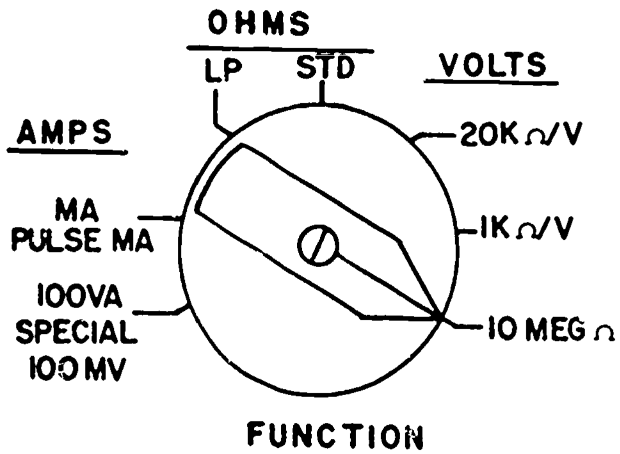
Frame 5

The OHMS ADJUST knob is found at the center and to the left of the meter front and is marked ADJ. It is used to compensate for the aging of the batteries that are in the meter. It is turned to make the needle line up on the "0" on the ohms scale, before you make a resistance check.

NO RESPONSE REQUIRED



The FUNCTION switch can be seen in the lower left on the meter front. It is used to set the meter up to test for AMPS, OHMS, or VOLTS. It has seven positions. The ones that you will have to use the most are the "MA" position for current checks, "LP" and "STD" for resistance checks, and "20KΩ/V" for voltage checks. The "LP" position on ohms has a low power output for use when testing solid state devices and very small values or resistance (0 to 60Ω). The "STD" is used for all other ohms checks.



Place a checkmark (✓) beside each true statement.

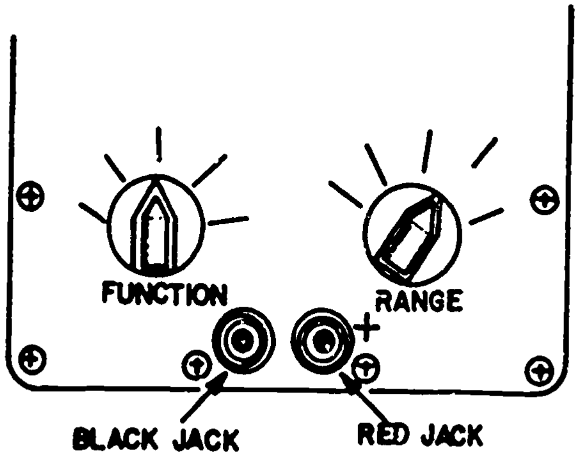
____1. To set the meter for measuring voltage, you would turn the function switch to one of the voltage settings.

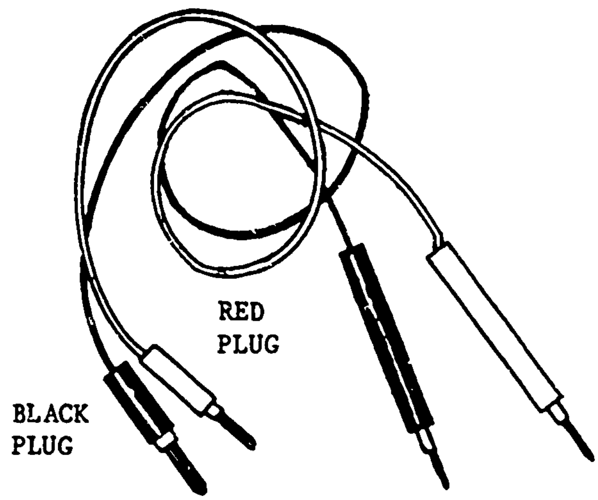
____2. The "STD" position of the function switch is for measuring low powered components.

Answers to Frame 4: 1. c, 2. a, 3. b, 4. f

Frame 7

The test jacks are found at the bottom center of the meter front. The red one is the positive jack and is marked with a + . The black jack is negative and is not marked. The two jacks give a connection point for the meter leads. There are two meter leads; one red and one black. The red lead will always be placed in the positive side of the circuit and the black in the negative. Be sure that you match the color of the lead with the color of the jack. If you reverse the leads, the meter may be damaged when it is connected to a live circuit (one that has power applied). Refer to the diagram below.





Complete the following statement(s) by choosing the correct word or words and record them on the response sheet.

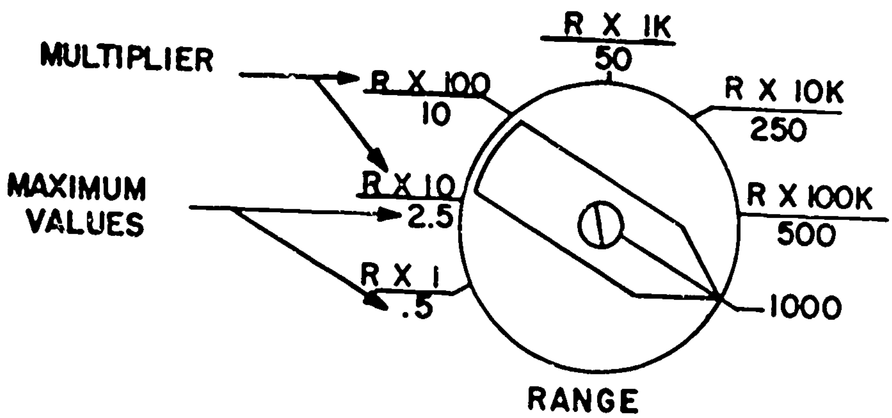
1. The red lead is__________ (negative/positive) and is connected to the__________ (red/black) meter jack. The __________(red/black) negative lead is connected to the __________(red/black) meter jack.

The RANGE switch is found in the lower right corner of the meter front and is marked RANGE. It is used to set the maximum values of voltage and current to be measured or, the multiplier for the resistance checks. The maximum range settings are those numbers below the lines. The multipliers are the R X numbers above the line. The position of the range switch relates one of three things to the operator:

1. The maximum voltage that the meter can measure at that particular range setting. Set the function selector to the volts - 10 Meg position and the range switch to the 10 position. The meter will measure a maximum of 10 volts.

2. The maximum current that the meter can measure at that part cular range setting. Set the function selector to AMPS - MA and the range switch to 500. The meter is capable of measuring a maximum of 500 ma (one-half of an amp).

3. The multiplier of the ohmic (resistance) value that the meter is reading. Set the function selector to the OHMS - STD position and the range switch to R X 1K. Multiply the meter reading by 1000 to get the correct resistance value.



Place a checkmark (✓) beside the true statement (s)

____1. The range switch means the maximum voltage the meter will meas..e on the OHMS function.

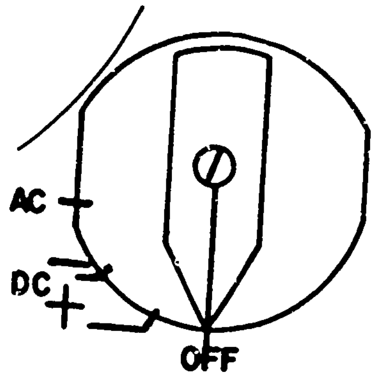
____2. While the PSM-37 is set to AMPS - MA, the range switch tells the operator the maximum current the meter is capable of measuring at that setting.

____3. With the RANGE switch in the R X 10K/250 setting, the operator would multiply the OHMS scale readings by 10,000.

Answers to Frame 6: ✓1. ____2.

Frame 9

The polarity switch turns the multimeter on and off, and sets the meter to test DC+, DC-, or AC. The + and - signs mean the polarity that must be applied to the red test lead when you make DC measurements so that the meter pointer will move up scale to the right. If the pointer moves to the left, just change the polarity switch to the other DC setting or reverse the test leads in the circuit. When you make OHMS checks, the + or - will mean the output polarity of the red test lead. The shape of the polarity switch knob will not allow the cover for the meter to be put on unless the switch is in the off position.



Complete the following statements by placing the correct word(s) in the blank spaces.

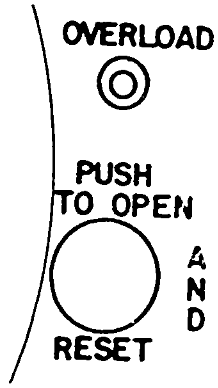
1. When a negative voltage is applied to the red lead, the polarity switch must be turned to the __________ position.

2. The meter polarity switch would be turned to ________ position when measuring alternating current.

3. If the meter needle moves to the left of the "0" on AC & DC scale, the ________ switch must be turned to the opposite DC position.

Answers to Frame 7: 1. positive, red, black, black

The OVERLOAD indicator, and the PUSH TO OPEN AND RESET control are both a part of the overload protection circuit. A red shaft will show in the overload indicator when the meter has been overloaded. To reset the meter for normal use, just take the meter leads out of the circuit, and push the "push to open and reset" control. The red shaft will retract and stay that way when you let go of the button, if the overload circuit breaker has been reset the right way. The next step is to set the meter to a higher range so that it will not be overloaded again. Now the meter is ready for use. The push to open and reset control should be pushed in when you change the range or function switch setting and you do not take the test leads from the circuit.

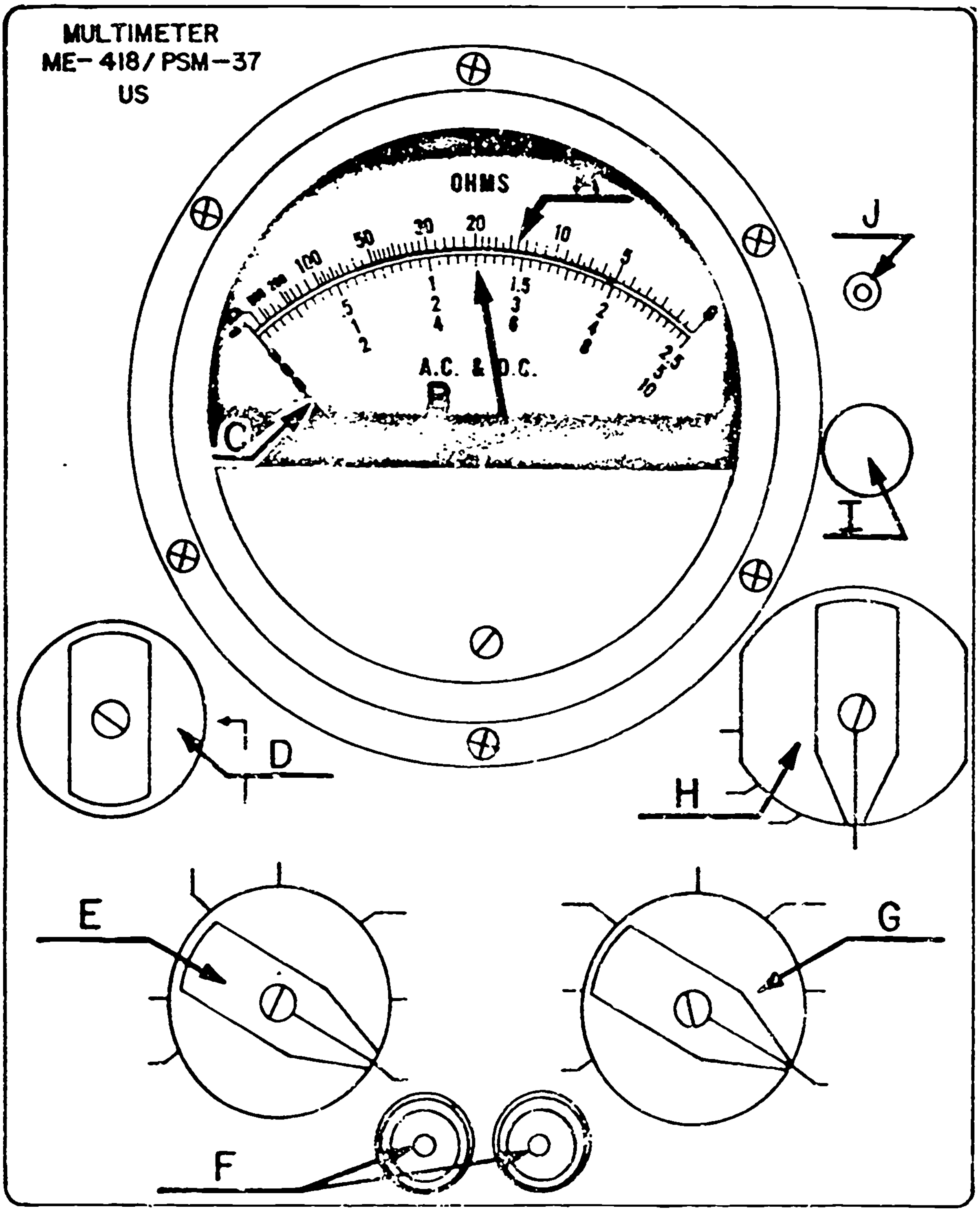


Complete the statements below by filling in the blank spaces with the correct answers.

1. If too much voltage or current is applied to the meter, the ____________ indicator will have a __________ shaft appear in it.

2. After removing the meter from a circuit due to an overload, you must push in the __________ button.

Answers to Frame 8: ____1. ✓2. ✓3.



This illustration is to be used with the meter controls and function exercise on the next page.

The following exercise checks your knowledge of the meter control names, location and functions. Use the illustration of the meter on the preceding page to select the letter that corresponds to the name of that control. Place the letter you chose from the illustration in the "Meter Letter" column. Then match up the function of the controls in the "Function" column with the name of the control in the "Name" column. Place your letter choice in the "Function Letter" column.

Name	Meter Letter	Function Letter
1. Needle (Pointer)	C	(b)
2. OHMS (Green)	____	( )
3. OHMS Adj.	____	( )
4. Test jacks	____	( )
5. Function switch	____	( )
6. Polarity switch	____	( )
7. PRESS TO OPEN and RESET	____	( )
8. AC & DC	____	( )
9. Overload	____	( )
10. Range Switch	____	( )

Functions

(a) scale used to indicate voltage or current readings.

(b) aligns with the scale to indicate value measured.

(c) hook-up point for leads.

(d) used to break meter input circuit and reset overload protector.

(e) used to "zero" the pointer on OHMS scale.

(f) determines if meter measures OHMS, VOLTS, or AMPS.

(g) used to select the type of current or voltage to be applied to the meter.

(h) indicates values in OHMS.

(i) determines maximum value to be measured or multiplier for ohms.

(j) indicates excessive power has been applied to PSM-37.

Answers to Frame 9:

1. DC-, 2. AC, 3. Polarity

Frame 12

Look at the face of the PSM-37 meter in front of you. The AC & DC scales are printed in black. On the lower left side of the meter face you will find the FUNCTION switch. It has three VOLTS positions. While in this block we will have you use the 20KΩ/V position. The only difference between the three positions is in circuit loading and this will be explained in more detail later in the course. On the lower right side of the meter face is the RANGE switch. This switch is very important since it is used to select the maximum range the meter can measure in volts and current. If you select the wrong range, you could cause damage to the meter.

Look at the AC & DC scale. You will notice that there are three sets of numbers. In the space below, write the range for each set of numbers. The first one has been done for you.

Top Scale: Numbers range from 0 to 2.5.

Middle Scale: Numbers range from ______ to ______.

Bottom Scale: Numbers range from ______ to ______.

Answers to Frame 10: 1. overload, red 2. Push to open and reset

Frame 13

The number to the far right of each scale shows the maximum deflection of the meter's needle. The values of these numbers (2.5, 5, and 10) will depend on where the range switch is set. There are seven ways to set the range switch: .5, 2.5, 10, 50, 250, 500, and 1,000. These numbers show the highest value which can be read with the meter for any of the settings of the range switch. For example, if the range switch was set at 250, the maximum value that could be checked with the meter would be 250. This value may be in volts or milliamps as determined by the function switch. If more than 250 were applied to the meter, it might be damaged.

Fill in the blanks with the correct number.

1. If the range switch is set at 50, the maximum voltage that can be measured would be ___________.
2. If the range switch is set at 2.5, the maximum voltage that can be measured would be ___________.
3. If you wanted to measure a voltage, the value which would be between 250V and 500V, the RANGE switch would have to be set at the _________ position.

Answers to Frame 11: 1. C (b) 2. A (h) 3. D (e) 4. F (c) 5. E (f) 6. H (g) 7. I (d) 8. B (a) 9. J (j) 10. G (i)

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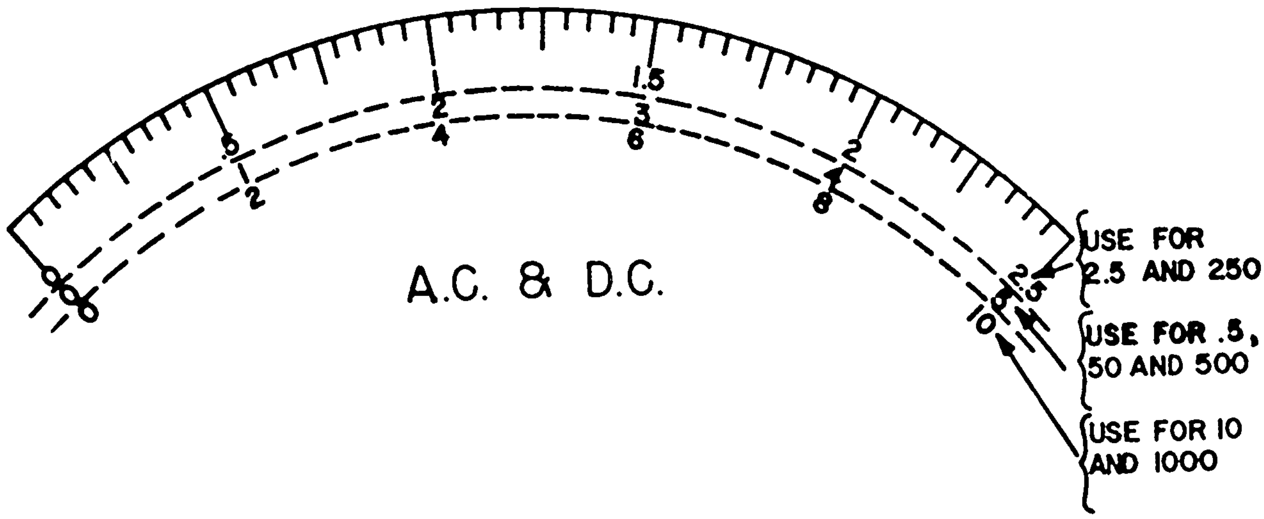
Frame 14

Since there are seven ways to set the range switch and only three different scales, each scale is used by several range positions. The 2.5 and 250 range switch positions use the top scale (0-2.5). The .5, 50, and 500 ranges use the middle scale (0-5). The 10-100 range use the bottom scale (0-10). Do not try to memorize these as they are easy to figure out. The first digit of the ranges that use the 0-5 scale is a 5. The first digit of the ranges that use the 0-2.5 scale is a 2. The first digit of the ranges that use the 0-10 scale is a 1.



Place either 0-2.5 or 0-5, or 0-10 in the spaces provided to indicate the scale that would be used for each of the range switch settings. The first one has already been done for you.

Range Switch Set at	Scale Used
.5	a. 0-5
2.5	b. ________
10	c. ________
50	d. ________
250	e. ________
500	f. ________
1000	g. ________

Answers to Frame 12: 0 to 5 0 to 10

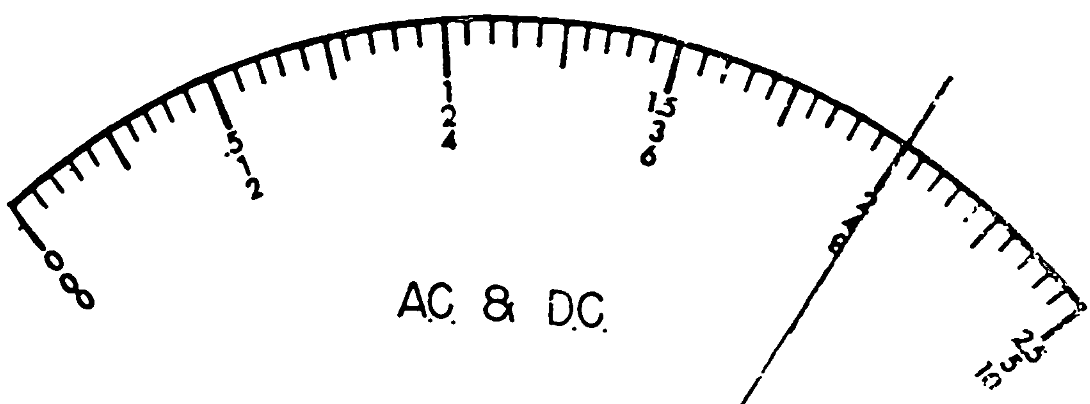
In the last frame you learned how to choose the right scale for each range position. With the RANGE switch set on 50, the readings are read from the 0-5 scale. Since the meter can now only read a maximum of 50, the number 5 will mean 50. The 4 will mean 40, the 3 will mean 30, and so on. Notice that the changing of 5 to 50 resulted in the maximum number on the scale matching the RANGE switch position, and the other numbers change by the same amount (multiplied by 10). The way you determine the value of the maximum number on the scale is by changing the maximum number on the scale to match the RANGE switch position. Example: The range position of 250 uses the 0-2.5 scale. The 2.5 will now mean 250, the 2 will mean 200, the 1.5 will mean 150, and so on.

For all the exercises below, the POLARITY switch is set on DC+, the FUNCTION switch is set on VOLTS 20KΩ/V. What is the voltage indicated on each of the following scales for each of the RANGE switch positions? The first one is completed for you.

1. Use figure A.

a. 50 range 40V DC   c. 500 range ________

b. 1000 range ______   d. .5 range ________



A.

Frame 15 (Cont'd)

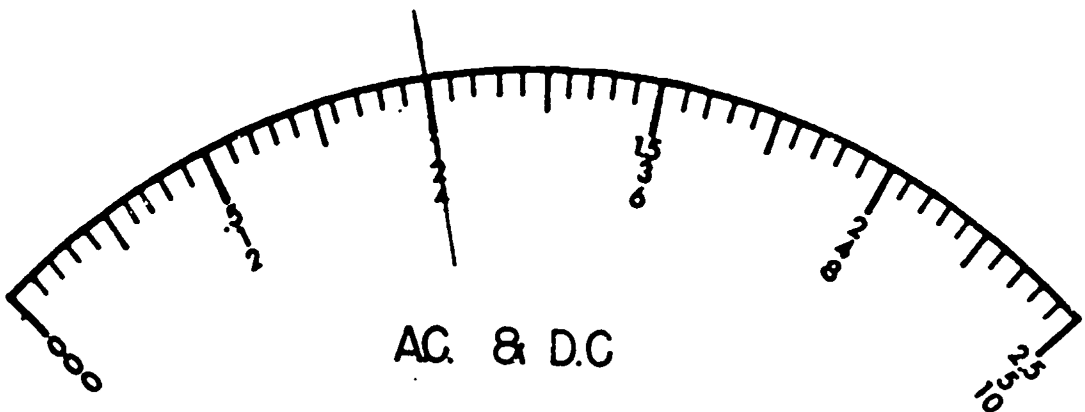
2. Use figure B.

a. 2.5 range __________

b. 10 range __________

c. 250 range __________

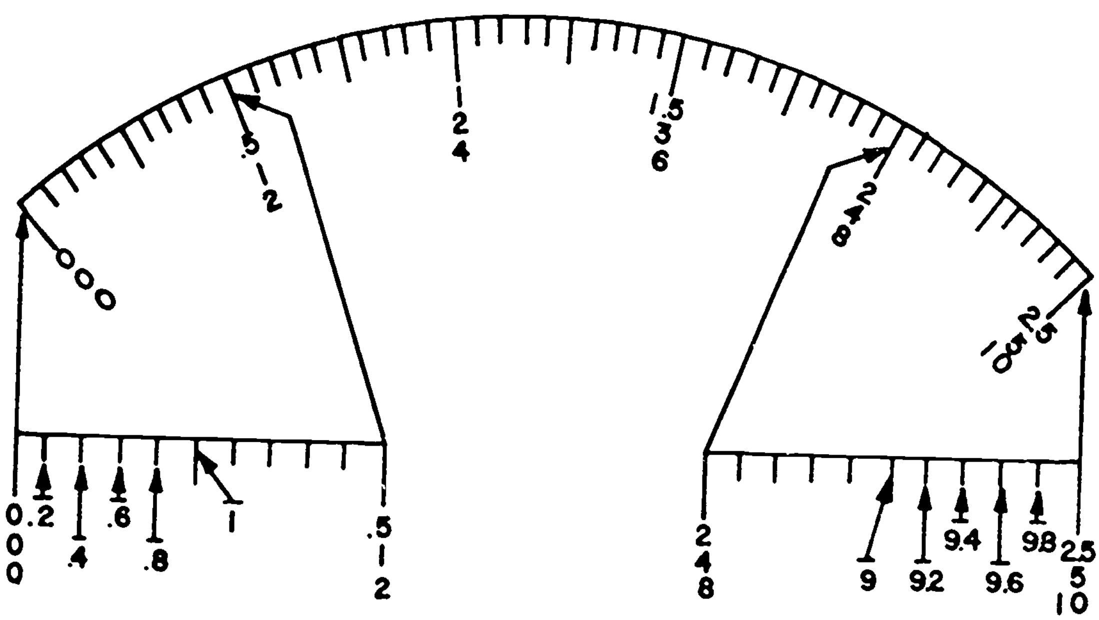
d. .5 range __________



B.

Answers to Frame 13: 1. 50V 2. 2.5V 3. 500V

The maximum value of each scale is determined by the position of the RANGE switch. With the RANGE switch at the 10 range, the 0-10 scale was read as is, Max 10. The difficulty in reading the scale comes when the needle stops on one of the small marks between the numbers. To find the value of each mark on the scale, divide the RANGE switch position by 50. Example: RANGE switch in 10 range, divide 10 by 50 to get .2. Each marking on the 0-10 scale is worth .2 points a piece. See figure A below. When you start at zero, you would count the marks, 0, .2, .4, .6, .8, 1 - - - - - - - - 9.2, 9.4, 9.6, 9.8, 10. You use the same procedure to find the value of the small mark for each of the RANGE switch positions. The reason we use 50 as the denominator is there are 50 marks along the AC & DC scale. Since the scale is linear (evenly spaced and marked), you can use the 50 as the denominator on all range positions and scales.



Frame 16 (Cont'd)

PROBLEM 1

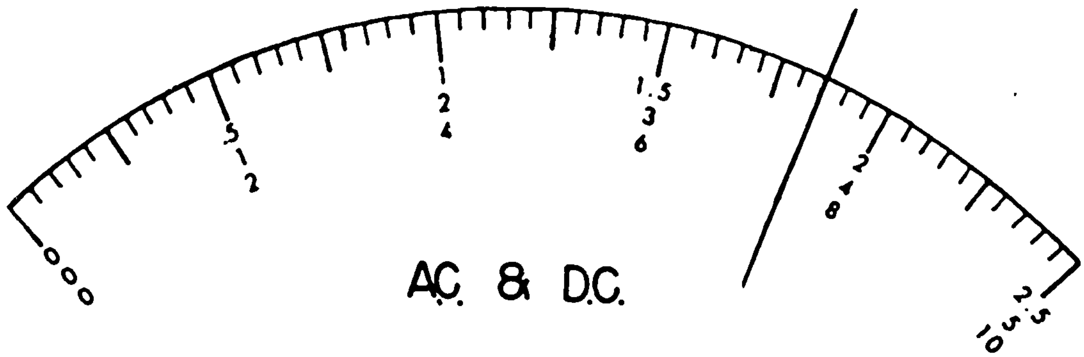
Fill in the blanks with the appropriate response for the scale used and the value of each black mark on the scale. The first one is accomplished for you.

Range Switch Set At	Scale Used	Value of Each Mark
.5	0-5	.01
2.5	a. ______	b. ______
10	c. ______	d. ______
50	e. ______	f. ______
250	g. ______	h. ______
500	i. ______	j. ______
1000	k. ______	l. ______

Answers to Frame 14: b. 0-2.5 c. 0-10 d. 0-5

e. 0-2.5 f. 0-5 g. 0-10

The following exercise is to insure your ability to interpret meter indications in various RANGE switch positions, and check your ability to determine the value of each mark on the meter scales. Fill in the correct answer in the appropriate space for each of the following items. Number one is completed for you.



Range Switch Set At	Value Indicated
1. .5	.37
2. 2.5	______
3. 10	______
4. 50	______
5. 250	______
6. 500	______
7. 1000	______

Answers to Frame 15: 1. b. 800V DC c. 400V DC d. .4V DC

2. a. 1V DC b. 4V DC c. 100V DC d. .2V DC

Frame 18

You now know how to read the scales and its values, with the range switch set in any of the ranges. What you have learned will be true even if the meter is measuring AC or DC voltage or current. In the next few frames you will learn how to set the meter up to read DC volts, AC volts, DC current and AC current. It is important that you know the positions of the three switches, so you can tell what the meter is reading. The switches are: The POLARITY switch to tell if you are measuring + or - DC or AC volts, or current; the FUNCTION switch to tell if you are measuring voltage (VOLTS position), resistance (OHMS position), or current (AMPS position); the RANGE switch to tell you the maximum value and scale to be used for the readings.

Place a checkmark (✓) beside the true statement(s).

____1. To measure OHMS, the polarity switch would be on either DC position, the function switch to OHMS, and the range switch to appropriate R X position.

____2. To measure a 30 volt battery, the polarity switch would be in +DC, the FUNCTION switch to VOLTS, and the RANGE switch to R X 1K/50 position.

Answers to Frame 16: a. 0-2.5 b. .05 c. 0-10 d. .2

e. 0-5 f. 1. g. 0-2.5 h. 5. i. 0-5 j. 10

k. 0-10 l. 20

When you want to read DC voltage it is important to have the meter set up right. The FUNCTION switch set to VOLTS (in school, 20KΩ/V position); the POLARITY switch set to the polarity of the voltage applied to the RED test lead; (Note: In most cases, this will be positive and the polarity switch will be set at "DC+".) the RANGE switch will be set to the value of the voltage to be read. For example, if the voltage to be read is 8 volts DC, the RANGE switch would be set at 10. It is important to keep in mind the range switch sets the maximum value can read; so, set the RANGE switch above the value to be read. When you want to read an unknown voltage, start with the range switch at the highest value. Then, turn the RANGE switch to a lower setting until the meter shows a voltage value. This procedure is a good practice to follow, regardless of what you are measuring.

Fill in the blanks with the correct switch position. For practice, set your meter up to measure the voltage in problem number one.

1. If you knew that you were going to measure approximately 120 volts DC, the RANGE switch would be set at ______, the POLARITY switch set at DC+ and the FUNCTION switch set at ______.

2. If you didn't know the approximate value of the voltage that you were measuring, you would use the ______ range first.

3. A negative voltage polarity is applied to the RED test lead, the POLARITY switch would be set at ______.

Answers to Frame 17: 2. 1.85 3. 7.4 4. 37 5. 185 6. 370 7. 740

Frame 20

When you use a voltmeter, you have to be sure the readings are as true as you can get them. <u>Always</u> choose the RANGE switch position which will cause the meter needle to move as close to a full scale reading as you can. For example, you could read 2 volts DC on the PSM-37 in front of you by setting the RANGE switch on 10 and read the voltage value off the bottom scale (0-10). But, it would be better if you set the RANGE switch to 2.5 and read the voltage on the top scale (0-2.5). By doing this, you can get more needle deflection than if you had set the RANGE switch on 10.

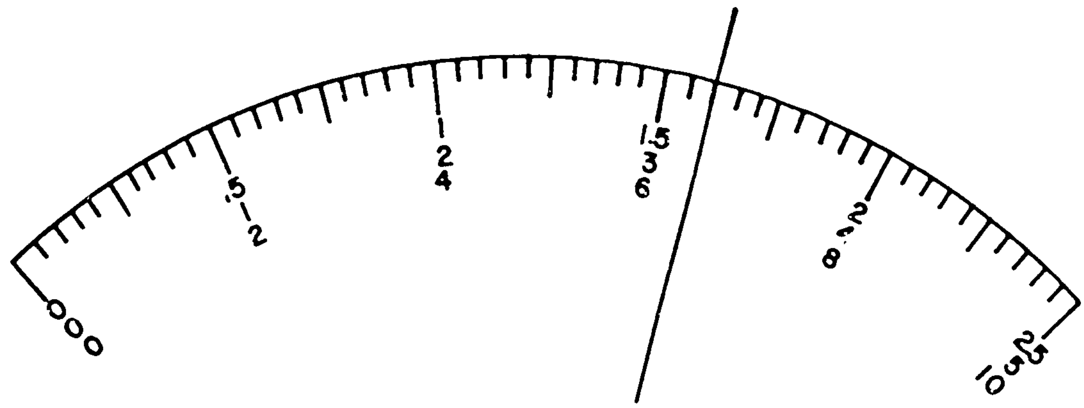
Fill in the blanks with the correct positions.

1. Look at the meter in front of you. If you were going to measure approximately 300V, you would have to set the range switch at ________ to get the most accurate reading.

2. If you wanted to accurately measure 30V, you would have to set the range switch at __________.

Answers to Frame 18: ✓ 1. ✓ 2.

1. Fill in the correct answers in the appropriate spaces for the meter scales shown below. The FUNCTION switch is set at VOLTS (20 KΩ/V), and POLARITY switch is set at DC+.



Range Switch Setting	Indication
a. .5	________
b. 2.5	________
c. 10	________
d. 50	________
e. 250	________
f. 500	________
g. 1000	________

2. For each of the following voltages, indicate on the blank, the range that should be used to obtain the most accurate readings.

Voltage	Range Switch Setting
a. .15	____________
b. 1.5	____________

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Frame 21 (Cont'd)

c. 15 ____________

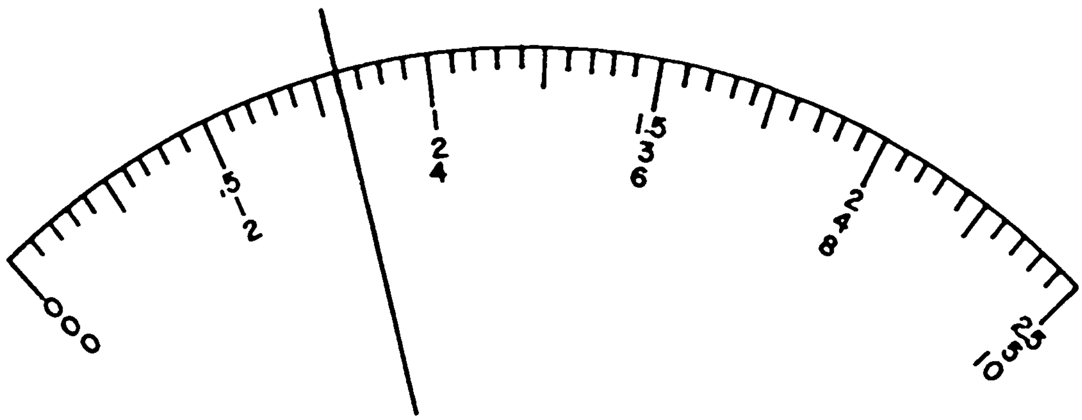
d. 150 ____________

e. 750 ____________

Answers to Frame 19: 1. 250, VOLTS (20 KΩ/V) 2. 1000 (highest)

3. DC-

Fill in the correct answer in the appriopriate spaces for each of the following items. The FUNCTION switch is set at volts (20KΩ/V) and the POLARITY switch is set at DC+.



Range Switch Set At	Voltage Indicated
1. .5	________
2. 2.5	________
3. 10	________
4. 50	________
5. 250	________
6. 500	________
7. 1000	________

Answers to Frame 20: 1. 500 2. 50

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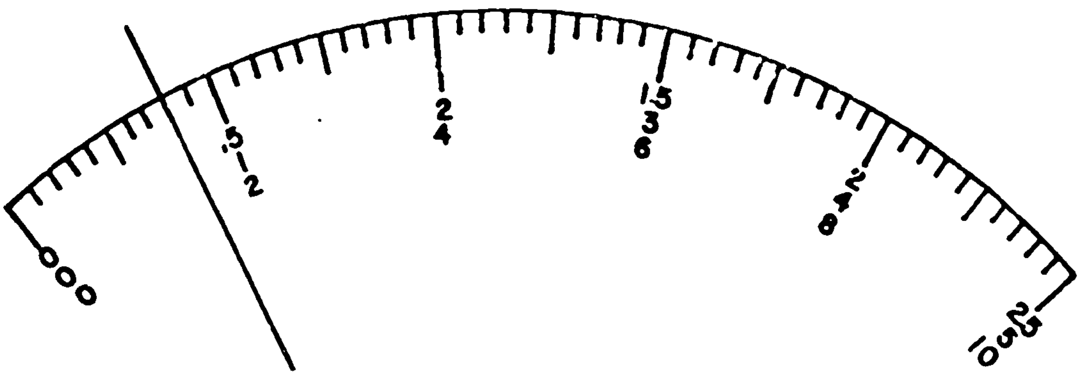
Frame 23

Fill in the correct answer in the appropriate spaces for each of the following items (the FUNCTION switch is set at volts 20KΩ/V) and the POLARITY switch at DC+.

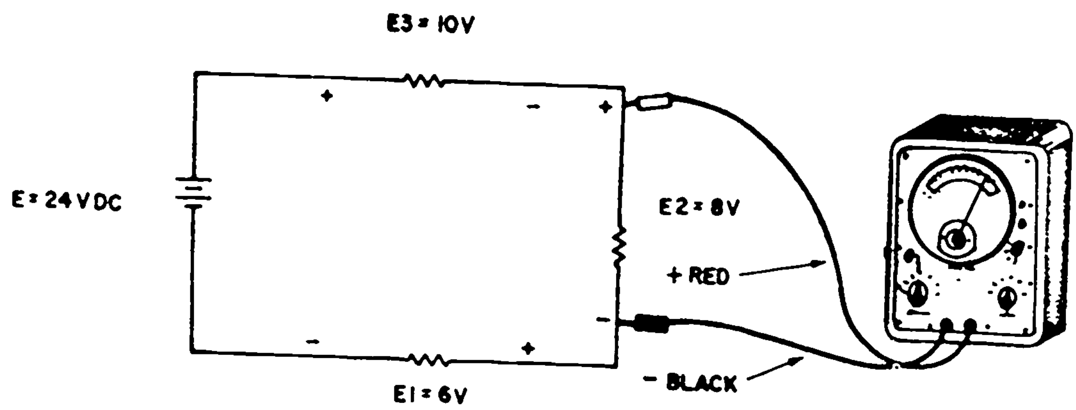


Range Switch Set At	Voltage Indicated
1. .5	____________
2. 2.5	____________
3. 10	____________
4. 50	____________
5. 250	____________
6. 500	____________
7. 1000	____________

Answers to Frame 21: 1. a. .32 b. 1.6 c. 6.4 d. 32 e. 160 f. 320 g. 640 2. a. .5 b. 2.5 c. 50 d. 250 e. 1000

When you test for the voltage of a DC circuit you must watch the polarity of the voltage drop before you place the test leads in the circuit. Once you know the polarity, place the black lead of the voltmeter to negative and the red lead to positive. The meter must be connected across (in parallel with) the component being measured, as shown in the diagram below. If you place the meter or leads in some other manner, you will have a wrong reading. Plus, it could cause damage to the meter.

> Note: Another thing that is important before you test for DC voltage, is that you should have your PSM-37 set up for the polarity value and the type of voltage that you will test.



The voltmeter is connected in parallel with R2.

Select the correct word and place it in the blank space to complete statements one, two, and three. For item four, fill in the blanks with the correct position of the switches.

1. When using the PSM-37 as a voltmeter, you would connect the meter in __________ (series/parallel) with the voltage to be measured.

2. If the meter is connected in series when making voltage checks, the readings will be __________ (accurate/inaccurate).

3. To measure the voltage E3 in the circuit above, the red lead will be placed on the __________ (right/left) of the resistor and the black lead on the ________ (other/same) end of the resistor.

Frame 24 (Cont'd)

4. Set your PSM-37 to measure the voltage E1 in the circuit above. The range switch position is ____________, the polarity switch position is ______________, and the function switch is set at ______________.

Answers to Frame 22: 1. .16 2. .8 3. 3.2 4. 16 5. 80

6. 160 7. 320

Answers to Frame 23: 1. .08 2. .4 3. 1.6 4. 8V 5. 40

6. 80 7. 160

You have now taken a reading at TP-A. The procedures will be the same for the other test points. However, before moving your positive lead to a different test point, set the RANGE switch back to the 50 position. Then, work down to the most accurate range for each test point.

For each of the following DC VOLTAGE test points indicate on the blank the amount of voltage that the meter is reading.

Position Number 1

A. __________ F. __________

B. __________ G. __________

C. __________ H. __________

D. __________ I. __________

E. __________ J. __________

Check your answers for A-E before continuing to F.

As you complete each of the following steps place a check on the blank by the number of the step.

_____1. Turn the DC VOLTAGE SWITCH on the voltage, current, and resistance readings trainer to the "OFF" position.

_____2. Turn both the TRAINER POWER PANEL SWITCH and the 28V DC POWER PANEL SWITCH on the workbench to the "OFF" position.

_____3. Turn the POLARITY switch on your PSM-37 to the "OFF" position.

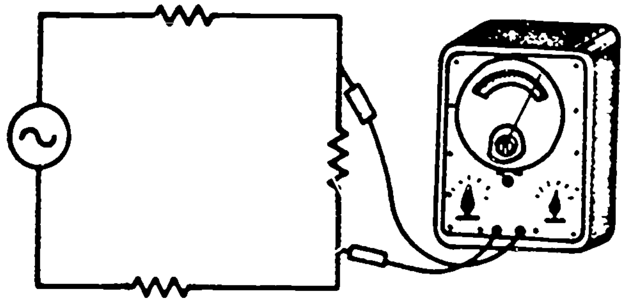
Answers to Frame 24: 1. parallel 2. inaccurate 3. left, other

4. 10, DC+, VOLTS

Frame 26

When you use the PSM-37 to measure the volts in an AC circuit it is used the same way as for DC circuits. The one difference is you do not need to observe polarity since AC means alternating current; a current that will first flow in one direction and then it will flow in the opposite direction.

To use the PSM-37 as an AC voltmeter, you must set the controls up properly; plus, you must place the meter in parallel with the voltage that you will test.



Meter in PARALLEL TO
measure AC voltage drop

Place a checkmark (✓) beside the true statement(s).

____1. You must observe polarity when measuring volts in an AC circuit.

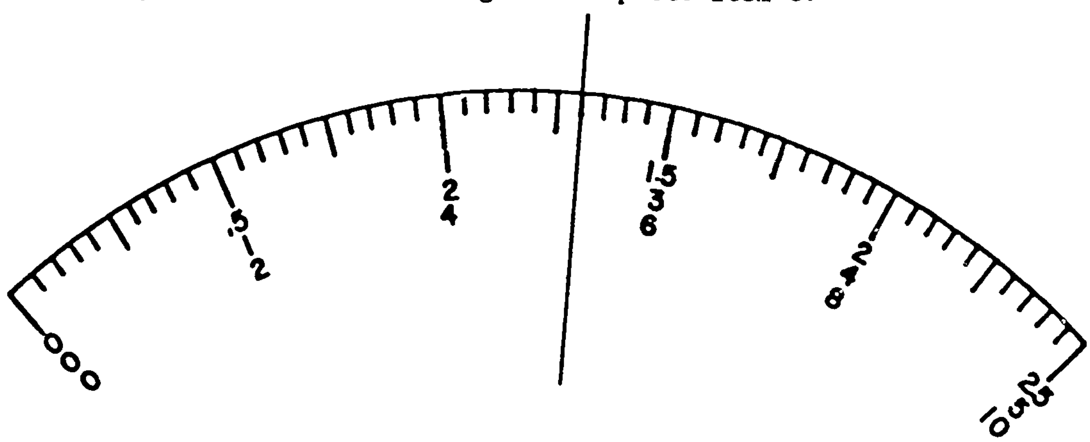
____2. An ammeter is connected in series to measure voltage in an AC circuit.

The way that you read AC voltage is much the same as for reading DC volts. The only change is that you set the POLARITY switch to the AC position. You see that the POLARITY switch must be set to match the type of voltage or current that you will measure. Since AC stands for alternating current, the meter leads have no set polarity while measuring AC.

Place the correct answer in the spaces for the following exercise. For practice, set your meter up to measure the voltage value in problem number one.

1. To measure 240 volts AC, turn the POLARITY switch to _______, the RANGE switch to ________, the FUNCTION switch to ______ and take the readings from the 0 to _______ scale.

2. Use the meter scale below to complete items a and b. Use your meter and knowledge to complete item c.



a.	Range switch at 50.	Voltage indicated _____V AC.
b.	Range switch at 250.	Voltage indicated _____V AC.
c.	Range switch at _____	Voltage indicated 5.2V AC.

Answers to Frame 25:

a. 1.15V	f. 0V
b. 20V	g. 11V
c. 9V	h. 3.6V
d. 24V	i. 2.8V
e. 18V	j. .35V

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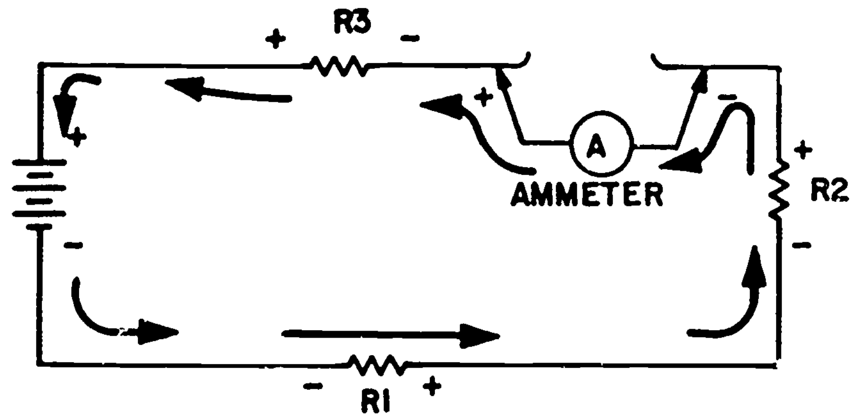
Frame 28

To measure current flow, the meter must be connected in series in the circuit. When you connect it in series the same current that flows through the circuit is the same that flows through the PSM-37. Do not place an ammeter in parallel to measure current. If you do, the meter can be damaged or the reading you take will be inaccurate and low. The circuit below shows you an ammeter that is properly placed in a DC circuit.



Place a checkmark (✓) beside the true statement(s).

____1. The ammeter must be connected in series with the circuit component being checked.

____2. To accurately measure current, the same current must flow through both the meter and the circuit component being checked.

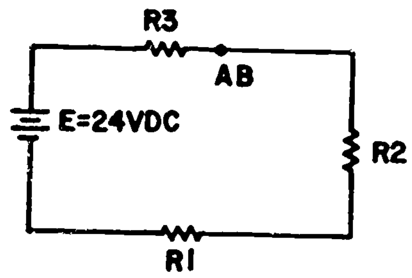
____3. If the PSM-37 is connected in parallel to measure current, the readings would be inaccurate and low.

Answers to Frame 26: ____1. ____2.

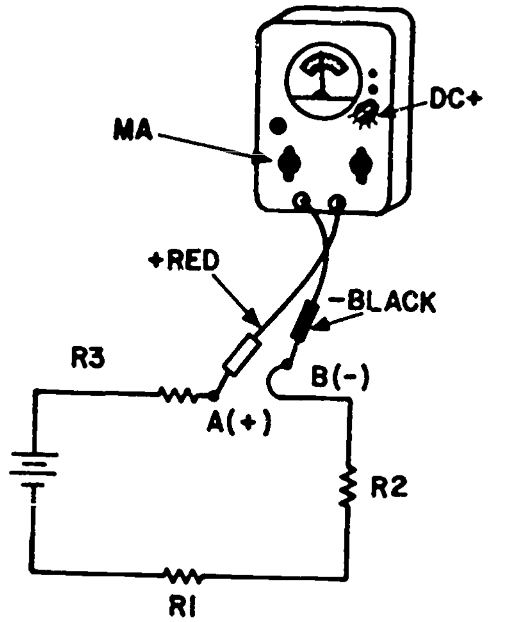
Answers to Frame 27: 1. AC, 250, VOLTS, 2.5

2. a. 26V AC b. 130V AC c. 10

Study the two diagrams for a few moments before reading the rest of this frame.



"CIRCUIT A"



"CIRCUIT B"

To connect an ammeter in a circuit to test current flow, the circuit must be broken. Notice in circuit A that there is a point marked AB. In circuit B this point has been separated to form - - points "A" and "B". Since point "A" is connected to the plus (+) post of the battery through R3, point "A" is positive (+); point "B" is connected to the minus (-) post of the battery through R1 and R2 so it is negative (-). Remember, this circuit has DC volts applied. You must observe the polarity of the points to which the meter is connected.

The red test lead will be connected to point "A" and the black test lead connected to point "B". The circuit current now leaves the minus side of the battery, goes through R1, R2, in the black lead, through the meter, out the red lead, through R3 and back to the plus post of the battery.

Caution: Turn power "off" to the circuit when connecting and disconnecting an ammeter in and out of a circuit.

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Frame 29 (Cont'd)

Place the correct answer in the blank space provided, to complete the following statement(s).

1. Before the PSM-37 can be used to test circuit current, the circuit must be __________ and the meter placed in ________ with the circuit.

2. Set your PSM-37 up to measure 29 MA DC.

   The position of the switches are:

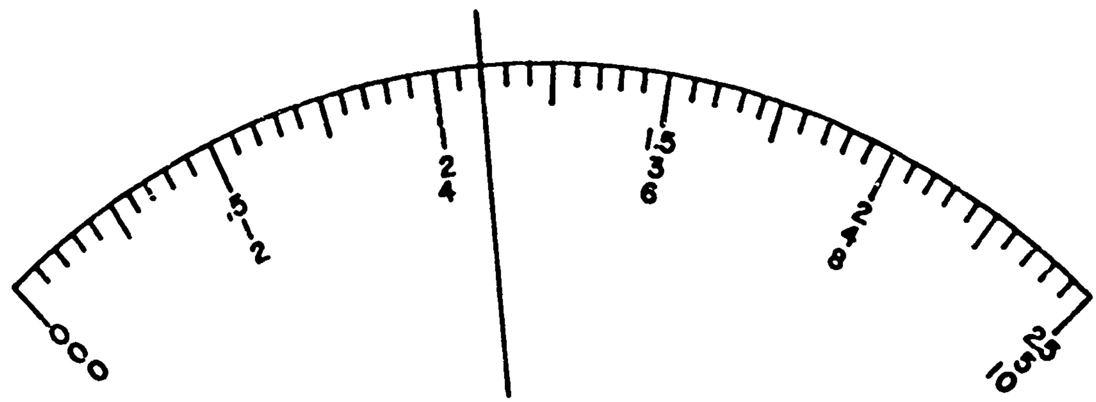
   a. Range switch __________.

   b. Function switch __________.

   c. Polarity switch __________.

You use the same scales to read current as you used to read volts. To measure DC milliamperes (MA) set the POLARITY switch to the DC+, set the FUNCTION switch to "MA/PULSE MA", and set the RANGE switch to the value that you wish to measure. The PSM-37 can read up to 1000 MA which is the same as one ampere.

Fill in the correct answer in the appropriate space for the following items.



1. FUNCTION switch set at AMPS, MA position.

   a. RANGE switch set at 1,000. Current indication is _____MA.

   b. RANGE switch set at 500. Current indication is _____MA.

   c. RANGE switch set at 250. Current indication is _____MA.

   d. RANGE switch set at 10. Current indication is _____MA.

Answers to Frame 28: ✓ 1. ✓ 2. ✓ 3.

Frame 30 (Cont'd)

2. Set your meter up to measure 22 MA DC.

   a. The RANGE switch setting is ______.

   b. The POLARITY switch setting is ______.

   c. The FUNCTION switch setting is ______.

We stated earlier that 1,000 milliamps is equal to one amp. Thus, two amps is equal to 2,000 milliamps and .6 amp is equal to 600 milliamps. Let's see why!

$$2 \text{ amps} \times \frac{1{,}000 \text{ ma}}{1 \text{ amp}} = 2{,}000 \text{ ma}$$

$$.6 \text{ amp} \times \frac{1{,}000 \text{ ma}}{1 \text{ amp}} = 600 \text{ ma}$$

Fill in the blanks with the correct number.

1. 6 amps = _____ ma
2. .1 amp = _____ ma
3. .25 amp = _____ ma
4. 5 amps = _____ ma
5. .5 amp = _____ ma
6. .05 amp = _____ ma

Answers to Frame 29: 1. broken, series 2. a. 50 b. AMPS-MA c. DC+

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Frame 32

In the last frame you learned how to convert amps to milliamps. In this frame you will learn how to convert milliamps to amps. For example, 2,000 ma is equal to two amps and 600 ma is equal to .6 amp. Let's see why!

$$2{,}000 \text{ ma} \times \frac{1 \text{ amp}}{1{,}000 \text{ ma}} = \frac{2{,}000}{1{,}000} = 2 \text{ amps}$$

$$600 \text{ ma} \times \frac{1 \text{ amp}}{1{,}000 \text{ ma}} = \frac{600}{1{,}000} = .6 \text{ amp}$$

Fill in the blanks with the correct number.

1. 6,000 ma = _____ a
2. 100 ma = _____ a
3. 250 ma = _____ a
4. 5,000 ma = _____ a
5. 500 ma = _____ a
6. 50 ma = _____ a

Answers to Frame 30: 1. a. 440MA, b. 220MA, c. 110MA, d. 4.4 MA.
2. a. 50 b. DC+ c. AMPS MA.

When you use the PSM-37 as a milliameter, you will start on the highest range (1000) of the RANGE switch and work the switch down to the most accurate range. You should always push in on the PUSH TO OPEN and RESET button when you change the RANGE switch. This will cut down the chance of harm to the meter when measuring current. You should note that the most accurate reading on the AC & DC scale will be made when the needle moves as far right on the scale as it can, and still not go past the end of the scale.

Fill in the blanks below with the most accurate range switch position for each of the readings given. You may refer to your PSM-37 for a list of the ranges.

READINGS	RANGE	READINGS	RANGE
1. 40 MA	______	4. 225 MA	______
2. 400 MA	______	5. 11 MA	______
3. 4 MA	______	6. 600 MA	______

Answers to Frame 31:

1. 6,000	4. 5,000
2. 100	5. 500
3. 250	6. 50

Frame 34

The difference in the way that you set up the meter for measuring AC current rather than DC, is the way you set the POLARITY switch. To read AC, the POLARITY switch is set in the AC position.

Fill in the blanks with the correct response.

1. Using your PSM-37, set the controls up to measure 150 MA AC.

   a. FUNCTION switch position is ________.

   b. RANGE switch position is ________.

   c. POLARITY switch position is ________.

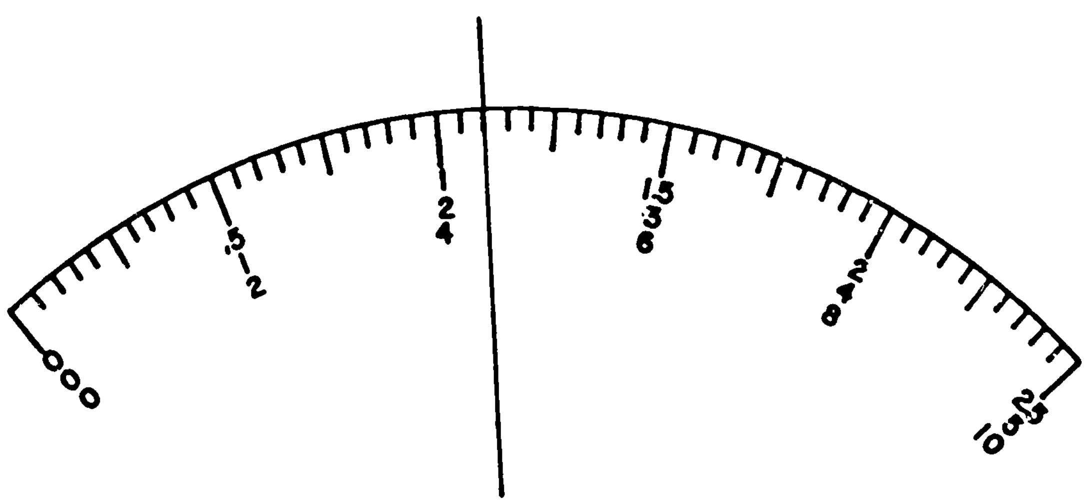
2. Using the meter scale below and your meter, fill in the blanks below with either the RANGE switch position or the indicated MA reading.

   a. Range switch at 1,000. Current indication is ____ MA.

   b. Range switch at 500. Current indication is ____ MA.

   c. Range switch at ____. Current indicated is 110 MA.

   d. Range switch at ____. Current indicated is 22 MA.



Answers to Frame 32: 1. 6, 2. .1, 3. .25, 4. 5, 5. .5, 6. .05

Answers to Frame 33: 1. 50 2. 500 3. 10 4. 250 5. 50 6. 1,000

The PSM-37 meter is built to measure many OHMS values. A look at the meter in front of you shows that there are six (6) positions for the ohmmeter function. They are R X 1, R X 10, R X 100, R X 1K, R X 10K and R X 100K. To measure resistance, the POLARITY switch must be turned to one of the DC positions (usually DC+); the RANGE switch must be set to one of the six positions listed above and the function switch must be set on OHMS. The OHMS position used in this block will be the STD position. (NOTE: The LP position is for testing low power devices and is used with the R X 1 position of the RANGE switch.) To measure resistance accurately, the ohmmeter must first be "zeroed". You zero the meter by touching the ends of the leads together with the meter set as you were told above. The meter needle should move to the zero end of the ohms scale. Note that the OHMS scale is GREEN. If the needle does not go all the way to zero, or goes past, then turn the OHMS ADJ knob. Turn the knob to bring the needle in line over the "zero" on the OHMS scale. When the test leads are separated the needle should go back to the left end of the OHMS scale, over the infinity (∞) mark.

Use your PSM-37 and zero the ohmmeter in the R X 10 through R X 100K range positions.

Note: The PSM-37 meter should not need to be rezeroed on each of the RANGE switch positions. Once zeroed, the meter should stay zeroed through all resistance range positions.

If your meter will not zero on any of the ranges, push the "Push to Open and Reset" button. If your meter still will not zero, ask your instructor for help.

Place a checkmark (✓) beside the true statement(s)

_____1. With the function switch in OHMS STD and RANGE switch in R X 1, the meter can be zeroed on OHMS. (Use your meter and test this statement.)

_____2. The readings are taken from the green scale of the PSM-37 when the function switch is in the OHMS function.

_____3. The PSM-37 meter needs only to be zeroed when you first start to use it as an ohmmeter.

_____4. The zero mark for OHMS is on the left side of the OHMS scale.

Frame 36

The OHMS (green) scale is probably the most easy to read. The value of each mark on the scale stays the same for each position of the RANGE switch. For example, the numbers on the OHMS scale will always be the same value; 5, 10, 20, 30, and so on. The range switch is what determines what you multiply these numbers by to get the resistance reading of what you are measuring. This will be covered in the next frame.

You will not have much trouble with reading the meter when the meter's needle comes to rest on one of the larger marks which are numbered, or when the needle comes to rest halfway between any two numbered marks. The hard part comes when the needle comes to rest on a small mark or between small marks. To find the small mark values follow these steps:

1. First step, note the two numbered values which the needle is resting between.

2. Subtract the smaller value from the larger value.

3. Count the number of divisions (blank spaces) between the two numbers.

4. Divide the value you got in step two by the number of divisions counted in step three.

5. You now have the value of one division on the scale you are using.

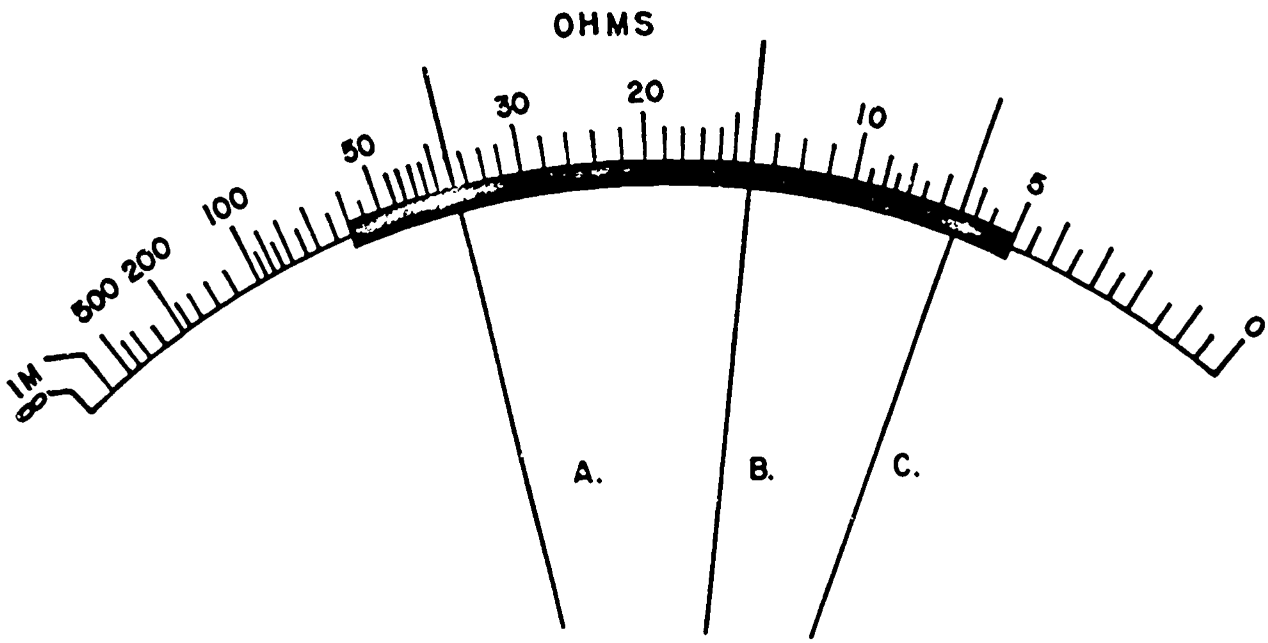
6. Add up the number of divisions your needle is from the lowest value you noted in step one.

7. The last step is to add the total value of the summed divisions in step six to the lowest number value to get the proper reading.

As an example of the procedure outlined above, we will go through the complete procedure for the value indicated by pointer A in the figure on the next page.

Answers to Frame 34: 1. a. AMPS-MA b. 250 c. AC

2. a. 440 MA b. 220 MA c. 250 d. 50



1. Needle is resting between 30 and 50.

2. Subtract 30 from 50 you get 20.

3. Count 10 divisions between 30 and 50.

4. Divide 20 (from step 2) by 10 to get 2.

5. One division is equal to 2.

6. The lowest value is 30 and the needle is four divisions to left of this value.

7. Multiply 4 times 2 to get 8; add 8 to 30 to get 38.

Using the figure above, complete the following by filling in the blank with the correct response.

1. Needle B is indicating ______________________________.

2. Needle C is indicating ______________________________.

3. Each division mark between 20 and 30 is equal to __________.

4. Each division mark between 50 and 100 is equal to __________.

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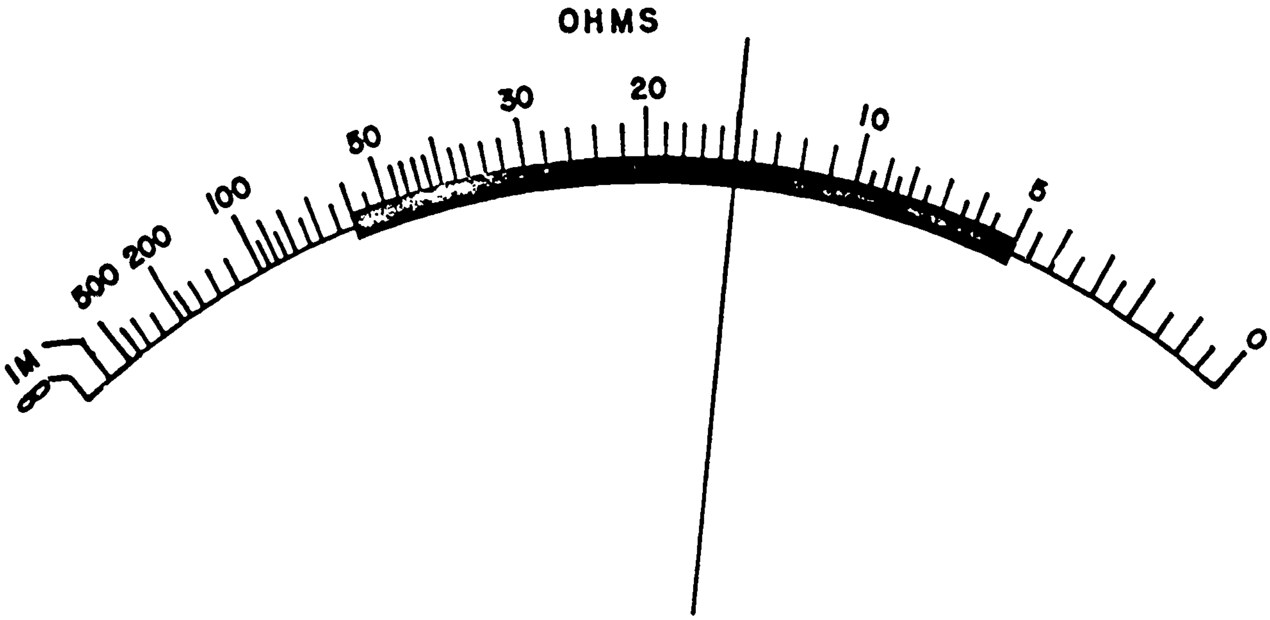
Frame 37

The illustration below shows the ohmmeter scale of the PSM-37. When measuring resistance in the R X 1 range, it is read just as is shown by the needle on the OHMS scale. With the RANGE switch in any of the other R X positions you would multiply the resistance reading (R) times the number at the R X position.

Example: In the R X 10 position the needle stops at the 30 mark on the OHMS scale. You would take 30 times 10. The ohmic value you have measured is 300 ohms. In the R X 100 position it would be 30 times 100, which equals 3000 ohms.

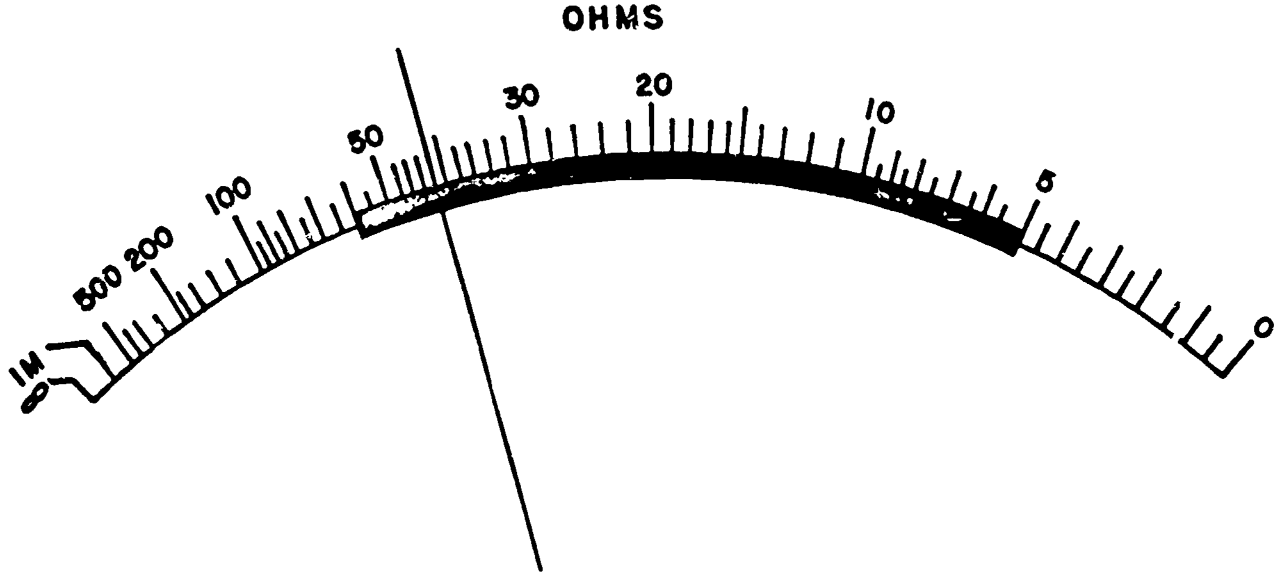
What resistance is indicated in each of the ohmmeter scales below?

1. R X 10 = ______________

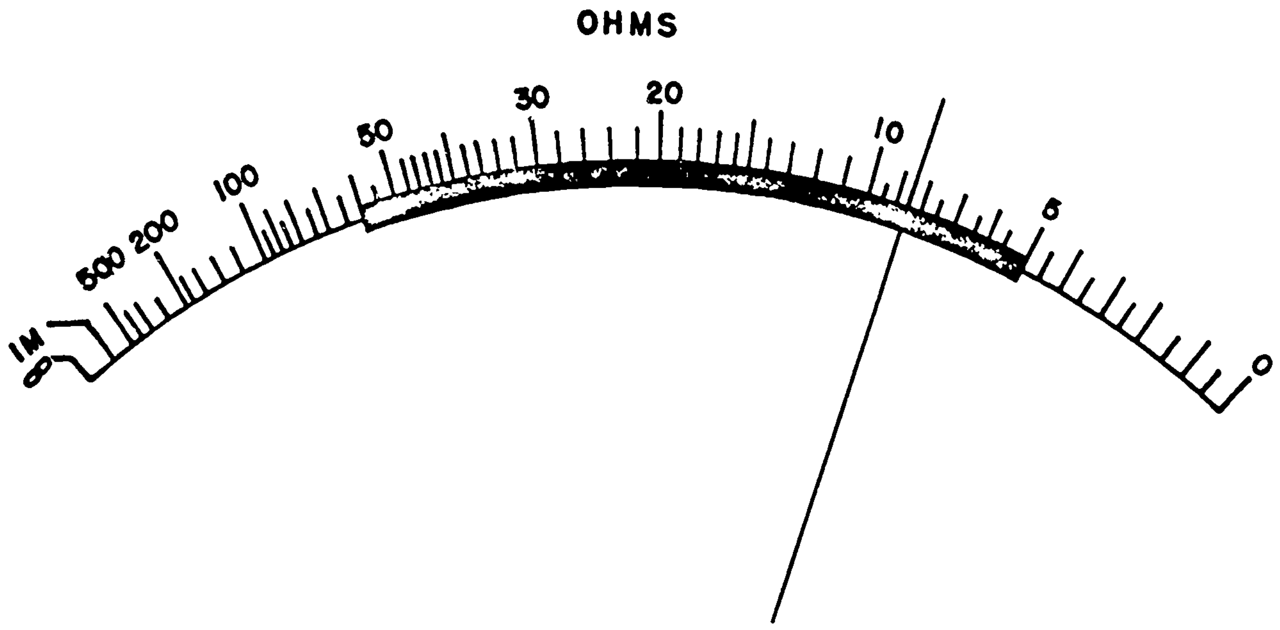


583

2. R X 10K = ____________



3. R X 1K = ____________



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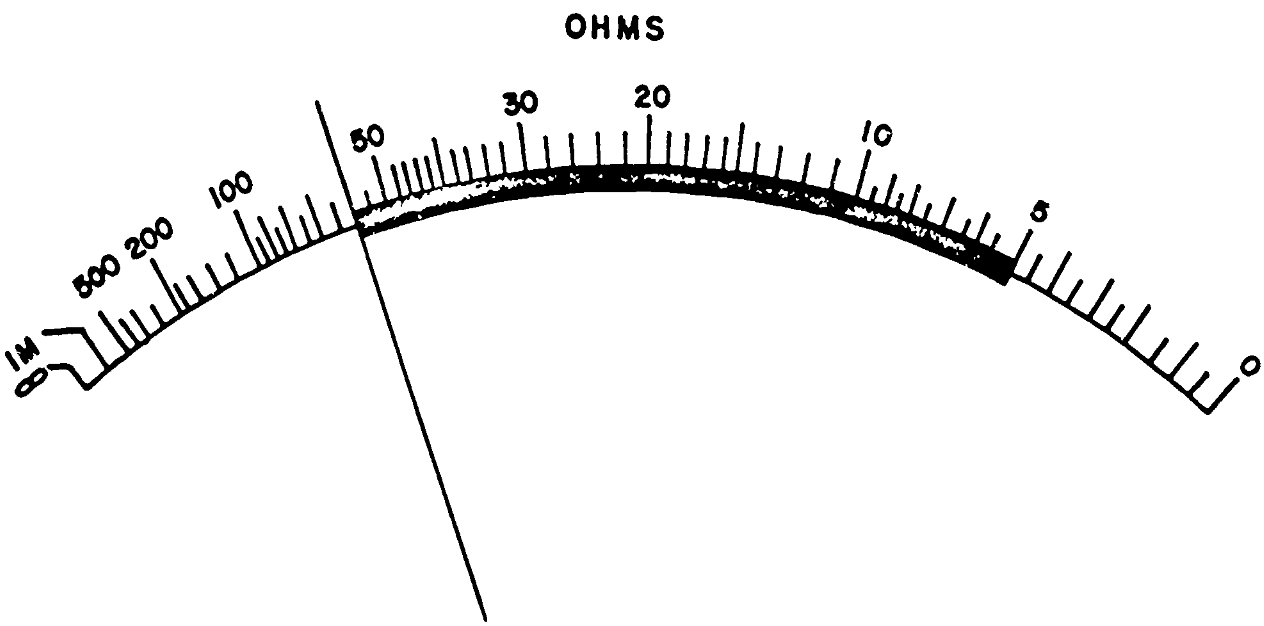
Frame 37 (Cont)

4. R X 1 = ________________



Answers to Frame 35: ____1. ✓2. ✓3. ____4.

The range to be used in measuring any resistance that you do not know depends on the ohmic value of the unknown resistance. Let us say that the R X 1 range of the PSM-37 is being used and that the unknown resistance that you have is more than 2,000 ohms. In this case the resistance is too great to move the pointer away from infinity (∞). The RANGE switch would then have to be set to the R X 10 position. If this was done and the needle still did not move, then you would have to use the R X 100 range, and so on. If the needle still does not move when you use the R X 10K range, you have a resistance that is too high to measure with the PSM-37. This is commonly referred to as an infinite amount of resistance and is represented by "∞".

> Note: To be sure no problem exists with the meter, check to see if the meter will zero in all resistance range positions.

Place a checkmark (✔) beside the true statement(s).

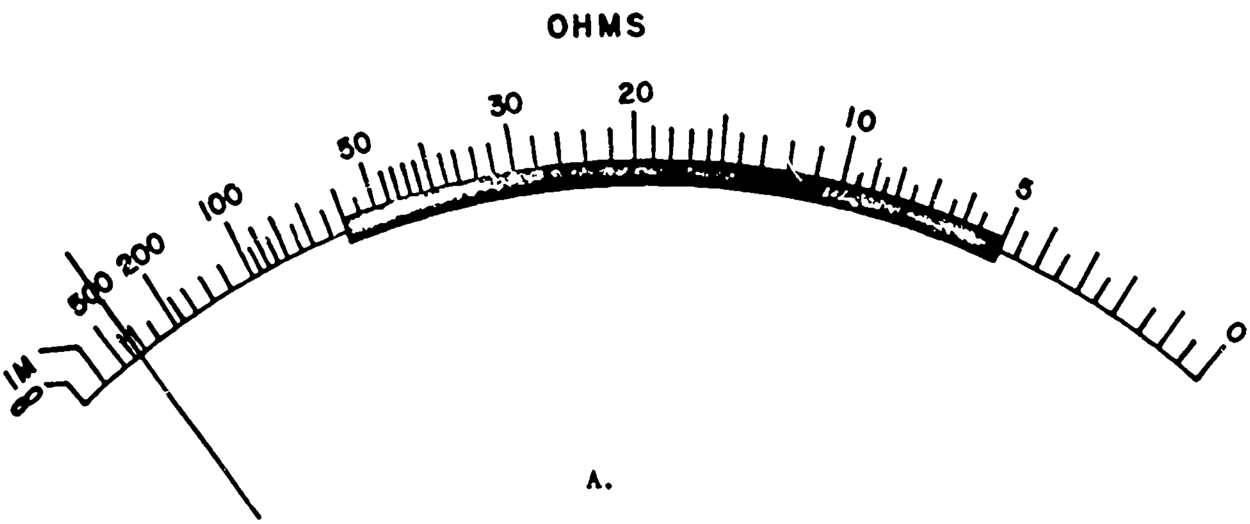
_____1. A resistance reading of ∞ is the same as one of 0 ohms.

_____2. When testing resistance, if the needle of the ohmmeter doesn't move, it is indicating infinity (∞).

Answers to Frame 36: 1. 14 2. 6.5 [illegible]

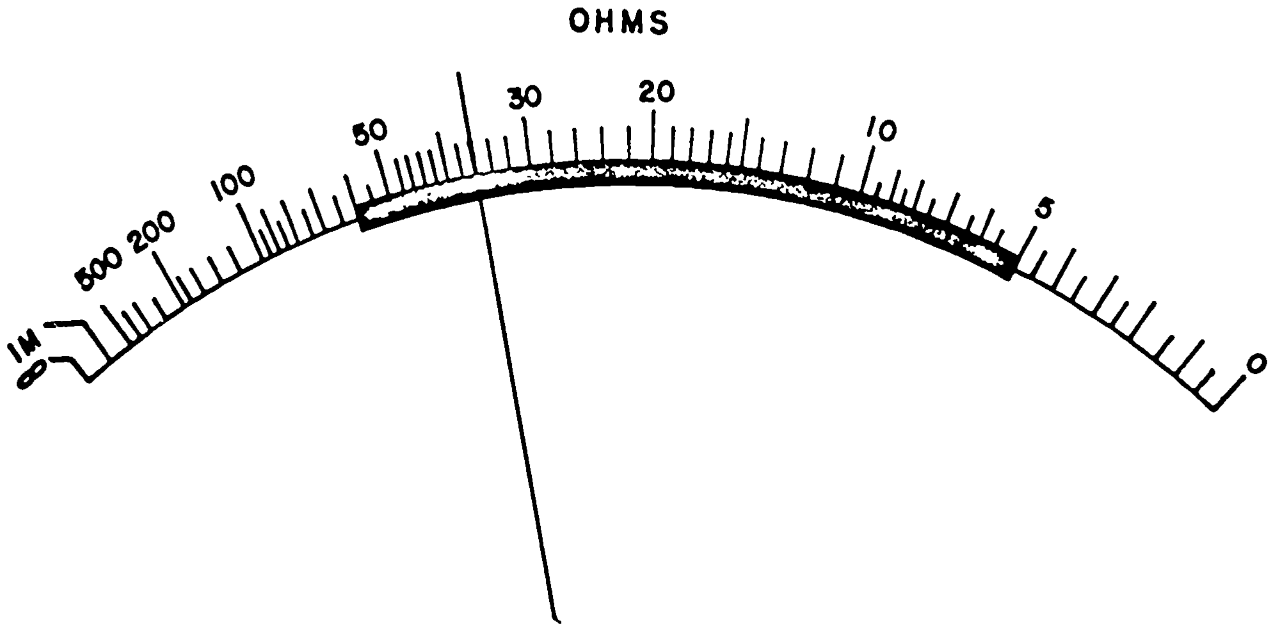
Frame 39

When you use the PSM-37 to check ohms, set the RANGE switch to a position where the needle rests in the wide green area of the OHMS scale. Try not to take the readings from any other part of the scale, if it is possible. We need to do this because the ohmmeter is less accurate from 0 to 5 and 60 to ∞ . In example A, a resistor with an ohmic value of 360 ohms is being measure with the range switch in the R X 1 range. The meter needle is between the 300 to 400 marks, a difference of 100 ohms. Since the operator is forced to guess at the reading, a large margin for error can exist.



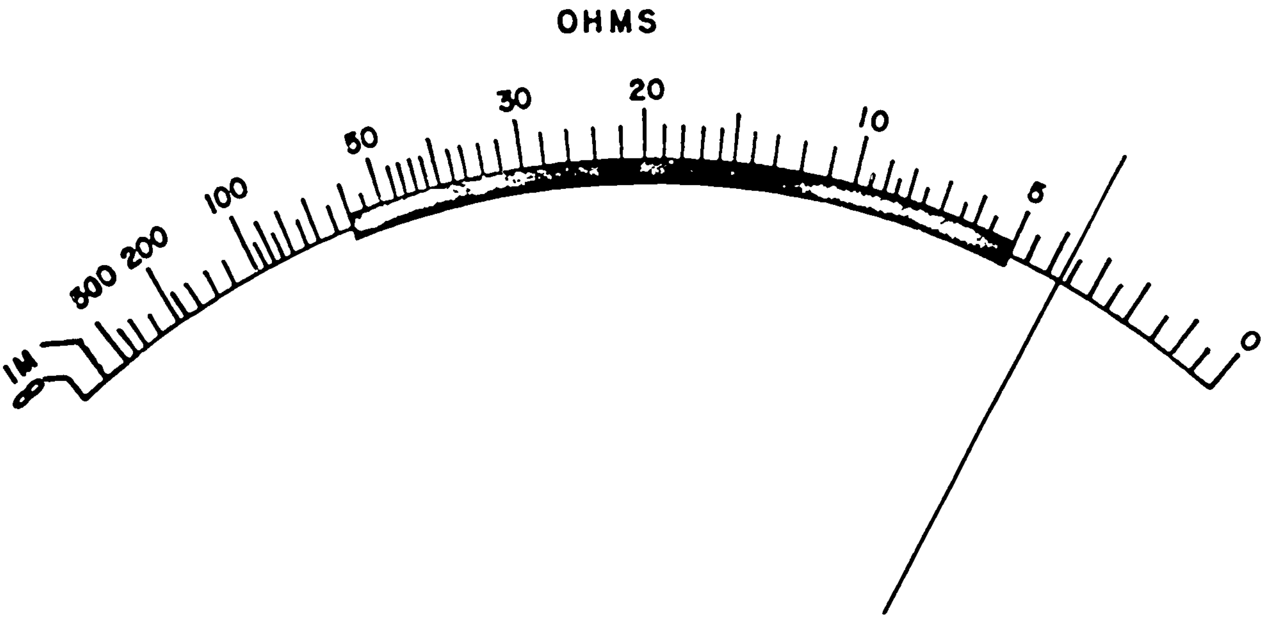
A.

Example B shows the same resistance measured using the R X 10 range. Even though the operator must multiply the scale reading by 10, the reading is more accurate because each mark in this area of the scale is 20 ohms (marks are 2 points each times 10, equals 20). Then, the margin for error is reduced.



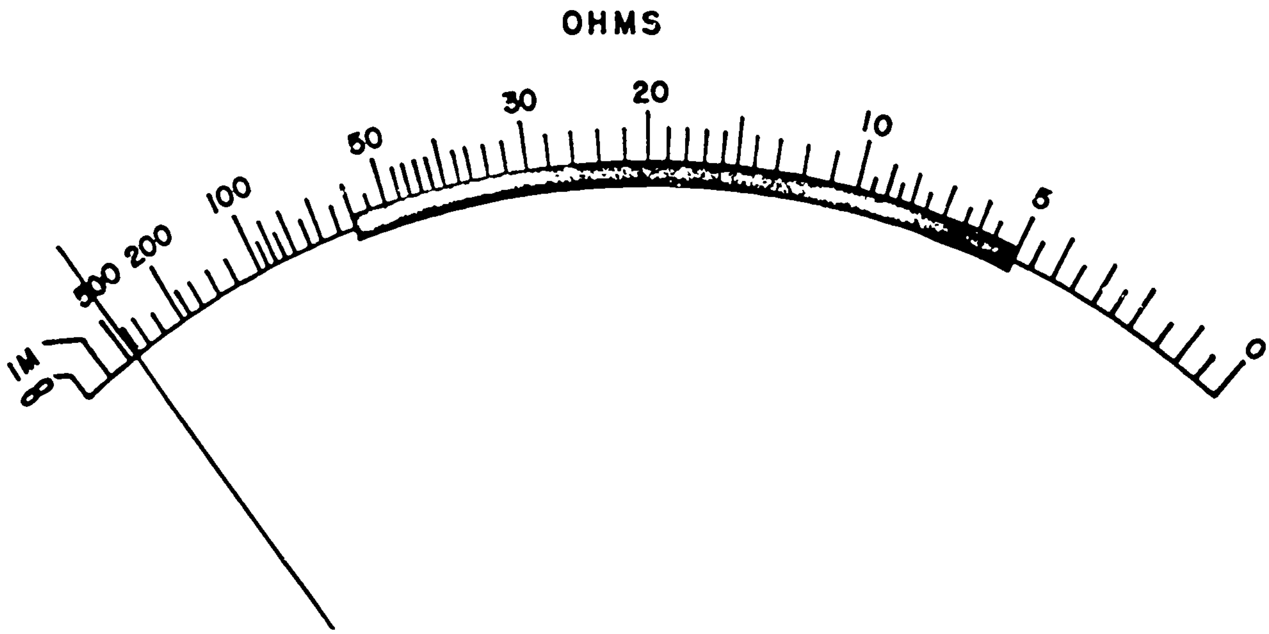
Frame 39 (Cont'd)

Example C shows a 360 ohm resistance reading on the R X 100 range. In this case you must multiply the scale reading by 100. The measurement is less accurate than B because each mark is worth 50 ohms (.5 X 100 equals 50). The margin for error is increased.



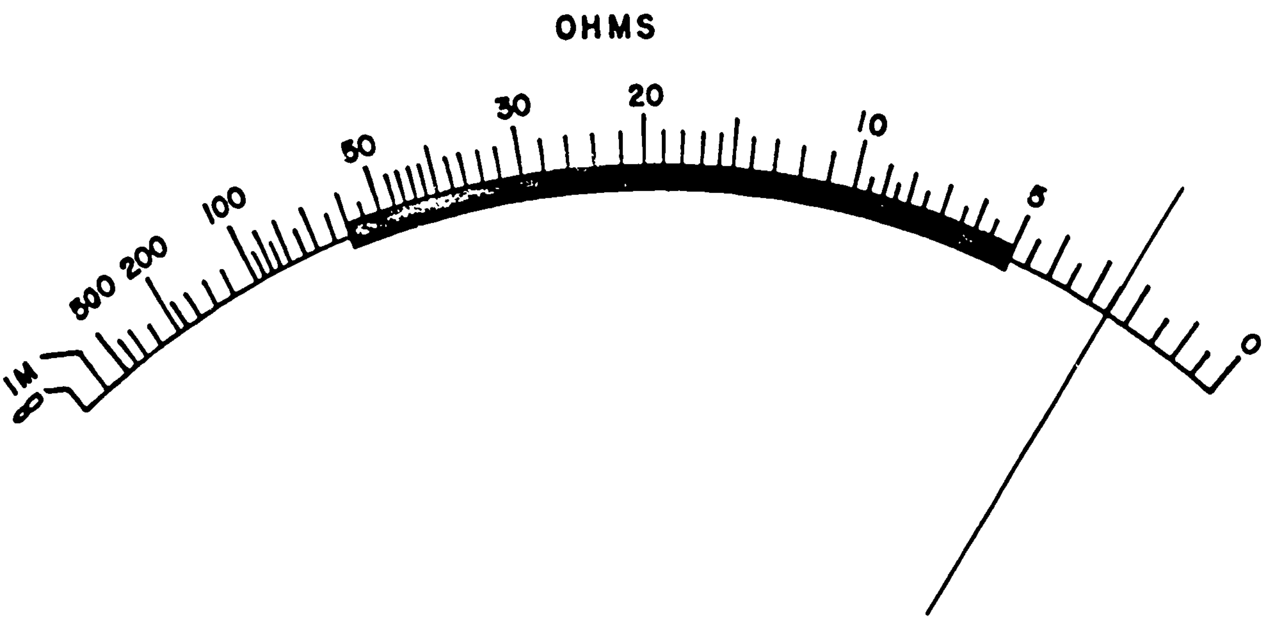
Study the ohmmeter scales shown below. Find out if the resistance is being read by the most accurate range. If the right range is used write "OK" in the blank next to that scale. If the right range is not used, write the range which should be used.

1. 480 ohms, R X 1 range ____________.

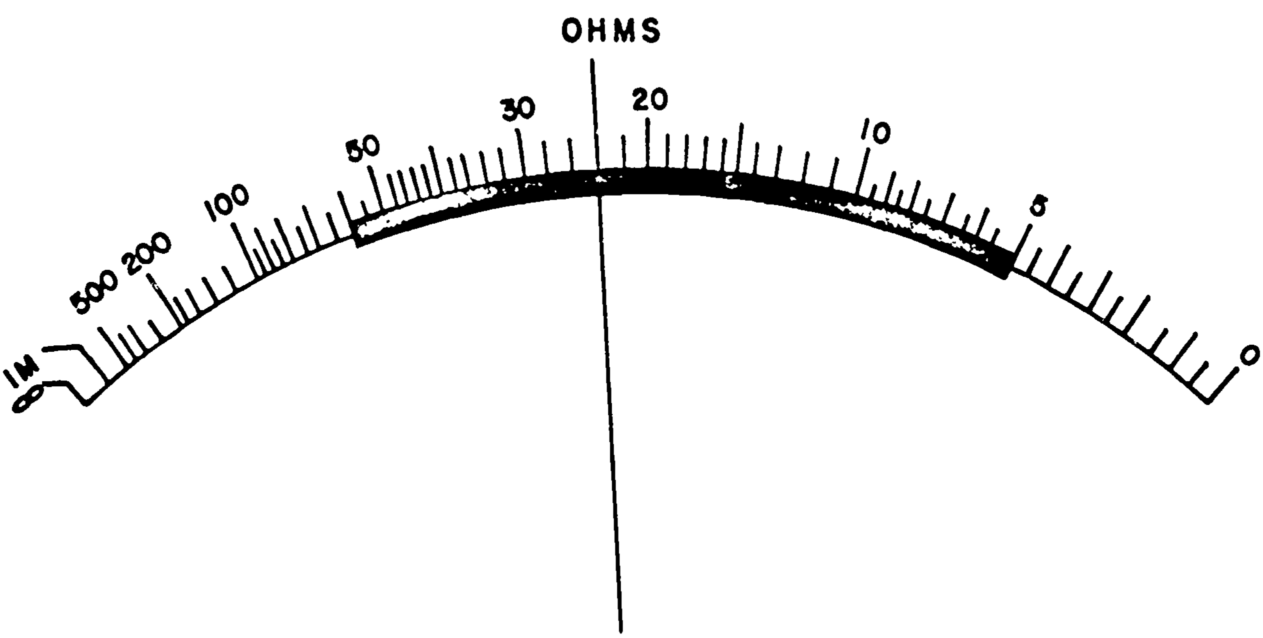


Frame 39 (Cont'd)

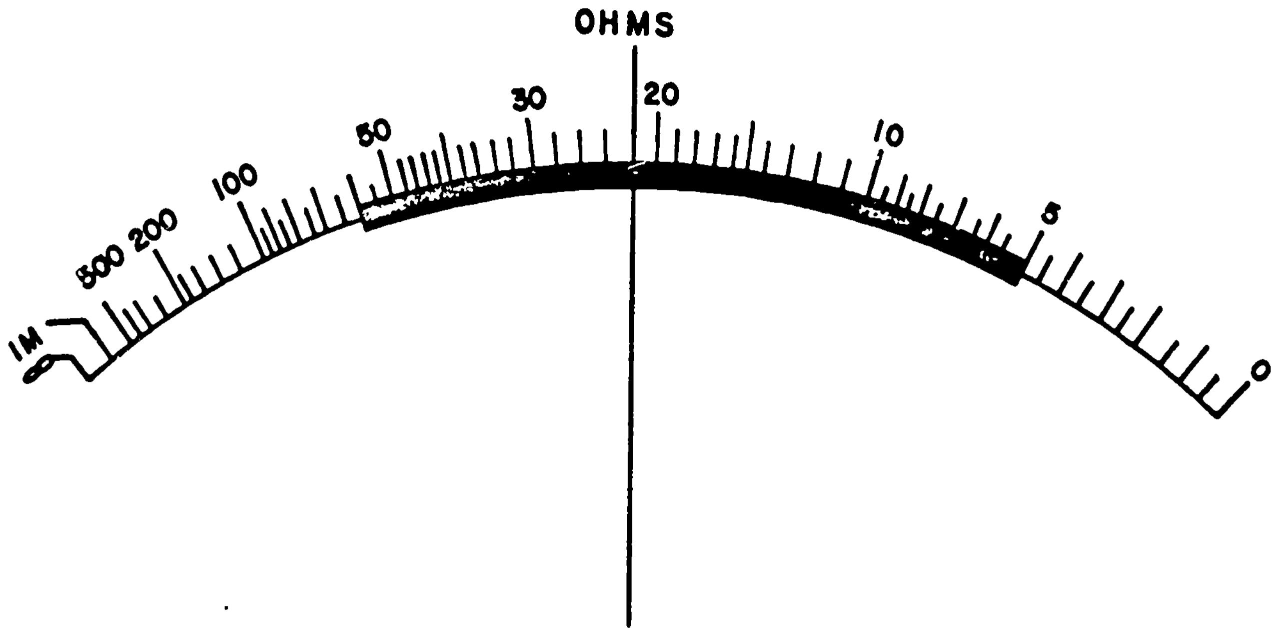
2. 25 ohms, R X 10 range ____________.



3. 240 ohms, R X 10 range ____________.



4. 2200 ohms, R X 100 ___________.



Answers to Frame 37: 1. 150 2. 420,000 3. 8,500

4. 60

Frame 40

There is an important safety precaution that you must follow when you use the ohmmeter functions of the PSM-37. Do not hook an ohmmeter to a live circuit (one that has power applied); be sure that no power is applied to the circuit. The parts in the meter need very little current to work. They could be easily damaged if the meter were to be hooked to a live circuit. There is a small battery in the PSM-37 that gives us the current required to operate the meter in the ohms function. Another thing to remember is that the ohmmeter must be "zeroed" before you make your first ohms test. Think back; to zero the meter you first set the multimeter up for measuring resistance. The POLARITY switch should be set on DC+, the FUNCTION switch should be set on OHMS-STD, and the RANGE switch on RX10. Touch the two lead tips together. The needle should move to the right and zero over the 0 on the ohms scale. If it does not, turn the ohms ADJ knob until it does. If the needle does not move at all, press the "push to Open and Reset" button. If it still will not zero, ask the instructor for assistance.

Place a checkmark (✓) beside the true statement(s).

_____1. The ohmmeter function of the PSM-37 requires current from the circuit being checked to operate.

_____2. The ohmmeter is zeroed before use to insure accuracy.

_____3. If the pointer can not be adjusted to zero on the ohms scale, this means that the internal battery is weak.

Check the correct answer.

4. If an ohmmeter is connected to a circuit with power on, which of the following would most likely occur?

____a. The reading would be accurate.

____b. The circuit would be damaged.

____c. The ohmmeter would be damaged.

Answers to Frame 38: ____1. __✓__2.

After the ohms adj knob has been adjusted, the needle should stop at "0". This means that here is no resistance to current flow. Keep in mind that the meter lead tips must be touching each other or be in contact with a common conductor. If the needle stops to the left of "0", there is some opposition to the flow of current. If the needle only moves part of the way toward "0", there is resistance being measured. If the needle does not move at all, a great (infinite ∞) amount of opposition to the flow of current is present. We refer to each of these conditions by different terms. First, a "0" reading means that there is continuity (no resistance), in the circuit. A reading which will cause the needle to move, but to stop short of "0", means that there is resistance in the circuit. If the needle does not move at all, an open circuit is indicated, or the meter is at infinity "∞" and the resistance is either too large to be measured on that scale, or by that meter.

Place a checkmark (✓) beside the true statement(s).

____1. Continuity refers to the amount of resistance in an open circuit.

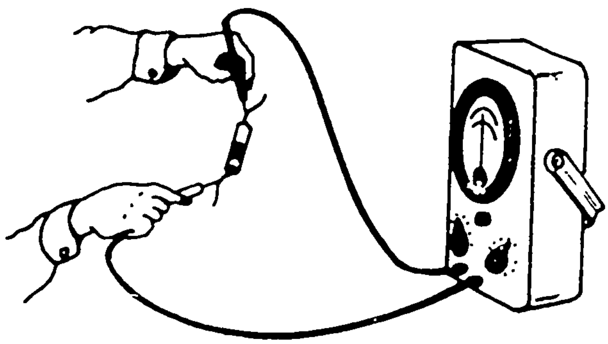
____2. A resistance that is too large to measure is referred to as infinity.

____3. When the pointer is reading a value other than "0", this means some resistance is present in the component being checked.

Answers to Frame 39: 1. R X 10 2. R X 1 3. OK 4. OK

Frame 42

The figure shows one test lead is placed to one side of the resistor. The other lead is placed to the other side of the resistor. When you make a resistance check on a component of a circuit, the component must be isolated (disconnected) from the rest of the circuit. This can be done in three ways: First, totally remove the resistor and test it out of the circuit; second, disconnect one end of the component to be tested from the circuit; third, is to take out the wire (conductor) leading up to one end of the component that you will test. In all three cases, the battery power from the meter will only have one path to flow through; that is, through the component being tested. If you do not isolate the part being checked, your ohms reading will be inaccurate.



Place a checkmark (✓) beside the true statement(s).

_____1. The component being checked with an ohmmeter does not have to be isolated from the rest of the circuit.

_____2. The ohmmeter must never be used to check the resistance of a circuit that has power on it.

_____3. The manner in which the ohmmeter is connected to the component being checked is similar to the way the voltmeter is connected.

Answers to Frame 40: ___1. ✓ 2. ✓ 3. c 4.

If you check a high ohms resistor on a low R X range, the needle may not move off "∞" mark. Turn the range switch up range until the needle stops in the wide green area of the OHMS scale. Then take the reading times (X) the range switch position. This will give you the value of the resistor under test. With the range switch in a high RX position and meter leads hooked to a low ohms resistor, the needle may move to "0". In this case, turn the range switch down range. When the needle stops between the 5 and 60 of the ohms scale, take the reading. Multiply the reading times the range position to get the value of the resistor.

Place a checkmark (✓) beside the true statement(s).

____1. With the ohmmeter on RX 100 and connected to a 10 ohm resistor, the needle will not move off "∞" mark.

____2. With the PSM-37 set up on the R X 1 range and connected to a 2500 ohms resistor, the needle will move to 25 on the ohms scale.

Answers to Frame 41: ____1. ✓2. ✓3.

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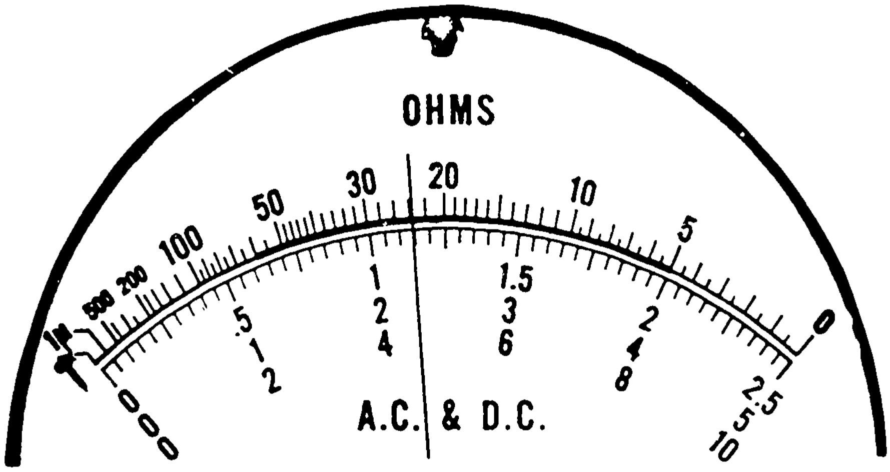
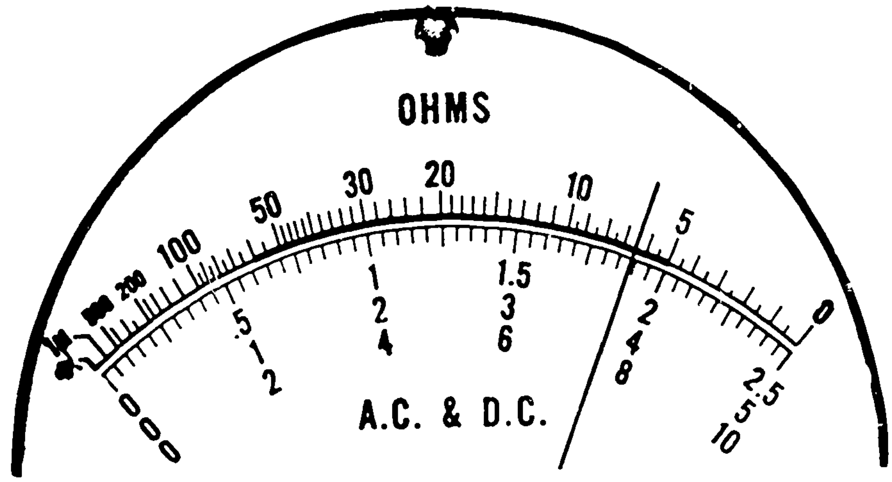
Frame 44

In this frame you will be given one of the two meter faces shown and the position of the polarity, function, and range switches. You will be required to provide the proper reading of the meter.



Meter #1.



Meter #2.

These are the meter faces that you will use. The exercise that you are to fill out is on the next page.

Fill in the blanks with the proper meter readings. Be sure to use the meter referred to for each of the control settings. PLUS, indicate in your answer if the value is V DC, V AC, MA DC, MA AC, or OHMS.

	METER NUMBER	FUNCTION Sw SETTING	RANGE Sw SETTING	POLARITY Sw SETTING	PROPER READING
1.	1	VOLTS	50	DC+	23V DC
2.	2	VOLTS	250	AC	______
3.	2	OHMS-STD	R X 100	DC+	______
4.	1	VOLTS	10	AC	______
5.	2	VOLTS	.5	AC	______
6.	1	OHMS-STD	R X 1K	DC+	______
7.	1	AMPS-MA	50	AC	______
8.	2	VOLTS	2.5	AC	______
9.	1	OHMS-LP	R X 1	DC+	______
10.	2	AMPS-MA	10	AC	______
11.	2	OHMS-STD	R X 10	DC+	______
12.	1	AMPS-MA	250	DC+	______

Answers to Frame 42: ____ 1. ✓ 2. ✓ 3.

Frame 45

This frame summarizes the safety precautions that must be observed when using the PSM-37 to test circuits.

1. The PSM-37 should never be handled carelessly. Aside from being expensive, it is sensitive and delicate. Don't abuse it.

2. When measuring voltage and current, start your check with the range switch set on "1000". Then move it to a lower setting if necessary. Then turn it to a range higher than that applied to the circuit after making the check. This way the meter will be ready for the next check.

3. Never connect the ohmmeter to a circuit that has power on it.

4. When used as a voltmeter, connect it in "parallel" with the voltage drop being checked.

5. When measuring DC voltage and current, be sure to observe polarity when connecting the meter to the circuit. Note if the meter needle moves left on the scale, either reverse meter leads on the circuit or turn the polarity switch to the other DC position.

6. When used as an ammeter, connect it in "series" with the portion of the circuit being checked.

7. Before connecting the meter to a circuit, make sure it is set up for the values to be measured. (AC or DC volts and amps, or ohms)

8. Periodically check the strength of the internal battery. Accomplish this by zeroing the ohmmeter on each of the range switch settings. If it does not zero on all settings, the battery needs to be replaced.

9. Store the meter with the switches in the following positions: POLARITY switch "OFF", RANGE switch "1,000", and FUNCTION switch VOLTS 20 KΩ/V. These positions give the meter some protection if the next person forgets to check the meter before placing it in a circuit.

NO RESPONSE REQUIRED, GO ON TO THE NEXT FRAME.

Answers to Frame 43: _____1. _____2.

Complete the following statements by entering the missing word(s) on the blank spaces provided.

1. When using the PSM-37 to measure a voltage of 34 volts DC, you will set the function selector to the (a) __________ position, the range switch to the (b) __________ position, and the polarity switch to the (c) __________ position. The reading will be taken from the 0 to (d) __________ scale.

2. When using the PSM-37 to measure .008 amps DC, you will move the function switch to (a) __________, polarity switch to (b) __________, and range switch to (c) ____________. The reading will be taken from the 0 to (d) __________ scale.

3. When measuring 210 volts AC, you will move the function switch to the (a) __________ position, polarity switch to (b) __________, and range switch to (c) __________. Your readings will be taken from the 0 to (d) __________ scale.

4. When using the PSM-37 as an ohmmeter you will take the readings from the (a) __________ (color) scale. The function switch must be set to the (b) ____________ position when making resistance checks. Now assume you are checking a resistor; you have the range switch set to R X 1K and the pointer stops at 21 on the OHMS scale. The reading of 21 is multiplied by (c) __________ and the value of the resistor is (d) __________ ohms.

Place a "T" in the blank space beside each true statement.

_____5. The ohmmeter readings will be most accurate when the readings are taken when the pointer is stopped in the wide green area of the ohms scale.

_____6. When measuring voltage, the meter must be connected in series with the component being checked.

_____7. If the ohmmeter is not "zeroed" properly, you will get inaccurate readings.

_____8. A DC ammeter must be connected in series with the component being checked and you must observe polarity when connecting the leads.

Frame 46 (Cont'd)

Match the items in the right-hand column to their correct statement in the left-hand column. Enter your letter answers in the space provided.

___9. An indication of zero ohms.

___10. Determine whether the meter measures ohms, volts or milliamps.

___11. Is always connected to the positive point of a DC circuit.

___12. An unmeasurable large resistance.

___13. Provides current in the ohms function only.

___14. Used to make the pointer of the ohmmeter read exactly "0".

___15. Used to measure AC and DC current and voltage, plus resistance.

___16. Is always connected to the negative point of the circuit.

___17. Determines the meters maximum voltages and current or multiplier for resistance readings.

___18. Protects the meter from overload and can be used to break the input circuit to the meter.

A. Black test lead

B. Press to Open and Reset Button

C. Continuity

D. PSM-37

E. Red test lead

F. Range switch

G. External switch

H. Function switch

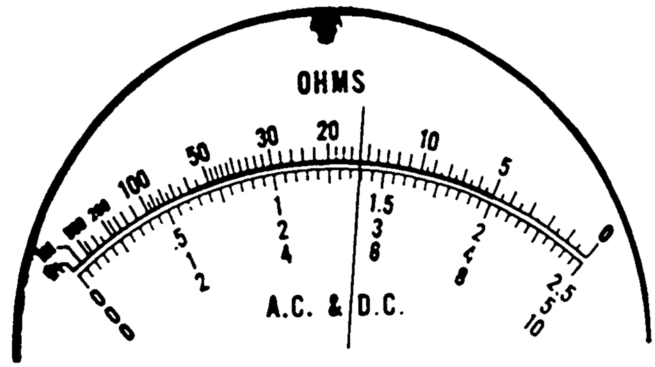
I. Internal battery

J. Infinity

K. Ohms Adj knob

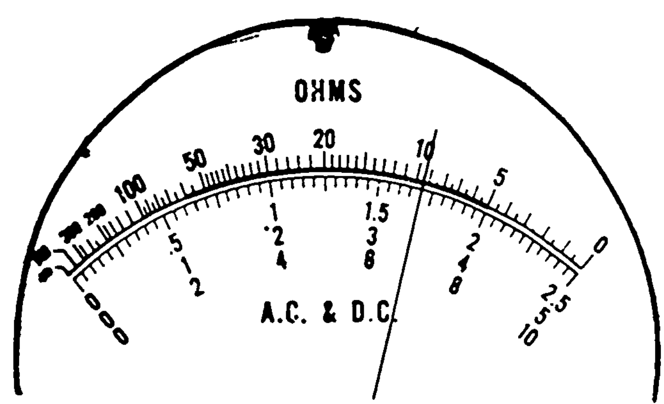
L. Red indicator

19. The function switch is set on VOLTS and the polarity switch is on AC. Use the meter face below to obtain the readings for the range switch positions given in the chart below the meter face.



RANGE SW. →	.5	10	50	250
READINGS →				

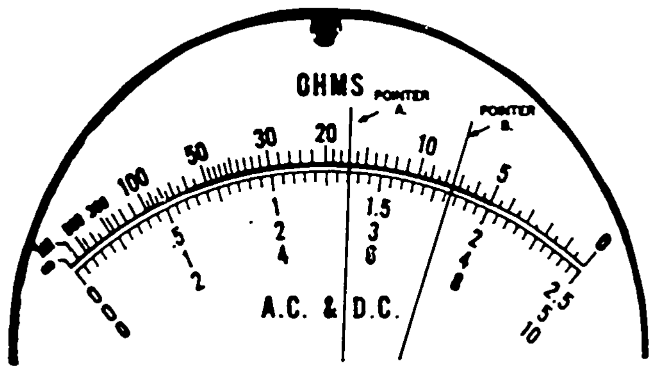
20. The function switch is set to AMPS-MA and the polarity switch is set to DC+. Use the meter face below to obtain the readings for the range switch position given in the chart below the meter face.



RANGE SW. →	2.5	10	500	1000
READINGS →				

Frame 46 (Cont'd)

21. The function switch is set to ohms and the polarity switch to DC+. Use the meter face below to obtain the readings for the range switch positions given in the chart below the meter face. Enter pointer A readings in line one and pointer B in line two.

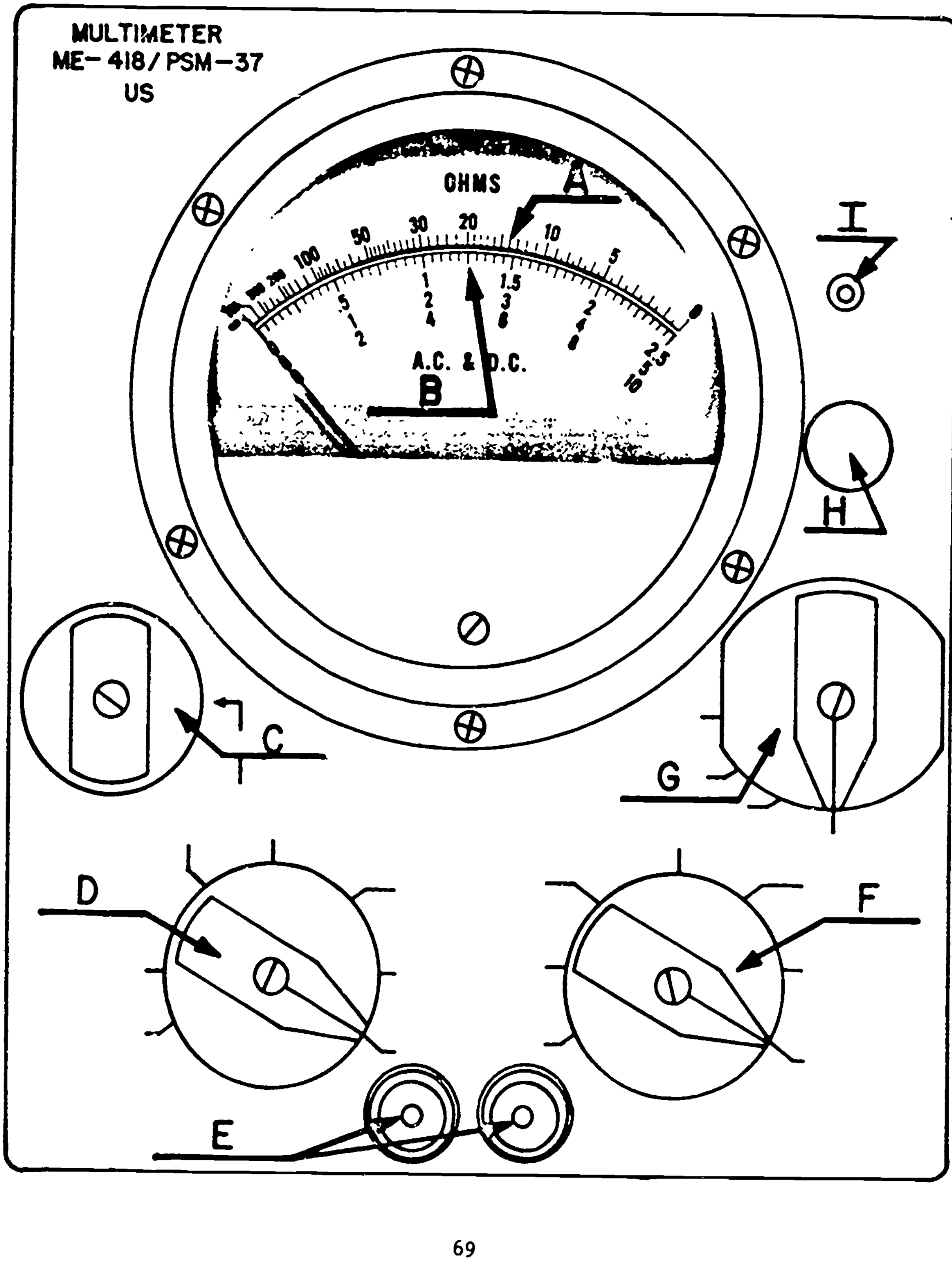


RANGE SW. →	RX10	RX1K	RX100K
POINTER "A"			
POINTER "B"			

22. Using the illustration of the complete PSM-37 meter on the next page, match the names of the controls anc scales in Column A with the letter that corresponds to that item from the illustration. Place your letter answers in the space provided in Column B.

Column A	Column B
a. Overload	________
b. Polarity switch	________
c. Function switch	________
d. Ohms - Adj	________
e. Ohms (Green)	________
f. AC & DC	________
g. Push to Open and Reset	________
h. Test Jacks	________
i. Range switch	________

22. Continued. This illustration is to be used in conjunction with item 22, matching exercise of meter controls and scales.



Answers to Frame 44: 23V DC 2. 190V AC 3. 650Ω 4. 4.6V AC

5. .37V AC 6. 24,000Ω 7. 23 MA AC 8. 1.9V AC 9. 24Ω

10. 7.4 MA AC 11. 65Ω 12. 115 MA DC

Answers to Frame 46:

1. (A) Volts
   (B) 50
   (C) DC+
   (D) 5

2. (A) AMPS-MA
   (B) DC+
   (C) 10
   (D) 10

3. (A) Volts
   (B) AC
   (C) 250
   (D) 2.5

4. (A) Green
   (B) Ohms
   (C) 1000
   (D) 21,000

5. T

6. F

7. T

8. T

9. C

10. H

11. E

12. J

13. I

14. K

15. D

16. A

17. F

18. B

Answers to Frame 46 (Cont'd)

19.

.5	10	50	250
.28VAC	5.6VAC	28 VDC	140VAC

20.

2.5	10	500	1000
1.7MA DC	6.8MA DC	340MA DC	680 MA DC

21.

RX10	RX1K	RX100K
170	17,000	1,700,000
75	7500	750,000

22. a. I f. B

b. G g. H

c. D h. E

d. C i. F

e. A

If you missed any of these items, turn to the part(s) of this PT which covered the item tested. If you still do not fully understand that item, ask your instructor for assistance. You should now be ready to test on this Programmed Text.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-215
19 February 1980

MEASURING TOOLS

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to measure propeller blade angles and trace electrical circuits using measuring tools.

INTRODUCTION

Aircraft and propeller manufacturers have designed special tools for use in the maintenance of their equipment. Expensive precision tools are required when working on parts of the aircraft and propeller. A knowledge of handling and using these tools will greatly assist you in doing your job.

The tools discussed in this study guide are classified as measuring tools. Each type has its special characteristics and purposes and should be used accordingly.

INFORMATION

The propeller universal protractor and multimeter are used on the propeller assembly to measure propeller blade angles and troubleshoot the electrical systems.

UNIVERSAL PROTRACTOR

The universal protractor is used by the propeller repairman to measure the angle of propeller blades. This is done either on the aircraft or in the shop. See figure 1. The protractor consists of an aluminum frame in which is mounted a steel ring and a disc. On the disc is the main or "whole degree" scale; and on the ring is the vernier or "fractional degree" scale. The ring and disc can be adjusted by using two adjusting knobs. In the upper right hand corner of the frame is the ring adjusting knob. When this knob is turned, the ring will rotate. The disc adjusting knob is located on the ring. Turning this knob will rotate the disc. Two locks are also provided on the protractor; one is the disc to ring lock, the other is the ring to frame lock. The disc to ring lock is located on the ring. It is a spring-loaded lock pin. When the zeros on the disc and ring are alined, the pin engages and locks the disc and ring together. To unlock the disc and ring, the pin can be lifted up and rotated 90 degrees. It will then remain in the raised, unlocked position. The ring-to-frame lock is a tightening screw. When the ring is locked to the frame, and the disc to ring lock is released, the disc can be adjusted independently. Two spirit levels are located on the protractor to enable the instrument to be leveled on two different axes.

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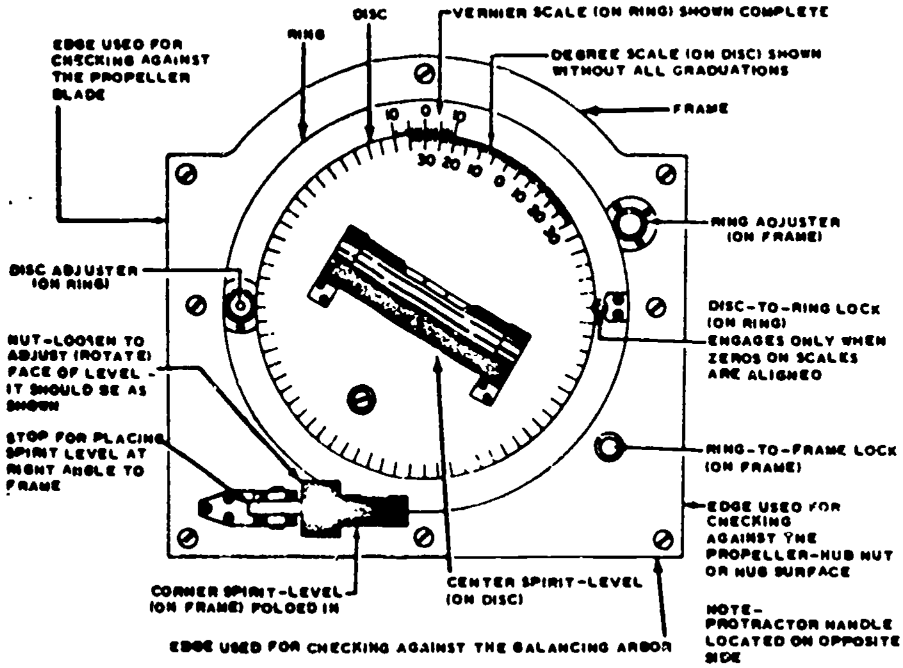

Figure 1. Universal Protractor.

The graduations of the "whole degree" scale on the disc are in degrees. The graduations on the vernier scale represent tenths of a degree.

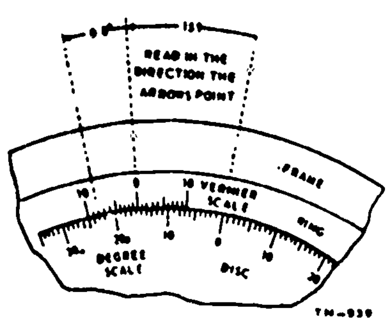

Figure 2. Protractor Reading.

The protractor is read by determining which graduation mark on the disc is alined with the zero on the ring. This will be the degree of blade angle. Figure 2 shows the zero on the ring is located between 15° and 16°.

To read tenths of a degree, determine which graduation on the ring alines with a graduation on the disc. Tenths of a degree are read on the ring. Figure 2 shows the 8 tenths graduation to be best alined. If the disc is read from right to left, the ring will also be read from right to left, beginning at the zero. The ring is always read in the same direction as the disc was read.

MULTIMETER

The multimeter is an instrument used to check electrical circuits. It is capable of performing three different tasks. It can be used as a voltmeter to measure the voltage in a circuit; it can be used as an ohmmeter to measure resistance of a circuit; or it can be used as an ammeter to measure the amount of current flowing in a circuit.

As a propeller repairman, you must know how to use and read the multimeter. This will enable you to check and troubleshoot the electrical circuits that control the propellers.

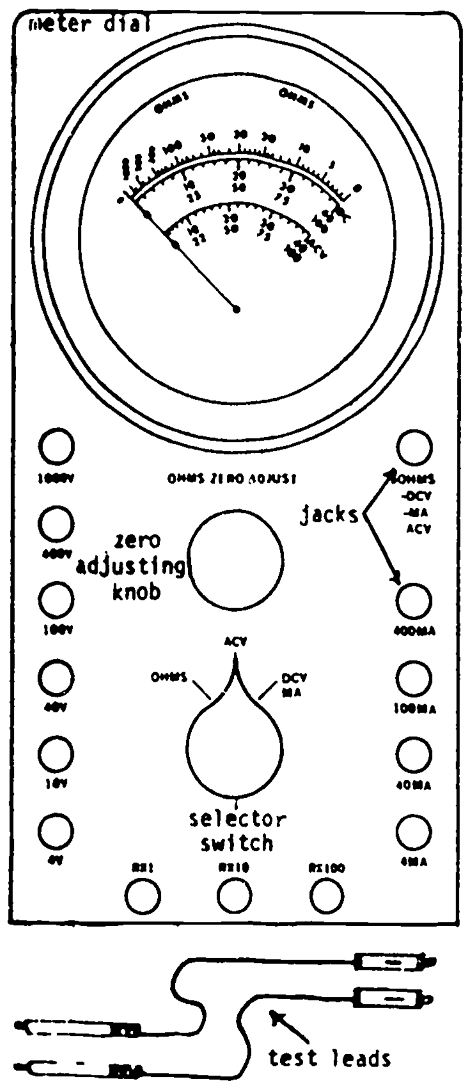

Figure 3. Multimeter.

In this study guide, you will study the operation of each function separately, but remember this is one instrument. Figure 3 shows the jacks, which is where the test leads are plugged in. The selector switch determines whether the multimeter will operate as a voltmeter, ohmmeter or ammeter. (The MA marked on the jacks on the right side of the meter, stands for millilamps, or one thousandth of an amp.)

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The zero adjusting knob is used only when the meter is functioning as an ohmmeter. It is used to set the meter dial on zero. This will insure an accurate reading each time the instrument is used.

Now, suppose you want to use the multimeter as a voltmeter, and you want to measure the aircraft voltage in a 28 volt DC circuit. You would first position the selector switch to DCV, direct current voltage. Next, you would insert the small end of the black test lead in the top jack on the right side of the meter. This is "common" to all operations of this instrument. The red test lead would then be plugged into the 40V jack on the left side of the instrument. The multimeter is now ready to perform as a voltmeter having a range of from 0-40V DC. Now, you must locate a point in the circuit that is not insulated, such as a terminal, or a connector. The red test lead is placed on this bare portion of the circuit. With the black lead grounded (touching the aircraft itself) the meter dial pointer will deflect to the right until it points to 28V DC. This is read on the middle scale of the meter dial.

The 40V jack was selected because 28V was the voltage to be measured. By using a jack that allows the voltage range to be greater than that to be measured, the meter movement will not be damaged. If the voltage to be measured is unknown, always start with the highest range jack. Then work down until a reading is obtained approximately midrange on the meter dial.

The ohmmeter is used to measure resistance in an electrical circuit. To enable the multimeter to operate as an ohmmeter, you must position the selector switch to "Ohms." Place one test lead in the jack marked "ohms, ACV, DCV, MA," and the other test lead in the "RX1" jack. It is at the lower portion of the multimeter. To insure that the meter will indicate the correct resistance, the test leads must be touched together. The pointer will be deflected toward the "0" because there is zero resistance between the test leads at this time. If the meter does not indicate zero, the "zero adjusting" knob must be positioned until a zero reading is obtained. The multimeter is now ready to be used as an ohmmeter. Any time the circuit is complete between the test leads, the meter will indicate a reading. The reading will either be zero, or the amount of resistance that exists in the circuits. For example, if you were to check a length of wire to determine if it were complete or broken, it would be done as follows:

One test lead would be placed on one end of the wire. The other test lead placed on the other end. If the wire is complete or continuous, the meter will read zero. (The amount of resistance in electrical wire is so small, the meter will not read it.) The completeness of the circuit is known as CONTINUITY.

Suppose the length of wire is so long that the test leads cannot be placed one on each end. Continuity would be checked by touching one end of the wire to the aircraft fuselage, then placing one test lead to the other end and the other test lead to the fuselage. The fuselage will serve as a conductor to complete the circuit. If the wire is complete, the meter will indicate continuity.

When the multimeter is being used as an ohmmeter, care should be taken to insure that it is never used on a "live circuit." Power must always be off. If not, the meter will be damaged.

SUMMARY

As a propeller repairman, you will be disassembling, checking, adjusting and assembling the propellers.

The universal protractor is used to measure propeller blade angle. It can be used on propellers mounted on the aircraft, or on the assembly post in the shop. The protractor is read in degrees and tenths of a degree.

The multimeter will be used to aid the repairman in troubleshooting the propeller electrical circuits. It can be used as a voltmeter, ohmmeter, or milliammeter. The repairman need not be concerned with the millia-meter portion because the electrical circuits require more current than the milliameter is capable of measuring.

QUESTIONS

1. What is the smallest reading that can be made with the Universal Protractor?

2. If the disc on the Universal protractor is read from right to left, which direction is the vernier scale on the ring read?

3. List three instruments the multimeter can be used as.

4. When using an ohmmeter in a circuit, should the circuit power be on or off?

5. What does "DCV" stand for on the front of the multimeter?

6. Which voltage jack would be used on the multimeter to measure 110V AC?

7. What is meant by "continuity?"

Jet Engine Branch
Chanute AFB, Illinois

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15 February 1980

MEASURING TOOLS

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to measure propeller blade angles and trace electrical circuits using measuring tools.

EQUIPMENT

	Basis of Issue
Universal Protractor	1/5 students
Multimeter	1/5 students

PROCEDURE

Follow the instructions given for each project in this workbook.

Project 1

INSTRUCTIONS

Using the universal protractor, prepare the protractor to take readings at flight idle, feather, and reverse blade angles on a 54H60 propeller.

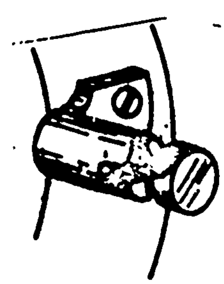

Figure 1. Ring to Disc Lock Pin.

1. To zero the protractor you must:

a. Engage the ring to disc lock pin to lock the ring and disc together. (See figure 1.)

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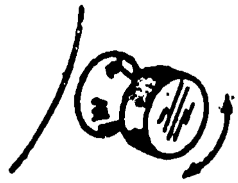

Figure 2. Friction Lock.

b. Release the ring to frame friction lock by loosening the lock approximately 1 turn, as illustrated in figure 2.

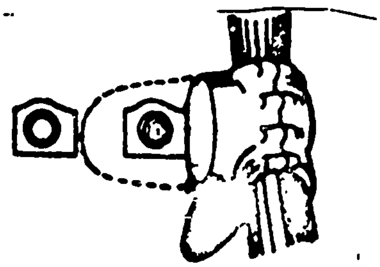

Figure 3. Positioning Protractor on the Propeller.

c. Place one side of the protractor on a flat surface of the propeller that is parallel to the plane of rotation. Use either the front of the hub, or the outer most end of the pitch change mechanism, as illustrated in figure 3.

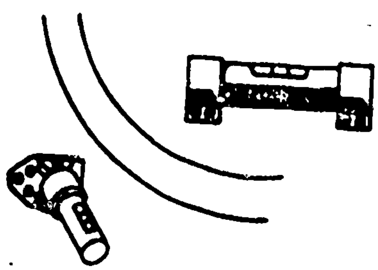

Figure 4. Disc Spirit Level.

d. Rotate the disc and ring until the spirit level on the disc indicates a level condition. Keep the protractor vertical by using the corner spirit level, as illustrated in figures 4 and 5.

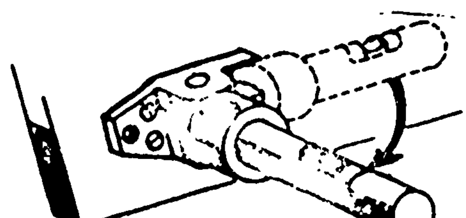

Figure 5. Corner Spirit Level.

Figure 5. Ring to Frame Friction Lock.

e. Lock the ring with the ring to frame friction lock. See figure 6.

f. The protractor is now zeroed and ready to measure angles.

Figure 7. Lock Pin.

g. Release the disc-to-ring lock pin. See figure 7.

Figure 8. Measuring Blade Angle.

h. Place the protractor on the flat side of the blade using the opposite side of the protractor than that used when you zeroed the protractor. See figure 8.

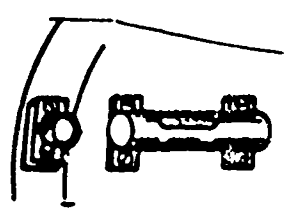

Figure 9. Adjuster and Level.

i. Turn the disc adjuster until the spirit level on the disc is level. See figure 9.

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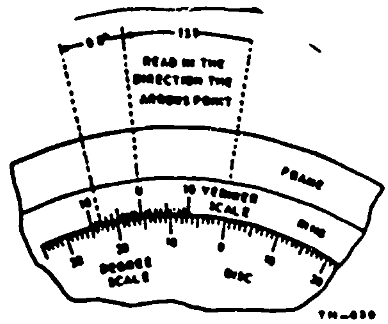

Figure 10. Degree Scale.

j. Read the number of whole degrees on the disc between the 0 on the disc and the 0 on the ring as illustrated in figure 10.

k. Read the tenths of a degree on the vernier scale on the ring. Read this in the same direction as the main scale was read.

Reading ______________

l. Enter your total reading here. ______________
(Steps j & k)

Project 2

INSTRUCTIONS

Using the multimeter, prepare the multimeter to take readings of electrical voltage and resistance on an electrical circuit.

1. To prepare the multimeter to serve as a voltmeter, position the selector switch to DCV.

2. Position the test leads in the jacks to measure 28 volts. Place one lead in the "OHMS, DCV, ACV, MA" jack and the other lead in the "40V" jack.

3. Measure the voltage sources assigned by the instructor.

4. Record your voltage readings in the blanks.

Reading a. ______________

Reading b. ______________

Reading c. ______________

5. If you were going to measure 115 volts AC, how would you prepare the meter?

a. Selector switch position ______________

b. Test leads position ______________

6. To prepare the multimeter to serve as an ohmmeter, position the selector switch to "OHMS."

7. Place one test lead in the jack marked "OHMS, DCV, ACV, MA." Place the other lead in the jack marked "RX1."

8. Touch the probes of the test leads together and rotate the "zero adjust" knob until the dial pointer indicates zero.

9. Use the ohmmeter to measure the resistance given you by the instructor.

10. Record your readings in the blanks below.

Reading a. ____________________

Reading b. ____________________

Reading c. ____________________

Reading d. ____________________

11. If any of the resistors are of such a high value that the meter will not indicate, change the test lead from the "R X 1" jack, to the "R X 10" or "R X 100" jack.

Note: This will extend the range of the meter 10 or 100 times. You must multiply the dial reading by 10 or 100, depending on which jack you have selected.

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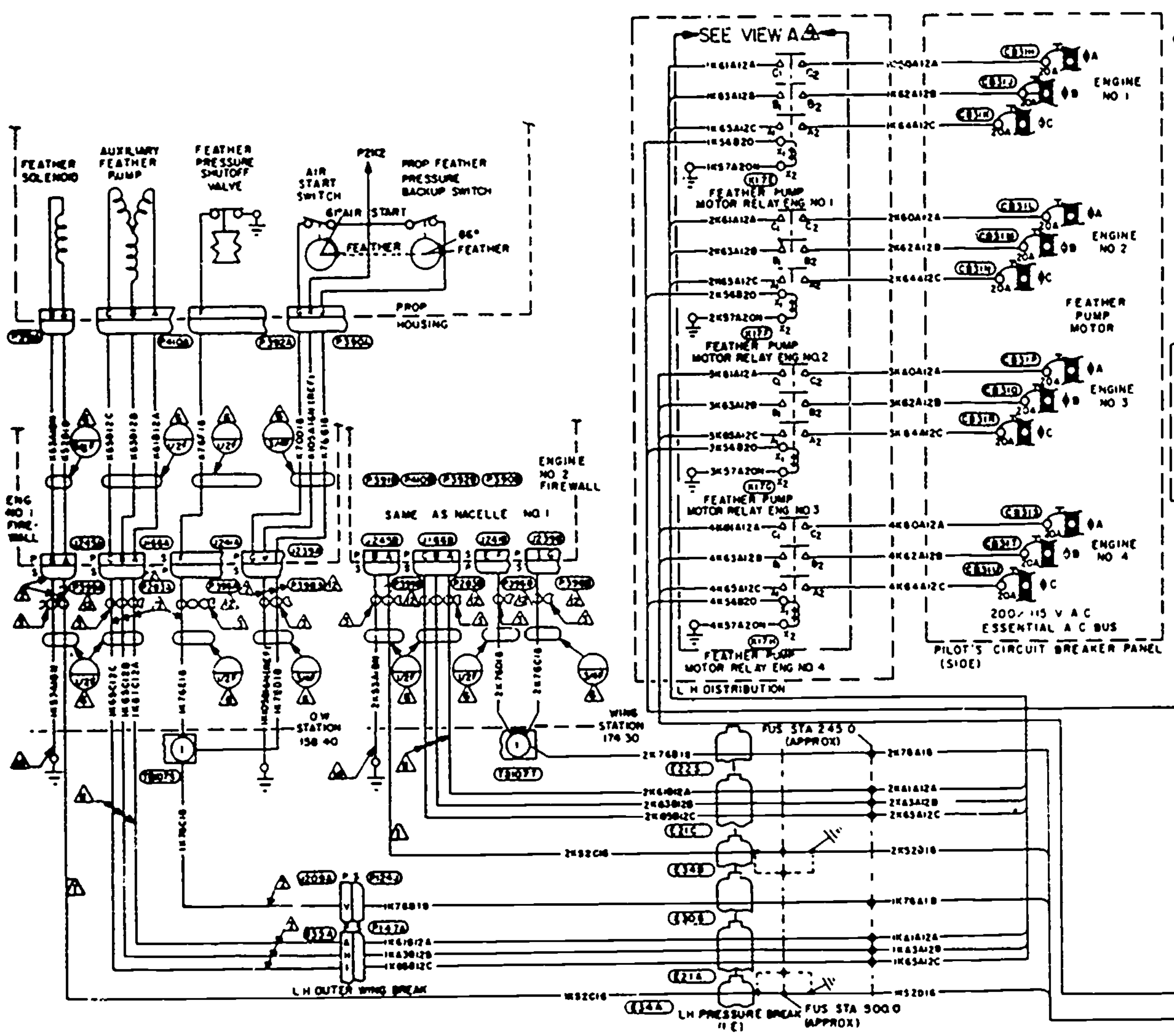

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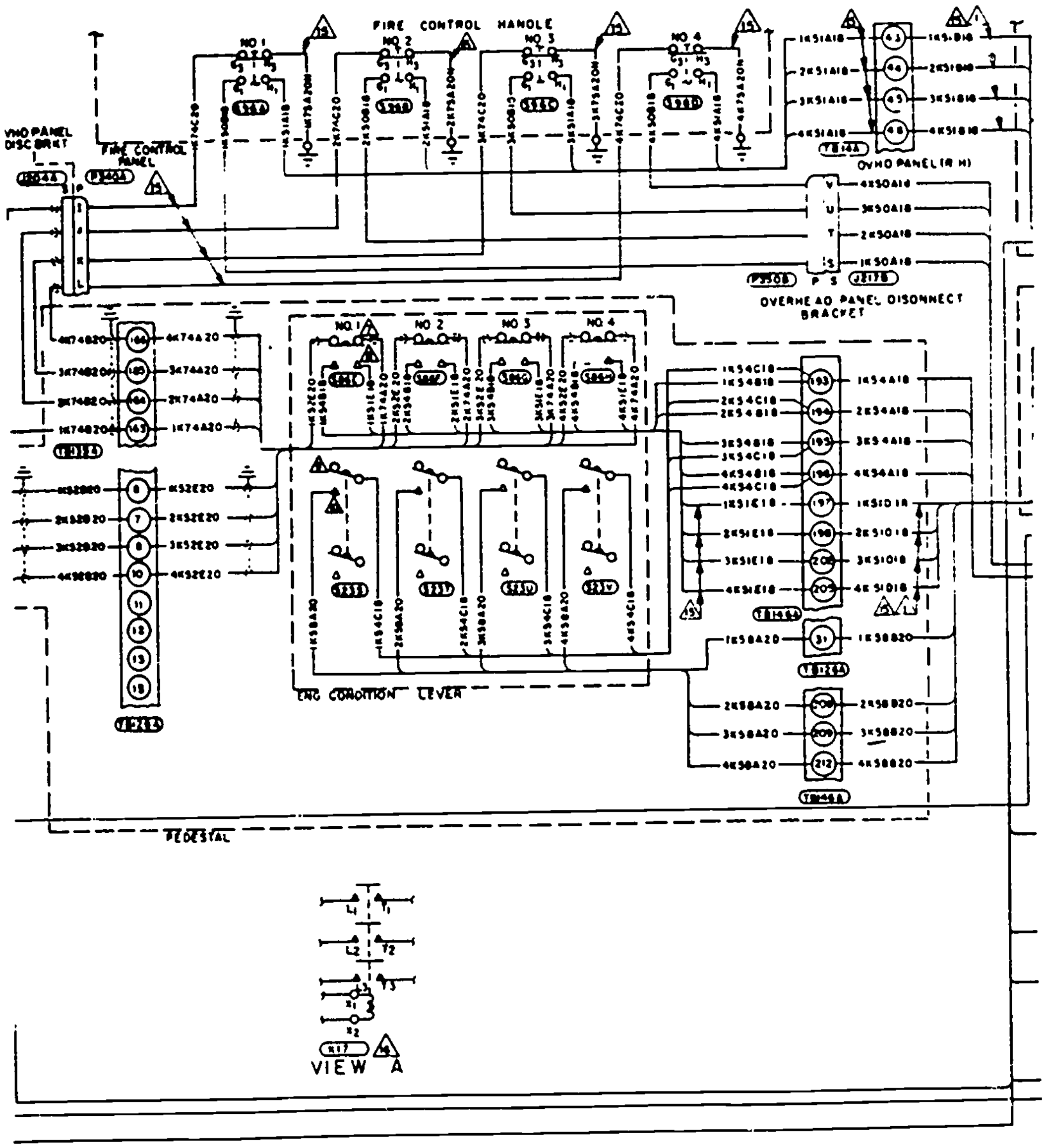
PROPELLER FEATHER AND AIR START CONTROL

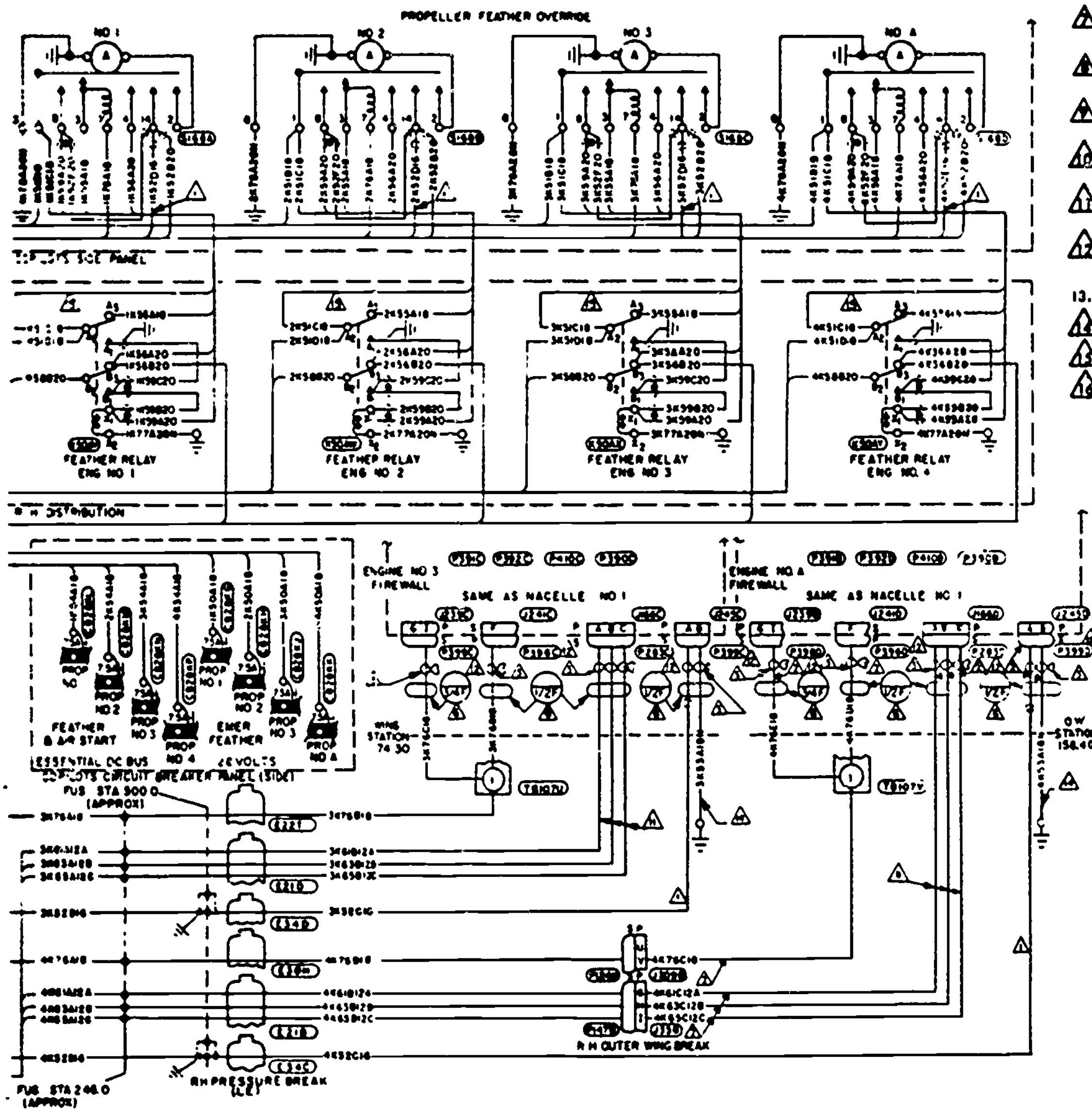
Use and study this handout as directed by your i[illegible]



NOTE

1. THIS WIRE TO BE ROUTED SEPARATELY.
2. WIRES & CONNECTORS PART OF REGULATED ASSY.
3. FOR ITEM IDENTIFICATION SEE ITEM LIST, TABLE 1-1.
4. ALL WIRES ON THIS DIAGRAM MUST BE KEPT A MINIMUM OF SIX INCHES FROM SENSITIVE WIRES.
5. ALL WIRES IN THIS CONDUIT TO BE TWISTED 2 TO 3 TURNS PER FOOT AND TWIST TO EXTEND A MINIMUM OF ONE FOOT BEYOND CONDUIT.
6. ALL WIRES IN THIS CONDUIT TUBE COVERED WITH GENCOTE NO. 135 TYPE 564 ASBESTOS SLEEVING, GENERAL PLASTIC CORP, PATTERSON, NEW JERSEY.
7. THIS SWITCH POSITION IS FOR CONDITION LEVER IN AIR START, RUN & GRD STOP.
8. THIS SWITCH POSITION IS FOR CONDITION LEVER IN FEATHER.
9. THIS SWITCH POSITION IS FOR CONDITION LEVER IN RUN, GRD STOP & FEATHER.
10. THIS SWITCH POSITION IS FOR CONDITION LEVER IN AIR START.
11. WIRE TO BE PE 400 (PACKARD ELECTRIC WARREN, OHIO).
12. SAFETY WIRE THIS PLUG, INSTALL LS7289-1 RED DOT DECAL ON ADJACENT STRUCTURE.
13. INSTALL WIRES PER MIL-W-5088.
14. PROVIDE SEPARATE GROUNDS.
15. ENTIRE LENGTH TO BE ENCLOSED IN VINYL TUBING.
16. ALL WIRES SHOWN ON TERM. C1, B1, A1 ON MS24192D1 ARE TERMINATED ON TERM L1, L2, L3 RESPECTIVELY ON AN3339-1 RELAY. ALL WIRES SHOWN ON TERMINALS C2, B2, A2 ON MS24192D1 RELAY ARE TERMINATED ON TERMINALS T1, T2, T3 RESPECTIVELY ON AN3339-1 RELAY.

ıstructor



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STUDY GUIDE

3ABR42633-SG-211

Technical Training

Turboprop Propulsion Mechanic

ELECTRICAL SAFETY AND THE MAINTENANCE MAN

13 February 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

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Do Not Use on the Job.

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Chanute AFB, Illinois

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ELECTRICAL SAFETY AND THE MAINTENANCE MAN

INTRODUCTION

Numerous maintenance articles written by experienced maintenance personnel or by engineers, well qualified in their fields, are printed in aviation magazines and publications. These articles contain maintenance information, techniques, reasons or causes of Air Force maintenance problems. They are written to inform Air Force personnel of the problem and its solution. It is hoped that this information will be of value to you if you should encounter the same or similar problems.

Since you will be on the job shortly and may be confronted with these problems, we feel that you could benefit from reading some of these articles along with the study guides issued to you. The content of the article in this handout is directly related to the subjects you will study. This article has been taken from Aerospace safety magazine and is informative in nature and should not be interpreted as being a regulation, technical order or directive in nature; however, it will be well for you to observe the safety practices given in this article.

INFORMATION

You will be working on electrical circuits on the C-130 aircraft. This study guide contains safety procedures for working on electrical circuits.

ELECTRICITY-SAFETY-AND THE MAINTENANCE MAN

If you have ever passed close to a high-tension power transmission line on a rainy day, a quiet pause near one of the support poles or towers would serve to make those "Danger--High Voltage" signs more meaningful. There is a hissing, buzzing, crackling sound from the wires where they pass over the insulators that sets the hair on end across the back of your neck--it sounds menacing, as it should. We've been taught, as part of our early training in this era of technology, to stay away from bare wires, especially those marked "High Voltage." We've seen movies with electric switchboards in submarines or the laboratories of "mad scientists" turning into fireworks displays as they overloaded or shorted out. In short, we are conditioned to think of high voltage electricity as dangerous, something to be treated with great respect even while we put it to work for us.

Of course, all this is true; if we are to stay alive, continuous caution is vital when we work around power stations, transmission lines, or distribution networks with high voltage potential. But most of the

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time, most of us deal with "low voltage" electrical equipment which operates on power stepped down by transformers from high voltage sources that are safely removed, we believe, from our work stations. We think that because the "high voltage" menace stops at the transformer station, or at the outside of the hangar, we are safe from electric shock--all we're exposed to is 220 or 110 volts alternating current, something we live with every day around the hangar or the house, something the wife can use to wash clothes or vacuum-clean the rugs. So each day, someone who feels "safe," someone who is complacent about "harmless low voltage" is injured or killed because he didn't obey the most fundamental rule for working safely with electricity--"Never allow your body to offer a path for current flow." Because it is current flowing through the body, not voltage, that determines the severity of an electric shock.

When the body is in a position to offer a path for the flow of current, the amount of current which will flow depends upon only two factors--the resistance offered by the body, and the voltage available to push current through that resistance. We often hear of cases where low voltage proved to be a killer because the resistance of the victim's body was low enough to allow heavy current flow through vital organs, or to cause fatal internal burns. On the other hand, some people have escaped the hazards of higher voltage shock solely because their bodies offered too much resistance to current flow. Since resistance is so important to survival, we should find out how it varies in the human body, and what effect these variations may have in prevention of electrical shock.

RESISTANCE VERSUS VOLTAGE

Figure 1 illustrates how resistance to current flow through the surface of the skin can vary according to circumstances. Careful study of this chart should leave you with the knowledge that you can exercise control over the total amount of resistance to shock when you touch a source of electrical potential. For example, if you keep your skin dry and if while grounded you touch the source lightly with your fingertip (only one-half of a square inch), the resistance to current flow may be as high as 400,000 ohms, and you probably will not feel even the slightest tingle of the shock sensation. But the chart shows much different resistance values on the "WET" side.

To demonstrate this, let's say you've been working hard on a hot day in the unventilated insides of your airplane, and you're sweating heavily. When you grasp anything fully with a wet hand, the increased contact area (up to 15 square inches) combines with the increased conductivity of the moist skin to lower your resistance at the area of contact to as little as 1000 ohms. Should the object you're grasping be a source of electrical potential like the metal case of a defective and improperly grounded electric drill motor, current will flow through your hand, arm or body at the instant you touch another object at ground potential. The shock could be very severe or perhaps fatal, even if the voltage is relatively "low," as you can see by looking at figure 2. For example, at 100 volts of 60-cycle alternating current and only 1000 ohms resistance, the current flow in most circumstances could be more than 100 milliamperes, and you couldn't let go or even move a muscle

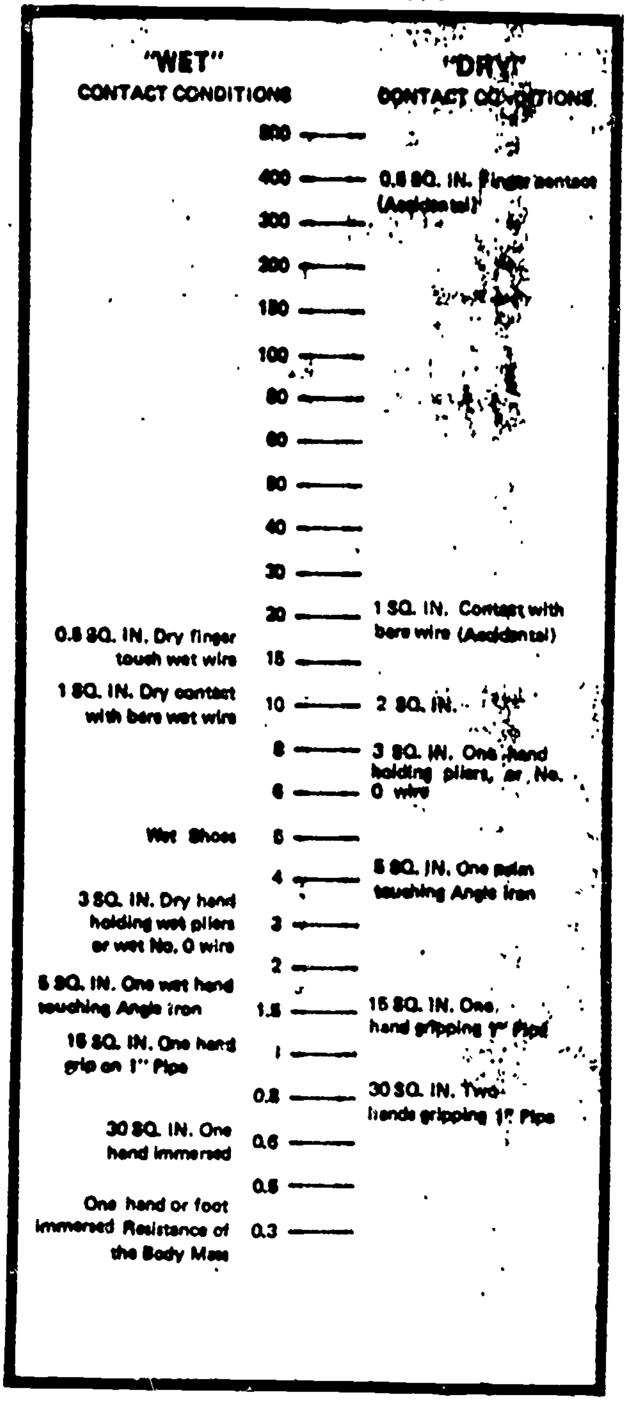

Figure 1. Variable Resistance of Typical Body Contacts.

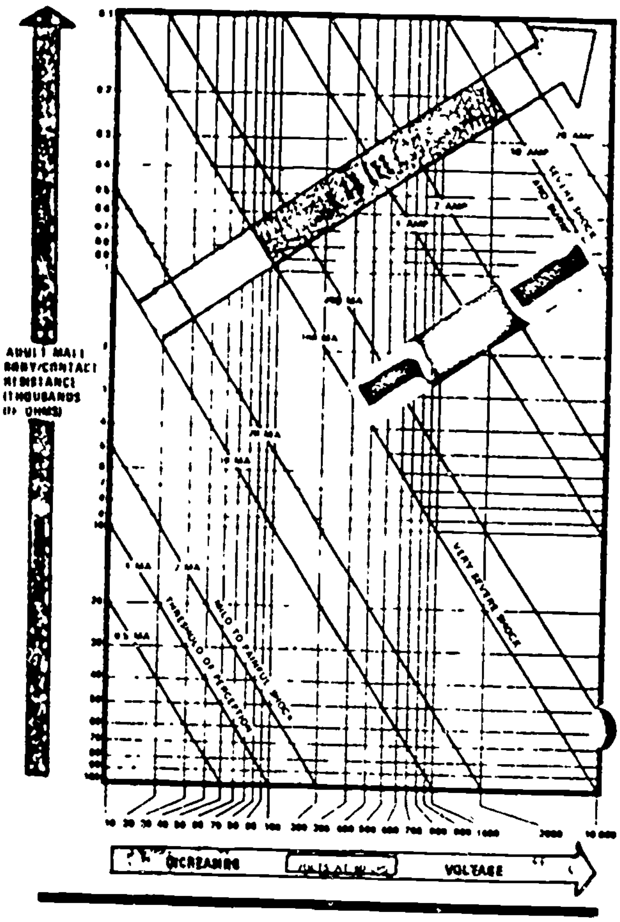

Figure 2. Electric Shock Hazard--Adult Males.

while the current continued to surge through your body. It takes only one-tenth this much current flow (10 milliamperes) to "freeze" your muscles and thus keep your body in the circuit until it is deenergized.

HOW RESISTANCE VARIES. Having looked at the illustrations and the big numbers along the scales, you may still feel that you wouldn't risk much from shock hazards in the type of work you do or the kind of equipment you normally work with. But you should have learned by now, at least, that the resistance of the human body cannot be relied upon to prevent a fatal shock from 115-volt or even lower voltage circuits. And this is because of the extreme variations in body resistance, almost all of them confined to the external area.

The internal resistance of the body is relatively constant and relatively low. We are all, inside of us, about 85 per cent water, an excellent and low impedance conductor. Conditions under the inner layers of the skin stay just about the same all the time, so that to find the causes for the variables in body resistance we must look at the skin, and what's in it and on it.

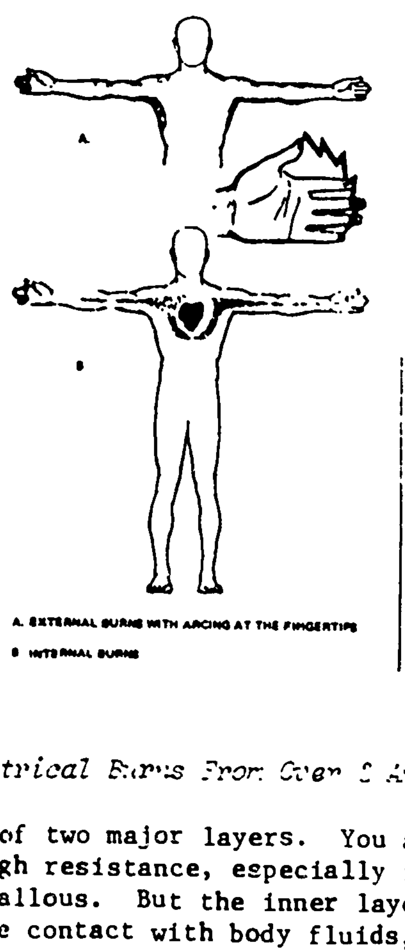

Figure 3. Electrical Burns From Over 5 Ampere Current.

Body skin is made up of two major layers. You already know that dry skin has relatively high resistance, especially if it is thick, such as in the area of a callous. But the inner layer of skin is naturally moist, due to the contact with body fluids, so resistance to current flow falls off rapidly if the inner layers are exposed, or if body fluids come closer to the surface, as when a blister forms. And blisters do form in seconds, from localized heating when current flows either along the surface of the skin or through a portion of the body, as shown in figure 3. The effect is cumulative--current flow through skin resistance causes heating, the heating brings moisture to the surface, blisters full of fluid lower the resistance even further, so the current flow increases, producing still more heat, etc. Your total body resistance might be pretty high to begin with, before you suffer a shock. Then as the skin resistance goes down, your total body resistance decays rapidly. An the longer it continues, as shown in this example, the worse it gets. In three seconds, while your internal resistance stays constant at only 300 ohms, your skin resistance plunges from 2000 ohms down to 200 ohms, while current flow zooms from 50 milliamperes to 230 MA. And all this time you can't let go to stop the vicious circle from completing itself.

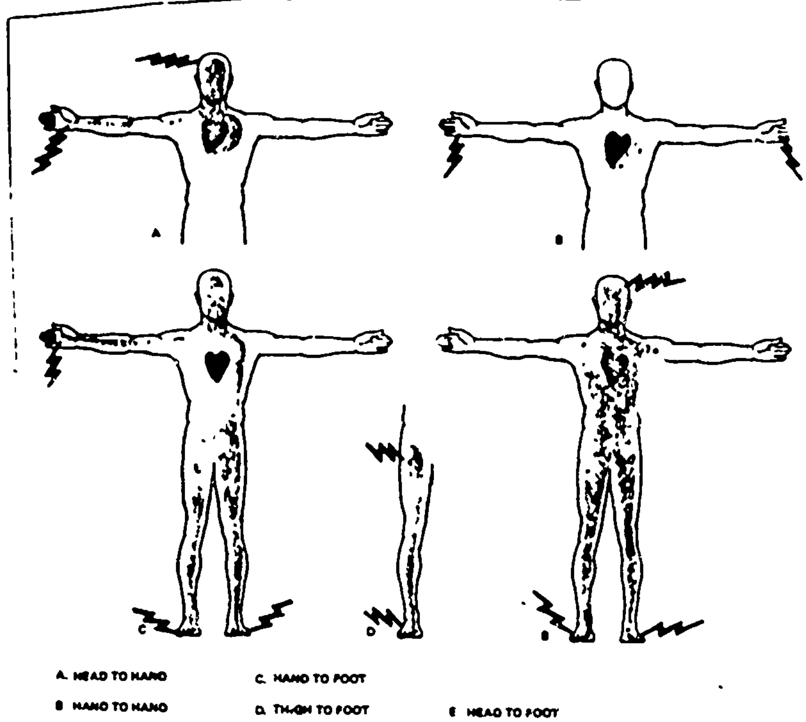

Figure 4. Current Path in Five Basic Types of Shock.

Two hundred thirty milliamperes of current flowing through your body through the region of the heart is well within the band of current flows (marked on our chart in figure 2) labeled "SURE DEATH"--the area where the heart stops pumping and just trembles ineffectually (ventricular fibrillation). Naturally, the effect of current flow on your body varies not only with its intensity but also with the path it follows. Figure 4 shows the five major flow paths through the body and the areas, shaded in red, that are affected most by the damage resulting from the shock.

EFFECTS OF SHOCK

To get an idea of the effects of so-called "low-voltage" shock, let's see what happens when 60-cycle alternating current at 110 volts passes through a man from hand-to-hand or hand-to-foot. As current flow gradually increases, the following effects become apparent:

1 to 8 MILLIAMPERES--a sensation of shock, not very painful. A man can still let go because muscle control is not lost.

8 to 15 MILLIAMPERES--painful shock, but still he can let go. The hazard up through this amount of current flow often comes from the so-called "fright reaction" or recoil when the shock occurs. Men have fallen from ladders and other high locations, or have bumped their heads hard enough to cause unconsciousness, increasing the possibility of remaining in the path of current flow, prolonging the exposure.

15 to 20 MILLIAMPERES--loss of muscle control begins, and the man cannot let go in spite of the painful shock. At 25 MA he will be "frozen" to the point of contact.

20 to 50 MILLIAMPERES--severe muscle contractions include those muscles controlling breathing. In addition to difficulty in breathing, the victim may be "knocked out."

50 to 75 MILLIAMPERES--almost certain unconsciousness.

75 to 100 MILLIAMPERES--as current nears 100 MA, the man is almost certain to die. Ventricular fibrillation sets in, the heart no longer circulates blood in the body, and even after the current is cut off, no pulse can be detected. Artificial respiration should be attempted, but unless a trained physician or a doctor can restore the natural rhythmic action of the heart by massage or controlled electrical shock treatment using special equipment usually found only in hospitals, it's almost impossible to save the victim's life. Usually the maximum time limit for resumption of natural heart function under these circumstances is about six minutes.

0.20 to 2 AMPERES--this intensity of flow will paralyze the nerves near the diaphragm or the nerve centers at the base of the brain. Breathing will be cut off.

2 AMPERES and over--the man will suffer severe burns due to "frying" of the body fluids and to external arcing at the point of contact. In addition, internal burns of the slow healing type will also occur. This latter fact might seem academic under the circumstances, but a peculiar thing sometimes happens when flows of above 10 AMPS occur for very short periods. The severe muscle contractions the man experiences may prevent ventricular fibrillation, and after release, if proper first aid is administered soon enough, he might survive if the heart picks up its regular pumping rhythm again.

The tabulation above is a general guide only. Naturally there will be variations due to individual circumstances. The physical condition of the victim may be a factor. But the important thing to remember is that fewer low voltage shock victims can be revived than those receiving 1000 volts or more.

SUMMING UP

With the foregoing facts in mind, we can do a summing-up exercise in relatively few words. Although we must be aware of the many variables in cases of electrical shock and the hazards which cause them, we can make some general statements which apply to almost all circumstances.

- If your body becomes part of a circuit, either as the load or as the conductor and the load, you will get an electrical shock.

- Your body will become part of the circuit if you come in contact with both a source of potential and a ground while your total resistance is low enough to allow a flow of current.

- Current flow is what kills or injures you--voltage only pushes the current through your body resistance.

- Direct current (DC) is generally considered to carry less shock hazard than alternating current (AC) for a given voltage, but it is likely to burn more severely since the arcs from DC are more persistent than those of AC.

- Body resistance is highly variable, principally because of changes in skin resistance from one body area to another due to thickness and amount of moisture on the surface.

- Electrical energy sources (AC or DC) operating with an open circuit potential of 30 volts or more with a capability of delivering 2.5 milliamperes or more into a short circuit are hazardous to you.

- Low voltage (less than 600 volts) can be more dangerous to you than high voltage. Accurate statistics show that 62 per cent of victims recovered after being knocked out by potentials over 1000 volts; for lower voltages, only 39 percent recovered.

- The seriousness of electrical shock depends on the balance between several factors--the voltage, the body resistance, the amount of current flow and its path through the body, the duration of contact and the condition of the body organs in the current path.

- The most hazardous currents are those in the frequency range from 20 to 100 cycles per second (cps). Currents of higher frequencies are less hazardous because they tend to flow on the surface of conductors rather than through the conductors themselves. High frequency current will cause electrical shock but to a lesser extent for a specific current value.

- The current required to operate just one 100-watt light bulb is eight to ten times the amount that is needed to kill you.

SAFETY PRECAUTIONS

There are a number of safety precautions you can take to minimize the degree of exposure and the potential for being on the receiving end of an electrical shock. Some of these precautions involve the equipment you work with--others have to do with your attitude toward your work and your interest in safe working conditions. Let's tick off some of the most time-tested precautions in both areas, as they apply to the mechanic or technician working either on the airplane or at the bench in the hangar or shops.

SAFE PRACTICES. Start with good housekeeping in your work area. Keep it clear of clutter, stray wires, solder drops, unusable spare parts and unoccupied people.

1. Don't work on energized circuits. If you can possibly avoid it, don't touch a live circuit anywhere. Of course, some of us must work on energized circuits to do our jobs, but in such cases we should be properly trained and always know for sure what voltages and frequencies we are involved with.

2. Avoid working alone. When using electrical equipment, if you can work with or around someone else, you are safer, especially if he knows how to turn off the power, how to get help in an emergency, and how to apply artificial respiration.

3. Follow the Technical Manual. Safe procedures for all the technical operations are contained in your approved technical publications. Follow them, and if there is a checklist for your particular operation, USE IT. Don't depend on your memory, and don't try to take short cuts.

4. Rig power cables properly. Never use portable cords or other equipment in such a way that a male plug can be energized except when it is in a receptacle. When connecting a motor or other equipment to a power source, first make sure that the switch or circuit breaker is open at the source. Then connect the cord or cable to the equipment you are going to use, and work back toward the power source with dead cable in your hands, making the connection to the source your next-to-last move. Your last move, then should be to turn on the switch or close the circuit breaker while watching to see if there is any evidence of overheating or arcing in the supply cable or the equipment itself. NEVER CONNECT TO A POWER SOURCE FIRST. NEVER MAKE INTERMEDIATE CONNECTIONS UNLESS THE POWER IS OFF.

5. Keep yourself and your equipment dry. Moisture is your enemy when you work with electricity.

6. Make sure that grounding is proper and complete. Most electrical industrial equipment comes with carefully designed grounding provisions. Most cords use three or four-wire cable to ensure your safety by providing a built-in low-resistance path to ground in case of a short circuit. Don't guess about this. If there is any doubt in your mind about the condition or function of any electrical equipment you may have to use, get help from authorized and trained personnel instead of taking a chance.

Grounding is one of the ways we prvent injury from electricity (the other is insulation). Adequate grounding of all non-current-carrying parts of electrical equipment which could become accidentally energized will help to keep you from "frying" when using such simple tools as a drill motor, or such complex ones as an electronic bench test set.

7. Be familiar with first aid procedures. If your buddy is not so careful as you, your knowledge may save his life.

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8. Use the right tool for the job. Don't overload or abuse electrical equipment or circuits beyond their capacity. Don't try to "fool" the circuit by using a fuse heavier than the one authorized, or by "bridging" a burned out fuse with heavier conducting material. Don't replace fuses by hand on live circuits; use a fuse puller.

9. Use safety lights in closed or fume-laden areas. Whenever you work in a closed area or in a place where volatile fumes could collect, use only approved, sealed safety lights and explosion-proof equipment. Some explosions in the past haven't killed anyone, but those present were electrocuted by the bare wires whipping around as a result of the big boom.

10. If someone else becomes a shock victim, don't join him. Don't become part of the circuit yourself. Turn off the power or manipulate the wires or the victim with something you're SURE is a non-conductor (some rubber items are pretty good conductors). As soon as you can touch him safely, apply artificial respiration. Speed is essential--in 600 cases studied, 70 percent recovered when artificial respiration was applied within three minutes. Another minute of delay reduced the figure to 58 percent. Five minutes are too long--the chances are slim.

WORKING WITH 400 CYCLE AC

400 cycle AC electricity HURTS! Ask the mechanic who has been careless, he'll tell you for certain. For removal and installation purposes on the aircraft there is no problem (unless you forget to pull the proper circuit breakers). However, overhauling components on the bench is quite a different matter. Usually it is necessary in the case of actuators, valves, relays, and so forth, to apply power to the component for adjustment/test purposes. In days gone by, when almost all components were powered by 28 volts DC, working with power applied presented very little danger. However, with the introduction of jet aircraft and the switch to 115-volts, 400 cycle AC, it's a different story. A mistake now presents a danger that could possibly be fatal.

Extreme care must be exercised during bench adjustments. Turn the switch on your power supply OFF if at all possible while making any adjustment. Be certain that no part of your body is in contact with a possible ground return.

One further word concerning the bench power supply. There are two types in common use at the present time. There are two types in common use at the present time. The latest model employs an "above-ground" transformer and protects the operator from possible feedback through a metal bench or a damp floor. The older model does not afford this protection. It is possible to have full voltage standing between either test lead and any surrounding metal objects. Remember: If you must move a power supply, check it with a voltmeter after inserting the wall plug. This will eliminate that moment of surprise (115/220 volts AC, 400 cycle lightning bolt!)

QUESTIONS

1. What is the danger involved while working on electrical circuits?

2. What will be the effect of electricity on your body with you wearing wet clothing?

3. What will be the effect of electrical current flowing through the human skin?

4. How many milliamperes of current flowing through your body, in the region of the heart, will cause sure death?

5. What is the frequency range of the most dangerous currents?

6. What is the main safety precaution to prevent electrical shock while working on electrical circuits or equipment?

7. What are the two types of electricity that are used on an aircraft?

8. Why is it important to make sure that all equipment is properly grounded prior to working on electrical equipment?

9. Why is knowledge of first aid procedures important to you as an aircraft mechanic?

10. Why should you never connect a power cord to a power source first?

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STUDY GUIDE

3ABR42633-SG-211A

Technical Training

Turboprop Propulsion Mechanic

FUNDAMENTALS OF AC AND DC ELECTRICITY

14 February 1980

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FUNDAMENTALS OF DC ELECTRICITY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to identify electrical circuits, components of electrical systems, and principles of electricity.

INTRODUCTION

You use electricity many times every day - in lights, fans, radios, shavers, and various other devices. Each of these devices operates because an electric current flows through it. The same type of current is used in many aircraft subsystems. It is used to provide power for airborne radio and radar equipment, to operate lights and motors, and to perform many other jobs.

INFORMATION

You will be working on electrical circuits on the C-130 aircraft. This study guide contains the principles of both direct current (DC) and alternating current (AC), electrical symbols used to represent electrical units in wiring diagrams, and circuit control devices, circuit protective devices, and other electrical devices.

ELECTRICITY DEFINED

Electricity is an invisible force that can produce light, heat, magnetism, and many other physical effects.

In direct current circuits, the current flows steadily in the same direction. Batteries or DC generators used as voltage sources produce direct current electricity. The direction of current flow is from the negative terminal of a voltage source, through the external circuit, and back to the positive terminal.

MAGNETISM

A magnet is an object which has the property to attract iron or steel to itself. The space around the magnet in which its force may be detected radiates lines of force called the magnetic field. A magnet has both a north and a south pole. The lines of force flow from north to south outside the magnet and return south to north inside the magnet. The greatest strength of the magnet lies at the poles. See figure 1.

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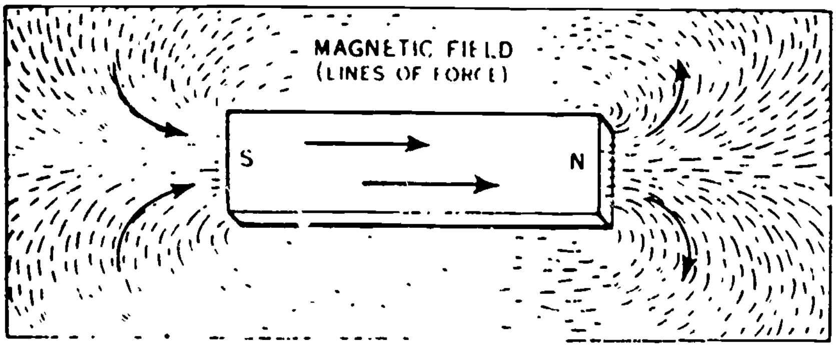

Figure 1. Magnet, Permanent Type.

Magnetism is the term associated with the magnetic field. By definition, magnetism is an invisible force that has the ability to do mechanical work of attraction or repulsion. We do not see magnetism, but we see the effects of magnetism. There are many useful effects of magnetism. Uses may vary from the simple magnetic effect used to hold refrigerator doors closed to the more complex electromagnetic effect used to close solenoid relay switches.

The first magnet discovered was a type of rock called LODESTONE. It has the property to attract certain types of metal, and is called a natural magnet. There is also a man-made magnet which is called an artificial magnet.

There are two types of artificial magnets; permanent and temporary. The permanent magnet is made of hard steel, steel alloy, or an alloy of aluminum, nickel, and cobalt. The length of time that magnetism remains in a magnet depends on the type of material and the way the magnet is handled. A magnet made of aluminum, nickel, and cobalt is hard to magnetize, but will stay magnetized, or retain its magnetism permanently, if properly handled. Any magnet will lose a great deal of its magnetism if it is heated excessively or hammered.

An electromagnet is called a temporary magnet. It is made by wrapping insulated wire around a soft iron core and passing current through the wire. The soft iron core stays magnetized as long as current is flowing through the wire. As soon as the current is turned OFF the core ceases to be magnetized.

Magnetic poles are opposite in the same sense as positive and negative polarities. Therefore, there is a mechanical force of repulsion between like poles and attraction between unlike poles. See figure 2. This action is due to the direction of flow of the magnetic lines of force around the magnet. The polarity of a temporary magnet can be changed by reversing the direction of current flow.

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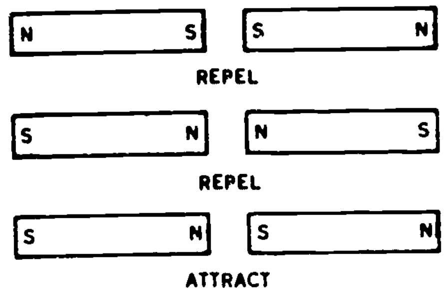

Figure 2. Magnetic Forces.

The operation of relays, motors, instruments, and other units depends upon the magnetism of either the permanent or temporary magnet.

You should remember the following things about magnetic lines of force:

1. They always form complete loops. They travel from north to south outside the magnet and from south to north inside.

2. They never cross each other.

3. They expand or contract like rubber bands as a force is exerted upon them and return to their original state when the force is removed.

4. They will pass more easily through magnetic material (soft iron, nickel, steel, etc) than through air or nonmagnetic materials (aluminum, copper, tin, glass, mercury, etc). No material can completely prevent their passage.

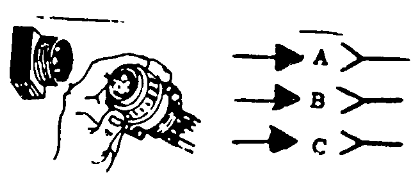

Figure 3. AN Connector and Symbol.
(AN is abbreviation for Air Force, Navy)

ELECTRICAL SYMBOLS

Electrical symbols, as shown in figures 3 and 4, are the electrical engineer's shorthand and are used to represent units and other items of electrical wiring diagrams.

There are many symbols not listed in this study guide. However, the symbols listed here will be sufficient at this time for studying electrical fundamentals. It is important that you learn to recognize and draw these symbols.

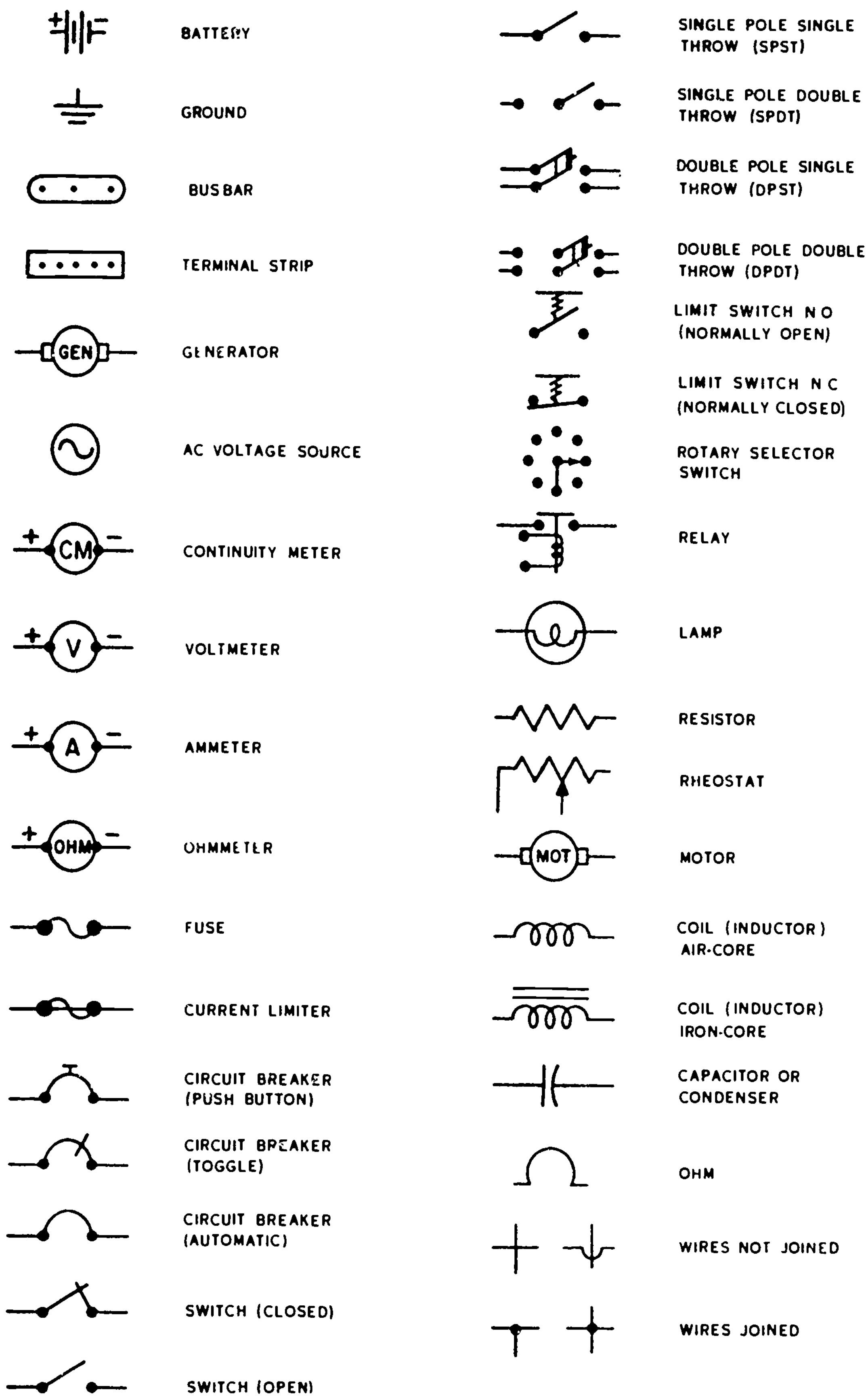

Figure 4. Electrical Symbols.

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CIRCUIT CONTROL DEVICES

The units in the electrical circuits in an aircraft are not intended to operate continuously. Instead, most of them are meant to operate at certain times or under certain conditions. Either a switch, a relay, or both, may be connected in the circuit for this purpose.

Switches

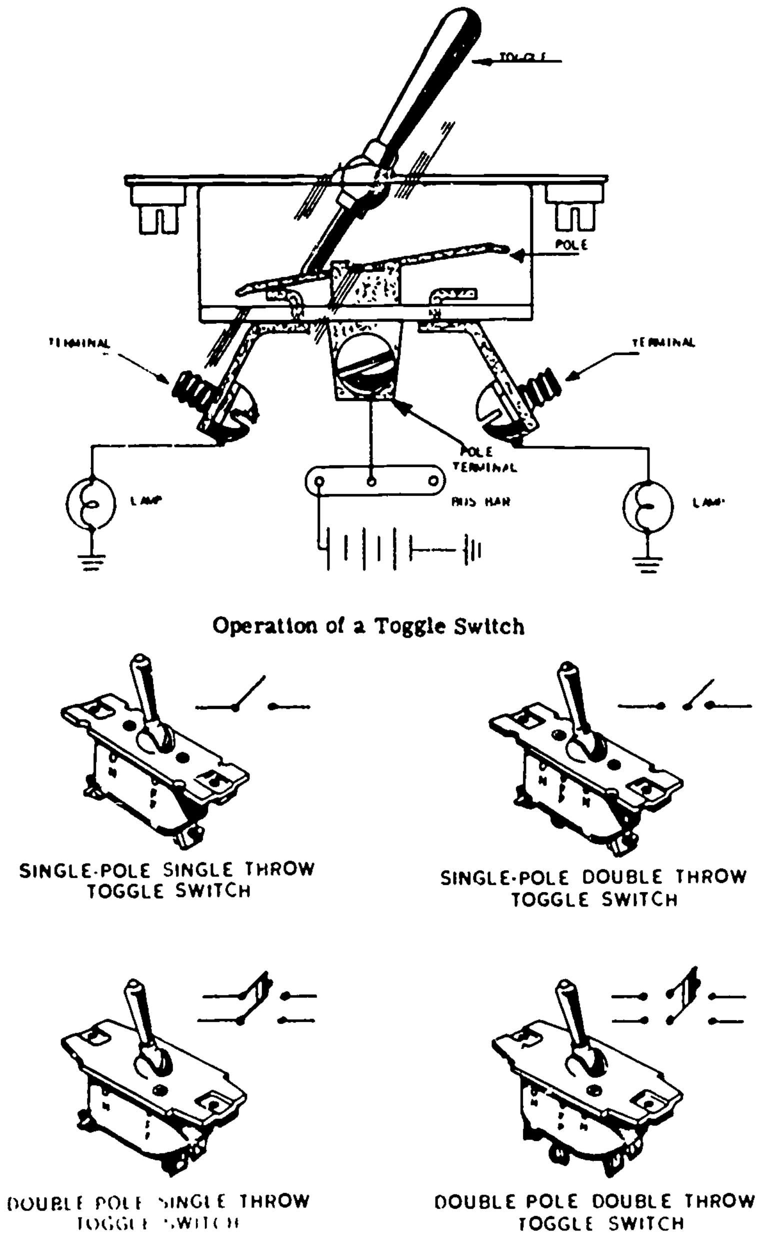

Figure 5. Toggle Switches.

Switches, as shown in figure 5, are used to control the current flow in most aircraft circuits. A switch is used to start, stop, or to change the direction of current flow in the circuit.

Toggle switches operate much the same as knife switches, but their moving parts are inclosed. They are used in aircraft circuits more than any other kind of switch.

Toggle switches are designated by the number of poles, throws, and positions they have. The pole of a switch is its movable blade or contactor. The number of poles is equal to the number of circuits that can be completed through the switch at any one time. The throw of a switch indicates the number of circuits each pole can complete through the circuit.

The number of positions a switch has is the number of places at which the operating device (toggle, plunger, etc) will come to rest and at the same time open or close one or more circuits. See figure 5.

A single-pole, single-throw (spst) switch will complete one circuit only.

A single-pole, double-throw (spdt) switch can complete two circuits, but only one at a time. If one circuit is closed, the other must be open.

The double-pole, single-throw (dpst) switch can complete two circuits both at the same time.

The double-pole, double-throw (dpdt) switch can complete four circuits; however, only two circuits can be completed at one time.

A toggle switch that is springloaded to the OFF position and must be held in the ON position to complete the circuit is a single-position switch. One that will come to rest at either of two positions, opening the circuit in one position and closing it in another, is a two-position switch. A toggle switch that will come to rest at any one of three positions is a three-position switch.

A switch that stays open, except when it is held closed is a normally-open (NO) switch. One that stays closed, except when it is held open is a normally-closed (NC) switch.

Both types are spring-loaded to their normal position and will return to that position when they are released.

Limit Switch. (Trade Name, Microswitch) A limit switch will open or close a circuit with a very small movement of the tripping device (1/16th inch or less). This fact is what gives the switch its nickname.

Limit switches are usually pushbutton switches which are spring-loaded (normally open or normally closed). They are used primarily as limit switches to provide automatic control of landing gears, actuator motors and the like.

Rotary Selector Switch. A rotary switch takes the place of several switches. When the knob of the switch is rotated, the switch opens one circuit and closes another. It is possible to interconnect two or more of these contacts and operate more than one circuit at a time. Ignition switches and voltmeter-selector switches are typical examples of this kind of switch. See figure 6.

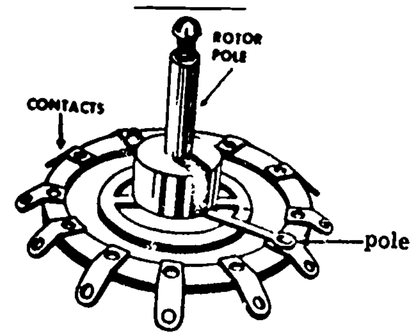

Figure 6. Rotary Switch.

CIRCUIT PROTECTIVE DEVICES

Circuit protective devices, as the name implies, all have a common purpose, to protect the electrical units and wires in the circuit from overload. They are designed to open the circuit when the current flow becomes greater than the circuit was designed to carry.

To protect aircraft electrical systems from damage and failure caused by excessive current, several types of protective devices are installed in the circuit. Fuses, current limiters, and circuit breakers are used for this purpose.

Fuses

A fuse is a strip of metal that will melt when its ampere rating is exceeded. For instance, if a fuse was rated at 15 amps and the current flow was 20 amps, it would melt the fuse. When the metal in the fuse melts, the circuit is then opened and current will cease to flow. A fuse is placed in a circuit so that all the current in the circuit passes through it. In most fuses the strip of metal is made of an alloy of tin and bismuth.

The two kinds of fuses used most in the Air Force are the "plug-in" and the "clip" types. Since the fuse is intended to protect the circuit, it is quite important that its capacity matches the needs of the circuit in which it is installed. When you replace a fuse, always consult technical orders first to be sure you select a fuse of the correct type and capacity.

Current Limiters

A current limiter is a type of fuse that will take large amounts of current for short periods of time. The metal strip in a current limiter is made of copper. An example of a system that uses a current limiter rather than a fuse is the starter system.

Like replacing a fuse, you must choose a properly rated current limiter when replacement is necessary.

Circuit Breakers

A circuit breaker is designed to open the circuit when current flow exceeds the rating of the circuit breaker. It is commonly used in place of a fuse and may sometimes eliminate the needs of a switch. A circuit breaker differs from a fuse in that it "trips" to open the circuit and it may be reset, while a fuse melts and must be replaced. After a circuit breaker has been reset it will trip again if the overload condition still exists. Three types of circuit breakers are: automatic, push-button, and toggle. The automatic resets itself while the other two must be reset by hand.

CONDUCTORS

A conductor is defined as any material which permits the passage of electrical current. Although most conductors are made of wire, the frame of the aircraft can serve as one of the conductors. (Usually the negative one.) The wires that connect to the negative side of the source of power are called negative conductors. Those conducted to the positive side of the source of power are called positive conductors.

There are four properties of a conductor that affect its resistance:

1. The length of the conductor. (The longer the wire, the more the resistance.)

2. The diameter of the conductor. (The larger the diameter, the less the resistance.)

3. The temperature of the conductor. (The higher the temperature, the more the resistance.)

4. The kind of material of the conductor. (Copper has less resistance than steel.)

Remember that the more "free" electrons a material has, the better conductor it is.

INSULATORS

There are times when conductors need to be supported, separated, or covered so as to prevent an undesired flow of current from the conductors to other objects. For this purpose we use a material that has very few, if any, "free electrons." Such a material is called an insulator. Many materials are used for the purpose of insulation. Among these are plastic, rubber, wood, and glass.

OTHER ELECTRICAL DEVICES

Busbar

A busbar is defined as a heavy conductor (usually copper or aluminum) used in aircraft and powerplants to carry heavy current.

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Terminal Strip

A terminal strip is an insulating strip equipped with terminals for connecting wires.

Resistor

A resistor is an electrical component which offers resistance to the flow of current. A resistor dissipates energy in the form of heat.

Rheostat

A rheostat is a variable resistor which may be used as a control device to vary the amount of current which flows to an electrical unit.

ELECTRICAL TERMS

Current

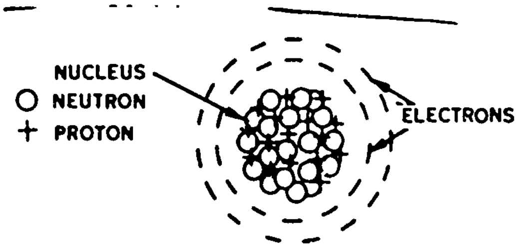

Figure 7. Atom Structure.

Current is the moving element of electricity. To help you understand what this moving element is, let us take a look at the structure of the atom. As you probably already know, all matter is made up of countless millions of atoms. The structure of one of these atoms is illustrated in figure 7.

The atom is similar to the solar system in which the planets revolve around the sun. The center of the atom is the nucleus and is made up of protons and neutrons. The protons have a positive electrical charge and the neutrons have no electrical charge. Revolving around the nucleus in a planetary fashion are the negative charges of electricity known as electrons. There is an electron for each proton. Some of the electrons are held quite strongly to the nucleus while the remainder are held rather loosely. Current is the movement of these loosely held or "free" electrons, from one atom to another along the conductor.

Other things you should remember about current are:

1. The symbol for current is the letter "I" (Intensity).

2. The unit of measurement for current is the ampere (abbreviated "amp").

3. Current is measured with an ammeter, connected in series with the circuit load.

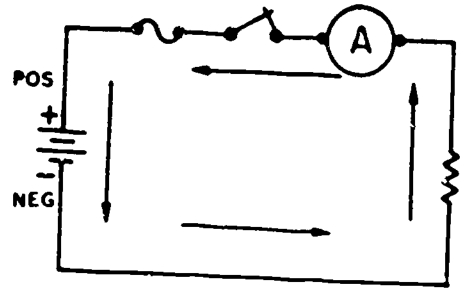

Figure 8. Direction of Current Flow.

4. Current flow is from negative side of the power source to the positive side. See figure 8.

5. Three effects of current are:

   a. Heat

   b. Magnetism

   c. Chemical Change

Voltage

Voltage is defined as electrical pressure. It is is this pressure, EMF (electromotive force) that pushes the current through the circuit.

You should remember the following things about voltage:

1. The symbol is the letter "E" (Electromotive Force).

2. The unit of measurement is the volt.

3. Voltage is measured with a voltmeter which is connected in parallel to the unit of resistance.

Resistance

The opposition to the movement of an aircraft through the air is air friction or drag. Similarly, the flow of water through a pipe is slowed down by friction. In an electrical circuit there is an opposition to current flow called resistance.

In addition to this definition, you should remember the following concerning resistance:

1. The symbol is the letter "R" (Resistance).

2. It decreases current flow and causes a voltage drop.

3. The unit of measurement is the ohm.

4. Resistance is measured with an ohmmeter with the circuit power OFF.

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ELECTRICAL METERS AND THEIR USES

Voltmeter

A voltmeter is an instrument used to measure the difference in electrical potential (pressure), or the voltage between two points.

A coil and several resistors are placed in the voltmeter making it an instrument of high resistance. A rotary switch on the front of the meter is used to connect the coil circuit with the proper resistance or the desired voltage range.

The voltmeter is connected in parallel in the electric circuit and gives the reading in volts.

Ammeter

An ammeter is an instrument that measures the amount of current flowing in a circuit.

The construction of the ammeter is much the same as the voltmeter in many respects. However, the chief differences are the ammeter has low resistance, and the dial is marked in amperes.

The ammeter is connected in series with a unit of resistance in a circuit. NEVER CONNECT IT IN PARALLEL AS SERIOUS DAMAGE TO THE INSTRUMENT WILL RESULT.

Ohmmeter

An ohmmeter is an instrument used to measure the amount of resistance in a circuit or unit.

This sensitive instrument has its own power source (a battery) and is never connected in a circuit with the circuit power ON. To do so will usually damage the instrument beyond repair.

The construction of this instrument includes precision resistors and a rheostat to properly zero the meter. An ohmmeter must be zeroed each time before use.

The ohmmeter is connected in series with the circuit or unit of resistance. It measures the resistance in ohms. Always remember to have the circuit power OFF when using this instrument.

Continuity Meter

The continuity meter is perhaps the simplest of electrical meters. It does not measure anything, but only indicates whether or not an open exists in a circuit or unit.

This meter is simply a small battery installed in a case with a pointer or light to indicate complete or closed circuits or devices.

PRODUCING A VOLTAGE

Three methods in which a voltage can be produced are:

1. By heat (thermocouple).
2. Chemically (battery).
3. Mechanically (generator).

Thermoelectric Method

Applying heat to certain metals will generate a voltage. The most common heat type electrical generator is the thermocouple. It is used for such things as to indicate, through an instrument, cylinder head temperature of engines and the presence of fire.

Chemical Method

A battery is a source of chemical energy. When a battery is connected in a circuit and the switch turned ON, a chemical action takes place and a voltage is produced.

Mechanical Method

In order to produce a voltage mechanically, three requirements are necessary. These requirements are:

1. Magnetic field.
2. Conductors.
3. Relative motion.

The generator has the necessary parts to produce a voltage mechanically. Rotation or movement of a magnet inside a coil of wire is a simple way of explaining how a generator changes mechanical energy into electrical energy.

AIRCRAFT ELECTRICAL CABLES

Most aircraft electrical cables are made of many small copper or aluminum strands. The number of strands per cable is only limited to the load capacity that it will have to carry to the electrical unit. The advantage of the strand type cable over solid cable is flexibility.

With the vast number of compartments and components in an aircraft, we often have to route our wires in small areas and around other units. Strand type wire will also withstand the large amount of vibration that we encounter with today's high-speed aircraft.

Cable Size

The cable size is determined by the amount of amperes that a unit needs to function. If a unit needs 20 amperes to function, the cable would have to be suitable to carry that load without overheating.

A.W.G. NR.	DIA. IN INCHES	AMP. CAPACITY	A.W.G. NR.	DIA. IN INCHES	AMP. CAPACITY
00	.610	220	16	.130	11
0	.550	185	18	.115	7
2	.445	130	20	.100	4
4	.370	90	22	.090	2.5
6	.310	65	24	.020	1.6
8	.255	45	26	.015	1.0
10	.200	33	28	.012	.6
12	.170	23	30	.010	.4
14	.150	16			

Figure 9. American Wire Gauge (Diameter and Ampere Rating).

Once you determine the amperes that the unit will need, you can then refer to a wire gauge chart such as the one shown in figure 9. The chart will give you the wire size (diameter) in American Wire Gauge (AWG) numbers.

Note: The smaller the AWG number, the larger the cable diameter and the larger the ampere capacity.

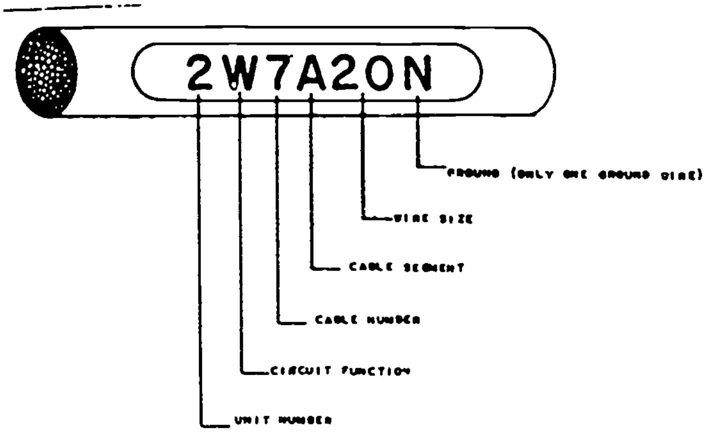

Figure 10. Electrical Cable Identification Number.

If the unit ampere rating is not known, you may determine the capacity by checking the Electrical Cable Identification Number. This will give you the information for cable replacement. See figure 10. This I.D. number will be stamped every 15 inches for easy accessibility.

Conduit

Depending on the type of aircraft, electrical cables must be protected by means other than just insulation. Conduit is often used for this purpose.

Aluminum conduit is used extensively because it possesses sufficient strength and can be easily formed to fit any contour. Conduit may be supported to the airframe at intervals specified in the applicable TO; this eliminates much of the wire vibration normally caused by high-speed aircraft.

Flexible transparent vinyl tubing is sometimes used as a protective covering for cable bundles. This eliminates tying the wires together and the identification numbers can also be seen.

During aircraft maintenance and inspection you will have to check wiring and conduit daily. The following are areas where problems often occur:

Aluminum Conduit

a. Splitting

b. Dents

c. Loose supports

Flexible Vinyl Conduit

a. Cracking

b. Tears

c. Overheating

Terminals

There are two basic types of terminals you should be familiar with when inspecting aircraft electrical systems. The first is the solder type. You will find these in portions of the aircraft where there is very little heat and the chance for corrosion is small.

The second and most common is the swaged or solderless type. This is used extensively on aircraft because of the maintenance factor. Swaged terminals are crimped in place and can be completed without electrical powered tools of any kind. This type terminal is heat resistant and can withstand intense vibrations without losing its conductive properties.

As you progress through the following blocks of instruction, you will be called upon to identify and inspect various electrical systems. These systems cannot function unless the circuit is installed properly. The correct size wire must be used, it must be properly protected, and the connections must be secure. It will be your job to insure this is correct.

DC ELECTRICAL CIRCUITS

An aircraft is provided with lighting to make flying, cargo handling, and maintenance easier at night. The electrical circuits that make up these lighting systems are wired in series, parallel, and a combination of series and parallel circuits.

As a mechanic you may be called upon to maintain and inspect these circuits. Wiring diagrams will aid you in tracing and inspecting electrical units.

WIRING DIAGRAMS

Aircraft technical orders contain diagrams of each electrical circuit on an aircraft. Most of the time, several of these circuits are included on the same diagram. It is important that you learn how to trace a single circuit in order to troubleshoot, maintain, or repair the individual circuit in question.

In most instances, tracing an individual circuit is simple to do. Perhaps one of the simplest methods is to start with the unit at the end of the circuit and trace back to the source of power.

TYPES OF ELECTRICAL CIRCUITS

Knowing the different types of circuits and how the current flows through each will enable you to trace a circuit in less time and with less difficulty on your individual aircraft.

Circuits

An electrical circuit is a continuous path through which current flows. The aircraft electrical system is made up of many circuits. These circuits are divided into three types according to the paths by which the current may travel. The three types of circuits are:

1. Series
2. Parallel
3. Series-Parallel

Series Circuits

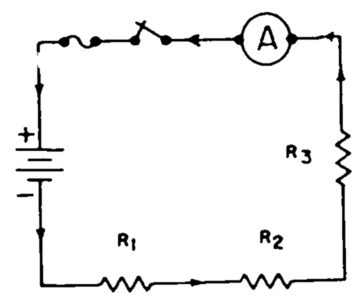

Figure 11. Series Circuit.

A series circuit is one in which two or more units of resistance are connected end-to-end as shown in figure 11.

A series circuit may, therefore, be defined as a circuit in which the current flows in only one path. In the series circuit, the current flow is the same in each part of the circuit.

Parallel Circuits

It is often necessary to connect electrical units so that the entire source of voltage is applied to each unit of resistance. A circuit in

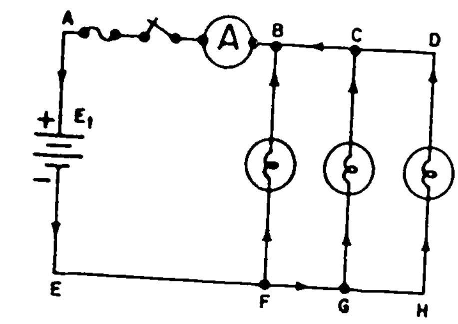

Figure 12. Parallel Circuit.

which two or more units of resistance are connected across the same source of voltage is a parallel circuit. Figure 12 is a parallel circuit. It consists of a battery, fuse, switch, ammeter, and three electrical lamps connected in a parallel. Note that the current which leaves the battery breaks up into three parts and then recombines as it returns to the battery. Parallel circuits have more than one path of current flow.

Series-Parallel Circuits

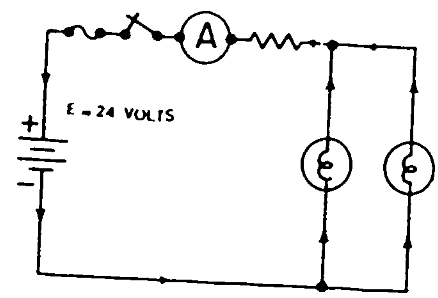

Figure 13. Series-Parallel Circuit.

Some aircraft electrical circuits are a combination of series and parallel circuits known as series-parallel circuits. Series-parallel circuits consist of some units connected in series while other units are connected in parallel. See figure 13.

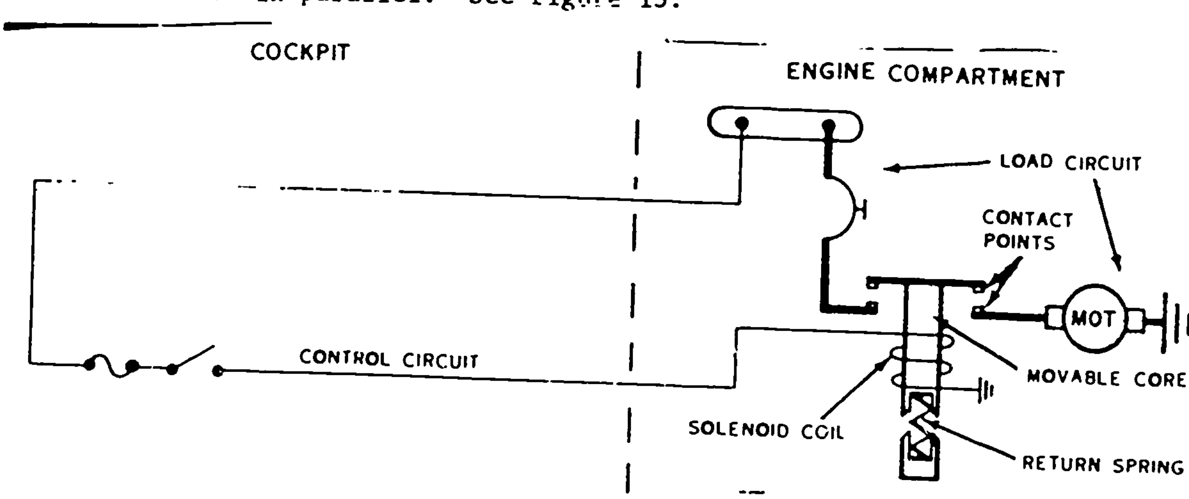

Figure 14. Relay Switch.

Relays, or relay switches, are used for remote control of circuits carrying heavy currents. A relay is connected in the circuit between the unit to be controlled and the nearest source of power. The relay is located as close to the unit to be controlled as possible, thereby making the heavy load wires as short as possible. Small wires are used from the cockpit to the control terminals of the relay. See figure 14.

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By using relays, the large diameter load cables can be shorter, therefore, reducing the weight of the aircraft electrical system.

A considerable amount of magnetism results from heavy current flow in large cables. If these magnetic fields were allowed in the cockpit, certain instruments would give false or incorrect readings.

When the switch in the control circuit is closed, a small amount of current will flow through the solenoid coil. This current flow will result in magnetic lines of force around the movable core. The magnetic field (lines of force) causes the core to move down; thus closing the contact points which completes the load circuit. When the switch in the control circuit is opened, the current flow through the solenoid coil will stop; therefore, the magnetic field effect is lost. With no magnetic effect, the return spring will open the points, stopping the current flow in the load circuit.

SUMMARY

Magnetism of the permanent and temporary magnets makes possible the use of relays, motors, and generators.

Electrical symbols are used on wiring diagrams to save time and space. In electricity, the force that moves "free" electrons is called voltage. The "free" electron movement is called current. Resistance is the opposition to current flow.

A continuous flow of current in all aircraft electrical circuits is not often necessary. Switches and relays are used when it is necessary to start, stop, or direct the flow of current to desired circuits.

The electrical system, like any other system on an aircraft, is subject to failures and malfunctions. In order to protect the electrical system, fuses, current limiters, and circuit breakers are used.

Conductors are used to transfer electricity from one point to another. A material containing many "free" electrons is a good conductor while those containing very few, if any, make good insulators.

Various size cables (conductors) are used throughout the aircraft electrical system. The load (amperes) required to operate the unit in the system determines the size of wire to use. The wires throughout the electrical system can be identified by a code. This code consists of numbers and letters, and is very useful when tracing a specific electrical circuit.

There are three basic types of circuits used in the aircraft electrical systems. The path of current flow determines if the circuit is a series, parallel, or a series-parallel.

In a series circuit, there is only one path for current flow. The parallel circuit has more than one path for current flow. The series-parallel is a combination of both and it is the most common circuit found in an aircraft.

QUESTIONS

1. Explain the difference between permanent and temporary magnets.

2. Name three electrical units that depend on magnetism for operation.

3. Draw the symbols for three circuit protection devices.

4. Give the definition for each of the following: current, voltage, and resistance.

5. What are the three purposes of a circuit control device?

6. Explain what happens to a fuse when the current flow is greater than its rated amperage.

7. Give a reason why relays are used in circuits.

8. What are the three effects of current flow?

9. Name three ways that a voltage can be produced.

10. Describe the use of the following meters:

    a. Voltmeter

    b. Ammeter

    c. Ohmmeter

    d. Continuity meter

11. As the size numbers of aircraft electrical cables increase, what happens to the diameter and amp rating of the wire?

12. Where would you find the wiring diagram for a specific aircraft electrical system?

13. How many paths for current flow is there in a series circuit?

14. What is a series-parallel circuit?

15. If one light bulb in a parallel circuit burns out, would the others continue to burn? Why?

FUNDAMENTALS OF AC ELECTRICITY

INTRODUCTION

In the DC electricity study guide, the discussions dealt primarily with direct current. Direct current has some applications where it is more useful than other forms of electricity. However, DC also has certain disadvantages or restrictions which limit its use. If you will recall, in a DC circuit current moves in one direction only--from the negative terminal of the power source, through the circuit, to the positive terminal of the power source. In alternating current, the current flows first in one direction and then in the opposite direction.

Where possible, alternating current has largely replaced direct current circuits in newer aircraft for a number of reasons, namely;

1. AC voltage can be increased or decreased very efficiently with transformers.

2. AC devices are much simpler and less troublesome than DC devices.

3. AC units are lighter.

4. They operate more efficiently at high altitudes.

AC DEFINED

Alternating current is a current that constantly changes in value and periodically reverses in direction.

Yesterday, you saw voltage produced by moving a bar magnet forward and back through a coil of wire.

The galvanometer connected to the coil proved that alternating current was flowing in the circuit. The pointer on the galvanometer moved gradually to the right as you moved the magnet in one direction and moved gradually to the left as you moved the magnet in the opposite direction. This experiment proved that when magnetic lines of force are cut by a conductor, AC voltage is induced in the conductor. The principle of inducing a voltage involves three factors:

1. A magnetic field.

2. Electrical conductors.

3. Relative motion.

Also, the action of the galvanometer proved that the DIRECTION of induced voltage depends upon the DIRECTION in which the conductor cuts the lines of force. THIS IS THE PRINCIPLE OF AC.

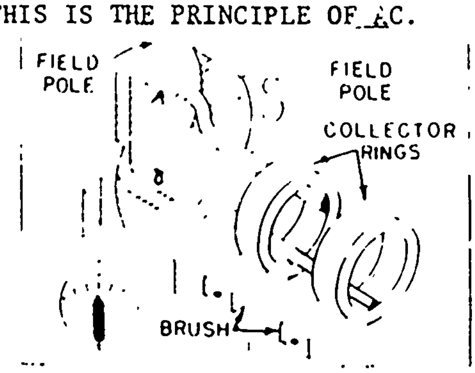

Figure 15. Conditions for Producing AC.

Now "picture" a coil of wire rotating on a shaft between the poles of a permanent magnet. The end of eac' coil is connected to a collector ring and a galvanometer is attached to show the results. See figure 15.

In the position shown in figure 15, the coil is not cutting the lines of force. Therefore, at this instant, no voltage is induced in the coil. However, as the rotor turns, it cuts lines of force between the magnetic poles. The more lines of force being cut, the more the induced voltage.

During each revolution of the rotor, the galvanometer needle will move gradually to the right and to the left the same amount.

Phase

The term phase is the relationship of two or more voltages which are produced by one alternator. When only one voltage is produced by an alternator, it is said to be a single phase AC. If, on the other hand, three voltages are generated by the same alternator, we say it is three phase AC.

Capacitor (or Condenser)

A capacitor is a device consisting of two conducting surfaces separated by an insulating material. The conducting surfaces are known as plates and the insulating material is known as dielectric. In an electrical circuit, a capacitor serves as a storage place for electricity. When the capacitor is charged, electrical energy is stored in the electrostatic field that exists between the plates.

Capacitance

Capacitance is the ability of a capacitor to store electrical energy. The capacitance of a capacitor is determined mainly by these three factors: the area of its plates, the substance used for the dielectric, and the thickness of the dielectric or the distance between the plates.

COMPARISON OF AC AND DC

Some of the principles, characteristics, and effects of alternating current are similar to those of direct current. Likewise, there are a number of differences and these differences serve as a basis for AC having more applications than DC.

You have already learned that direct current flows constantly in one direction. The polarity of the applied direct voltage is constant causing the electrons to move through the circuit in one direction only.

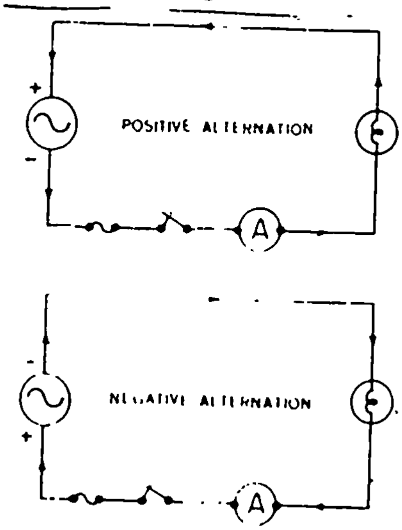

Figure 16. Current Flow in an AC Circuit.

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In alternating current, the electrons move through the circuit in one direction for a short period of time and then they move back in the opposite direction for a like period of time. Think back on the definitions for CYCLE and ALTERNATION. The alternation is half of a cycle. The current flows in one direction during one alternation and in the opposite direction during the other alternation. In other words, on each alternation, the polarity of the AC applied voltage changes causing the current flow to change directions. See figure 16.

In direct current, the opposition to current flow is called RESISTANCE and is represented by the letter R. Most of the resistance in DC circuits is the resistance of circuit components such as a light bulb, electric motors, etc. You know that resistance is expressed in terms of OHMS. A resistance of one ohm limits the current flow to one ampere when the applied voltage is one volt.

In alternating current, the total opposition to current flow is called IMPEDANCE and is represented by the letter Z. Impedance is also expressed in terms of OHMS. An impedance of one ohm limits the flow of alternating current to one ampere when the applied AC voltage is one volt.

A capacitor in an AC circuit serves as a reservoir or a storehouse for electricity. The capacitor stores its energy in the electrostatic field that exists between the plates. A capacitor BLOCKS the flow of DC current and serves the same EFFECT as an open circuit.

In order to understand the operation of a capacitive circuit, let's review the definition, purpose, and physical construction of a capacitor.

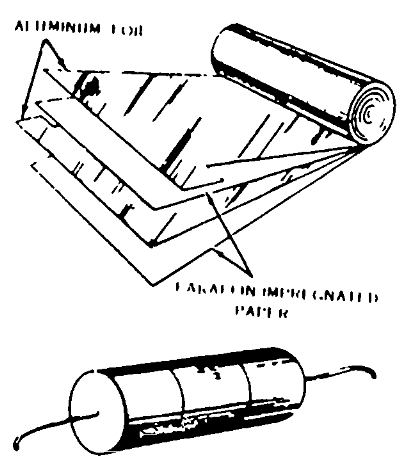

Figure 17. Tubular Paper Capacitor.

A capacitor is a device consisting of two conducting surfaces separated by an insulating material. Figure 17 shows a tubular paper capacitor.

The conductors are called the plates of the capacitor and the insulating material is called the dielectric. Some of the various dielectrics used in capacitors are air, oil, mica, and impregnated paper.

The purpose of a capacitor is to store electrical energy. Its ability to store electrical energy is known as CAPACITANCE. The capacitance depends upon the area of the plates, the distance between the plates, and the type of dielectric material used.

TRANSFORMERS

There are two classes of transformers--voltage transformers and current transformers. Of the two types, the voltage transformer is the more common and that is the type we shall deal with in this study guide.

A voltage transformer is a device used to step-up or step-down AC voltage.

The transformer is one of the most common electrical devices used in radio and radar equipment. Also, by using transformers, an alternating voltage can be stepped up for the transmission of power over a long power line and stepped down again to the proper value for the consumer. This procedure is used to minimize the loss of power along the transmission line.

When voltage is stepped up, current is stepped down. Therefore, less current flows over the power line than would flow if the power were transmitted at a voltage rating of 110 volts. This makes it possible to use smaller conductors for the transmission line which permits a great saving.

Since transformers are designed to accomplish so many jobs, it is apparent that a basic understanding of transformers is of considerable importance.

Transformer Construction

A transformer consists of three parts:

1. Primary Windings (or Coil).
2. Core (usually laminated iron).
3. Secondary Windings (or Coil).

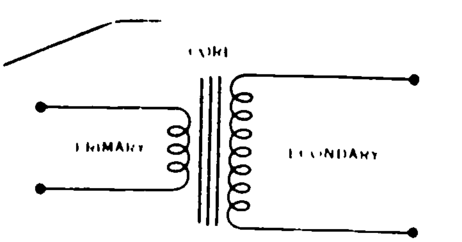

Figure 18. Symbol for a Transformer.

Most transformers have a laminated iron core which strengthens the magnetic field around the coils. The symbol for a transformer with an iron core is shown in figure 18.

The primary coil is always connected to the supply voltage.

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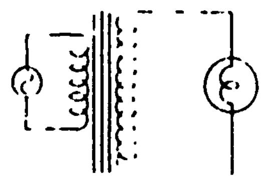

Figure 19. Step-Up Transformer.

When a transformer delivers a higher voltage than the applied voltage, it is called a STEP-UP transformer. A step-up transformer must have MORE turns in the SECONDARY COIL than in the PRIMARY COIL. See figure 19.

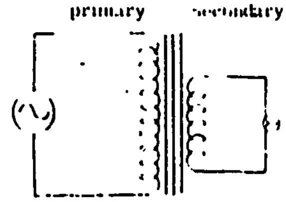

Figure 20. Step-Down Transformer.

When a transformer delivers less voltage than the applied voltage, it is called a STEP-DOWN transformer. A STEP-DOWN transformer must have FEWER turns in the SECONDARY COIL than in the PRIMARY COIL. See figure 20.

A Few Important Facts

In either a step-up or a step-down transformer, the INPUT side is the primary and the OUTPUT side is the secondary.

When voltage is stepped up, current is stepped down.

A transformer will operate on AC because in AC, the magnetic field is always in motion. Therefore, a transformer in AC has the three elements necessary for inducing a voltage; namely,

1. Magnetic Field

2. Conductors

3. Motion (the moving magnetic field provides the motion)

A transformer will NOT operate on pure DC because in pure DC, the magnetic field is steady. Therefore, there is no motion, and one of the elements of inducing a voltage is missing.

The turns ratio of a transformer is defined as the ratio of the number of turns of the PRIMARY windings to that of the SECONDARY windings.

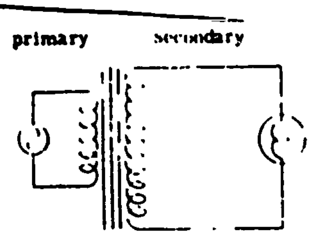

Figure 21. 3:1 Step-Up Transformer.

For example, in the transformer shown in figure 21, the turns ratio is 300/600 or 1:2 (1 to 2). Since there are more turns in the secondary coil than in the primary coil, the transformer is a 1:2 step-up. Therefore, two facts must be given to fully describe transformer ratios:

1. The ratio of the turns.

2. Whether the transformer is step-up or step-down.

Mutual induction, as defined previously, is the action of inducing a voltage in one circuit by varying the current in a neighboring circuit. In a transformer, a changing current through the primary induces a voltage in the secondary, and a changing current through the secondary induces a voltage in the primary. Therefore, it is said that mutual induction occurs and that the two coils have mutual inductance.

The above facts are essential to your understanding transformer action.

Transformer Action

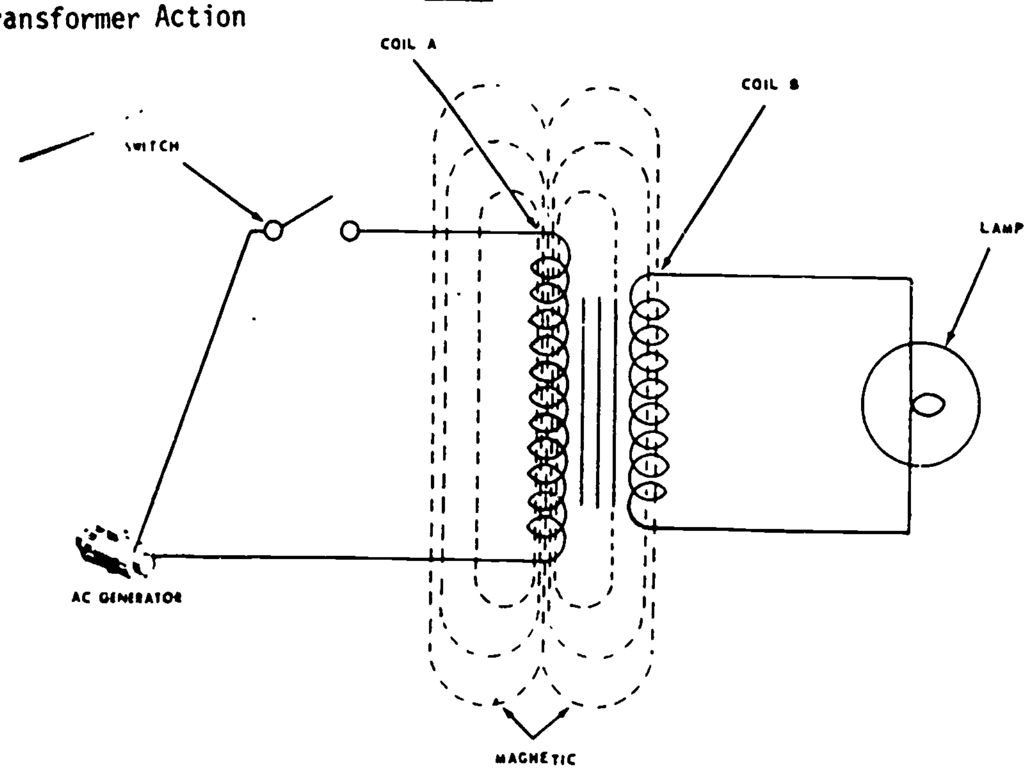

Figure 22. Transformer Action.

The process of transferring electrical energy from one circuit to another by electromagnetic induction is called transformer action. See figure 22.

Refer to figure 22 and notice that a lamp is connected in series with coil B. Coil B is the output side of the transformer. Also notice that an AC generator (alternator) and a switch are connected in series with coil A. Coil A is the input side of the transformer.

With the alternator generating AC electricity and the switch closed, there is a constant buildup and collapse of a magnetic field about coil A. By a process of mutual induction, electrical energy is transferred from coil A to coil B causing the lamp to burn.

Things to Remember About a Transformer:

1. A transformer is used to step-up or to step-down AC voltage.

2. The parts of a transformer are: primary windings, secondary windings and core.

3. The turns ratio of a transformer is defined as the ratio of the number of turns of the primary windings to that of secondary windings.

4. Compare the input and output voltage to determine if the transformer is a step-up or a step-down.

5. To increase voltage through a transformer, you lose current; to decrease voltage, you gain current.

6. The output of a transformer will be zero when connected to a pure DC voltage source.

SUMMARY

In a DC circuit, current moves in one direction only. In an AC circuit, the current is constantly changing in value and periodically reversing in direction. Although both AC and DC current is used on aircraft, AC has certain advantages over DC in many cases. Review these advantages listed at the beginning of this section of the study guide.

The terms cycle, alternation, frequency, amplitude, and other terms listed at the beginning of this section are important to the understanding of alternating current. Study the definitions of these terms carefully so that you may have a full understanding of each.

The alternator (AC generator), like the DC generator, is normally engine driven. The source of AC power for the aircraft electrical system is normally supplied by AC generators and inverters. The most common frequency used in the aircraft AC electrical system is 400 cycles.

Transformers are used to step-up or to step-down AC voltage. Since not all electrical units operate on the output voltage of the AC generator, transformers are used in various aircraft circuits.

The part of the transformer connected to the input source of power is the primary and the output is the secondary. A laminated iron core is used to increase the strength of the magnetic field set up by an electric current. Transformer action is the process of transferring electrical energy from one circuit to another by electromagnetic induction. In a step-up transformer, you gain voltage and lose amps; in a step-down transformer, you lose voltage and gain amps.

QUESTION

1. List the advantages of AC over DC.

2. Draw an AC sine wave and label the part that identifies each of the following:

   a. Cycle

   b. Positive Alternation

   c. Negative Alternation

   d. Amplitude

3. What is transformer action?

4. What are the parts of a transformer?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-211B
14 February 1980

PROPELLER ELECTRICAL SYSTEM

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to identify hazards of electrical circuits and components of the electrical control system used to actuate or control the propeller.

INTRODUCTION

The turbopropeller is a hydraulically operated propeller, but many of the components that are used in the hydraulic system must be actuated electrically. This study guide will explain, briefly, the electrical control system and related components.

INFORMATION

This study guide contains information on the components of the propeller electrical system that are used to control or indicate that the electrical system is being operated.

CONDITION LEVERS

The condition levers serve primarily as a feathering and unfeathering control. Each condition lever is linked to the engine coordinator and only moves the (alpha) input shaft when it is placed in the feather position. The air start circuit is energized when the condition lever is pushed full forward and held in this position. Ground or static operation is obtained in this manner. This position will energize the auxiliary motor. The other positions of the condition lever are used to control the engine. These positions are Ground-Stop and Run.

FIRE EMERGENCY CONTROL HANDLE

There are two warning lights in each fire emergency control handle. One light will blink or flash when the thermal detectors are overheated. The other warning light will burn steady when a fire is detected. The fire emergency handle is pulled to feather the propeller electrically. It also completes the following circuits: (1) closes the fuel control shutoff valve, (2) closes the engine oil shutoff valve, (3) closes the fire wall fuel shutoff, (4) renders the engine start system inoperative, (5) positions the fire extinguisher systems control valves, and (6) arms the extinguisher agent discharge switch.

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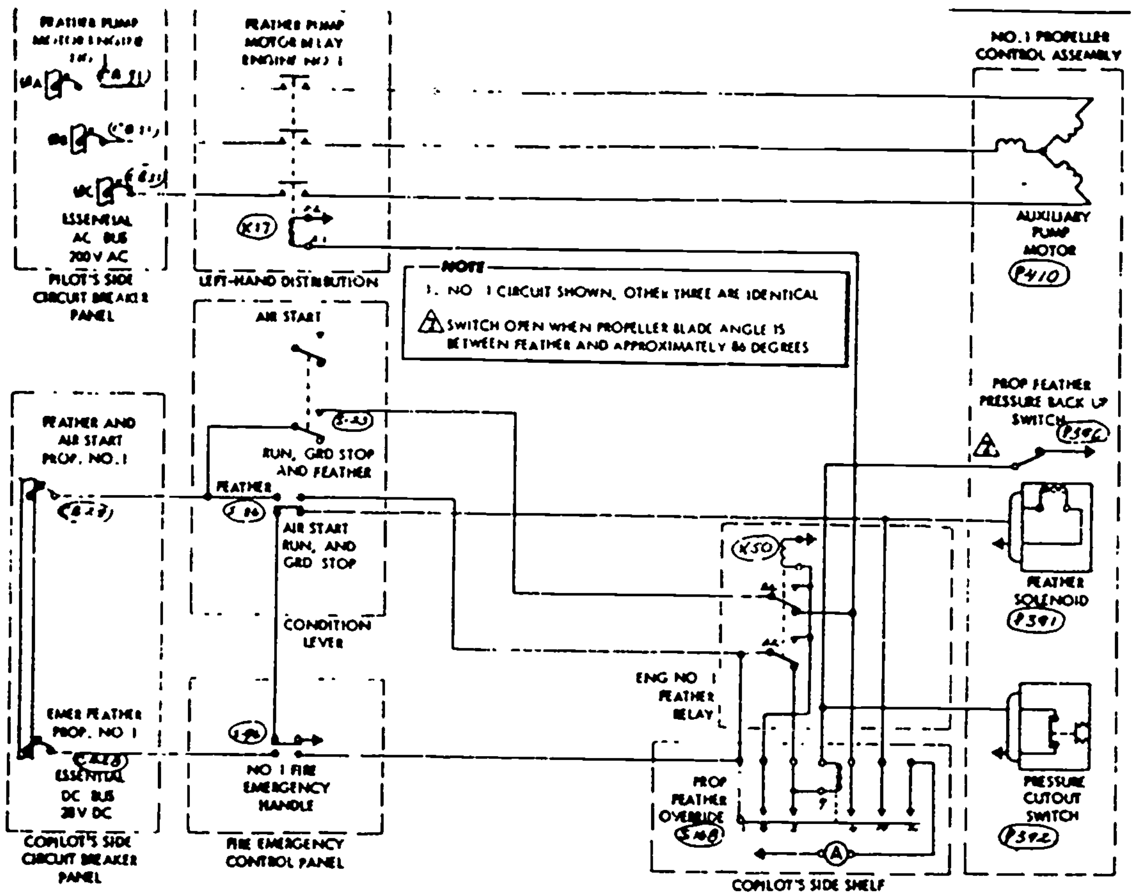

Figure 1. Propeller Feathering and Air Start Control Circuit Schematic Diagram.

The electrical system for emergency fire feather is similar to the normal electrical system. See figure 1.

FEATHER OVERRIDE BUTTONS

The four feather override buttons, each provides a means for manually stopping the auxiliary pump of each propeller. When the condition lever is pulled to feather or the fire emergency handle is pulled, a circuit is completed through the button to ground. The button pulls in automatically and remains in until the propeller is completely feathered. If, for some reason, we wanted to stop this feathering action, we would simply pull out on the override button.

LOW OIL WARNING SYSTEM

The low oil warning light system indicates when one or more of the propeller systems is low of oil and it also indicates which of the props is low. No provisions are provided for replenishing, so for several external leaks, the propeller would have to feather and the engine shut down or the propeller would be operated in a pitch lock condition.

FEATHER VALVE AND NEGATIVE TORQUE SIGNAL CHECK SYSTEM

When the feather valve and NTS check switch is in the "valve position," it completes a circuit from the DC bus through the feather valve, NTS check lights and to the contacts of each NTS check relay. Then it continues on to the feather valve check switch in each of the control assemblies. If the feather valve is positioned for feathering the propeller, it completes the circuit on the ground. The light will come on indicating the feather valve has been positioned mechanically in the control assembly.

When the feather valve and negative torque system (NTS) switch is placed to the "negative torque system (NTS) position," two circuits are completed.

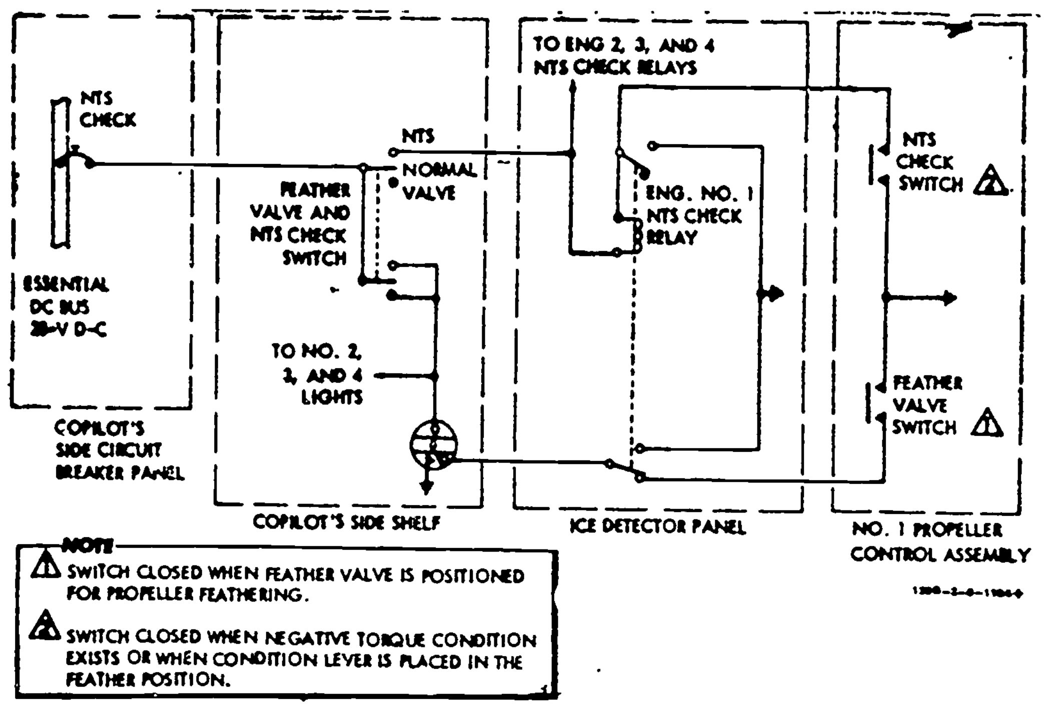

Figure 2. Feather Valve and NTS Check Circuit Schematic Diagram.

One is to the check light and to the NTS check relay points. The other circuit goes to the check relay coil. When the linkage from the engine signals an NTS condition the NTS plunger actuates a linkage which closes the NTS switch. The NTS switch completes a circuit to ground for the NTS check relay coil and energizes the relay. The relay will remain energized and the light will remain on as long as the check switch stays in the "NTS position." See figure 2.

SUMMARY

The electrical system consists of the circuits needed to feather, unfeather, and air start the propeller. This can be done with the condition lever or the fire emergency handle. To check the feather valve and the NTS circuit for operation, an electrical system is incorporated to test these areas by using switches in the aircraft.

QUESTIONS

1. What control is used to feather the propeller?

2. What is the purpose of the feather override button?

3. Where does the coil on the feather override button ground?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-211
3 March 1980

PROPELLER ELECTRICAL SYSTEM

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to trace electrical circuits in condition lever feather, emergency feather, and all airstart circuits using the aircraft propeller electrical wiring diagram.

EQUIPMENT

	Basis of Issue
Assorted colored pencils	1 set/student

Project 1

PROCEDURE

The following components are necessary for normal feather. Identify component on No. 1 propeller by number as you locate it in figure 1.

1. Bus bar 28V DC __________
2. Condition lever feather switch __________
3. Feather relay __________
4. Feather override switch __________
5. Pressure cutout switch __________
6. Pressure back-up switch __________
7. Feather solenoid __________
8. Feather pump motor relay __________
9. Bus bar 200V AC __________
10. Auxiliary pump motor __________

Note: In order to progress smoothly from a schematic diagram such as figure 1 to a wiring diagram, find the same components on the wiring diagram, as you have on the schematic diagram.

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Project 2

PROCEDURE

The following components are necessary for emergency feather. Identify each component by number as you locate it in the wiring diagram. Use No. 2 propeller.

1. Bus bar and 28V DC circuit breakers ______________
2. Fire emergency control handle ______________
3. Feather relay ______________
4. Feather override switch connector ______________
5. Pressure cutout switch connector ______________
6. Pressure back-up switch connector ______________
7. Feather solenoid connector ______________
8. Feather pump motor relay ______________
9. Bus bar and 200V AC circuit breakers ______________
10. Auxiliary pump motor connector ______________

Project 3

PROCEDURE

The following components are necessary for airstart. Identify each component by number as you locate it on the wiring diagram for No. 3 propeller.

1. Bus bar and circuit breaker 28V DC ______________
2. Condition lever airstart switch ______________
3. Feather relay ______________
4. Feather pump motor relay ______________
5. Bus bar and circuit breaker 200 UAC ______________
6. Auxiliary pump motor ______________

Project 4

PROCEDURE

Use colored pencils as indicated and trace the normal (condition lever) feather operational on No. 1 propeller.

	CIRCUIT	COLOR CODE
1.	Override button pull-in	Red
2.	Override button holding	Orange
3.	Light - Override button handle	Yellow
4.	Auxiliary pump relay	Brown
5.	Auxiliary pump motor (200 VAC)	Green
6.	Feather relay (K50) pull-in	Blue*
7.	Feather relay holding	Blue*
8.	Feather solenoid	Purple

*Feather relay has two circuits, but in troubleshooting they appear to be the same.

Project 5

PROCEDURE

Use colored pencils as indicated and trace the fire (emergency) feather operational circuits on No. 2 propeller on the wiring diagram.

	CIRCUIT	COLOR
1.	Override button pull-in	Red
2.	Override button holding	Orange
3.	Light in override button	Yellow
4.	Auxiliary pump relay	Brown
5.	Auxiliary pump motor	Green
6.	Feather relay pull-in	Blue
7.	Feather relay holding	Blue
8.	Feather solenoid	Purple

Project 6

PROCEDURE

Use colored pencils as indicated and trace the airstart circuits on No. 3 propeller.

1.	Auxiliary pump relay	Red
2.	Auxiliary pump motor	Blue

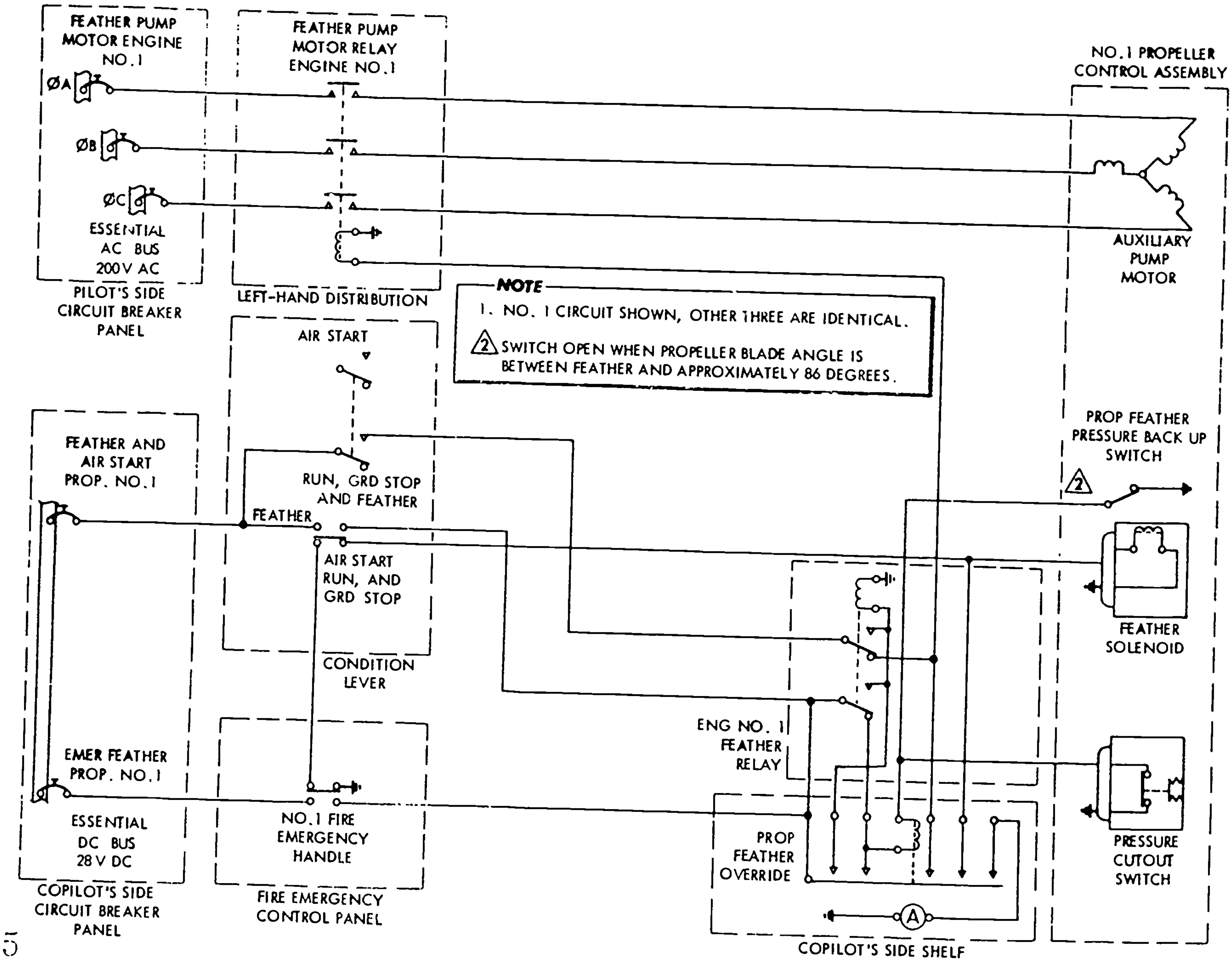
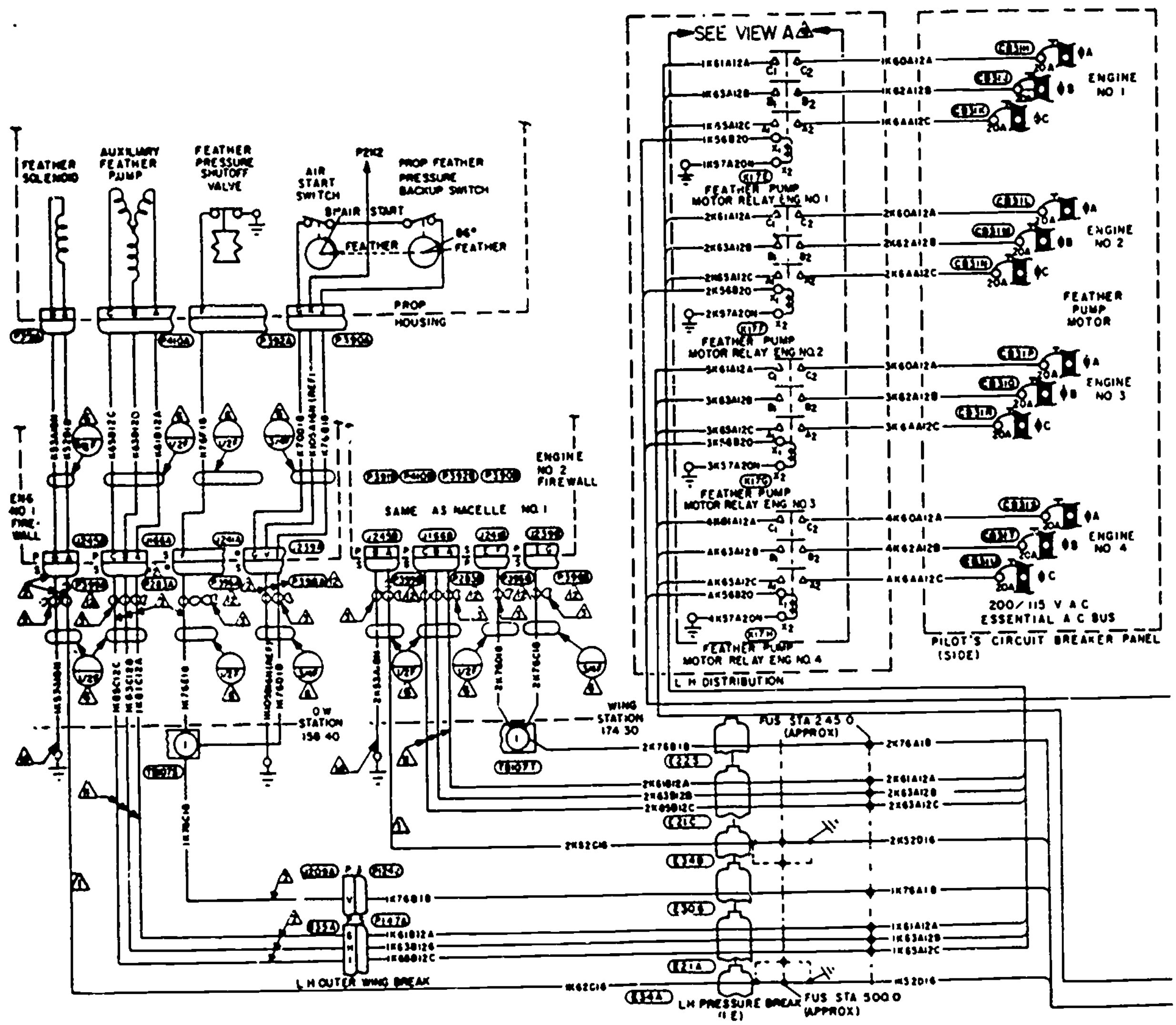
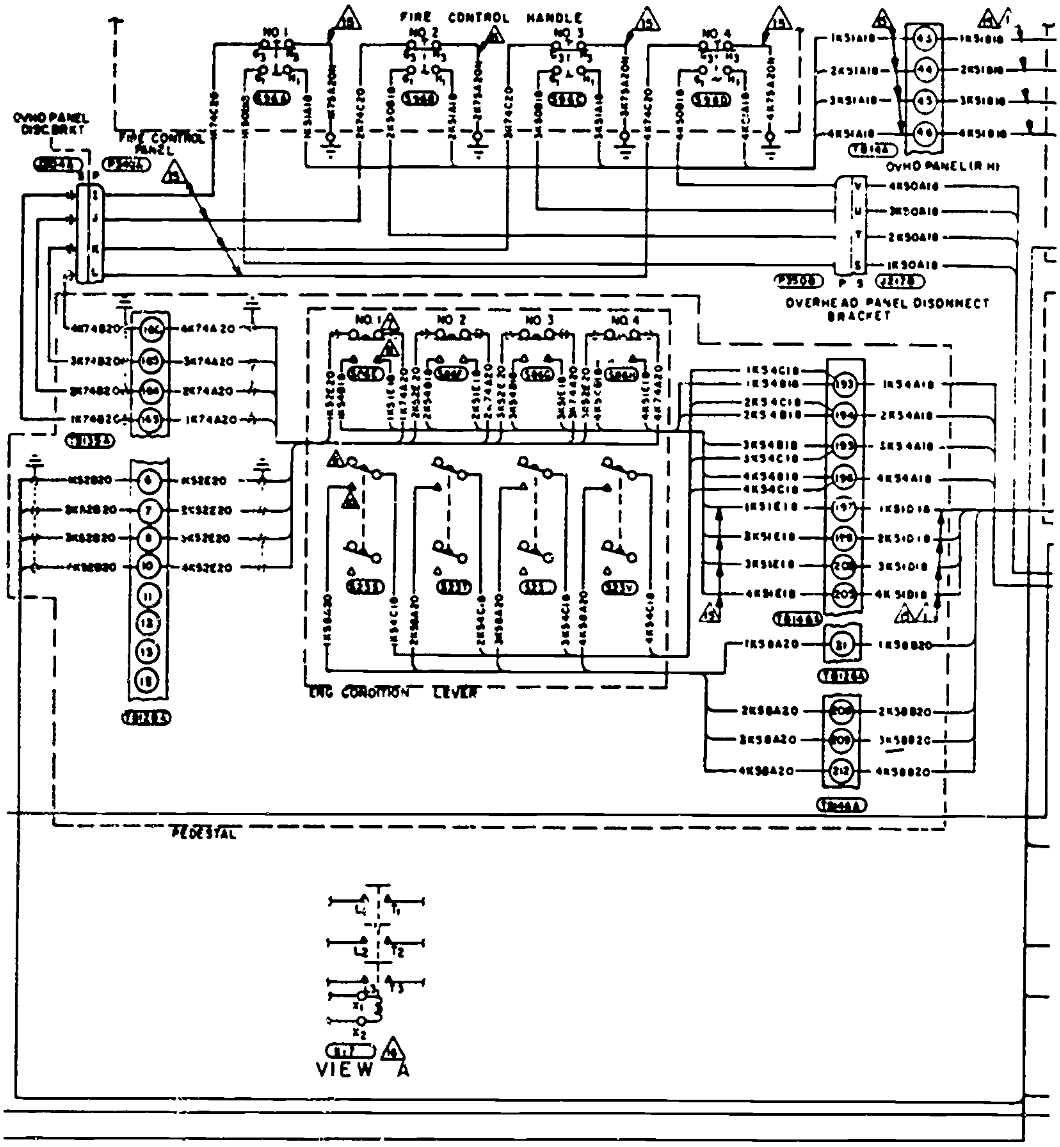


Figure 1. Feather, Airstart Wiring Diagram.


SEE VIEW A
FEATHER SOLENOID
AUXILIARY FEATHER PUMP
FEATHER PRESSURE SHUTOFF VALVE
AIR START SWITCH
PROP FEATHER PRESSURE BACKUP SWITCH
AIR START
FEATHER
86° FEATHER
PROP HOUSING
ENG NO 1 FIRE-WALL
ENGINE NO 2 FIREWALL
SAME AS NACELLE NO 1
OW STATION 158 40
WING STATION 174 30
FEATHER PUMP MOTOR RELAY ENG NO 1
FEATHER PUMP MOTOR RELAY ENG NO 2
FEATHER PUMP MOTOR RELAY ENG NO 3
FEATHER PUMP MOTOR RELAY ENG NO 4
L H DISTRIBUTION
ENGINE NO 1
ENGINE NO 2
ENGINE NO 3
ENGINE NO 4
FEATHER PUMP MOTOR
200/115 V A C ESSENTIAL A C BUS
PILOT'S CIRCUIT BREAKER PANEL (SIDE)
FUS STA 245 0 (APPROX)
FUS STA 500 0 (APPROX)
L H OUTER WING BREAK
L H PRESSURE BREAK (I E)


FIRE CONTROL HANDLE
NO 1
NO 2
NO 3
NO 4
OVHD PANEL DISC BRKT
FIRE CONTROL PANEL
OVHD PANEL (R H)
OVERHEAD PANEL DISCONNECT BRACKET
ENG CONDITION LEVER
PEDESTAL
VIEW A

NOTE

1. THIS WIRE TO BE ROUTED SEPARATELY.
2. WIRES & CONNECTORS PART OF REGULATED ASSY.
3. FOR ITEM IDENTIFICATION SEE ITEM LIST, TABLE 1-1.
4. ALL WIRES ON THIS DIAGRAM MUST BE KEPT A MINIMUM OF SIX INCHES FROM SENSITIVE WIRES.
5. ALL WIRES IN THIS CONDUIT TO BE TWISTED 2 TO 3 TURNS PER FOOT AND TWIST TO EXTEND A MINIMUM OF ONE FOOT BEYOND CONDUIT.
6. ALL WIRES IN THIS CONDUIT TUBE COVERED WITH GENCOTE NO. 135 TYPE 564 ASBESTOS SLEEVING, GENERAL PLASTIC CORP, PATTERSON, NEW JERSEY.
7. THIS SWITCH POSITION IS FOR CONDITION LEVER IN AIR START, RUN & GRD STOP.
8. THIS SWITCH POSITION IS FOR CONDITION LEVER IN FEATHER.
9. THIS SWITCH POSITION IS FOR CONDITION LEVER IN RUN, GRD STOP & FEATHER.
10. THIS SWITCH POSITION IS FOR CONDITION LEVER IN AIR START.
11. WIRE TO BE PE 400 (PACKARD ELECTRIC WARREN, OHIO).
12. SAFETY WIRE THIS PLUG, INSTALL LS7289-1 RED DOT DECAL ON ADJACENT STRUCTURE.
13. INSTALL WIRES PER MIL-W-5088.
14. PROVIDE SEPARATE GROUNDS.
15. ENTIRE LENGTH TO BE ENCLOSED IN VINYL TUBING.
16. ALL WIRES SHOWN ON TERM. C1, B1, A1 ON MS24192D1 ARE TERMINATED ON TERM L1, L2, L3 RESPECTIVELY ON AN3339-1 RELAY. ALL WIRES SHOWN ON TERMINALS C2, B2, A2 ON MS24192D1 RELAY ARE TERMINATED ON TERMINALS T1, T2, T3 RESPECTIVELY ON AN3339-1 RELAY.

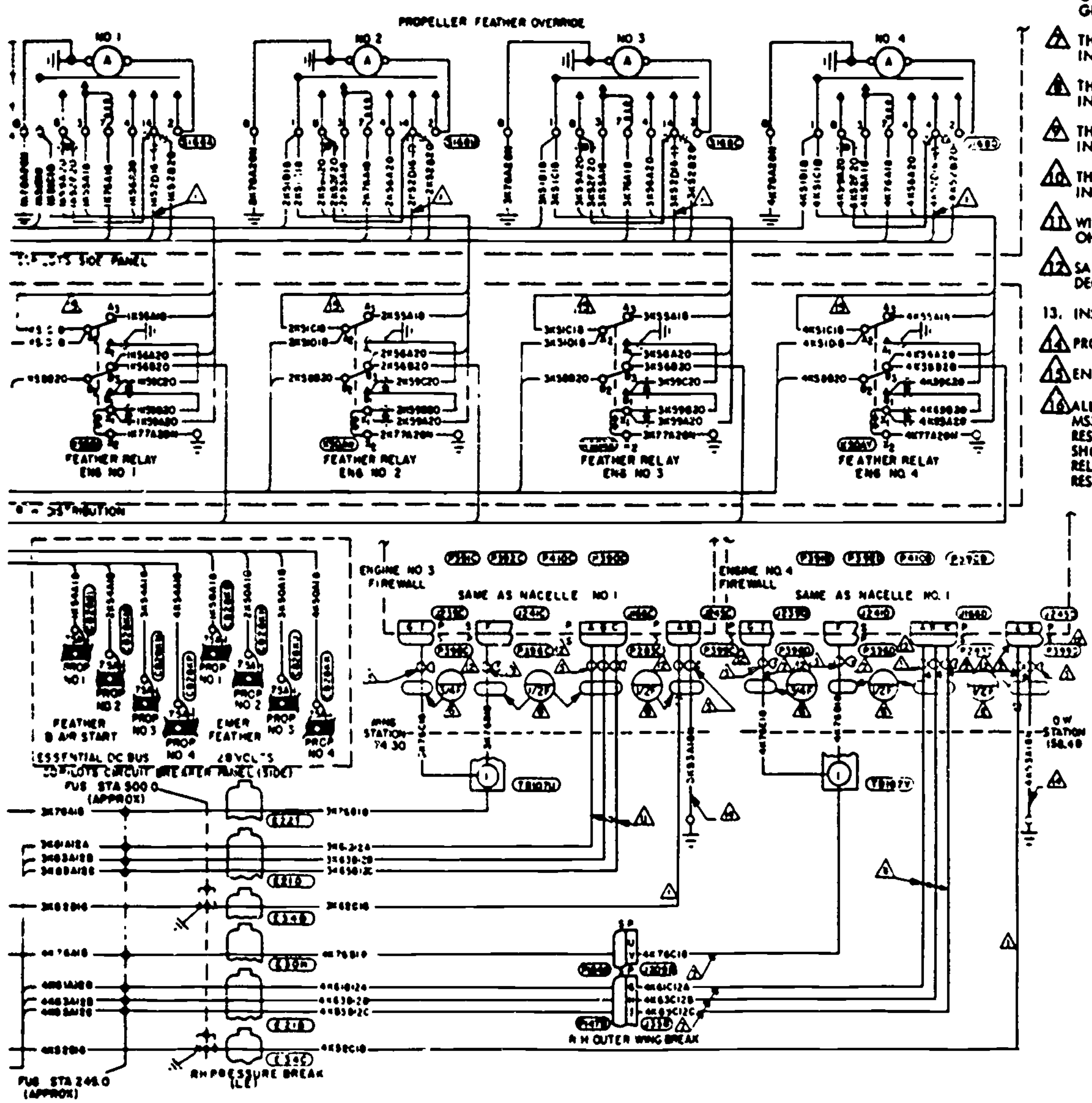


Figure 2. Propeller Feather and Air Start Cc

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STUDY GUIDE

3ABR42633-SG-310

Technical Training

Aircraft Fuel System Mechanic

PROPELLER CONTROL ASSEMBLY

22 January 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.
Do Not Use on the Job.

Jet Engine Branch
Chanute AFB, Illinois

PROPELLER CONTROL ASSEMBLY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to explain propeller control system construction features, function and operating principles, and disassembly and reassembly of the control assembly.

INTRODUCTION

The propeller control assembly is a non-rotating unit mounted on the hub extension. A drive bracket assembly mounted on the gearbox of the engine will keep the control assembly from rotating. The control assembly contains the hydraulic oil supply, pumps, valves, and components to operate the propeller pitch changing mechanism.

INFORMATION

The control assembly is divided into two main sections, the pump housing and valve housing. When disassembling the control assembly, there are several steps which must be followed for safety and FOD prevention.

CONTROL ASSEMBLY

The control assembly has two main sections, the pump housing and the valve housing. See figure 1.

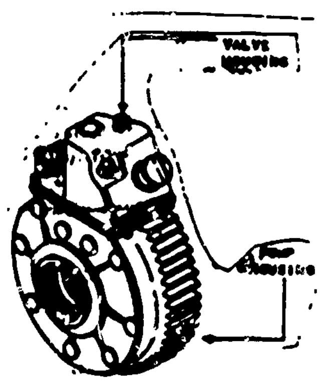

Figure 1. Control Assembly

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PUMP HOUSING

The pump housing contains five gear type pumps. They are the main pump, main scavenge pump, standby pump, auxiliary pump, and auxiliary scavenge pump. The auxiliary pumps are in a single unit housing driven by the auxiliary motor. The rotating sleeve, which is driven by propeller rotation, serves as a transfer bearing. Oil pressure passes through passages in the stationary sleeve and the rotating sleeve to get from the stationary control assembly to the rotating propeller. Mounted on the rotating sleeve is a gear which meshes with the drive gears of the main pumps, main scavenge pump and standby pump.

A pressure cutout switch is located in the pump housing. This hydraulically controlled switch is used to stop the feather cycle. The dome piston movement stops when the dome stop ring contacts the stop lugs. This causes a pressure buildup which actuates the pressure cutout switch, opens the electrical circuit to the feather override button, and terminates the feather cycle.

A pulse generator coil is mounted on the pump housing. A magnet is mounted on the deicing contact ring plate. The magnet rotates past the coil producing an electrical pulse for each propeller revolution. This signal is sent to an electronic unit for the synchrophasing system.

VALVE HOUSING

The valve housing contains the necessary valves and cams to control and direct oil pressure for all pitch changes. It also contains the anticipation potentiometer, feather and NTS check switches, and the servo bias motor. Reverse blade angle, ground idle and mechanical governing adjustments are made through the filler cap, sometimes referred to as the "gas cap," located on the valve housing cover.

The valve housing can be replaced without removing the propeller.

A list of the components that make up the valve housing and pump housing can be found in the back of this study guide beginning on page 9.

INSPECTION

Periodic inspection periods will allow maintenance personnel to detect evidence of propeller or control failure. Listed here are some of the areas of inspection performed to prolong the life of the equipment.

Several precautions should be observed while working on the propeller and control assembly. Here are a few to keep in mind.

Never turn the propeller blades while the rigging pins are installed to lock the beta shaft in position. Rotating the blades will cause severe damage to the valve housing. Any time the electrical connector to the valve housing of any propeller is disconnected, the propeller circuit breaker on the "Essential AC Panel" should be disengaged. This will prevent burning out resistors in the synchrophaser.

Always check the fluid level in the control before checking propeller operation. This is especially true before feathering the propeller.

With a low fluid supply the pressure cutout switch will not stop the auxiliary motor at the completion of feather. This could burn out the motor. You should allow two minutes after propeller operation before opening the filler cap to check oil level. This will allow the pressure to bleed off.

The general condition of the control should be checked and any accumulation of grit or dust removed.

The mechanical linkage to the control should be checked for proper fit and security and rigging.

Electrical receptacles should be disconnected at the control and the contact holes and pins checked for corrosion.

The fluid level of the control should be checked at phase inspection periods, after every 150 hours, or if there is evidence of oil leakage.

The supply and standby filter should be removed and thoroughly cleaned every 150 hours and after the first 25 hours of operation on a new control.

Inspect for external leakage at the base of the valve housing cover, at the drain plug, at the front and rear rotating seals and at the cover seals.

The brush block assembly should be removed from the control housing and the brushes inspected for freedom of movement and brush wear. TO 3H1-18-2 or TO 1C-130B-2-11 specifies minimum brush length.

TURBOCONTROL MECHANICAL LINKAGE

All mechanical and electrical linkages necessary for propeller operation are connected to the control assembly. The mechanical linkages are the negative torque system (NTS) bracket and linkages from the engine coordinator to the input control shaft.

OPERATION

Throttle Lever

Each throttle (figures 2 and 3) is mechanically linked through the engine coordinator to an input shaft (alpha shaft) on the propeller control assembly. When the throttle is in the governing range, between flight idle and takeoff, the input shaft rotates with the throttle movement. It has no effect on propeller speed (RPM) except throttle anticipation and speed stabilization action. When the throttle is below flight idle, movement of the throttle is transmitted to the pilot valve to provide for a positioning of the pilot valve to give a desired beta angle. When the throttle is at maximum reverse, the blade angle is as far into reverse as it can go hydraulically. Negative torque system (NTS) and synchrophasing are blocked out of the operation when the throttle is in the beta range. This is done by a switch in the throttle pedestal and the manual feather cam in the control assembly.

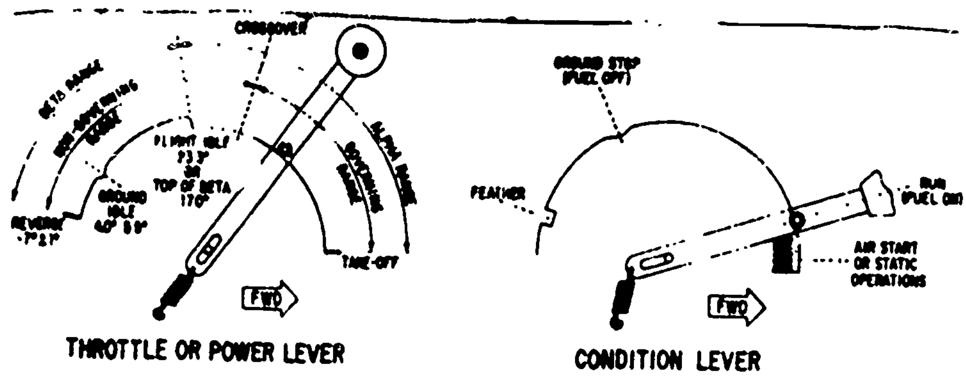

Figure 2. Throttle and Condition Lever.

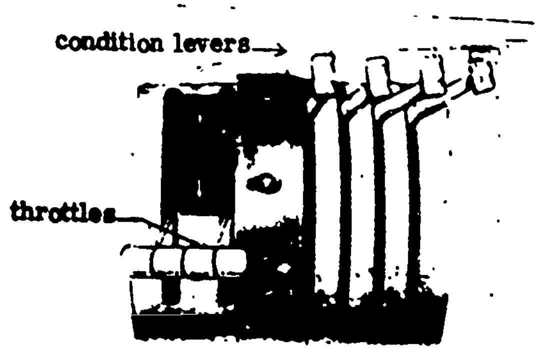

Figure 3. Throttles and Condition Levers.

Engine Condition Levers

The condition levers serve primarily as a feathering and unfeathering control. See figures 2 and 3. Each condition lever is linked to the engine coordinator and only moves the (alpha) input shaft when it is placed in the feather position. The air start circuit is energized when the condition lever is pushed full forward and held in this position. Ground or static operation is obtained in this manner. This position will energize the auxiliary motor. The other positions of the condition lever are used to control the engine. These positions are Ground-Stop and Run.

Anticipation Potentiometer

Movement of the power lever actuates the anticipation potentiometer. A sudden or rapid movement of the power lever causes the potentiometer to send a signal to the synchrophaser calling for a fast pitch change. This blade angle change varies the load on the engine before the engine has a chance to overspeed or underspeed. In this manner, closer control of engine speed is maintained.

Servo Bias Motor

The tension on the speeder spring is normally set at 100%. Variations from this setting are obtained by operating the servo bias motor.

When an out of phase or offspeed condition exists, the synchrophaser sends a signal to the servo bias motor causing it to change the position of the pilot valve.

Feather and NTS Check Switches

These switches are used during a ground check of the propellers to determine if the feather and NTS operations are functioning properly. If the feather linkage shifts the feather valve, a switch is closed to provide ground for an indicator light. If the NTS plunger is actuated, a switch closes and grounds an indicator light. When these lights illuminate, we know that the systems are operating. Feather will be checked during static operation and NTS will be checked during engine shutdown.

Alpha and Beta Shafts

The correct operation of the turbocontrol depends greatly on the alpha and beta shaft and the cams operated by each shaft. An understanding of their function in the control is recommended to enable you to fully understand the operation of the control.

Movement of the alpha shaft is received from the engine coordinator. Four cams are mounted on this shaft. They are the manual feather cam, speed set cam, beta set cam, and alpha backup cam.

The manual feather cam actuates mechanical linkage to the feather valve and feather actuating valve for feathering. A secondary function of this cam is to block out NTS correction in the beta range.

The speed set cam provides 110-114% rpm setting on the speeder spring when the power lever is below flight idle. Normal constant speed control is then lost and blade angle scheduling takes over.

The beta set cam controls the positioning of the pilot valve. As the throttle lever is moved within the beta range, movement is transmitted to the beta set cam. The pilot valve is moved to an off-speed condition and a rapid blade angle change occurs. When the blades reach the desired scheduled angle, the pilot valve is repositioned to "on speed." With the throttle lever in takeoff position, the beta set cam mechanically prevents an angle lower than 28 degrees should the governing system fail.

The alpha backup cam opens the backup valve to direct hydraulic pressure to the spring side of the low pressure relief valve. This action provides sufficient pressure to hold the low pressure relief valve closed. This allows the system pressure to buildup and shift the servo valve, providing the propeller with sufficient pressure to enter the beta range.

Beta Shaft

Unlike the alpha shaft, the beta shaft gets its turning force from the actual blade angle change through the beta feedback gear on No. 1 blade and the differential gearing in the control. Located on this shaft are three cams: the pressure cutout switch backup cam, the beta followup cam and the beta backup cam. The pressure cutout switch backup cam will be used as a mechanical parallel ground for the pressure cutout switch.

During feathering, pressure surges could build up high enough to actuate the pressure cutout switch and terminate the feathering operation too soon. To prevent this, an extra ground is provided through the pressure cutout switch backup cam up to approximately 86° blade angle. After the blade angle passes this point, the ground for the feather override button is provided by the pressure cutout switch only.

Beta Followup Cam

The beta followup cam works in conjunction with the beta set cam. It repositions the linkage controlling the position of the pilot valve in the beta range. The pilot valve is moved to the "onspeed" condition when the beta angle agrees with the beta schedule of the beta set cam.

Beta Backup Cam

The beta backup cam actuates the backup valve. This directs pressure to back up the low pressure relief valve. Now the pressure can build up high enough to unfeather (airstart) the propeller. A high pressure is required to move the stop ring from behind the feather locks. This backup action occurs at 30° blade angle to full feather angle. The condition lever is placed in air start and the auxiliary motor and pump will be operating.

Hydraulic Operation

Hydraulic fluid is pressure fed from the pressurized sump into the main pump and standby pump. Approximately 25 quarts of fluid is used to operate the propeller. The pressure is controlled in the pressurized sump by a sump relief valve. It has a setting of 15-20 psi. Cooling is provided when the fluid is returned from the propeller. It passes through a passage next to the external cooling fins. Here the heat is dissipated when the air passes over these fins.

The atmospheric sump will collect all internal leakage and lubricating oil. This collected leakage will be pumped back to the pressurized sump by the scavenge pump. In this manner, no loss of hydraulic fluid is experienced. A float switch is located in the pressurized sump. It is used to complete a circuit to indicator lights in the cockpit. This will indicate that the oil level in the control is low. The circuit will be completed when the oil level drops two quarts below the normal full position. A dip stick, located under the filler cap, is provided for ground checking the fluid level. The control is also serviced at this point. A drain plug is located in the bottom of the pump housing.

A differential gear train is located in the pump housing. It transmits the movement of the #1 beta feedback gear to the beta shaft in the valve housing. This is the beta range. This compares the actual angle of the #1 blade with the desired angle scheduled from the alpha shaft.

Pilot Valve

The pilot valve directs hydraulic pressure to and from the dome during normal constant speed and beta operations. Centrifugal force and speeder spring tension are used for the positioning and movement of the pilot valve. The bleed from the standby valve is controlled by the position of the pilot valve. Whenever more than 1% offspeed condition is present, the pilot valve blocks off the bleeding action. This causes the standby valve to close. High pressure in the standby system builds up and opens the standby check valve. Pressure from the standby system enters the main pressure system for a quick blade angle response. In this manner the engine is held on-speed.

During feather or NTS, (negative torque system) oil pressure is directed to a pilot valve positioning chamber. This is to position the pilot valve in case of feather valve failure. In other words, the pilot valve backs up the function of the feather valve in case of malfunction.

Normal speeder spring tension is 100% rpm. Small variations of tension can be obtained to allow synchrophasing of the propeller.

Rotation of the flyweights is received from the rotating sleeve and the differential gear train. Thus, flyweight speed is in direct proportion to propeller speed.

Feather Valve

The feather valve directs hydraulic pressure to and from the propeller for feathering and NTS correction. There are two ways the pilot can feather the propeller. One is placing the condition lever to the feather position. The other is by pulling out on the fire control handle.

The feather valve can be shifted mechanically or by hydraulic pressure. The condition lever moves the mechanical linkage to the engine coordinator. From there the linkage connects to the input shaft on the valve housing. Linkage actuated by the manual feather cam positions the feather valve to feather. Also, when the condition lever is placed in feather, a switch is actuated. This initiates electrical feathering. The solenoid valve is energized to direct oil pressure to the positioning chamber of the feather valve. It will shift for feathering. Spring tension keeps this valve in the normal position when feathering is not required.

High Pressure Relief Valve

Excessively high pressure is prevented in the propeller by the high pressure relief valve. A setting of 1250 $\pm$ 125 psi will allow normal operating pressures. Pressure greater than that will be relieved back into the pressurized sump.

Low Pressure Relief Valve

The low pressure relief valve will control the hydraulic pressure according to the demands of the propeller. The selector valve will provide a passage for oil pressure to back up the low pressure relief valve. This helps hold it closed. This is done when a higher pressure is needed in the system.

Solenoid Valve

The solenoid valve is electrically energized by the condition and/or the fire emergency handle during feather operation. This valve will provide an oil passage to position the feather valve and the pilot valve to the feather position.

Feather Actuating Valve

The feather linkage and/or the NTS linkage can position the feather actuating valve. This valve provides a passage to hydraulically position the feather valve and the pilot valve.

SUMMARY

The control assembly houses the mechanism to produce the hydraulic pressure, direct it to the propeller and limit the pressures under most operating conditions.

The condition lever and power lever will control the normal governing beta and feathering operations. These controls will affect the propeller both electrically and mechanically. This is to provide a margin of safety in propeller control.

TURBOCONTROL COMPONENTS

1. Pump Housing
   a. External Components
      (1) Cooling Fins
      (2) Control Drive Bracket
      (3) Filler Cap/Dip Stick
      (4) Drain Plug
      (5) Seal Plate
   b. Internal Components
      (1) Stationary Sleeve
      (2) Rotating Sleeve
      (3) Main Pump
      (4) Main Scavenge Pump
      (5) Auxiliary Pump
      (6) Auxiliary Scavenge Pump
      (7) Standby Pump
      (8) Differential Gear Train
      (9) Oil Float Switch
      (10) Pressure Cut-out Switch
      (11) Pressurized Sump Relief Valve

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2. Valve Housing

   a. External Components

      (1) Input Shaft

      (2) NTS Lever

      (3) Oil Filter

      (4) Cannon Plugs

      (5) Gas Cap

      (6) Access Cover

   b. Internal Components

      (1) Pilot Valve

      (2) Fly Weights

      (3) Speeder Spring

      (4) Feather Valve

      (5) Feather Solenoid Valve

      (6) Feather Actuating Valve

      (7) High Pressure Relief Valve

      (8) Low Pressure Relief Valve

      (9) Selector Valve

      (10) Back-up Valve

      (11) Standby Valve

      (12) Standby Check Valve

3. Valve Housing Cams

   a. Alpha Shaft Cams

      (1) Manual Feather Cam

      (2) Speed Set Cam

      (3) Beta Set Cam

      (4) Alpha Back Up Cam

b. Beta Shaft Cams

(1) Pressure Cutout Back Up Cam

(2) Beta Follow Up Cam

(3) Beta Back Up Cam

QUESTIONS

1. What unit in the propeller control assembly is mechanically connected to the throttle?

2. When does throttle movement position the pilot valve?

3. What propeller systems or operations are blocked out during beta range?

4. What prevents the control from rotating with the propeller?

5. List the two major assemblies that make up the control.

6. What would happen if you turned the blades while the rigging pins were installed?

7. When does the condition lever move the alpha shaft?

8. What are the positions of the condition lever?

9. What are the names of the cams mounted on the alpha shaft?

10. What turns the beta shaft?

11. Name the cams on the beta shaft.

12. What is the purpose of the atmospheric sump?

13. What does NTS stand for?

14. When is the solenoid valve energized?

15. How is the feather valve shifted?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-310
4 January 1980

PROPELLER CONTROL ASSEMBLY

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to trace the flow of hydraulic fluid on schematic diagrams for governing, feather, and reverse operations.

EQUIPMENT

	Basis of Issue
Colored pencils	1 set/student

PROCEDURE

Using colored pencils, trace the following conditions on the diagrams (figures 1, 2, 3, and 4, located in the back of this workbook).

1. Onspeed

2. Underspeed

3. Feather

4. Reverse

OPR: 3350 TCHTG
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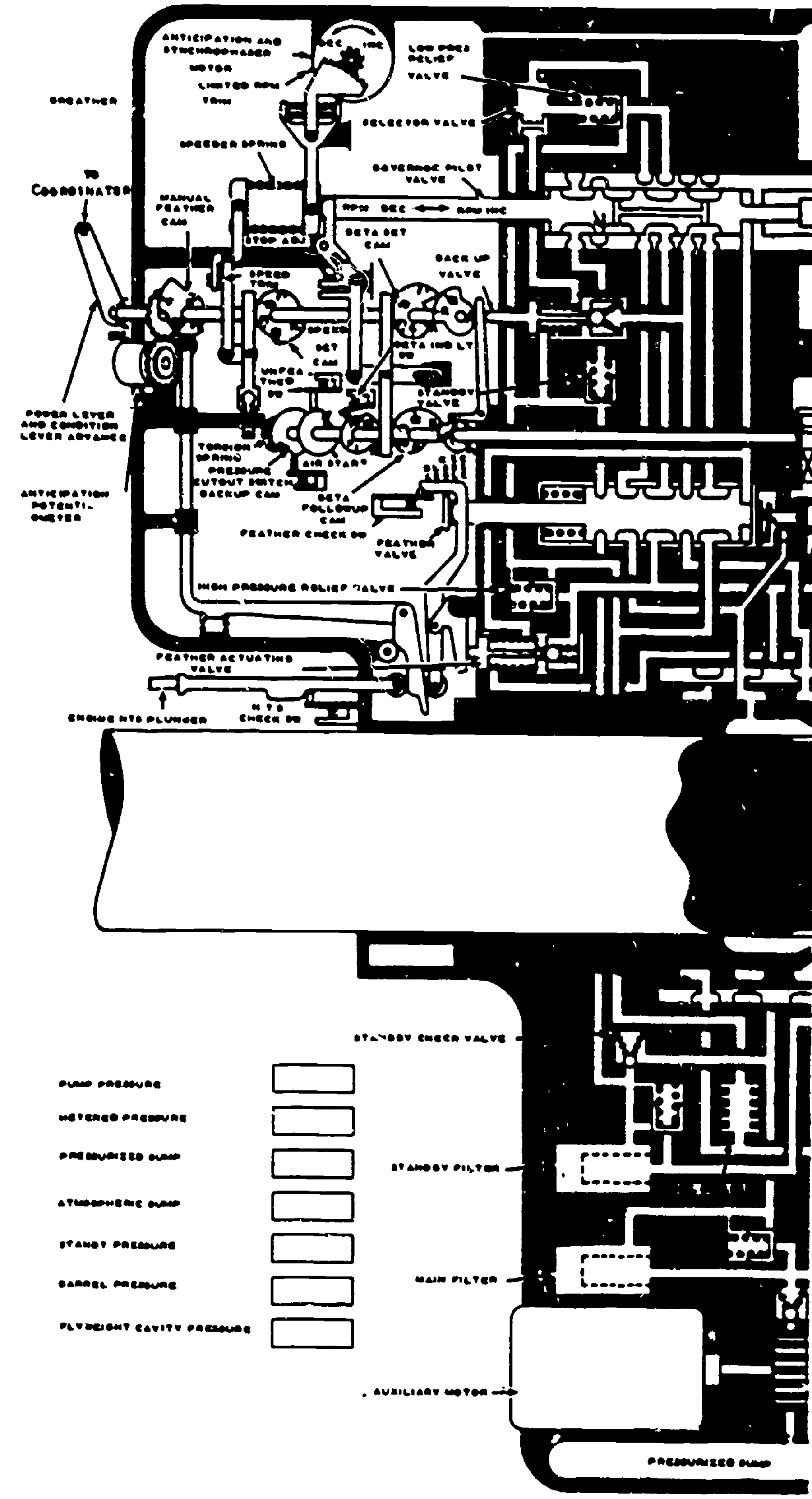

ANTICIPATION AND SYNCHROPHASER MOTOR
LIMITED RPM TRIM
BREATHER
LOW PRESSURE RELIEF VALVE
SELECTOR VALVE
SPEEDER SPRING
GOVERNOR PILOT VALVE
TO COORDINATOR
MANUAL FEATHER CAM
RPM DEC RPM INC
BETA SET CAM
BACK UP VALVE
SPEED SET CAM
STANDBY VALVE
POWER LEVER AND CONDITION LEVER ADVANCE
AIR START
TORSION SPRING PRESSURE CUTOUT SWITCH BACKUP CAM
ANTICIPATION POTENTIOMETER
BETA FOLLOWUP CAM
FEATHER VALVE
HIGH PRESSURE RELIEF VALVE
FEATHER ACTUATING VALVE
ENGINE NTS PLUNGER
STANDBY CHECK VALVE
PUMP PRESSURE
METERED PRESSURE
PRESSURIZED SUMP
ATMOSPHERIC SUMP
STANDBY PRESSURE
BARREL PRESSURE
FLYWEIGHT CAVITY PRESSURE
STANDBY FILTER
MAIN FILTER
AUXILIARY MOTOR
PRESSURIZED PUMP

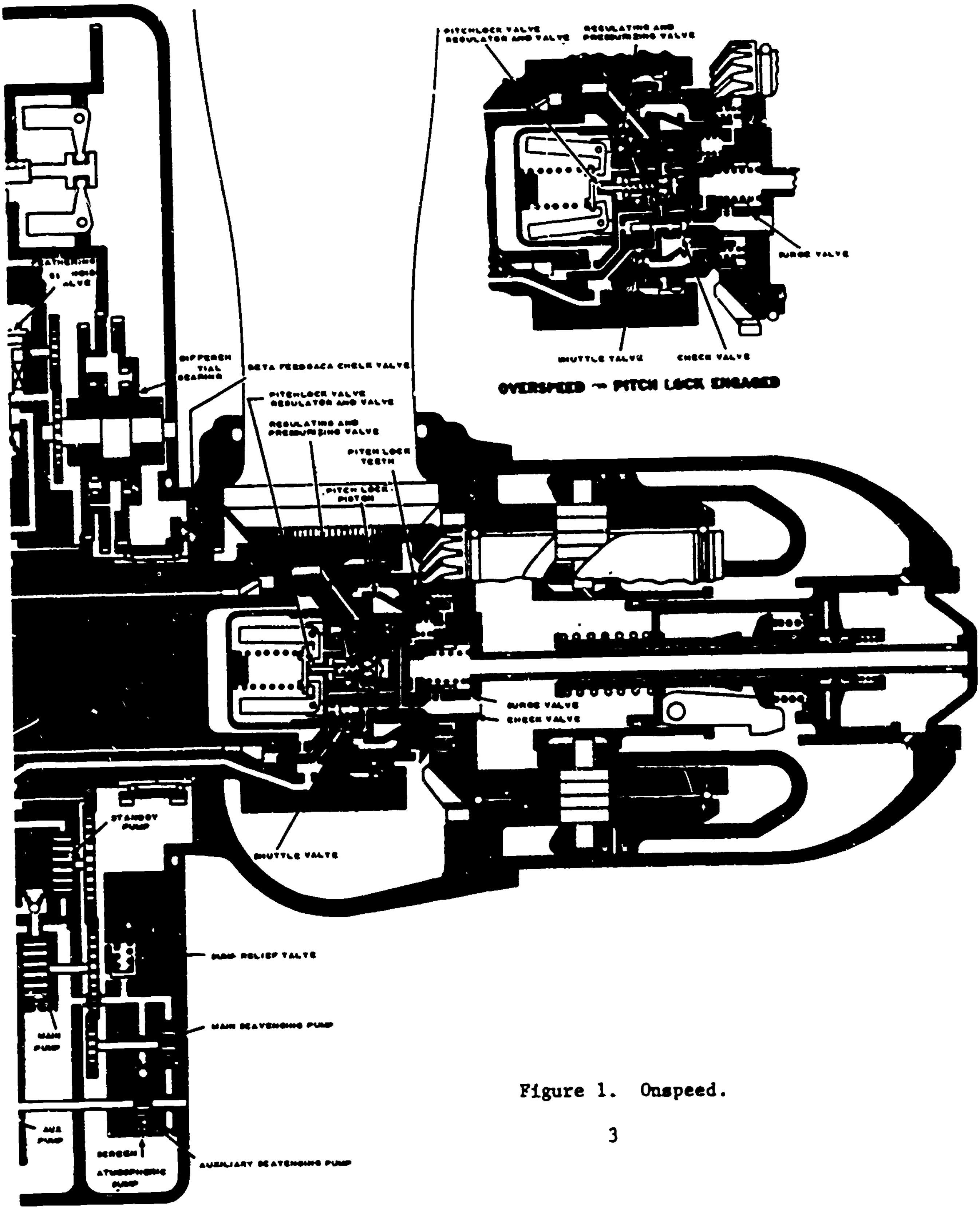
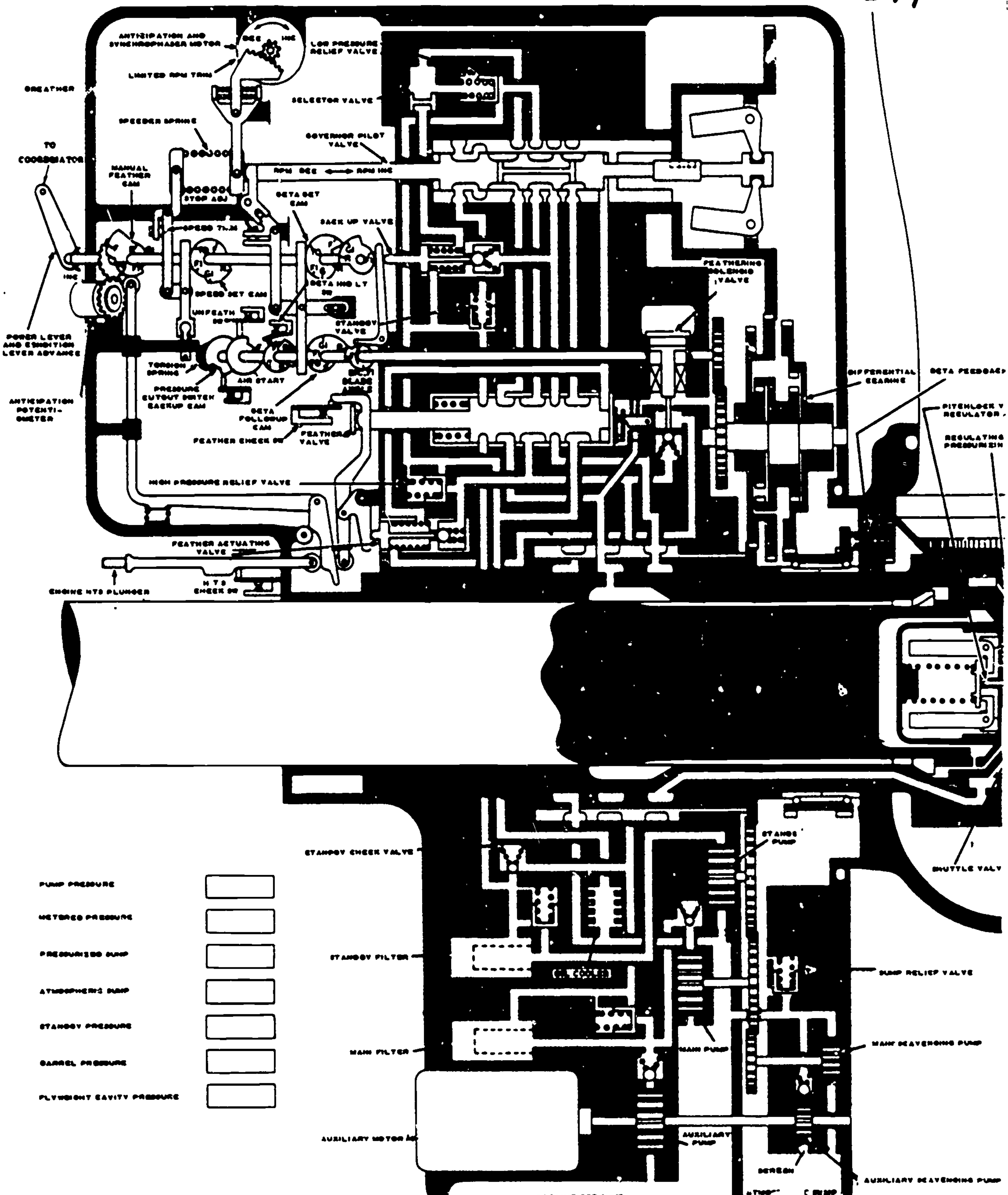


Figure 1. Onspeed.



BREATHER
LIMITED RPM TRIM
LOW PRESSURE RELIEF VALVE
SELECTOR VALVE
SPEEDER SPRING
GOVERNOR PILOT VALVE
TO COORDINATOR
MANUAL FEATHER CAM
STOP ADJ
BETA SET CAM
BACK UP VALVE
SPEED SET CAM
FEATHERING SOLENOID VALVE
STANDBY VALVE
POWER LEVER AND CONDITION LEVER ADVANCE
TORSION SPRING
AIR START
DIFFERENTIAL BEARING
BETA FOLLOWUP CAM
FEATHER VALVE
HIGH PRESSURE RELIEF VALVE
FEATHER ACTUATING VALVE
ENGINE NTS PLUNGER
STANDBY CHECK VALVE
STANDBY PUMP
PUMP PRESSURE
METERED PRESSURE
PRESSURIZED SUMP
ATMOSPHERIC SUMP
STANDBY PRESSURE
BARREL PRESSURE
FLYWEIGHT CAVITY PRESSURE
STANDBY FILTER
OIL COOLER
SUMP RELIEF VALVE
MAIN FILTER
MAIN PUMP
MAIN SCAVENGING PUMP
AUXILIARY PUMP
SCREEN
AUXILIARY SCAVENGING PUMP
PRESSURIZED SUMP

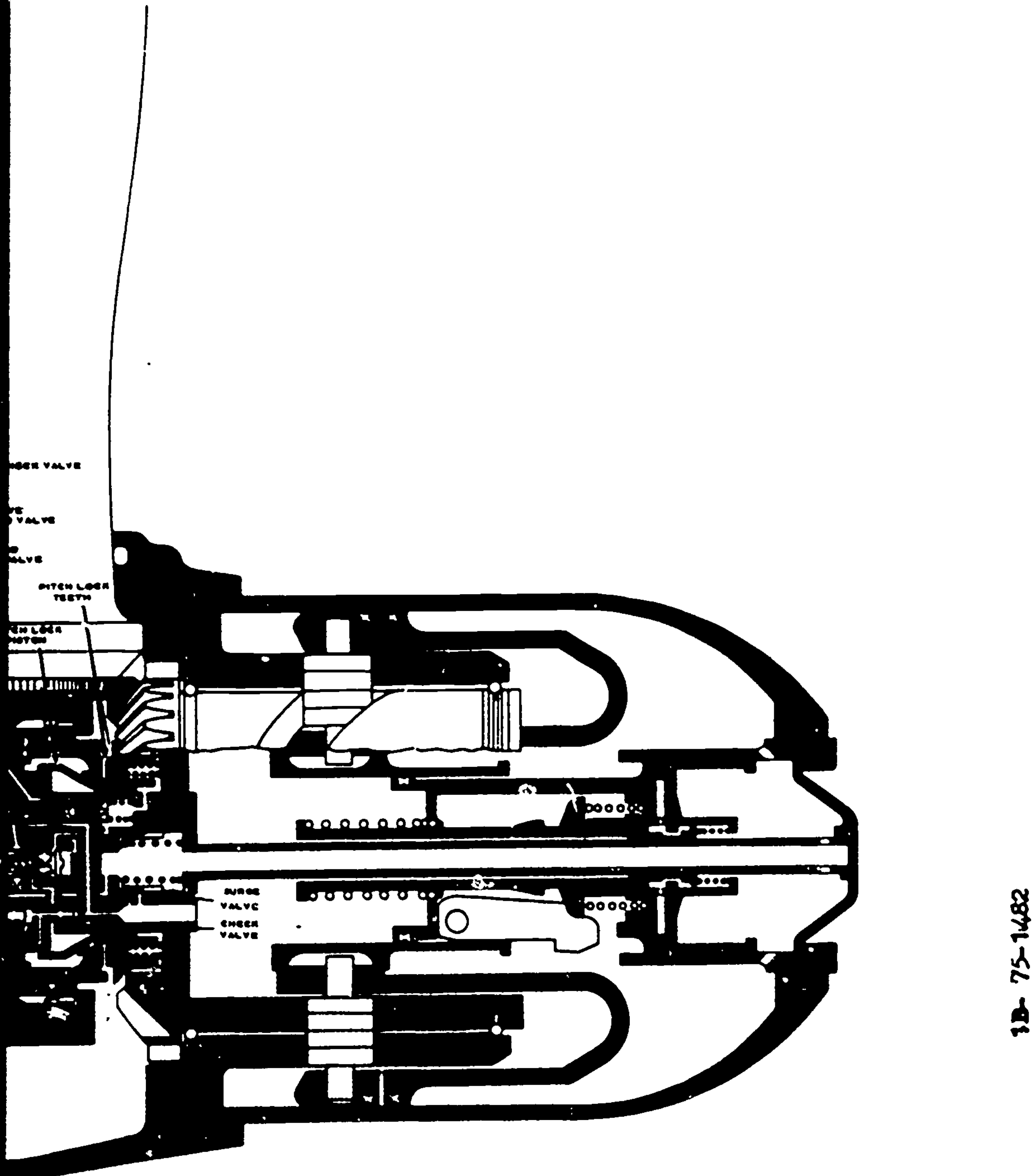
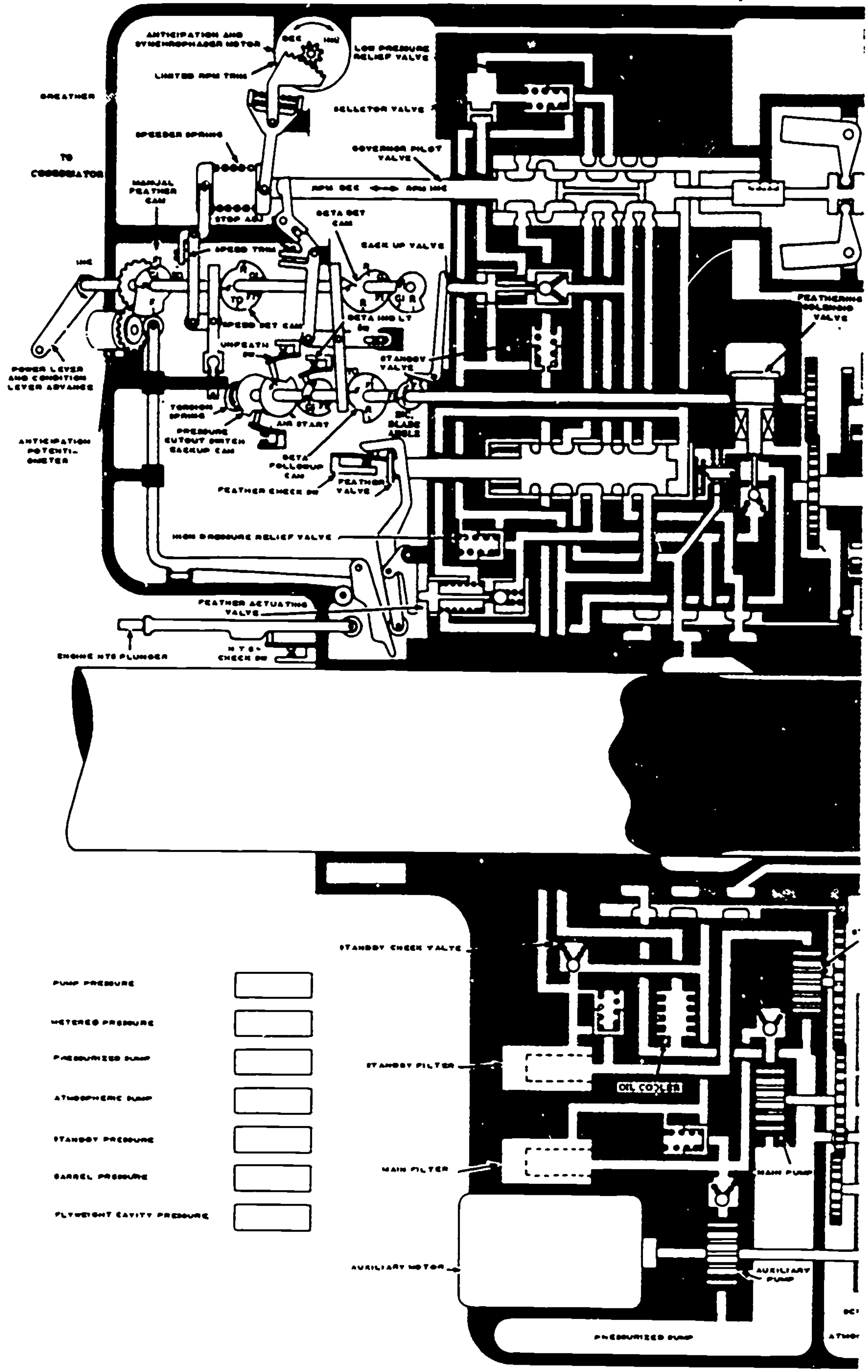


Figure 2. Underspeed.


ANTICIPATION AND SYNCHROPHASER MOTOR
LOW PRESSURE RELIEF VALVE
LIMITED RPM TRIM
BREATHER
SELLECTOR VALVE
SPEEDER SPRING
TO COORDINATOR
GOVERNOR PILOT VALVE
MANUAL FEATHER CAM
RPM DEC
RPM INC
BETA SET CAM
BACK UP VALVE
SPEED TRIM
SPEED SET CAM
BETA IND LT SW
UNFEATH SW
POWER LEVER AND CONDITION LEVER ADVANCE
STANDBY VALVE
TORSION SPRING
AIR START
PRESSURE CUTOUT SWITCH BACKUP CAM
ANTICIPATION POTENTIOMETER
BETA FOLLOWUP CAM
FEATHER CHECK SW
FEATHER VALVE
HIGH PRESSURE RELIEF VALVE
FEATHER ACTUATING VALVE
ENGINE NTS PLUNGER
NTS CHECK SW
FEATHERING SOLENOID VALVE
STANDBY CHECK VALVE
PUMP PRESSURE
METERED PRESSURE
PRESSURIZED SUMP
ATMOSPHERIC SUMP
STANDBY PRESSURE
BARREL PRESSURE
FLYWEIGHT CAVITY PRESSURE
STANDBY FILTER
OIL COOLER
MAIN FILTER
MAIN PUMP
AUXILIARY MOTOR
AUXILIARY PUMP
PRESSURIZED SUMP

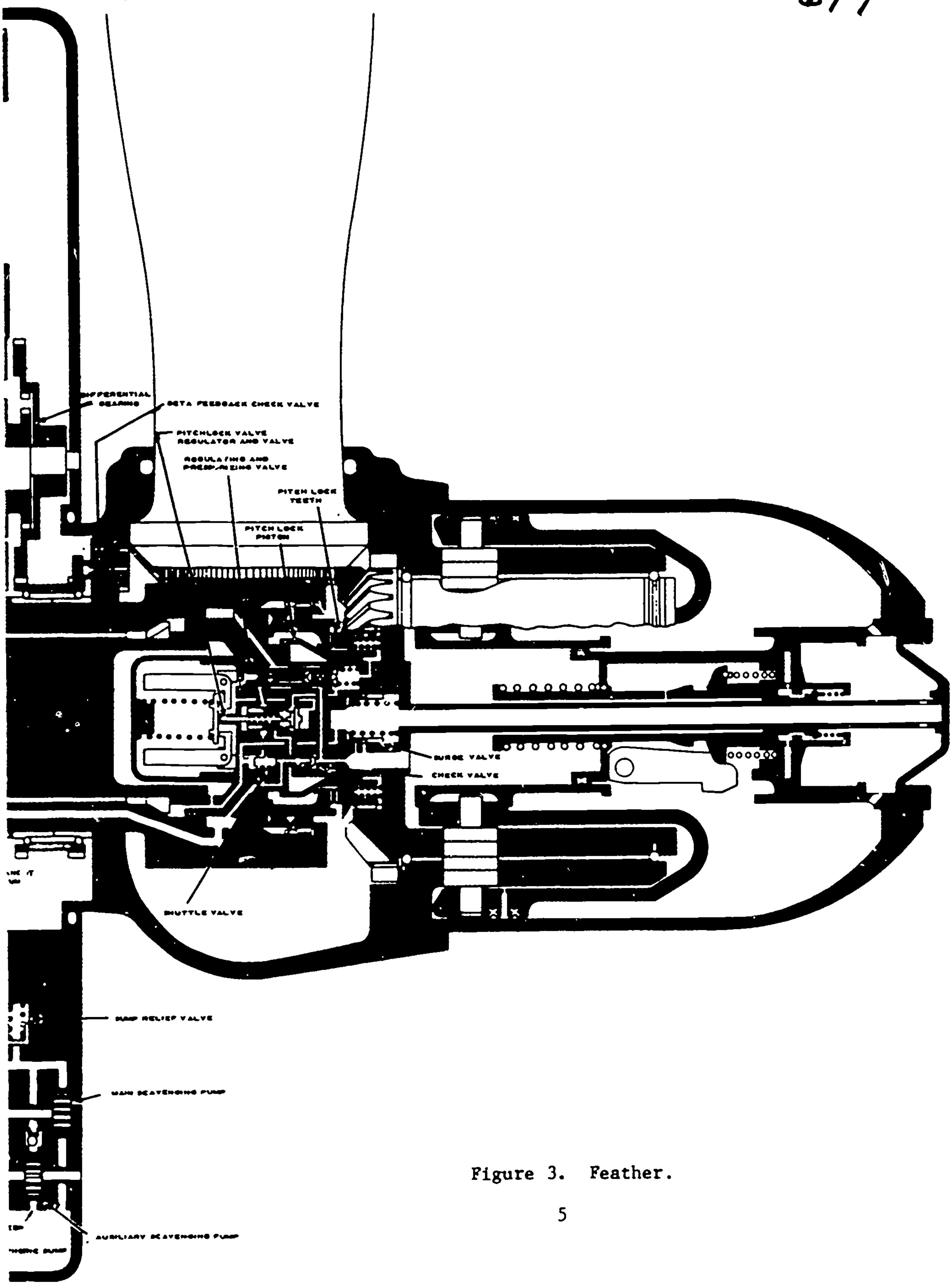


Figure 3. Feather.

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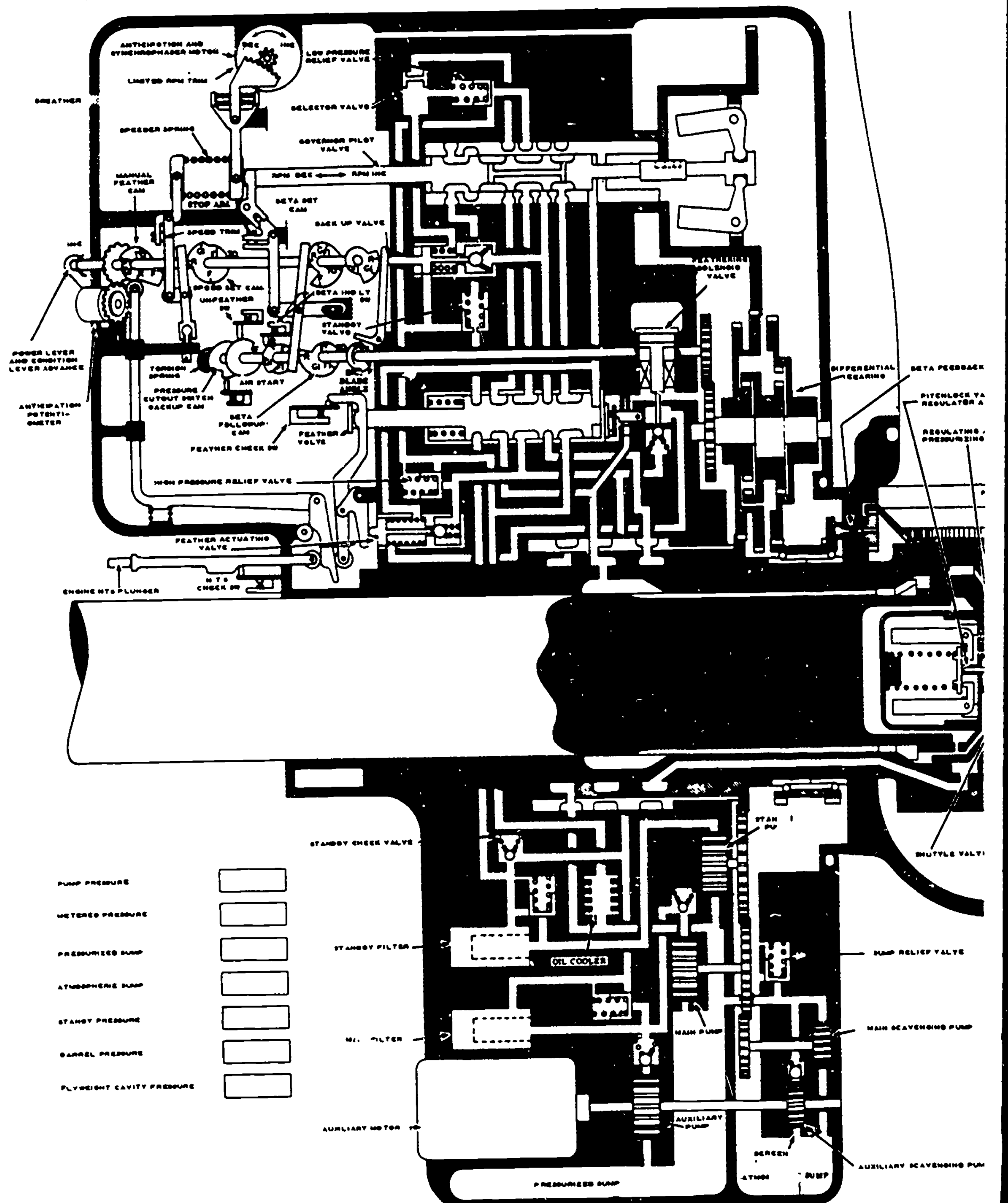
ANTICIPATION AND SYNCHROPHASER MOTOR
DEC
INC
LOW PRESSURE RELIEF VALVE
LIMITED RPM TRIM
BREATHER
SELECTOR VALVE
SPEEDER SPRING
GOVERNOR PILOT VALVE
RPM DEC RPM INC
MANUAL FEATHER CAM
STOP ARM
BETA SET CAM
BACK UP VALVE
SPEED TRIM
SPEED SET CAM
UNFEATHER SW
STANDBY VALVE
FEATHERING SOLENOID VALVE
POWER LEVER AND CONDITION LEVER ADVANCE
TORSION SPRING
PRESSURE CUTOUT SWITCH BACKUP CAM
AIR START
ANTICIPATION POTENTIOMETER
BETA FOLLOWUP CAM
BLADE ANGLE
FEATHER CHECK SW
HIGH PRESSURE RELIEF VALVE
DIFFERENTIAL GEARING
BETA FEEDBACK
FEATHER ACTUATING VALVE
ENGINE NTS PLUNGER
NTS CHECK SW
STANDBY CHECK VALVE
SHUTTLE VALVE
OIL COOLER
STANDBY FILTER
PUMP RELIEF VALVE
MAIN PUMP
MAIN SCAVENGING PUMP
AUXILIARY MOTOR
AUXILIARY PUMP
SCREEN
AUXILIARY SCAVENGING PUMP
PRESSURIZED SUMP

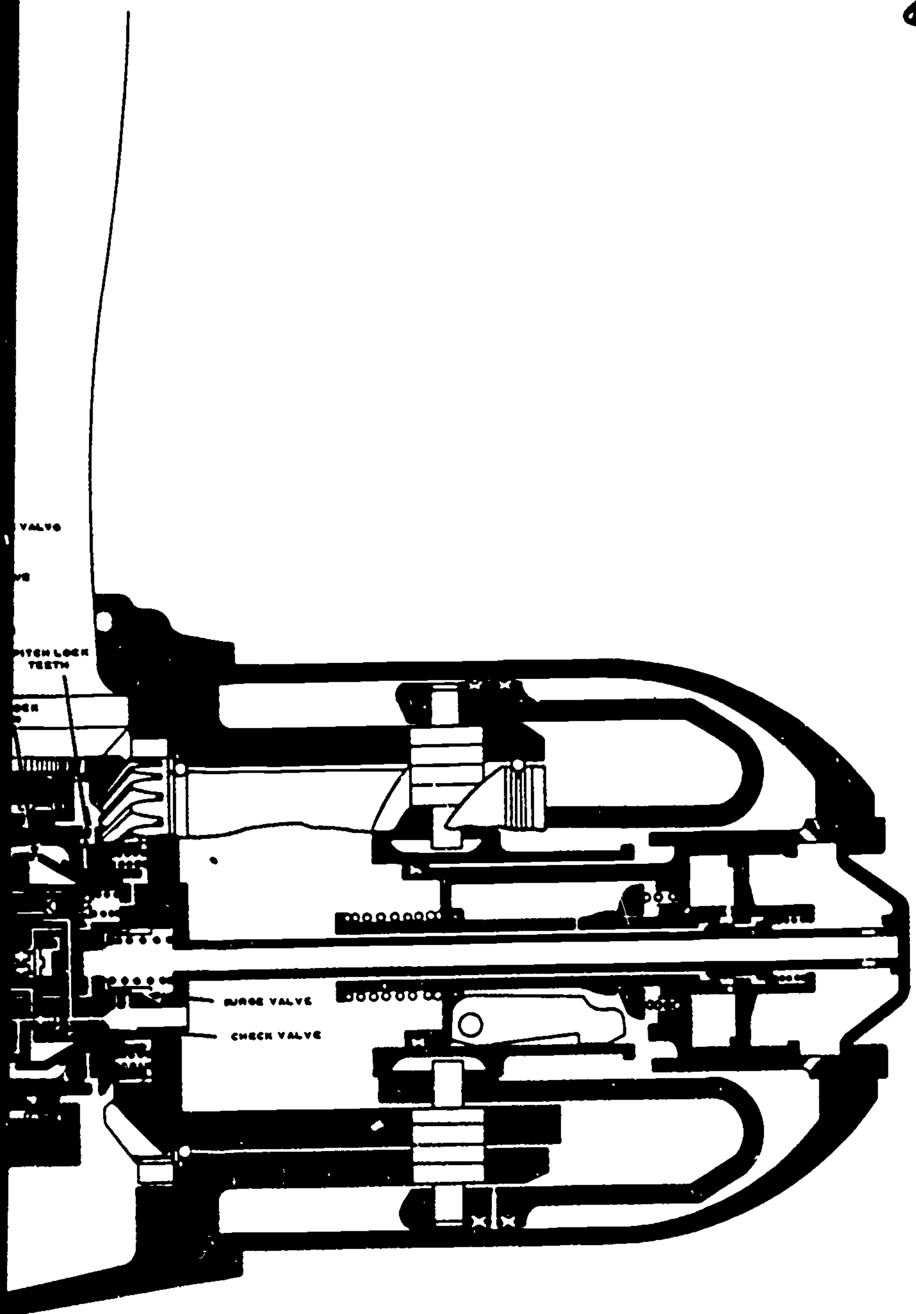

Figure 4. Reverse.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-310
8 May 1981

PROPELLER CONTROL ASSEMBLY

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate and use the proper technical order to disassemble and assemble a propeller control.

2. Locate and use the proper technical orders to document AFTO Forms 349 and 350 for disassembly and assembly of the propeller control.

EQUIPMENT

	Basis of Issue
3ABR42633-HO-300	1/student
TO 00-20-2-10	1/student
TO 1C-130A-06	1/student
TO 3H1-18-2	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

PROJECT 1

DIRECTIONS

Using TO 3H1-18-2, answer the following questions and complete the statements.

1. What paragraph in this technical order covers pump housing front cover seal replacement? ________

2. How long is the front cover and seal heated in an oven to facilitate removal of the seal? __________

3. What is the nomenclature for tool number GS13717-1? ________

____

4. What is used to clean the mating surfaces after they have been buffed? ____

____

5. What caution should be observed during the cleaning of the mating surfaces? ____

____

____

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RGL: N/A
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6. After a thin coat of Pliobond is applied to the mating surfaces of the seal, how long must it be air dried? ________________

7. What is done to contract the seal and facilitate installation of the front cover plate? ______________________________

____

____

8. After the seal and cover plate are installed in the arbor press, how long should it cure at room temperature? ________________

9. How much torque is applied to the bolts on the dummy brush block while pressure testing the atmospheric sump? ________________

10. What is the part number of the control external leakage test fixture?

____

11. How long is compressed air applied to the submerged control and at what psi? __________ __________

12. What paragraph, in the technical order, covers an alternate method for the control pressure test? ________

PROJECT 2

DIRECTIONS

Using the information given and the applicable technical order references, make the correct entries on the AFTO Form 349 in figure 1.

1. You are assigned to the turboprop shop and given the task of removing and replacing the front cover seal on a control assembly that was removed from aircraft QA-7787.

2. The job began at 1200 hours and was completed at 1200 hours on the following day. Your duty hours are 0700 - 1600 hours (day shift).

3. The following information is provided to complete the necessary form required for the job.

a. General Information:

Priority	2
Location	H-6
Time Spc Req	0700
Job Standard	2 hours

b. Propeller Data:

Part Number	54H60-91
Serial Number	N822123
ID No.	QA8887
Time	1300.6

c. Pump Housing Data:

From the AFTO Form 350 Tag, Figure 2

MAINTENANCE DATA COLLECTION RECORD — OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPC REQ	18. JOB STD.

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO	24. SERIAL NUMBER	25. OPER. TIME

ACT. LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

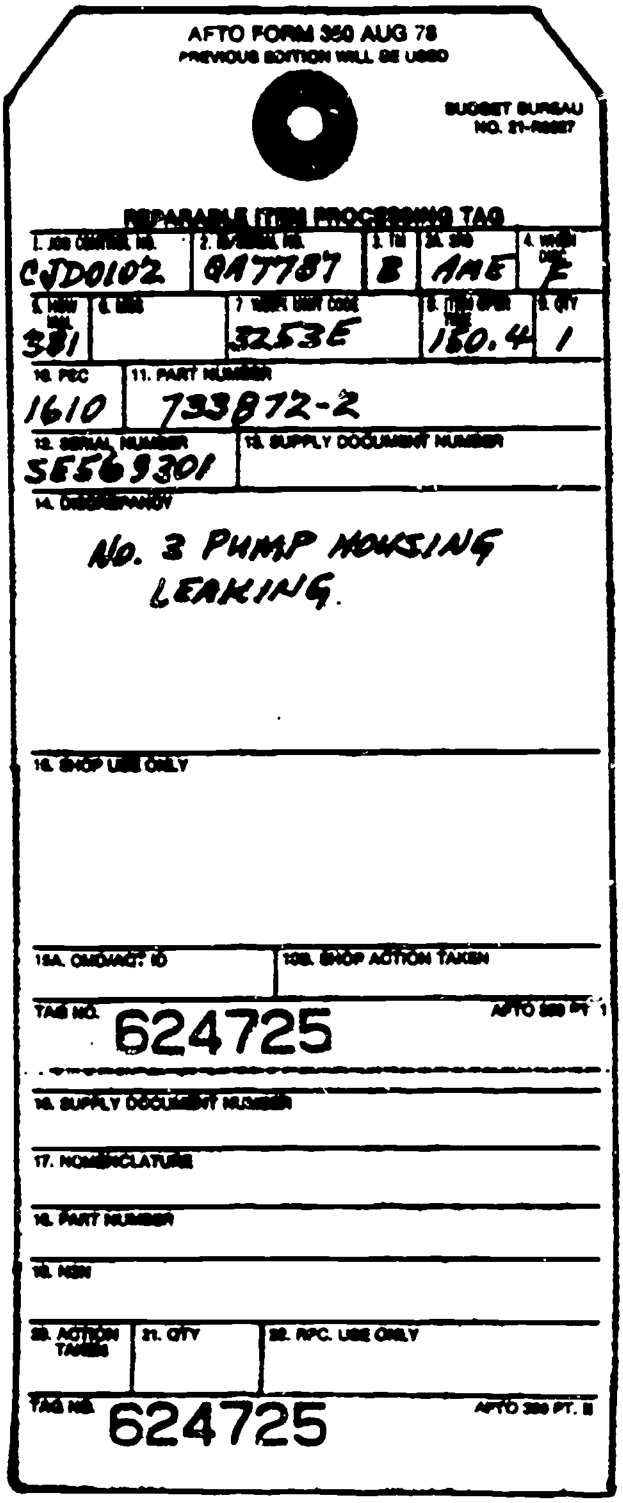
NO. 3 PUMP HOUSING LEAKING

27. CORRECTIVE ACTION

28. RECORDS ACTION

AFTO FORM MAY 79 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.



AFTO FORM 350 AUG 78
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU
NO. 21-R0257

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO.	2. ID/SERIAL NO.	3. TM	3A. SRD	4. WHEN DISC.
CJD0102	9A7787	B	AME	F

5. HOW MAL.	6. UNITS	7. WORK UNIT CODE	8. ITEM OPER TIME	9. QTY
381		3253E	180.4	1

10. FSC	11. PART NUMBER
1610	733872-2

12. SERIAL NUMBER	13. SUPPLY DOCUMENT NUMBER
SE569301	

14. DISCREPANCY

No. 3 PUMP HOUSING LEAKING.

15. SHOP USE ONLY

15A. CMD/ACT ID	15B. SHOP ACTION TAKEN

TAG NO. 624725 AFTO 350 PT I

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE

18. PART NUMBER

19. NSN

20. ACTION TAKEN	21. QTY	22. RPC. USE ONLY

TAG NO. 624725 AFTO 350 PT. II

Figure 2. AFTO Form 350.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-209A
1 April 1980

MODIFICATION OF PROPELLER SYSTEMS

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to identify simple facts pertaining to the modification of propeller systems.

INTRODUCTION

The propeller assembly is just like any other type of equipment. Sometimes the internal parts fail, or become unserviceable, when this occurs the propeller system must be modified to either improve the part or completely change the part. We will discuss some of the modifications that have taken place on the 54H60 propeller assembly.

INFORMATION

In this study guide, we will discuss a few of the modifications that have been incorporated into this system. During the past few years, the valve housing assembly, propeller dome assembly, low pitch stop assembly, pitch lock regulator assembly, and synchrophaser assembly have been or are currently being modified to improve their operation on the C-130 aircraft.

STANDARD MODIFICATIONS

The Hamilton Standard turbopropeller assembly has been modified very little, considering the many years it has been on an operational aircraft. Most of the modifications to the 54H60 propeller assembly have taken place during the past ten years. Some of these modifications to the propeller assembly have been originated by maintenance people working in the field on the operational aircraft, and others have been started by the technical engineers working at either depot overhaul facility or at the Hamilton Standard factory. Most of the modifications were started by the propeller mechanics working in the field. These mechanics noticed that the parts of the propeller assembly were either failing, or causing excessive maintenance to be performed on the propeller assembly. These propeller mechanics submitted suggestions to the depot maintenance facility to improve the parts that were either failing or causing excessive maintenance on the system. You would be amazed at some of the suggestions that have been incorporated into a propeller system modification. One major modification to the

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propeller assembly was to redesign a rubber preformed packing (rubber seal) on the propeller oil control assembly. This rubber seal was allowing oil to leak from the propeller assembly and caused the propeller to become uncontrollable on the ground and in flight. The technical engineers were notified by the maintenance personnel submitting an AF Form 1000, Air Force Suggestion form on this seal. The maintenance people who wrote the suggestion were awarded, by the Air Force, a monetary sum of $1000.00 to each of them. Before the new type of seal was installed into the propeller control assembly, the failure rate for this seal was over 60 percent. After the new type was installed, the failure rate decreased to zero percent, and this saved the Air Force thousands of dollars over the past seven years.

Most of the modifications to the propeller assembly take months of research by the technical engineers to develop the improvements that will be incorporated into it. The technical engineers are highly qualified and experts in their specific field, whether it is mechanical or electrical engineering, and they have a thorough background on the operation of a propeller system. When these technical engineers are notified that there is a major problem with the operation of a propeller, they will thoroughly investigate the requirement for either improving or modifying the system affected by the problem. If the technical engineers consider the problem to be a major flight safety problem, they will notify the Air Force, that a major flight of safety condition exists and failure of that specific part could cause an aircraft to crash. The Air Force will immediately issue an immediate action time compliance technical order (TCTO) to correct the major problem. Most of the time, the Air Force TCTO will be either immediate action or urgent action when a major flight or safety condition exists on a propeller assembly. With the 54H60 propeller system the modification of parts of this assembly are of a routine nature, and will not be incorporated into the time compliance technical order system. These modifications will first be researched, and then a test program will be established to see if the improvement or modification will improve the operation of the propeller assembly. These improvements are generally considered simple modification of this system, and do not affect a safety of flight condition on the aircraft.

SPECIFIC MODIFICATIONS

During the past fifteen years, most of the modifications to this propeller assembly have been on the propeller valve housing assembly. In the past ten years, this assembly has had one major modification and two simple modifications incorporated into it. The major modification was to the valve housing pilot valve. The pilot valve is used to meter hydraulic fluid to the propeller dome to change the pitch of the propeller blades. Before this major modification was incorporated the pilot valves were failing at an extremely high rate and causing this propeller to become uncontrollable in flight. In fact, the Air Force had two C-130 aircraft to crash. The technical engineers immediately redesigned the complete pilot valve, and tested the valve for operation. Since that time, the new pilot valves have not had a single failure, and the C-130 aircraft has not had a single crash because of pilot valve failure.

Today, Hamilton Standard has redesigned the propeller governor on the 54H60 propeller, and these new valve housing assemblies are being installed on operational aircraft. The new type of valve housing is a great improvement over the older models; these valve housings have a servogovernor on them instead of the mechanical governor. You will learn more about the new servogovernor type valve housings after you have completed this technical school.

There have been several other modifications completed on the 54H60 propeller assembly. Some of these modifications are currently still in the test portion of development, and have been approved for use in the field on operational aircraft. These modifications are for the propeller low pitch stop lever assembly, pitch lock regulator assembly, and the propeller synchrophaser assembly. Currently, the synchrophaser assembly is being replaced with a completely redesigned and engineered assembly, that has all solid state parts instead of the electrical wiring and tubes in the old type. In the future, you will probably see more modifications incorporated on this propeller assembly. Maybe you will be helping the technical engineers in the testing of the parts that have been modified to improve their operation on the propeller assembly.

SUMMARY

You should remember that most of the modifications to the propeller assembly are done for either improvement of the system or to correct a major safety of flight condition. The safety of flight condition is a very serious condition, and problems with the many parts of a propeller assembly could cause a C-130 aircraft to crash. Any part involved in a safety of flight condition, that is part of a propeller assembly, will automatically prevent an aircraft from flying any type of mission. These parts will be modified to correct the problem, and either an immediate action or urgent action time compliance technical order will be issued to correct this problem.

QUESTIONS

1. What type of time compliance technical order will be issued to correct a flight safety problem?

2. How is the valve housing assembly being modified today?

3. What are the three parts of the propeller assembly that are currently being tested in the Air Force?

4. Who will investigate the requirement to either improve or modify a part on the propeller assembly?

STUDY GUIDE
3ABR42633-SG-214

Technical Training

Turboprop Propulsion Mechanic

PROPELLER AND ENGINE ANTI-ICING AND DEICING SYSTEMS

28 April 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-214

PROPELLER AND ENGINE ANTI-ICING AND DEICING SYSTEMS

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to explain the purpose, operation, and arrangement of the propeller and engine anti-icing and deicing systems.

INTRODUCTION

The engine and propeller anti-icing and deicing systems are used on the C-130 aircraft to prevent the buildup of ice on the T56 engine compressor inlet housing, engine intake scoop, oil cooler intake scoop, and torquemeter housing shroud. The propeller system uses the anti-icing and deicing to prevent or remove ice formations on the outside of the propeller assembly. Without this system on an aircraft, severe damage could occur to the aircraft and engine.

INFORMATION

In this study guide, we will discuss the engine and propeller anti-icing and deicing system parts, purposes, operation, and their arrangement.

ENGINE ANTI-ICING SYSTEM

The T56 engine anti-icing system shown in figure 1 is very important to you as a turboprop engine and propeller mechanic. This anti-icing system's primary purpose is to prevent ice formation on the engine intake scoop, oil cooler intake scoop, the eight radial struts of the air inlet housing assembly, and the lower half of the torquemeter housing shroud. The formation of ice in the engine intake can cause severe damage to the engine compressor section. The engine anti-icing system is incorporated in the engine to prevent ice from forming in the air intake area.

The engine anti-icing system controls are located in the aircraft cockpit, on the overhead panel, figure 2. The main control for this system is the engine/propeller master anti-icing control switch. On the same panel there are four individual switches for operating each engine anti-icing solenoid valve. To operate this system, the engine/propeller anti-icing master switch can be placed in three positions. These positions are manual, automatic, and reset. In order for the anti-icing master switch to operate in the automatic mode of operation, the master switch must be pushed up to the RESET position and allowed to return to the automatic position. Then the switches for the engine inlet air ducts must be placed in the ON position. After these two

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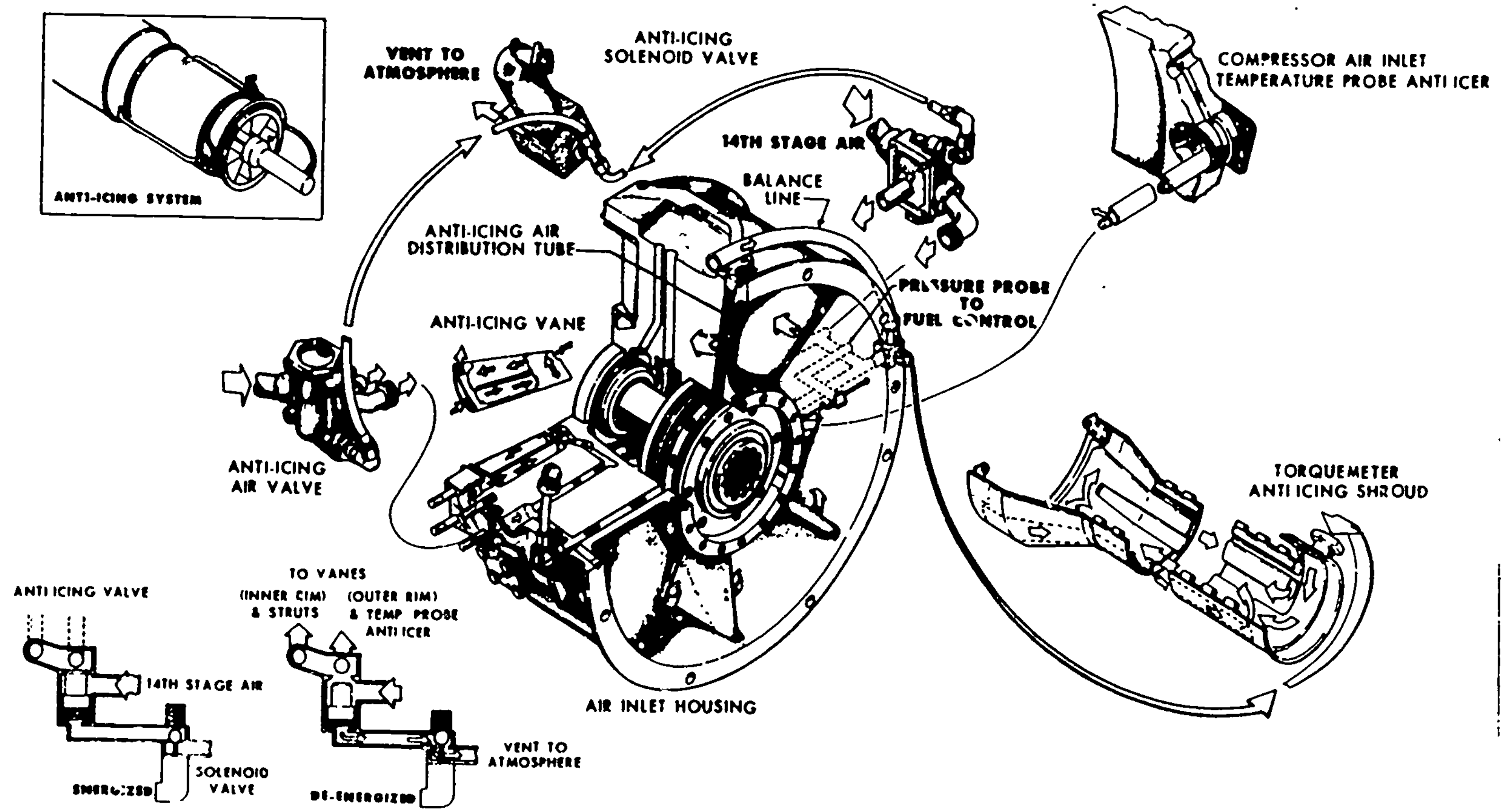

Figure 1. Engine Anti-Icing System.

3

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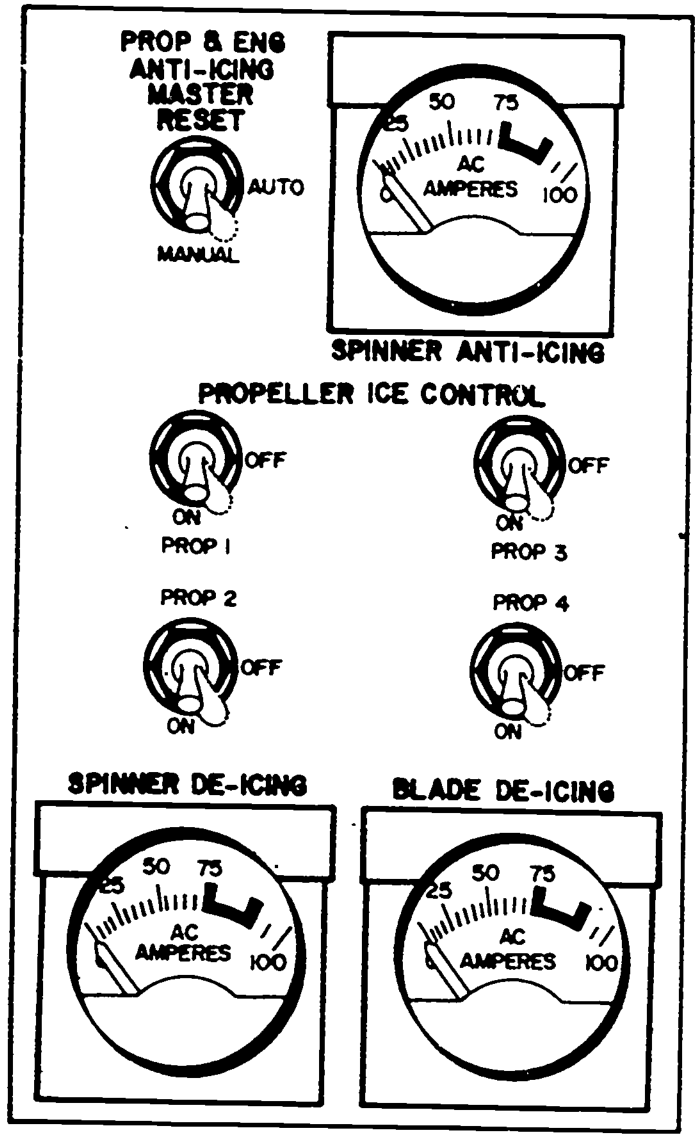

Figure 2. Anti-Icing Control Panel.

switches have been activated, they will complete an electrical circuit to the ice detector system. There are ice detector probes, located in the four engine intakes, but only No. 2 and No. 3 are operational. These ice detector probes can "feel" the presence of ice accumulating on their outside. When ice is detected, the probes will automatically complete a circuit to energize the anti-icing system. After the ice detector probes have energized the system, the power section mounted anti-icing solenoid and QEC kit mounted anti-icing solenoid valve will be de-energized to the open position, thus allowing hot air from the engine diffuser to be routed to the engine air inlet housing area, intake scoop, and oil cooler intake scoop. The anti-icing solenoid valve and anti-icing solenoid are energized to the closed position and de-energized to the open position.

After the anti-icing solenoid valve has been de-energized, the hot compressor air is routed from the engine compressor diffuser bleed air ports, on the 14th stage compressor, to the anti-icing air valves. There are two anti-icing air valves on the T56 engine and these are mounted on the air inlet housing at the three and nine o'clock positions. The air valves are connected to the diffuser bleed air ports and the anti-icing solenoid valve by metal air tubes. When the hot compressor air has reached the two air valves, it is then routed through the air inlet housing to five areas of the engine. These areas are:

1. Air inlet housign struts (8).
2. Compressor air inlet guide vanes.
3. Compressor air inlet temperature probe.
4. Compressor inlet pressure probe.
5. Lower half of the torquemeter housing shroud.

The compressor diffuser assembly will also send hot air to the nacelle air intake and the oil cooler air scoop to prevent ice formation on these parts. The hot air is routed to the bleed air manifold, located on the right side of the nacelle, to the intake scoop and oil cooler scoop. On the compressor diffuser there are air bleed ports located on the outside of the 14th stage compressor, which are connected to ducting which is connected to the bleed air manifold, then to ducting which is directly connected to the nacelle intake and oil cooler scoop. This portion of the anti-icing system is operated by the same switches mentioned in the previous paragraphs. (See figure 1.)

PROPELLER ANTI-ICING AND DEICING SYSTEM

The propeller anti-icing and deicing system is different from the engine anti-icing system. We discussed that the engine anti-icing system uses hot compressor air to prevent a buildup of ice. The propeller assembly uses electrical current to operate the anti-icing and deicing system. The anti-icing portion of the system is to prevent ice formation on certain parts of the propeller and the deicing portion is to remove the ice that has accumulated on the propeller. We will discuss each part of this system and the complete operation of the propeller anti-icing and deicing system.

The propeller anti-icing and deicing system is operated by the same switch as the engine anti-icing system. To operate the system you must place the engine/propeller anti-icing master switch to either the auto or manual position. Then the four propeller ice control switches must be placed in the ON position. This action will complete an electrical circuit to the propeller deicing timer, spinner anti-icing relays, and the deicing relays. The propeller deicing timer is used to control the heating cycle for propeller deicing only, but the deicing timer is also connected to the ice detector probes located on the engine. The deicing timer has a set cycle, it is activated for a 15-second heating period, and a 45-second cooling period, this heating cycle is the same for all four propellers. The heating cycle will be switched from one propeller to the next

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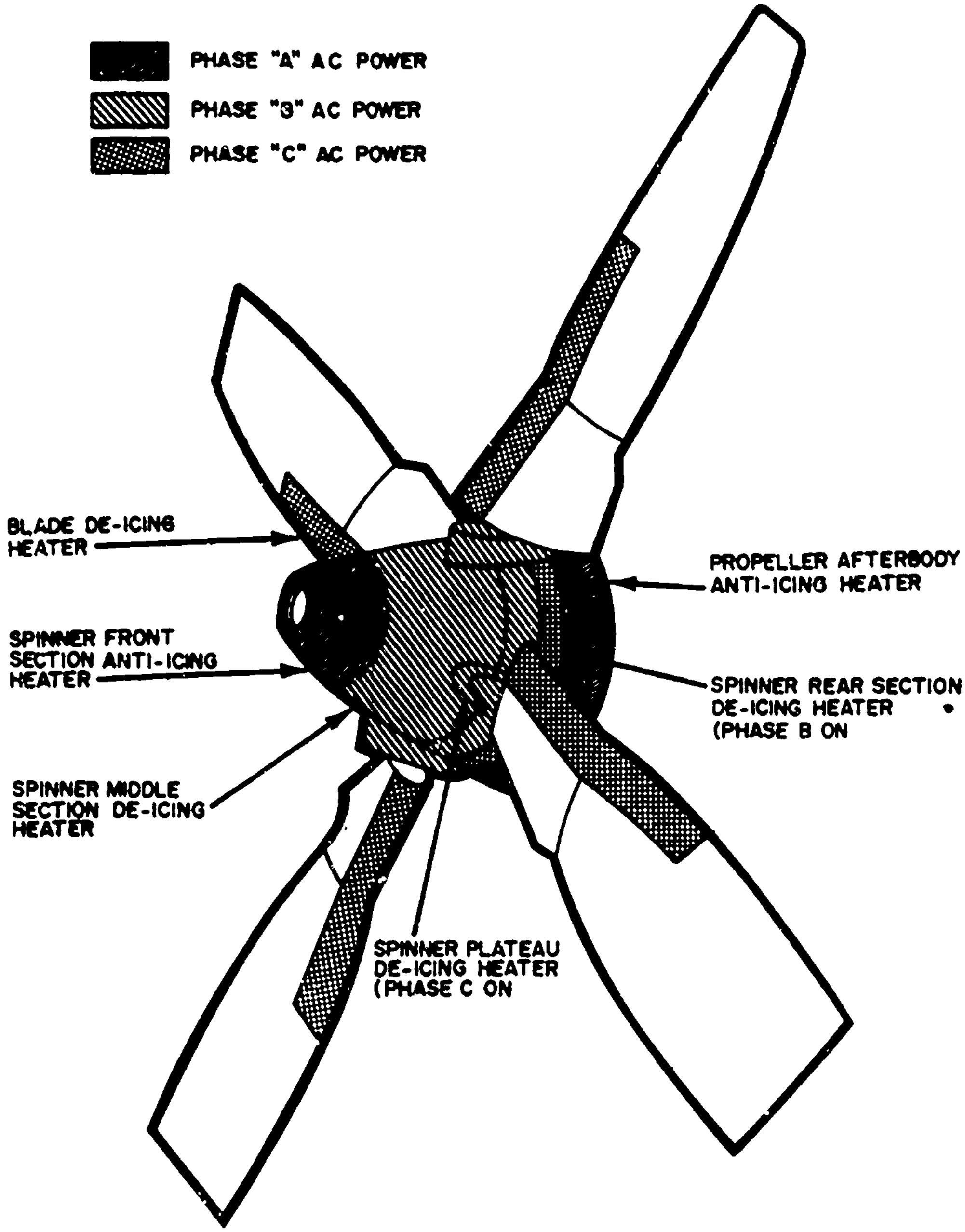

Figure 3. Propeller Anti-Icing and Deicing System.

propeller in the sequence of propeller numbers one, two, three, and four. This system uses alternating current (AC) for both the anti-icing and deicing portions.

The first part of the propeller assembly we will discuss is the brush block assembly. The brush block is mounted on the propeller control assembly. Its purpose is to transfer electrical current from the stationary part (nonrotating) to the rotating part of the propeller assembly. The brush block is constructed with four rows of carbon brushes, with three carbon brushes on a single row. These brushes transfer the electrical current to the rotating part.

The rotating part is the deicer contact ring holder assembly. The brushes on the brush block mate with four copper sliprings on the deicer contact ring holder. The four copper sliprings have a specific purpose: the outside ring is for anti-icing only, this ring is for "D" phase AC voltage; the second ring from the outside is for blade and the back half of the rear spinner deicing only, this ring is for "C" phase AC voltage; the third ring is for front spinner and front half of the rear spinner deicing only, this ring is for "B" phase AC voltage; and the inside ring is for ground for the anti-icing and deicing system, this ring is for "A" phase. The deicer contact ring holder transfers the electrical power to the blade deicing heater (deicing boot) by four contact brush assemblies mounted on the deicer contact ring holder. These contact brush assemblies directly contact two blade sliprings on the blade shank for deicing of the propeller blade only. Then the deicer contact ring holder assembly is connected to the rear spinner assembly by connector straps. These connector straps transfer the electrical power to the rear spinner and front (nose) spinner for either anti-icing or deicing of these assemblies. The rear spinner has the capability of being deiced only. The front (nose) spinner uses both anti-icing and deicing, the first seven inches of the nose spinner is for anti-icing only, and the remainder of this assembly is deiced. The propeller afterbody assemblies are connected by electrical leads from the brush block assembly to four terminal bolts on the afterbody mounting bracket, and the afterbodies are connected to these terminal bolts by electrical bonding straps. The afterbody has anti-icing only. (See figure 3.)

The propeller anti-icing and deicing system has three ammeters located on the overhead panel in the cockpit to indicate the current draw being used by the propeller assembly. One of these ammeters is for spinner anti-icing, the other two are for either blade deicing or spinner deicing. (See figure 2.)

The maximum allowable current draw for anti-icing is from 16 to 21 amps and the maximum allowable current draw for deicing is from 65 to 90 amps per propeller assembly.

SUMMARY

The engine and propeller anti-icing and deicing system are of major importance to the turboprop mechanic, the complete system is to eliminate the possibility of icing conditions affecting the operation of both the engine and propeller. This system can be operated in either the automatic or manual modes of operation.

QUESTIONS

1. What is the purpose of the engine anti-icing solenoid valve?

2. What is the part which is used to operate the anti-icing or deicing system?

3. What are the four areas of the engine that hot air is directed?

4. What is the purpose of the engine anti-icing system?

5. What are the areas of the spinner that are anti-iced?

6. What are the areas of the propeller that are deiced?

7. What is the cycle of the deicing timer?

8. What is the purpose of the deicer contact ring holder?

9. Which slipring carries electrical current for blade and rear spinner deicing?

10. Which heating elements have power cycled to them by the deicing timer?

11. What is the maximum allowable amperage draw for deicing and anti-icing?

12. What part sends hot air for nacelle intake and oil cooler air scoops for anti-icing?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-214
2 April 1980

PROPELLER AND ENGINE ANTI-ICING AND DEICING SYSTEMS

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Trace out electrical circuits for blade deicing, spinner deicing, and spinner anti-icing.

2. Explain the purpose, operation, and arrangement of the engine anti-icing system, and propeller anti-icing and deicing systems.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-10	1/student
TO 2J-T56-24	1/student
TO 3H1-18-2	1/student
Multimeter, PSM 37	1/2 students
Deicing trainer	1/15 students

PROCEDURE

Complete the three projects following the directions given for each project.

Project 1

DIRECTIONS

Using TO 1C-130B-2-10 and TO 2J-T56-24, answer the following questions.

1. What is the name of the switch that activates the anti-icing system on a T56 engine? ______________________

2. What is the name of the part that directs airflow to the air inlet housing assembly? ______________________

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3350 TCHTG/TTGU-J - 300; TTVSA - 1

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3. How is the air routed to the intake inlet scoop and oil cooler scoop? ____________________

4. What stage of compression is used for the engine anti-icing system? ____________________

5. What is the name of the part that serves as the primary control of the engine anti-icing system? ____________________

Project 2

DIRECTIONS

Using TO 1C-130B-2-10 and TO 3H1-18-2, answer the following questions.

1. What is the purpose of the deicing timer? ____________________

2. What slip ring on the deicer contact ring holder assembly is used for blade deicing? ____________________

3. What section of the front (nose) spinner is anti-iced? __________

4. What is the purpose of the brush block assembly? __________

5. What is the current draw for spinner anti-icing (one propeller)?

____

6. What type of electrical power is used for propeller anti-icing and deicing? ____________________

Project 3

DIRECTIONS

Using a multimeter and deicing trainer, take voltage and resistance checks as required.

1. What is the power voltage at the deicing timer? __________

2. What is the resistance of the complete anti-icing system?

____

3. What is the resistance of the blade deicing system? __________

4. What is the voltage at the circuit breaker? __________

STUDY GUIDE
3ABR42633-SG-216

Technical Training

Turboprop Propulsion Mechanic

INSPECTION AND BLADE REPAIR

27 February 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-216

INSPECTION AND BLADE REPAIR

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to identify the types of inspections performed on a propeller assembly and the procedures for repairing damage to the propeller blades.

INTRODUCTION

This study guide contains information pertaining to propeller blade inspection and repair. This information will be used throughout your Air Force career as a turboprop propulsion mechanic.

INFORMATION

Propeller blades are constructed of aluminum and treated with a corrosion preventive solution. The propeller blades are subject to damage from all types of weather conditions, stresses, and forces. Because of this, the blades are subject to wear. For example, if an aircraft takes off from a runway that is not free of foreign objects, the propeller blades are likely to be nicked or damaged. You will be inspecting and repairing this damage.

TYPES OF INSPECTION

Visual

A visual inspection is the most common and frequent inspection used in today's Air Force. It is the greatest support of the preventive maintenance concept. What is the preventive maintenance concept? The Air Force uses billions of dollars of equipment daily. You, as a propeller mechanic, can eliminate possible malfunctions before they evolve into more complex or expensive repairs. You are responsible to locate and repair defects before they cause more serious problems.

As an example of visual inspection items to look for: defective or worn clamps, broken or loose safety wire, worn or chaffed lines (hoses) or wires or improperly routed wires, hoses, or lines.

No matter how small the discrepancy may appear, always consult your TO and be sure of the repair action. THINK!

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Nondestructive Inspection (NDI)

Nondestructive inspections are primarily the responsibility of another AF career field. You as a propeller mechanic may at sometime be responsible for performing or assisting on nondestructive inspections.

Dye penetrant insepctions are performed on all metals that may appear to have a crack. Using a special dye that darkens in the crack under ultraviolet light, the inspector can determine if a suspected crack is in fact a crack or not.

Dye Penetrant

Dye penetrant method of inspection is used to reveal surface defects in any type of metal. This method consists of coating the surface to be inspected with colored dye. This will penetrate any defects that might be present, then the excess is wiped off. A white developer is now applied and allowed to dry. If surface defects are present, the dye that has penetrated them will now bleed through the developer. It will show as a colored indication. The amount of color that bleeds through the developer indicates the severity of the damage.

Zyglo Method of Inspection

Zyglo is a method for inspecting nonmagnetic or magnetic metal parts. It uses ultraviolet or black light to detect defects by fluorescent indications. This operation must be performed in a darkened booth or in a dark room.

A fluorescent liquid is applied to the part and allowed to penetrate any surface openings. After removal of all surface liquid, and dusting with a dry powder, the fluorescent material emerges by capillary action. Under black light, glowing indications appear, revealing the exact location and extent of the defect.

BLADE REPAIR

Propeller blades are subjected to all types of weather conditions, stresses and forces. Because of this, the blades are subject to wear. For example, if an aircraft takes off from a runway that is not free of stones, the propeller blade is likely to be nicked or damaged. Should a nick or a scratch not be detected, it is likely to develop into a crack. If this should happen, the forces acting on the rotating blade might cause the blade to break. It is important then, that defects be detected by inspection as early as possible and repaired. This study guide will discuss the types of blade damages, methods of repair and the meaning of blade track.

TYPES OF BLADE DAMAGE

Blade Buckle

This type of damage may occur on either the thrust or camber surface. A blade buckle can be caused by contact with heavy slush, snow or water. This may be thrown into the propeller during a landing. It may also be caused by the blade being dropped or struck by an object. This will give it a "caved in" appearance. A buckle is usually chordwise on the blade. A buckled blade will not be returned to service.

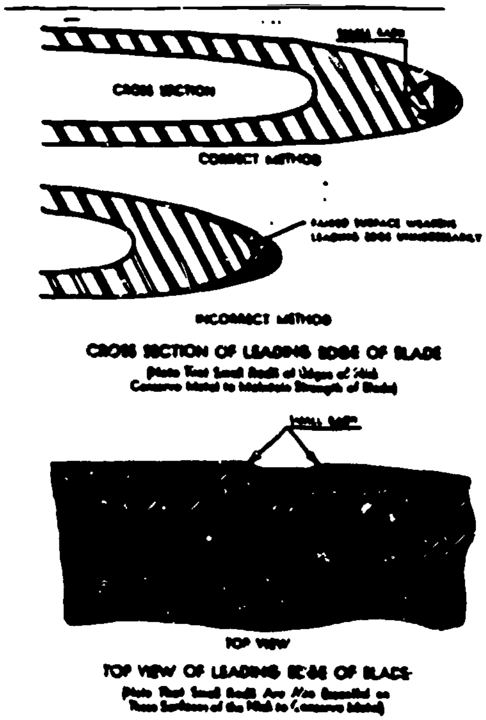

Figure 1. Repairs to Lead and Trail Edges.

Surface Abrasions

Surface abrasions can be divided into such types as nicks, scratches, and gouges. These are usually caused by the blade coming in contact with stones or other hard objects. Small nicks and scratches may be reworked with fine hand stones and emery cloth. See figure 1.

Electrical Burns

Burns are caused by static discharges of electricity. The greatest danger of a burn is the heat effect on the metal. Only burns in the solid portion of the blade and confined to the outboard 24 inches can be reworked. All other burns require removal of the blade from service.

INSPECTION, REPAIR, AND DISPOSITION OF DAMAGED PROPELLER BLADES

Blades having dents which are greater than .040 inch in depth shall be removed from service.

Blade Damage Repair Peening

The propeller blade has a shotpeened area extending from midway of the shank to almost midway of the blade. This shotpeened surface adds to the strength of the aluminum blades by compressive stress of the surfaces. When damage to this area has occurred, rework of the damage must be performed by repeening the area.

The procedures for blade repair peening are contained in TO 3H1-18-2. These procedures must be followed without fail to prevent damaging the blade beyond repair. This repair is performed by using a special hand peening hammer.

TYPES OF ALUMINUM BLADE DAMAGE

Damage to aluminum alloy blades will be classified as minor damage, major damage and irreparable damage.

Minor Damage

This type of damage can be repaired locally at any activity having qualified people.

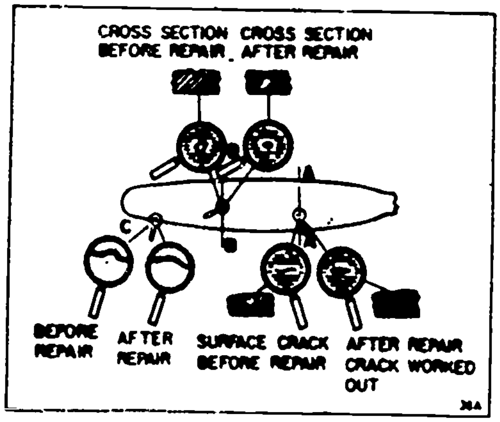

Figure 2. Method for Repairing Surface Defects.

Small nicks or dents in the leading edges or tips may be removed by reworking the blade locally. This is done with a curved or "riffle" file. In urgent cases, this can be done while the propeller is on the aircraft, if the nicks are not too large; however, most desirable results are obtained if the propeller is rebalanced. Care will be taken to remove the sharp base of nicks, as these act as stress concentration points. Longitudinal surface cuts or scratches which are located beyond the 50% radius may be reworked to form saucer-shaped depressions. The whole length, width and depth must not exceed specified tolerances. More than one of these defects is permitted, providing they do not form a continuous line and are not located nearer than a specified distance to one another. See figures 2, 3, and 4.

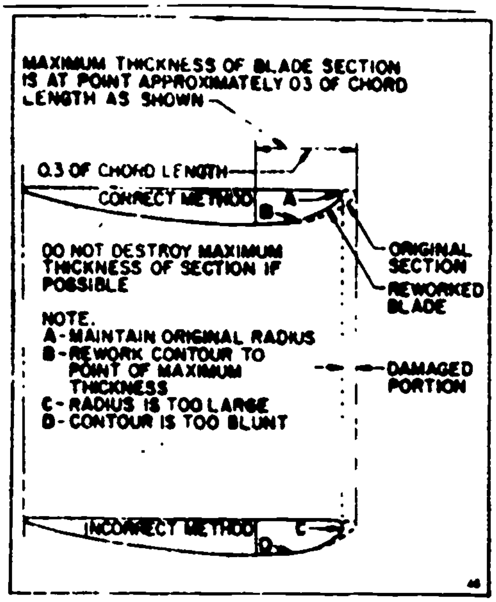

Figure 3. Method for Reworking Leading Edge.

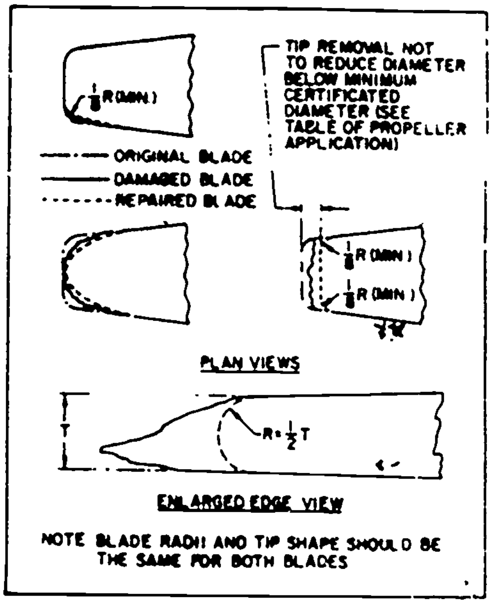

Figure 4. Method for Repairing Blade Tip.

Major Damage

Major damage on reparable blades consists of all damage other than minor damage. Aluminum alloy blades receiving major damage will be forwarded to Air depots for repair. This type of repair will be accomplished only at designated air depots.

Two types of major damage are bent blades and damaged tip sections. After a blade has undergone major repair, the blades of the assembly should be correctly matched. Then the propeller assembly should be balanced.

Irreparable Damage

Irreparable damage results from the following defects:

- A cracked or damaged thrust bearing washer on Hamilton-Standard blades.

- Cracked metal inside the station which locates the minimum usable diameter.

- Bends which exceed specified limits.

- Cuts, nicks, or any damage to metal which, after repair, will be beyond tolerance.

Disposition of Blades Damaged
Beyond Repair

Blades determined damaged beyond repair will be condemned and salvaged. No attempt will be made by activities within the Area Command to salvage damaged blades. The damaged blades will be forwarded to the appropriate Air Logistics Center for disposition.

Deicing Heater and Coverstock Repair

The blade deicing heater (deicing boot) is subjected to the same types of hazards as the aluminum blade. Since the deicing heater and coverstock are made of rubber material, the damage to these parts can penetrate beneath the rubber and go unnoticed without a visual inspection. The procedure for determining the extent of damage is covered in detail in TO 3H1-18-2.

The blade deicing heater can be damaged by impact with foreign objects or from electrical overheating. This damage to the heater generally appears as a bubble or blister. In more severe cases, it will appear as a burned area. To determine the extent of damage and repair procedures, you will have to refer to TO 3H1-18-2.

BLADE TRACK

Blade track is one blade following the same plane of rotation as the other blades of the propeller.

If a propeller blade is out of track far enough, it will cause a propeller vibration. In general, all propeller blades are checked for track in the same manner. A fixed standard is placed so it will contact the blade at approximately the tip area. All blades of the propeller will be rotated past this standard. All should pass within a predetermined distance of this standard. This out of track tolerance varies with different propellers and will be listed in the applicable TO.

If a blade is out of track beyond the specified tolerance the blade must be removed from the propeller and replaced with a serviceable blade.

QUESTIONS

1. What type of inspection will you be doing as a turboprop mechanic?

2. When will you be required to have a propeller blade inspected by the dye penetrant method?

3. What type of light is used when inspecting parts with the Zyglo equipment?

4. Can Zyglo be used on nonmagnetic metals?

5. What are the three different types of surface abrasions mentioned in this study guide?

6. Where must a propeller blade having a major damage be repaired?

7. What will occur if a blade is out of track beyond tolerance?

8. Name three types of aluminum blade damage considered irreparable.

9. What will the damage to a propeller blade deicing heater appear as after being overheated?

10. What action must be taken if a blade is out of track beyond the specified tolerance?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-216
14 February 1980

INSPECTION AND BLADE REPAIR

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to inspect a propeller blade for damage of the aluminum and rubber components, determine the extent of repair, and repair the damage.

EQUIPMENT

	Basis of Issue
TO 3H1-18-2	1/student
Dial Indicator	1/2 students
Blade Repair Files	1/2 students
Blade Repair Kit	1/2 students

PROCEDURE

Using the TO, inspect the propeller blade and determine the depth of damage. Repair the damage using the blade repair files and blade repair kit. Follow the instructions for each project in this workbook.

Project 1

INSTRUCTIONS

Using the dial indicator, HSP 1827, place the dial indicator on a smooth hard surface, depress the plunger button and turn the movable dial face to zero. Lock the dial face in this position. Place the dial indicator on the propeller blade, and using TO 3H1-18-2, take readings from the damaged area of the blade and find the deepest area of damage.

1. Record your deepest measurement. __________

2. What is the minimum length of your rework area? __________

3. What is the total rework depth? __________

4. What is the maximum allowable amount of metal that can be removed at this blade station? __________

5. What is the maximum allowable additional rework depth for an electrical burn on a blade assembly? __________

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6. What is the maximum allowable depth of rework allowed on the camber side? ________

7. How much rework is allowed on the blade tip? ________

8. What is the length of rework in longitudinal blade direction? ________________________________

Project 2

INSTRUCTIONS

Using TO 3H1-18-2 and equipment, repair damage to the blade shot peened area and determine the maximum and minimum area of rework and/or repair that is allowed in the technical order.

1. What is the minimum area of the propeller blade that shall not be repeened? ____________

2. What is used to cover the blade during repeening?

____

3. What is the maximum area of a blade that can be repeened during blade repair? ________________

4. What material is used to remove the high spots after repeening a blade? ________________________________

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STUDY GUIDE
3ABR42633-SG-213

Technical Training

Turboprop Propulsion Mechanic

SOLDERING ELECTRICAL CONNECTIONS

27 February 1980

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3350 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-213

SOLDERING ELECTRICAL CONNECTIONS

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to state the purpose and procedure for soldering electrical connectors.

INTRODUCTION

The ability to understand and know the correct procedures for soldering electrical connectors and the equipment required to complete the job with safety in mind first of all, is of utmost importance to you as a turboprop propulsion mechanic.

INFORMATION

This study guide contains the necessary information to correctly solder electrical connections and the definition of terms that pertain to soldering procedures.

SOLDERING

Repair and replacement of electrical parts sometimes includes soldering of the wire terminal ends. AN connectors also may have the individual wires soldered in place. The proper methods used in soldering are described below.

Soldering is a relatively simple task. Still, something must be known about the tools to use and the material to be soldered. Also, you must know about solder that is being used and the specific procedures to follow when soldering. If not, the soldered connection may break loose or form an electrical connection that will not conduct electricity. You, as a repairman, may be called upon to repair electrical connections. It may be attaching new terminals on wires or connecting electrical wires to an AN connector. A bad connection on an electrical circuit of an aircraft system could cause serious damage. Your knowledge of soldering is important whether you are performing the repair or inspecting the completed job.

Facility

The worker is responsible for maintaining soldering areas in a clean, orderly condition. Smoking, eating, or drinking at the work stations is not permitted.

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The soldering area shall have a controlled environment which limits entry of contamination. It should have a temperature of 75° ± 10°F with a relative humidity of 25% minimum to 60% maximum. Lighting should be a minimum of 100-foot candles on the surface being soldered. Where required control conditions cannot be met, special care should be taken to maintain the quality of solder connections.

Solvents

Solvents shall be nonconductive and noncorrosive, and shall not dissolve or degrade the quality of parts or materials. Solvents shall be properly labeled and maintained in a clean and uncontaminated condition. Those showing evidence of contamination or decomposition shall not be used.

> CAUTION: Flux or solvents shall not be used in any manner which will carry to or deposit residue on contact surfaces such as those in switches or connectors.

The following solvents are acceptable when properly used for cleaning before or after soldering:

1. Ethyl alcohol, ACS grade, 99.5% or 95% by volume.
2. Isopropyl alcohol, best commercial grade, 99% pure.
3. Trichlorotrifluoroethane, clear, 99.8% pure.
4. Any mixtures of the above.
5. 1,1,1-Trichloroethane, Federal Specification O-T-620.
6. Deionized water; however, care shall be used to ensure that proper drying is accomplished immediately after its use.

> CAUTION: Sonic or ultrasonic vibration shall not be used as a method for cleaning electrical or electronic parts or assemblies unless it has been demonstrated that the reliability of the parts or assemblies will not be degraded by the process to be used.

Thermal Shunts

Thermal shunts (also called heat sinks or heat dissipator clamps) shall be used to absorb heat from part leads or wire where necessary to protect parts, insulating materials, and/or previously completed connections from damage during soldering operations. Care shall be taken in the selection, application and removal of thermal shunts to avoid damage to conductors, components, parts, insulation, or associated solder connections.

Flux

Have you ever watched metal change color as it heats? This is due to oxides forming on the metal face. This oxide prevents the solder from making a good bond with the metal. To remove the effects of the oxide, a flux is needed. The flux acts to cut the coating of oxide and permits a firm bond between the solder and the metal. Numerous types of flux are used in soldering. Some of the more common are zinc chloride, ammonium chloride, hydrochloric acid and rosin.

Solder

There are many kinds of solder in use. Solder is made of a combination of tin and lead. Some of the ratios are 40% tin and 60% lead, 50% tin and 50% lead, 60% tin and 40% lead. Solder having a higher tin content makes somewhat stronger bonds. For electrical work, solder in wire form with rosin flux in the core is most commonly used. Be sure to look on the spool--it must be a rosin core for electrical work. An acid core solder will corrode the connections and cause trouble.

Preparation of Conductors

INSULATION REMOVAL. Stripping machines or handtools used to remove conductor insulation shall be of the correct size and in current adjustment and/or calibration.

DAMAGE TO INSULATION. After insulation removal, the remaining conductor insulation shall not exhibit any damage such as nicks, cuts, crushing, or charring. Conductors with damaged insulation shall not be used. Slight discoloration from thermal stripping is acceptable.

DAMAGE TO CONDUCTORS. After removal of the conductor insulation, the conductor shall not be nicked, cut, scraped, or otherwise damaged. Part leads and other conductors which have been reduced in cross-section area shall not be used. Damaged wires shall not be used.

WIRE LAY. The lay of wire strands shall be restored as nearly as possible to the original lay if disturbed. Contact with bare fingers shall be avoided; however, if contact is made, the wire shall be cleaned with an approved solvent prior to further processing.

Soldering Procedures

Soldering tools or coppers, figure 1, come in various sizes and shapes. The one selected will depend upon the size of the job as well as working space. The soldering tip or iron must be designed to give up its heat rapidly. It must channel this heat directly into the working area. Any heat delivered out of the immediate vicinity of the joint is wasted. Some jobs, where a larger area is to be heated, require a flat surfaced tip; for other cases, an AN connector, for example, you'll need a small four faced or pointed tip. Some tools require 28V DC; others work on 115V AC.

Perhaps you'll be lucky enough to have one of the quick heating electric irons in the shop. These are like transformers molded to fit the hand. They have a high current output fitted

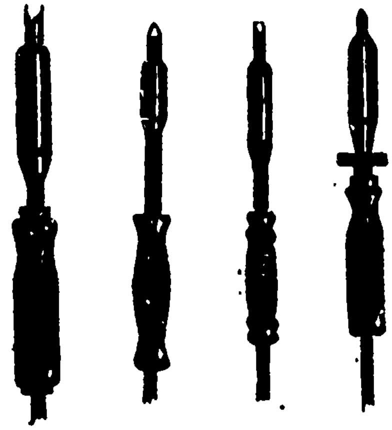

Figure 1. Soldering Coppers.

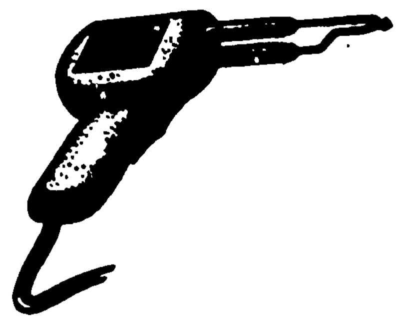

Figure 2. Solder Gun.

to a replaceable tip. These soldering "guns" usually have a trigger switch which has two positions. Pull back just a little and you have enough heat for the ordinary job. Exert enough force to pull the trigger back a little farther and more heat is available. A soldering gun is shown in figure 2.

Remember that soldering guns are not made for continuous service. They are made for spot work and heat in a matter of seconds. If you try to keep them in constant operation, the transformer won't last. The tips will soon fail.

Once you've chosen a gun of the right wattage, and tip of the correct shape, you're in business. But there is still another fact to remember—the best tool in the shop is worthless in the hands of a man who can't use it. A tip may have plenty of heating area, but the energy will be wasted in space unless you hold the tool correctly. Bring as much of the heating area into use as possible. Remember that heat rises, so hold the iron under the work to be soldered, not over it.

We have been emphasizing the need for getting heat to the work area. This is the reason for your first step in soldering—tinning the soldering tip. Oxides have an insulating effect and tend to block the heat flow. File or sand the working surface of the tip free of any discoloration. See figure 3. There is no need to be heavy handed about this task; simply remove the surface coat of oxides. If you use a file, take care to make a flat stroke; keep the tip shape the same.

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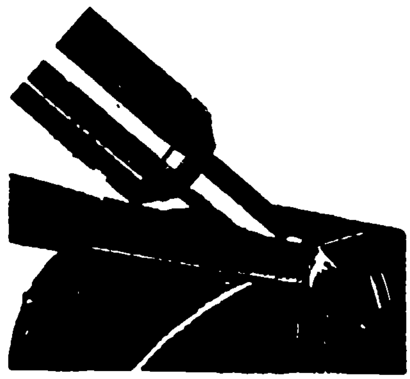

Figure 3. Preparing Tip Surfaces.

After the face has been cleaned and heated, rosin cored solder should be applied until there is a bright, shiny, surface of solder. The excess solder is wiped off with a damp rag. See figure 4.

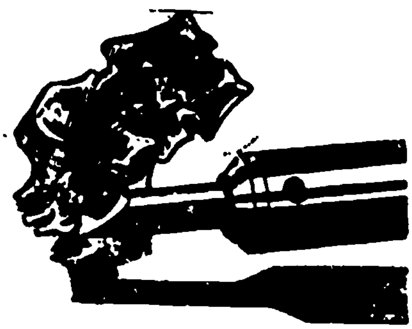

Figure 4. Wiping the Tinning Job.

This is known as tinning the soldering iron. Without this tinning, oxide builds up on the tip, preventing the transmission of heat. Proper tinning is the keynote to successful soldering; any time during your work that solder begins to show burning and oxidation, the heat is being transferred too slowly. You should re-tin immediately. By all means don't flip the iron, or throw the hot solder into space, injury to nearby personnel may result.

Surfaces for soldering must be free of oil, grease, paints, etc., or solder will not stick. Surfaces should be cleaned with sandpaper, emery cloth, or file and then wiped clean. The work must be as carefully cleaned as the tool itself. It is then sanded and shaped to the exact appearance of the finished job.

Solder is not intended to furnish a great deal of mechanical strength, but it does surprisingly well. Once cleaning and forming have been completed, you will save time by applying a thin coating of solder to each piece.

Now the pieces should be joined together. The soldering tip is held underneath them if at all possible. Since heat rises, the action will be much more efficient in this position. When using rosin cored solder, you should keep the solder in contact with the work itself, and not with the iron. See figure 5. If

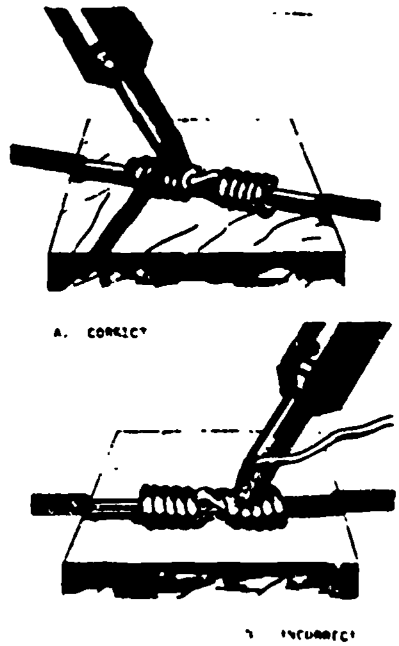

Figure 5. Applying Cored Solder.

you allow the rosin to drip down over the whole surface of the tip, it will break down before it strikes the work area--its fluxing ability will be largely destroyed.

Some men try to hold the work with one hand and the iron with the other; consequently, the part isn't steady when the solder passes from the liquid state to the solid form. A slight movement at this moment will cause a weak place which will soon break. A vise or some other clamping device, to hold the work, should be used.

The best jobs have a thin film of solder. Strangely, these thin films are stronger than "blobs." When soldering terminals, try for a rounded effect. Sharp points in electrical work may cause shorts.

Signs of a "<u>cold joint</u>" may be recognized by its dirty-grey, grainy texture. Cold joints are either caused by not properly heating the metal to be soldered, or by improper cleaning and tinning.

Don't let the iron become too hot. If it does, the solder will flow too freely, and show oxidization colors. Heating should be stopped when the tip shows a blue color.

Inspection

Each soldered connection shall be visually inspected. Inspection shall be aided by magnification appropriate to the size of connections between 4X and 10X magnification. Additional magnification shall be used as necessary to resolve suspected anomal defects. Parts and conductors shall not be physically disturbed to aid in detection.

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Acceptance Criteria

An acceptable solder connection will be characterized by:

1. Clean, smooth, bright, undisturbed surface.

2. Solder fillet between wire or lead and termination as described herein.

3. Contour of wire sufficiently visible to determine the presence of the direction of the bend and the terminating end of the wire.

4. Complete wetting.

5. Proper amount and distribution of solder.

Rejection Criteria

The following are some characteristics of unsatisfactory solder condition of which is cause for rejection:

1. Conductors and Parts:

   a. Damaged, crushed, cracked, charred, or melted insulation.

   b. Improper insulation clearance.

   c. Improper tinning.

   d. Separation of wire strands.

   e. Part improperly supported or positioned.

   f. Part marking not visible.

   g. Part damaged.

   h. Loose conductors.

   i. Cut, nicked, stretched, or scraped leads or wires.

   j. Flux residue or other contaminations.

   k. Improper wrap or stress relief.

   l. Spliced conductors.

2. Solder Connections:

   a. Cold joint.

   b. Overheated granular joint.

   c. Fractured joint.

   d. Improperly bonded joint.

   e. Pitted or porous joint.

   f. Excessive solder.

   g. Insufficient solder.

   h. Splattering of flux or solder on adjacent areas.

   i. Rosin solder connection.

j. Unclean connection (e.g., lint, flux, dirt, etc).

k. Dewetting.

Remember, a neat job means only one thing. The solder must have melted quickly; flowed into and around the union; then frozen into place without air bubbles, oxides, carbon particles or other foreign matter. Any impurity weakens a joint and builds up electrical resistance.

SUMMARY

Improper soldering techniques can cause damaged equipment and unsafe conditions. The mechanic should know that flux is used to prevent oxides from forming. These would prevent the solder from making a good bond with the metal. Various soldering tools are available to properly accomplish each job. You should know the procedures for preparing the material to be soldered. You should know the steps to be followed during soldering. Then with practice, you can do a soldering job that will be safe and dependable.

DEFINITIONS

The following definitions apply to terms used in this study guide.

Blister - Delamination in distinct local areas.

Bridging - A build-up of solder or conformal coating between parts, part leads and/or base substrate forming an elevated path (see fillet).

Cold Solder Joint - Unsatisfactory connection resulting from dewetting or movement of conductor during cooling and frequently exhibiting an abrupt rise of the solder from the surface being soldered. These usually appear frosty and granular.

Conduction Soldering - Method of soldering which employs a soldering iron for transfer of heat to the soldering area.

Conductor - A lead or wire, solid or stranded, or printed wiring path serving as an electrical interconnection between terminations.

Connection - An electrical termination.

Cracked Solder Joint - A soldered connection which has fractured or broken within the solder.

Dewetting - The condition in a soldered area in which the liquid solder has not adhered intimately, characterized by an abrupt boundary between solder and conductor, or solder and terminal/termination area.

Disturbed Solder Joint - Unsatisfactory connection resulting from relative motion between the conductor and termination during solidification of the solder.

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Electrical Component - An assembly of one or more electronic/ electrical parts that may be disassembled or separated without destruction of designed use, e.g., printed wiring assembly.

Excessive Solder Joint - Unsatisfactory connection wherein the solder obscures the configuration of the connection.

Fractured Solder Joint - A joint showing evidence of cracking.

Joint - A solder joint; a termination.

Overheated Joints - An unsatisfactory solder joint, characterized by rough solder surface.

Part - One piece, or two or more pieces joined together which are not normally subject to disassembly without destruction of designed use.

Part Lead - The conductor, solid or stranded, attached to a part.

Porous Solder Joint - A joint having a grainy or gritty surface.

Pits - Small holes or sharp depressions in the surface of the solder.

Repair - Operations performed on a nonconforming article to place it in usable condition.

Resistance Soldering - Method of soldering by passing a current between two electrodes through the area to be soldered.

Rework - The reprocessing of articles or material that will make it conform to drawing specification or contract.

Rosin Solder Joint - Unsatisfactory connection which has entrapped rosin flux.

Solder - A nonferrous, fusible metallic alloy used to join metallic surfaces.

Solder Icicle - A cone shaped peak or sharp point of solder usually formed by the premature cooling and solidification of solder upon removal of the heat source.

Solder Joint - A termination.

Soldering - The process of joining metallic surfaces through the use of solder without direct fusion of the base metals.

Terminal - A tie point device used for making electrical connections.

Termination - The point at which electrical conductors are joined.

Thermal Shunt - A device with good heat dissipation characteristics used to conduct heat away from an article being soldered.

Tinning - The coating of a surface with a uniform layer of solder.

Wetting - Flow and adhesion of a liquid to a solid surface, characterized by smooth, even edges.

QUESTIONS

1. What is the indication of a cold soldered joint?

2. Why does the repairman need to know how to solder properly?

3. What is the purpose of the flux?

4. Why should a soldering iron be tinned?

5. When soldering, why should the surface be cleaned?

6. Why shouldn't the soldering iron be "flipped" to remove the excess solder?

7. What type of core should the solder contain for electrical work? Why?

8. What is the indication that the soldering iron tip is too hot?

9. What determines which soldering iron to use?

10. What do the numbers 60/40 on a spool of solder tell you?

11. Why is it important to have a controlled environment for soldering?

12. Why do we use solvents in soldering?

13. What is meant by wire lay?

14. What characterizes an overheated solder joint?

15. Is the use of a five power (5X) magnification allowed for inspection of soldering?

16. Should soldering coppers be held above or below the item being soldered? Explain why.

17. Who is responsible for keeping the soldering work area clean?

18. Why is lighting so important in soldering?

Jet Engine Branch
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3ABR42633-SG-~~302~~
8 January 1980

REMOVAL OF PROPELLER ASSEMBLY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to remove a turbopropeller from a T56 engine gearbox assembly.

INTRODUCTION

In a previous lesson in this block of instruction you learned how to install a turbopropeller on the T56 engine gearbox. In this lesson you will learn how to remove the turbopropeller, which is one of your most important jobs as a turbopropeller mechanic. Some reasons for propeller removal are:

1. Oil leaks

2. FOD

3. Expiration of operating hours (3,600 hours). Another item you must understand is the technical orders needed to complete the job safely and completely, and how to document the work performed for record keeping.

INFORMATION

USING TO INSTRUCTIONS AND TOOLS

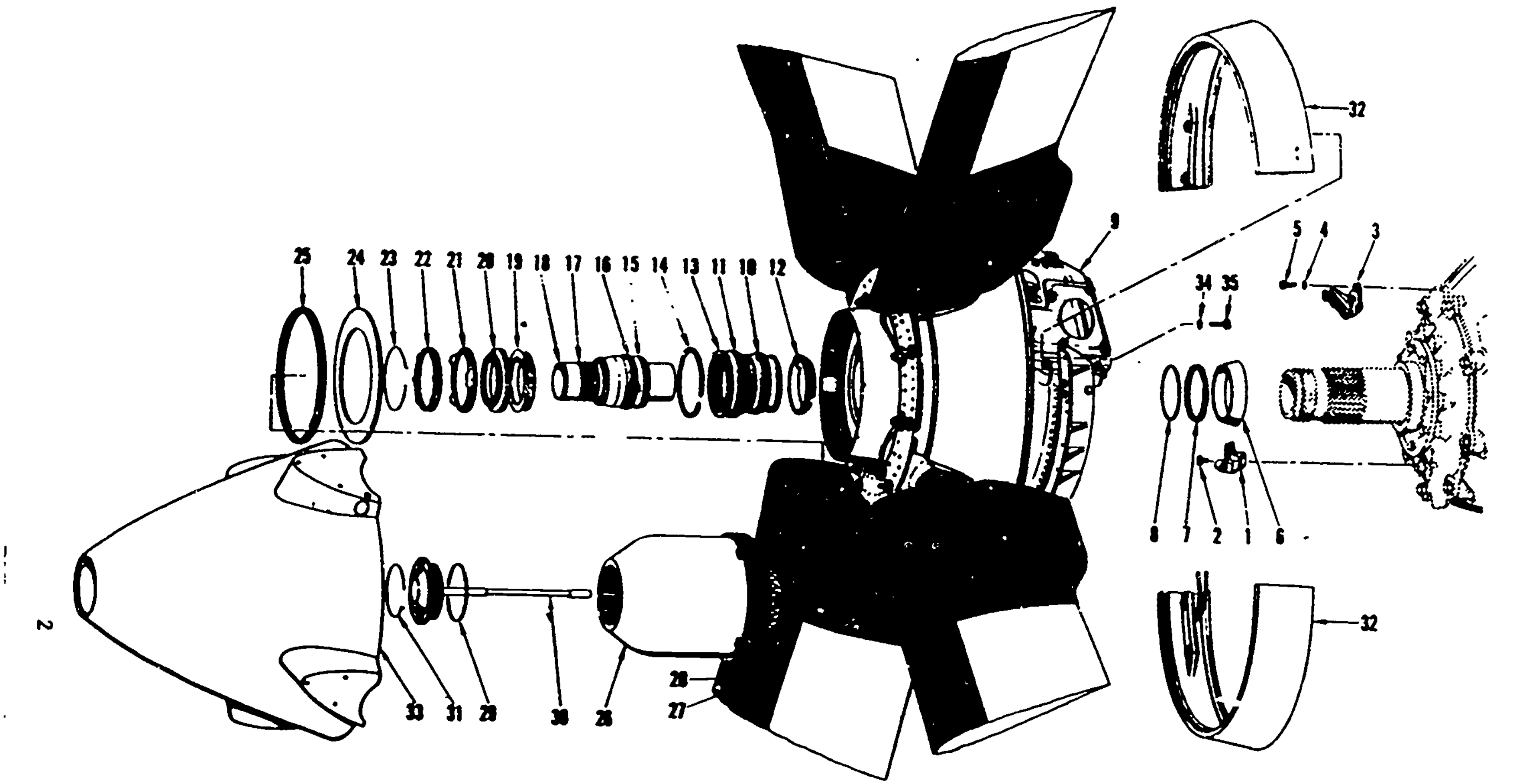
The step-by-step procedure for removing the C-130 propeller is illustrated in TO 1C-130B-2-11 following the descriptions and pictures of the necessary tools. When you handle heavy parts such as the dome or the hub and blade assembly, it is essential to have the "know how" to enable you to safely lift the parts. Each step will be explained with the applicable tools.

REMOVAL OF THE AFTERBODY TOP HALF

Refer to figure 1 to determine the location of items to be removed. Also note that the removal sequence is in reverse of the index numbering.

The afterbody top half (32) is located in a position which makes it difficult to extract it from beneath the blade cuffs. The propeller is statically operated to the reverse blade angle to provide clearance for removal of the forward access panels. The blade angles are then positioned to ground idle for the afterbody top half removal, then to the FEATHER angle for removal and installation of the Hamilton 54H60 propeller.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1



22-270-236

1 Control Drive Bracket
2 Bolt
3 Negative Torque Bracket Assembly
4 Flat Washer
5 Bolt
6 Rear Cone
7 Spacer
8 Packing
9 Control Assembly
10 Packing
11 Packing
12 Front Cone
13 Propeller Retaining Nut
14 Propeller Nut Retaining Ring
15 Packing
16 Packing
17 Packing
18 Pitch Lock Regulator Assy
19 Splined Spacer Ring
20 Ratchet Ring
21 Locking Control Cam
22 Externally Threaded Ring
23 Retaining Ring
24 Gear Preload Shim
25 Dome Barrel Seal
26 Dome Assembly
27 Lock Screw
28 Cotter Pin
29 Packing
30 Fluid Transfer Tube
31 Lock Wire
32 Spinner Afterbody
33 Front Spinner Assembly
34 Washer
35 Bolt

Figure 1. Propeller Group Installation.

REMOVAL OF THE CONNECTIONS AND SPINNER NOSE

AN connector plugs located at the deicing brush block, auxiliary pump motor, pump housing connector, valve housing, and feather solenoid must be unsafetied and removed. The ring type nut should be carefully backed off while jiggling the conduits. A universal coupling is disconnected from the input shaft by completely extracting the 1/4" X 28 bolt which fits in a groove in the splines of the input shaft.

The spinner nose is attached to the -63 propeller by eight retaining screws which must be screwed in to release, then turned 1/4 turn while pushing in. This locks the screw disengaged. The -91 propeller has a retention ring which is released by installing a socket on the adjusting screw and turning counterclockwise. The spinner front section is pulled straight off.

REMOVAL OF THE DOME ASSEMBLY

When preparing to remove the dome cap and dome (26), a container must be provided to catch the hydraulic fluid. To remove the cap, the lockwire (31) is removed from the dome cap. The dome lifting handle takes the place of the cap and provides a place to attach the hook of the dome lifter. It is important to use these tools when removing the dome because the dome weighs approximately 125 pounds. After unsafetying and loosening the dome retaining nut, it is slowly moved forward to avoid splashing the hydraulic fluid. The dome must be secured to prevent it from rolling off the maintenance stand.

REMOVAL OF THE PITCH LOCK GROUP

The pitch lock parts are retained by an externally threaded ring. The safety for it is a type of lock wire called retaining ring (23). After removing the externally threaded ring (22), the mechanical puller is screwed into the front of the pitch lock regulator. A few light taps with the slide handle of the puller will dislodge the pitch lock regulator along with the cam out ring (21), stationary ratchet (20), and the externally splined spacer (propeller retaining nut lock ring) (14).

REMOVAL OF THE HUB AND BLADE ASSEMBLY

The base plate is installed on the barrel shelf and retained to the barrel by a retaining ring. The base plate provides an attaching place for the sweeney power wrench and the propeller lift assembly.

After loosening of the propeller retaining nut (13) the propeller can be hoisted off the shaft. Remove the spider to shaft seal (8) spacer (7), and rear cone (6) are then removed so that the shaft can be cleaned and inspected.

Remember that the weight of the propeller is nearly 1,000 pounds which makes handling it dangerous. Do not stand under the equipment while it is suspended on the hoist. The assembly can then be placed on a stand or propeller dolly. If it is left in a horizontal position, it will drain slowly, therefore, the control should be drained into a large drip pan placed under it.

SUMMARY

The removal of propellers can be a safe operation providing you stay alert, do not rush, and pay close attention to all safety precautions described in the maintenance manual. Failure to think before each step of the operation could be disastrous. Carefully check the condition of your equipment and tools before use.

The aircraft maintenance technical order gives the step-by-step instruction for propeller removal. Attention to those details will provide quality maintenance.

QUESTIONS

1. What is the speed of the propeller shaft in normal flight in RPM? In percent?

2. What is the normal engine speed of the T-56 engine?

3. Where is the propeller brake located?

4. What is the recommended blade angle for removal of the afterbody top half?

5. Name the connector plugs which must be disconnected before removing the 54H60 propeller.

6. What fits in the threads in the front of the dome when removing the dome disassembly?

7. Name the parts which must be removed along with the pitch lock regulator.

8. What is the purpose of the special tool called "base plate"?

9. What parts must be removed to allow cleaning and inspection of the propeller shaft?

10. What effect does NTS action have on blade angle?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-301
21 April 1981

REMOVAL OF PROPELLER ASSEMBLY

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to locate information pertaining to the removal of a 54H60 turbo propeller from a T56 engine gearbox assembly.

EQUIPMENT

	Basis of Issue
TO 00-20-2-2	1/student
TO 00-20-5	1/student
TO 1C-130A-06	1/student
TO 1C-130B-2-11	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Using TO 1C-130B-2-11, answer the following questions.

1. The blades are positioned in a beta range blade angle to provide clearance for removal of which parts? ______________________________

2. Which figure number shows removal of the Hamilton Standard Model 54H60-91 propeller? _______

3. Tool No. _______ is used to remove the spinner front section.

4. How far must you loosen the dome retaining nut during dome removal? ______________________________

5. Name the parts of the pitch lock which are removed after dome removal.

   a. ______________________________

   b. ______________________________

Supersedes 3ABR42633-WB-302, 9 January 1980. RGL: N/A
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 400; DAV - 1

c. ____________________

d. ____________________

e. ____________________

f. ____________________

6. Name the parts removed from the engine shaft after propeller removal.

a. ____________________

b. ____________________

c. ____________________

7. What step number tells you to remove the pitch lock regulator?

____

8. What is the nomenclature of tool part number HS7611? ________

____

9. What tool group is tool number SWE-866380 listed in? ________

____

Project 2

DIRECTIONS

Using TO 00-20-5, answer the following questions pertaining to the AFTO Form 95.

1. What is the title of the AFTO Form 95? ____________________

2. As a minimum, what should the information on the AFTO Form 95 portray? ____________________

3. What entry is made in Block 1 of the AFTO Form 95? ________

____

4. What is entered in Block 4 of the AFTO Form 95 when the acceptance date is not known? ____________________

Project 3

DIRECTIONS

Using TO 00-20-2-2, answer the following questions.

1. Whose work center is entered in Block 2 of the AFTO Form 349?

____

2. Is an entry required in Block 20 of the AFTO Form 349 when documenting propeller removal? ______________

3. Part I of the AFTO Form 350 is the ______________

4. Which TO has the applicable SRD codes for completing Block 3A of the AFTO Form 350? ______________

5. From which source do you obtain the federal supply classification code for completing the AFTO Form 350? ______________

Project 4

DIRECTIONS

Using the following information and the applicable references, make the correct entries on the AFTO forms in figures 1 and 2.

1. Today, you and one assistant are dispatched to remove number 3 propeller for leaking, found by the ground crew. The propeller change began at 1000 hours and at 1200 hours you and your crew stopped for lunch.

2. At 1300 hours you and your crew returned from lunch, the propeller removal was completed at 1500 hours.

3. The following information is provided to complete the necessary forms required for this job.

a. General Information

Priority:	2
Location:	H2
Time Specialist Required:	1000 hours
Job Standard:	4 hours

b. Aircraft Data

MDS:	C130E, Assigned to 317 TAW
SN:	61-4820
ID:	QA4820
Time:	1575.1 hours
Work Center:	Q2115

c. Removed Propeller Data

PN:	PL21403
SN:	N221782
Time:	870.2 hours
Work Center:	Q3220
ID:	QA1782
Stock Number:	1610-00-783-5191

MAINTENANCE DATA COLLECTION RECORD

OMB NO 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO	9. LOCATION
003C								

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17 TIME REC REQ	18. JOB STD.

19. FSC	20. PART NUMBER	21. SER NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER. TIME

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26 DISCREPANCY

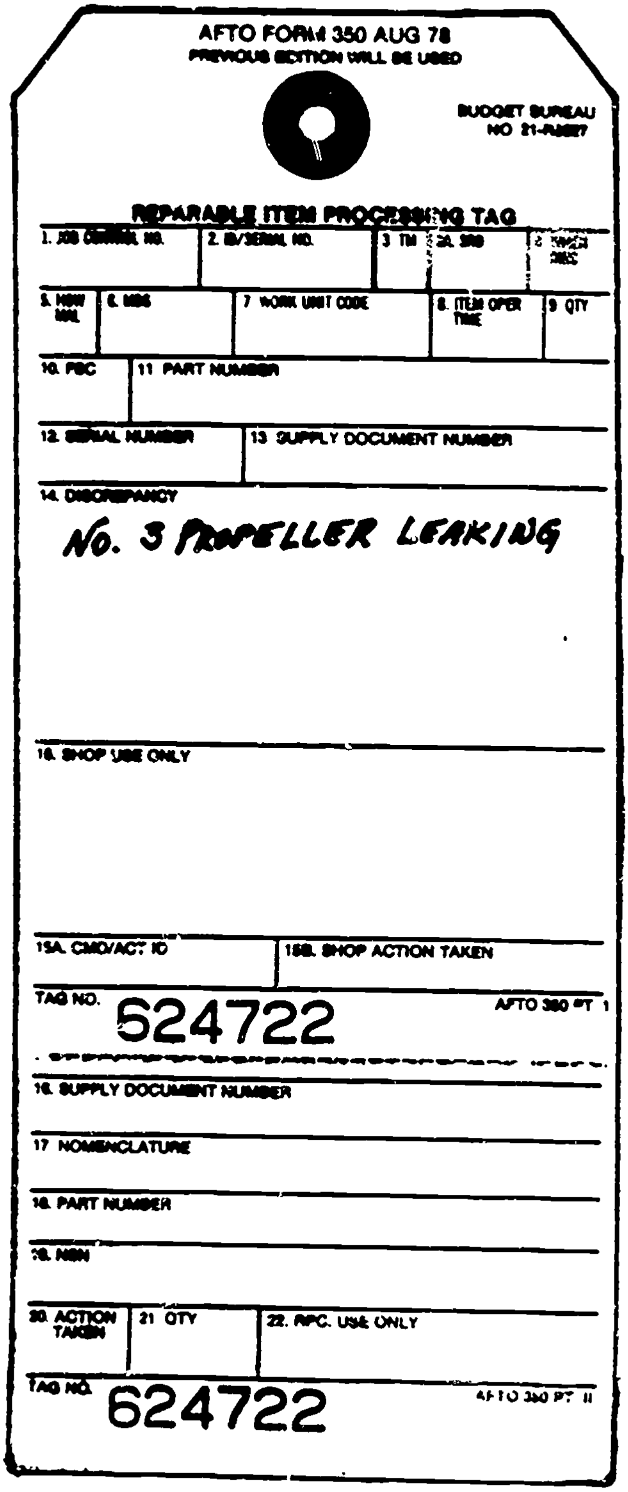
NO. 3 PROPELLER LEAKING

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 79 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.


AFTO FORM 350 AUG 78
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU NO 21-R[illegible]

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. | 2. ID/SERIAL NO. | 3 TM | 3A. SRD | [illegible]

5. HOW MAL | 6. MDS | 7 WORK UNIT CODE | 8. ITEM OPER TIME | 9 QTY

10. FSC | 11 PART NUMBER

12. SERIAL NUMBER | 13 SUPPLY DOCUMENT NUMBER

14. DISCREPANCY

NO. 3 PROPELLER LEAKING

15. SHOP USE ONLY

15A. CMD/ACT ID | 15B. SHOP ACTION TAKEN

TAG NO. 524722 AFTO 350 PT I

16. SUPPLY DOCUMENT NUMBER

17 NOMENCLATURE

18. PART NUMBER

19. NSN

20. ACTION TAKEN | 21 QTY | 22. RPC. USE ONLY

TAG NO. 624722 AFTO 350 PT II

Figure 2. AFTO Form 350.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-~~303~~ 302
24 January 1980

REMOVAL OF CONTROL, REAR SPINNER AND DEICING CONTACT RING

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to remove the contact assembly, rear spinner, and deicing contact ring from a 54H60 turbo propeller.

INTRODUCTION

After the propeller has been removed, the components mounted on the back can now be removed to prepare for repair or packaging to ship out for overhaul.

INFORMATION

AFTERBODY REMOVAL

Two components of the afterbody which remain with the propeller when it is removed from the aircraft are the afterbody bottom half and afterbody mounting bracket. The electrical wires and mounting bolts are removed at this time to avoid damage to the afterbody and its parts when the propeller control assembly is handled.

CONTROL REMOVAL

The control is removed while the No. 1 blade angle is still at or slightly above feather angle. This will avoid snapback of the beta linkage.

The pin retaining ring is removed from the spider bore by lifting the two pins out of the holes. Then the control puller tool is bolted to four of the studs which hold the rear seal assembly in place. By turning the long threaded bolt of the puller clockwise, the control will slide off the hub extension. Be prepared to catch the spilled fluid. Carefully support the control (which weighs about 117 lbs) to prevent it from falling.

REMOVAL OF DEICER CONTACT RING AND REAR SPINNER

The purpose of the deicer contact ring slipring is to transmit electrical power from the brush block mounted on the pump housing to the rotating propeller. Also, four smaller brush blocks are mounted on the front side of the deicing contact ring assembly to transmit deicing power to the blade sliprings which are wrapped around the shank of each blade.

OPR: 3350 TCHTC
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1

726

After disconnecting the four straps attached to the spinner, unsafety and loosen the eight socket head cap screws and washers. Removing the socket head bolts will allow the deicer contact ring, seal ring and preformed packing to be removed. The purpose of the seal ring and preformed packing is to prevent leakage between the rotating rear barrel and the front of the stationary pump housing (cover plate).

The rear spinner is attached to the aft side of the hub bulkhead and seal assembly. Removing 8 self-locking nuts inside the rear spinner will allow the spinner to come off. The dowel bolts, spacers, and washers should be placed together with the nuts to prevent losing them. The propeller is ready for further disassembly as soon as it is placed on the assembly post.

SUMMARY

Components to be removed prior to hub and blade disassembly are afterbody bottom half and bracket, control, deicer contact ring, and rear spinner assembly. Special care and attention will assure that the parts are not damaged during removal.

QUESTIONS

1. Which parts of the propeller will remain until after removal from the aircraft?

2. What is the reason for removing the afterbody bracket from the pump housing?

3. Removing the control assembly while the blades are at feather angle protects which parts?

4. What is mounted on the deicer contact ring?

741

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-302
21 April 1981

REMOVAL OF PROPELLER CONTROL ASSEMBLY, DEICING CONTACT RING, AND REAR SPINNER

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate and use the technical order to locate specific instructions for removal of control, rear spinner, and deicing contact ring assemblies.

2. Locate and use the technical orders needed to document the proper forms for removal of control, rear spinner, and deicing contact ring assemblies.

EQUIPMENT

	Basis of Issue
TO 00-20-2-10	1/student
TO 1C-130A-06	1/student
TO 3H1-18-2	1/student
3ABR42633-WB-301	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Using TO 3H1-18-2, answer the following questions about the control assembly removal.

1. The afterbody __________ half must be removed before the propeller control can be removed.

2. What advantage can be gained by removing the control while the blades are at the feather angle? ______________________________

Supersedes 3ABR42633-WB-303, 24 January 1980. RGL: N/A
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 400; DAV - 1

3. What position must the propeller be in for control assembly removal? ____________________

4. What must be removed from within the barrel extension during control removal? ____________________

5. What is the name of the tool shown in figure 3-60? ____________________

6. What is the part number of the mechanical puller used to remove the control assembly? ____________________

7. What direction is the mechanical puller handle turned to remove the control? ____________________

Project 2

DIRECTIONS

Using TO 3H1-18-2, answer the following questions about the deicer contact ring holder assembly removal.

1. What paragraph covers the procedure for contact ring holder removal? ____________________

2. How many electrical connector straps must be disconnected from the deicer contact ring holder assembly? ____________________

3. What type screws hold the deicer contact ring holder assembly to the hub assembly? ____________________

Project 3

DIRECTIONS

Using TO 3H1-18-2, answer the following questions about the rear spinner removal.

1. What figure is given as a reference for the eight self-locking nuts that are removed during rear spinner removal? ____________________

2. What is the figure and index number of the flat washers, and dowel bolts removed during rear spinner removal? ________, ________, and ________.

Project 4

DIRECTIONS

Using the following information and the applicable references, make the correct entries on the AFTO Forms 349 and 350 in figures 1 and 2.

1. You are assigned to the Turbo Propeller Shop and are given the task of removing the control assembly that was leaking on the prop that was removed on the last lesson in WB-301.

2. The job started at 0900 hours and was completed at 0930 hours.

3. The following information is provided to complete the necessary forms required for this job.

a. General Information

Priority:	2
Location	P3
Time Specialist Required:	0900 hours
Job Standard:	1/2 hour
Work Center:	Q3220

b. Aircraft Data

SN:	61-4820
ID:	QA4820
Time:	1575.1 hours

c. Pump Housing Data

PN:	733872-2
SN:	SE7355
Time:	730.6 hours
Stock Number:	1610-00-005-8685

MAINTENANCE DATA COLLECTION RECORD

OMB NO 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7 PRI	8. SORTIE NO.	9 LOCATION
0030	Q3220							

10 ENG TIME	11. ENGINE I.D.	12 INST ENG TIME	13. INST. ENG. I.D.	14.	15	16	17 TIME SPC REQ	18 JOB STD

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER TIME

ACT. LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 75 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU NO 21-R0237

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. | 2. ID/SERIAL NO. | 3. TM | 3A SRD | 4 WHEN DISC

5. HOW MAL | 6. MDS | 7. WORK UNIT CODE | 8 ITEM OPER TIME | 9. QTY. 1

10. FSC | 11. PART NUMBER

12. SERIAL NUMBER | 13 SUPPLY DOCUMENT NUMBER

14 DISCREPANCY

15 SHOP USE ONLY

15A CMD/ACT ID

TAG NO. 096900 AFTO 350 PT. 1

16 SUPPLY DOCUMENT NUMBER

17 NOMENCLATURE

18 PART NUMBER

19 NSN

20 ACTION TAKEN | 21 QTY | 22 RPC USE ONLY

TAG NO. 096900 AFTO 350 PT. 2

Figure 2. AFTO Form 350.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-304
9 January 1980

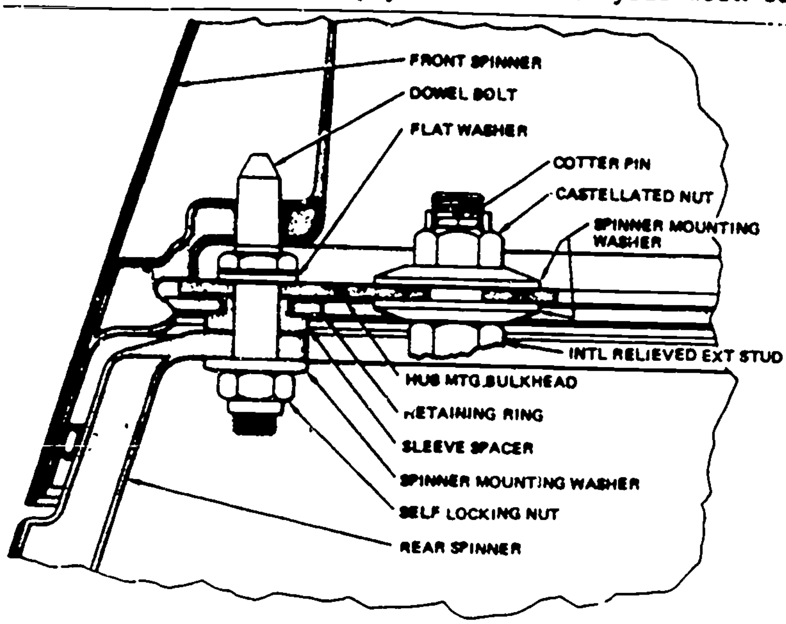
INSTALLATION OF REAR SPINNER, DEICING CONTACT RING, AND CONTROL ASSEMBLIES

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to install, with assistance, the 54H60 propeller rear spinner, deicing contact ring, and propeller control assemblies.

INTRODUCTION

After the propeller has been assembled and tested, it is ready for the external parts necessary for installation on the aircraft. A detailed description will help you understand your work better.



INFORMATION

REAR SPINNER

Refer to figure 1 to determine the installation sequence of the following items as they are mentioned.

After the hub mounting bulkhead has been attached and safetied to the barrel bolt extension studs, eight dowel bolts are used to attach the rear spinner to the propeller. The dowel bolts have bullet shaped ends that project into holes in front spinner. Behind the bulkhead a sleeve spacer allows the dowel bolts to be torqued tight without

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1
Desigend for ATC Course Use. Do Not Use on the Job.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-303
21 April 1981

INSTALLATION OF REAR SPINNER, DEICING CONTACT RING, AND CONTROL ASSEMBLY

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate and use the proper technical order to install the 54H60 propeller rear spinner, deicing contact ring and control assembly.

2. Locate and use the proper technical orders to document AFTO Forms 349 and 350 for installation of the rear spinner, deicing contact ring, and control assembly.

3. Use the proper TO to locate information pertaining to AFTO Form 95 entries.

EQUIPMENT

	Basis of Issue
TO 00-20-2-10	1/student
TO 00-20-5	1/student
TO 1C-130A-06	1/student
TO 1C-130B-2-11	1/student
3ABR42633-WB-301	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Using TO 1C-130B-2-11, answer the following questions and complete the incomplete statements.

1. How do you align the rear spinner to the hub mounting bulkhead? ______________________________

2. How much torque is applied to spinner mounting nuts?

____

3. What is the specification of the varnish that is used to coat the electrical connections? ______________________

Supersedes 3ABR42633-WB-304, 9 January 1980. RGL: N/A
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 400; DAV - 1
Designed for ATC Course Use. Do Not Use on the Job.

4. Before installing the control assembly, number one blade must be set at what degree blade angle? ________________

5. What is the part number of the rigging pin that is used to lock the beta shaft in position? ____________________

6. Why must the two beta shaft adjustment screws be backed off?

____

7. What are the specifications of the lubricant used to lubricate the propeller barrel extension? ____________________ and

____

8. How many bolts and washers are used to attach the slip ring assembly to the barrel? ______________

9. When installing the control assembly using tool P/N HS-7556 or HS-8173, in what direction is the puller handle turned? __________

10. What is used to lock the control assembly into position on the barrel extension bore? ________________________________

Project 2

DIRECTIONS

Using TO 00-20-5, answer the following questions pertaining to AFTO Form 95.

1. What section of the this TO covers the AFTO Form 95 entries?

____

2. What entry is made in column A of the AFTO Form 95?

____

3. What entry is made in block 4 of the AFTO Form 95?

____

Project 3

DIRECTIONS

Using the following information and the applicable references, make the correct entries on the AFTO Form 349 in figure 1.

1. You are assigned to the turbopropeller shop and given the task of installing the control assembly on a propeller that is to be installed on a C-130E,ID number QA-4820, that is assigned to 317 TAW.

2. The job began at 0800 and was completed at 1000 hours.

3. The original discrepancy was No. 3 prop control assembly leaking, which was discovered between flights by the ground crew.

4. The following information is provided to complete the necessary form required for this job.

a. General information:

Job Control Number - Use job control number from WB-301

Priority:	2
Location:	P3
Time Specialist Required:	0800
Job Standard:	2 hours

b. Propeller data:

Part Number:	54H60-91
Serial Number:	N221782
ID:	AA4820
Work Center:	Q3220
Time:	1290.2 hours

c. Pump Housing Data: (Control Assembly)

Part Number:	733872-2
Serial Number:	SE8643
350 Tag No:	148748
Work Center:	Q3220
Time:	00.0 hours
Stock Number:	1610-00-005-8685

d. Aircraft Data:

ID:	QA-4820
Serial Number:	61-4820
Time:	1575.1 hours

MAINTENANCE DATA COLLECTION RECORD

OMB NO 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7 PRI	8. SORTIE NO	9. LOCATION
0030	Q3220							

10. ENG. TIME	11 ENGINE I D	12. INST ENG TIME	13 INST ENG I.D	14.	15	16.	17 TIME SPC MEAS	18 JOB STD

19. FSC	20. PART NUMBER	21 SER NO./OPER. TIME	22 TAG NO	23. INST. ITEM PART NO.	24 SERIAL NUMBER	25 OPER TIME

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

INSTALL PROPELLER CONTROL ASSEMBLY

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 75 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-~~301~~ 305
4 January 1980

INSTALLATION OF PROPELLER ASSEMBLY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to install the 54H60 propeller assembly on the T56 engine gearbox.

INTRODUCTION

One of the most important tasks you can expect to perform on the flightline as a turboprop mechanic is propeller installation. The C-130 propeller requires special care because of the pitch lock parts that must be installed prior to installing the dome.

INFORMATION

PREPARATION

Before installing the 54H60 propeller, several steps are necessary. The shaft must be cleaned, inspected and recoated with oil (hydraulic fluid). After insuring that the thrust nut is properly tight and safetied with a lock ring, install the rear cone and spacer with a new spider to shaft "O" ring seal. The cone is kept dry and free of oil to insure a tight fit when the propeller shaft nut torque is applied.

The drive bracket is checked for wear by temporarily placing it in between the tangs on the back of the propeller control and measuring the clearance must not exceed .050 of an inch. The drive bracket must be installed at the six o'clock position on the nose section of the engine.

The NTS bracket assembly is attached to the nose section of the engine over the plunger at the ten o'clock position. Three screws hold the bracket in place.

The blade gear positioning tool must be removed to install the baseplate. Care must be taken not to turn #1 blade when alignment pins are installed in the valve housing. When the alignment pin is removed from the beta shaft, #1 blade can be turned, but not beyond minus 10° or plus 100° blade angle. The stops on the beta shaft would be broken in case of excessive travel.

Installation on the Shaft

After all the preparation steps are completed, the propeller assembly is hoisted in place on the shaft. The prop retaining nut must have external grooves of the nut. The nut should be hand

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1

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started on the shaft to avoid cross threading. Torque is applied to the nut using the sweeney power wrench. To compute the actual torque, the data plate under the handle is used.

The pitchlock parts are installed after the retaining nut torque has been applied. The pitchlock regulator must have three external preformed packings in place in the proper grooves. The slide hammer type special tool is used to drive the pitchlock regulator in until a solid sound is heard. An externally splined spacer is fitted in place around the regulator to lock he prop retaining nut. The stationary ratchet is installed next with the small dowel pin aligned directly with the center line of number 2 blade. The spider bore is marked with an etch mark to aid in alignment of the ratchet. The control cam (cam out ring) is positioned over the ratchet with the dowel hole aligned to the same etch mark. The pitch lock components are retained in the spider bore by an externally threaded ring and safetied with a retaining ring. With the blades at feather angle the dome can now be installed.

The dome should be checked to insure the stop ring is properly indexed at 92.5° and placed in the feather position. The dome preload shims must be selected in accordance with the thickness etched on the barrel shelf. When installing the preload shims, place them under the serration in the front barrel half. If the location of the dome retaining nut lock screw was marked at removal, the dome retaining nut should be re-installed to line up at the same mark. If not marked, the dome must be installed without the "O" ring seal as directed by the technical order. After the dome is safetied, the dome lifting handle is unscrewed and the dome cap is installed. The cap is safetied with a wire retaining ring. The holes should be marked before putting on the dome cap to allow seating of the lock wire because the holes are not visible with the cap in place.

Connecting Linkage and Electrical Plugs

The universal joint is connected to the input shaft and safetied with safety wire.

AN connectors must be attached to the de-icing brush block, auxiliary motor, solenoid valve, valve housing main connector plug and the pump housing connector plug. Each of the connector plugs must then be safetied with safety wire.

Final steps such as servicing, adjusting the pulse generator and NTS bracket are discussed in Block III of this course. The remaining parts of the spinner and cowling access panels will complete the installation of the propeller.

SUMMARY

The removal and installation of the propeller assembly requires special care. The front of the engine should be properly prepared and necessary units installed before hoisting the prop in place. The retaining nut and pitchlock parts must have their seals in place and then carefully installed. The final steps include servicing, adjusting and installing spinner parts and cowling.

QUESTIONS

1. What parts require a coating of hydraulic fluid prior to installing the prop?

2. Where is the drive bracket mounted? NTS bracket?

3. What precaution must be observed after removing the blade gear positioning tool?

4. What unit acts as the propeller retaining nut lock?

5. Which parts are required to be aligned with #2 blade center line?

6. What procedures are used to insure that both blades and dome are at the same blade angle during propeller installation?

7. Which procedure is used to determine the location of the dome retaining nut safety screw if the location was not marked during disassembly?

8. What type of safety device prevents loss of the dome cap?

9. Name the mechanical and electrical hookups from the prop to the engine.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-304
22 April 1981

INSTALLATION OF PROPELLER ASSEMBLY

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to, working with a group, install the 54H60 propeller assembly on the T56 engine in accordance with TO 1C-130B-2-1.

EQUIPMENT

	Basis of Issue
TO 00-20-2-2	1/student
TO 1C-130A-60	1/student
TO 1C-130B-2-11	1/student
Trainer, Propeller Change	1/5 students
Handtools & Special Tools	1/5 students
Applicable AGE	1/5 students

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Using TO 1C-130B-2-11 and complete the statements and answer the following questions.

1. Before installing the propeller check the condition of the __________ and _________, and _____________ the O-ring seal.

2. What is the maximum clearance allowed between the drive bracket and the torque retainer? ________________

3. What type oils must be used to lubricate packings when installing the propeller retaining nut? __________, _____________, or ________________

4. Tighten the propeller retaining nut to between ____________ and ____________ foot-pounds torque.

Supersedes 3ABR42633-WB-301, 17 January 1980. RGL: N/A
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 400; DAV - 1

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5. How is the locking control cam aligned during installation?

____

6. Place all blades and the dome assembly in the __________ position.

7. List six cautions to be observed during prop installation.

a. ____

____

b. ____

____

c. ____

____

d. ____

____

e. ____

____

f. ____

____

8. To connect the propeller control linkage the engine throttle must be in the ______________ position.

Project 2

DIRECTIONS

Use TO 00-20-2-2 and complete the statements and answer the following questions.

1. Who assigns job control numbers for AFTO Form 349 entries? ______

____

2. An entry is required in Block 6 of the AFTO Form 349 for _______ and ____________ of items identified with an __________ in the work code manual.

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3. When must you enter the time the specialist is required on an AFTO Form 349? ____________________

4. What part number is entered in Block 23 of the AFTO Form 349?

____

5. Does removal and replacement of items identified by the abbreviation TCI in the work unit code manual require any entry in the "RECORDS ACTION" block when completing an AFTO Form 349? __________

Project 3

DIRECTIONS

Use TO 1C-130A-06 and answer the following questions.

1. What action taken code will be entered on the AFTO Form 349 for installing the propeller? __________

2. What is the How mal code for "no defect"? __________

3. What is the work unit code for the complete propeller assembly?

____

Project 4

DIRECTIONS

Using the following information and the applicable references, make the correct entries on the AFTO Form 349 in figure 1.

1. You and a crew of two assistants are dispatched to install the number 3 propeller assembly. The propeller was removed because of leaking, found by the ground crew between flights.

2. The propeller installation began at 1900 hours and was completed at 2300 hours.

3. The following information is provided to complete the necessary form for this job.

a. General Information

Job Control Number - Use job control number from WB-301

Priority:	3
Location:	P2

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	Time Specialist Required:	1900
	Job Standard:	4 hours
b.	Aircraft Data	
	MDS:	C130E, Assigned to 317 TAW
	SN:	61-4820
	ID:	QA-4820
	Time:	1575.1 hours
	Work Center:	Q2115
c.	Propeller Data	
	PN:	PL21403
	SN:	N221782
	Time:	870.2 hours
	Work Center:	Q3220
	ID:	QA1782
	Stock Number:	1610-00-783-5191

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MAINTENANCE DATA COLLECTION RECORD

OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO	9 LOCATION
0030								

10. ENG. TIME	11. ENGINE I.D.	12 INST ENG TIME	13. INST. ENG I.D	14	15.	16.	17 TIME SPC NEU	18. JOB STD

19 FSC	20 PART NUMBER	21 SER NO./OPER. TIME	22 TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25 OPER. TIME

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26 DISCREPANCY

INSTALL No. 3 PROPELLER

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 73 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-305
22 January 1980

DISASSEMBLY AND INSPECTION OF HUB AND BLADE ASSEMBLY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to disassemble and inspect the hub and blade assembly.

INTRODUCTION

After the propeller has been removed, the disassembly of the hub and blades is necessary for either replacement of seals or preparation for shipment to the overhaul facility.

This study guide is designed to familiarize you with the parts to be disassembled.

INFORMATION

The hub and blade assembly consists of two major components. These are the barrel assembly and the blades and their associated parts. When disassembling the hub and blade assembly, there are certain steps which must be followed for safety and FOD prevention.

BARREL ASSEMBLY

The barrel assembly serves as a housing for the entire propeller and retains the blades in the assembly. See figure 1. The barrel is manufactured in two halves. These are machined and balanced as one unit and kept together throughout the service life of the propeller. The rear barrel half has an extension on it to mount the control assembly. Internal splines of the barrel will mate with the splines of the propeller shaft. Front and rear cones center the propeller on the shaft. Oil passages are provided in the front cone by machined out grooves. Barrel bolts hold the barrel halves together. Minor balance adjustment is made by attaching bolts, nuts, and washers on the hub bulkhead and seal assembly. Barrel half seals provide an oil seal between barrel halves. They protrude into the blade seal to prevent any leakage in this area. See figure 1, items 14 and 23.

BLADE ASSEMBLY

The major items that make up this assembly are the: blade; beveled thrust washer; split thrust washer; split roller thrust bearing; blade bushing; balance plug; balance washer or washers; and deicer heater. See figure 2. The blade is forged from a hard aluminum alloy. It is machined and handworked into its final shape. The beveled thrust washer is installed on the blade before the butt is formed. The centrifugal loads generated by the blades are transmitted from the butt through the

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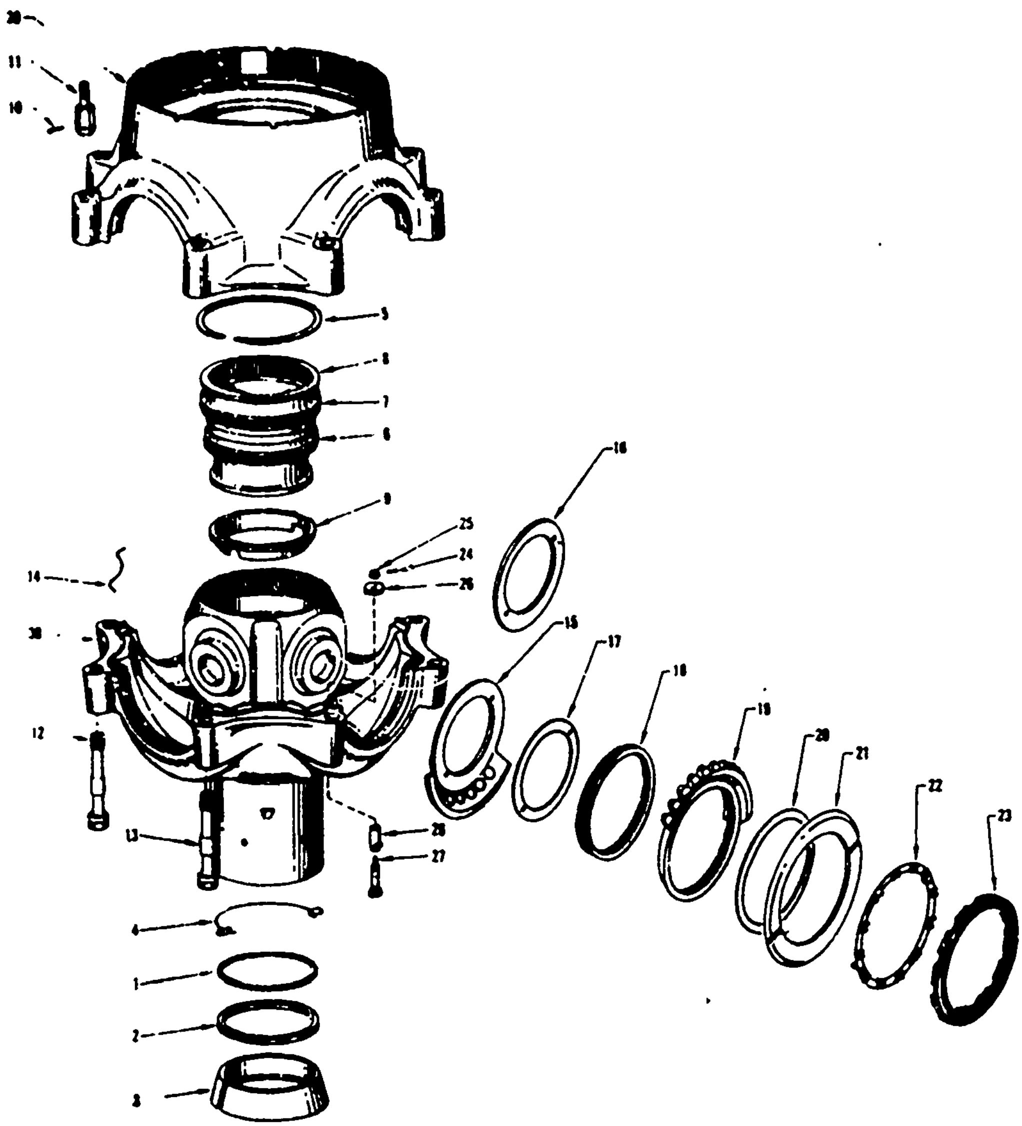
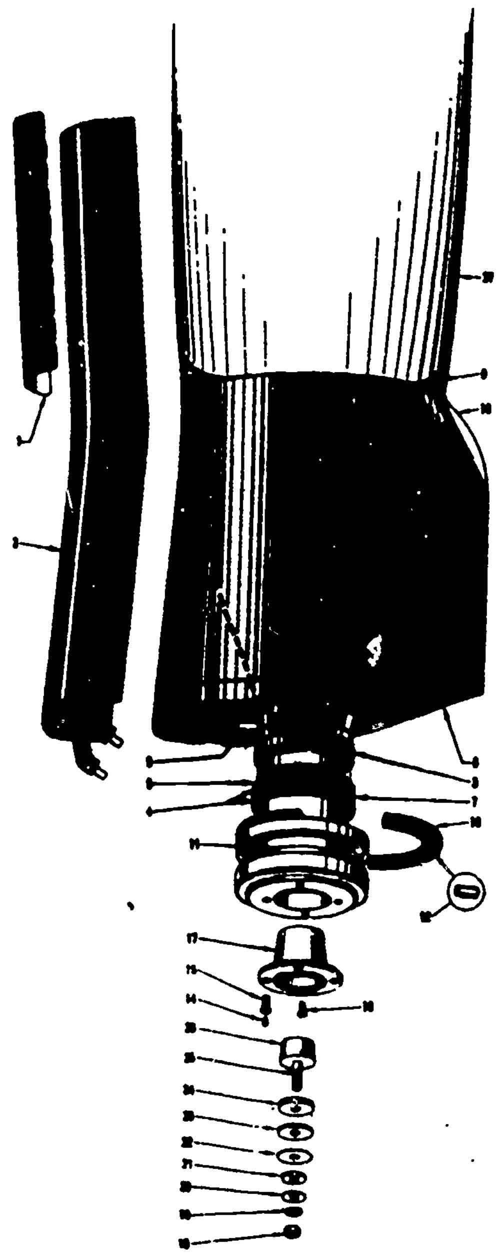


1. Preformed Packing
2. Packing Retainer
3. Rear Cone
4. Pin Retaining Ring
5. Retaining Ring
6. Preformed Packing
7. Preformed Packing
8. Prop Retaining Nut
9. Front Cone
10. Cotter Pin
11. Barrel Bolt Nut
12. Barrel Bolt
13. Barrel Bolt
14. Barrel Half Seal
15. Beta Gear Segment
16. Blade Shim Plate
17. Blade Barrel Shim
18. Micro Adjusting Ring
19. Blade Gear Segment
20. Gear Segment Shim
21. Thrust Washer
22. Packing Lock Ring
23. Preformed Packing
24. Cotter Pin
25. Hex Slotted Nut
26. Spur Gear
27. Beta Feedback Shaft
28. Feedback Gear Bushing
29. Front Barrel Half
30. Rear Barrel Half

Figure 1. Hub Assembly



1. Anti-Erosion Sheath
2. Blades Deicer Heater
3. Rubber Strip Seal
4. Electrical Contact Rings
5. Insulation Sheath
6. Special Purpose Cable Assembly
7. Electrical Contact Ring Holder
8. Rubber Fairing Boot
9. Coverstock
10. Formed Fairing
11. Friction Reduction Strip (Teflon)
12. Crowned Roller
13. Thrust Bearing Retainer
14. Shim Plate Drive Pin
15. Drive Pin
16. Flat Head Screw
17. Blade Bushing
18. Hex Head Nut
19. Lock Washer
20. Flat Washer
21. Plain Washer
22. Flat Lead Washer
23. Flat Lead Washer
24. Flat Lead Washe-
25. Stud
26. Plug
27. Blade

Figure 2. Blade Assembly

beveled thrust washer, split roller thrust bearing and split thrust washer. A portion of the shank is hollow and bored to size. This is done to lighten the blade, to provide for major balance and make room for the blade bushing. The blade plug prevents oil from entering the hollow blade shank. The bushing is secured to the blade butt by two flathead screws and four drive pins. Two of the drive pins aline the bushing to the blade. The other two are used to locate the blade shim. The flange of the bushing is splined to receive the micro adjusting ring.

The blade plug incorporates a stud onto which washers are installed to accomplish major balance. The fairing or cuff is designed to streamline the blade. It will also direct the flow of air into the engine. The fairing is made of a plastic foam (lock foam) and covered with nylon reinforced rubber. The inboard end of the fairing is sealed with a rubber boot. It is indented on the butt face to provide a recess for the deicer heater head straps. The purpose of the heater is to prevent ice from building up on the blades. The micro adjusting ring that attaches to the bushing has both internal and external splines. The micro adjusting ring provides for small angle adjustment between the blade gear segment and the blade. The blade gear segment is held in place by its internal splines mating with the external splines on the micro adjusting ring. The blade gear segment meshes with the gears on the rotating cam in the dome assembly. The dome provides the force needed for changing blade angle. The shim and shim plate are used to obtain proper fit to the blades in the barrel assembly. A beta gear segment is used in place of the shim plate on the number one blade. It transmits blade angle position to the control assembly through the feedback gear. This gear is in the rear barrel assembly. The adjustments that will be required on the propeller are: the blade shims selection; gear segment shim selection; and indexing the gear segment and micro adjusting ring.

The propeller hub is the foundation for the propeller and retains the blades to the assembly. The aluminum blades will change pitch under the turning force created by the dome assembly. The low pitch stop lever assembly will stop blade angle travel at flight idle, but will allow travel into the beta range.

Anti-icing and deicing provisions are provided on the propeller blades and spinner. This will eliminate the possibility of icing conditions affecting the operation of the propeller.

QUESTIONS

1. Where is the propeller control mounted?

2. How does the front cone provide oil passages?

3. How is minor balance accomplished on the 54H60?

4. Why is the flange in the blade bushing splined?

5. What is the purpose of the micro adjusting ring?

6. Name two purposes of the blade plug.

7. What is the purpose of the beta gear segment?

8. What is the purpose of the blade heater?

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-305
13 February 1980

DISASSEMBLY AND INSPECTION OF HUB AND BLADE ASSEMBLY

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate procedures listed in the applicable technical order for disassembly and inspection of a 54H60 propeller.

2. Identify safety practices, FOD prevention, and special tools pertaining to disassembly and inspection, of a 54H60 propeller.

3. Use applicable publications and forms to document disassembly and inspection of a 54H60 propeller.

EQUIPMENT

	Basis of Issue
3ABR42633-HO-300	1/student
TO 00-20-2-10	1/student
TO 1C-130A-06	1/student
TO 3H1-18-2	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Use TO 3H1-18-2 to answer the following questions.

1. What section of TO 3H1-18-2 will list the different data sheets for the 54H60 propeller? ______________________

2. What figure of TO 3H1-18-2 will list the weight of the A propeller blade? ______________

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

RGL: N/A

Designed for ATC Course Use. Do Not Use on the Job.

3. What section of TO 3H1-18-2 will list the inspection requirements for 54H60 propeller hub and blade assembly? ________________

4. What paragraph of TO 3H1-18-2 will list blade damage inspection? ________________

5. During a visible inspection of the propeller blade, what are types of damage will you be looking for on a blade surface? __________

____

6. What are the types of damage you will be inspecting on blade heaters? ____

7. What paragraph of TO 3H1-18-2 will list major characteristics of 54H60 propeller? ____

Project 2

DIRECTIONS

Use TO 3H1-18-2 to answer the following questions.

1. What section of TO 3H1-18-2 will list the special tools required for disassembly of the propeller hub and blades? ________________

2. What is the part number of the 54H60 propeller barrel half puller? ________________________

3. What is the nomenclature of the assembly which the propeller is placed on during disassembly? ____________________________

4. What is the part number of the work handle? ______________

5. What is the nomenclature of the assembly used to lift a propeller blade? ____

6. What is the nomenclature of the special tool used to measure the depth of damage on a blade surface? ________________________

Project 3

DIRECTIONS

Use TOs 00-20-2-10, 1C-130A-06, and HO-300 to answer the following questions pertaining to AFTO Forms 349 and 350 entries.

1. What is the work unit code for the hub and blade assembly of a 54H60-91 propeller? ____________________

2. What entry is made in block 20 of the AFTO Form 349 for disassembling the hub and blade assembly? ____________________

3. What is the section of TO 00-20-2-10 that lists the AFTO Form 349? ____________________

4. What form is required to be submitted along with the AFTO Form 350 and attached to the hub and blade assembly? ____________________

5. What is the standard reporting designator for a C-130E assigned to 317 TAW? ____________________

6. What is the category labor code for military personnel working eight (8) hours on disassembly and inspection of the hub and blades?

____

7. What technical order will list the type maintenance, action taken, and when discovered codes? ____________________

Project 3

DIRECTIONS

Use TOs 00-20-2-10 and 1C-130A-06, and HO-300 to complete the AFTO Form 349 in figure 1.

The propeller assembly was removed for vibration on the ground. The propeller is in the shop for disassembly and inspection. Federal stock class 1610; part number 54H60-91; serial number N221350; tag number 901252; and four people were required to complete the disassembly.

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MAINTENANCE DATA COLLECTION RECORD

OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION
	Q3220	QA 7842				3		SHOP

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPC RQD	18. JOB STD.
							0715	8.0

19. FSC	20. PART NUMBER	21. SER NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO	24. SERIAL NUMBER	25. OPER. TIME

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

DISASSEMBLE AND INSPECT PROPELLER HUB AND BLADES

27. CORRECTIVE ACTION

28. RECORDS ACTION

AFTO FORM MAY 78 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-306
22 January 1980

ASSEMBLY AND CHECK OF THE HUB AND BLADE ASSEMBLY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to assemble and check the hub and blade assembly.

INTRODUCTION

By taking extra care during assembly of the propeller, such as seating the seals properly, installing the parts correctly, etc., less trouble will be encountered later on during operation.

INFORMATION

When assembling the hub and blade assembly, each step listed in TO 3H1-18-2 must be followed in order to prevent damage to the propeller assembly. These procedures are to insure that safety and FOD procedures are followed during assembling of the hub and blade.

ASSEMBLY OF PROPELLER

Various components of the propeller are numbered to indicate their assembled location. It is imperative that these parts shall be installed in their correct positions in order to obtain proper fits and balance of the propeller. The blade butt, gear segment shim, micro adjusting ring, blade gear segment, blade barrel shim, blade shim plate, and each half of each split thrust washer. The front barrel half bolt holes are numbered and each barrel bolt is marked with the barrel bolt hole number. Each barrel half is marked with the blade position numbers.

During assembly of the propeller, the propeller blade angle shall be measured with the blade angle protractor and the blade checking template, unless otherwise specified. The blade angle shall be measured at the blade reference station which is the 42 inch station for this propeller. The reference station is marked on the blade face with a chordwise paint stripe. It also may be located by measuring from the propeller axis a distance of 42.875 inches (42 in. plus a hub allowance factor of 7/8 in.). All blade angles referred to are the effective aerodynamic angles which are the angles actually measured plus or minus the correction angles. The correction angle is painted on the camber side of the blade and also marked on the blade butt. The plus or minus sign appearing before the correction angle indicates that the correction angle shall be added to or subtracted from the blade angle actually measured. Normally, however, the proper position of the micro adjusting ring and blade gear segment is

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1

marked when the propeller is new or <u>overhauled</u>. At that time, the blade angle correction factor is applied to the acutal measurement at the feather position to arrive at the aerodynamic angle. Then, if necessary, the ring and segment are positioned to obtain an aerodynamic angle within specification. Etch marks across the blade bushing, micro adjusting ring and blade gear, provide the alignment during propeller build up.

During assembly of the propeller, all visible preformed packings and their mating surfaces shall be lubricated with hydraulic fluid, Military Specification MIL-H-6083 Type I, unless otherwise specified.

> Caution: During assembly of the propeller, use care when turning the blades without the dome being installed to ensure that the blade gear segments do not contact each other or the barrel walls so as to cause damage.

INDEXING GEAR SEGMENT AND MICRO ADJUSTING RING

The micro adjusting ring is a vernier adjustment used to correct variations in blade thrust. Variations of airfoil effecting thrust are the result of each blade being individually machined and hand worked during manufacture. The micro adjusting ring corrects this variation by raising or lowering individual blade angle to achieve the desired thrust. See figure 1.

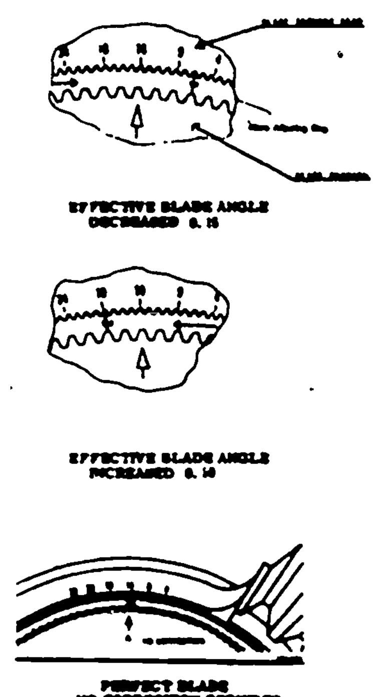

Figure 1. Indexing of Micro Adjusting Ring and Blade Gear Segment.

Other adjustments required on the propeller are the blade track, blade backlash, and the propeller balance.

Remember when assembling the propeller it is imperative that the parts are installed in their correct positions in order to obtain proper fit and balance of the propeller.

All parts must be clean and free of contaminating particles and some of the parts are coated with hydraulic fluid or grease.

BLADE TRACK CHECK

Using four HS 6762 blade turning bars, unfeather the propeller by turning all blades simultaneously toward low pitch. Turn the blades to flat pitch so that the face of one blade, about 3-4 inches from the blade tip, is about parallel with the assembly bench. Establish a reference point on the bench which is directly beneath the blade centerline and 3-4 inches in from the blade tip. Rotate the propeller so that each blade in turn will be in the same position over the reference point and measure the distance from each blade centerline to the reference point. All blades of a propeller not installed on an aircraft shall track within 13/32 inches of each other.

BLADE BACKLASH CHECK

a. Using two HS 6762 blade turning bars, turn the blades to 45 degrees, measuring the blade angle as previously described.

b. Using a blade turning bar, check the backlash of each blade by first turning the blade in one direction and measuring the blade angle, and then turning the blade in the other direction and measuring the blade angle.

c. The difference between the two measurements of each blade shall not exceed 0.50 degrees. If the backlash is not as specified, check for the proper thickness of the gear preload shims and the proper assembly of the numbered parts which are installed on the blade shanks.

d. When the backlash is within limits, install the HS 7597 dome lifting handle in the dome cap threads. Loosen the dome retaining nut with the HS 7967 dome retaining nut wrench. Using a hoist, lift the dome off the propeller and set it down carefully to avoid shifting of the rotating cam. Remove the gear preload shims from the barrel shelf.

PROPELLER BALANCE CHECK

Horizontal Balancing

If the propeller has just been overhauled, the balancing bolts, washers, and nuts will be furnished with the propeller along with a WRNE Sketch No 386 chart or equivalent. Use the chart to locate the balancing bolts and nuts, and the proper amount of washers per bolt, on the hub mounting bulkhead assembly. This assembly must now be used with this propeller and balancing is not necessary.

QUESTIONS

1. What is the purpose of the blade micro adjusting ring?

2. Where is the micro adjusting ring located?

3. What is meant by blade correction angle?

4. What component of the blade assembly is affected when the micro ring is moved one large tooth (.05°)?

5. Which parts have blade arm bore numbers marked on them?

6. During assembly of the propeller what is used to make blade angle measurements?

7. What is used to coat preformed packings used in assembly of the propeller?

8. Where is the gear segment index #14 located when properly mounted? (See figure 1.)

9. What may happen if the blades are carelessly turned while the dome is removed?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-306
11 February 1980

ASSEMBLY AND CHECK OF THE HUB AND BLADE ASSEMBLY

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate procedures listed in the applicable technical order for assembly and check of the hub and blade assembly of a 54H60 propeller.

2. Identify safety practices, FOD prevention, torque limits pertaining to assembly, and check of the hub and blades.

3. Use applicable publications and forms to document assembly and check of 54H60 propeller.

EQUIPMENT

	Basis of Issue
3ABR42633-HO-300	1/student
TO 00-20-2-10	1/student
TO 1C-130A-06	1/student
TO 3H1-18-2	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Use TO 3H1-18-2 to answer the following questions:

1. What section of TO 3H1-18-2 lists the procedures for assembling the 54H60 propeller? __________

2. What section of TO 3H1-18-2 lists the tools and equipment for assembling the 54H60 propeller? __________

3. What is the specification of grease used to coat each blade packing prior to installation on the blade shank? ____________

OPR: 3350 TCHTG
RGL: N/A
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

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4. What paragraph in TO 3H1-18-2 lists the approved cleaning method of a 54H60 propeller? ________

5. What is the specific caution concerning the Teflon strip during blade installation? ____

____

6. How are the barrel bolt bosses identified? ____________

____

7. What is the specific caution stated in the technical order concerning barrel half alignment? ______________________________

8. What paragraph in the technical order states the procedures for tightening the eight (8) extension studs on the barrel bolts?

____

9. What is used to lift the blades into the rear barrel half to prevent damage to the blade butt? __________________________

10. What component(s) of the blade assembly must be clean prior to installing the blade into the barrel half? ________________

____

11. What are the three blade checks listed in the applicable technical order? ____

____

12. What are two shim sizes supplied with the propeller assembly for gear preload? ________________________________

13. What type of tool is used to drive the barrel bolts into the barrel halves? ____

14. When installing the blades, what are the turning limits of number one blade? ____
Why? ____

15. How is the bevel thrust washer aligned? ______________

____

16. When installing barrel bolts, how are they torqued?

____

17. How should the thrust bearing retainers be positioned?

____

Project 2

DIRECTIONS

Use TOs 00-20-2-10 and 1C-130A-06 and HO-300 to answer the following questions:

1. What is the when discovered code used during assembling a propeller that was withdrawn from Supply? ____________

2. What is the action taken code for assembling a propeller that was withdrawn from Supply? ____________

3. During assembly of a 54H60 propeller, are AFTO Forms 349 and 350 required for documenting equipment maintenance action?

______

4. What is the work unit code used for assembling a propeller that was withdrawn from Supply? ____________

5. How many line entries are completed on the AFTO Form 349 for a crew that has three military and two civilians assembling a propeller? ______

6. What is the type maintenance code used for assembling a propeller that was withdrawn from Supply? ____________

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-307
22 January 1980

DISASSEMBLY AND ASSEMBLY OF DOME ASSEMBLY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to disassemble and reassemble the dome assembly and locate the procedures in the applicable technical order.

INTRODUCTION

The turbopropeller dome is retained to the front barrel half by a detachable retaining nut. The dome is held stationary to the barrel by serrations instead of dowel pins. It is aligned by a machined out portion of the barrel threads and a lug on the dome shell.

INFORMATION

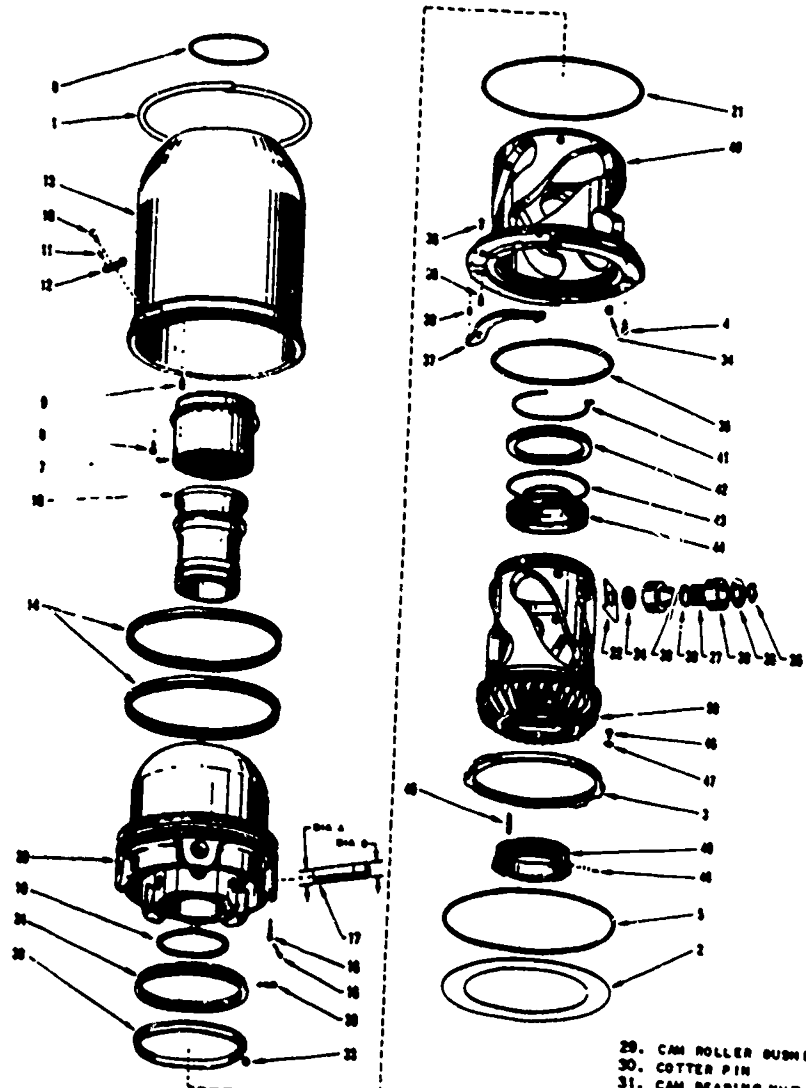
The dome assembly contains the mechanical components to change propeller blade pitch and to limit the range of travel between feather and reverse. The dome assembly is hydraulically actuated and controlled by hydraulic pressure.

The dome (shell) encloses the internal parts of the dome and is held in place by the dome retaining nut and four special screws (shoulder screws). See figure 1, item 4. Inside the front end is the lever sleeve bushing (item 7) which supports the low pitch stop lever assembly.

The stationary and rotating cams serve the same function on this propeller as other hydromatic propellers. The cam assemblies are held together by a cam bearing nut. See figure 1, item 31. There are 5 cam roller tracks instead of 4. This distributes the pitch change loads of the dome assembly more evenly. The cam rollers have only 2 sets of rollers and 2 sets of needle bearings. See figure 1, items 22 thru 29. The cam roller assemblies will not accidentally come apart during disassembly. The thrust washers are pressed on the roller shaft ends to keep the assembly in one piece.

The dome piston has 2 "quad" seals. These are square type seals to prevent internal leakage between the piston and the dome shell. A bleed hole drilled between the quad seals lubricates them and prolongs their service life.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1



1. THRUST RING
2. GEAR PRELOAD SHIM
3. STOP RING
4. SHOULDER SCREW
5. PREFORMED PACKING O-RING
6. CAP SCREW
7. LEVER SLEEVE BUSHING
8. PREFORMED PACKING, O-RING
9. STRAIGHT HEADLESS PIN
10. RIVET
11. STRAIGHT HEADLESS PIN
12. DOME LUG
13. PROPELLER DOME
14. PREFORMED PACKING, QUAD RING
48. STRAIGHT HEADLESS PIN

15. COTTER PIN
16. SET SCREW
17. CAM ROLLER SHAFT
18. RETAINING RING
19. PISTON SLEEVE
20. PISTON
21. PREFORMED PACKING, O-RING
22. WEAR PLATE
23. RETAINING RING
24. CAM ROLLER THRUST WASHER
25. CAM ROLLER THRUST WASHER
26. ROLLER BEARING
27. CAM ROLLER NEEDLE
28. CAM ROLLER NEEDLE SPACER
49. ROTATING PITCH LOCK RATCHET

29. CAM ROLLER BUSHING
30. COTTER PIN
31. CAM BEARING NUT
32. BALL RACE
33. BALL BEARING
34. BALL BEARING
35. PREFORMED PACKING O-RING
36. RIVET
37. FEATHER LOCK
38. STRAIGHT HEADLESS PIN
39. STRAIGHT HEADLESS PIN
40. STATIONARY CAM
41. RETAINING RING
42. EXTERNALLY THREADED RING
43. PREFORMED PACKING O-RING
44. PITCH LOCK BULKHEAD
45. HELICAL COMPRESSION SPRING
46. MACHINE BOLT
47. LOCK LUG
50. ROTATING CAM

Figure 1. Dome Assembly.

Only one stop ring is used to set the blade angles. This is the feather stop ring. See figure 1, item 3. It has a double set of lugs. One set is for feather angle and one set for mechanic reverse angle. The stop ring is indexed to the rotating cam by aligning the index number 14 on the stop ring to the tooth representing 92.5 degrees on the rotating cam. This will also set the mechanical reverse blade angle limit to a -9 degrees. The desired reverse angle will be scheduled by the control assembly. It will hydraulically be held at an angle of -7 degrees. The blades will stop at feather angle when the stop ring lugs contact the lugs on the stationary cam. Feather locks will engage with the stop ring and hold the rotating cam at this setting. See figure 1, item 37.

During flight, an attitude change of the aircraft could cause the propeller blades to move out of feather. To prevent this, the propeller is locked at feather by the feather locks. Only when oil pressure is applied to the piston can the propeller be unfeathered.

SUMMARY

The dome is the pitch changing mechanism for the 54H60 propeller, just as it was for the earlier types. Changes and improvements are found in many parts of the dome. Blade angles are limited at feather and reverse by lugs on the stop ring. Feather locks hold blades to prevent vibration or wind currents from unfeathering the prop accidentally.

QUESTIONS

1. What is the purpose of the lever sleeve bushing?

2. What is the purpose of the bleed hole between the dome piston "Quad Seals?"

3. How are the blades held in feather position if used during flight?

4. What holds the rotating and stationary cams together?

Note: Use figure 1 and name the following parts which:

5. Provides a mounting place for the stop lever assembly.

6. Sets mechanical reverse and feather angles.

7. Adjusts rotating cam gear to blade gear clearance.

8. Prevents leakage between dome and barrel (give index No.).

9. Prevents loss of blade angle in case of 103% overspeed.

10. Provides adjustment between rotating cam gear and blade gears.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-307
11 February 1980

DISASSEMBLY AND ASSEMBLY OF DOME ASSEMBLY

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate procedures listed in the applicable technical order for disassembling and assembling of the dome assembly.

2. Identify torque limits, safety procedures, and FOD prevention procedures pertaining to disassembling and assembling the dome assembly.

3. Use applicable publications and forms to document disassembly and assembly of the dome assembly.

EQUIPMENT

	Basis of Issue
3ABR42633-HO-300	1/student
TO 00-20-2-10	1/student
TO 1C-130A-06	1/student
TO 3H1-18-3	1/student

PROCEDURE

Follow the directions given for each project in this workbook.

Project 1

DIRECTIONS

Use TO 3H1-18-3 to answer the following questions:

1. What section of TO 3H1-18-3 lists the procedures for disassembling the dome assembly? ________

2. What section of TO 3H1-18-3 lists the required special tools used for disassembling the dome assembly? ________

3. What is the figure number of dome assembly as listed in the list of illustrations? ________

4. What are the three (3) types of inspections performed on the dome assembly after disassembly? ____________________________

____

5. What is the specific safety warnign concerning removal of the dome shell? ____________________________

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

RCL: N/A

Designed for ATC Course Use. Do Not Use on the Job.

6. What special tool is used to remove the cam roller shafts? ____________________

7. What special tool is used to remove the externally threaded ring? ____________________

8. What paragraph in TO 3H1-18-3 lists the procedures for cleaning the metal parts of the dome assembly? ________

9. What is used to coat the metal parts of the dome assembly to prevent corrosion? ____________

10. What is the specific warning concerning use of methyl ethyl ketone? ____________________

11. What type of consumable supplies are used to coat the 65 steel balls during assembly of the dome? ____________

12. Why must the "0" marking be aligned during assembly of the stationary and rotating cams? ____________________ ____________________

13. What is the torque applied to the cam bearing nut? ________

14. What safetying hardware is used to secure the cam bearing nut? ____________________

15. What is used to coat the dome shell and piston packings? ____________________

16. What is the torque of the shoulder screws used to secure the dome shell to the stationary cam? ____________

17. What part of the dome assembly sets the feather and reverse angles? ____________________

Project 2

DIRECTIONS

Using TOs 00-20-2-10 and 1C-130A-06 and HO-300, answer the following questions:

1. What is the type maintenance code for a dome assembly removed for internal leakage during a major inspection? ________

2. What is the action taken code for replacing the preformed packings on a dome assembly? ________

3. What is the work unit code used for replacing the preformed packings on a dome assembly? ________

4. What is the how malfunction code for a dome assembly with internal leakage? ________

5. What is required to document the work completed on a dome assembly? ______________________________

6. What is the standard reporting designator (SRD) for a propeller dome assembly removed from a C-130E at the 374 TAW?

____

7. What is the category labor code used to document two hours overtime on reassembling the dome? ________

766

Project 3

DIRECTIONS

Using TOs 00-20-2-10 and 1C-130A-06 and HO-300, complete the AFTO Form 349 in figure 1.

You have disassembled and reassembled the propeller dome, replaced all the preformed packings for internal leakage. The discrepancy was found during minor inspection.

MAINTENANCE DATA COLLECTION RECORD — OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION
	Q3220	QAT891				3		SHOP

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPC REQ	18. JOB STD.
							0800	4.0

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER. TIME
1610	548546		350			

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ALT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

NO. 2 PROP WILL NOT GO TO FEATHER (INTERNAL LEAKAGE)

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 73 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-308
22 January 1980

DISASSEMBLY AND ASSEMBLY OF LOW PITCH STOP AND PITCH LOCK REGULATOR

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to disassemble and reassemble the low pitch stop lever and pitch lock regulator assembly.

INTRODUCTION

You will be working with the internal parts of the propeller assembly, low pitch stop lever, and pitch lock regulator assemblies. During the disassembly and reassembling of the low pitch stop lever and pitch lock regulator assemblies, the procedures in the technical order must be followed without any deviation. This is to insure that these components operate trouble-free to control the propeller.

INFORMATION

The Hamilton Standard propeller has two main components which control blade movement into the ground range and to restrain overspeeding of the engine and propeller unit. When disassembling or reassembling the low pitch stop lever or pitch lock regulator, the safety and FOD procedures must be followed to prevent damage to the components.

LOW PITCH STOP ASSEMBLY

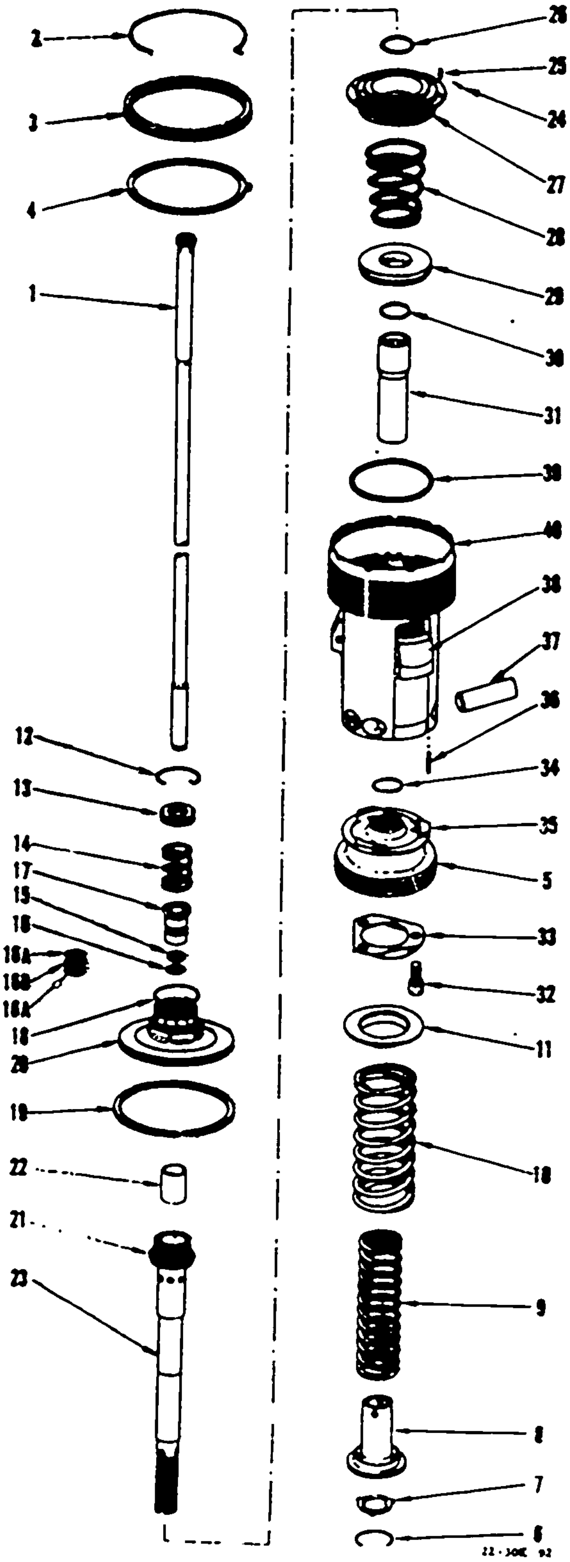
The low pitch stop lever assembly will stop the blade angle travel at flight idle. See figure 1. Flight idle is the lowest blade angle that can be reached in the flight range. Further blade angle will not occur until oil pressure shifts the servo valve in the low pitch stop lever. Once the servo valve shifts, the oil pressure is exerted against the servo piston. Movement of the servo piston will cause the wedge to move from behind the stop levers. The force of the oil pressure acting on the dome piston will force the stop levers inward. This will allow the dome piston to travel into the beta range. The beta range is used for taxiing and ground handling of the aircraft. Blade angle movement from top of beta to maximum reverse is controlled by the throttle lever in the cockpit.

PITCH LOCK REGULATOR

The pitch lock regulator assembly, see figure 2, is located within the propeller retaining nut. It is secured in position by the following:

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1

Designed for ATC Course Use. Do Not Use on the Job.



KEY TO FIGURE 1

1 Fluid Transfer Tube
2 Retaining Ring
3 Externally Threaded Ring
4 Key Washer
5 Preformed Packing
6 Snap Ring
7 Retaining Ring
8 Stop Return Spring Seat
9 Helical Compression Spring
10 Helical Compression Spring
11 Spring Guide
12 Retaining Ring
13 Spring Nut
14 Helical Compression Spring
15 ID Channel Seal
16 Preformed Packing
16A Packing Retainer
16B Preformed Packing
17 Servo Piston Valve
18 Retaining Ring
19 Piston Ring
20 Servo Piston
21 Preformed Packing
22 Servo Valve Seat
23 Servo Piston Shaft
24 Cotter Pin
25 Set Screw
26 Preformed Packing
27 End Plate
28 Helical Compression Spring
29 Piston Wedge
30 Preformed Packing
31 Wedge Stop
32 Socket Head Cap Screw
33 Lock Plate
34 Preformed Packing
35 Lever Sleeve Cover
36 Headless Straight Pin
37 Lever Pin
38 Piston Stop Lever
39 Preformed Packing
40 Lever Support Sleeve

Figure 1. Low Pitch Stop Assembly.

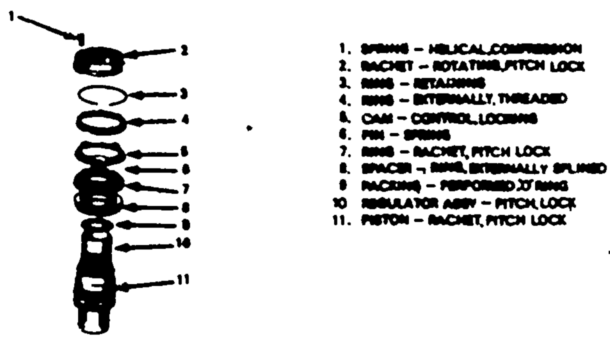


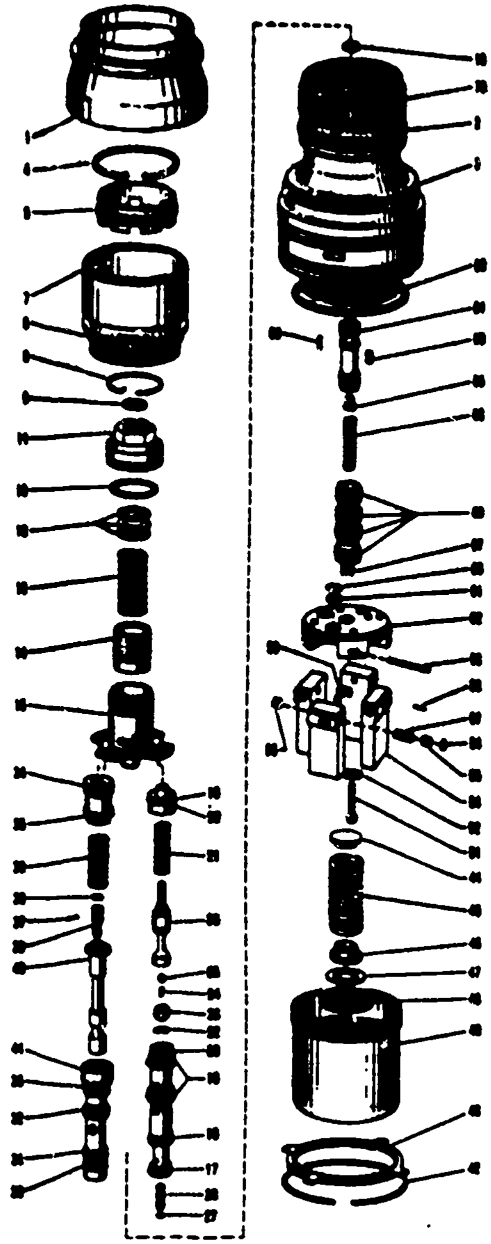
Figure 2. Pitch Lock Regulator and Components.

an external splined ring; a spacer; the stationary pitch lock ratchet ring and pin; and a pitch lock control cam. All these components are secured by an external threaded ring and retaining ring. The principle components of the pitch lock regulator assembly, see figure 3, are as follows: servo valve, pressure regulating and pressurizing valve, surge valve, pitch lock flyweight assembly, shuttle valve, and pressurizing valve. The surge valve functions only when excessive decrease pitch oil pressure is present as during reversing. At reverse, the surge valve will be actuated and drain the excessive pressure into the increase pitch pressure line. This oil will return to the control. The other valves in the pitch lock regulator function during operations that pertain to the regulator.

The purpose of the pitch lock regulator assembly is to restrain the over-speeding of the engine-propeller unit. This may occur in the event of a loss of oil pressure or during an over-speeding condition. The regulator does this by actuating a ratchet secured to the rotating cam. The rotating cam ratchet meshes with a stationary ratchet splined to the barrel bore. This prevents a further decrease in blade angle. This action occurs at 103 to 104% which is a few percent above normal speed. A higher blade angle may be obtained at any time for feathering or regaining control of the propeller.

The ratchets are normally kept disengaged by oil pressure acting on the pitch lock piston. A mechanically operated "cam-out" system disengages the ratchets at blade angles of 25 degrees and lower or 55 degrees and higher, when no pitch lock is needed. Between these blade angles the ratches will engage when the oil pressure acting on the pitch lock piston is removed. This may occur due to loss of pressure by action of the fly-weight controlled servo valve and flapper valve. The flyweights and flapper valve are actuated when the rpm increases to 103%. This permits the pressure acting on the pitch lock piston to drain into the barrel allowing the ratchet teeth to engage. After oil pressure is restored and constant speed operation is resumed, the pitch lock ratchet teeth are disengaged from normal operation.

1 ROTARY PISTON
2 PREFORMED PACKING
3 PREFORMED PACKING
4 RETAINING RING
5 SLOTTED LOCK RING
6 PREFORMED PACKING
7 FLUID TRANSFER HOUSING EXTENSION SLEEVE
8 LOCK RING
9 PREFORMED PACKING
10 PREFORMED PACKING
11 RETAINING CAP
12 SHIM
13 HELICAL COMPRESSION SPRING
14 [illegible] VALVE PLUNGER
15 VALVE HOUSING
16 PREFORMED PACKING
17 PREFORMED PACKING
18 PREFORMED PACKING
19 PREFORMED PACKING
20 VALVE HOUSING CAP
21 HELICAL COMPRESSION SPRING
22 RETAINING RING
23 SPRING SEAT
24 HELICAL COMPRESSION SPRING
25 STAINLESS STEEL BALL
26 PLUNGER
27 RETAINING RING
28 SHUTTLE VALVE
29 SHUTTLE AND PRESSURIZING VALVE HOUSING
30 PREFORMED PACKING
31 PREFORMED PACKING
32 PREFORMED PACKING
33 PREFORMED PACKING
34 PREFORMED PACKING
35 PRESSURE REGULATOR GUIDE CAP
36 HELICAL COMPRESSION SPRING
37 SPRING PIN
38 PREFORMED PACKING
39 BARREL BLEED STRAINER
40 PRESSURE REGULATOR PLUNGER
41 PRESSURE REGULATOR PLUNGER GUIDE
42 RETAINING RING
43 INTERNAL SPLINED KEYED RING
44 FLUID FLOW RESTRICTOR ✦
45 HELICAL COMPRESSION SPRING
46 PITCH LOCK SPRING SEAT
47 FLAT DISC ELEMENT
48 DISC SEAT
49 PITCH LOCK WEIGHT COVER
50 PREFORMED PACKING
51 CAP SCREW
52 FLAT WASHER
53 STRAIGHT HEADLESS PIN
54 THRUST WASHER
55 NEEDLE ROLLER BEARING
56 PITCH LOCK WEIGHT ARM
57 PITCH LOCK WEIGHT SPACER
58 SPRING PIN
59 PITCH LOCK WEIGHT
60 RETAINING RING
61 FABRIC AND WIRE RING
62 PITCH LOCK WEIGHT MOUNT
63 PREFORMED PACKING
64 PITCH LOCK REGULATOR PLUNGER
65 FLUID FLOW RESTRICTOR
66 HELICAL COMPRESSION SPRING
67 PITCH LOCK VALVE SLEEVE
68 SPRING PIN
69 SCREW THREAD INSERT
70 PITCH LOCK HOUSING



✦ flapper valve

Figure 3. Pitch Lock Regulator.

QUESTIONS

1. What is the purpose of the low pitch stop assembly?

2. What valve allows oil pressure to be exerted against the stop lever servo piston?

3. Describe what happens when the stop lever servo piston moves.

4. What is the blade angle travel range when the stop levers are retracted within the piston sleeve?

5. What holds the pitch lock teeth disengaged during flight range?

6. What prevents the pitch lock teeth from engaging during the beta range?

7. Under what two conditions will the pitch lock ratchet teeth be allowed to engage during flight?

In questions 8, 9, and 10, use figure 3, Pitch Lock Regulator.

8. Which part receives the aft end of the oil transfer tube?

9. Name the part which converts oil pressure to forward movement to release the pitch lock ratchet.

10. Which part encloses the pitch lock spring and flyweights?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-308
11 February 1980

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DISASSEMBLY AND ASSEMBLY OF LOW PITCH STOP AND PITCH LOCK REGULATOR

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate procedures listed in the applicable technical order for disassembly and assembly of the low pitch stop lever and pitch lock regulator.

2. Identify torque limits, special tools, FOD procedures, and safety procedures pertaining to disassembly and assembly of the low pitch stop lever and pitch lock regulator.

3. Use applicable publications and forms to document disassembly and assembly of the low pitch stop lever and pitch lock regulator.

EQUIPMENT

	Basis of Issue
3ABR42633-HO-300	1/student
TO 00-20-2-10	1/student
TO 1C-130A-06	1/student
TO 3H1-18-3	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Use TO 3H1-18-3 to answer the following questions:

1. What section of the technical order lists disassembly and assembly of the low pitch stop lever assembly? ________

2. What paragraph in the technical order lists the instructions for disassembling the low pitch stop lever assembly? ________

3. What is the table number for identifying the tools required to disassembly the low pitch stop lever and pitch lock regulator? ________

OPR: 3350 TCHTG
RGL: N/A
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1
Designed for ATC Course Use. Do Not Use on the Job.

What special tool is used to remove the servo valve spring nut? ____________________

5. What are the two (2) special wrenches used to remove the servo valve? ____________________

6. What paragraph in TO 3H1-18-3 lists the procedures for disassembling the pitch lock regulator? ________

7. What specific FOD procedures must be followed during disassembly and assembly of the pitch lock regulator? ____________________

____

8. What is the special wrench used to remove the pitch lock weight cover? ____________________

9. What is the torque of the socket head screws that hold the flyweight assembly in the pitch lock housing? __________

10. What is the torque applied to the fluid transfer housing extension sleeve? __________

Project 2

DIRECTIONS

Using TOs 00-20-2-10 and 1C-130A-06 and HO-300, answer the following questions pertaining to AFTO Forms 349 and 350 entries.

1. What is the work unit code for a pitch lock regulator?

____

2. What part of the low pitch stop lever is a time change item? __________

78

774

Project 3

DIRECTIONS

Use TOs 00-20-2-10 and 1C-130A-06 and HO-300 to complete the AFTO Form 350 in figure 1.

The low pitch stop lever assembly was removed from aircraft 63-7767, assigned to 62 MAW, during a major inspection.

AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU NO. 21-R0227

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO.	2. ID/SERIAL NO.	3. TM	3A. SRD	4. WHEN DISC

5. HOW MAL	6. MDS	7. WORK UNIT CODE	8. ITEM OPER. TIME	9. QTY.
	C-130E			

10. FSC	11. PART NUMBER
1610	582779

12. SERIAL NUMBER	13. SUPPLY DOCUMENT NUMBER

14. DISCREPANCY

NO. 3 PROP LOW PITCH STOP QUAD SEAL DUE TIME CHANGE

15. SHOP USE ONLY

15A. CMD/ACT ID

TAG NO. 096907 AFTO 350 PT. I

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE

18. PART NUMBER

19. NSN

20. ACTION TAKEN	21. QTY.	22. RPC. USE ONLY

TAG NO. 096907 AFTO 350 PT. II

Figure 1. AFTO Form 350.

FINAL ASSEMBLY, BALANCE, AND OIL TEST

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to balance, oil test, and complete final assembly of the propeller.

INTRODUCTION

The propeller is not ready for use until the proper balancing and oil testing procedures have been accomplished. This study guide is designed to provide information for you about preparation of the propeller for use.

INFORMATION

The propeller assembly must be balanced and oil tested prior to the propeller being installed on an aircraft. The balancing of the propeller will prevent the propeller from causing vibrations in an aircraft, which can cause the aircraft to crash. The oil test procedures are performed prior to installation to insure the propeller hub and blade assembly is operating correctly and no oil is leaking from the blade seals and barrel halves. There cannot be any oil leaking from the hub and blade assembly.

The dome is removed and excessive oil cleaned up using the suction line of the tester. Also, the pitch lock regulator, prop retaining nut, and front cone must be removed before moving the propeller off the test post.

The blades should be turned to +45° blade angle.

Before installing the control, correct balance must be assured.

Vibrations in an aircraft can be caused by a propeller, an engine or the airframe. We must determine the cause of the vibration before a correction action can be taken. If it is the propeller that is at fault, the propeller will require balancing.

When balancing propeller assemblies, it is important that the balancing room be free of air currents. The hub and blades should be cleaned and properly assembled.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1

776 Prior to checking the final balance, the mechanic must insure that the following items are not installed. Dome, gear preload shims, pitchlock regulator assembly, hub nut (prop retaining nut), front cone, packing seat ring, and device contact ring assembly. The hub mounting bulkhead shall be installed. The blades must be turned to 45° blade angle.

Final balance is obtained by adding flat washers, bolts, and self-locking nuts and attaching them to the outer circle of drilled holes in the hub mounting bulkhead.

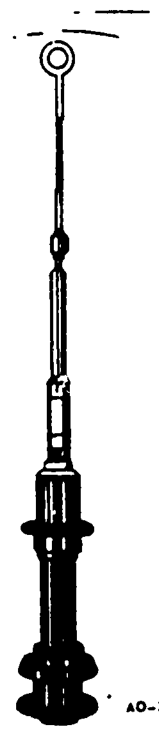
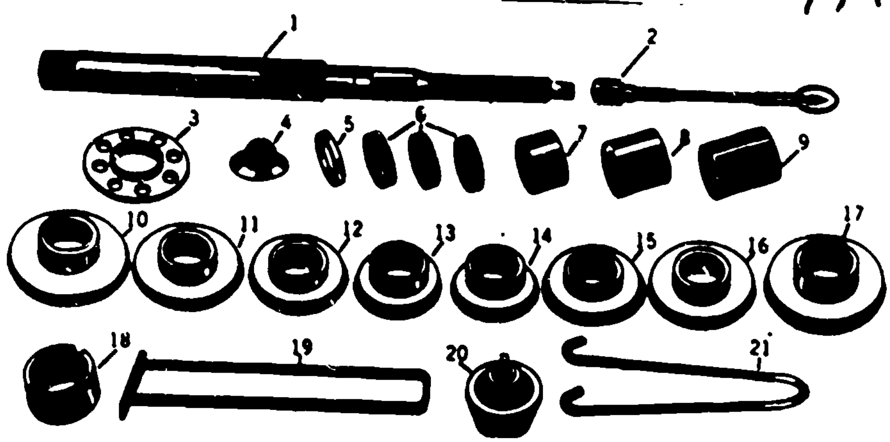


Figure 1. Balancer Assembled.

The Model 7A100 Marvel balancer, shown in figures 1 and 2, is the suspension type balancer, used to balance the propeller in a horizontal position. This equipment is designed to balance propellers weighing up to 2500 pounds and fitting 50 to 80 size propeller shafts.

The Marvel balancer is sensitive. It can detect a very slight out of balance condition. Care must be taken when handling this equipment. It is easy to damage or mar the machined portion of the balancer. Damage to this machined area can cause difficulty in installing the cone adapters and spacers.

The balancer contains oil in its inner portion to provide a dampening action. Otherwise, long periods of oscillation would occur during the balancing process. The balancer should not be laid down because the oil would drain out and be lost. The balancer should always BE STORED IN AN UPRIGHT POSITION.



1 Balancer Shaft
2 Quick Disconnect Coupling Assy.
3 Rear Nut
4 Front Nut
5 Locking Ring
6 Spacer-1 inch
7 Spacer-2 inch
8 Spacer -3 inch
9 Spacer -4 inch
10 Cone-Rear, 80 Spline
11 Cone-Rear, 70 Spline
12 Cone-Rear, 60 Spline
13 Cone-Rear, 50 Spline
14 Cone-Front, 50 Spline
15 Cone-Front, 60 Spline
16 Cone-Front, 70 Spline
17 Cone-Front, 80 Spline
18 Adapter-50 Spline
19 Tool-Adapter Inserting
20 Fixture-Dome Lifting
21 Yoke-Dome Lifting

Figure 2. Balancing Kit.

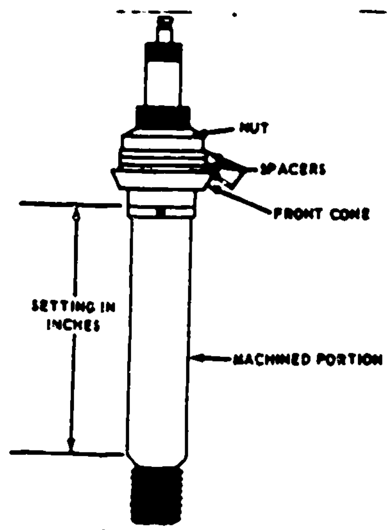


Figure 3. Front Cone Setting.

Sensitivity of the balancer is adjusted by correctly positioning the balancer in the propeller hub. This establishes the correct center of gravity for each propeller. See figure 3.

The proper distance for the balancer to be located in the hub for various propellers is listed in a chart. This chart is located in TO 32A1-3-11. The "settings" listed in the chart refer to the distance in inches from the beginning of the machined portion of the lower end of the balancer shaft to the lower portion of the front cone.

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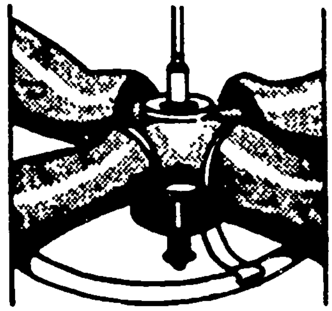

Figure 4. Propeller Suspended for Balancing.

After the balancer has been positioned in the propeller hub, the complete unit (balancer and propeller) is suspended from a hoist. See figure 4.

Figure 5. Indicator Bushing Shows Propeller Perfectly Balanced.

Balance readings are taken visually, from a circular indicator bushing on the top of the balancer shaft. When a propeller is balanced this bushing is centered within the black disc set in the end of the shaft. See figure 5.

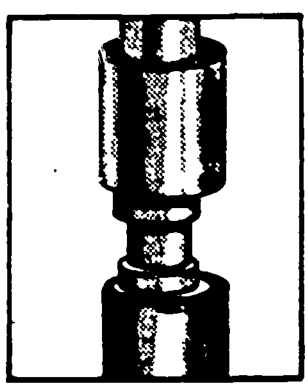

Figure 6. Indicator Bushing Offset-Propeller is Unbalanced.

When unbalanced the bushing and disc are offset. This indicates both the direction of unbalance and the amount of correction necessary. See figure 6.

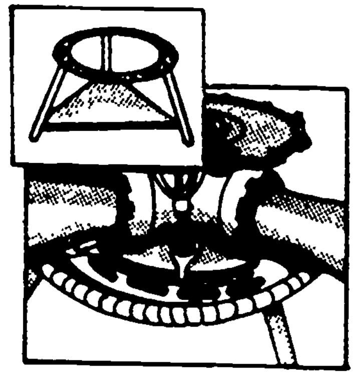

Figure 7. Balancer Stand Without Adapter.

A balancer stand is used to support the propeller while installing the balancer. See figure 7.

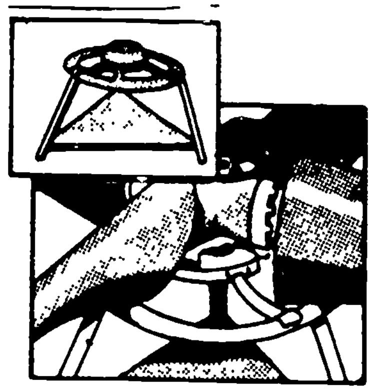

Figure 8. Balancer Stand with Adapter.

To protect blade cuffs or anti-icing equipment, an adapter is used. In this case the propeller is supported on its hub. See figure 8.

Oil Test

When the propeller has built up (assembled) after removal from a shipping crate or replacement of new seals, it must be tested to determine proper operation and freedom from oil leaks.

SUMMARY

A propeller that is out of balance can cause much damage to the aircraft. It may even cause it to crash.

The types of unbalance are static, mass moment and aerodynamic.

Two methods of performing the static balance check are vertical and horizontal. The horizontal is most widely used. The Marvel balancer is used to horizontally balance a propeller. It is very sensitive and requires care in handling.

780 Before operating the oil test equipment the prestart checks are required to assure proper operating condition.

QUESTIONS

1. Where is minor balance adjusted on the 54H60 propeller?

2. How is the sensitivity of the Marvel balancer adjusted?

3. Where can the chart for determining correct positioning of the balancer be located?

4. How does the Marvel balancer indicate an out of balance condition?

5. Which parts must be removed prior to final balance check?

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Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-309
11 February 1981

FINAL ASSEMBLY, BALANCE AND OIL TEST

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate procedures in the applicable technical order for final assembly and balancing of the 54H60 propeller.

2. Identify torque limits, safety practices, special tools, and FOD prevention pertaining to final assembly and balancing of the propeller.

EQUIPMENT

	Basis of Issue
3ABR42633-SG-309	1/student
TO 3H1-18-2	1/student

PROCEDURE

Using TO 3H1-18-2 and SG-309, answer the following questions.

1. What is the nomenclature of the special tool used to balance a 54H60 propeller? ______________

2. What paragraph, in the technical order, lists the procedures for balancing a propeller? ______

3. What component is installed on the propeller prior to installing the balancer? ______________

4. What is the position of the blades during the balancing check? ______________

5. How do you determine the size of the rear cone to be used on the Marvel balancer? ______________

6. What is furnished with an overhauled propeller that will make balancing a propeller not necessary? ______________

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

RGL: N/A

Designed for ATC Course Use. Do Not Use on the Job.

7. In what position must the Marvel balancer be stored?

____

8. What is the amount of torque that is applied to the castellated nuts on the hub extension studs? ____________

9. What is the maximum lifting capability of the Marvel balancer? ______________

10. What is the part number of the propeller balance stand?

____

11. How are the readings taken while performing the balance checks?

____

12. What are the components which will be installed on the propeller during final assembly? __________________________

13. What is the torque limits for the rear spinner dowel bolts?

____

14. How is the rear spinner indexed on the mounting bulkhead assembly? __________________________________

15. How many screws retain the deicer contact ring to the hub extension? __________

16. What is used to coat the electrical connector straps on the deicer contact ring? ___________________________

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STUDY GUIDE/WORKBOOK

3ABR42633-SW-309

Technical Training

Turboprop Propulsion Mechanic

PROPELLER OIL TEST

18 March 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

Do Not Use on the Job.

PROPELLER OIL TEST

OBJECTIVES

When you have completed this study guide/workbook and your classroom instruction, you will be able to explain the purpose and procedures for oil test of the propeller assembly.

INTRODUCTION

When the propeller has been assembled after removal from the shipping crate or replacement of oil seals, it must be oil tested to determine that it operates properly with no internal or external oil leakage from the hub, blade, or dome assemblies.

INFORMATION

This lesson contains all the information you will need to know about the oil testing of the 54H60 propeller assembly in accordance with procedures contained in TO 3H1-18-2.

HYDRAULIC PROPELLER TESTER

The hydraulic propeller tester, GS 1221-M9 is used to perform operational, and external and internal leakage checks on the 54H60 propeller assembly. The tester simulates actual propeller operation as if the propeller assembly was installed on an aircraft engine. The tester has incorporated into the system a control panel consisting of an instrument panel, pressure control panel, and temperature control panel, an oil tank, electrical heaters, electrical driven motor and pump assembly, and three filters. It is mounted on four caster type wheels, which makes the tester portable.

The following is a list of the major parts on the instrument panel, temperature control panel, and pressure control panel. See figure 1 and figure 2 for the location of these parts. It will be to your benefit to know the location of these parts, because you will be operating the tester in a later lesson.

Instrument Panel

1. TOGGLE SWITCH - Used to test the indicator light for proper operation.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 300; TTVSA - 1

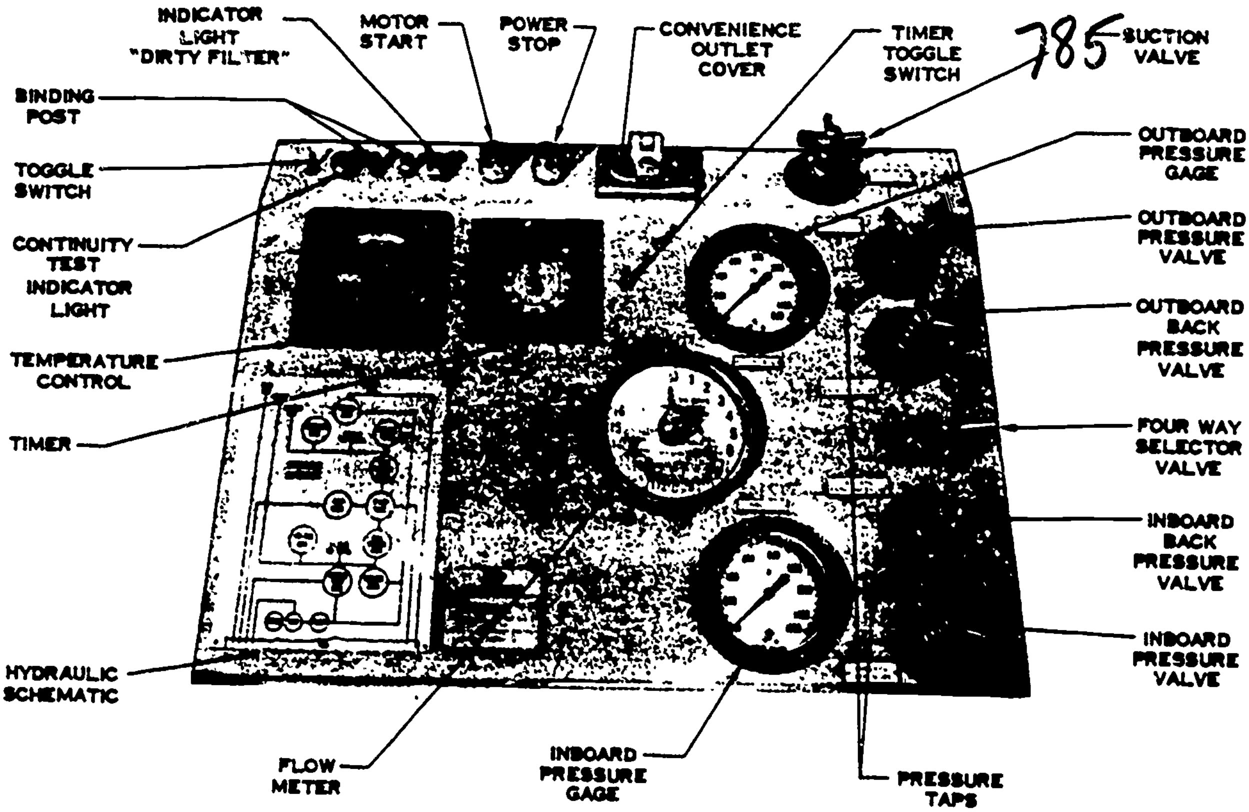

Figure 1. Hydraulic Propeller Tester Control Panel.

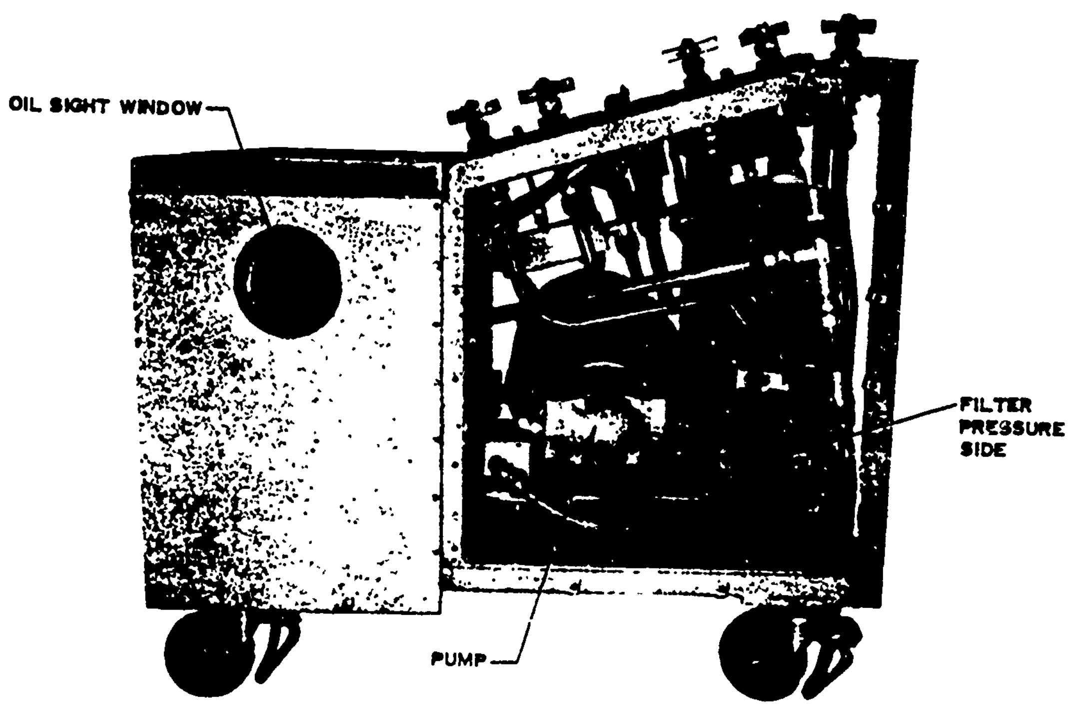

Figure 2. Pressure Side Filter Location.

2. INDICATOR LIGHT - Used as a warning indicator for a dirty filter on the pressure pump filter assembly.

3. MOTOR START - Turns the propeller tester motor on and off.

4. POWER STOP - Turns off electrical power to the hydraulic propeller tester.

5. TIMER - Used when checking for internal leakage and pressure checks.

6. CONVENIENCE POWER OUTLET - Used to provide 115 volts AC power for whatever requirement exists in the vicinity of the tester.

7. CONTINUITY TEST INDICATOR LIGHT - Used when troubleshooting electrical problems on the hydraulic propeller tester.

Temperature Control Panel

1. TEMPERATURE SELECTOR - Allows the operator to select the maximum oil temperature necessary to operate the propeller tester.

2. TEMPERATURE GAGE - Shows the operator the temperature of the oil during the test procedures.

Pressure Control Panel

1. OUTBOARD PRESSURE VALVE - Ports oil to the outboard side of the propeller dome assembly for blade movement.

2. OUTBOARD BACK PRESSURE VALVE - Ports hydraulic oil from the tank, through the flowmeter to the outboard side of the dome assembly, and is used to increase blade angle during oil test procedures.

3. INBOARD PRESSURE VALVE - Ports oil to the inboard side of the propeller dome assembly for blade movement.

4. INBOARD BACK PRESSURE VALVE - Ports hydraulic oil from the tank through the flowmeter to the outboard side of the dome assembly and is used to decrease blade angle.

5. FOUR WAY SELECTOR VALVE - Used to select inboard or outboard oil pressure, to be measured on the two pressure gages.

6. OUTBOARD PRESSURE GAGE - Measures the oil pressure in pounds per square inch for the outboard side of the dome assembly.

7. INBOARD PRESSURE GAGE - Measures the oil pressure in pounds per square inch for the inboard side of the dome.

8. FLOWMETER - Measures oil flow in fluid ounces for either the inboard or outboard oil during the oil test procedures.

9. PRESSURE TAPS - Are used to calibrate the outboard and inboard pressure gages during inspections or as required by the applicable technical order.

QUESTIONS

1. What does the indicator light on the control panel indicate when it is illuminated?

   a. Dirty filter on the pressure pump filter
   b. The timer is being used
   c. Clean filter on the pressure pump filter
   d. Temperature of the oil is at operating temperature

2. What is the purpose of the hydraulic propeller tester, GS 1221-M9?

   a. To test a pitch lock assembly
   b. To check electrical wiring on the propeller
   c. To perform operational, external and internal leakage checks on 54H60 propellers
   d. To perform operational checks on the engine

3. What part on the temperature control panel allows the hydraulic test machine operator to select the maximum oil temperature necessary to operate the propeller tester?

   a. Temperature selector
   b. Toggle switch
   c. Temperature gage
   d. Four way selector valve

4. Name the part on the pressure control panel that is used to port oil to the outboard side of the propeller dome assembly for blade movement?

   a. Outboard back pressure valve
   b. Inboard pressure valve
   c. Four way selector valve
   d. Outboard pressure valve

5. What measures oil flow in fluid ounces for either the inboard or outboard oil during the oil test procedures?

   a. Outboard pressure gage
   b. Flowmeter
   c. Pressure taps
   d. Timer

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TESTER PREPARATION

With the completion of the assembly of the hub and blade assemblies, the propeller assembly is now ready for testing on the hydraulic propeller tester. Before testing the propeller on the hydraulic propeller tester, there are several necessary steps that must be completed to prepare the tester for the operation procedures.

1. The following hydraulic oil must be used with the hydraulic propeller tester, Model GS 1221-M9. The types of oil are: MIL-H-6083, Type I; MIL-H-6083, Type II; or MIL-H-5606; with no substitutes allowed in accordance with TO 3H1-18-2. The capacity of the oil tank on the tester is approximately 39.5 gallons of hydraulic fluid.

2. There are three hydraulic lines that must be connected to the propeller test fixture, HSP-8961. Attach the inboard and outboard oil lines from the hydraulic propeller tester to the connectors located on the propeller oil test fixture, which is installed on the barrel extension. These are marked as LOW PITCH and HIGH PITCH, then attach the oil drain line from the tester to the bottom of the test post, HSP 2100. The oil test post is the assembly which the propeller assembly is mounted on during the oil test procedures.

3. There are two water lines on the hydraulic propeller tester, GS 1221-M9, that are used for cooling of the oil. When the oil temperature exceeds 170 degrees F, the tester will automatically allow the cold water to be ported to the oil tank through metal pipes to cool the oil during the test procedures.

The oil temperature is adjusted by turning the temperature selector knob until the indicator in the lower window is set at 140 degrees F. When the tester is turned on, the electric motor and oil pump will automatically heat the hydraulic oil to 140 degrees F, and then the tester will shut off the heaters, located in the oil tank, when the oil temperature reaches the preset temperature of 140 degrees F. The tester will automatically turn the heaters on again, if the oil temperature goes below the 140 degree setting. On the tester we will be using to test the 54H60 propeller assembly, the two water lines are not connected to the test machine. If the oil temperature goes above 170 degrees F, the tester will have to be shut off and allowed to cool until the oil temperature is below 170 degrees F.

4. Before the tester motor is started, the two pressure valves and the two back pressure valves must be opened by turning the valve handles in the counterclockwise direction. The suction valve must be closed. Do this by turning the valve handle in a clockwise direction. The four way selector valve must be turned in a downward position, towards the inboard pressure gage. After the valves are in the correct position, the tester motor can be started. This is completed by pushing the motor start button on the control panel. The tester must be allowed time to warm up the hydraulic oil in it before any pressure can be applied to the tester. The oil temperature must be at least 140 degrees F. After the oil has warmed up to 140 degrees F., close the outboard pressure valve. The outboard back pressure and the inboard pressure valves are left in the open position. The suction valve is left in the closed position. Slowly apply

decrease pitch oil pressure to fill the barrel and the inboard side of the dome assembly, by adjusting the inboard back pressure valve. After filling the barrel and the inboard side of the dome assembly, open the inboard back pressure valve first, and then the outboard pressure valve. Now, close the inboard pressure valve. The outboard pressure and the inboard back pressure valves are left in the open position. Then, slowly adjust the outboard back pressure valve to fill the outboard side of the dome assembly and to release the pitch lock ratchet ring that is attached to the bottom of the dome assembly. After the outboard side of the dome assembly has filled with hydraulic fluid, open the outboard back pressure valve, and open the inboard pressure valve to allow oil pressure to be released from the propeller assembly.

5. With the inboard and outboard sides of the dome assembly, and the barrel assembly filled with hydraulic fluid, cycle the propeller from feather to reverse blade angles by closing the outboard pressure valve, and slowly closing the inboard back pressure valve. Do not allow the propeller blades to stop when taking the blades to the reverse blade angle. So, keep the pressure at about 300 psi while using this procedure. When the propeller has reached the reverse blade angle and pressure starts to increase, open the inboard back pressure valve first, and then the outboard pressure valve. To cycle the propeller assembly back to feather blade angle, close the inboard pressure valve. Slowly close the outboard back pressure valve. Keep enough pressure applied to the propeller assembly to have smooth movement of the propeller blades. After the propeller assembly has reached the feather blade angle, which will be indicated by an increase in oil pressure, open the outboard back pressure valve first, and then the inboard pressure valve. Cycle the propeller assembly from feather to reverse blade angles at least eight times, using the above procedures, to purge air trapped in the propeller assembly. This will avoid erratic operation during the oil test procedures.

CAUTION: DO NOT STOP THE PROPELLER IN THE PITCH LOCK RANGE FROM 55 DEGREES TO 25 DEGREES OF BLADE ANGLE. IT MAY CAUSE THE PITCH LOCK RATCHET TEETH TO ENGAGE FULLY OR PARTIALLY CAUSING DAMAGE TO THE TEETH. IF THE PROPELLER ASSEMBLY DOES STOP IN THE ABOVE RANGE, THE PROPELLER ASSEMBLY MUST BE CYCLED BACK TO THE FEATHER BLADE ANGLE BEFORE THE PROPELLER BLADES ARE ALLOWED TO DECREASE TOWARDS THE REVERSE BLADE ANGLE. THEN THE CYCLE PROCEDURES CAN BE RESTARTED.

QUESTIONS

1. What type of oil is used in the hydraulic propeller tester, Model GS 1221-M9?

a. MIL-H-6083 or MIL-H-5606

b. MIL-H-8306 or MIL-H-6505

c. MIL-G-2146

d. MIL-L-23699B or MIL-L-21440

790 What is the temperature reading at which the test machine will automatically allow water to cool the hydraulic oil?

a. 140°F

b. 160°F

c. 170°F

d. 180°F

3. In what position is the suction valve set prior to starting tester operation?

a. Fully open

b. Partially opened

c. Partially closed

d. Fully closed

4. What is the name of the valve that is used to fill the barrel and inboard side of the dome?

a. Inboard pressure valve

b. Suction valve

c. Inboard back pressure valve

d. Outboard back pressure valve

5. Why is the propeller assembly cycled between feather and reverse at least eight times?

a. To fill the dome assembly

b. To purge air from the system

c. To empty the propeller of oil

d. To test the propeller blades

OIL TEST PROCEDURES

Now that we have completed the preliminary checks of the hydraulic oil test procedures, we can start the testing of the 54H60 propeller assembly for specific operational and leakage checks in accordance with TO 3H1-18-2.

Step One - External Leakage Test

With the barrel drain petcock, which is located on the oil test fixture, HSP 8961, in the closed position, cycle the propeller between feather blade angle HIGH PITCH and reverse blade angle LOW PITCH for at least eight (8) cycles and until the barrel assembly is at 150 psi, as read on the pressure gage of the HSP 8961 oil test fixture. If the barrel assembly pressure reaches 150 psi before the eight cycles are completed, open the barrel drain petcock until the total of eight (8) cycles are completed. There is no external leakage allowed during this check or while performing any of the hydraulic test procedures. If there is leakage from the barrel halves or blade seals, the propeller hub and blades will have to be disassembled and new seals installed, and then reassembled in accordance with TO 3H1-18-2. The oil test procedures will have to be started again at the beginning.

Step Two - Low Blade Angle Setting Check

Using the hydraulic propeller tester, move the blades from feather blade angle to the low pitch stop setting, by closing the outboard pressure valve and adjusting the inboard back pressure valve. Do not allow the inboard oil pressure to exceed 200 psi, as indicated on the inboard pressure gage. While maintaining this pressure and using blade turning bars, HS 6762, pull the blades into the mechanical low pitch stop, measure the low blade angle, using the blade angle protractor, P/N PE 105 and template, HS 7548. Low blade angles of all the blades shall be the same reading, within a total variation of 0.20 degree; and shall be within 0.50 degree of the 23.3 degree blade angle setting with the blade angle correction factors applied that are stencilled on the camber side of the blade fairing. If the specified blade angles are not within the limits, it will be necessary to adjust the low pitch stop assembly by either turning the low pitch stop assembly in or out of the piston sleeve of the dome assembly.

To make this adjustment, it will be necessary to take the propeller assembly to the feather blade angle, to move the low pitch stop levers away from the piston sleeve. To increase the low pitch stop blade angle, turn the low pitch stop assembly clockwise, and counterclockwise to decrease the low pitch stop assembly setting. This procedure can be completed by removing the dome cap from the dome assembly, removing the oil transfer tube assembly, and the low pitch stop retaining ring and snap ring. After completing the adjustment on the low pitch stop assembly, reinstall the low pitch stop retaining ring and snap ring, oil transfer tube assembly, and dome cap.

Step Three - Feather Pressure Test

To perform this test, slowly move the blades to the feather angle by closing the inboard pressure valve and adjusting the outboard back pressure valve. The pressure required to move the propeller assembly to the feather blade angle shall not exceed 350 psi as measured on the outboard pressure gage. Leave the inboard pressure valve and the outboard back pressure valve in the above position for further checks that are required in the feather position.

QUESTIONS

1. What is the purpose of the external leakage test?

   a. To check leakage on the barrel halves and blade seals

   b. To check leakage of the dome assembly

   c. To check leakage of the pitch lock and barrel halves

   d. To check leakage of the blades and dome assembly

2. How is the low pitch stop (LPS) adjusted during the low blade angle setting check, if the reading is 24.6 degrees?

a. By turning the LPS clockwise

b. By readjusting the blade microadjusting ring

c. By turning the LPS counterwise

d. No adjustment is required

3. What is the total variation of blade angle of all the blades at low blade angle?

a. 0.10 degree

b. 0.20 degree

c. .020 degree

d. 0.50 degree

4. What is the maximum pressure required to move the propeller assembly to the feather blade angle as measured on the outboard pressure gage?

a. 300 psi

b. 325 psi

c. 350 psi

d. 360 psi

5. What valves are used to move the propeller assembly to feather blade angle?

a. Inboard pressure and inboard back pressure

b. Outboard back pressure and inboard pressure

c. Outboard pressure and inboard back pressure

d. Outboard pressure and outboard back pressure

Step Four - Feather Blade Angle Setting Check

With the propeller in the feather position, apply 200 psi outboard oil pressure, measured on the outboard pressure gage. While maintaining this pressure, twist all the blades simultaneously towards the low pitch stop using the blade turning bars, HS 6762, to take up blade backlash. Slowly remove the torque simultaneously from the blade turning bars. Now, using the blade angle protractor, P/N PE 105 and the template, HS 7548, measure the feather blade angles of each blade. This measurement shall be the same reading within a total variation of 0.20 degree of the 92.5 degree feather angle setting with the blade angle correction factors applied. Record this reading for further use when checking the reverse blade angles.

Step Five - Internal Leakage in Feather Check

With the propeller assembly still in the feather position, apply outboard oil pressure until it is 600 psi greater than the inboard oil pressure as measured on the outboard pressure gage. The oil leakage from the outboard to inboard sides of the dome piston assembly shall be 15-45 fluid ounces per minute, which equals 1-3 pints of hydraulic oil in 64 seconds, as measured on the flowmeter. To take the reading accurately, you must use use the timer on the instrument panel.

With the propeller and tester still set as in the previous paragraph, the oil leakage from the outboard side of the piston to the barrel shall be collected in a graduated container from the barrel drain petcock of the oil test fixture, HSP 8961. This leakage from the petcock shall be 10-35 fluid ounces per minute. The combined fluid leakage of the two tests shall not exceed 75 fluid ounces per minute. Now, open the outboard back pressure valve, and the inboard pressure valve.

QUESTIONS

1. Why do you use blade turning bars, HS 6762, to twist the blades towards the low pitch stop?

   a. To maintain oil pressure

   b. To take up blade backlash

   c. To hold the blade from moving

   d. To release the feather locks

2. What is the maximum allowable internal oil leakage permitted during the internal leakage in feather check?

   a. 10 to 40 fluid ounces

   b. 10 to 45 fluid ounces

   c. 15 to 40 fluid ounces

   d. 15 to 45 fluid ounces

3. What is the maximum allowable oil leakage allowed from the outboard side of the dome to the barrel?

   a. 10-20 fluid ounces

   b. 10-30 fluid ounces

   c. 10-35 fluid ounces

   d. 10-40 fluid ounces

4. What valves are used to unfeather the propeller?

   a. Inboard pressure and outboard back pressure

   b. Outboard pressure and outboard back pressure

   c. Inboard back pressure and outboard back pressure

   d. Outboard pressure and inboard back pressure

5. What is the minimum oil pressure required to release the feather locks?

a. 160 psi

b. 170 psi

c. 180 psi

d. 190 psi

Step Six - Unfeather Pressure Test

With the propeller assembly still in the feather position, close the outboard pressure valve, and using the inboard back pressure valve, slowly apply inboard oil pressure until the propeller unfeathers. While applying the inboard oil pressure, and looking at the inboard pressure gage, slowly apply 180 psi of oil pressure to the propeller. The propeller shall release the feather locks at a minimum oil pressure of 180 psi. Leave the outboard pressure valve and the inboard back pressure valve in this position and do not apply any more pressure to the propeller.

Step Seven - Reverse Pressure Tests

With the hydraulic oil tester valves in the same position as in step six, apply enough inboard oil pressure to position the propeller blades at the low blade angle setting. Do not exceed 200 psi of inboard oil pressure during blade movement. After the propeller has stopped on the low pitch stop assembly, slowly increase the inboard oil pressure to 235 psi, as shown on the inboard pressure gage, and hold this pressure for one minute. The propeller shall not decrease blade angle to the reverse position. Slowly, apply more increase oil pressure. The propeller shall change blade angle at a pressure of 250 to 280 psi, as shown on the inboard pressure gage, and shall move to the full reverse blade angle. After the propeller has reached the reverse blade angle position, remove the inboard oil pressure by opening the inboard back pressure valve and the outboard pressure valve.

Apply oil pressure to the propeller to move the blades towards the low blade angle setting, this movement must be no more than one to 10 degrees below the low blade angle setting of 23.3 degrees of blade angle. To make this blade angle movement, close the inboard pressure valve, and adjust the outboard back pressure valve. After the desired blade angle movement has been completed, open the inboard pressure valve and the outboard back pressure valve. Close the outboard pressure valve and adjust the inboard back pressure valve to apply 85 psi of inboard oil pressure, read the amount of oil pressure on the inboard pressure gage. The result of this action is that the propeller blades should not move towards the reverse blade angle. Slowly apply more inboard oil pressure. The propeller blades shall move to the reverse position at a pressure of between 85 to 125 psi of oil pressure. After the blades have reached the reverse position, remove the outboard back pressure, and the inboard pressure by opening the two valves.

Step Eight - Reverse Blade Angle Setting

With the propeller blades in reverse, using the blade angle protractor, P/N PE 105, and the template, HS 7548, measure the blade angle at the reverse position and record the readings of all the blades. The reverse angle of each blade shall be equal to the feather angle of the blade minus the range of the feather stop ring. Use the feather angles previously recorded during the feather blade angle setting check (step four). Since the correction factors were previously applied to the feather blade angles, do not apply them to the reverse blade angles. Now using the stop ring range of 100 degrees to 102 degrees of blade angle, and the feather blade angle readings, subtract the feather blade angle from the stop ring range. The result will be the reverse blade angle limits.

EXAMPLE:

Stop Ring Range	-100.0 Degrees	-102.0 Degrees
Feather angle Recorded	+92.6 Degrees	+92.6 Degrees
Reverse Angle Limits	-7.4 Degrees	-9.4 Degrees

The reverse blade angle readings taken using the blade angle protractor and template previously in the above paragraph shall be within the reverse angle limits.

Step Nine - Internal Flow and Leakage Test in Reverse

With the propeller still in reverse, slowly apply inboard oil pressure until the pressure is 500 psi greater than outboard oil pressure and the surge valve has not opened. Use the inboard oil pressure gage. The oil leakage from the inboard to outboard side of the dome piston assembly shall be 15 to 45 fluid ounces per minute, which equals 1 to 3 pints of hydraulic fluid in 64 seconds as read on the flowmeter of the hydraulic oil test machine.

With the propeller still set up as in the previous paragraph, the oil leakage from the inboard side of the dome piston assembly to the barrel will be collected in a graduated container from the barrel drain petcock of the oil test fixture, HSP 8961. The combined oil leakage of the two above tests shall not exceed 75 fluid ounces per minute.

Slowly apply inboard oil pressure until it is no greater than 700 psi and the surge valve has opened as indicated by no further rise in the inboard oil pressure. The oil flow from the inboard to the outboard side of the dome piston assembly shall be a minimum of three quarts per minute as measured by the flowmeter on the instrument panel.

We have completed the oil test procedures for the 54H60 propeller assembly. Now, the propeller assembly must be removed from the oil test post, HSP 2100, and the hydraulic propeller tester disconnected. First, the propeller assembly must be placed in the feather position. Then the oil pressure must be removed from the propeller and the hydraulic propeller tester. After the propeller is in the feather position, and no oil pressure is applied to the propeller, we can remove the dome cap from the dome assembly. Then close the outboard pressure valve and the inboard pres... valve, and open the suction valve. This will pick up all excess oil in the propeller dome assembly and we will be able to further disassemble the propeller from the tester. You will be using the suction line as each assembly is removed from the oil test post, HSP 2100.

After the oil has been removed from the outboard side of the dome assembly, using the dome spanner wrench, HSP 648, remove the dome assembly from the hub and blade assembly. Using the suction line again, remove the excess oil in the dome shelf, which is part of the barrel assembly. After this has been completed, remove the pitch lock externally threaded ring. Using the pitch lock mechanical puller, HS 7580, and exercising caution not to damage the threads of the pitch lock cap, insert the puller into the pitch lock cap and remove the pitch lock assembly from the propeller retaining nut. Using the socket sleeve, SWE 86630, remove the propeller retaining nut, front cone, the associated parts from the propeller barrel assembly, and the oil test post, HSP 2100.

With the propeller still on the test post, recheck the torque on the barrel bolt extension studs and align the cotter pin holes on the barrel bolts and safety with the correct cotter pins.

Using the hoist, lift the propeller from the oil test post, HSP 2100, and remove the oil test fixture, HSP 8961, using the mechanical puller, HSP 1584, oil tester fixture puller. Then remove the preformed packing, phenolic spacer, and the rear cone from the oil test post. After the above procedures are completed, the propeller assembly is ready for minor balance and assembly of the hub mounted bulkhead assembly, rear spinner assembly, and deicer contact ring holder assembly. This concludes the operational and leakage tests for the 54H60 propeller assembly.

QUESTIONS

1. What is the maximum pressure allowed to release the low pitch stop levers?

a. 270 psi

b. 280 psi

c. 290 psi

d. 295 psi

2. Why do you not exceed 200 psi of inboard oil pressure when unfeathering the propeller?

a. To stop the propeller at the low pitch stop

b. To move the propeller to reverse

c. To release the low pitch stop levers

d. To check the pitch lock assembly

3. What is the maximum pressure allowed to move the propeller blades into reverse? 797

a. 85 psi

b. 95 psi

c. 115 psi

d. 120 psi

4. What is the range of the feather stop ring?

a. 100-102 degrees

b. 100-105 degrees

c. 100-110 degrees

d. 92-100 degrees

5. What is the maximum oil leakage allowed in reverse?

a. 10-45 fluid ounces

b. 15-45 fluid ounces

c. 10-50 fluid ounces

d. 15-50 fluid ounces

Jet Engine Branch
Chanute AFB, Illinois

3ABR426 798-011
22 January 1980

VALVE HOUSING MAINTENANCE AND ADJUSTMENT

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to remove and replace the valve housing on the propeller, adjust mechanical rpm setting, beta schedule, reverse torque, and feather adjusting screws, and the procedures for maintenance and adjustment of the valve housing assembly.

INTRODUCTION

A propeller malfunction caused by an inoperative component on the turbocontrol valve housing will be corrected by replacing the complete valve housing.

INFORMATION

This study guide contains all the information that is necessary to remove and replace, and to perform the different adjustments on the valve housing assembly. These adjustments must be made using the applicable technical order to prevent damage to equipment and personal safety.

Valve housings can be interchanged from one control assembly to another.

Prior to removing the valve housing you will place the condition lever in the air start and the throttle in ground idle. This will operate the propeller to ground idle. Then the electrical connections will be disconnected from the control assembly.

> Note: The electrical power must be turned off before removing the electrical connections to prevent burning out panels in the synchrophaser. The control linkage must now be disconnected from the alpha input shaft. The valve housing cover will be removed next. At this point you will check the protractor on the beta shaft indicator and note the reading. (See figure 1.) The replacement valve housing will be set at the same angle less 2° to provide for adjustment of beta shaft.

A rig pin must now be installed in the beta shaft (figure 2) to prevent the torsion spring from "snapping" the beta shaft and drive gear against the stop, when the valve housing is removed (figure 3). If the rig pin cannot be inserted, you must loosen the feather adjusting screws.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1;

799

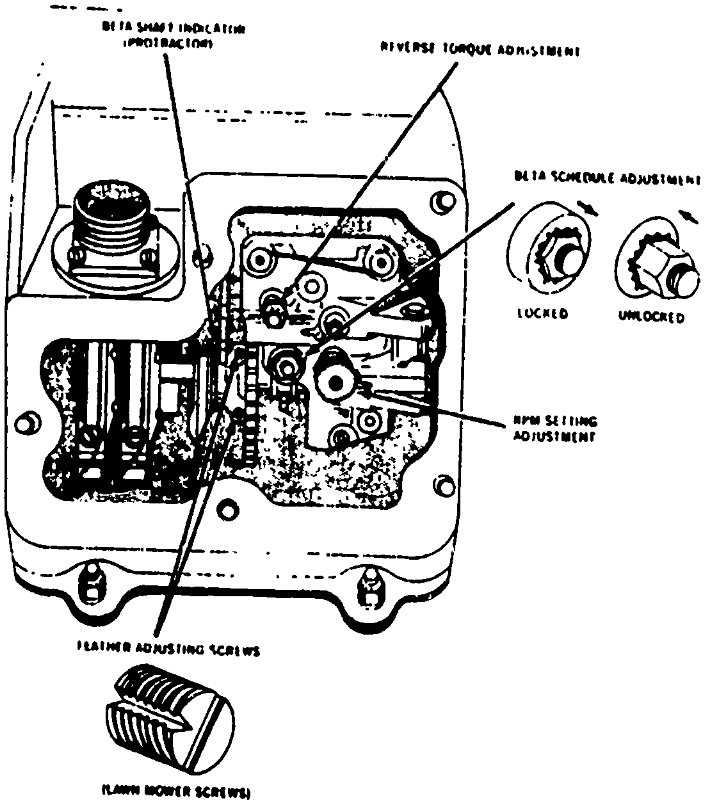

Figure 1. Valve Housing Assembly Adjustments.

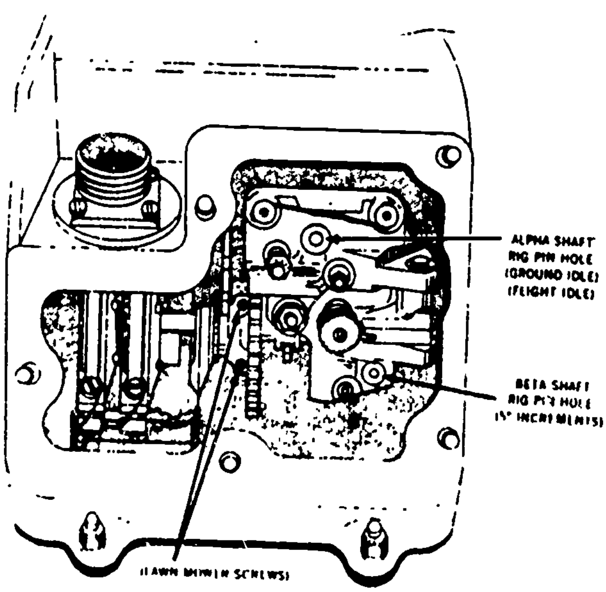

Figure 2. Beta Rig Pin Location.

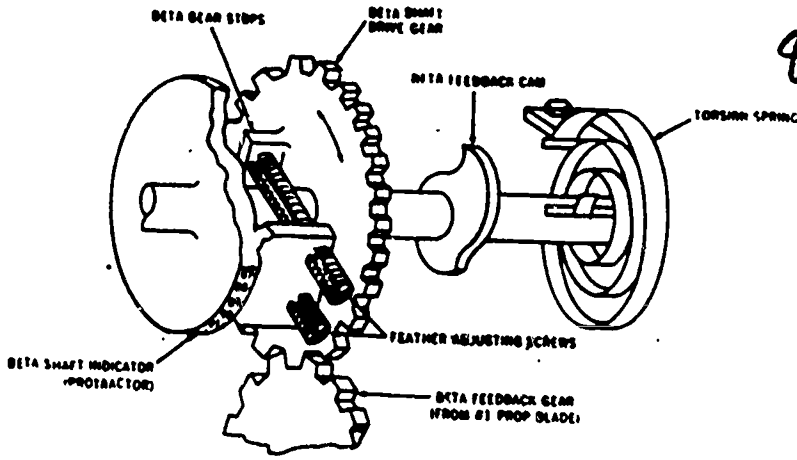

Figure 3. Beta Cam Adjustment.

This will allow the beta shaft to turn so the rig pin will fit. The blades should not be turned while this rig pin is installed. Severe damage to the valve housing will occur.

The nuts and washers that hold the valve housing on will now be removed and the valve housing and seal plate lifted off.

To remove the beta shaft rig pin, you should hold the beta drive gear, remove the rig pin and let the drive gear slowly rotate to the stop.

Before installing the replacement valve housing, a new seal plate should be installed on the pump housing. Then you should center the feather adjusting screws so feather angle can be adjusted later on.

Now the beta drive gear will be rotated until the protractor on beta shaft indicates near the same angle as was noted on the removed valve housing. The shaft will be locked in this position with the rig pin. The valve housing is ready to be installed. During installation, care should be taken to insure that the beta gear meshes properly with the inter-gearing. Tightening the valve housing down without proper mesh will result in damage to the valve housing. If the gears do not mesh you should loosen the feather adjusting screws, or "lawnmower" screws on the protractor about one turn each. This will allow movement of the beta gear enabling it to mesh with the intergearing.

The attaching washer and nuts would now be installed and evenly torqued according to the TO. Next the rig pin should be removed and the "lawnmower" screws adjusted to set the protractor to the angle noted during removal of the valve housing. The setting of the beta shaft is accomplished at ground idle, but the actual angle must be correct at feather.

To install the valve housing cover you must index the alpha input shaft in the cover to the alpha shaft on the valve housing. To do this you must lock the alpha shaft at the flight idle position with a rig pin. The rigging spacer that the rig pin fits into has two slots. To insure that you have the pin in the correct slot, you should try to rotate the alpha shaft. With the pin installed all the way in there shall be no free play of the alpha shaft.

The input lever on the valve housing cover should be positioned at flight idle. The cover should now be installed. If the split gears in the cover do not exactly mesh with the input gear on the alpha shaft, the input lever will be forced away from the flight idle position as the cover is installed. An adjustment to bring the input lever back to flight idle is made by repositioning the micro adjusting ring on the input shaft. Once the input lever is alined the housing cover can be attached with the retaining nuts.

There must be no backlash between the split gears in the valve housing cover and the gear on the alpha shaft. To remove the backlash an adjustment is made with the screw on the split gears. This adjustment is made with the input lever placed at reverse. The electrical connections and control linkage should now be attached. A check will now be performed to insure that the beta cam is correctly set. The condition lever would be placed in the feather position. When the blade angle stops changing you should check the reading on the beta shaft indicator (protractor). It must read 92.5°.

The valve housing change is not completed until three more checks are performed. They are: Beta schedule, reverse stop (reverse torque) and mechanical governing. The adjusting screws are shown in figure 1.

SUMMARY

Changing a valve housing requires care and a good knowledge of the procedures to be followed. Improper handling and careless maintenance can easily damage the valve housing. After the valve housing has been installed, it must be adjusted to set the reverse torque, beta schedule, and mechanical governing rpm. Anytime a valve housing or a turbocontrol has been changed, the NTS bracket clearances must be checked and adjusted. The procedures for performing all the rigging and adjustments on the propeller installation can be found in TO 1C-130B-2-11.

QUESTIONS

1. With the alpha shaft pinned at flight idle, and the input shaft positioned at flight idle, the split gears in the valve housing cover will not mesh with the alpha shaft gear. What adjustment is used to correct this?

2. What precaution should be taken during removal of the valve housing?

3. Why must electrical power be off before the electrical connectors are disconnected from the turbocontrol?

4. Where is the correct angle of the valve housing to propeller adjusted following valve housing removal and replacement?

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5. What device is used to adjust backlash (gear lash) in the input shaft?

6. How is the blade angle reading of the beta shaft checked to see if it agrees with #1 blade angle?

7. What is the result of failing to remove the beta shaft rig pin prior to OPS checks?

8. What checks are required following valve housing change?

9. Which Tech Order gives complete valve housing replacement instructions?

10. Which clearances must be checked following valve housing change?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-803
11 February 1983

VALVE HOUSING MAINTENANCE AND ADJUSTMENTS

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to:

1. Identify nomenclature of the propeller valve housing components and their function and operating principles pertaining to valve housing maintenance and adjustment.

2. Locate procedures, torque limits, safety practices, FOD prevention, and special tools pertaining to valve housing maintenance and adjustment.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-11	1/student
TO 3HA2-7-3	1/student

PROCEDURE

Using information given by the instructor and TOs 1C-130B-2-11 and 3H2-7-3, complete the following projects.

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1
Designed for ATC Course Use. Do Not Use on the Job.

RGL: N/A

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Project 1

DIRECTIONS

Using the components listed below, fill in the nomenclature opposite each function by matching the correct component with each function listed for valve housing maintenance and adjustment.

COMPONENTS

Speed Set Cam

Beta Set Cam

Pressure Cutout Backup Cam

Beta Followup Cam

Backup Valve Cam

Beta Feedback Shaft

Manual Feather Cam

Protractor Cam

Condition Lever

FUNCTION	NOMENCLATURE
1. Moves linkage at the turbocontrol in feather position only.	______
2. Cams out negative torque system in beta range.	______
3. Cams out mechanical governor in beta range.	______
4. Schedules pilot valve movement in beta range.	______
5. Insures the propeller goes to full feather.	______
6. Positions pilot valve as scheduled by power lever.	______
7. Backs up the low pressure relief valve to shift the low pitch stop servo valve.	______
8. Indicates actual blade angle.	______
9. Transmits blade angle reading from No. one blade to cam on beta shaft.	______

Project 2

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DIRECTIONS

Using TOs 1C-130B-2-11 and 3HA2-7-3, answer the following questions.

1. What technical order lists the procedures for valve housing removal and replacement on the flight line? ______________________

2. What is the paragraph number for removal and replacement of the valve housing assembly? ________

3. What section of the technical order lists the special tools required for removal and replacement of the valve housing assembly?

____

4. What is the specific caution in the technical order that concerns electrical power to the synchrophaser assembly? ________

____

5. What are the three components on the propeller assembly which must be removed prior to removing the valve housing assembly?

____

6. What is the special tool which must be installed prior to removing the nuts that secure the valve housing assembly to the pump housing assembly? ______________________________

7. What is the nomenclature of the special tool used to remove the inaccessible nuts on the valve housing? ____________

8. Why do you compensate for backlash in the beta gear train during installation of the valve housing assembly? ____________

____

9. What is the torque limit on the nuts that secure the valve housing to the pump housing? __________

10. What is the position of the alpha shaft when installing the valve housing cover? ______________________________

11. How do you adjust the input lever on the valve housing cover that aligns with the index plate? ______________________

____

12. What is the clearance gap limits on the negative torque system bracket? ____________

13. What is the maximum limit for ground idle blade angles?

____

14. What is the maximum limit for adjustment of the reverse blade angle? __________

15. What section of the technical order lists the procedures for adjusting propeller control linkage? __________

16. What secion of the technical order lists the procedures for the operational checks with engine not running? __________

17. What section of the technical order lists the troubleshooting procedures for the propeller assembly? __________

Technical Training

Turboprop Propulsion Mechanic

PREPARE PROPELLERS/PROPELLER UNITS FOR RETURN TO SUPPLY

28 February 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

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Jet Engine Branch
Chanute AFB, Illinois

PREPARE PROPELLERS/PROPELLER UNITS FOR RETURN TO SUPPLY

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to state the procedures for preparing the propeller/propeller units for return to Supply.

INTRODUCTION

This study guide is designed to introduce you to the procedures of preparing the propeller/propeller units for return to Supply.

INFORMATION

When the 54H60 propeller assembly is removed from the aircraft for time expiration, it must be prepared for shipment to the overhaul facility. There are certain steps that must be adhered to in order to prevent corrosion and foreign objects from damaging the propeller parts during the shipment of the propeller assembly to the overhaul facility.

The propeller assembly must be completely disassembled in order to prepare the propeller for shipment to the overhaul facility. The bottom afterbody assembly is removed from the afterbody mounting bracket assembly. The two terminal nuts, washers, and retaining plate that connect the deicing heater leads on the afterbody assembly to the afterbody mounting bracket assembly must be removed. Remove the safety wire holding the four bolts to the adjacent flat head screws. Loosen the four bolts that retain the afterbody assembly to the afterbody mounting bracket assembly. The propeller blades will have to be turned towards the ground idle position. This position of blade angle is where the blade tips are almost parallel to the floor when the propeller assembly is on the assembly bench. On the aircraft, this position is where the blade tips are almost parallel to the aircraft wing. The propeller blades must be in this position to be able to remove the bottom afterbody assembly from the slot on the rear spinner assembly. Remove the bottom afterbody assembly from the propeller assembly, taking care to not damage any of the other parts on the propeller assembly. When the bottom afterbody assembly has been removed, turn the propeller blades back to the feather position. Exercise caution not to turn number one blade off the beta feedback gear and the feedback pinion gear. Have someone else watch the blade gear segment to tell you when the blade is nearing the 90-degree mark that is etched on the barrel shelf. If the blade does

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DISTRIBUTION: X
3350 TCHTG/TTGU-J - 200; TTVSA - 1

go beyond 110 degrees, the blade is off the beta feedback gear. Do not attempt to turn the blade back to the feather blade angle. By turning the blade back, this action will cause damage to the beta feedback shaft and gear assembly.

The next assembly to be removed is the afterbody mounting bracket assembly. Remove the safety wire holding the ten cap screws and washers that secure the afterbody mounting bracket to the propeller control assembly. Remove the two electrical leads from the brush block assembly, located on the top of the propeller control assembly. Remove the ten cap screws and washers from the afterbody mounting bracket and the propeller control assembly. Then, the afterbody mounting bracket can be removed from the propeller control assembly.

Prior to removing the propeller control assembly from the propeller barrel extension, use a suitable container of approximately five-gallon capacity to drain the propeller control assembly's pressurized and atmospheric sumps of hydraulic fluid. For personnel safety, place an oil drip pan under the propeller assembly to catch the residue oil, preventing the possibility of injury to the individuals who are disassembling the propeller assembly by slipping or falling on a wet floor. It is also advisable to have mops and buckets readily available to clean up the floor, in case some of the hydraulic fluid does spill onto the surrounding floor area. There will be approximately three and a half gallons of hydraulic fluid in the propeller hub and control assemblies. Most of the hydraulic fluid will be drained in a suitable container, but there will be some hydraulic fluid spill into the drip pan or on the floor during the disassembly.

With the propeller assembly in the vertical position, turn number one blade, exercising caution, until the backup valve control cam (protractor) located in the valve housing assembly, reads 90 degrees of blade angle. Install the beta shaft rig pin, P/N 546455, through the beta shaft sleeve bushing into the stop disk on the beta shaft. These parts are located in the valve housing assembly. To install the beta shaft rig pin, the valve housing access cover (gas cap) will have to be removed. After the beta shaft rig pin has been installed, the propeller control assembly's pin retaining ring can be removed from the barrel extension bore. Using the mechanical puller, HS 8173, the propeller control assembly can be removed from the propeller assembly. First, four self-locking nuts must be removed from the studs on the aft end of the control assembly. Then, attach the mechanical puller to the four studs and secure the mechanical puller with the four self-locking nuts. Make sure the puller end plate is secured inside the barrel extension. Turn the mechanical puller in a clockwise direction until the propeller control assembly separates from the barrel extension. Be prepared to support the control assembly as it comes off the barrel extension. Do not let the control assembly drop on the mechanical puller, this can cause damage to the control assembly's rotating sleeve. If damage is done to the rotating sleeve, the pump housing assembly will have to be shipped to the overhaul facility, because repair of the item cannot be done by a field maintenance repair facility.

810 After the control assembly has been removed from the barrel extension, place the assembly in the portable dolly, or lay it on its side, with the rotating sleeve pointing upwards. The mechanical puller will have to be removed prior to placing the control assembly on its side, then replace the four self-locking nuts back on the studs to protect the threads on the studs from being damaged. The beta shaft rig pin, previously installed in the valve housing assembly, must be retained in the beta shaft until the propeller control assembly is reinstalled on another propeller hub and blade assembly.

The next part to be removed is the deicer contact ring holder assembly. Detach the four rear spinner electrical connector straps from the terminals of the deicer contact ring holder assembly, and loosen the four self-locking nuts on the deicer contact ring holder assembly enough to allow the electrical connector straps to be turned away from the rear spinner assembly. Remove the safety wire from the eight socket head cap screws and remove the socket head cap screws and washers which retain the deicer contact ring holder assembly. Remove the packing seat ring and the preformed packing from the propeller barrel rear extension.

The rear spinner assembly is the next part to be removed from the propeller assembly. Remove the eight self-locking nuts, spinner mounting washers, sleeve spacers, flat washers, and dowel bolts which retain the rear spinner assembly to the hub mounted bulkhead assembly. After the rear spinner assembly has been removed, the propeller assembly can now be placed on the propeller assembly bench.

Use the hoist and the propeller lifting assembly to place the propeller assembly on the assembly bench and post assembly.

The hub mounted bulkhead assembly is the next part that must be removed from the hub and blade assembly. Remove the cotter pins which secure the castellated nuts and the barrel bolt extensions. Remove the castellated nuts and the washers from the hub mounted bulkhead assembly and remove the bulkhead assembly. With the completion of the removal of the afterbody, afterbody mounting bracket, propeller control, deicer contact ring holder, rear spinner, and hub mounted bulkhead assemblies, all of the propeller associated parts have been removed from the propeller hub and blade assembly. They must each be tagged with an AFTO Form 350. Each item must have a separate AFTO Form 350 so they can be cleaned, inspected, and/or repaired as required in accordance with the applicable technical order. Each item will be cleaned with an approved cleaning solution, such as PD-680, dry cleaning solvent. After cleaning, the items will be inspected for deterioration of the rubber seals, metal corrosion, wear, and other damage. All electrical wiring will be inspected for broken wires, damaged sheath coverings, corrosion, loose and damaged electrical pins, and security of the retention receptacle mounts. All the electrical receptacles must be covered with plastic or capped with electrical caps, and the propeller control assembly rotating sleeve must be covered to prevent contamination from entering the control assembly.

The hub and blade assembly will be disassembled using the correct procedures contained in TO 3H1-18-2. With the hub and blade assembly on the assembly post and bench, remove the eight cotter pins from the barrel bolt extension studs. To remove the barrel bolt extension studs, it will be necessary for you to use a one and one-sixteenth inch socket, a torque breaking work handle, and a 15/16 inch box end wrench. Remove the extension studs. Then, using a soft-faced mallet tap the barrel bolts out of the barrel assembly. Install the front barrel half fuller, HS 7031, and the hoist. Then, slowly pull the front barrel half apart from the rear barrel assembly. Remove the rubber seals from the barrel halves, and throw the rubber seals in a trash container. Then, exercising caution, remove the serially numbered split thrust washers from around the blade shanks. It may be necessary to move the blade tips in an up-and-down motion very slightly while rotating the split thrust washers. This will aid in the removal of the split thrust washers. Remove the thrust bearing retainers in the manner as described in removing the split thrust washers.

NOTE: THE SPLIT THRUST WASHERS ARE SERIALIZED AND MUST BE KEPT TOGETHER AS A MATCHED SET.

To remove each of the propeller blades, place an HSP 1682, sling assembly, around the blade which will be removed first from the barrel assembly. Pull the blade outward, towards the blade tip, just enough to clear the barrel arm stub, and then lift the blade straight up using the hoist. Make sure the numbered shim plate or the beta segment gear does not fall off the blade butt and get damaged. Using a soft rag moistened with an approved cleaning solvent, such as PD-680, dry cleaning solvent wipe the blade shank and blade butt clean. After the blade shank and blade butt has been cleaned, protect the teflon strip around the blade shank by wrapping it with adhesive cloth, adhesive paper, or heavy wrapping paper. Remove the remaining three blades in the same manner as described in the above paragraphs. After all the blades have been removed from the barrel assembly, the blade seals can be cut off the blade shank using a knife. Use caution not to damage the blade shank and the teflon strip. Remove the blade seal retaining rings from each of the blades. The seal retaining rings must be sent to the overhaul facility with the propeller assembly. Do not remove the microadjustment rings, blade segment gear, and segment gear shim from the blade butt. Wrap the blade butt and shank in adhesive cloth, adhesive paper or heavy wrapping paper and secure it with tape. When this has been completed, the blades can be placed in the propeller shipping crate.

With the completion of the blade removal, the barrel assembly must be cleaned out with PD-680, dry cleaning solvent and wiped dry with rags. The top barrel half must now be installed on the rear barrel half. Using the barrel bolts and the barrel extension studs, secure the two barrel halves together. Using an approved wrapping material, the barrel assembly should be wrapped and placed in the shipping crate.

The pitch lock assembly and the dome assembly must be drained of all hydraulic fluid, and flushed with PD-680, dry cleaning

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solvent, and allowed to air dry. This is to comply with Air Force directives concerning the shipment of equipment that contains flammable fluid such as fuel or oil. The pitch lock and dome assemblies then can be wrapped with an approved wrapping material and placed in the shipping container.

Now, clean and wipe dry the split thrust washers, bearing retainers, external splined ring spacer, pitch lock ratchet ring, pitch lock locking control cam ring, pitch lock externally threaded ring, propeller retaining nut, front and rear cones, and the packing seat ring. Wrap these parts in an approved wrapping material. Remember, the split thrust washers are serialized as a matched set and must be kept together, so wrap these parts in a separate package. Place the parts in the shipping crate. After the complete propeller hub assembly and the associated items are placed in the shipping crate, the lids for the two end boxes can be installed. The shipping crate frame can be installed and secured with the bolts and nuts that are provided.

With the completion of the disassembly of the propeller hub and blades, you will be required to completely fill out the following forms: AFTO Form 349, Maintenance Data Collection Record; AFTO Form 350, Reparable Item Processing Tag; and DD Form 1577-2, Unserviceable (Reparable) Tag Materiel. These forms are for maintenance documentation and will have to be taken to a supervisor who is authorized to sign them. The AFTO Form 95, Significant Historical Data, will be sent to the shop from the aircraft records section. The aircraft records section is part of the Deputy Commander for Maintenance complex. The AFTO Form 95 will be secured to the outside of the shipping crate. The AFTO Form 349, AFTO Form 350, and DD Form 1577-2 will be turned in for documentation by the supervisor.

QUESTIONS

1. What is the first part to be removed from the propeller assembly during disassembly?

a. Top afterbody
b. Bottom afterbody
c. Rear spinner assembly
d. Afterbody mounting bracket

2. Why do you place an oil drip pan under the propeller control assembly during disassembly?

a. For personal safety
b. To catch the hydraulic fluid
c. To hold handtools
d. To catch residue hardware

3. The reason for not turning number 1 blade past 90 degrees of blade angle is because it will damage the

a. pump housing.
b. valve housing.
c. beta feedback shaft and gear.
d. beta shaft.

4. What unit mounted on the control assembly must be removed during disassembly of the propeller assembly?

a. Afterbody assembly
b. Rear spinner assembly
c. Afterbody mounting bracket
d. Brush block assembly

5. What is the nomenclature of the rig pin installed prior to removing the control assembly?

a. Alpha shaft rig pin
b. Backup valve ring pin
c. Beta shaft rig pin
d. Blade angle rig pin

6. What is the part number of the mechanical puller used to remove the control assembly from the barrel extension bore?

a. HS 8163
b. HS 8165
c. HS 8173
d. HS 8175

7. In what direction is the HS 8173 mechanical puller turned to remove the control assembly?

a. Clockwise
b. Counterclockwise
c. Laterally
d. Horizontally

8. What part will be damaged if the control assembly drops on the mechanical puller?

a. Barrel extension
b. Control assembly
c. Stationary sleeve
d. Rotating sleeve

9. How many cap screws hold the deicer contact ring holder assembly to the propeller assembly?

a. Six
b. Seven
c. Eight
d. Nine

17. What are the propeller parts wrapped with for shipment to depot?

a. Adhesive cloth
b. Paper
c. Cloth
d. Waxed paper

18. What three forms will be taken to your supervisor after the propeller assembly has been placed in the shipping crate?

a. AFTO Form 349, AFTO Form 350, DD Form 1577-2
b. AFTO Form 350, AFTO Form 781, DD Form 1577-2
c. AFTO Form 95, AFTO Form 349, AFTO Form 350
d. DD Form 95, AFTO Form 781, AFTO Form 350

17. What are the propeller parts wrapped with for shipment to depot?

a. Adhesive cloth
b. Paper
c. Cloth
d. Waxed paper

18. What three forms will be taken to your supervisor after the propeller assembly has been placed in the shipping crate?

a. AFTO Form 349, AFTO Form 350, DD Form 1577-2
b. AFTO Form 350, AFTO Form 781, DD Form 1577-2
c. AFTO Form 95, AFTO Form 349, AFTO Form 350
d. DD Form 95, AFTO Form 781, AFTO Form 350

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WORKBOOK

3ABR42633-WB-401

Technical Training

Turboprop Propulsion Mechanic

DISASSEMBLY, INSPECTION, AND REASSEMBLY OF TURBINE AND COMBUSTION SECTION

12 February 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

817

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-401

DISASSEMBLY, INSPECTION, AND REASSEMBLY OF TURBINE AND COMBUSTION SECTION

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Locate and identify specific special tools using the proper technical order.

2. Locate and use the proper technical orders to locate specific directions for disassembly, inspection, and reassembly of turbine and combustion section.

EQUIPMENT

	Basis of Issue
TO 00-20-2-4	1/student
TO 1C-130A-06	1/student
TO 2J-T56-26	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Using TO 2J-T56-26, answer the following questions and complete the incomplete statements.

1. How many changes have been made in this TO? __________

2. What does section three of this TO cover? ______________

____

3. What figure number shows an illustration of turbine shroud No. 6799819? __________

4. What table lists combustion liner inspection limits?

____

5. Who authorizes Field Maintenance to be accomplished on the T56 engine? ____

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

6. The engine consists of a ____________ ____________ ____________ ____________, ____________ ____________, and a reduction gear assembly.

7. What is the title of TO 2J-T56-607? ____________________________________

8. What type hammer heads should be used when driving on any part of the engine? ____________

9. What is the part number of the tool that must be used with 6796524? ____________

10. What is the stock number of tool part number 6799053?

____

11. In what tool group is the wedge inlet guide vanes located?

____

12. In what tool group is the tool part number 6799976 located?

____

13. What figure shows an illustration of the inner rear exhaust cone puller No. 6795867? ________

14. What is used to mark parts of the hot section of the engine?

____

15. How many bolts are used to attach the rear scavenge oil pump support? ________

16. What tool group must you refer to for turbine unit and combustion assembly removal? ____________

17. What step tells you to remove the spark igniters, liner supports, and drain valves? ____________

18. Before you install the turbine unit lifting adapter, how many bolts have to be removed from the combustion outer casing-to-turbine inlet case split line? ________

19. What is used to number each combustion liner for relocation at assembly? ____________________

20. What position must the turbine unit be in on the stand to remove the turbine rear bearing? ________________________

21. When does the turbine front bearing scavenge pump have to be removed? ________________________________

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22. If difficulty is encountered when removing the seal and ring from the turbine front bearing, it must be removed IAW paragraph ________.

23. How must the four turbine inlet casing separators be installed on the turbine vane casing-to-turbine bearing support split line? ________________

24. What must be used if it is desired to lift the turbine rotor in a horizontal position? ________________

25. What TO do you refer to for the cleaning solvent recommended for the nonferrous parts? ________________

26. What do you inspect the turbine rotor shaft bearings for?

____

27. What is used to clean the igniter plugs? ________________

28. When inspecting the turbine inlet casing, what figure must you refer to to replace damaged or loose thermocouple studs?

____

29. If there is any evidence of undercutting at the base of the turbine blades, what must be done with the turbine rotor? ________

____

30. If you are inspecting a turbine blade and find a rough and crusty appearance on the blade leading edge and airfoil section, what must be done with the turbine? ________________

31. What must be done with the turbine-tc-compressor tie bolt if any cracks are found in it? ________________

32. What TO do you refer to for calibration of the thermocouple resistance tester No. 6799327? ________________

33. When a torque wrench is used at right angles to the adapter, the reading is ________.

34. What TO do you refer to for inspection and age control of rubber engine parts, and cure date control? ________________

35. What lubrication is required during assembly of the turbine front bearing case split seal rings? ________________

36. What sealing compounds are applied to the rear scavenge pump mounting bolt threads during assembly? ________________

37. During buildup of the turbine, what step tells you to install the turbine rotor adjusting jack? ________

38. During buildup of the turbine, what is used to drive the vane casing into position? ________

39. What is the torque on the oil nozzle for the turbine rear bearing? ________

40. Is it permissible to intermix different part number combustion liners? ________

41. What paragraph applies to thermocouples and thermocouple harness installation? ________

42. Where are the thermocouples installed on the T56 engine?

____

43. When setting turbine rotor clearance, how much does one turn of the tie bolt increase the front of vane clearance? ________

Project 2

DIRECTIONS

Using TO 00-20-2-4, answer the following questions and complete the incomplete statements.

1. What is entered in block 3 of the AFTO Form 349 for in-shop engine work? ________

____

2. What is entered in block 5 of the AFTO Form 349 for in-shop engine work? ________

3. When will entries be required in blocks 19 through 25 of an AFTO Form 349? ________

____

4. Which columns on the AFTO Form 349 are you not authorized to use ditto marks to indicate repetitive data elements? ________

____

5. When entering the start hour in column H, how must it be entered? ________

6. Where does the job control number entry on an AFTO Form 350 tag come from? ________

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7. What goes in block 6 of an AFTO Form 350 tag put on a turbine rotor? ______________________________

8. When can an AFTO Form 350 tag be used for more than one item? ______________________________

____

9. Who is responsible for completing block 29 of an AFTO Form 350? ______________________________

Project 3

DIRECTIONS

Using TO 1C-130A-06, answer the following questions and complete the incomplete statements.

1. During what change number to this TO was page V-005 changed?

____

2. What is the type maintenance code for gas turbine engine Field Maintenance (JEBM)? __________

3. What is the type maintenance code for a time compliance technical order (TCTO)? __________

4. What is the action taken code for disassemble? __________

5. What is the when discovered code for in-shop repair and/or disassembly for maintenance? __________

6. What is the how malfunction code for bearing failure?

____

7. What is how malfunction code 486? ______________________

8. What is the work unit code for the exhaust cone? __________

9. What is the work unit code for the turbine coupling shaft?

____

10. What is the work unit code for the turbine rotor assembly A-15? __________

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Project 4

DIRECTIONS

Using applicable publications, select the necessary data from given information and complete the necessary forms (figures 1, 2, 3, and 4) indicating that you have completed the task required by the discrepancy. Additional forms will be provided if you request them. Complete only the front side (Part I) of the required AFTO Forms 350.

1. Today, you and a crew of three are assigned the job of removing and disassembling the turbine section. You begin removal at 0800 and complete removal at 1000 hours, at which time you begin disassembly of the turbine section. Your lunch is from 1130 to 1230, and you complete the disassembly at 1600 hours.

2. During disassembly and insepction of the parts you found the following items bad.

a. The turbine inlet casing is cracked.

b. The pump idler gear shaft, for the rear turbine scavenge pump, is sheared.

c. A combustion liner assembly cracked.

3. Use what you need from the following data and complete the required forms.

a. General information

(1) Job control number will be current Julian date and 0101

(2) SRD Code - XM3

(3) Workcenter is T3230

(4) FSC is 2840

b. Engine data

(1) Model and series T56-A-7B

(2) Serial number AE104320

(3) ID number TX 4320

c. Part numbers for the parts can be located in the IPB for the engine.

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MAINTENANCE DATA COLLECTION RECORD — OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION
0101								

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPC REQ	18. JOB STD.

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER. TIME

ACT. LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M. SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

TURBINE FAILURE

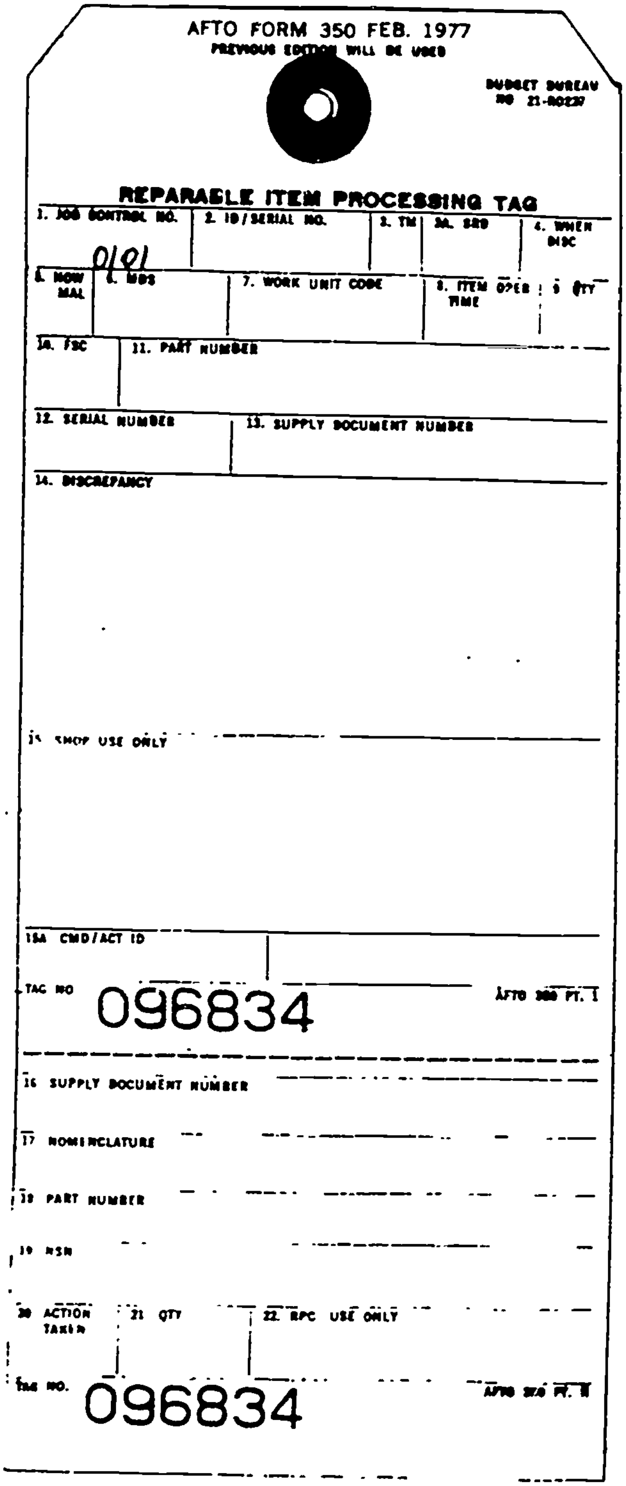
27. CORRECTIVE ACTION

28. RECORDS ACTION

AFTO FORM MAY 73 349 — PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

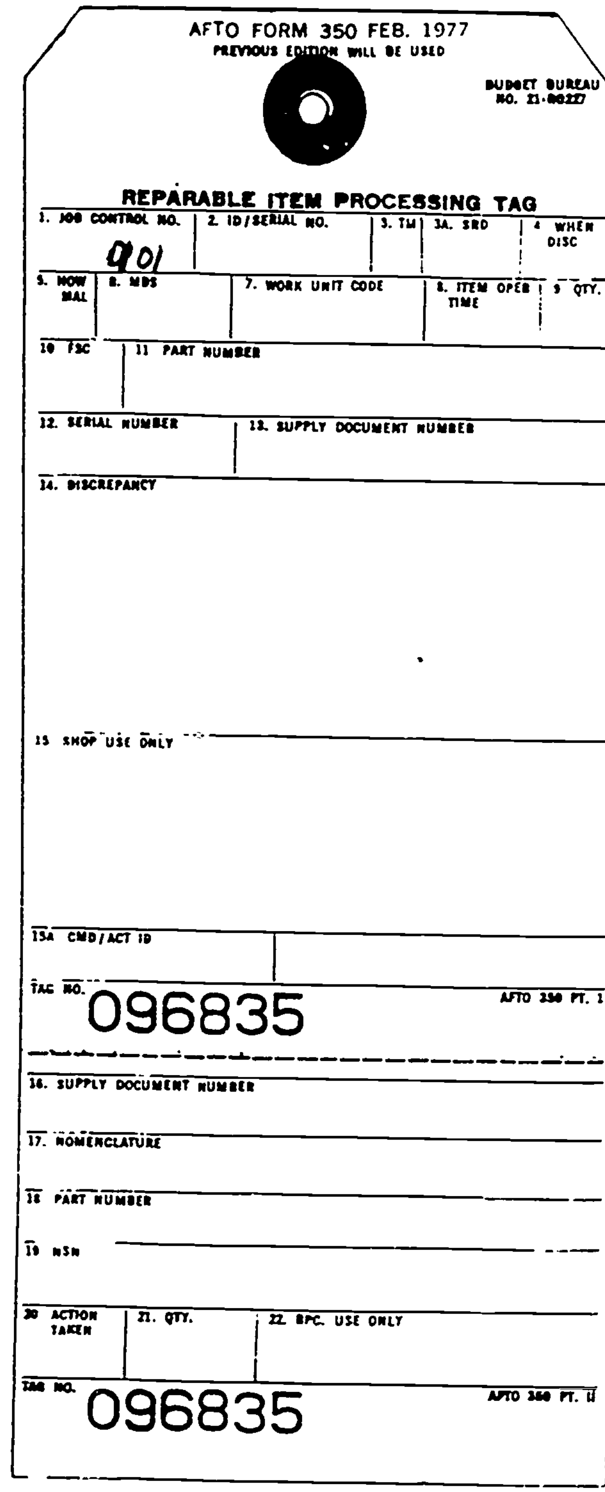
838


AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED
BUDGET BUREAU NO. 21-R0227

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. 0101 | 2. ID/SERIAL NO. | 3. TM | 3A. SRD | 4. WHEN DISC
5. HOW MAL | 6. MDS | 7. WORK UNIT CODE | 8. ITEM OPER TIME | 9. QTY
10. FSC | 11. PART NUMBER
12. SERIAL NUMBER | 13. SUPPLY DOCUMENT NUMBER
14. DISCREPANCY
15. SHOP USE ONLY
15A. CMD/ACT ID
TAG NO. 096834 AFTO 350 PT. I
16. SUPPLY DOCUMENT NUMBER
17. NOMENCLATURE
18. PART NUMBER
19. NSN
20. ACTION TAKEN | 21. QTY | 22. RPC USE ONLY
TAG NO. 096834 AFTO 350 PT. II

Figure 2. AFTO Form 350.


AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED
BUDGET BUREAU NO. 21-R0227

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. 0101 | 2. ID/SERIAL NO. | 3. TM | 3A. SRD | 4. WHEN DISC
5. HOW MAL | 6. MDS | 7. WORK UNIT CODE | 8. ITEM OPER TIME | 9. QTY.
10. FSC | 11. PART NUMBER
12. SERIAL NUMBER | 13. SUPPLY DOCUMENT NUMBER
14. DISCREPANCY
15. SHOP USE ONLY
15A. CMD/ACT ID
TAG NO. 096835 AFTO 350 PT. I
16. SUPPLY DOCUMENT NUMBER
17. NOMENCLATURE
18. PART NUMBER
19. NSN
20. ACTION TAKEN | 21. QTY. | 22. RPC. USE ONLY
TAG NO. 096835 AFTO 350 PT. II

Figure 3. AFTO Form 350.

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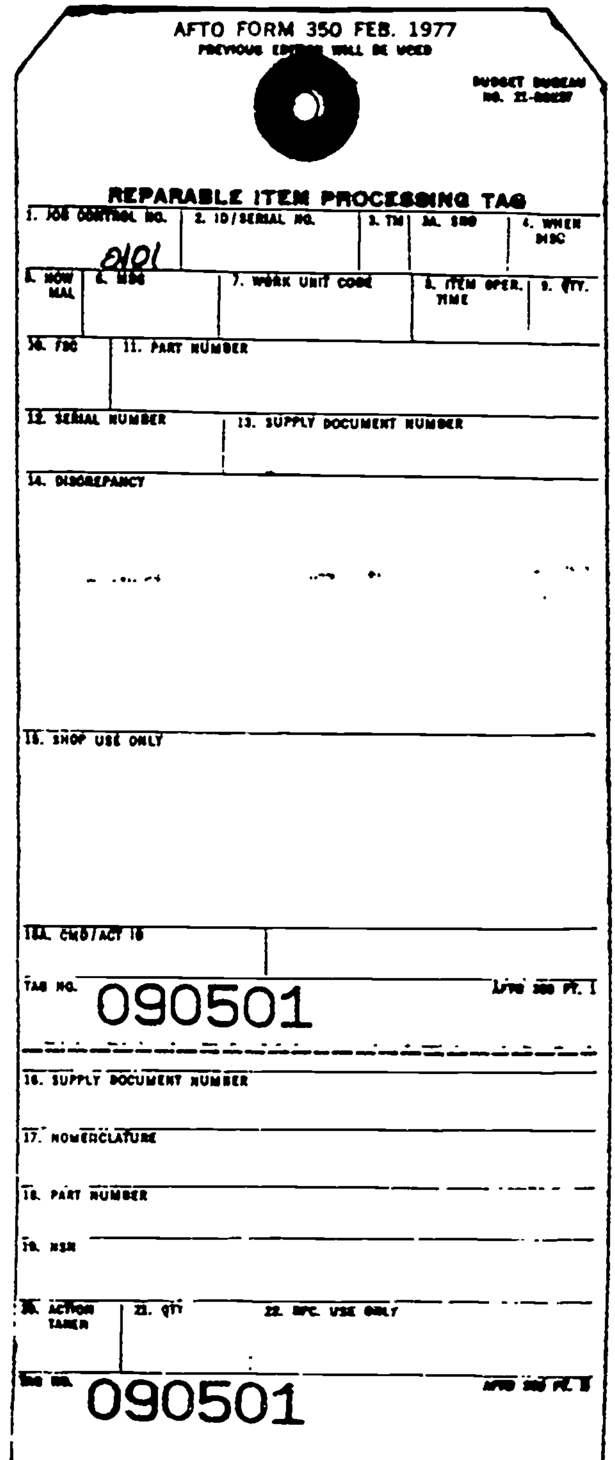

AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU NO. 21-[illegible]

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO.	2. ID/SERIAL NO.	3. TM	3A. SRD	4. WHEN DISC
0101				

5. HOW MAL	6. MDS	7. WORK UNIT CODE	8. ITEM OPER. TIME	9. QTY.

10. FSC	11. PART NUMBER

12. SERIAL NUMBER	13. SUPPLY DOCUMENT NUMBER

14. DISCREPANCY

15. SHOP USE ONLY

15A. CMD/ACT ID

TAG NO. 090501 AFTO 350 PT. I

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE

18. PART NUMBER

19. NSN

20. ACTION TAKEN	21. QTY	22. RPC. USE ONLY

TAG NO. 090501 AFTO 350 PT. II

Figure 4. AFTO Form 350.

STUDY GUIDE/WORKBOOK
3ABR42633-SW-401/402

Technical Training

Turboprop Propulsion Mechanic

T56 CONSTRUCTIONAL FEATURES

4 February 1980

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

Do Not Use on the Job.

827

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SW-401/402

T56 CONSTRUCTIONAL FEATURES

OBJECTIVES

Upon completion of this study guide/workbook and your classroom instruction, you will be able to explain the constructional features and operating principles of the turbine and combustion sections, reduction gearbox, and torquemeter assembly.

INTRODUCTION

Once you get out in the field and start work, one of the most important jobs you will do is work on the turbine and combustion sections. If you know these sections, you will be able to perform better maintenance because you will know what you are working on.

INFORMATION

COMBUSTION SECTION ASSEMBLY

As you study this part of the text, refer to figure 1 and relate the terminology used to the illustration of the various parts.

The outer combustion casing is a fabricated steel assembly which is secured to the compressor diffuser and the turbine inlet casing. It is the structural member used to support the entire weight of the turbine section and forms the outer wall of the combustion section. This chamber provides mounting for two igniter plugs and four liner supports which are equally spaced near its forward end. The igniter plugs and liner supports extend into the combustion liners and thereby, axially position and retain the combustion liners within the outer combustion casing. Two burner drain valves are located on the bottom of the outer combustion casing, one at the forward end and the other at the aft end. These are used to drain any fuel overboard that may collect in the combustion section at engine shut-down. The drain valves are lightly spring-loaded open and are closed when the internal pressure of the combustion section reaches 2 to 3 psi.

The combustion inner casing is fabricated to the turbine inlet casing and "slip fits" into the compressor diffuser combustion inner casing sleeve. An alignment bellows, located near the aft end, allows for slight misalignment of the turbine casing and compressor diffuser without damage to the inner combustion casing. The inner combustion casing has two grooves near its forward end. Each groove houses a seal ring expander. These seal rings are used to prevent leakage of air at the forward end of the combustion section into the cavity in which oil is scavenged by the external scavenge pump. The inner combustion casing

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 600; TTVSA - 1

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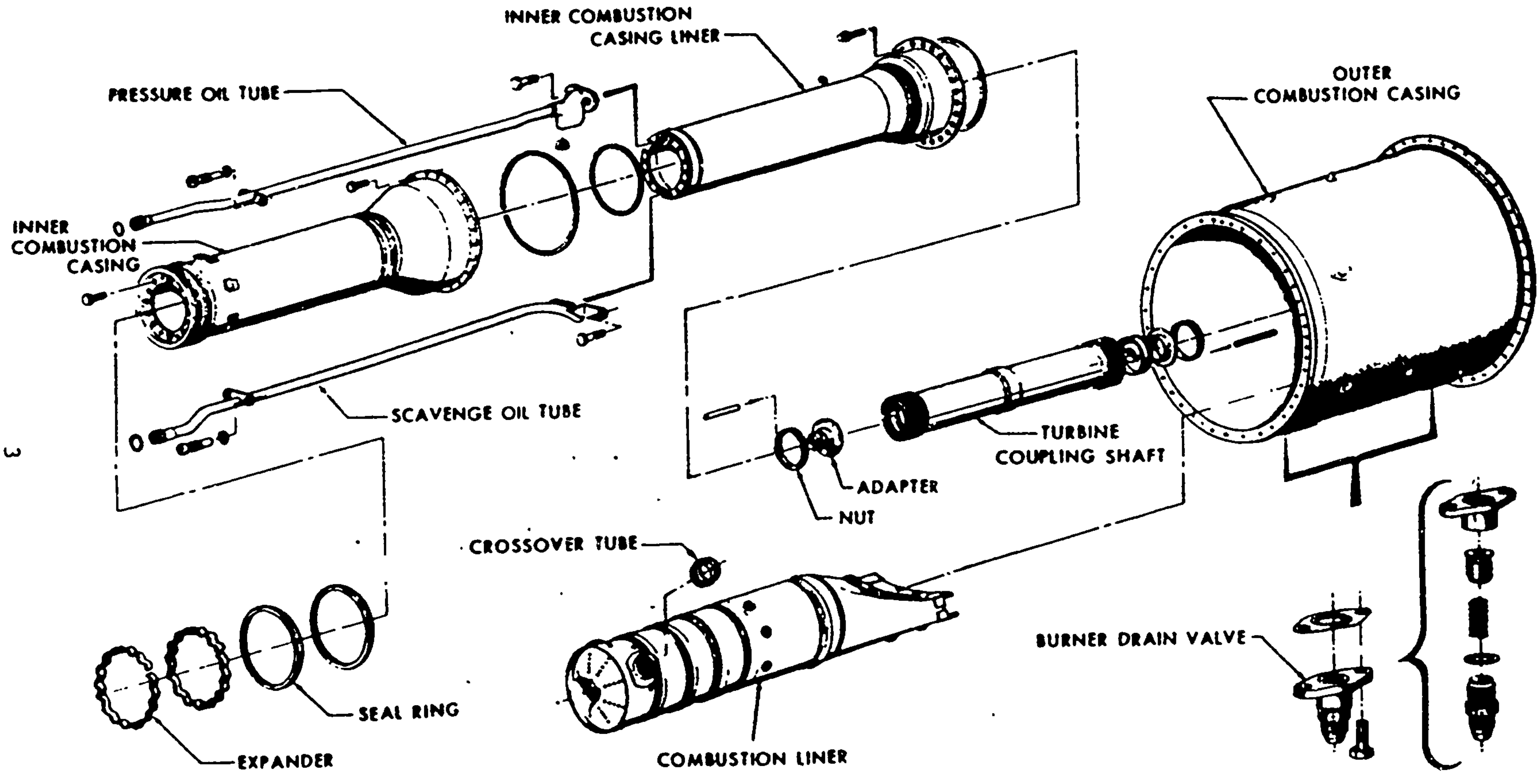

Figure 1. Combustion Section Assembly.

liner forms a double walled inner combustion chamber. The outer wall, being nearer to the combustion area, tends to expand more than the inner wall. Therefore, an expansion bellows, located on the inner wall is used to prevent possible damage due to the difference in expansion and contraction between the inner and outer walls. The space between the two walls is pressurized by inner stage seal pressure through holes in the turbine inlet casing.

Six identical combustion liners are housed between the outer and inner combustion chambers. These liners are positioned axially by either an igniter plug or a liner support mounted on the outer combustion chamber. The liners are radially positioned at the front by fuel nozzles secured to the compressor diffuser, and at the rear by the first stage turbine inlet casing. Combustion liners are designed to control flame length and flame position within the liner, and to provide a rapid fuel/air mixing area. The liners are inter-connected near their forward ends by cross-over tubes which are used to equalize internal pressures, and to provide a path for flame crossover during starting.

The turbine coupling shaft passes through the interior of the inner combustion casing liner. It is used to transfer turbine rotor torque to the compressor rotor. This shaft is externally splined at the front and rear. It splines into the compressor coupling at the front, and into the shaft to turbine coupling at the rear.

Since the turbine coupling shaft rotates at power section rpm, it is mandatory that it be held concentric with the turbine and compressor rotors in order to prevent vibration. This shaft has two coupling adapters. These adapters are retained in the ends of the turbine coupling shaft by externally threaded nuts which thread into the turbine coupling shaft and are pinned in place. The front coupling adapter fits into the hollow hub of the 14th stage compressor wheel. The rear coupling adapter fits over the hub of the first stage turbine wheel. Thus, through the coupling adapters, the turbine coupling shaft is mated concentric with the compressor and turbine rotors. The turbine coupling shaft also has in its interior, a bolt spacer used to properly position the turbine-to-compressor tie bolt which passes through the turbine coupling shaft. The shaft is free to "float" fore and aft in the compressor and turbine couplings. This design enables easy assembly and disassembly of the power section, and allows for differentials of expansion and contraction of the parts of the "hot section."

An oil pressure line extends rearward through the inner combustion casing liner to provide for lubrication of the front turbine bearing. Oil pressure is supplied to the line from the compressor rear bearing oil jet assembly.

INSTRUCTIONS

Complete the following statements by writing the correct words in each blank space.

1. The ________ ________ ________ is used to support the entire weight of the turbine section and forms the outer wall of the ________ ________.

2. The ________ ________ are used to drain any fuel overboard that may collect in the combustion section at engine ________.

3. A ________ ________ or ________ ________ positions the combustion liners axially.

4. The liners are radially positioned at the front by ________ ________ secured to the compressor diffuser and at the rear by the ________ ________ ________ ________ casing.

5. Combustion liners are designed to control ________ ________ and ________ within the liner, and to provide a rapid fuel/air mixing area.

6. The ________ ________ ________ is used to transfer turbine rotor torque to the compressor rotor.

7. The turbine coupling shaft has a ________ ________ in its interior used to properly position the turbine-to- ________ tie bolt which passes through the turbine coupling shaft.

TURBINE UNIT ASSEMBLY

As you study this part of the text, refer to figure 2 and relate the terminology used to the illustration of the various parts.

The turbine unit assembly uses the hot gases from the combustion section. By means of a four-stage turbine, the energy in the expanding gases is connected into shaft horsepower for driving the compressor rotor. Also six oil pump assemblies, the engine driven accessories, and the propeller. The turbine rotor is radially supported by two roller bearings; one at the front, the other at the rear. By means of the turbine-to-compressor tie bolt and the compressor rear bearing, the turbine rotor is positioned and retained in its proper axial position.

The turbine inlet casing outer and inner shells are interconnected by six hollow, radial supporting struts. The outer shell mounts to the combustion inner casing and inner casing liner. Eighteen dual element thermocouple assemblies are mounted on the outer shell, with their probes extending into the hot gases at the outlets of the six combustion liners. Each of the thermocouple assemblies contains two individual thermocouples. These are gas-shielded (shrouded) thermocouples which use two sampling holes on the forward side, and one larger exit hole on the rear side. A

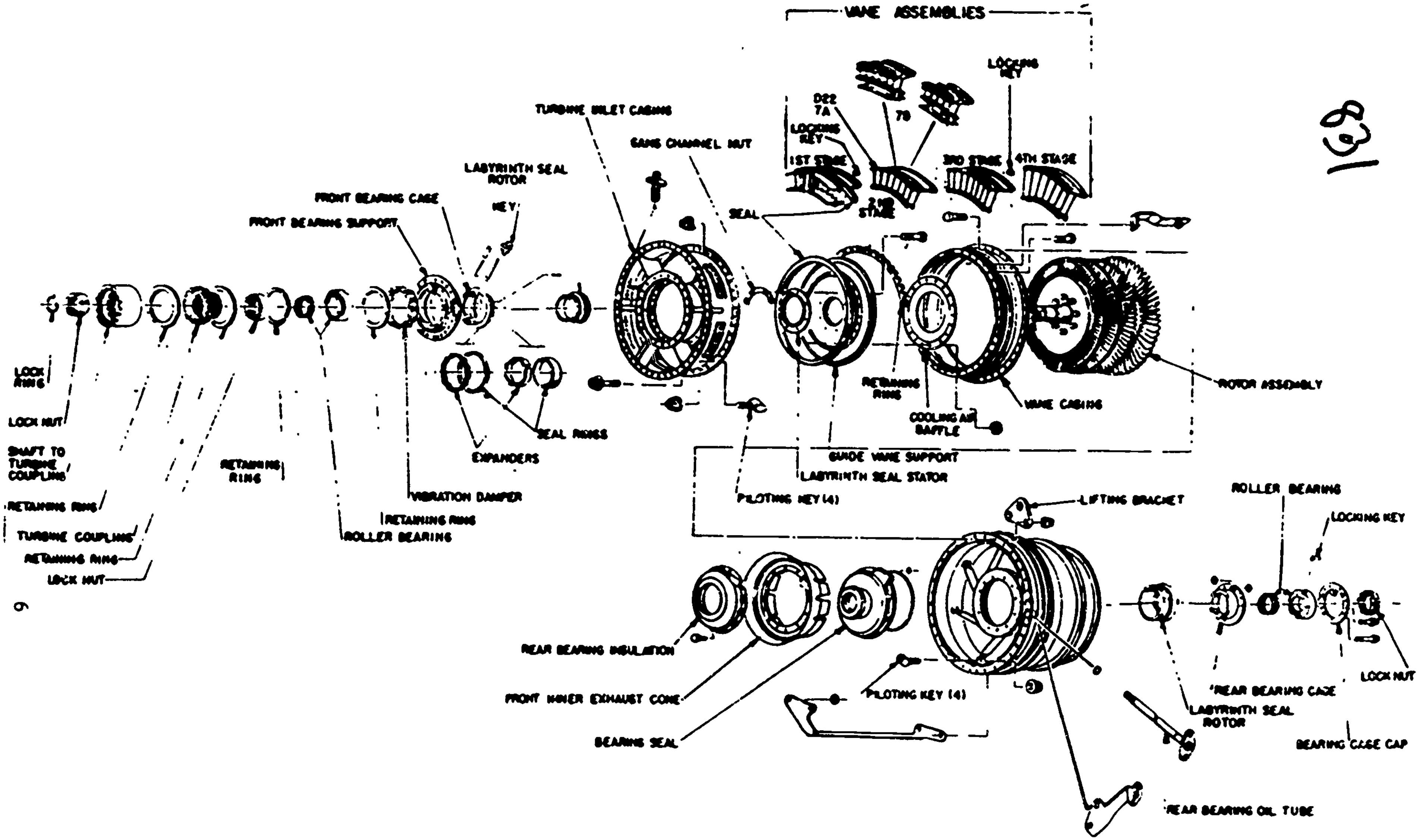

Figure 2. Turbine Unit Assembly.

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thermocouple of each assembly is connected in a parallel circuit that sends a signal of turbine inlet temperature (TIT) to the temperature indicating system. The remaining eighteen thermocouples (one per assembly) are also connected in a parallel circuit which sends a turbine inlet temperature signal (millivoltage) to the temperature datum control (amplifier) of the electronic fuel trimming system. This amplifier compares the temperature signal to a reference signal, and the signal difference is used by the amplifier for the purpose of limiting or controlling the turbine inlet temperature.

Holes in the mounting flange of the turbine inlet casing index with holes in the mounting flange of the combustion inner casing liner. These air passages allow the space between the two walls of the combustion inner casing assembly to be pressurized by interstage seal pressure. Air which leaks past the rear step of the turbine front labyrinth seal, is vented through the casing and two of its struts. The guide vane support and cooling air baffle are secured to the rear side of the inlet casing. Turbine rotor cooling air is directed from within the turbine inlet casing through the mounting flanges of the inlet casing and guide vane support. The cooling air baffle guides this cooling air toward the base of the turbine rotor.

Six first stage vane assemblies, contained within the turbine inlet casing, provide the stator for the first stage of the turbine. The guide vane support retains the first stage vane assemblies in the inlet casing during engine buildup and provides rigidity and structural support when the turbine unit assembly is completely built up. The spaces between the vanes in the vane assemblies are convergent ducts. Thus, the vane assemblies increase the velocity of the gases passing through them as they direct the gases at the proper angle onto the first stage turbine blades. The outer rim of the first stage vane assemblies contains holes for the thermocouples that are mounted to the inlet casing and extend into the combustion liner outlets. The rear end of the combustion liners' transition section fits over the inner and outer rims of the first stage vane assemblies. Thus, the vane assemblies support and position the combustion liners. Two seal rings are placed between the outer rim of the vane assemblies and the inlet casing, and one seal ring is used between the inner ring of the first stage vane assemblies and the turbine inlet casing, to minimize gas leakage at these points.

The turbine vane casing secured to the outer shell of the turbine inlet casing, serves as a structural member. Eighteen vane assemblies provide the stators for the second, third, and fourth turbine stages. These vane assemblies are enclosed within the turbine vane casing. The outer rims of these vane assemblies and the six first stage vane assemblies have lips which engage with lips in the inner diameter of the turbine vane casing. The interlocking of the vane casing lips with the vane assemblies lips retains and properly position the vane assemblies radially and axially. The second stage vane retaining ring (halves) is used to retain the second stage vane assemblies axially. This vane retaining ring is installed between the mounting flanges of the inlet casing and the vane casing and fits into a groove cut in the outer ring of the second stage vane assemblies. First to second stage vane locating keys, which fit in matching slots of the vane assemblies and vane casing, are used to locate and retain the first and second stage vane assemblies in position. The [illegible] and fourth stage vane assemblies are similarly located and retained in position in the vane casing by six third to fourth stage vane locating keys. Each turbine stator consists of six vane assemblies, with gaps at each end to allow for the normal expansion and contraction of the vane assemblies. Two machined shoulders on the inner rims of the second, third, and fourth stage vane assemblies shroud the knives on the turbine wheel spacers to form air seals. The use of this air seal arrangement increases turbine efficiency by minimizing air leakage between the vane assemblies and the turbine rotor. The first, second, and third stage vane assemblies shroud the turbine wheel blades in these stages.

The turbine blade shrouds of the first and second stage turbine wheels have three knives on the outer diameter to form air seals with their respective vane assembly shrouds. By maintaining minimum clearances between these vane assemblies and blades, an increased turbine efficiency results due to less air leakage over the tips of the blades.

In order to maintain proper blade tip clearances, radial clearance between turbine wheel spaces and vane assemblies, and axial clearances between the turbine blades and vanes, it is absolutely necessary that the turbine rotor be properly positioned.

The roller bearings, which radially support the turbine rotor, are contained within bearing cages housed in the turbine rear bearing support and the turbine front bearing support. The front bearing cage is retained in the front bearing support by an external retaining ring. A vibration dampener, between the bearing cage and the front bearing support, dampens turbine vibration which tends to occur during engine start when the various parts are expanding at different rates. When the temperature of the parts stabilize, vibration dampening is not required, and the vibration dampener then supports and positions the bearing cage in its support. The outer race and rollers of the turbine front bearing are retained in the bearing cage by an internal retaining ring. The front bearing cage and front bearing outer race cannot rotate because they are locked in the bearing support assembly by a slotted pin. The inner race of the turbine front bearing, and the labyrinth seal are retained on the turbine rotor shaft by a spanner nut. The front bearing shrouds, the front and rear steps (stages) of the labyrinth seal. The labyrinth seal and cage form a double seal which minimizes air leakage into the front bearing area, and oil leakage out of the front bearing area. Some turbine cooling air will leak past the rear step of the labyrinth seal to the space between the two labyrinth seal steps. This air is called interstage pressure and is vented through the front bearing cage and turbine inlet casing inner shell through two struts of the inlet casing. A controlled amount of air will leak past the labyrinth seal front step, and into the turbine front bearing area.

Thus, any oil which tends to leak through this front step will be returned into the front bearing area. The front bearing cage has an internal baffle which minimizes the amount of oil that can get to the labyrinth seal front step. The front bearing support has two external grooves which holds an expander and a ring in place. These rings contact the inner diameter of the guide vane and seal support and prevents turbine cooling air from leaking into the passage used to vent the area between the two steps of the labyrinth seal. The ring which contacts the guide vane and seal support, prevents turbine cooling air from leaking into the passage used to vent the area between the two steps of the labyrinth seal. The ring, which contacts the front bearing support, prevents oil from leaking out of the front bearing area into the labyrinth seal vent passage. Air which leaks past the front step of the labyrinth seal into the turbine front bearing area, is vented along with the combustion inner casing and the combustion inner casing and diffuser cavities through a vent line which extends from the diffuser to the engine breather mounted on top of the air inlet housing.

The front bearing support is secured to the turbine inlet casing by a set of bolts.

A spanner nut is used to retain the front bearing inner race and labyrinth seal on the turbine rotor shaft. A turbine coupling, splined on a turbine rotor shaft, is retained by an internal threaded coupling clamp nut. The shaft to turbine coupling splines into the turbine coupling and is secured by two internal retaining rings. The turbine coupling shaft, which transfers torque from the turbine rotor to the compressor rotor, splines into the shaft-to-turbine coupling. A rear adapter in the turbine coupling shaft fits over the extended stub shaft of the first stage turbine wheel.

The turbine coupling clamp nut is secured by a snap ring extending from inside the forward turbine shaft, and into a hole in the coupling clamp nut. When properly torqued, the coupling clamp nut "jams" the turbine coupling tightly against the spanner nut, which is retained in its torqued position on the forward turbine shaft by the "tight" fit.

The turbine rear bearing support secured to the vane casing, houses a bearing cage used to support and position the turbine rear bearing. The inner and outer shells of the rear bearing support are interconnected by seven tangential struts. In addition to supporting the turbine rear bearing, the rear bearing support guides exhaust gases rearward into an aircraft tailpipe. The outlet of the rear bearing support is the jet (exhaust) nozzle of the engine. An oil pump support is secured to the rear bearing support. The turbine rear scavenge oil pump is secured to the interior of the oil pump support. An inner exhaust cone and an outer exhaust cone insulation are retained by the oil pump support. The inner exhaust cone streamlines the passage through which the exhaust gases are directed to the jet nozzle.

An oil seal spacer, an oil slinger, and the rear bearing inner race are retained on the rear rotor shaft by the rear bearing clamp nut. The bearing cage not only houses the bearing, but it also provides pressure and scavenge oil passages. The oil seal provides a single step labyrinth seal when working with the oil seal spacer. This seal provides a controlled airflow into the turbine rear scavenge pump cavity. The airflow carries into the cavity, and stops any oil that tends to leak through the seal. The rear turbine bearing oil tube mounts on a bracket which is attached to the outer shell of the turbine rear bearing support. The pressure oil tube is connected to the oil seal, and follows inward along the leading edge of the lower left strut. The oil seal has a drilled passage to index with a drilled hole in the inner ring of the rear bearing support. Pressure oil is then directed through a drilled hole in a bearing cage and into a drilled passage in the bearing cap. The bearing cap provides the oil nozzle for lubrication of the turbine rear bearing. The bearing cage cap retains the rear bearing's outer race and rollers in the bearing cage. The bearing cage, its cap and the oil seal are retained to the rear bearing support by the same set of bolts.

The turbine rear scavenge pump cavity is insulated from the heat of exhaust gases by the rear bearing insulation and inner exhaust cone insulation.

A lifting bracket, located on the top of the rear bearing support, is secured with the rear bearing support to the vane casing. This lifting bracket is used during disassembly and assembly of the power section. The front inner exhaust cone is secured by bolts to the forward side of the inner ring of the rear bearing support to guide the exhaust gases rearward into the aircraft tailpipe.

Section 2

INSTRUCTIONS

Complete the following statements by writing the correct words in each blank space.

1. The turbine rotor is radially supported by two ____________ bearings; one at the ____________, the other at the ____________.

2. The thermocouples send signals to the ____________ ____________ ____________ and the ____________ ____________ ____________.

3. Six ____________ ____________ ____________ assemblies, contained within the turbine inlet casing, provide the stator for the first stage of the turbine.

4. The spaces between the vanes in the vane assemblies are ____________ ____________ ducts.

5. The rear end of the combustion liners' transition section fits over the ____________ and ____________ of the first vane assemblies.

6. The outer rims of the second, third, and fourth stage vane assemblies and the six first stage vane assemblies have lips which engage with lips in the inner diameter of the ____________ ____________ ____________.

7. Each turbine stator consists of ____________ vane assemblies, with gaps at each end to allow for the normal expansion and contraction of the ____________ assemblies.

8. The ____________ bearings, which radially support the turbine rotor, are contained within bearing cages housed in the ____________ ____________ ____________ support and the ____________ ____________ ____________ support.

9. The inner race of the turbine front bearing, and the labyrinth seal are retained on the turbine rotor shaft by a ____________ ____________.

10. The front bearing cage has an ________ ____________ which minimizes the amount of oil that can get to the labyrinth seal front step.

11. The turbine coupling clamp nut is secured by a ____________ extending from inside the forward turbine shaft and into a hole in the coupling clamp nut.

12. The turbine rear bearing support, secured to the ____________ ____________, houses a bearing cage used to support and position the ________ ____________ ____________.

13. The turbine rear scavenge oil pump is secured to the interior of the ________ ________ ____________.

14. The turbine rear scavange pump cavity is insulated from the heat of exhaust gases by the ________ ____________ ____________ and inner exhaust cone ____________.

15. The front inner exhaust cone is secured by bolts to the ____________ side of the inner ring of the rear ____________ ____________ to guide the exhaust gases rearward into the aircraft tailpipe.

TURBINE ROTOR ASSEMBLY

The turbine rotor assembly, in conjunction with the turbine vane assemblies, extracts energy from the hot exhaust gases to develop the shaft horsepower which drives the compressor rotor, engine driven accessories, oil pumps, and the propeller. The amount of power available from the turbine depends upon the weight and velocity of airflow per unit of time. The turbine rotor assembly is composed of the following components; tie bolt spacer, four turbine wheels and blades, three turbine wheel spacers, eight turbine clamp bolts, and four balance plates.

The four-stage turbine rotor assembly is supported by two roller bearings. It is positioned and retained axially by means of the turbine-to-compressor tie bolt.

The first and fourth stage turbine wheels have integral stub shafts, which are used to support the turbine rotor on two roller bearings. The forward turbine shaft has external splines to provide a means for attaching the turbine couplings, and is externally threaded to allow a clamp nut to retain the turbine coupling. The forward turbine shaft is machined to position and retain the labyrinth oil seal and inner race of the front turbine bearing. The rear turbine shaft is machined to position the oil seal spacer, oil slinger, and inner race of the rear turbine. It is also threaded to allow a spanner nut to secure these parts on the shaft.

The tie bolt spacer is mounted within the forward turbine shaft and is retained by a dowel pin. This spacer provides support for the turbine-to compressor tie bolt which extends through the interior of the turbine rotor and the turbine coupling shaft. The four turbine wheels have machined shoulders near the inner diameter which have curvic splines cut in them for mounting adjacent wheels to each other. Each turbine wheel is drilled so the eight turbine clamp bolts may be used to secure the four turbine wheels and three wheel spacers. The outer rims of the wheels are broached for mounting the turbine blades. The turbine blades used in the first and second stage wheels are shrouded to improve turbine efficiency. Raised shoulders on the first stage turbine wheel prevent the first stage turbine blades from moving forward out of the wheel broaches, while raised shoulders on the fourth stage turbine wheel prevent the fourth stage turbine blades from moving rearward out of the wheel broaches.

The three turbine wheel spacers (first to second stage, second to third stage, and third to fourth stage) are located between adjacent turbine wheels. Spacers are mounted to number two, three, and four turbine wheels. Each spacer is mounted to the turbine wheels aft of the spacer by means of a machined lip on the inner hub of the turbine wheel. The front and rear edges of the outer rim of these three spacers contact the outer rims of the four turbine wheels to retain the turbine blades in their respective wheels. Thus, by means of these spacers and raised shoulders on the first and fourth turbine wheels, all turbine blades are retained without the use of blade retaining pins. All spacers have raised edges on their outer rims, which in conjunction with the turbine vane assemblies shrouding them, act as air seals to minimize air leakage between the turbine rotor assembly and turbine vane assemblies. Minimizing this air leakage causes the air to pass through the vane assemblies, and results in greater turbine efficiency. The first and second stage wheel spacer has drilled holes on its inner hub which contact the second stage turbine wheel. These holes provide for the passage of turbine air, used to cool the forward face of the second stage turbine wheel. The second to third stage wheel spacer has drilled holes in its outer rim to exhaust the air used to cool the second stage turbine wheel.

Since the turbine rotor must rotate at very high rpm in order to develop the horsepower efficiently, it is imperative that the rotor be balanced within extremely close tolerances. The wheels are individually balanced with their blades installed, the wheel spacers are individually balanced, and then the turbine rotor is assembled. Final balancing of the turbine rotor is done by the addition of balance plates which are retained by snaprings near the hub of either the first or fourth stage turbine wheels.

Not all of the air, delivered to the combustion section, is directed to the interior of the combustion liners. Some of the air flows along the outside of the combustion cans to keep them cool. After cooling the combustion liners, this air is directed to the front side of the turbine rotor where it flows in two directions, one, toward the outer rim of the first stage turbine wheel; and the other, toward the first stage turbine wheel hub. The air, which is directed toward the outer rim of the first stage turbine wheel, serves to cool this wheel and to prevent the exhausting gases from leaking over the front face of the first stage turbine wheel.

That air which flows toward the first stage wheel hub is directed through the first stage wheel and its spacer, thus cooling the rear face of the first stage wheel. Cooling air is also allowed to flow through drilled holes near the hub of the first to second stage wheel spacer to cool the forward face of the second stage turbine wheel. Cooling air flows outward over the front and rear faces of the second stage turbine wheel, and exits through the series of holes drilled in the outer rim of the second to third stage wheel spacer. The air from the front side of the second stage wheel flows to the rear side through spacers formed by the bases of the turbine blades and second stage wheel. The turbine "cooling" air may be several hundred degrees Fahrenheit, but it is considerably cooler than the exhausting gases, and thus may be termed "cooling air."

Section 3

INSTRUCTIONS

Complete the following statements by writing the correct words in each blank space.

1. The amount of power available from the turbine depends upon the ____________ and __________ of airflow per unit of time.

2. The four-stage turbine rotor assembly is supported by two ______________ bearings.

3. Each turbine wheel is drilled so the ____________ turbine clamp bolts may be used to secure the ____________ turbine wheels and ____________ wheel spacers.

4. The turbine blades used in the __________ and _________ stage wheels are shrouded to improve turbine efficiency.

5. The _________ to __________ stage wheel spacer has drilled holes in its outer rim to exhaust the air used to cool the ________ stage turbine wheel.

TORQUEMETER ASSEMBLY

As you study this part of the text, refer to figure 3 and relate ther terminology used to the illustration of the various parts.

The torquemeter assembly provides the means of measuring shaft torque being delivered from the power unit to the reduction gear. Under any given set of conditions, the maximum torque developed occurs when the turbine inlet temperature is 971°C and the engine rpm is 13,820. However, the maximum torque developed under this condition is greatly affected by air density at the engine inlet.

The torquemeter housing is secured to the air inlet housing and to the rear case of the reduction gear assembly. The torquemeter shaft assembly is covered by the housing which also provides the mounting point for the torquemeter pickup. Alignment of power section-to-reduction gear assembly is provided by the torquemeter housing. There are two tie struts which extend between the air inlet housing and the reduction gear assembly, and provide the necessary rigidity to maintain the alignment established by the torquemeter housing.

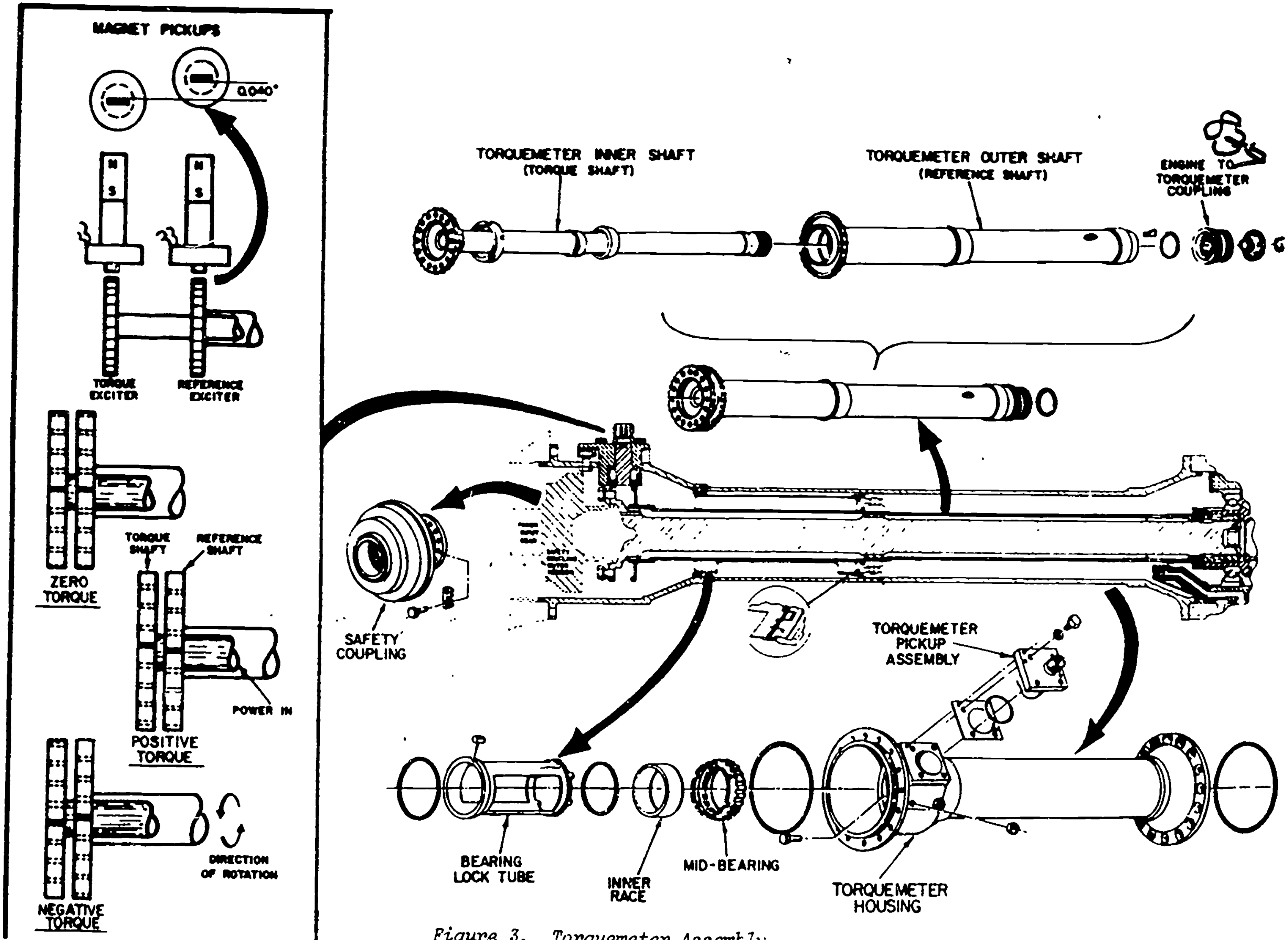

Figure 3. Torquemeter Assembly.

The torquemeter shaft assembly includes the inner shaft (to 840 shaft), the outer shaft (reference shaft), three torquemeter bearings (center, intermediate, and front) and three retainers, outer shaft locating key, lockwasher, locknut, oil plug, and O-ring seals. The torque shaft splines into the compressor extension shaft at the power section, and is bolted to the outer member of the safety coupling at the reduction gear. Any torque (positive or negative) is transmitted by the torque shaft. This shaft always operates at the same rpm as the power section rotors. Therefore, it is necessary that the torque shaft be concentric with the power section rotors and reduction gear pinion input gear. Concentricity with the power section rotor is established by the compressor extension shaft. The safety coupling outer member establishes concentricity of the torque shaft with the pinion input gear. The reference shaft is positioned on the torque shaft by the outer shaft locating key, which is retained by a locknut and lockwasher. Concentricity between the torque and reference shafts is maintained by the three torquemeter bearings.

The rear ends of the torque and reference shaft are always in the same relative position with one another due to the outer shaft locating key. The relative position of the forward ends of the torque shaft to the reference shaft is determined by the amount of torque being transmitted, because the torque shaft will twist with torque transmission, whereas the reference shaft will not. The amount of torque shaft twist is a straight line function of the torque transmitted. The reference and torque shafts each include an exciter wheel at their forward ends.

The exciter wheels have rectangular teeth which are aligned at zero torque, and thus are "in phase." When torque is transmitted, the teeth of the torque shaft exciter wheel are no longer aligned (in phase) with the teeth on the reference shaft exciter wheel. As the amount of torque increases, the out-of-phase increases. The direction of engine rotation is always the same with either positive or negative torque. However, positive torque twists the torque shaft in one direction, and negative torque twists the shaft in the opposite direction. Therefore, the direction that the torque shaft exciter wheel teeth are out-of-phase with the reference shaft exciter teeth is dependent upon whether positive or negative torque is being transmitted by the torque shaft.

The torquemeter electrical components consist of a pickup phase detector, indicator, and the necessary electrical harness. The torquemeter pickup is a dual unit; one located over the torque shaft exciter wheel, and the other located over the reference shaft exciter wheel. These pickups sense the amount that the torque shaft exciter wheel teeth is out-of-phase with the reference shaft exciter wheel teeth. The pickups send phase displacement impulses to the phase detector which convert these impulses into electrical signals. These electrical signals are sent to the indicator which indicates in inch pounds of torque. The phase detector and indicator require 115V, 400 Hz, AC power for their operation.

The indicator main dial is scaled in increments of 1000 inch-pounds, and a sub-dial is scaled at 100 inch-pounds. The phase detector has a calibration switch and "CAL A" and CAL B" adjustments. This switch and the two adjustments are used to adjust the torquemeter; therefore, it is highly desirable and essential to have an accurate indication of engine torque.

841 The function of the torquemeter is to measure electronically, the angular deflection (twist) which occurs in the power transmitting shaft, and to indicate the torque required to produce this angular deflection. This indication will be shown in the terms of inch-pounds of torque on the cockpit torque indicator. The torquemeter assembly includes mechanical structural and electrical components. The mechanical structural components consist of the torquemeter housing and the components with the torquemeter shaft assembly.

Section 4

INSTRUCTIONS

Complete the following statements by writing the correct words in each blank space.

1. Under any given set of conditions, the maximum torque developed occurs when the turbine inlet temperature is ____________ and the engine rpm is ______________.

2. The function of the __________ is to measure _____________ the angular deflection which occurs in the power transmitting ____________, and to indicate the torque required to produce this angular ____________.

3. The torquemeter assembly includes ____________ structural and ____________ components.

4. The torquemeter housing is secured to the ____________ ____________ ______________ and to the _________ ______________ of the reduction gear assembly.

5. Alignment of the power section-to-reduction gear assembly is provided by the ____________ ________________.

6. The torque shaft splines into the ___________ ______________ ____________ at the power section, and is bolted to the outer member of the ____________ ________________ at the reduction gear.

7. The reference and torque shafts each include an ____________ ______________ at their forward ends.

8. The direction of engine rotation is always the same with either ______________ or ______________ torque.

9. The torquemeter electrical components consist of a ___________ _________ _________, __________, and the necessary electrical harness.

10. The pickups send phase displacement impulses to the ________ __________ which convert these impulses into ___________ ______________.

REDUCTION GEAR ASSEMBLY

As you study this part of the text, refer to figure 4 and relate the terminology used to the illustration of the various parts.

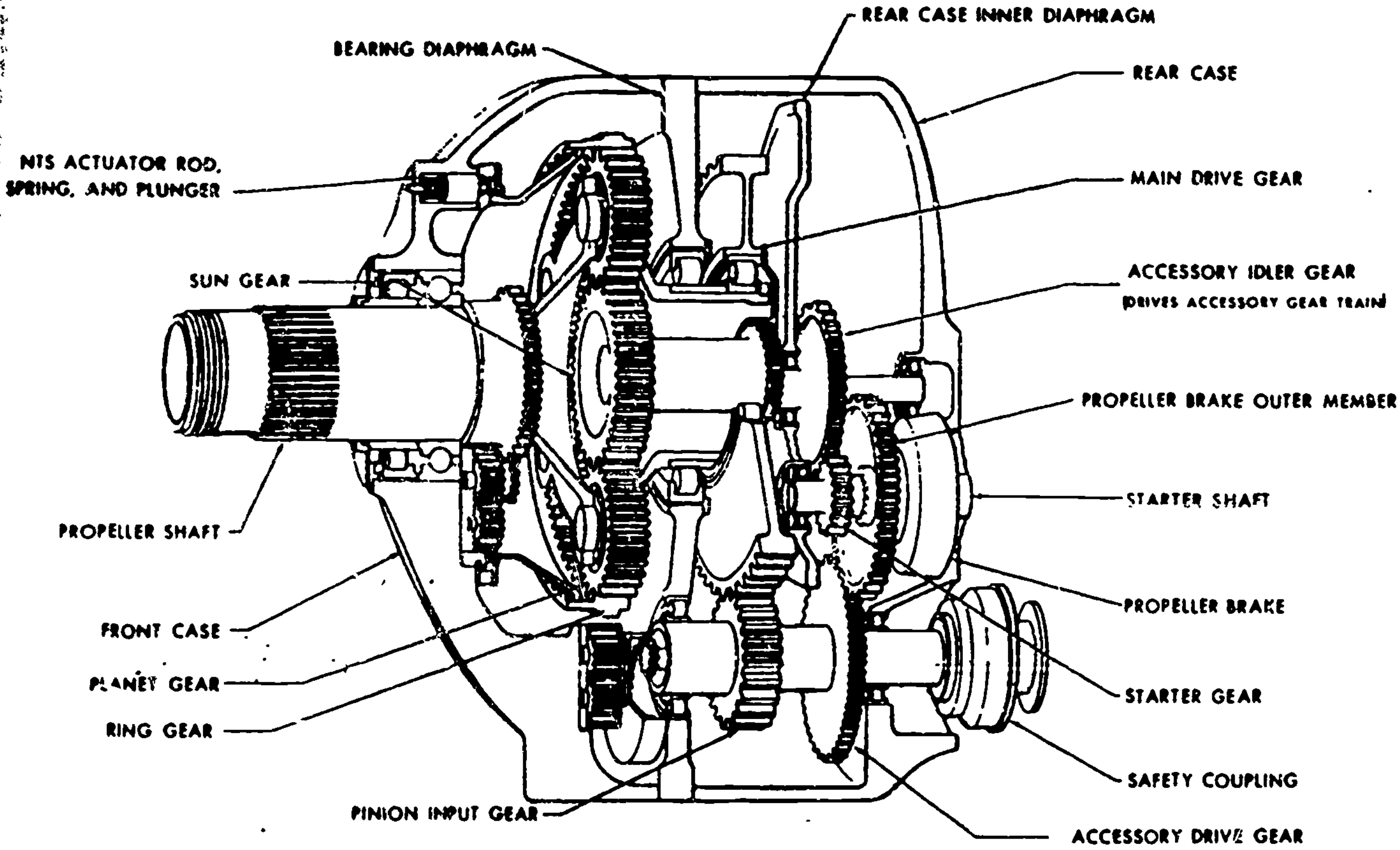

Figure 4. Reduction Gear Assembly.

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The reduction gear assembly has four magnesium alloy castings which provide the structural support for the two stages of reduction gearing and the accessories drive gear train. These structural members are the front case, bearing diaphragm, rear case, and rear case inner diaphragm. Passages for pressure oil are drilled in the bearing diaphragm, rear case, and rear case inner diaphragm while scavenge oil passages in the front case, bearing diaphragm, and rear case are "cored" in the castings. These pressure and scavenge oil passages index between the structural members as required by the reduction gear lubrication system.

The rear case provides the front attachment for the torquemeter housing. Within the torquemeter housing is the torquemeter shaft assembly which transmits power section torque to the pinion input gear. Between the pinion input is the safety coupling. Two eyebolts on either side of the rear case provide attachment for two tie struts which connect to the air inlet housing. These tie struts along with the torquemeter housing, provides the rigidity required to maintain the alignment between the power section and reduction gear assembly. On each side of the rear case are large mounting pads. Engine mounts, connected to these, support the engine within the nacelle.

The rear case inner diaphragm, secured to the interior of the rear case, along with the rear case provide the structural support for the accessory drive gear train. The accessory drive gear, bolted to the pinion input gear, provides the drive for the accessory drive gear train. Accessories, which are mounted on the aft face of the rear case and which are driven by this accessory drive gear train, are as follows: generator, hydraulic pump, tachometer generator, and oil pump. The starter also mounts on the rear side of the rear case. During ground starts, the starter cranks the engine and accessories through a portion of the accessory drive gear train. The main scavenge pump, secured within the front case, is driven by a gear on the forward end of the pinion input gear shaft. Any oil, scavenged by this pump, flows through a screen type filter which has a magnetic plug at one end. The magnetic plug, threaded into the front case, can be removed for inspection, or to drain residual oil from the reduction gear assembly. The oil scavenged in the reduction gear assembly, is directed to the scavenge oil return port near the bottom of the rear case.

The propeller brake is located in the accessory drive gear accessories drive gear train. During ground starts, starter torque is transmitted through the prop brake assembly to the accessory drive gear. During all other operation, the torque required to drive the accessories drive gear train is transmitted from the accessory drive gear through the prop brake assembly.

The pinion input gear, supported by bearings in the rear case and bearing diaphragm, drives the main drive gear. These two spur gears provide the first stage reduction of 3.125 to 1. The main drive gear is positioned and supported by the main drive gear bearing which is on the shaft portion of the rear planet carrier. The sun gear hub is bolted to the main drive gear. The reduced rpm of the first stage reduction is reduction is delivered to the second stage reduction by the sun gear hub and a sun gear which is secured to the hub. The sun gear meshes with five planet gears which, in turn, mesh with the ring gear that surrounds them. The planet gears are supported by the rear planet carrier and the propeller shaft. The ring gear cannot rotate as the planet gears are rotated by the sun gear, they cause the prop shaft and rear plane carrier to rotate. This planetary gear train provides a speed reduction of 4.333 to 1. The two stages of reduction provides an overall speed reduction of 13.54 to 1. (When power section rpm is 13,820, prop shaft rpm is approximately 1020.) The rear carrier is supported by a bearing housed in the bearing diaphragm. Two bearings on the prop shaft are housed in the front case. One of these is a roller bearing which radially supports the prop shaft, while the other is a ball bearing that axially retains the prop shaft in the reduction gear assembly. Thus, the ball bearing is the thrust bearing.

The ring gear cannot rotate, but can move fore and aft. When there is positive torque, the ring gear is in its maximum rearward position. If negative torque exceeds approximately -820 to -1230 inch-pounds of torque, helical splines cause the rear gear to move to its maximum forward position. When this occurs, the negative torque signal (NTS) spring is compressed by the plunger being moved by the ring gear, and the actuator rod is moved forward in the front case. The actuator rod moves linkage to the propeller, and the propeller responds to this negative torque signal as required to limit the negative torque to a safe value.

Oil is directed to the oil delivery flange which is secured to the prop shaft. The oil delivery flange directs this oil to sun gear oil jets, to prop shaft oil jets, and to the interior of the prop shaft. The sun gear oil jets spray oil on the sun gear where it comes out-of-mesh with the five planet gears.

Section 5

INSTRUCTIONS

Complete the following statements by writing the correct words in each blank space.

1. The structural members of the reduction gear are the ____________, ____________ ____________, ____________ ____________, and ____________ ____________ ____________ ____________ ____________.

2. Within the torquemeter housing is the ____________ ____________ assembly which transmits power section torque to the pinion input gear.

3. Two eyebolts on either side of the ____________ ____________ provide attachment for two ____________ ____________ which connect to the air inlet housing.

4. Accessories which are mounted on the aft face of the rear case and which are driven by this accessories drive gear train are the ____________ ____________, ____________ ____________, ____________ ____________, and ____________ ____________.

845 The oil scavenged in the reduction gear assembly is directed to the scavenge oil __________ ______________ near the bottom of the rear case.

6. The pinion input gear supported by bearings in the ________ ________ and ________ ______________, drives the main drive gear.

7. The sun gear meshes with five ________ __________.

8. The two stages of reduction provides an overall speed reduction of ________ to ______.

9. When there is positive torque, the ring gear is in its maximum ________ position.

10. When negative torque occurs the ring gear moves __________.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-846
14 February 1980

REMOVAL AND INSTALLATION OF REDUCTION GEARBOX ASSEMBLY AND DISASSEMBLY, INSPECTION, AND REASSEMBLY OF TORQUEMETER

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to locate procedures, special tools, torque limits, and safety procedures pertaining to removal and installation of the reduction gearbox assembly and disassembly, inspection, and reassembly of the torquemeter.

EQUIPMENT

	Basis of Issue
TO 2J-T56-26	1/student

PROCEDURE

Using TO 2J-T56-26, answer the following questions and complete the incomplete statements.

1. What section of this TO covers special tools and equipment?

____

2. What tool group covers the reduction gear assembly? __________

3. What is the part number of the holder-starter shaft?

____

4. What tool group covers the torquemeter and safety coupling?

____

5. What figure covers the guide for the torquemeter midbearing?

____

6. What is the stock number of part number 6797898?

____

7. How many stages of reduction gears are in the reduction gearbox? __________

8. What must be removed before separating the reduction gear from the power section? __________

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 500; TTVSA - 1
Designed for ATC Course Use. Do Not Use on the Job.

RGL: N/A

847 9. What must be installed over the rear end of the torquemeter once the gearbox is removed? ______________________

10. What tool group do you refer to for torquemeter removal?

____

11. What caution applies to using the midbearing guide tool when removing the torquemeter? ______________________

12. What tools are used to facilitate disassembly of the torquemeter shaft from the safety coupling? ______________________

13. What paragraph explains torquemeter midbearing removal?

____

14. What is used to clean Fafnir Bearing Company control linkage rod ends? ______________________

15. The safety coupling and torquemeter assembly shall be replaced if the torquemeter outer shaft OD shows indications of

______________ or ______________.

16. What must be used to remove all burrs from the torquemeter exciter teeth? ____________________

17. What is the midbearing inspected for and what series TO do you refer to? ______________________ __________

18. If you are inspecting the torquemeter anti-icer cowl duct, cowl cover, and dome cover assemblies and you find cracks excessive deformation and wear on the shroud brackets, what should be done with the part? ______________________

19. What must be done with the propeller brake assembly when the outer lining shows evidence of uneven wear or the surface of the lining is within 0.001 inch of the rivet head? ______________

____

20. How much corrosion is acceptable on the reduction gear strut? ______________________

21. What paragraph covers lockwire installation? __________

22. What is applied to the safety coupling-to-torquemeter bolts during assembly? ______________________

23. What is applied to the terminal assemblies, thermocouples, etc., during assembly? ______________________

848

24. What size feeler gauge is used to check the reduction gear eyebolts during assembly? ____________

25. What is the torque on the spawner nut for the safety coupling? ________

26. How is the torquemeter shaft aligned with the safety coupling? ____

27. What position will the torquemeter pickup pad be at when the torquemeter housing is installed correctly? ______________
____

28. What is the part number of the depth gauge used during installation of the torquemeter pickup? ________________

29. When using the depth gauge to check for shims needed under the torquemeter pickup, you obtain a measurement of 0.022 inch, how many shims need to be installed under the pickup? _______

30. What is the torque value on the torquemeter shaft to safety coupling bolts? ____________

ENGINE BUILDUP AND TEARDOWN

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to define terms about engine buildup and teardown and identify the technical orders which deal with B-1 and B-2 accessories.

INTRODUCTION

When you put an engine in a car, there are some parts that have to be put on before the car will run right. On an aircraft engine there are parts that must be put on before the engine is put on the aircraft.

INFORMATION

Engine buildup is a job where you get an engine from the depot and make it ready to put on an aircraft. When you get this engine from the depot, some parts are already put on the engine. These parts are called B-1 accessories (engine manufacturer supplied). Some of these would be fuel pumps, fuel controls and so forth. When these parts are put on an engine it is called a basic engine. TO 2J-1-24 (Equipment Comprising a Complete Basic Gas Turbine Engine) lists all the B-1 accessories for all of the different types of engines used in the Air Force. To find a part number for a B-1 accessory you would have to look in a basic engine TO. Example: TO 2J-T56-24.

When you take the engine and reduction gearbox from their shipping containers and put them on the buildup truck, the job of engine buildup is ready to start. This is when you will put the B-2 accessories (aircraft manufacturer supplied) on the basic engine to get it ready for the aircraft. There are many different names for these parts: (1) quick engine change kit (QEC); (2) engine buildup (EBU) kit; and (3) power package (PP).

To put the B-2 (aircraft) accessories on the engine you will have to use an aircraft TO. Example: TO IC-130B-10. This TO has all the information that you need to put all of the B-2 accessories on the basic engine. This TO also has an illustrated parts breakdown (IPB) that lists all of the part numbers for the B-2 accessories.

Supersedes 3ABR42633-SG-501, 27 February 1980. RGL: 9.7
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 150; TTVSA - 1

Designed for ATC Course Use. Do Not Use on the Job.

850 The aircraft manufacturer buys the engine from the engine manufacturer and supplies all of the parts needed to mate the engine to the aircraft. The aircraft manufacturer then supplies the aircraft to the Air Force as a complete unit.

Engine teardown is the job of removing the B-2 accessories from an engine to get it ready to go back to the depot.

QUESTIONS

1. What kind of accessories are put on a basic engine to make it complete?

2. What kind of accessories are put on an engine during engine buildup?

3. What technical order lists the accessories on all the different types of engines used in the Air Force?

4. What are the three names used for B-2 accessories?

5. What type of TO lists part numbers for B-1 accessories?

6. What type of TO is used when you put on the B-2 accessories?

7. What is engine teardown?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-501 851
3 March 1980

ENGINE BUILDUP AND TEARDOWN

OBJECTIVES

When you have completed this workbook and your classroom instruction, you will be able to:

1. Define the terms engine buildup, QEC kit, basic engine, and B-1 and B-2 accessories.

2. Locate and list selected B-1 and B-2 accessories.

3. Identify and use the technical orders pertaining to engine buildup.

4. Document engine teardown on AFTO Forms 349 and 350.

EQUIPMENT

	Basis of Issue
TO 00-20-2-4	1/student
TO 1C-130A-06	1/student
TO 1C-130B-10	1/student
TO 2J-1-24	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Using the information given by the instructor, accomplish the following:

1. Describe a basic engine.

2. What is engine buildup?

3. What type accessories are included on a basic engine?

4. Who supplies the accessories on a basic engine?

5. What TO contains part numbers for the accessories on a basic engine?

6. Who supplies the B-2 accessories?

7. What is the purpose of the EBU kit?

8. By what two other names is the QEC kit known?

9. What TOs contain part numbers for B-2 accessories?

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 500; TTVSA - 1

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Project 2

DIRECTIONS

Using TO 2J-1-24, answer the following questions.

1. What is the title of this TO?

2. List four B-1 accessories on the T56 engine that must be entered on the AFTO Form 781E.

3. What is the purpose of this TO?

4. Which series of the T56 engine reduction gearbox has a Bracket Assembly - Prop Control listed as a B-1 accessory?

Project 3

DIRECTIONS

Using TO 1C-130B-10, answer the following questions and complete the incomplete statements.

1. What is the complete title of this TO?

2. What section of this TO gives buildup instructions?

3. Which figure shows the fuel flowmeter installation?

4. What is used on the inside groove of Marman clamps when installing sections of the engine compressor bleed manifold?

5. Which coupling clamps require safety wiring during buildup?

6. What is the torque value on a clamp PN 18276-200?

7. Before opening the engine shipping container what should you inspect for?

8. How is the eyebolt spanner nut for the tie struts torqued down?

9. What is the Federal stock number for the propeller shaft cover?

10. What is the Federal specification of the lubricant used to lubricate the hydraulic pump slings?

11. What is the torque on the AC generator nuts?

12. How is the engine tachometer generator placed on the drive pad?

13. What figure should you refer to for installation of the fuel flowmeter electrical harness?

14. On which load mount is the bonding tab installed under the upper rear bolt?

15. What should be done if the extension shaft seal is not free to "float" when the retainer assembly is tightened?

16. What is the minimum clearance allowed between the upper compressor bleed manifold and the fire detection sensing element?

17. What is the part number of the temperature datum control amplifier?

18. How many units per assembly are there for part number 383198-1-4?

19. What does the usable on code 4 mean for part number GEU-7/A?

20. What is the figure and index number for part number LS4764-4?

Project 4

DIRECTIONS

Use applicable publications, select necessary data from given information and complete the necessary forms (figures 1, 2 and 3) indicating that you have completed the task indicated by the discrepancy.

1. Today you and a crew of three turboprop mechanics are assigned the job of teardown on a T56 engine. You begin at 0700 hours and continue until 1100 hours, at which time you all went to chow. At 1230 hours you and two men returned and completed the job at 1600 hours.

2. During removal and insepction you found the following problems:

   a. Oil tank cracked.

   b. Starter splines worn beyond limits.

3. Use what you need from the following data and complete the required forms.

   a. General Information

Job Control Number	Current Julian Date plus 0246
Job Standard	6.0 Hours

b. Engine Data

Model and Series	T56-A-7B
Serial Number	AE 439949
ID	TX9949
Time	842.9
Work Center	T3749

c. Accessory Data

FSC	2840
Part No.	From TO
Serial Number	From Removed Item

MAINTENANCE DATA COLLECTION RECORD

OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION
0246								

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPC REQ	18. JOB STD.

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER. TIME

ACT. LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

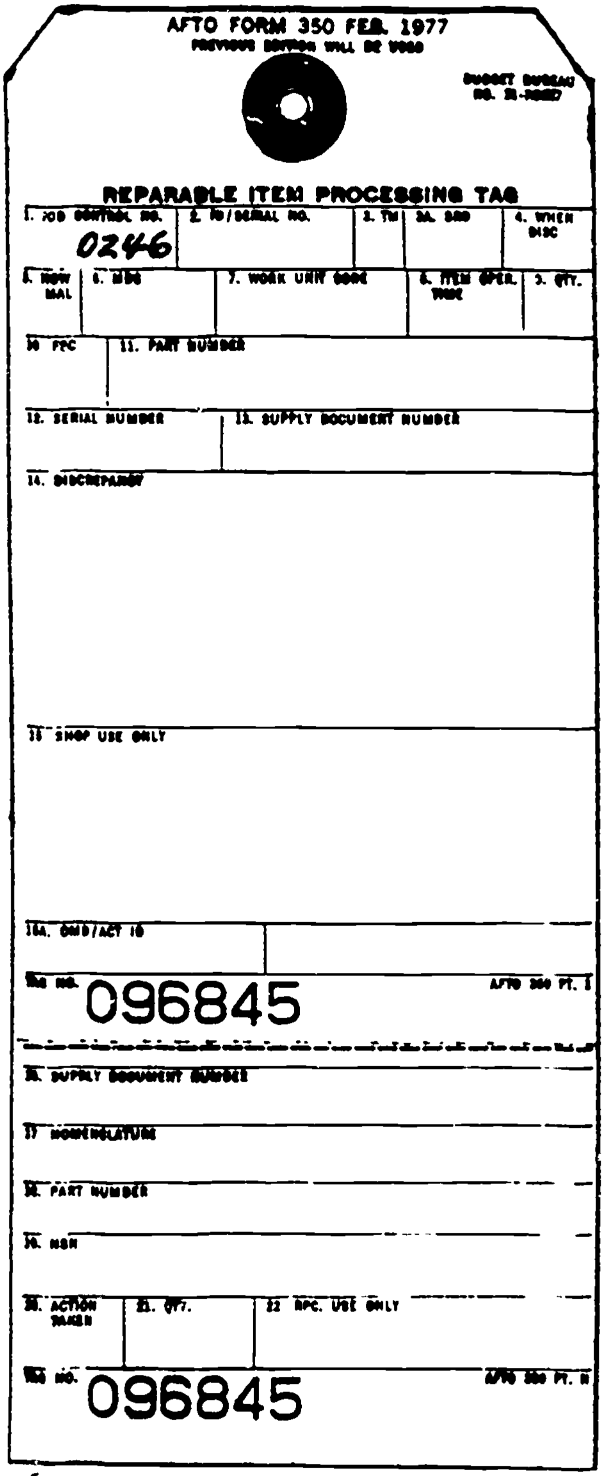
27. CORRECTIVE ACTION

28. RECORDS ACTION

AFTO FORM MAY 78 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

855



AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU NO. 21-R0227

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. 0246 | 2. ID/SERIAL NO. | 3. TM | 3A. SRD | 4. WHEN DISC

5. HOW MAL | 6. MDS | 7. WORK UNIT CODE | 8. ITEM OPER. TIME | 9. QTY.

10. FSC | 11. PART NUMBER

12. SERIAL NUMBER | 13. SUPPLY DOCUMENT NUMBER

14. DISCREPANCY

15. SHOP USE ONLY

15A. CMD/ACT ID

TAG NO. 096845 AFTO 350 PT. I

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE

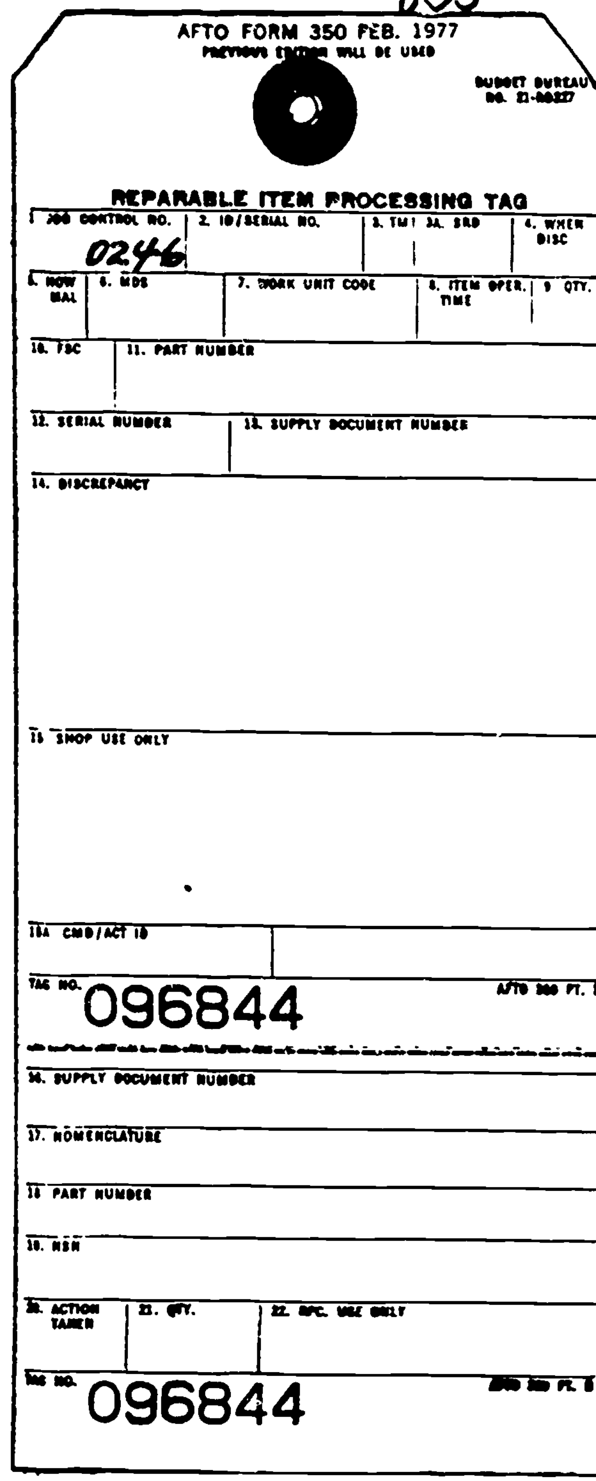
18. PART NUMBER

19. NSN

20. ACTION TAKEN | 21. QTY. | 22. RPC. USE ONLY

TAG NO. 096845 AFTO 350 PT. II

Figure 2. AFTO Form 350.



AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED

BUDGET BUREAU NO. 21-R0227

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. 0246 | 2. ID/SERIAL NO. | 3. TM | 3A. SRD | 4. WHEN DISC

5. HOW MAL | 6. MDS | 7. WORK UNIT CODE | 8. ITEM OPER. TIME | 9. QTY.

10. FSC | 11. PART NUMBER

12. SERIAL NUMBER | 13. SUPPLY DOCUMENT NUMBER

14. DISCREPANCY

15. SHOP USE ONLY

15A. CMD/ACT ID

TAG NO. 096844 AFTO 350 PT. I

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE

18. PART NUMBER

19. NSN

20. ACTION TAKEN | 21. QTY. | 22. RPC. USE ONLY

TAG NO. 096844 AFTO 350 PT. II

Figure 3. AFTO Form 350.

ENGINE AND PROPELLER INSPECTION

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to identify the right technical orders in which engine and propeller inspection and maintenance tasks can be found.

INTRODUCTION

Do you perform an inspection on your car often or before you take a long trip? If you are a smart driver, you do. The Air Force inspects the aircraft before a mission, after a mission, and after a number of flying hours or calendar days. You may be able to afford for your car to break down on the road, but the pilot can't afford for his aircraft to break down.

INFORMATION

All work that is done on engines and propellers must be done by the technical orders (TOs). You are going to learn all about these TOs in this lesson. These TOs are the aircraft -6 (Inspection Requirements), aircraft -10 (Engine Buildup Instructions), Engine Maintenance Instructions, and aircraft -2 (Organizational Maintenance Instructions). We are going to discuss each of these TOs in detail.

INSPECTION REQUIREMENT TECHNICAL ORDERS.

The aircraft -6, Inspection Requirement Technical Order, lists what items are to be inspected what the minimum inspection requirements are, and when the items are to be inspected. This technical order has the requirements for all of the inspections to be done at different times on the whole aircraft and its systems. Some examples of the inspections that are done include the preflight, thruflight, basic postflight, home station check, minor and major inspections.

Inspection Workcards

The information that is in the aircraft -6 TO is given to you in a smaller, more usable size on inspection cards. The inspection requirements that are in the aircraft -6 are found in the aircraft -6 WC (workcards) in a more logical working order. Workcards give you a checklist to be used in doing the inspection to make sure no item is overlooked.

Inspection Wordcard Sections

TO 1C-130A-6WC-15, Minor and Major Inspection Workcards, is broken down into three parts:

Supersedes 3ABR42633-SG-502, 27 March 1980. RGL: 10.4
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 150; TTVSA - 1
Designed for ATC Course Use. Do Not Use on the Job.

1. The introduction, which tells the overall arrangement and purpose of the technical order.

2. Inspection work areas, which shows the area of the aircraft where the work is to be done.

3. Workcard section, which shows the work assignments. This includes the card number, work area, type of mechanic, mechanic number, card time and information about the inspection.

The inspection workcards have only the information for one or two related inspections. Other sets of workcards are used to do some other inspections such as:

1. TO 1C-130A-6WC-12, Workcards--Preflight Inspection
2. TO 1C-130A-6WC-14, Workcards--Home Station Check

ORGANIZATIONAL MAINTENANCE INSTRUCTION TECHNICAL ORDERS

More technical orders must be used for removal and installation rules, wear and damage limits, torque values, special tools, and trouble-shooting procedures.

Some of the parts that are listed in the aircraft -6 WC TO must be removed from the equipment that is to be inspected. The aircraft -2 TO lists these removal instructions along with other needed information about the job. You can also get information from the aircraft -10 and the engine maintenance manual.

Information in these TOs may be found by using the table of contents at the front of the manual or the alphabetical index in the back of the manual. This is shown in the introductory part of the manuals.

INSPECTION PROCEDURES

Each inspection done on an aircraft or engine can be broken down into two steps, the look phase and the fix phase.

Look Phase

At this step of the inspection, the inspection workcard items are inspected, or looked at. Any major defects found are recorded on the AFTO Form 349. No repair actions are taken at this time. If any minor defects are found, that is, broken safety wire, loose bolts, missing cotter keys, etc., they are fixed at this time and no entry is made on the AFTO Form 349. There is a common maintenance practice of inspecting the three most serious trouble areas of the engine first. These areas are the intake and the exhaust for FOD and oil and fuel filters and strainers for contamination of any type.

Fix Phase

This step of the inspection starts when all of the workcard items have been inspected. At this step, all of the major defects entered on the AFTO Forms 349 during the look phase are taken care of by repair or replacement.

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SUMMARY

Now you can see that a turboprop mechanic must use more than one technical order to complete the inspection. The aircraft -6 WC (Inspection Workcards) must be used with the aircraft -2 (Organizational Maintenance Instructions), -10 and/or engine or propeller maintenance manual, to properly complete any inspection.

QUESTIONS

1. What technical orders should you use when completing any inspections?

2. What three items of information can be found in the aircraft -6 technical order?

3. What technical orders tell you how to inspect?

4. What technical order lists <u>what</u> and <u>when</u> to inspect?

5. At which part of the phase inspection is a broken safety wire repaired?

6. Each type of inspection is broken into what two steps?

7. Give a brief description of these two steps of an inspection.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-859 01
18 March 1980

ENGINE AND PROPELLER INSPECTION

OBJECTIVES

After completing this workbook and your classroom instruction, you will be able to:

1. Determine differences in specific inspections and describe the inspection system and the inspection concepts.

2. Use inspection workcards to identify additional TOs and personnel needed to complete an inspection.

3. Identify safety practices, accident prevention, and FOD precautions.

4. Use applicable publications and forms to document an inspection.

EQUIPMENT

	Basis of Issue
TO 00-20-1	1/student
TO 00-20-5	1/student
TO 1C-130A-06	1/student
TO 1C-130A-6WC-15	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Use TO 00-20-1 to answer the following questions.

1. Which TOs list the scheduled inspections?

2. The planned inspection and maintenance concept provides a method of performing inspections on what basis?

3. What are the two inspection methods?

OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 300; TTVSA - 1

RGL: N/A

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460 What is the abbreviation for preflight?

5. Inspection workcards provide the specialist with ______________ ______________________________.

6. Specific conditions for the mandatory use of the red X symbol are contained in which other TOs?

Project 2

DIRECTIONS

Use TO 00-20-5 to answer the following questions.

1. What are the major inspection concepts?

2. What is the last inspection accomplished prior to takeoff?

3. Flying hours are translated to calendar periods to facilitate which inspection concept?

4. Who will establish the necessary controls to assure that inspections will be done at or near their scheduled due time?

5. Who normally makes the entries in the symbol block of the AFTO Form 78A?

6. What goes in block 4 of the AFTO Form 95?

7. What goes in block 3 of the AFTO Form 44?

Project 3

DIRECTIONS

Use TO 16-130A-6WC-15 to answer the following questions.

1. The minor/major inspection workcard deck covers how many inspections? Which ones?

2. When will inspection requirements preceded by an asterisk (*) be inspected?

3. All NDI inspection requirements outlined herein will be IAW TO ______________________________.

4. What does the mechanic code SHT, MTL stand for?

5. What is the description of zone 4A?

6. What does the lubricating symbol OGT stand for?

7. How long does it take to inspect workcard 1-004?

8. What is the oil capacity of starter-part number 350690? 861

9. How long does it take to inspect the ice detector for condition, security, and cleanliness?

10. What is the air inlet housing and duct shaft seal inspected for?

11. What is the starter control valve filter inspected for?

Project 4

DIRECTIONS

Use TO 1C-130A-06 to answer the following questions.

1. What is the system code for the turboprop power plant?

2. What is the type maintenance code for a periodic, phased, or major inspection?

3. What is the type maintenance code for gas turbine engine scheduled inspections?

4. What is the action taken code for repairs and/or replacement of minor parts, hardware, soft goods?

5. What is the work unit code for a major inspection?

6. What is the work unit code for a propeller shaft dye check?

7. What is the work unit code for the thermocouple harness?

8. What is the work unit code for the synchrophaser assy?

Project 5

DIRECTIONS

Using applicable publications, select necessary data from given information. Complete the AFTO Form 349s (figure 1 and figure 2) in this workbook. Generate the forms required for the given discrepancies discovered by you during the inspection.

1. Today you and two other turboprop mechanics are dispatched to perform a minor inspection. The look phase begins at 0700 hour and ends at 1000 hour. The fix phase begins at 1000 hour until 1400 hour. Lunch was from 1200 till 1300.

2. During the look phase you discovered the following problems and they were repaired during the fix phase.

a. Starter housing cracked.

d. Dirty brush block on the propeller.

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MAINTENANCE DATA COLLECTION RECORD									OMB NO. 21-R0227
1. JOB CONTROL NO. E100	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6 TIME	7 PRI 2	8. SORTIE NO	9 LOCATION	
10. ENG. TIME	11. ENGINE I.D.	12 INST ENG TIME	13. INST. ENG. I.D.	14.	15	16	17 TIME SPC REQ	18 JOB STD.	
19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST ITEM PART NO.	24 SERIAL NUMBER	25 OPER TIME			

ACT LINE	A TYPE MAINT	B COMP PCS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 75 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

3. General Information

Job Number - Today's Julian Date plus E100

Priority - 2

Location - P-2

Time Specialist Required - 0700 hour

Job Standard - 6.0 hours

4. Aircraft Data

MDS - C-130E

Serial Number - 72-7882

ID No. - IA 7882

Flying Time - 1346.7

Workcenter - 1E22A

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MAINTENANCE DATA COLLECTION RECORD

OMB NO 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO	9 LOCATION
E100						2		

10. ENG TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15	16	17 TIME SPC REQ	18 JOB STD

19. FSC	20 PART NUMBER	21. SER. NO./OPER. TIME	22 TAG NO.	23 INST ITEM PART NO	24. SERIAL NUMBER	25 OPER TIME

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 75 349 PREVIOUS EDITION IS OBSOLETE.

Figure 2. AFTO Form 349.

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-SG-503
13 May 1981

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ENGINE REMOVAL AND INSTALLATION

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to find and use the right steps and select the proper tools and equipment for engine removal and installation.

INTRODUCTION

For this part of the lesson, your class will remove and install an engine on the C-130 engine change trainer. Although this lesson will be limited to this type of aircraft, the job of engine removal is similar on most aircraft. Keep in mind, you must always use the specific organizational maintenance manual for the type, model, and series of aircraft you are going to work on.

INFORMATION

When doing work on the aircraft and engines, adequate planning should include the inspection of all the equipment, tools, materials, and the work area to be used during the job.

SAFETY

Aircraft Forms

Before performing work on the C-130 aircraft, or any type aircraft, you must first review the aircraft AFTO Form 781 forms to make sure that the work you are going to do will not endanger the safety of the aircraft, yourself, or other people.

Aircraft Grounding

When you have checked the aircraft forms and before beginning the work, make sure that the aircraft is properly grounded. When you are working on the C-130 aircraft, two ground wires are required. One located at the nose just aft of the nose radome, and one is at the single point refueling (SPR) panel, which is found on the right aft side of the aircraft just forward of the paratroop door.

Fire Extinguisher

Make sure that a fire extinguisher is placed near easy access of your work area. Check the extinguisher for serviceability and proper charge. Check the fire extinguisher operational steps with all members of the engine change team. Coordinate with other members so that they are aware of what action they are to take in case of an emergency. Remember, the safety of the aircraft and the lives of all the personnel depend on quick, coordinated response.

Supersedes 3ABR42633-SG-503, 13 February 1980. RGL: 10.7
OPR: 3350 TCHTG
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 150; DAV - 1

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Maintenance Stands

The most commonly used maintenance stands for C-130 engine removal and installation are the B-1 and B-5. All the stands used on the flight line are required to have at least two serviceable wheel locks. It is a good maintenance practice to lock all the available wheel locks before you go up a maintenance stand. You must check the equipment records, AFTO Form 244 (System/Equipment Status Record), and perform an operator's inspection to make sure it is serviceable prior to use. When raising the B-1 and B-5 stands, be careful not to extend them past the maximum height limitation. The maximum extension for a B-1 stand is when the lifting ram is at a 45° angle or the base of the platform is 10 feet from the ground. The maximum extension for a B-5 stand is when the base of the platform is 15 feet from the ground. When the stand is at the desired height, put in the safety lock. For the B-1 stand, use the ramlock, and on the B-5 stand use the two platform pins, one on each side just forward of the platform rollers. Do not remove the handrails unless it is necessary to do the job. Do not stand or sit on the handrails at any time. Use caution when on the stands, they can become slippery when wet. Wipe off all spilled hydraulic fluid and oil from the platform and ladder immediately. When lowering the stands, take out the safety locks and slowly release the hydraulic pressure so that the platform comes down in a slow, steady manner. If you lower the platform too fast, it could cause the hydraulic seals on the lifting ram to rupture. Use extreme caution when positioning the stands near the aircraft to prevent damage to the engine and the aircraft surfaces.

Support Equipment

Prior to using the support equipment, you must check the equipment records, AFTO Form 244, and perform an operator's inspection to determine the condition and serviceability of the unit. The most commonly used support equipment for the removal and installation of a T56 engine are the J1-B hoist, engine buildup and transportation truck, and the engine nacelle sling.

Handtools

All the handtools that are used for engine change can be found in the mechanic's toolkit. You must keep the tools in good condition, broken tools should be replaced as soon as possible and do not use them for any job. When selecting the tools, use the right tool for the job. Do not use a tool for a task other than what it was made for. (Example: Do not use a screwdriver for a punch or chisel.) To avoid injury, never place or carry handtools in your pockets. If safety wire must be removed, remember to cut the wire; do not try to break the wire. When cutting safety wire, hold the loose end of the wire or place your free hand over it to prevent eye injury.

Safety Precautions

Good planning and the observance of all the safety rules and the technical order "CAUTIONS" and "WARNINGS" can prevent damage to the equipment and injury to personnel.

PREPARATION FOR ENGINE REMOVAL AND INSTALLATION

The speed and ease with which you complete an engine installation or removal will depend on how well you prepare for the task prior to arriving at the job site.

Technical Data

The TOs that you will need for the installation and removal of a T56-A7 engine on a C-130 aircraft: 1C-13CB-2-4, has the steps for the engine installation and removal; 1C-130B-10, has the information on the quick engine change (QEC) kit; 1C-130B-2-2, has the information for the grounding of the aircraft and servicing of the engine; and 1C-130A-6, which has the special inspection requirements.

Special Tools

The special tools that you will need are listed in the organizational maintenance technical order, aircraft -2. Check all special tools for their condition and serviceability prior to arrival at the job site.

Torque Wrenches

Since a variety of torque ranges are used for engine installation, your selection of torque wrenches should include a 1/4 inch drive, 3/8 inch drive, and a 1/2 inch drive. Do not use a torque wrench if it has been dropped or if it is overdue on its calibration date.

Caps and Plugs

All engine pneumatic lines, fluid lines, and electrical connectors must be covered as soon as they are disconnected, as well as the engine inlet and exhaust. You must take sufficient caps and plugs to the job site.

Waste Containers

When it is possible, use a rubber bucket to catch the fuel and oil from the disconnected lines. If it is necessary to use a metal bucket, the bucket must be grounded due to the hazard of static electricity. Try not to mix oil and fuel together. Use separate buckets. This is necessary because all fuel and oil waste can be sold by the Air Force to recycling agencies. Separate bowsers are used in the maintenance areas for the purpose of depositing fuel and oil waste to the recycling agencies.

FOD Containers

Some containers should be taken to the job site to place trash: cut safety wire, cotter pins, etc.

Rags

Rags should be available to wipe up spills.

Support Equipment

Preposition all the necessary support equipment at the job site.

T56 ENGINE REMOVAL AND DOCUMENTATION

T56-A7 engine removal steps are found in TO 1C-130B-2-4. No deviations are authorized from these steps.

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Entries must be made in the aircraft forms (AFTO Form 781) to reflect that the engine has been removed. You must make entries in the aircraft forms for special inspections that are required prior to engine installation and Job Control must be told of these entries.

An AFTO Form 350 tag (Reparable Item Processing Tag) must be filled out and placed on the removed engine. When you are done with the engine removal, fill out an AFTO Form 349 (Maintenance Data Collection Record) and tell Job Control of your job status.

T56 ENGINE INSTALLATION

Prior to beginning the installation, you must check the aircraft forms to make sure that all the special inspections have been done and documented. Visually inspect the engine to be installed and the aircraft engine bay area to make sure that no discrepancies exist which would cause the engine to be removed again.

Installation Procedures

The steps for the T56-A7 engine installation can be found in TO 1C-130B-2-4. No deviations from these procedures are authorized.

Documentation

Proper documentation of a completed job is as important as the task itself. Once the installation of the engine is done, you must clear the discrepancies concerning the engine removal in the aircraft forms. An engine that has just been installed will also require: an engine inlet inspection prior to the next engine start, IAW TO 00-20-5; an engine runup to operationally check the engine systems, IAW TO 1C-130B-2-4; and some special inspections as shown in TO 1C-130A-6. These entries must be placed in the aircraft forms prior to leaving the job site. Fill out an AFTO Form 349 (Maintenance Data Collection Record) and tell Job Control of your job status.

FOD PREVENTION

Foreign object damage is the main enemy of all aircraft jet engines. The prevention of damage to jet engines by FOD is everyone's job. Tool boxes must be inventoried prior to and after each job to make sure that all the tools are accounted for. Clean up your area when you are done with the job and put all waste materials in the appropriate dispensers.

QUESTIONS

1. What is the first thing to check before starting to remove the engine?

2. Where should the ground wires be located on the aircraft?

3. What is the form used to check the serviceability of support equipment?

4. When can the handrails be removed from the maintenance stands?

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5. What is the best way to prevent damage to equipment and injury to personnel?

6. What TO will you need to find the steps on engine removal and installation?

7. When should a torque wrench not be used?

8. What type of container should you use to drain fuel?

9. Why should you not mix your waste oils and fuels together?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-869
3 March 1980

ENGINE REMOVAL AND INSTALLATION

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to locate information pertaining to the removal and installation of a T56 engine.

EQUIPMENT

	Basis of Issue
TO 00-20-2-2	1/student
TO 1C-130A-06	1/student
TO 1C-130B-2-4	1/student

PROCEDURE

Follow the directions given for each of the projects in this workbook.

Project 1

DIRECTIONS

Using TO 1C-130B-2-4, answer the following questions pertaining to engine removal.

1. If more than one engine is removed from an aircraft, what should be done before removing the second engine? ____________

____

2. What area must be clear of personnel and equipment prior to engine removal? ______________________________

3. Which circuit breakers, located on the copilot's side circuit breaker panel, must be open prior to engine removal?

____

4. In what position is the condition lever placed prior to disengaging the engine controls from the aircraft? ____________

____

5. In accordance with the general maintenance procedures, when should caps and plugs be placed on openings? ____________

____

OPR: 3350 TCHTG
RGL: N/A
DISTRIBUTION: X
3350 TCHTG/TTGU-J - 500; TTVSA - 1
Designed for ATC Course Use. Do Not Use on the Job.

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6. What caution must be observed if lifting any load with the 10 FM, 10,000 pound crane? ____________

____

7. What hoists may be used in place of the nacelle and engine hoisting unit? ____________

8. What is the removed engine installed in for transportation?

____

9. Which mount bolts are removed first? ____________

____

10. How are the engine controls disengaged from the aircraft cable system? ____________

____

11. In accordance with the general maintenance procedures, what should all parts be observed for during dismantling? ____________

____

12. What cleaning solvent is recommended for nonferrous metals?

____

13. What position must the throttle be in before disengaging the engine controls from the aircraft cable system? ____________

____

14. Why must the propeller be feathered before mounting the engine on the trailer? ____________

15. What does draining the fuel heater and strainer prevent?

____

Project 2

DIRECTIONS

Using TO 1C-130B-2-4, answer the following questions pertaining to engine installation.

1. What must be done to the upper and lower mount bolts prior to reuse? ____________

2. What must be done if cracks are suspected in the tailpipe clamp assembly? ____________

3. In accordance with the general maintenance procedures, what standard of lockwire is used? ____________

4. Why is specification MIL-L-21164, Antiseize, Graphite-Petrolatum Thread Compound, used to coat the power package mounting bolts and cones at reinstallation?

5. Which hydraulic system must be bled if the power package is installed in the No. 2 engine position?

6. In accordance with the general maintenance procedures, what diameter lockwire is used on electrical harness coupling nuts?

7. What is the final torque value of the tailpipe clamp bolts?

8. How much torque is applied to the fuel line connection at the firewall?

9. Why must brushless type generators be matched with brushless regulators and brush type generators matched with brush type regulators?

10. Where do you measure the distance between the tailpipe clamp and the tailpipe assembly?

11. In accordance with the general maintenance procedures, what does axial rotation of the solid or broken line along the length of a hose indicate?

12. When installing the power package, which mount bolts are installed first?

13. What may be necessary to achieve proper engagement of the tailpipe with the rear turbine bearing support?

14. Why should all foreign matter dropped into the engine during maintenance be removed?

15. What is the part number of the bolts used to attach the 404055-1 nacelle sling to each side of the nacelle?

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Project 3

DIRECTIONS

Using the following information and the applicable references, make the correct entries on the AFTO Form 349 in figure 1 and the AFTO Form 350 in figure 2.

1. Today you and three assistants are dispatched to remove the No. 4 engine for time change. The engine removal began at 0730 and was completed at 1145 hours.

a. General Information

Job Control Number:	Current Julian Date and 0013
Priority:	3
Location:	X5
Time Specialist Required:	0730
Job Standard:	4 hours
When discovered:	Special Inspection
Type Maintenance:	Special Inspection

b. Aircraft Data

MDS:	C-130E, assigned to 317 TAW
SN:	63-7815
ID:	AA7815
Time:	2372.2 hours
Workcenter:	A2210

c. Removed Engine Data

PN:	362503-11
SN:	AE104630
Time:	3998.3
Workcenter:	Q3233
ID:	AX4630
Stock Code:	1560-00-188-3610
Records Action:	Yes

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MAINTENANCE DATA COLLECTION RECORD

OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPC REQ	18. JOB STD.

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23 INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER. TIME

ACT LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

NO. 4 ENGINE DUE TIME CHANGE

27. CORRECTIVE ACTION

28 RECORDS ACTION

AFTO FORM MAY 75 349 PREVIOUS EDITION IS OBSOLETE.

Figure 1. AFTO Form 349.

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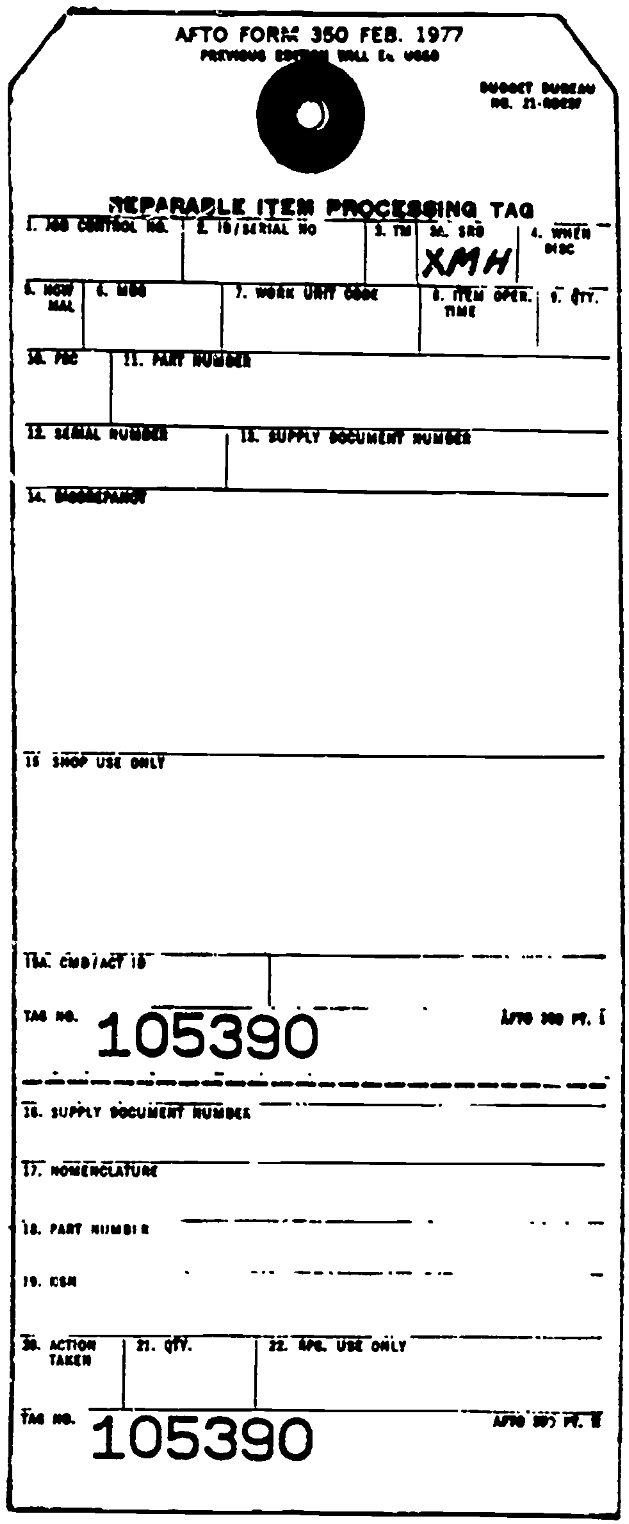

AFTO FORM 350 FEB. 1977
PREVIOUS EDITION WILL BE USED

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. | 2. ID/SERIAL NO | 3. TM | 3A. SRD XMH | 4. WHEN DISC

5. HOW MAL | 6. MDS | 7. WORK UNIT CODE | 8. ITEM OPER. TIME | 9. QTY.

10. FSC | 11. PART NUMBER

12. SERIAL NUMBER | 13. SUPPLY DOCUMENT NUMBER

14. DISCREPANCY

15 SHOP USE ONLY

15A. CMD/ACT ID

TAG NO. 105390 AFTO 350 PT. I

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE

18. PART NUMBER

19. NSN

20. ACTION TAKEN | 21. QTY. | 22. MFG. USE ONLY

TAG NO. 105390 AFTO 350 PT. II

Figure 2. AFTO Form 350.

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STUDY GUIDE
3ABR4[illegible]-3-SG-504
875

Technical Training

Turboprop Propulsion Mechanic

ENGINE AND PROPELLER RIGGING

24 June 1981

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3350 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

RGL: 10.4

Jet Engine Branch
Chanute AFB, Illinois

ENGINE AND PROPELLER RIGGING

OBJECTIVES

After completing this study guide and your classroom instruction, you will be able to explain the purpose, procedures, and tasks involved in rigging the engine and propeller. You will also be able to rig the engine and propeller using the appropriate technical orders.

INTRODUCTION

As a turboprop mechanic you will learn the importance of engine and propeller rigging procedures and be able to maintain an important part of the turboprop power plant that provides control of the engine and propeller. This control must be correctly rigged from the cockpit to the engine and to the propeller.

INFORMATION

This lesson has all the information you will need to know about the engine and propeller rigging in accordance with the steps that are found in TOs 1C-130B-2-4 and 1C-130B-2-11.

THROTTLE CONTROL SYSTEM

Each of the throttle levers in the engine control quadrant is linked mechanically by cables, rods, and levers to a throttle shaft of the engine control coordinator on the corresponding engine, as shown in figure 1. A throttle output lever on the right side of the coordinator is linked by mechanical linkages to a throttle lever on the engine fuel control. A propeller output lever on the left side of the coordinator is linked to the coordinator throttle shaft, and is connected by linkages to the input shaft on the propeller. A movement of the throttle lever is transmitted through the mechanical linkages and the control coordinator, and causes a corresponding movement of both the fuel control throttle lever and the propeller input shaft. The forward and aft positions of the flight station throttle lever are TAKEOFF and MAXIMUM REVERSE, respectively, as shown in figure 2. When moved aft from the TAKEOFF position, the lever hits a gate at the FLIGHT IDLE position; it must be lifted over the gate to be moved into GROUND IDLE and MAXIMUM REVERSE. Pointers on the coordinator shaft and the fuel control throttle lever show their positions in degrees. The two should be within 1 degree of each other at all times. Each of the throttle positions and coordinator positions should read as follows:

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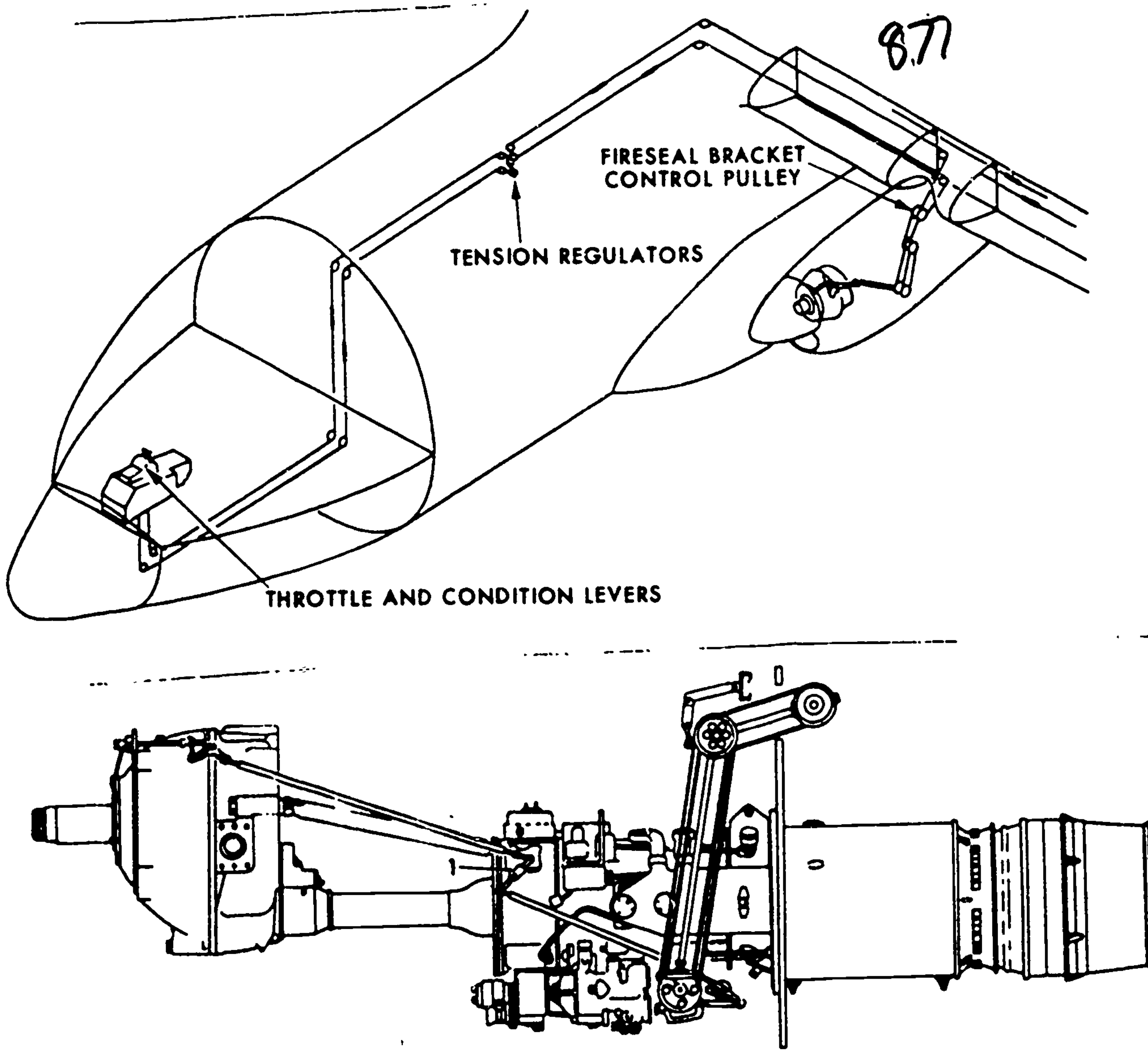

Figure 1. Aircraft and Engine Mechanical Controls.

THROTTLE POSITIONS	COORDINATOR POSITIONS
TAKEOFF	90 degrees
FLIGHT IDLE	34 degrees
GROUND IDLE	18 degrees
MAXIMUM REVERSE	0 degrees

When the throttle is below FLIGHT IDLE (34 degrees on the coordinator) in the taxi range, propeller pitch is controlled directly by the position of the throttle. In this way, the thrust and horsepower produced by the engine are controlled by positioning the throttle. Engine fuel flow in this range is controlled by the throttle position and by the governing action of the fuel control.

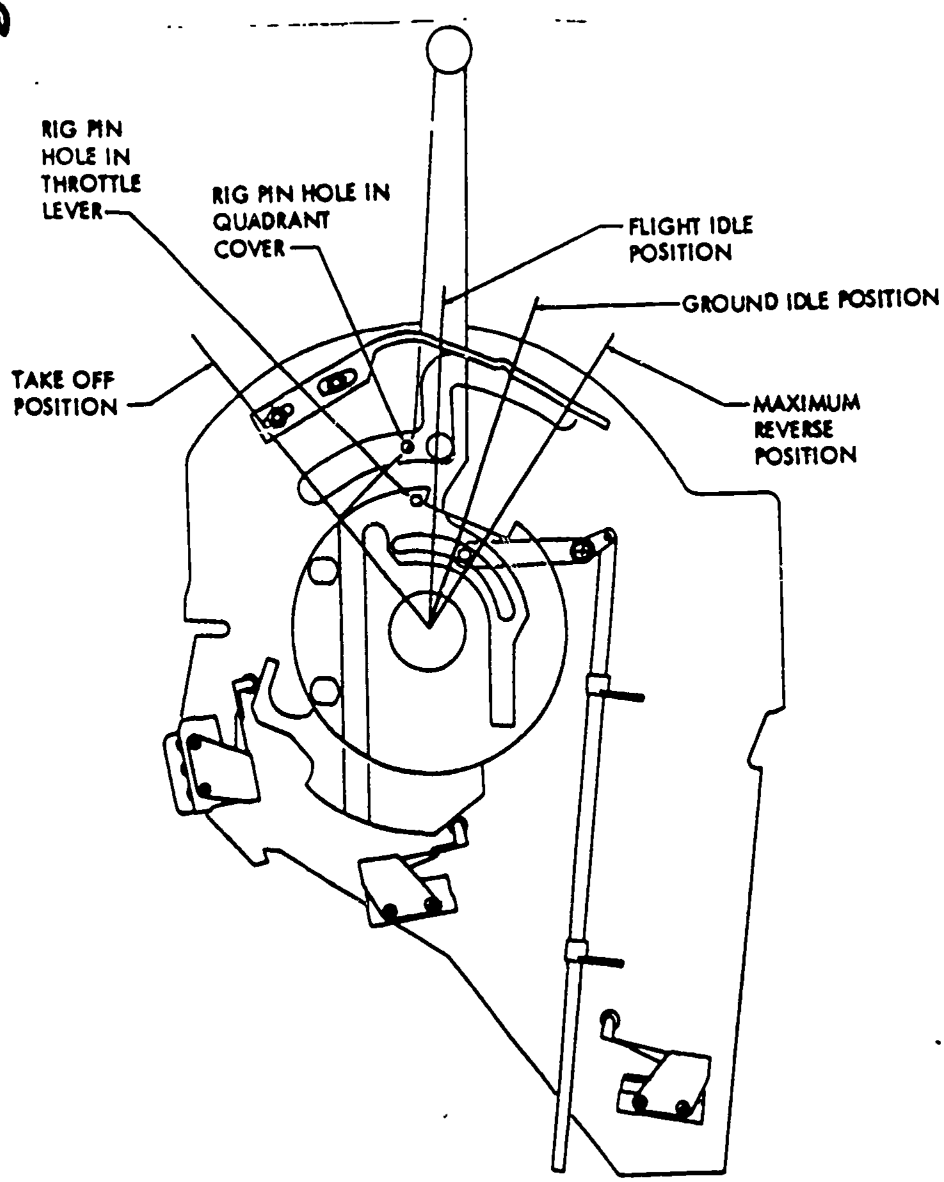

Figure 2. Control Quadrant Throttle Lever.

When the throttle setting is in the range of FLIGHT IDLE or TAKEOFF (34 and 90 degrees, respectively, read on the coordinator), the propeller pitch is controlled by the propeller governing system to hold a 100% engine speed. The low pitch stop is limited to 23.25 degrees for the 54H60-91 propellers on the C-130E airplanes. As a result, the engine speed will not be 100% rpm when the throttle is between 34 and 60 degrees (read on the coordinator) during ground operation because the engine will not put out enough power to keep 100% rpm at this blade angle. The power put out by the engine is controlled by the fuel control which sends fuel flow to the engine according to the throttle position. With the throttle set above 65 degrees, the electronic temperature datum control can control the engine power by altering the fuel flow as is needed to hold the turbine inlet temperature scheduled by a temperature selected potentiometer in the coordinator. The temperature selector potentiometer and the two micro-switches in the coordinator are controlled by the movement of the throttle.

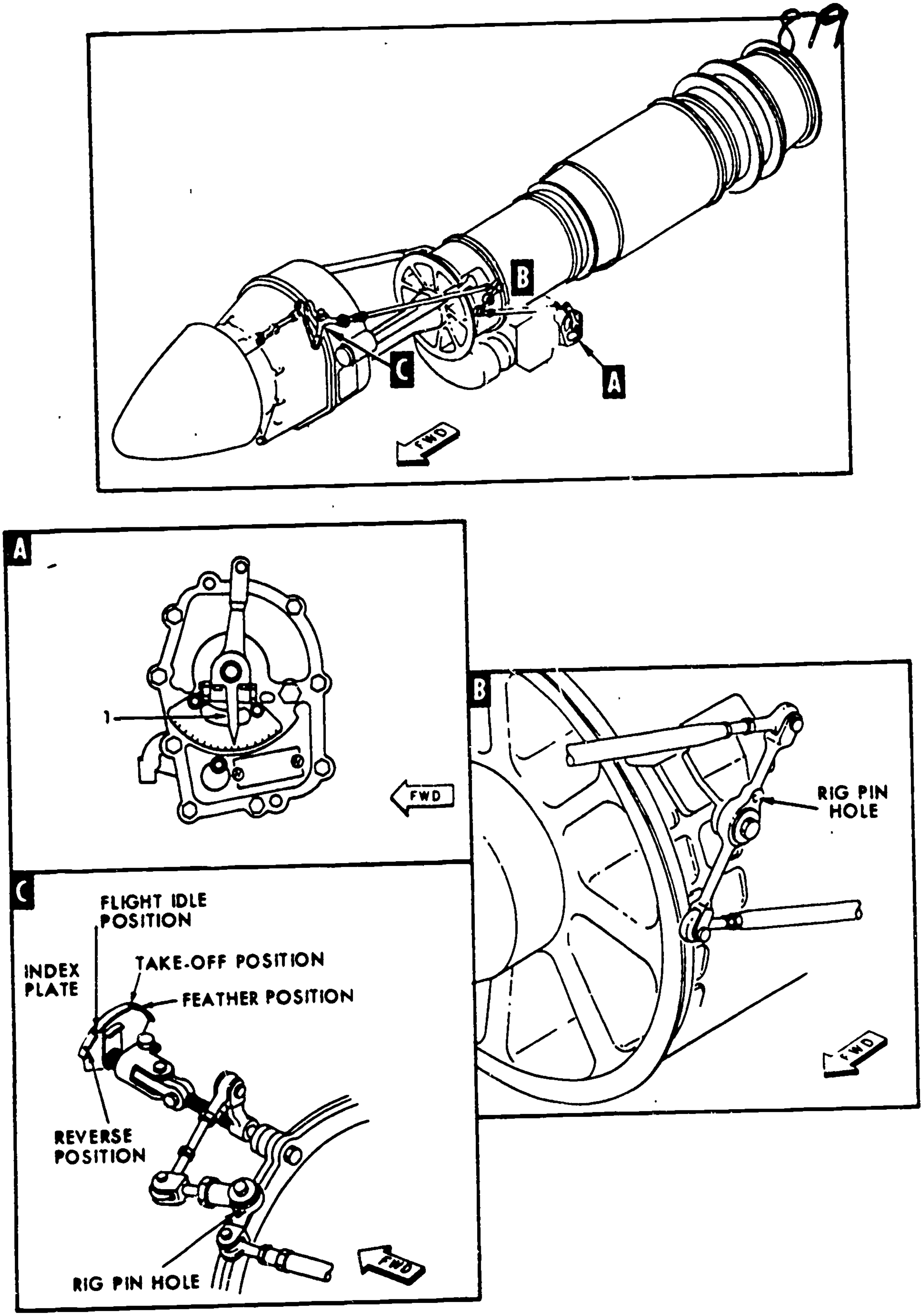

Figure 3. Mechanical Linkage From Coordinator to Propeller.

880 perform the throttle system checkout as follows:

1. Raise the throttle about 0.75 inch at the FLIGHT IDLE gate and let it drop. The throttle should fall free with no binding or interference of any kind. Check the scale reading of the throttle cable tension regulator. The scale reading should be 7.5 pounds plus or minus 1 pound at an ambient temperature of 24 degrees Celsius (75 degrees Fahrenheit).

2. Insert a rig pin through the quadrant cover into the throttle. Insert a rig pin through the bracket and pulley, located under the flight station. Insert a rig pin through the pulley and fireseal bracket at the vertical firewall. The rig pin holes should align so that the rig pins can be inserted. Shaking the cables at the pulleys may be required to line up the holes. There should be no evidence of rubbing or binding of the control cables between the control quadrant and the fireseal bracket.

3. Place the condition lever in the RUN position. Move the throttle to TAKEOFF. Check that the reading on the coordinator pointer reads 90 degrees plus or minus 1 degree. Put an alignment pin, tool no. HS545611, through the takeoff slot in the indexing plate on the propeller control assembly into the indexing lever, see figure 3, detail C. The pin should fit through the slot easily. Take out the alignment pin and check the reading of the coordinator pointer after moving the throttle to FLIGHT IDLE. Pull the throttle back slowly until it is against the flight idle gate. The reading of the coordinator pointer should not be more than 35 degrees. Put the alignment pin in the flight idle slot of the propeller indexing plate. Take the alignment pin out.

4. Move the throttle to TAKEOFF. Pull the throttle back to FLIGHT IDLE in one second. Check that the reading on the coordinator pointer does not read less than 34 degrees.

5. Move the throttle to the GROUND IDLE position. Check that the coordinator pointer reads 18 degrees plus or minus 1/2 degree.

6. Move the throttle to the MAXIMUM REVERSE position. Check the reading of the coordinator and put a rig pin through the reverse slot in the indexing plate on the propeller control. The reading of the coordinator pointer should be 0 degrees plus or minus 1 degree, and the rig pin should fit through the slot easily. Remove the rig pin and move all four throttles to TAKEOFF and MAXIMUM REVERSE. Check that the four throttle handles are within one-half knob of alignment of each other at both TAKEOFF and MAXIMUM REVERSE. Each throttle should be stopped at least 0.2 inch from each end of the slot in the quadrant cover.

Adjustment of the throttle control system is done in accordance with figure 4-3 of TO 1C-130B-2-4.

QUESTIONS

1. What are the four throttle positions and their corresponding coordinator position readings?

2. How is thrust and horsepower produced by the engine controlled in the taxi range?

3. On the 54H60-91 propeller, what is the low pitch stop limited to above the flight idle range?

4. How is power produced by the engine controlled in the flight range?

5. When checking the throttle cable tension regulator, what should it read at an ambient temperature of 24 degrees Celsius?

6. With the throttle at FLIGHT IDLE, name all the places that you should be able to insert a rig pin?

7. What is the tool number for the rig pin used in the propeller indexing plate and indexing lever?

8. All four throttle handles in the control quadrant should be within how much of alignment of each other at both TAKEOFF and MAXIMUM REVERSE?

ENGINE CONDITION CONTROL SYSTEM

Each of the condition levers in the control quadrant is linked mechanically by cables, rods, and levers to a feather shaft in the coordinator, as shown in figure 1. The feather shaft is in line with the coordinator throttle shaft and sticks out from the right side of the coordinator. These mechanical linkages that are connected from the engine condition lever give you a manual feathering system. When the condition lever is pulled aft to the FEATHER position, the linkage from the coordinator feather shaft to the fuel control shuts the fuel shutoff valve. The feather shaft then engages the propeller output lever on the coordinator and turns it. The propeller output lever sends the motion through the propeller control linkages to move the input shaft on the propeller into the feather position. The throttle shaft in the coordinator is disengaged from the propeller output lever when the feather shaft engages the lever.

Each of the engine condition levers also operate four switches in the engine control quadrant. These are shown in figure 4. One of these is an air start switch which is turned on when the lever is held in the AIR START position. Actuation of the switch causes operation of a relay which puts power to the auxiliary pump motor of the propeller. Two feather switches are actuated at the same time that the lever is moved to FEATHER. One switch closes the propeller auxiliary pump motor and feather solenoid valve control circuits. The other closes a circuit to energize a fuel shutoff valve actuator in the engine fuel control and opens the engine start control circuit. A ground stop switch is actuated when the lever is moved to GROUND STOP. This switch completes a circuit to energize the fuel shutoff valve actuator in the fuel control.

You perform the engine condition control system check as follows:

1. Check this system from the control quadrant to the engine firewall. There should be no interference or binding in the cables or the pulleys. All the turnbuckles should be properly safetywired and all guard pins should be in place.

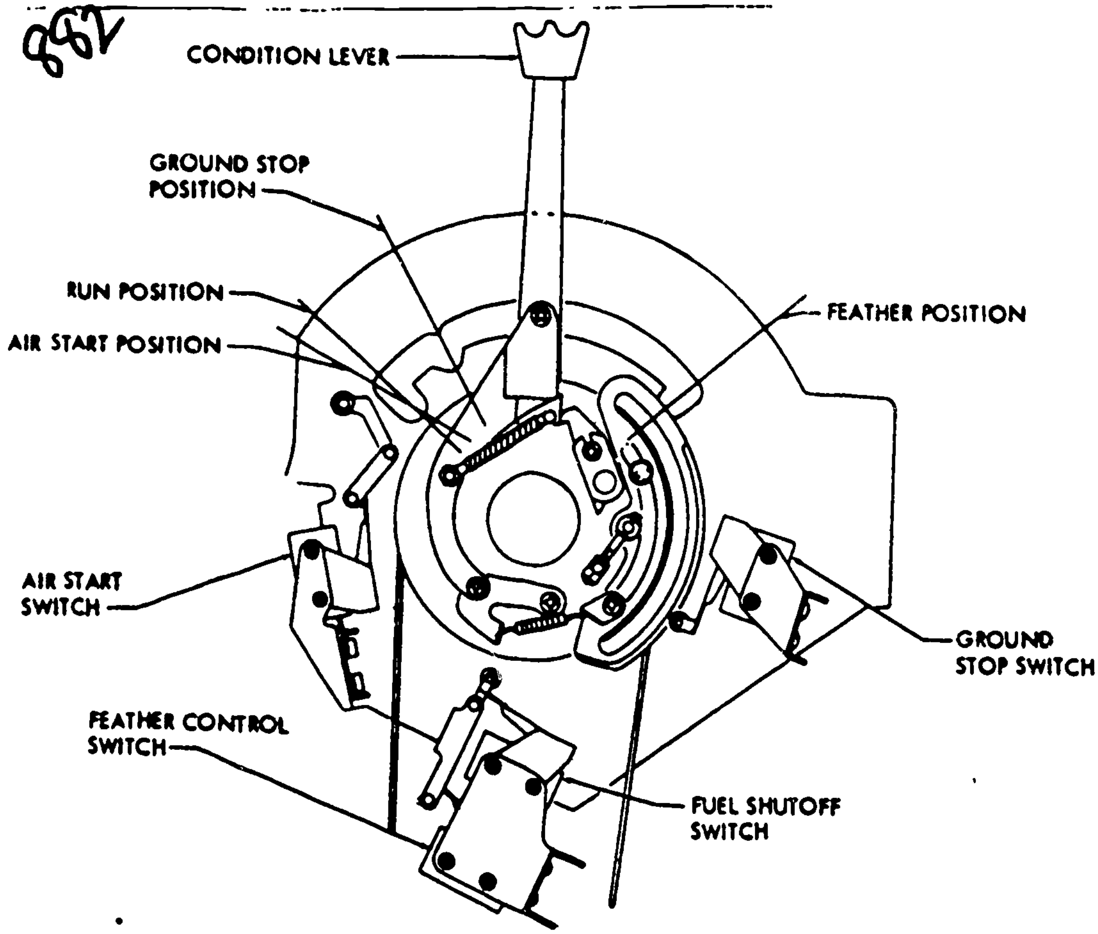

Figure 4. Control Quadrant Condition Lever.

2. Move the condition lever to the FEATHER position and check the reading on the condition cable tension regulator scale. The scale reading should be 6.5 pounds plus or minus inuse 1 pound at an ambient temperature of 21°C (70°F). See TO 1C-130B-2-4, figure 4-1, for scale readings at other ambient temperatures.

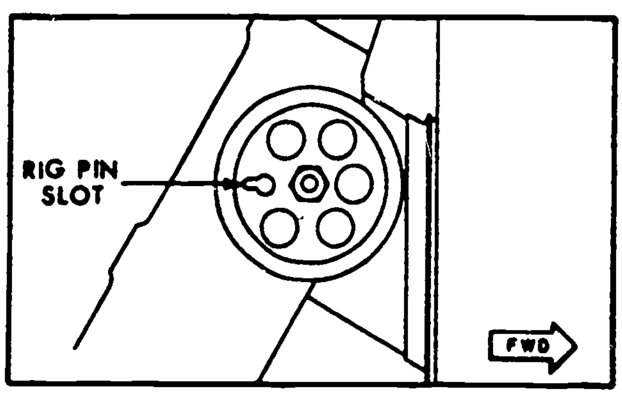

Figure 5. Fireseal Bracket.

3. Insert a rig pin through the condition control pulley on the fireseal bracket into the fireseal bracket, see figure 5. The pulley may

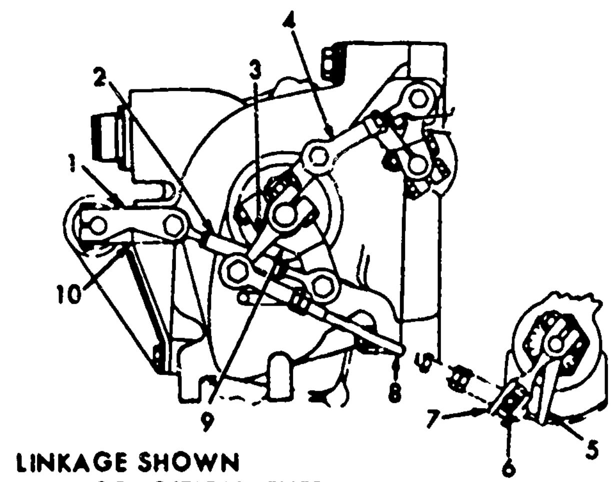

Figure 6. Engine Coordinator and Fuel Control.

be turned slightly so that the rig pin can be put in, provided the pulley will stay in the same place when the rig pin is removed. If the conditions of the previous steps are met, the condition control system from the control quadrant to the fireseal bracket is properly adjusted. Next, place the throttle in the FLIGHT IDLE position and move the condition lever to FEATHER. Check to see if the lever, figure 6 (1), is against the coordinator external feather stop (10).

4. Place a rig pin, tool no. 546455 or alternate part no. 6796757, through the feather slot in the indexing plate on the propeller control into the lever. Take out the rig pin.

5. Grip the pulley, figure 7, in both hands and turn it clockwise until the propeller indexing lever (1) has passed the feather slot in the index bracket (2). Release the pulley and the indexing lever should go back to the feather position.

6. Move the conditi lever to the RUN position. Pull the condition lever back to the FEATHER position with a spring scale. The spring scale reading should be between 13 and 15 pounds when the condition lever gets to the FEATHER detent, see figure 8.

7. If the previous conditions are met, the condition control system from the fireseal bracket to the propeller is properly adjusted. If the conditions were not met, and some adjustments need to be made, adjust the engine condition controls from the control quadrant in the flight deck through the coordinator as shown in steps 1 through 27, and the final adjustments in steps 28 through 33 of figure 4-1 in TO 1C-130B-2-4. Adjust the linkage from the coordinator to the propeller control in accordance with TO 1C-130B-2-11.

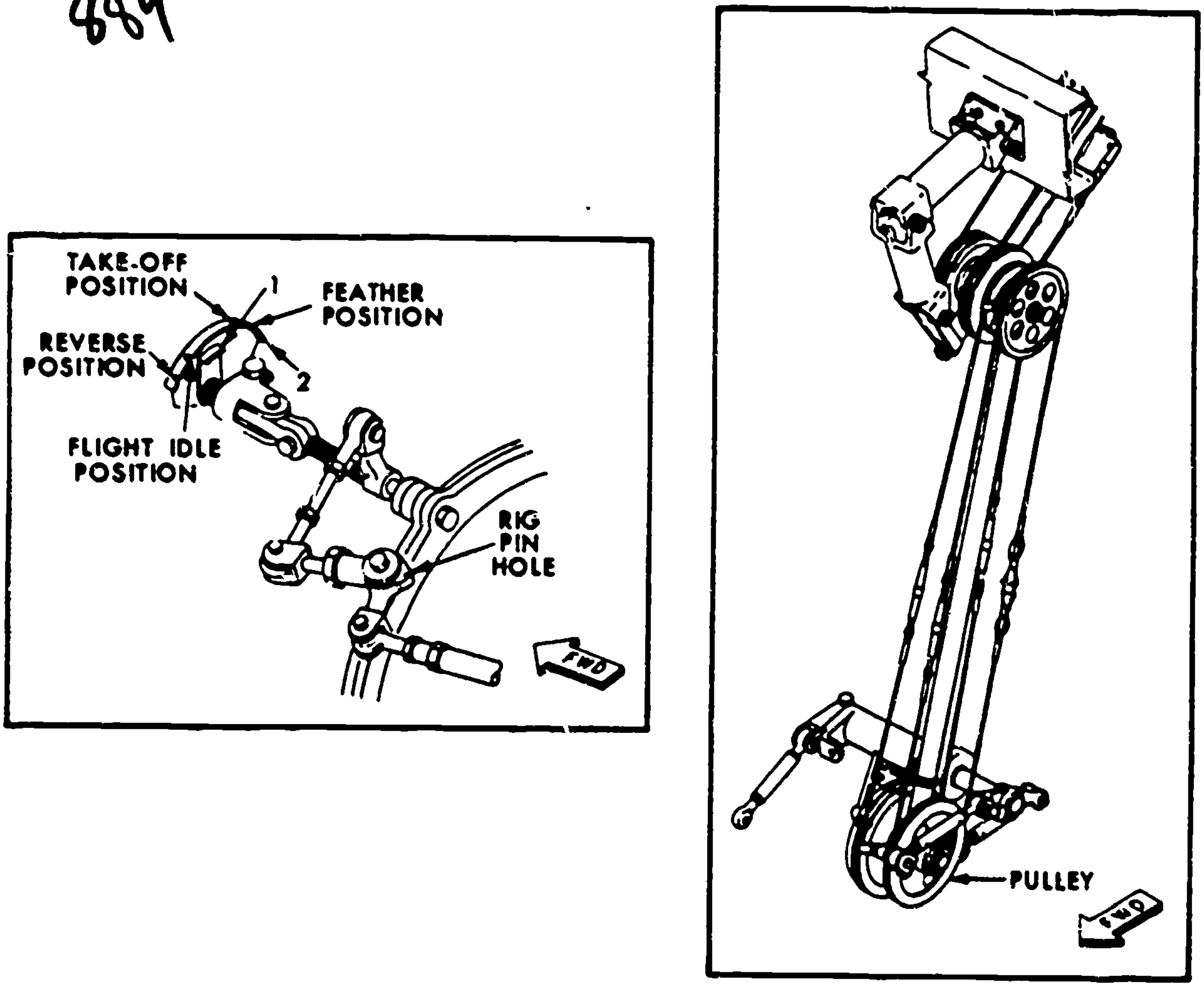

Figure 7. Condition Control System Feather Checkout.

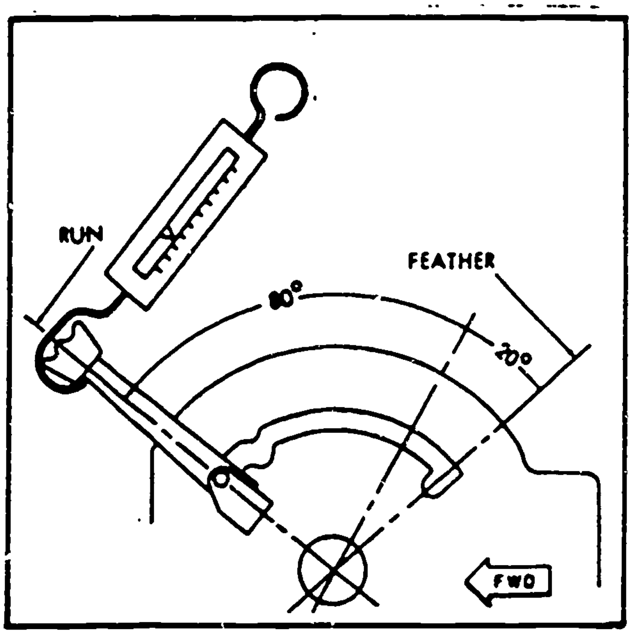

Figure 8. Spring Scare Check of Condition Lever.

QUESTIONS

1. What are the four positions of the engine condition lever in the cockpit?

2. What are the four switches operated by the condition lever?

3. What may be done if a rig pin cannot be inserted in the condition control pulley on the fireseal bracket?

4. With the throttle in FLIGHT IDLE and the condition lever in FEATHER, through what slot in the indexing plate of the propeller control assembly will an alignment pin be inserted?

5. In accordance with what TO and figure is final adjustment of the condition controls adjusted?

ENGINE COORDINATOR-TO-FUEL CONTROL LINKAGE

You perform the coordinator to the fuel control linkage check as follows:

1. Move the condition lever to the RUN position and move the throttle lever to the FLIGHT IDLE position. Place a rig pin, NAS 1104 bolt, in the clevis lever, figure 1 (1). The coordinator pointer, figure 9 (2), should read 34 degrees.

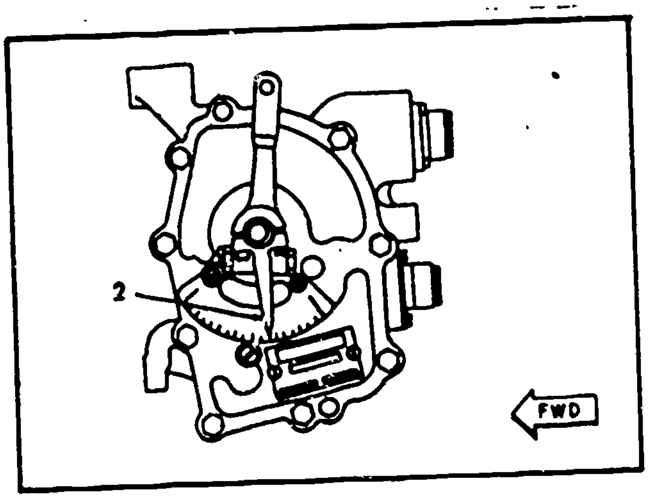

Figure 9. Engine Coordinator.

2. Disconnect the rod assembly, figure 6 (2), from the coordinator condition lever (9). Move the lever (9) clockwise to the full UNFEATHER position. Disconnect the rod (8) from the throttle lever (7) and move the fuel control pointer (5) through its full range. End readings should be 0 degrees plus or minus 1/2 degree and 90 degrees plus : minus 1 degree.

3. Move the pointer (5) to 73.5 degrees. The throttle lever (7) should be vertical (45 degrees on the protractor). If necessary, adjust the micromatic adjustment screw until the throttle lever (7) is vertical. Use part no. 6796658, fuel control throttle lever position fixture. Set the length adjusting screw (6) at the center of its range. Adjust the

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rod (8) so that the thread engagement with the rod ends is equal. The witness holes must be covered. Connect the rod (8) to the throttle lever (7). Adjust the rod so that the coordinator and the fuel control pointers both read 34 degrees. Lever (7) and lever (3) should be parallel. Remove the rig pin from the clevis lever at this time.

4. Move the throttle from TAKEOFF to MAXIMUM REVERSE. The readings of the coordinator and the fuel control pointers should read within 1 degree of each other at all points.

5. Reconnect the rod assembly (2) to the coordinator condition lever (9). Move the condition lever to the FEATHER position. Lever (1) should rest on top of the external feather stop (10). Check that the fuel cutoff rod (4) measures 2-23/64 inches plus or minus 1/64 inch from each of the bolt hole centers.

6. After installing the linkage and tightening the jam nuts, operate the throttle linkage through its entire range with the condition lever in the GROUND STOP detent and again with the condition lever in the RUN detent. If interference occurs, check for loose linkage bolts and/or rod end jam nuts and rotate the rod ends as necessary.

QUESTIONS

1. What is the range of the fuel control pointer in degrees?

2. Within how many degrees of each other should the fuel control and coordinator pointers read?

3. What should be checked if interference occurs when operating the throttle linkage through its entire range during coordinator to fuel control rigging?

ENGINE COORDINATOR-TO-PROPELLER RIGGING

This rigging is necessary to make sure that the propeller blade angle corresponds to the amount of fuel being fed to the engine. The rigging of the propeller linkage must be done if the engine, propeller, valve housing, or pump housing is replaced.

Before you start propeller rigging, make sure that the engine is properly rigged from the cockpit to the engine coordinator. You will check the coordinator pointer (1), figure 3, detail A, position for all throttle positions. With the throttle at TAKEOFF, the coordinator will read 90 degrees. At FLIGHT IDLE, the coordinator will read 34 degrees and at GROUND IDLE it will read 18 degrees. When the throttle is in the MAXIMUM REVERSE position the coordinator will read 0 degrees. The condition lever must be in the RUN position to place the coordinator as it will be in flight or with the engine running.

A system of cables and pulleys connect the throttle and condition lever to the coordinator. Pushrods and bellcranks make up the linkage that connects the coordinator to the propeller turbo control, shown in figure 3. The pushrods can be shortened or lengthened to get proper positioning of the input shaft on the turbo control valve housing assembly. The use of the rig pins and rig pin holes in the linkage make it possible for the mechanic to adjust the linkage to correspond to the throttle position. See details B and C in figure 3. 887

To rig the propeller, you will first place the condition lever in RUN. Then place the throttle in the FLIGHT IDLE position. If the linkage is correctly adjusted, you will be able to install the rig pins in the linkage holes shown in figure 3, detail B and C, in the indexing plate, detail C, and in the alpha shaft inside the valve housing assembly.

If the rig pins cannot be placed in the linkage rig pin holes, the pushrods will have to be adjusted to correctly align the holes. If the rig pin cannot be placed in the indexing plate of the valve housing, the micro adjusting ring on the input shaft will have to be adjusted.

When all rig pins can be placed at flight idle, they will be removed and the throttle placed at the TAKEOFF position. The input shaft should align with the indexing plate to allow rig pin installation. If it does not align, again, the pushrods must be adjusted. The steps will be performed for FEATHER and MAXIMUM REVERSE throttle positions. The propeller linkage is correctly rigged when rig pins can be placed for FLIGHT IDLE, TAKEOFF, and REVERSE positions of the throttle and the condition lever is placed in the FEATHER position.

These steps and adjustments of the propeller rigging will be in accordance with TO 1C-130B-2-11.

QUESTIONS

1. Why must the propeller control linkage be rigged correctly?

2. What must be checked prior to starting the propeller rigging?

3. What will the engine coordinator read when the throttle is placed in the FLIGHT IDLE position?

4. In what position must the condition lever be in to begin your rigging procedures and why?

5. How do you know when the control linkage is properly rigged?

6. All but the rig pin hole on the valve housing indexing plate will align at the FLIGHT IDLE position. Where would an adjustment be made to correct this problem?

Jet Engine Branch
Chanute AFB, Illinois

3ABR42633-WB-808
5 May 1980

ENGINE AND PROPELLER RIGGING

OBJECTIVE

After completing this workbook and your classroom instruction, you will be able to rig (adjust) engine and propeller control systems using appropriate technical orders.

EQUIPMENT

	Basis of Issue
TO 1C-130B-2-4	1/student
TO 1C-130B-2-11	1/student

PROCEDURE

Follow the directions given for each project in this workbook.

Project 1

DIRECTIONS

Using TO 1C-130B-2-4, figure 4-1, complete the following statements.

1. Pointers on the coordinator shaft and the fuel control throttle lever indicate their positions in ____________________.

2. Adjust the cables for an engine ____________________ in small increments to keep the tension regulator from ____________________.

3. When adjusting turnbuckles, not more than ______ threads of each end fitting should be ____________________ out of the turnbuckle.

4. When adjusting the engine condition control system, check that the witness holes in the rod assembly barrels are ______________.

5. When connecting the rod assembly to the lever during engine condition control system adjustment, insert the bolt so that the nut is ____________________ the ____________________ of the engine.

6. The temperature datum system will be checked in accordance with TO ______________, section ________, after mechanical control rigging is completed.

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Project 2

DIRECTIONS

Using TO 1C-130B-2-4, figure 4-2, answer the following questions and complete the incomplete statements.

1. What must the coordinator pointer read with the throttle lever in the "flight idle" position and the condition lever in the "run" position? __________

2. What must be done if there is a lock plug in the coordinator?

____

3. When adjusted properly, the ____________________ pointer and ____________________ pointer will both indicate 34 degrees.

4. Tighten the fuel control lever and throttle lever micromatic screw 1/4"-20 self-locking nuts to a torque value between __________ inch-pounds.

5. Rod ends should be replaced when the ____________________ movement to the mounting hole of the rod exceeds ______________.

Project 3

DIRECTIONS

Using TO 1C-130B-2-4, figure 4-3, steps 15-48, answer the following questions and complete the incomplete statements.

1. If a power package has been replaced, connect the replacement power package controls to the aircraft ____________________ by performing steps ______________.

2. When adjusting cable length, exercise care when installing a locking clip or safety-wiring the turnbuckle to avoid turning the ______________ and ______________ in the cable.

3. What must the cable tension be after adjusting the turnbuckles? ______________

4. What must the coordinator pointer indicate when the throttle is moved to "ground idle" position? ____________________

5. Refer to TO ____________________ to adjust the engine coordinator-to-propeller control assembly linkage.

6. Check all turnbuckles for proper installation of ____________ or ____________.

Project 4

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DIRECTIONS

Using TO 1C-130B-2-11, figure 4-6, answer the following questions and complete the incomplete statements.

1. With the throttle lever in the "takeoff" position, the pointer on the coordinator protractor should be at the ______________.

2. What is the number of alignment pin tool inserted through the flight idle slot of the valve housing cover index bracket?

____

3. With the throttle lever in the "reverse" position, the pointer on the coordinator protractor should be at the ______________.

4. Check the linkage through ____________ range of travel for ______________ or ______________.

5. All bellcrank 3/8"-24 self-locking nuts must be torqued to ____________________.

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STUDY GUIDE

3ABR42633-SG-505

Technical Training

Turboprop Propulsion Mechanic

SYNCHROPHASER THEORY AND OPERATION

11 May 1981

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SYNCHROPHASER THEORY AND OPERATION

OBJECTIVE

After completing this study guide and your classroom instruction, you will be able to explain synchrophaser theory and operation and trace the operation of the synchrophaser system on a block diagram.

INTRODUCTION

You have been introduced to the Hamilton turbopropeller and the parts of the turbocontrol assemblies. Your past knowledge and introduction to this propeller is not complete without the synchrophasing system. This system controls and keeps a constant desired engine RPM and it keeps a relative position of all four propeller blades. This maintaining of the relative position is called synchrophasing. Synchrophasing will decrease noise and vibration on the aircraft.

INFORMATION

The four main parts of the synchrophaser system are the pulse generator, electronic unit, propeller manual phase and trim control, and the speed bias servocontrol, as shown in figure 1. The tachometer generator on each of the engines is connected to the speed sensing circuit, see figure 4.

PULSE GENERATOR

A pulse generator is put on each propeller and consists of a moving magnet and a fixed coil. The magnet is attached to a moving part of the propeller. As the magnet moves past the coil, a voltage is induced and a pulse is generated. The rotating propeller and magnet will generate one pulse for each revolution. See figure 4.

SYNCHROPHASER ELECTRONIC UNIT

The electronic unit gets its information from the pulse generator and from the throttle levers. This voltage is needed to drive the speed bias servocontrol which is mounted on each propeller.

The synchrophaser electronic unit is housed in ventilated protective cover and has six plug-in panels which are made up of printed circuit panels on which are mounted vacuum tubes, transistors, and other electrical parts. See figure 1.

The electronic unit of the synchrophasing system keeps a constant engine speed and controls all the blade positions (phase angles) by continually comparing the three slave propeller pulse signals with the master pulse. The difference between the master and the slave

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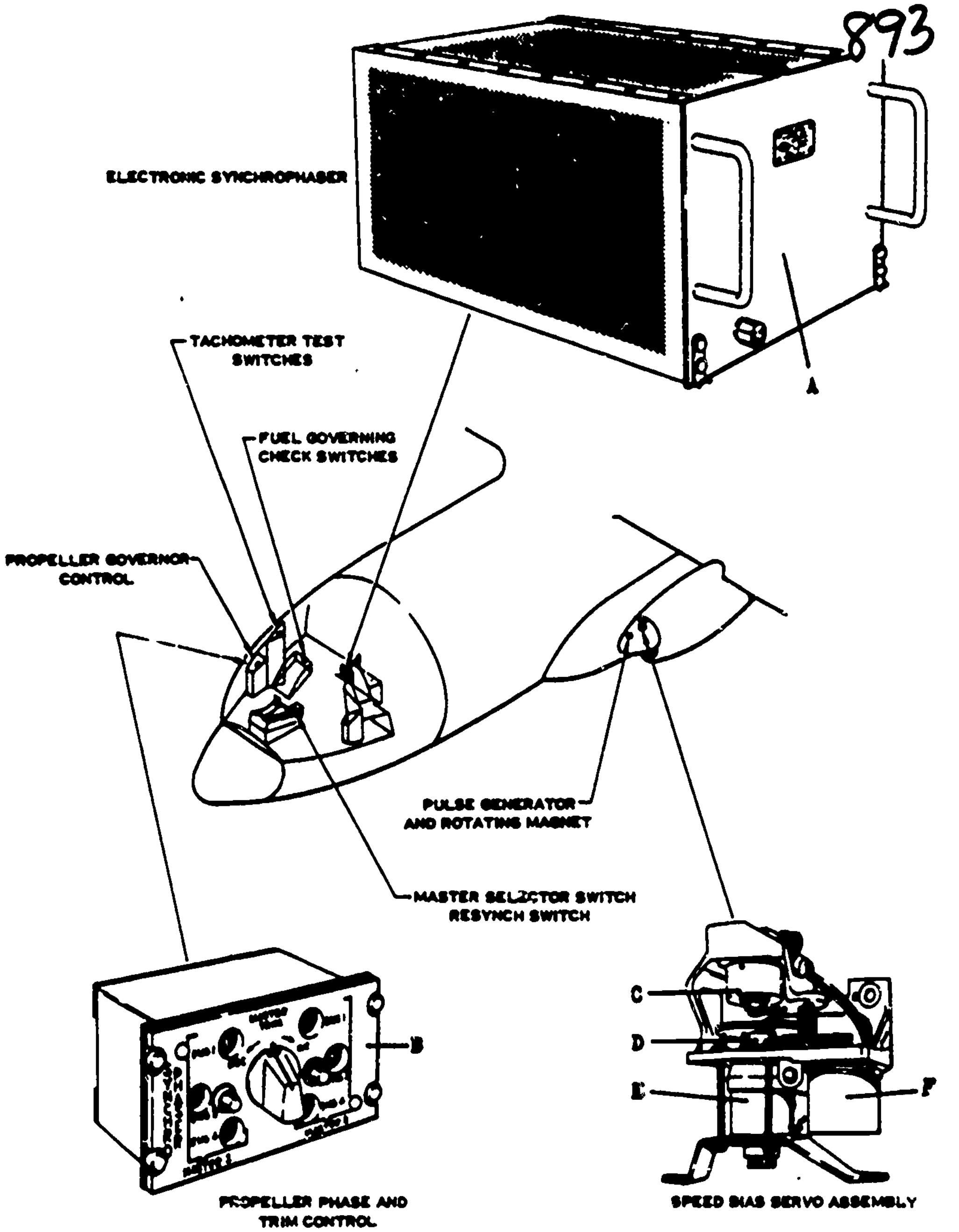


Figure 1. Electronic Synchrophaser.

pulse is called an error voltage. This voltage is used to drive the speed bias servocontrol of the slave propellers.

The electronic unit uses the signals from an anticipation potentiometer and an engine-driven tachometer generator to keep the engine speed constant during and after the throttle lever has been moved. Movements of the throttle will turn the anticipation potentiometer. See figure 4 (D). Signals from the potentiometer are to the synchrophaser which will electrically control the two-phase motor in the speed bias servo assembly. In this way, the synchrophaser anticipates changes in engine speed due to the throttle lever being moved, and keeps the engine from overspeeding or underspeeding for all throttle lever movements. When engine speed is increasing or decreasing during or just after a throttle movement, the synchrophaser electrically changes a signal from the tachometer generator into an engine speed rate of change. The synchrophaser then sends an increase or decrease pitch signal to the two-phase motor which acts on the pilot valve to keep a constant engine speed.

PROPELLER PHASE AND TRIM CONTROL

The propeller manual phase and trim control determines the phase angle of the slave propellers in relation to the master propellers. See figure 4 (G).

The propeller manual phase control has a master engine speed trim knob, six screwdriver adjusting potentiometers, and a relay. This control gives you a preselection of the desired phase angle relationship between the master and the slave propellers, and for the adjustment of the speed of the engine that is selected as the master.

The master engine speed trim knob of the manual phase and trim control provides for a master engine speed adjustment of ± 1% rpm.

SPEED BIAS SERVOCONTROL ASSEMBLY

The speed bias servocontrol gets the control voltage as a signal to change the speed setting of the propeller. As the voltage repositions the speed bias motor, the motor will change the speeder spring tension in order to set the pilot valve which will meter oil to the dome to cause a blade angle change. This will provide the desired speed change. See figure 4.

The speed bias servocontrol is made up of a two-phase motor, figure 1, item F, a magnetic clutch and the brake unit, figure 1, item E, a feedback potentiometer, figure 1, item C, a reduction gear train, figure 1, item D, and the associated wiring, all are mounted on a frame base. Each propeller has a speed bias servocontrol in the control assembly. The servomotor is reversible so that it can cause an increase or decrease change to the engine and propeller speed. The direction of rotation of the motor is dependent upon which of the two windings in the motor has the controlling voltage sent to it.

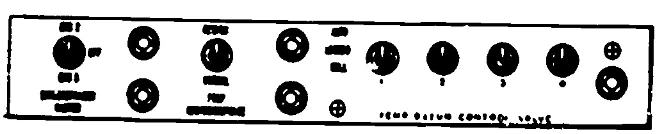


Figure 2. Pilot's Pedestal.

The output signal from the synchrophase electronic unit will correct the slave engines within ± 2% of the master engine speed. This is to stop the slave engines from following the master engine too much in the event of a malfunctioning master engine. If more than a 2% change is desired, the pilot can push the "resynch" switch, found on the pilot's pedestal, see figure 2, let it go, and the servo bias motor will reposition itself to allow another two percent correction to be made. See figure 4 (B).

When the resynchrophasing switch is released, at least one minute is required for the change to take place, or before resynchrophasing can be done again. With each "resynch" operation, the slave servomotor recenters. It is then repositioned to make an increase or decrease correction to keep phase and speed relation with the selected master propeller. It is important to do the resynchrophasing operation after each significant change in throttle lever setting, or when the master selector switch is used to change from one master engine to the other.

SYNCHROPHASE MASTER SWITCH

The synchrophase master switch can be found on the pilot's pedestal in the flight deck. It is a three-position toggle switch which is labeled ENG 2, ENG 3, and OFF. See figure 2.

Either the No. 2 or the No. 3 propeller may be used as the master by placing the synchrophase master switch in the desired position. In the OFF position, the synchrophaser operation on all of the propellers is disconnected.

PROPELLER GOVERNOR CONTROL SWITCH

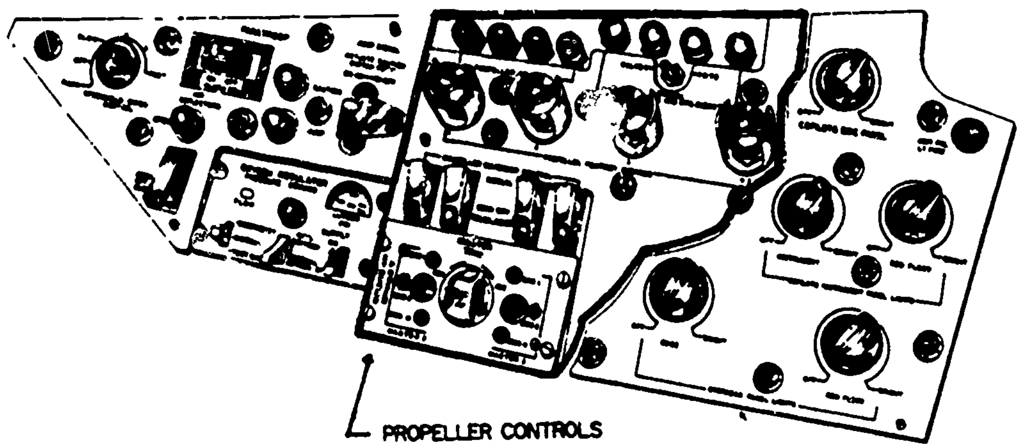


Figure 3. Copilot's Side Shelf.

These four two-position toggle switches can be found on the copilot's side panel. See figure 3. When they are put in the MECHANICAL position, all the signals to the propeller control are isolated by removing the reference voltage. See figure 4 (E). The propeller works only on the mechanical governing. When the switches are in the NORMAL position, the propeller gets signals from the synchrophaser system.

SUMMARY

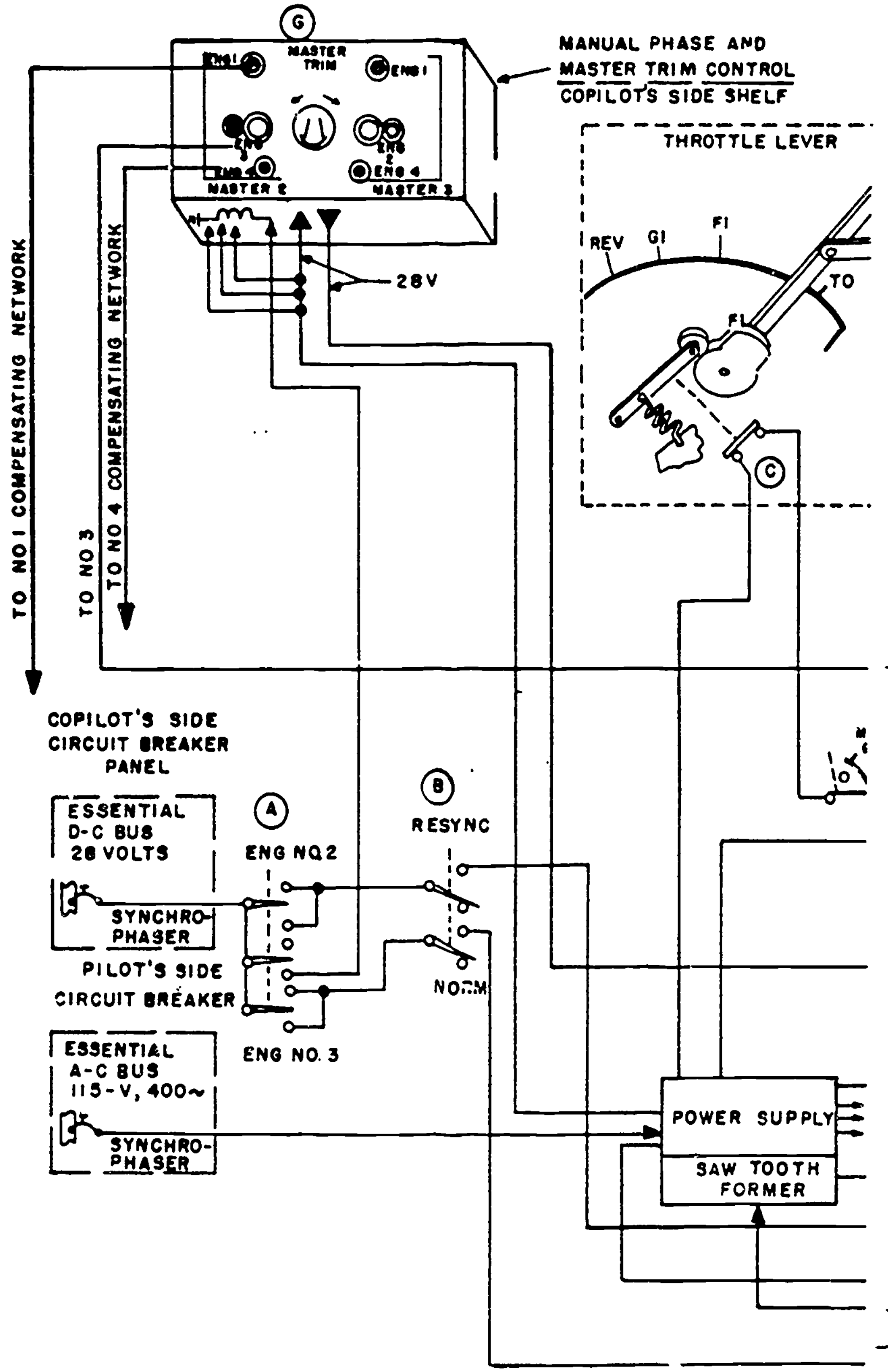
The synchrophasing system is used to make control of the propeller RPM more precise. The prop RPM and the position of the propeller blades are kept at a specific setting. The parts of the synchrophasing system work together to keep those settings.

QUESTIONS

1. What are the four main units of the synchrophasing system?

2. What is the purpose of the pulse generator?

HAMILTON TURBOSYNCHROPHASER BLOCK DIAGRAM



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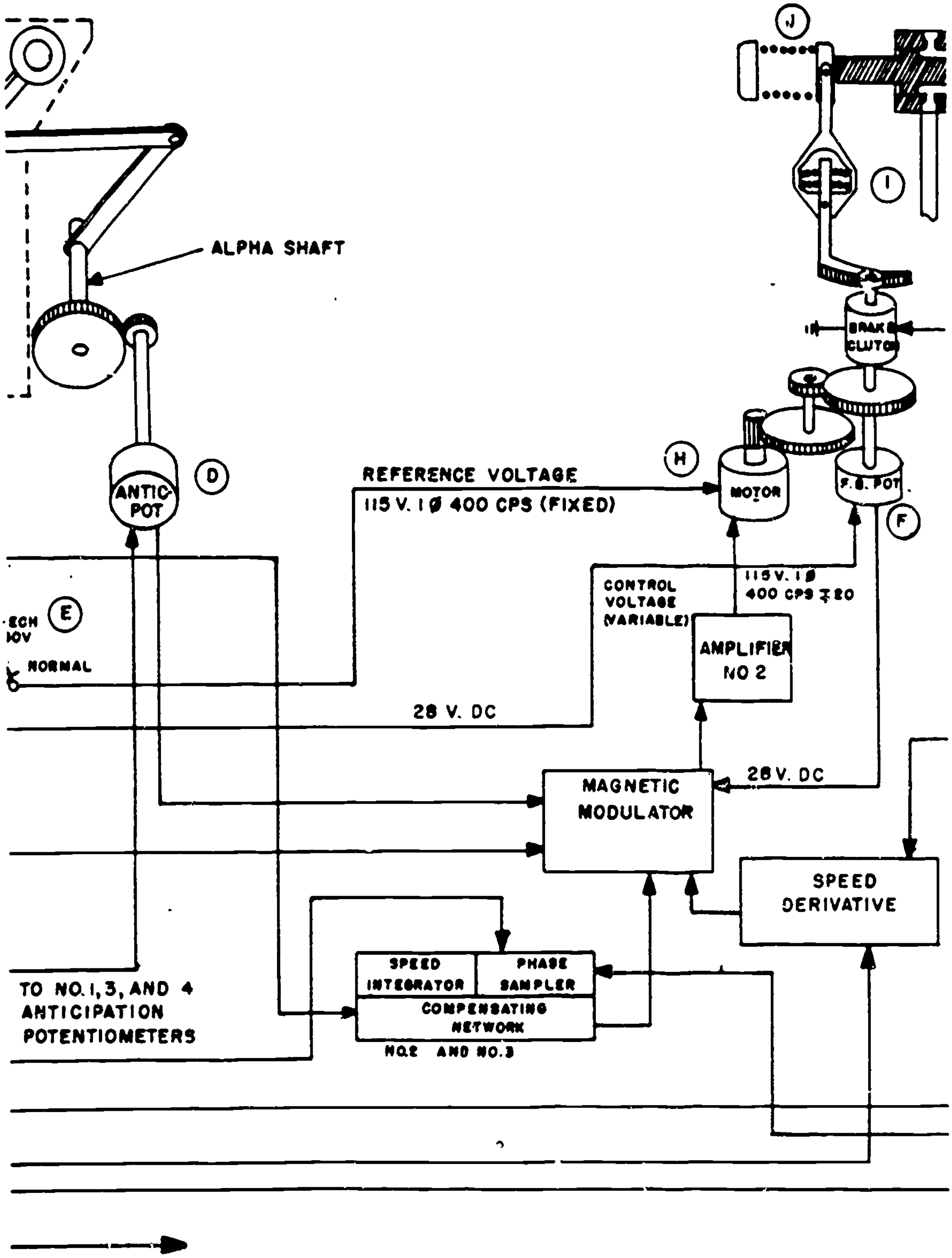
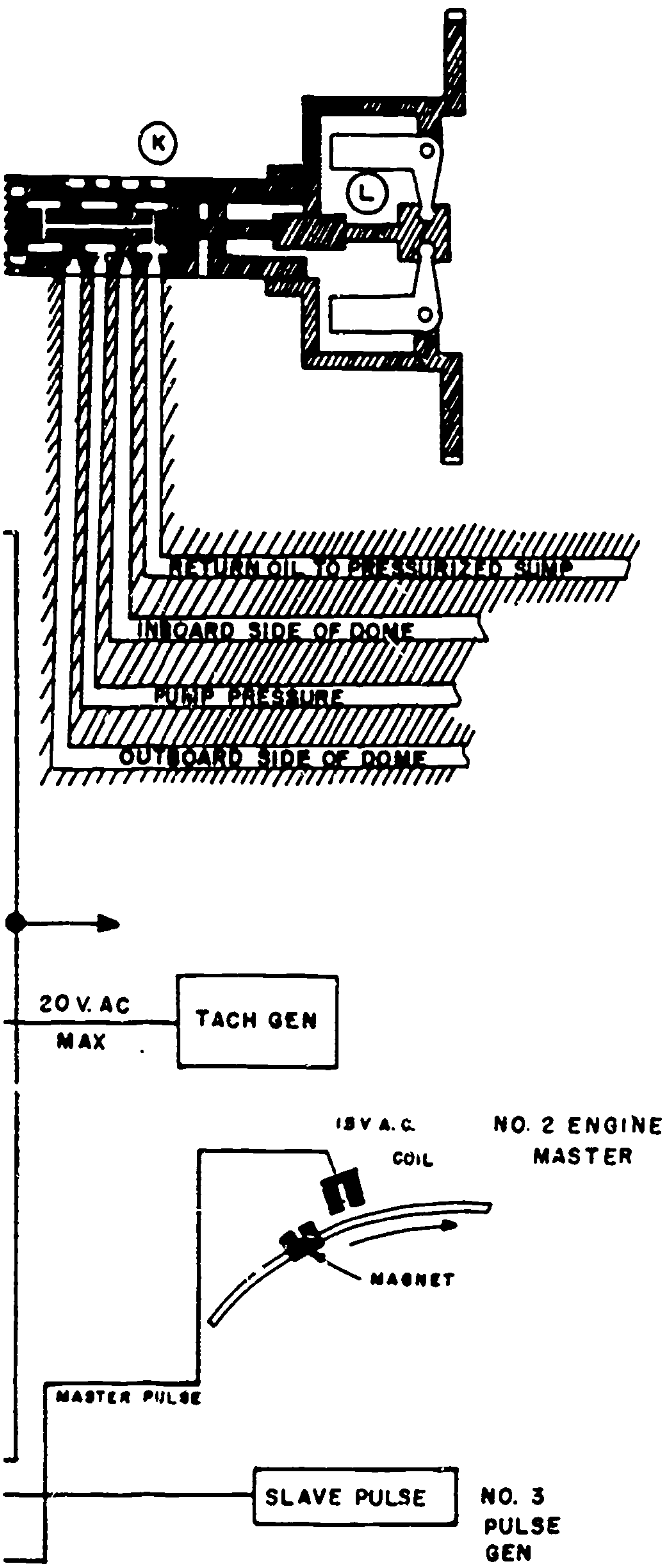


ALPHA SHAFT
ANTIC POT
D
J
I
BRAKE CLUTCH
H
MOTOR
F. B. POT
F
REFERENCE VOLTAGE
115 V. 1Ø 400 CPS (FIXED)
E
NORMAL
CONTROL VOLTAGE (VARIABLE)
115 V. 1Ø 400 CPS ∓ 20
AMPLIFIER NO 2
28 V. DC
28 V. DC
MAGNETIC MODULATOR
SPEED DERIVATIVE
SPEED INTEGRATOR
PHASE SAMPLER
COMPENSATING NETWORK
NO.2 AND NO.3
TO NO.1, 3, AND 4 ANTICIPATION POTENTIOMETERS



(A) SYNCHROPHASE MASTER SWITCH
(B) PROP RESYNCHROPHASE SWITCH
(C) SYNCHROPHASE DISARMING SWITCH
(D) ANTICIPATION POTENTIOMETER
(E) PROPELLER GOVERNOR CONTROL SWITCH
(F) FEEDBACK POTENTIOMETER
(G) MANUAL PHASE AND MASTER TRIM CONTROL
(H) SERVO BIAS MOTOR
(I) SPEED BIAS BRAKE LEVER
(J) SPEEDER SPRING
(K) GOVERNOR PILOT VALVE
(L) GOVERNOR FLYWEIGHTS

Figure 4. Hamilton Turbosynchrophaser Block Diagram.