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ABSTRACT

This publication contains a teaching guide and student instructional materials for conducting a high school or adult vocational education course to train persons to perform duties as an aircraft environmental systems mechanic. Course content has been adapted from a military course. The instructional design for this course is self-pace and/or small group-paced. Instructor materials contained in the course guide include lesson plans detailing training equipment needed, training methods, multiple instructor requirements, and instructional guidance. The student material includes a workbook and programmed texts with review exercises. A bibliography and glossary of terms are provided to aid both teacher and students. The course includes information on organizational and field maintenance of aircraft pressurization, air conditioning, and air starter systems, and life raft inflation equipment. The course is composed of four parts (see note). Block II (contained in this document) is composed of eight lessons covering 124 hours of instruction. Topics covered include fighter cabin air conditioning system; rain removal system; equipment air conditioning system; temperature control system tester; bomber air conditioning system; decade resistor functions and windshield amplifier bench check; cargo bleed air and anti-icing system; and cargo air conditioning system. (KC)

Military Curriculum Materials for Vocational and Technical Education

AIRCRAFT ENVIRONMENTAL SYSTEM MECHANIC, 2-9
BLOCK II - AIR CONDITIONING SYSTEMS

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 material 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.

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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

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Military Curriculum Materials Dissemination Is . . .

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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.

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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

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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

AIRCRAFT ENVIRONMENTAL SYSTEM MECHANIC
3ABR42331

Classroom Course 2-9

Developed by:

United States Air Force

Development and Review Dates:

October 17, 1978

Occupational Area:

Aviation

Target Audiences:

Grades 11 - adult

Print Pages:

3122

Availability:
ERIC
National Center Clearinghouse

Contents:	Type of Materials: Lesson Plans	Programmed Text	Student Workbook	Handouts	Text Materials	Audio-Visuals	Instructional Design: Performance Objectives	Tests	Review Exercises	Additional Materials Required	Type of Instruction: Group Instruction	Individualized
Block I -												
Fundamentals	•	•	•		•		•		•		•	•
Block II -												
Air Conditioning Systems	•	•	•		•	X	•		•		•	•
Block III - Aircraft Environmental Systems Units	•	•	•		•	X	•		•	X	•	•
Block IV - Utility Systems and Flight Line Maintenance	•	•		•	•	X	•		•	X	•	•

X Materials are recommended but not provided.

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

Course Description

The instructional design for this course is self-paced and/or small group paced. This course trains personnel to perform duties as an Aircraft Environmental Systems Mechanic. It includes organizational and field maintenance of aircraft pressurization, air conditioning, and air starter systems, and life raft inflation equipment.

Block I - Fundamentals contains 24 lessons requiring 115 hours of instruction. These are: safety; aircraft familiarization; physics; electron theory; magnetism; DC generation and basic circuit symbols and terms; wiring diagram fundamentals; control and protective devices; multimeter; Kirchoff's current law; Kirchoff's voltage law; Ohm's law; series circuits; parallel circuits; series-parallel circuits; switching circuits; DC motors and control circuit; temperature control circuits; alternating current; capacitance; inductance; AC motors and control circuits; solid state devices; magnetic amplifiers; and trainer aircraft air conditioning system.

Block II - Air Conditioning Systems consists of 8 lessons convering 124 hours of instruction. These are: fighter cabin air conditioning system; rain removal system; equipment air conditioning system; temperature control system tester; bomber air conditioning system; decade resistor functions and windshield amplifier bench check; cargo bleed air and anti-icing system; and cargo air conditioning system.

Block III - Aircraft Environmental Systems Units contains 13 lessons covering 102 hours of instruction. These are the following: tools, hardware, safetying devices, and wire repair; maintenance of moisture separators; maintenance of bleed air distribution ducting; air turbine motor maintenance; turbine refrigeration devices; advanced fighter/bomber air source control system; advanced fighter/bomber air conditioning system; advanced fighter/bomber windshield clearing system; maintenance of air control units; anti-G suit system; canopy seal system; pressurization systems; and cabin pressure leakage check.

Block IV - Utility Systems and Flight Line Maintenance consists of 9 lessons requiring 114.5 hours of instruction. These lessons are entitled: gaseous O_2 systems; liquid O_2 systems; liquid refrigeration systems and components; inspection maintenance of O_2 systems (liquid); cryotainer systems maintenance; liferaft inflation equipment, fire extinguisher system maintenance; flight line maintenance - inspections; and flight line maintenance; removal and replacement of system components.

This course contains both teacher and student materials. Printed instructor materials include plans of instruction detailing training equipment needed, training methods, multiple instructor requirements and instructional guidance. The student material includes workbook, and programmed texts with review exercises. A bibliography and glossary of terms have been provided to aid both the instructor and the student. In Blocks I and III, lessons on Orientation, Security, Progression in Career Field, Maintenance Management, and the Technical Order Publications Systems have been deleted because of military specific materials.

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PROGRAMMED TEXT
3ABR42331-PT-201

Technical Training

Aircraft Environmental Systems Mechanic

FIGHTER BLEED AIR SYSTEM

17 August 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

DO NOT USE ON THE JOB

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FOREWORD

This programmed text was prepared for use in the 3ABR42331 instructional system. The materials contained herein have been validated using students enrolled in the 3ABR42331 course. Ninety percent of the students taking this text surpassed the criteria called for in the lesson objective. The average student required 3.5 hours to complete the text.

OBJECTIVES

1. Associate each bleed air system component with its operation with a minimum of 80% accuracy.

2. Select safety precautions that are applicable to the maintenance of bleed air systems without error.

INSTRUCTIONS

This text presents information in small steps called "frames." After each frame you are asked to respond by completing a statement. Read each frame carefully before responding. The answers to the statements for each frame are located on the top of the next frame. If you select the correct answers, continue to the next frame. If you are incorrect, read the material again and correct your answers before continuing.

Supersedes 3ABR42231-PT-201, 13 February 1973.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 300; TTVSR - 1

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In previous lessons you learned the trainer type aircraft air conditioning system. You should recall that the air used for air conditioning came from the jet engine.

Do you remember what to call the air that was tapped from the jet engines? Yes, it's called "engine bleed air."

You should keep in mind that engine bleed air is an extremely hot, high pressure air. The actual temperature and pressure will depend on the engine throttle setting and ambient air temperature.

The temperature can range from close to 500 F to 900 F and the pressure from close to 100 to 250 psi.

Engine bleed air as a rule is taken from the last stage of engine compression. Keep in mind, the number of stages of compression will vary with the different jet engines.

On the fighter aircraft that is used as an example in this lesson, the bleed air is tapped from the 17th stag of compression. This is the last stage of compression on this engine.

Fill in the blanks to complete the following statements.

1. The air tapped from the jet engine is called ___________ ___________ air.

2. The pressure and temperature of the engine bleed air depends on the engine ___________ ___________.

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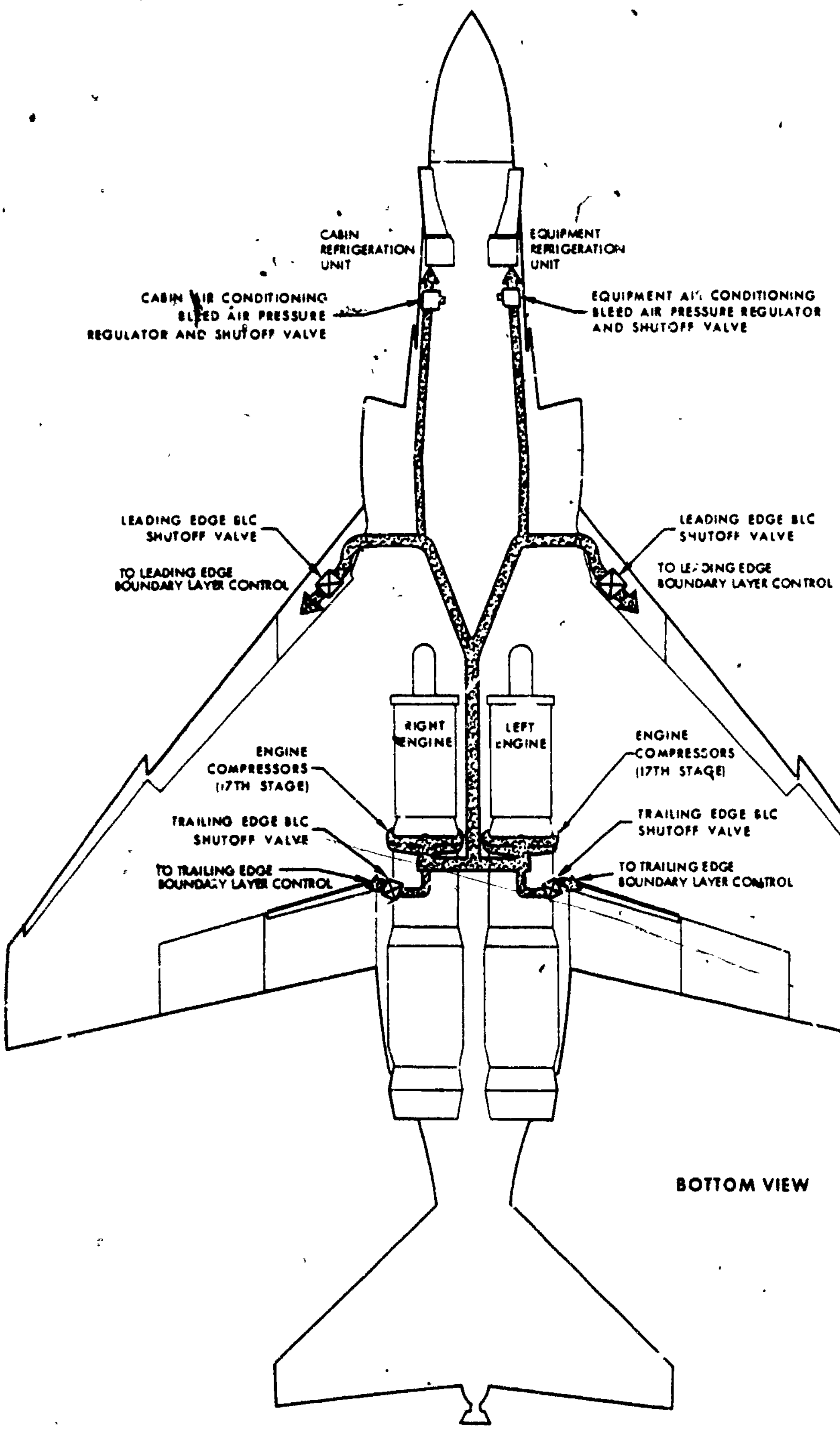

Figure 1. Bleed Air System.

Answers to Frame 1: 1. engine bleed 2. throttle setting

Frame 2

Engine bleed air is used for several purposes on the aircraft. It is used to air-condition the cockpit, cool the electronic equipment, keep the windshield clear of rain, and aid in aircraft control through the boundary layer control system.

When the engines are running, bleed air is supplied to the cabin air conditioning system, equipment air conditioning system, and to the boundary layer control (BLC) system. Each of these systems has a shutoff valve to control the bleed air. You will learn how the bleed air is used in each of these systems in future lessons.

Figure 1 shows the bleed air system. The air is tapped from the 17th stage of compression on each of the two engines and is directed into one duct. From there it is distributed to each of the systems.

Follow the path of airflow in figure 1 from the engines.

Fill in the blanks to complete the following statements.

1. The air used for air conditioning is tapped from the ______ stage of engine compression.

2. The boundary layer control system receives air from the ______ ______ ______ system.

3. Engine bleed air is used for removing rain from the ______.

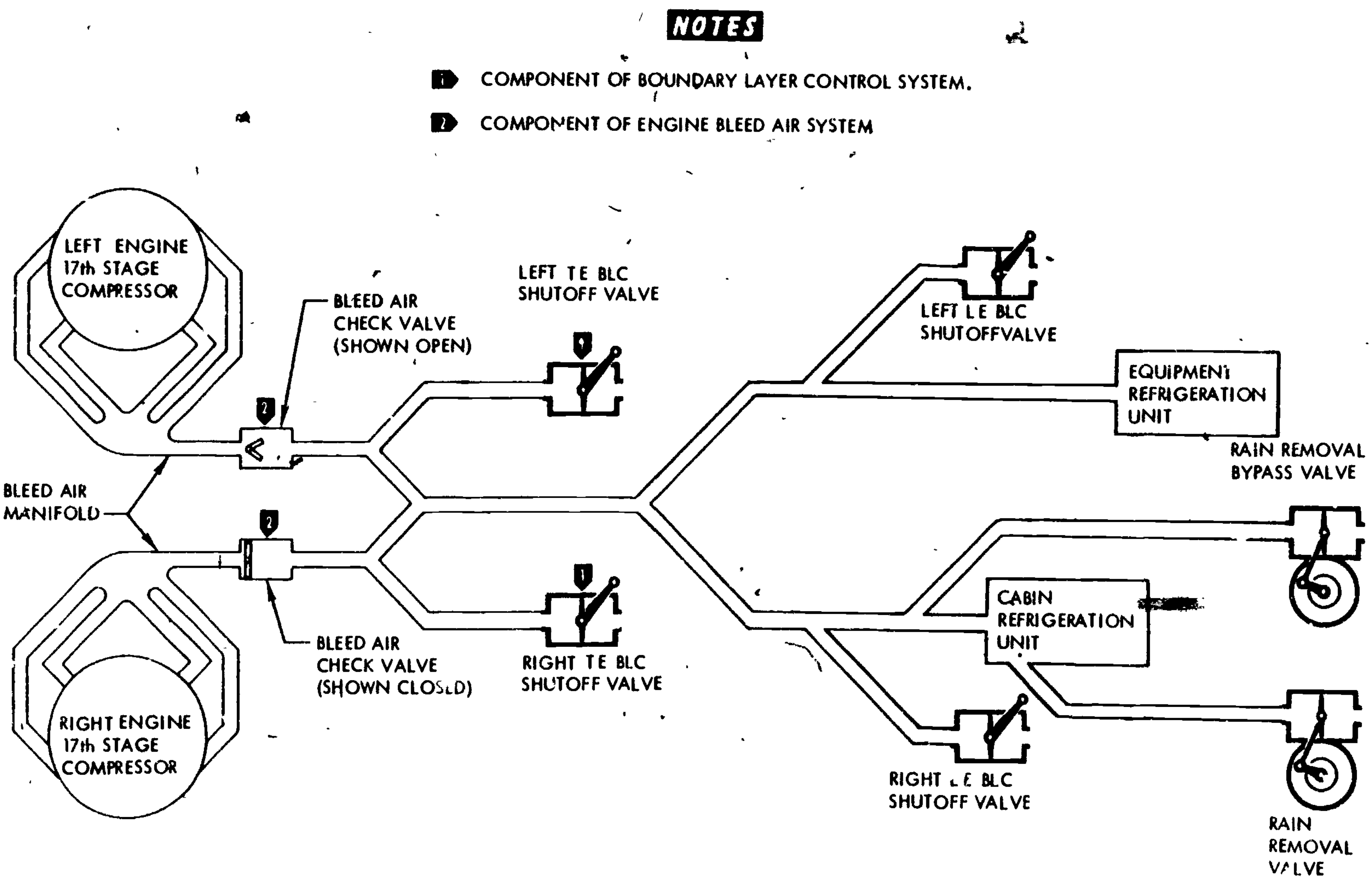

Figure 2. Bleed Air System Schematic.

Answers to Frame 2: 1. 17th 2. engine bleed air 3. windshield

Frame 3

On this aircraft, bleed air is supplied by two engines. Check valves are used to prevent loss of bleed air if one of the engines is inoperative. Remember, check valves allow airflow in one direction only, or we can say, they prevent a reverse flow of air.

Notice the check valves in figure 2. In this system there is one check valve for each engine. These are flapper type check valves, similar to those used in the trainer aircraft air conditioning system.

Air flowing in one direction will open the flappers, but airflow in the opposite direction will force the flappers to close. Check valves normally have an arrow stamped on the body of the valve to indicate the direction of airflow.

Fill in the blanks to complete the following statements.

1. Loss of air through an inoperative engine prevented by a ______________ ______________.

2. The check valves are opened by ______________ ______________.

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Answers to Frame 3: 1. <u>check valve</u> 2. <u>air pressure</u>

Frame 4

Read each statement below then mark each one T (true) or F (false).

_____1. Engine bleed air is tapped off the 17th stage of compression on both the left and right engines.

_____2. Check valves allow bleed air to flow out of the engine compressor, and also prevent a reverse flow of air into an inoperative engine.

_____3. The arrows on the check valves indicate the direction of airflow.

_____4. The check valves are opened by spring tension.

_____5. The engine bleed air system supplies hot, high pressure air to the boundary layer control system, equipment refrigeration unit, and the cabin refrigeration unit.

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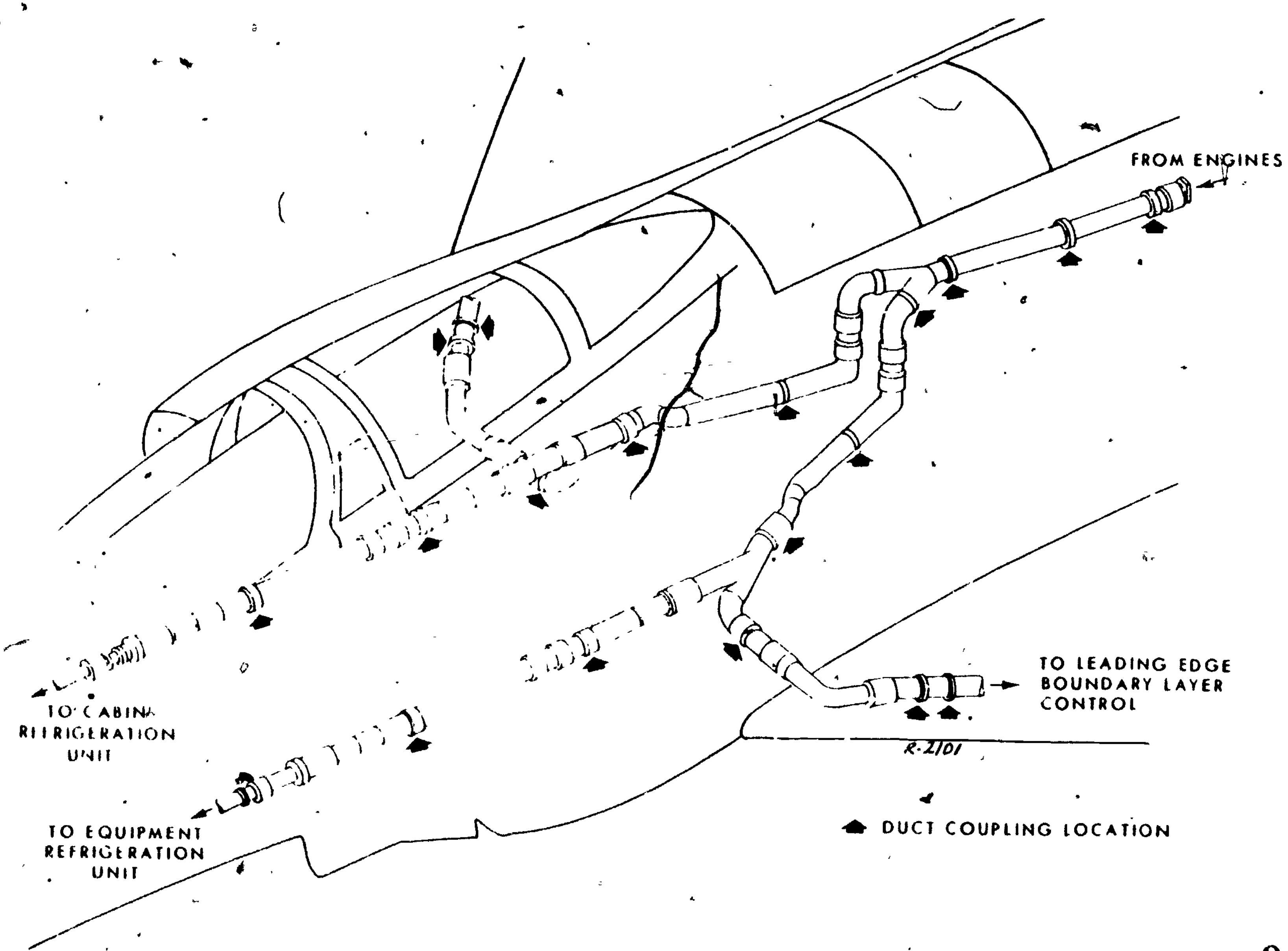

Figure 3. Bleed Air System.

Answers to Frame 4: _T_ 1. _T_ 2. _T_ 3. _F_ 4. _T_ 5.

Frame 5

From the engines, the bleed air is routed through ducting to the different systems. The ducting is made up of short sections connected together with duct couplings.

Short sections of ducting are used to make it possible to remove and reinstall the ducts for maintenance.

Figure 3 shows part of the bleed air ducting. The small arrows point to some of the many couplings used to hold the sections of ducting together.

The duct sections are made of a stainless steel alloy which can withstand extremely high temperatures.

The walls of the duct sections can be made very thin, thereby saving weight. For this reason they have to be handled with care. A dent or scratch will weaken the duct and can cause it to crack. This will result in a hot air leak, or rupture of the ducting.

Hot air leaks are very dangerous on aircraft as the hot air can burn the electrical wiring which can cause system failure, ignite flammable materials, or soften or burn through structural members. In some cases, total engine failure and loss of flight control has occurred.

Fill in the blanks to complete the following statements.

1. Duct sections are held together by ________ ________.
2. Engine bleed air ducting is made of ________ ________ alloy.
3. To make it possible to remove and reinstall engine bleed air ducting with ease, the ducting is made in ________ ________.
4. One precaution to observe when maintaining the bleed air system is to handle the ________ with care.

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Answers to Frame 5: 1. <u>duct couplings</u> 2. <u>stainless steel</u>
3. <u>short sections</u> 4. <u>ducting</u>

Frame 6

Most of the stainless steel duct sections are rigid. For this reason a means is needed which will allow for variations in duct length and for movement of the ducts.

The duct length will change with temperature changes. Increases in temperature will cause the duct to expand. This is called thermal expansion.

<u>Thermal compensators</u> are used to allow for duct movement caused by thermal expansion and contraction.

A thermal compensator is shown below. This part is made up of a flexible bellows that allows for linear (lengthwise) movement and a ball and swivel joint that allows for angular (sideways) movement.

The inner tube (2) is connected to the outer chamber (1) by the bellows (3). The duct is connected to the inner tube. If the duct moves due to expansion, the flexible bellows will allow the inner tube to move inside the compensator.

On the opposite end of the compensator, the duct is connected to the swivel joint. The swivel joint (4) allows the ducting to move angular (sideways) approximately 5 degrees.

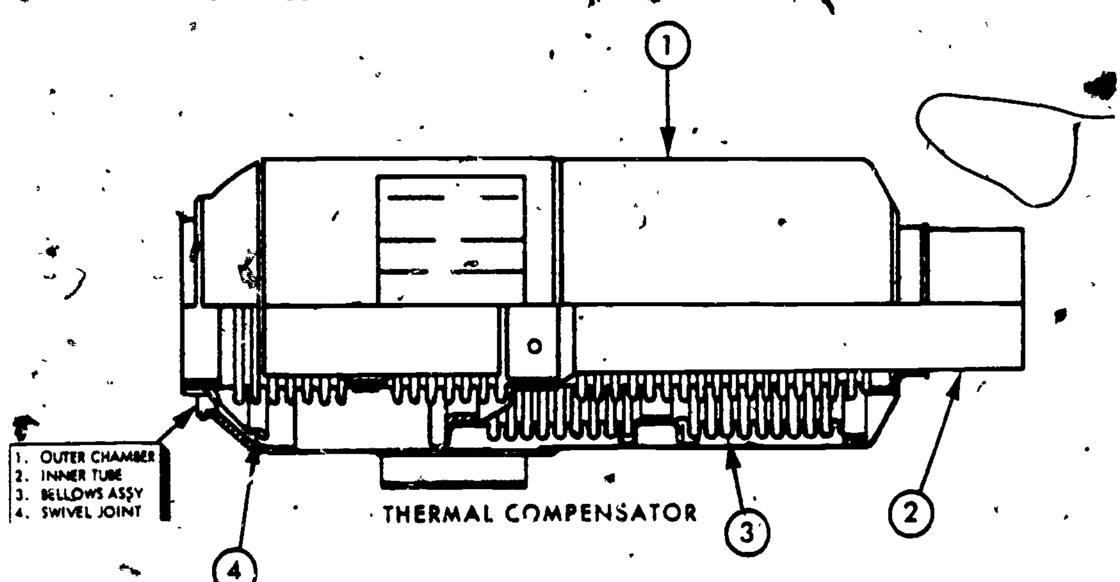

Figure 4. Thermal Compensators.

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Fill in the blanks to complete the following statements.

1. An increase in temperature will cause the ducting to ______.

2. Movement of the bleed air ducting due to thermal expansion or contraction is compensated for by the ____________ ____________.

3. The swivel joint allows for ________ ________ of the ducting.

Answers to Frame 6: 1. <u>expand</u> 2. <u>thermal compensator</u>
3. <u>angular movement</u>

Frame 7

When a duct section is removed during maintenance and a new section is installed, it's possible the ducting will not fit together the same as the old section did. Duct length may vary slightly.

Ambient (surrounding) temperature changes may cause variations in the aircraft structure and the bleed air ducting due to the difference in expansion rates of different metals. This can make it difficult to align the ducting and to insure a leak proof connection.

<u>Tolerance compensators</u> are installed in the system to compensate for variations in duct length.

The tolerance compensator is shown below. This unit consists of a bellows section for flexibility and a threaded section that allows the maintenance man to adjust the duct length. This is done by screwing the threaded section in to shorten the tolerance compensator, or out to make it longer.

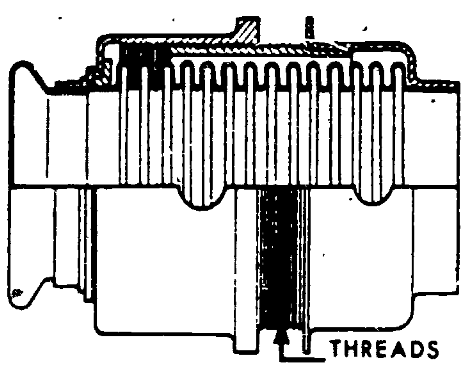

Figure 5. Tolerance Compensator.

Fill in the blanks to complete the following statements.

1. If the duct sections do not align properly, the maintenance technician should adjust the ____________ ____________.

2. The purpose of the tolerance compensator is to allow for ________________ in duct length.

Answers to Frame 7: 1. tolerance compensator 2. variations

Frame 8

There are several types of clamps and couplings used to join duct sections together and to attach the units such as compensators and control valves.

Four different couplings used in the bleed air system are shown below. They are the Marman V band, Marman Conoseal, Marman J11, and Janitrol couplings.

Notice that the Marman couplings use gaskets to make an air tight seal between the ducts, while the janitrol coupling does not.

The Janitrol coupling is designed to make the joint air tight by pulling the duct flanges together to form a metal to metal seal.

Care must be taken to insure the flanges on this coupling are not bent or nicked during maintenance, as a damaged flange will cause an air leak.

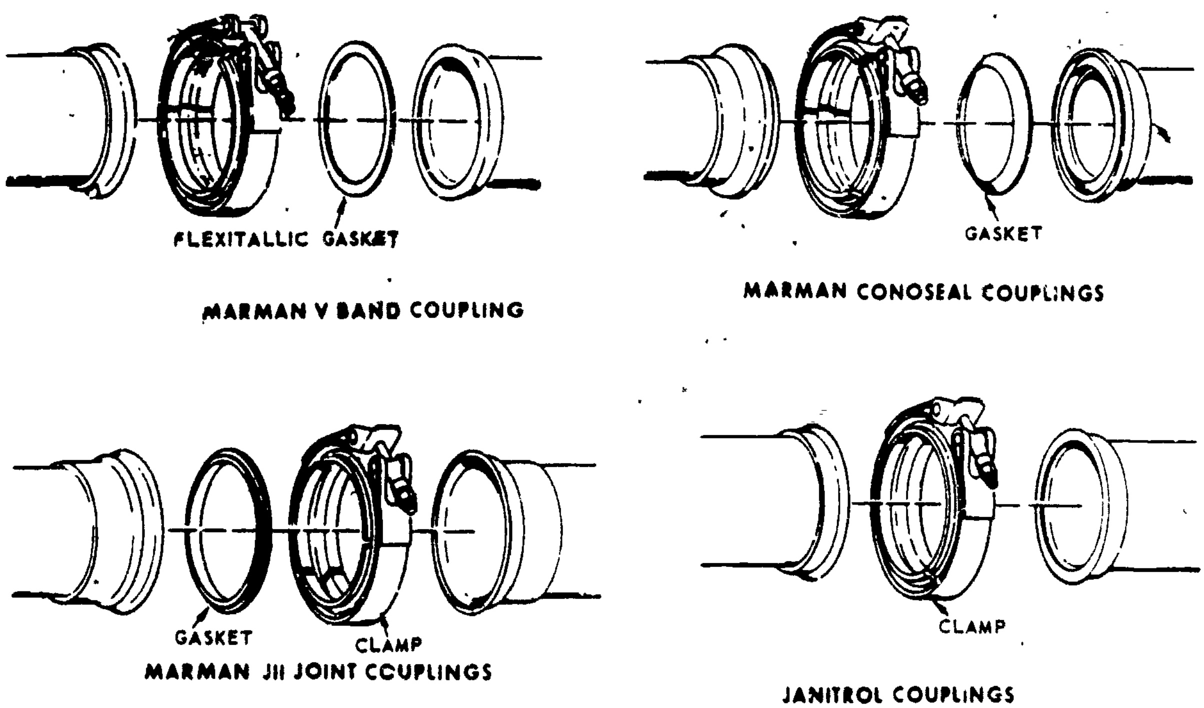

Figure 6. Duct Section Couplings.

Fill in the blanks to complete the following statements.

1. Duct sections are held together by __________ __________.

2. An air tight seal is formed in the Marman coupling by the __________.

3. An air tight seal is formed in the Janitrol coupling by the flanges forming a __________ to __________ seal.

4. A leak at a janitrol coupling could be caused by a damaged __________.

Answers to frame 8: 1. duct couplings 2. gaskets
3. metal to metal 4. flange

Frame 9

Each of the couplings shown in figure 6 will be referred to as a "V" (Vee) band coupling or clamp. This will be the general flight line terminology that you will encounter. They are called V-band couplings because of their V shape.

The sketch shown (figure 7) identifies some of the parts of a V-band coupling. Notice the "T" bolt and quick coupler latch. This permits disconnecting the coupling without complete removal of the nut.

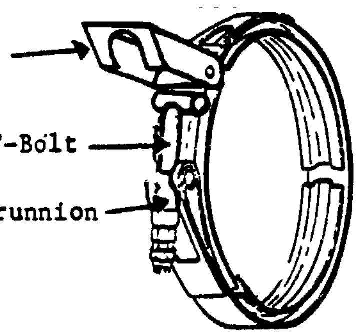

Figure 7. Components of a V-band Coupling.

The V-band couplings are normally used where the pressure and temperature are high, such as in the bleed air manifold ducting and the ducting leading to the air conditioning package.

Fill in the blanks to complete the following statements.

1. Couplings having a V shaped groove that fits over the duct flanges are normally called ____________ ____________ ____________.

2. Couplings used on the ducting carrying the bleed air to the equipment refrigeration unit would be of the ____________ ____________ type.

Answers to Frame 9: 1. V band couplings 2. V band

Frame 10

The gaskets used with the Marman V-band couplings are made of a metal wire molded into an asbestos material. These gaskets are called flexitallic gaskets.

The gaskets used with the Marman Conoseal couplings are cone shaped stainless steel gaskets.

The gaskets used with the Marman J11 are made of a copper alloy and are formed to fit machined grooves in the duct flanges.

Each of the gaskets are designed to fit a specific type of the duct connection and can not be interchanged.

When a duct connection is loosened, or removed and replaced, new gaskets must be installed.

To prevent damage to the gaskets they must be handled with care. Hot air leaks can take place at the couplings if the gasket is damaged or if the gasket is not put in properly.

Proper installation means having the duct flanges aligned so the flanges mate properly, insuring the coupling is on the connection straight, and torquing the coupling to the torque value specified by the applicable technical order.

Fill in the blanks to complete the following statements.

1. The material used in the gaskets for Marman V band couplings is metal and ____________________.

2. Whenever a duct connection is disconnected, a new __________ should be installed.

3. A leak at a Marman V-band coupling could be caused by a defective ____________________.

Answers to Frame 10: 1. asbestos 2. gasket 3. gasket

Frame 11

The sketch below shows two additional types of couplings. These are the Marman Channel Band and Rubber Teck couplings. Couplings of this type are not used in the hot bleed air system. They are used in the air conditioning system where the pressure and temperature have been reduced.

To form an air tight seal, the rubber teck couplings uses a synthetic rubber seal. The Marman Channel Band coupling uses a fiberglas reinforced rubber sleeve. When installing these couplings the maintenance man must insure their proper alignment.

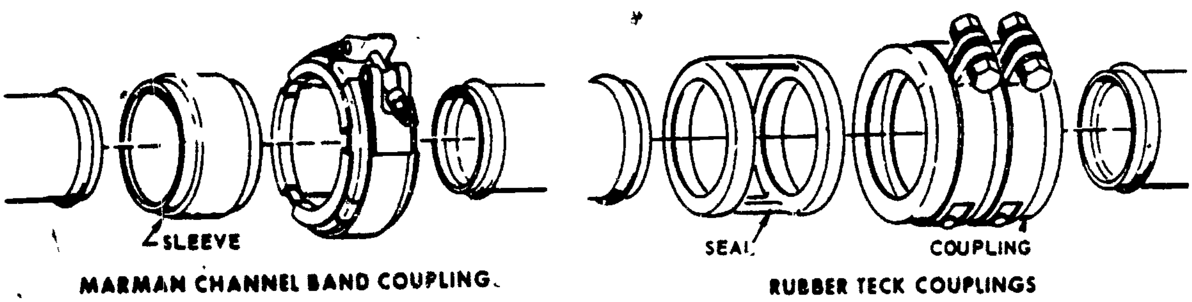

Figure 8. Air Conditioning System Couplings.

Fill in the blanks to complete the following statements.

1. The Marman Channel Band coupling is normally used where the pressure and ________________ have been reduced.

2. An air tight seal is formed in the Rubber Teck coupling by a rubber ____________ and in the Marman Channel Band by a rubber ____________.

Answers to Frame 11: 1. temperature 2. seal sleeve

Frame 12

Some maintenance on the bleed air system requires you to take off and put on the duct sections of some parts. This means you will remove and install duct couplings.

When a duct coupling is put on it must be tightened to a specific value. How can you tell when it's tight enough? This is one place you must use a torque wrench.

The exact torque value to use will change with the type and size of the clamp or coupling. When torquing couplings, you must refer to the chart of torque values in the technical order for the aircraft on which you're working.

For example, on the F-4C aircraft, the torque value for a 4 inch Marman V band coupling is 35 to 40 inch pounds. A 4 inch Marman Conoseal coupling is torqued to 120 to 140 inch pounds.

To stop complete separation of the connection in case of a "T" bolt failure, the couplings are safety wired. The sketch shows a duct coupling with the safety wire installed.

Note: This is a double stranded, twisted safety wire.

When installing couplings, you will have to check the applicable technical order to determine specific procedures for safey wiring couplings.

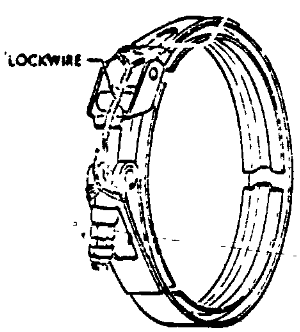

Figure 9. Coupling Safety Wired.

Fill in the blanks to complete the following statements.

1. When duct couplings are replaced, they must be tightened to a specific ______________ value.

2. To determine the proper torque value, you should refer to the ____________ ____________ in the technical order.

3. To determine if a coupling should be safety-wired you should check the applicable aircraft _________ _________.

Answers to Frame 12: 1. torque 2. torque chart
3. technical order

Frame 13

The following information gives some general guidelines that must be followed when working with ducting and couplings.

1. Preinstallation checks:

a. Exercise particular care during handling and installing ducts to ensure that flange faces are not scratched, distorted, or deformed.

b. Use protective flange caps on the ends of all ducts until the installation progresses to the point where removal of the cap is essential to the installation.

c. Clean the flange faces and inspect them every time a clamp is removed. Clean the flange faces by wiping with a clean cloth. Do not use a wire brush to remove dirt.

2. Installation:

a. Check the part number to ensure the proper coupling is being installed.

b. When reinstalling a used coupling, visually check it for spreading of the V section, broken spot welds, worn T-bolt threads, bent T-bolt, and freedom of movement of the latch and trunion.

c. When gaskets are used, use care to avoid nicks or burrs on the gasket surfaces. Whenever a joint is disassembled, a new gasket should be used when reassembling. Ensure the gasket is properly seated.

d. Determing the correct torque for the T-bolt by referring to the applicable technical order.

e. Tighten the nut to about 2/3 of the specified torque, then tap the coupling lightly with a plastic mallet. Continue alternately torquing and tapping until the torque wrench stabilizes at the specified value.

f. Safety wire the T-bolt as directed by the applicable technical manual.

NO RESPONSE REQUIRED

Read each statement below, then mark each one T (true) or F (false).

_____1. Angular movement and linear growth due to thermal expansion is compensated for by the thermal compensator.

_____2. The ball joint on the thermal compensator allows for angular movement.

_____3. The thermal compensator is used to adjust for variations in duct length during maintenance.

_____4. To align the ducts when installing a new section of ducting, the maintenance man can adjust the tolerance compensator.

_____5. The gaskets used with the Marman couplings must be replaced each time the connection is loosened.

_____6. A damaged gasket could cause an air leak in a Janitrol coupling.

_____7. Couplings are used to join duct sections and control units to the duct.

_____8. The Marman Channel Band couplings use a sleeve to form an air tight seal.

_____9. Marman Channel Band couplings are used in the hot, high-pressure bleed air system to attach units to the ducts.

_____10. When installing duct couplings, the maintenance man must tighten them with a torque wrench.

_____11. To determine the proper torque value for a duct coupling, you should refer to the technical order.

_____12. An air leak at the duct coupling could be the result of a damaged gasket, or an improperly torqued coupling.

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Answers to Frame 14: T 1. T 2. F 3. T 4. T 5.

F 6. T 7. T 8. F 9. T 10.

T 11. T 12.

Frame 15

Since the air passing through the bleed air ducting is extremely hot, the heat from the duct can damage nearby equipment. If touched, the hot ducting can cause injury to maintenance personnel.

To stop damage to equipment and to protect the maintenance personnel the engine bleed air ducting is insulated.

Four different types of insulation are used; they are: fiberglas blankets, metal foil, fiberglas tape, and preformed fiberglas.

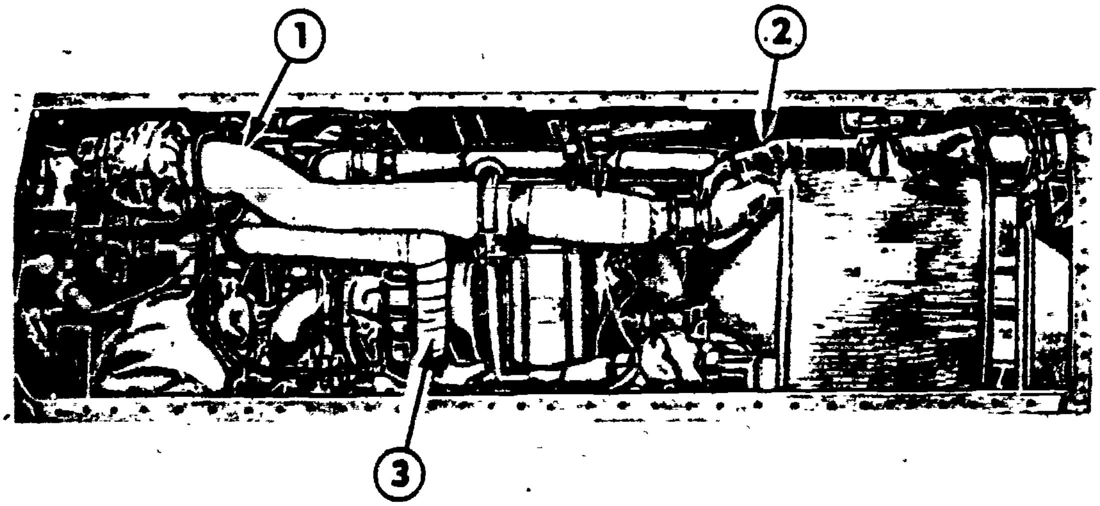


Figure 10. Bleed Air Duct Insulation.

The fiberglas blanket insulation is made up of fiberglas covered with a fabric material and sewn together with a fiberglas thread. The blankets are made to fit specific sections of ducting or valves. The ends are clamped to the duct with a metal band clamp.

The metal foil insulation is made up of fiberglas with a thin metal foil covering on each side. Each piece of this insulation is made to cover specific sections of ducting or certain units. There is also a piece of this metal foil insulation covering the refrigeration unit heat exchanger. This insulation is held in place with safety wire laced around small metal studs along joining edges.

The fiberglas tape is a material that is approximately 2 inches wide and is simply wrapped on the duct and held in place with a special thermosetting tape. This insulation is used on some of the smaller sections of ducting.

Fill in the blanks to complete the following statements.

1. To prevent heat damage to adjacent equipment and injury to personnel, the bleed air ducting is ________________.

2. The four types of insulation used on hot air duct are fiberglas ______________, metal ________________, fiberglas ________________, and ____________ fiberglas.

3. Metal foil insulation is held in place with ______________ ________________.

1276

Answers to Frame 15: 1. insulated 2. blankets, foil, tape, preformed
3. safety wire

Frame 16

The illustration below shows insulation installed on a section of ducting. Number 1 points to the preformed fiberglas insulation (our fourth type) and number 2 points to metal foil insulation.

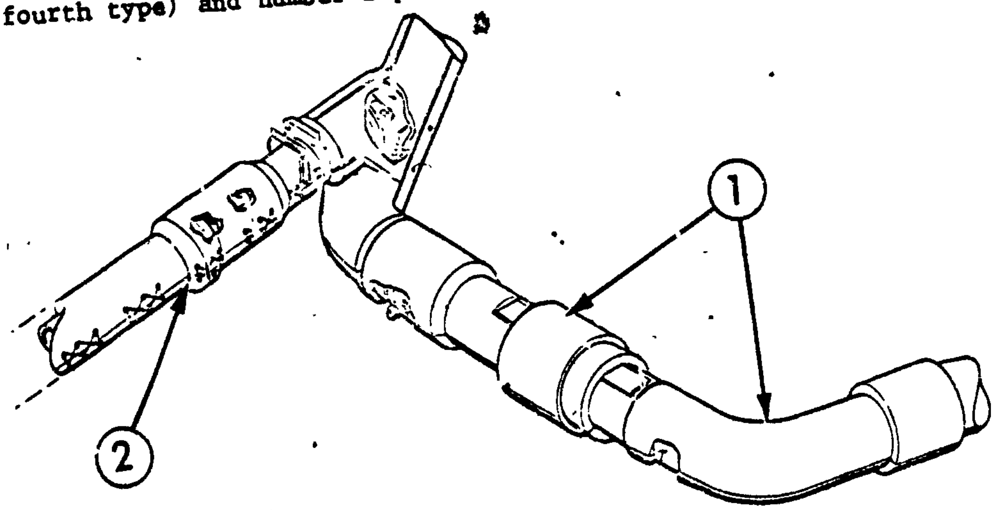


Figure 11. Duct Insulation.

The preformed fiberglas insulation (1) shown above, is a solid piece that is formed to fit specific installations such as around a duct or compensator. This insulation is usually made in two pieces (halves) and is held together on the duct by insulation clamps and thermosetting tape.

The metal foil insulation (2) above, is the same material as the metal foil explained in the previous frame. This sketch shows the insulation on a section of ducting. Notice how the safety wire is laced to hold the insulation in place.

The metal foil insulation is also used in the form of an insulation strap to cover duct couplings. The metal foil insulation strap is shown below. The insulation straps are held in place with safety wire. Notice in the sketch that the insulation strap is designed with a slotted area for the coupling bolt (T bolt) to fit through.

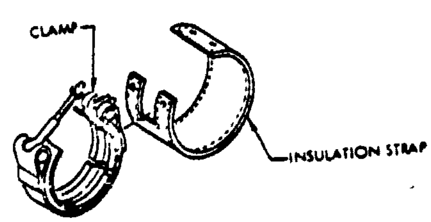


Figure 12. Insulation Strap.

6

In areas where the ducting or a coupling is not covered with insulation, the maintenance man must use caution to avoid getting burned. An exposed duct coupling can become extremely hot during operation of the system.

Fill in the blanks to complete the following statements.

1. The insulation used on bleed air ducting consists of ______ and ________________ foil materials.

2. Metal foil insulation straps are used to insulate duct _______________.

3. One precaution to observe when working on or near the bleed air ducting is to avoid touching an exposed section of _______________ or an exposed duct ________________.

1278

Answers to Frame 16: 1. fiberglas and metal 2. couplings
3. duct couplings

Frame 17

A leak check must be made after completion of repairs or whenever leaks are thought to exist in the bleed air system.

A leak check on the bleed air system requires the use of special duct plugs, adapter, and a ground air compressor.

The plugs are put in at several points in the system to isolate the bleed air system from the refrigeration units, boundary layer control system, and the engines.

The adapter is put in at one of the engine tapoffs. Air from the air compressor is put through the adapter to pressurize the ducting.

Excessive leakage is found by pressurizing the system to a specified pressure, then monitoring the pressure drop over a set period of time.

As an example, the F-4 is pressurized to 250 psi, then the system is closed off. The pressure drop is timed and should not drop below 225 psi in five minutes. If the drop is greater, then the leakage is excessive. The point of leakage can be located by sound and by feel.

After this part of the leak check is performed, the duct plugs and adapters are removed, and the couplings reinstalled. These couplings must also be checked for leakage. This is done by running the engines and feeling each connection for leakage.

Actual performance of the leak test requires that you follow detailed procedures outlined in the technical order.

When performing the leak test you must avoid standing near or in line with any of the duct plugs while the system is pressurized. Severe injury may result if a plug is blown out.

Fill in the blanks to complete the following statements.

1. After you install a new section of ducting you must perform a ______________ ______________.

2. When performing a leak test of the bleed air system you should follow the procedures outlined in the ______________ ______________.

3. When performing a leak test, the bleed air system is isolated by using ______________ ______________.

4. Duct plugs are used to isolate the __________ ______ ___ system for the leak testing.

5. Leakage in a bleed air system can be determined by timing the __________ ______________.

6. One precaution to observe when performing a leak test is to avoid standing in line with a __________ ______________ while the system is pressurized.

Answers to Frame 17: 1. leak test 2. technical order
3. duct plugs 4. bleed air
5. pressure drop 6. duct plugs

Frame 18

There are several safety precautions that you must follow while working on the bleed air system. These precautions are to protect the equipment, to protect you and other maintenance personnel, and to insure the aircraft is safe to fly. Some of these precautions are listed below.

1. Extreme care should be used to avoid denting or scratching the ducts when these ducts are removed or installed. A dent or scratch could weaken the duct and cause the duct to rupture.

2. Use care when installing ducting with janitrol couplings to avoid damaging the flanges. A damaged flange will cause an air leak.

3. All coupling gaskets and seals should be handled with care. Damage to the gaskets or seals can result in a severe air leak which could damage the aircraft or adjacent equipment.

4. Always install a new gasket whenever a duct connection is loosened.

5. Torque each coupling to the value specified by the technical order.

6. Avoid touching or otherwise coming in contact with the exposed ducts and duct joints.

7. Do not stand near or in line with the bleed air duct plugs when performing a bleed air system leak test. You could get hurt if a plug blows out while under pressure.

Fill in the blanks to complete the following statements.

1. To determine the torque values for duct couplings, you should refer to the ____________ ____________.

2. When installing a new Marman coupling, you should install a new ____________________.

3. An air leak at a duct coupling could be caused by a damaged ________________ or an improperly __________ coupling.

4. Ducting should be handled with care to avoid ___________ or __________________.

5. Precautions to observe when maintaining the bleed air system require that you avoid ___________ the hot air ducts and standing in line with ____________ ______________.

Answers to Frame 18: 1. technical order 2. gasket
3. gasket torqued 4. denting or scratching
5. touching duct plugs

Frame 19

Read the following statements, then mark them T (true) or F (false).

_____1. The coupling shown in figure 13 is used to join sections of ducting in the bleed air system.

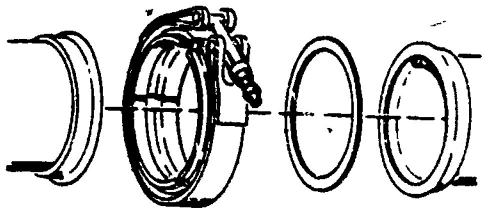


Figure 13.

_____2. The coupling shown in figure 14 is used to attach units to the ducts in the hot bleed air system.

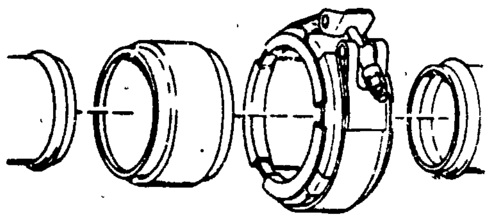


Figure 14.

_____3. To prevent possible air leaks, the gaskets used with the duct couplings should be replaced each time the coupling is loosened.

_____4. To prevent possible injury, maintenance personnel could avoid coming in contact with hot, exposed duct couplings.

_____5. All duct coupling seals and gaskets should be handled with care to prevent possible damage.

_____6. To prevent stripping the nut and bolt on the couplings, the nut is tightened only hand tight.

_____7. An air leak at the coupling could be caused by a gasket damaged during handling or an improperly installed gasket.

_____8. Couplings using a rubber seal or sleeve are designed for use on ducts carrying hot, high-pressure air.

_____9. All clamps must be tightened to technical order specification with a torque wrench.

_____10. Asbestos material is used to insulate all bleed air ducts.

Frame 19 (Continued)

____11. Duct couplings are insulated with a metal foil strap.

____12. The bleed air ducting is insulated to prevent heat damage to adjacent equipment.

____13. Metal foil and preformed fiberglas are two types of duct insulation.

Place the letter of the unit shown below in the blank space opposite the statement that identifies the purpose of the unit.

____14. Permits linear growth of a duct caused by thermal expansion and allows angular movement of the ducting.

____15. Permits the necessary adjustments during maintenance of the bleed air system.

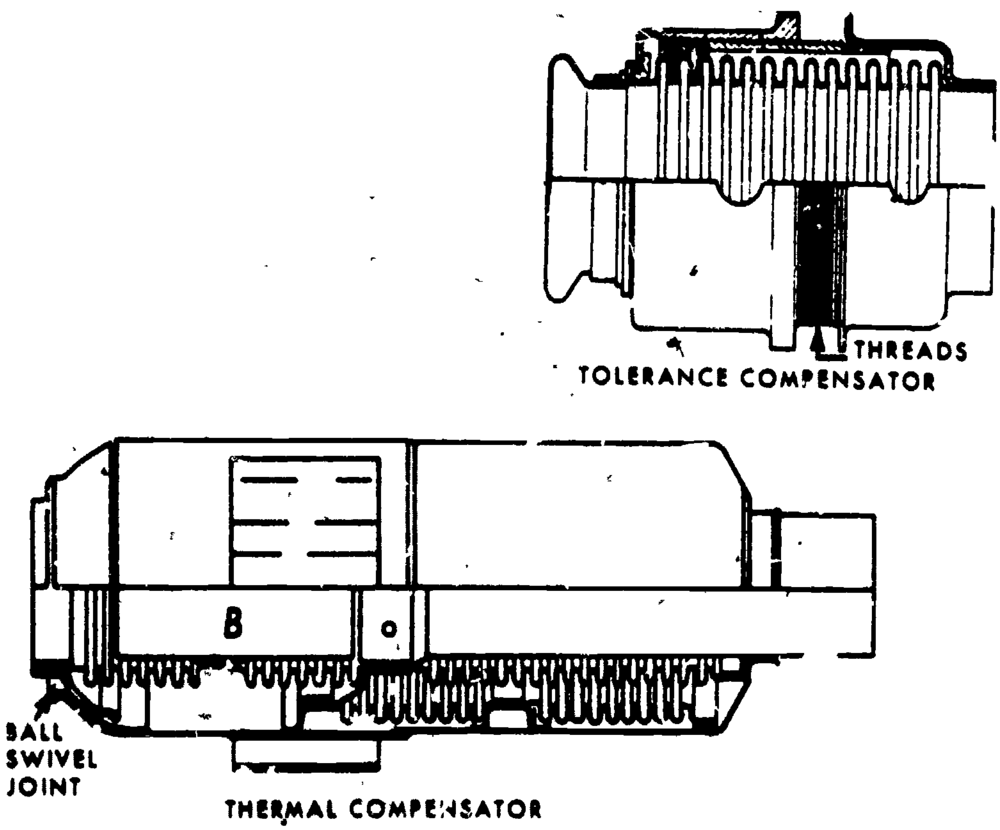


Figure 15.

Answers to Frame 19: 1. T 2. F 3. T 4. T 5. T 6. F 7. T 8. F 9. T 10. F 11. T 12. T 13. T 14. B 15. A

1283

PROGRAMMED TEXT
3ABR42331-PT-201A

Technical Training

Aircraft Environmental Systems Mechanic

FIGHTER CABIN AIR CONDITIONING SYSTEM

18 July 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

1284

OBJECTIVE

After you complete this programmed text, you will be able to: Identify cabin air conditioning system component operation with a minimum of 80% accuracy.

INSTRUCTIONS

This programmed text presents information in small steps called "frames." After each frame you are asked to complete a statement or match some statements. Read the material presented and make your response as directed. After you have made your response, compare your answer with the correct answer given at the back of the text. If your answer is incorrect, restudy the frame to get the information correct. Write the answer next to your original response and then proceed to the next frame. If necessary, you may go back to check information previously given, but do not skip ahead.

Supersedes 3ABR42231-PT-201A, 24 July 1973.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 300; TTVSR - 1

In your job as an Environmental System Mechanic, it is vital that you know how various types of aircraft air conditioning systems work. In one of your past lessons you learned about trainer type aircraft air conditioning system. In this lesson, you will learn how a typical fighter aircraft air conditioning system works.

The fighter air conditioning system serves quite a few purposes. It will furnish conditioned air for crew comfort, windshield and canopy defrosting, and for cooling the electronic equipment found in the cockpit.

The fighter air conditioning system is similar to the trainer aircraft air conditioning system. That is, the fighter system will also get hot, high pressure bleed air from the engines and cool it through the use of a refrigeration unit. Look for and learn the differences in the parts used to control the airflow and temperature in this system. Remember, to do maintenance on an air conditioning system, you must first know how the system works.

Fill in the blanks to complete the following statements about the fighter air conditioning system.

1. It provides conditioned air for ________________ and __________ defrosting.

2. It provides air for cooling the ______________ equipment located in the cockpit.

3. It provides conditioned air to the cockpit for __________ comfort.

4. It receives ?, high-pressure bleed air from the _______________.

Frame 2

In the fighter air conditioning system, the air conditioning components are grouped into an assembly called the "refrigeration unit." The two drawings on the opposite page are the front and back views of the refrigeration unit. The refrigeration unit consists of the following components, which are identified by corresponding numbers in the illustration.

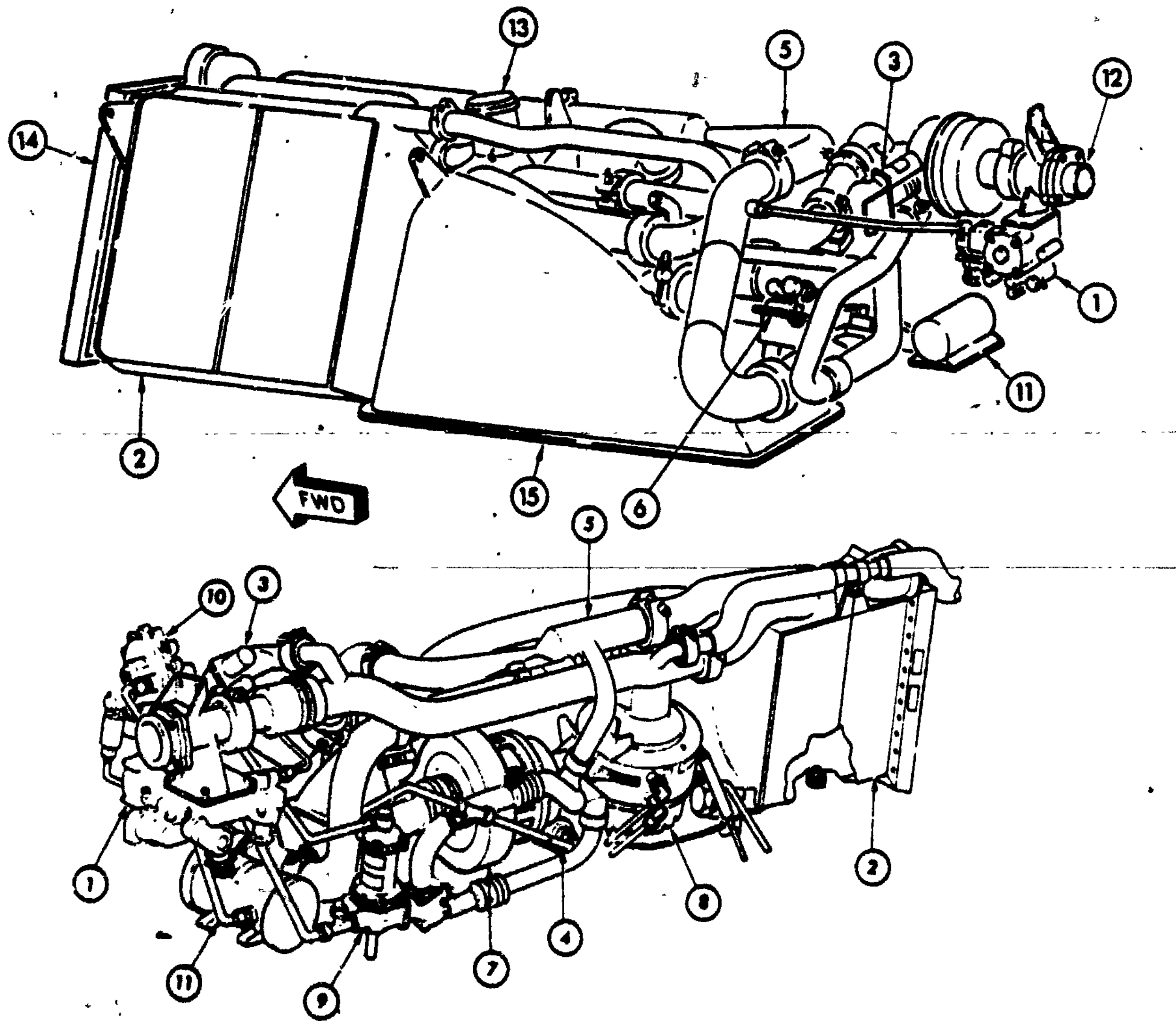
1. Bleed air pressure regulator and shutoff valve.
2. Heat exchanger.
3. Ground cooling ejector shutoff valve.
4. Turbine overspeed pressure switch.
5. Flow limiting venturi.
6. Cabin dual temperature mixing valve.
7. Turbine assembly.
8. Water separator.
9. Anti-ice valve.
10. Anti-ice controller.
11. Lag chamber.
12. Engine bleed air duct.
13. Conditioned air outlet.
14. Ram air inlet.
15. Ram air outlet.

In the frames that follow, each of these components will be described. As each component is described, you should refer back to the illustrations of the refrigeration unit. This will help you see how each component makes up a part of this system.

The bleed air that enters inlet number 12 is from the bleed air manifold. Remember, this is hot, high-pressure air from the engine compressor.

NO RESPONSE REQUIRED

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



1. BLEED AIR PRESSURE REGULATOR AND SHUTOFF VALVE
2. HEAT EXCHANGER
3. GROUND COOLING EJECTOR SHUTOFF VALVE
4. TURBINE OVERSPEED PRESSURE SWITCH
5. FLOW LIMITING VENTURI
6. CABIN DUAL TEMPERATURE MIXING VALVE
7. COOLING TURBINE
8. WATER SEPARATOR
9. TI-ICE VALVE
10. ANTI-ICE CONTROLLER
11. LAG CHAMBER
12. ENGINE BLEED AIR INLET
13. CABIN AIR OUTLET DUCT
14. RAM AIR INLET DUCT
15. RAM AIR OUTLET DUCT

1288

Frame 3

In a few of the following frames, small diagrams will be used to show you how the air flows through this system. These diagrams are simplified and will start by showing only part of the system. As you move on through this text, other parts will be added until the system is complete.

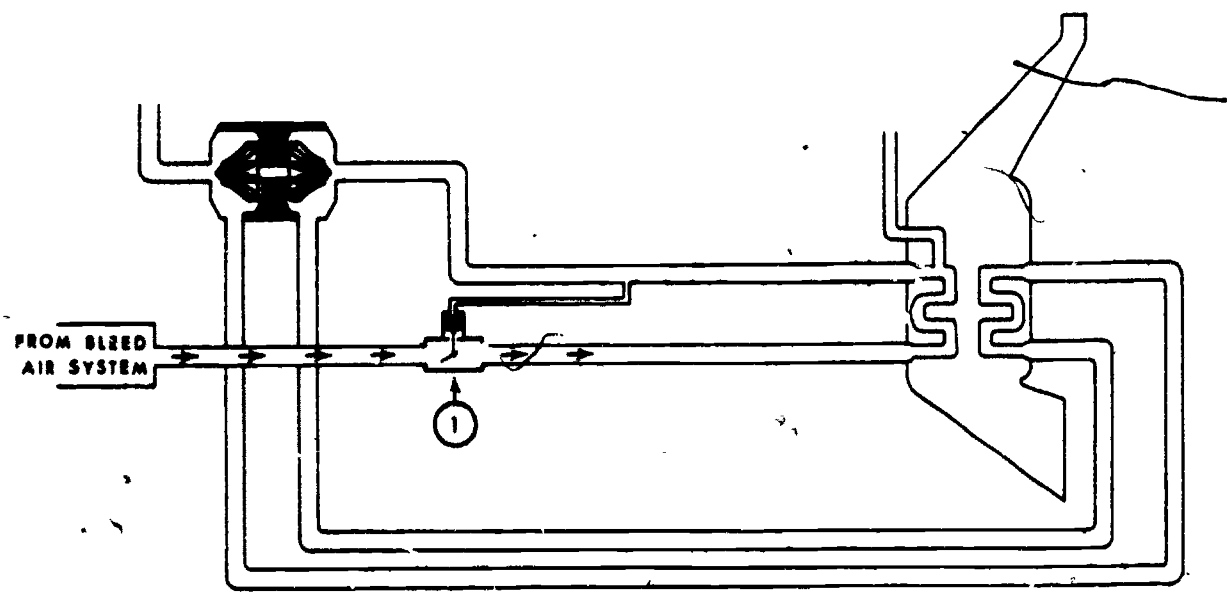
For example, the diagram below shows only the flow of air from the bleed air system to the turbine assembly. By following the airflow on these diagrams, it should make it easier for you to see how each part fits into this system.

From your studies of the trainer system, you should recall that the first part in the system was a shutoff valve. The fighter is similar; that is, it also has a valve to control the starting and stopping of airflow through the system.

The valve that does this task on the fighter system is the <u>bleed air pressure regulator and shutoff valve</u>.

Actually, as the name implies, this valve serves two purposes. It serves as a shutoff valve for the cockpit air conditioning system and it also serves to <u>regulate the air pressure</u> going through the air conditioning system.

During normal operation of the air conditioning system, this valve will regulate pressure at 62 psi. NOTE the location of this valve (number 1) in the schematic below.



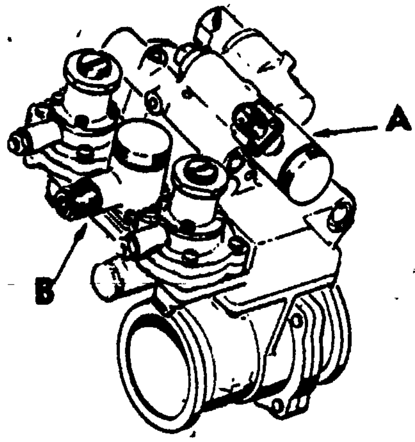
Fill in the blanks to complete the following statements.

1. The unit used to shutoff the air conditioning system is the bleed air pressure regulator and ________ ________.

2. The air going through the air conditioning system is regulated at 62 psi by the bleed air ________ ________ and shutoff valve.

The bleed air pressure regulator and shutoff valve is an air actuated, solenoid controlled valve. It is made up of a pneumatic actuator, butterfly valve, and two solenoids.

Engine bleed air that is used to operate the valve is taken upstream of the butterfly valve and led through the solenoid (marked "A" in the illustration) to the pneumatic actuator.



When this solenoid is de-energized, the air pressure is directed to close the valve. When the solenoid is energized, the air pressure is directed to open the valve. This will let airflow through the valve and to the air conditioning system.

The pressure of this airflow is regulated at 62 psi by the regulating portion of the valve.

The pressure in the duct is sensed by a sensing line before it enters the turbine assembly. When the pressure in the duct reaches 62 psi, the sensing line will allow this pressure to be applied to the regulating portion of the valve. This will cause the valve to adjust to position (partially closed) that will maintain 62 psi in the system.

The second solenoid (marked "B" in the illustration) is used to reduce air conditioning system pressure to 40 psi when the rain removal system is operated. The rain removal system will be explained in a separate text.

Fill in the blanks to complete the following statements.

1. The bleed air pressure regulator and shutoff valve is controlled by a ______________.

2. The bleed air pressure regulator and shutoff valve is actuated by __________ __________________.

3. The bleed air pressure regulator and shutoff valve requires both __________ ______________ and ______________ power for operation.

4. The unit that controls air pressure for the air conditioning system is the bleed air ____________ ____________ and ________ ________.

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Frame 5

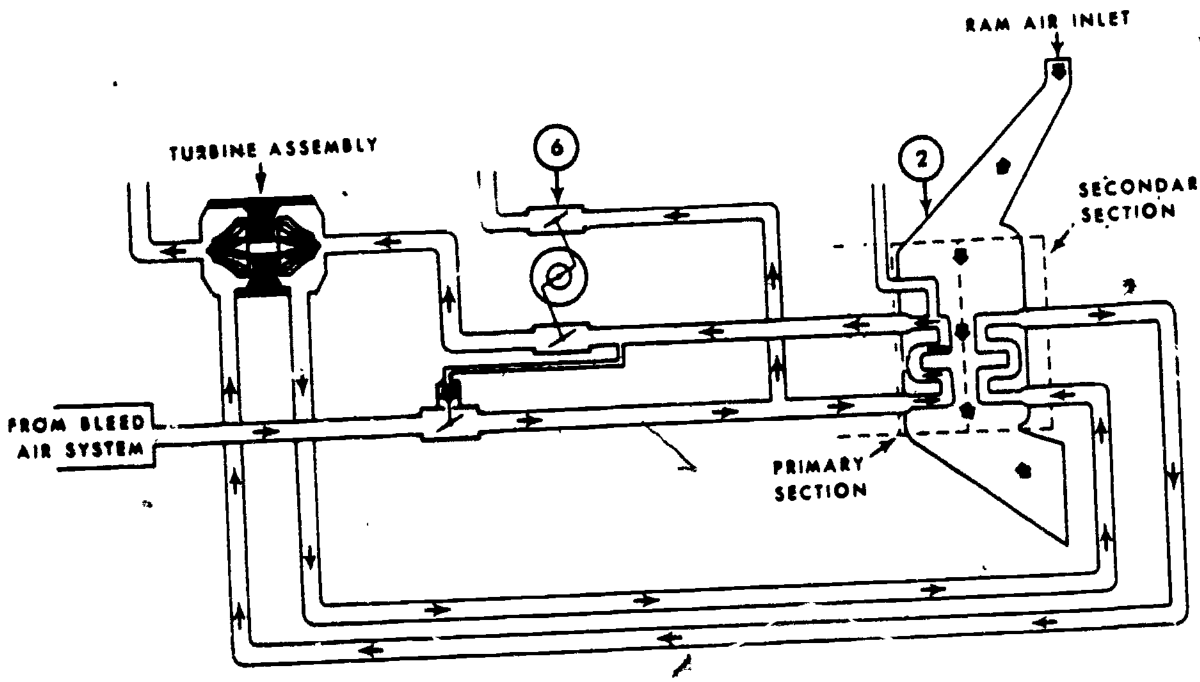
After the regulated bleed air flows through the pressure regulator and shutoff valve, it flows through the heat exchanger (number 2 in the illustration shown) and to the hot side of the temperature control valve (number 6 in the illustration).

On the illustration shown, note the path of airflow from the pressure regulator and shutoff valve to the heat exchanger and the path to the temperature control valve.

The heat exchanger is an air-to-air type and works on the same principle as the heat exchanger in the trainer aircraft air conditioning system. That is, it cools the engine bleed air by transferring heat from the bleed air to the ram air.

As shown in the illustration, this heat exchanger is divided into two sections; the primary, or hot bleed air section, and the secondary, or the compressor discharge section.

The hot engine bleed air is directed through the primary section for initial cooling. From there it flows through the turbine assembly and is then directed to the secondary section for additional cooling.



Fill in the blanks to complete the following statements.

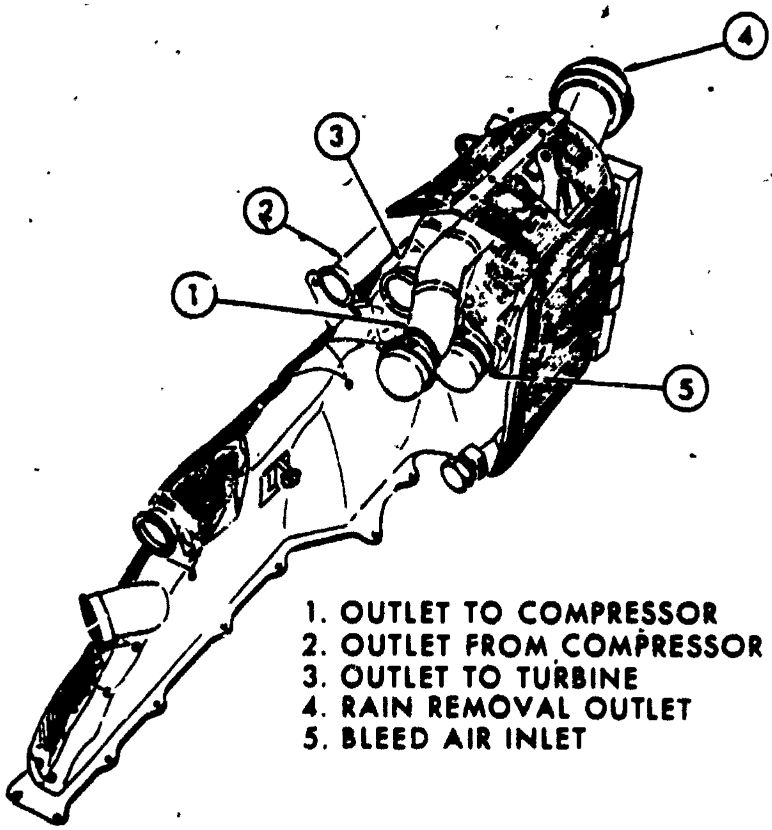
1. The heat exchanger consists of the ____________ section and the ____________ section.

2. Initial cooling of the bleed air is accomplished by the ____________ section of the heat exchanger.

Frame 6

The illustration below shows the heat exchanger for the cockpit air conditioning and identifies the various connections. The engine bleed air from the pressure regulator and shutoff valve enters the primary air inlet (5), passes through the primary section of the heat exchanger and then to the compressor section of the turbine assembly (1). Air is also taken from the primary section of the heat exchanger for the rain removal system (4).

The air from the compressor section of the turbine assembly enters the secondary inlet (2), passes through the secondary section, and out to the expansion turbine through the secondary outlet (3).



1. OUTLET TO COMPRESSOR
2. OUTLET FROM COMPRESSOR
3. OUTLET TO TURBINE
4. RAIN REMOVAL OUTLET
5. BLEED AIR INLET

Fill in the blanks to complete the following statements:

1. The primary section cools the air for the ____________ air conditioning system, and the ____________ removal system.

2. As the bleed air passes through the heat exchanger, the heat is transferred to the __________ air.

3. The air from the turbine assembly flows through the ______________ section of the heat exchanger.

1292

Frame 7

In flight the forward movement of the aircraft gives plenty of ram air for the heat exchanger operation. But for ground operation, another means must be used to draw ram air across the heat exchanger.

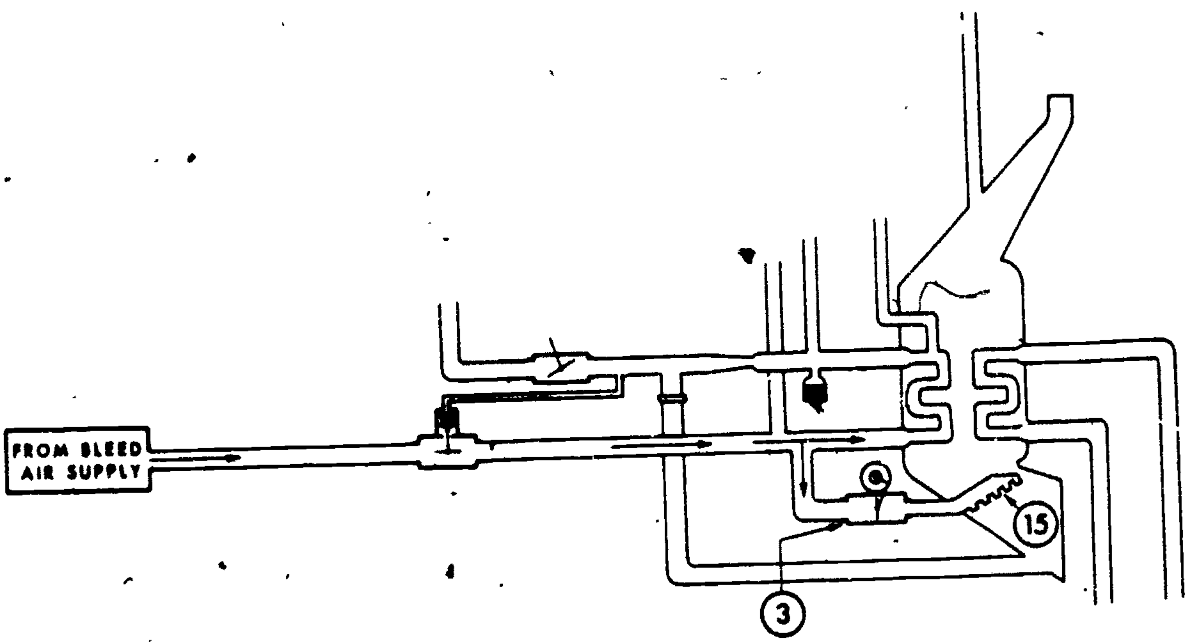
A ground cooling ejector assembly is used to boost the cooling efficiency of the heat exchanger while the aircraft is on the ground.

This assembly is made up of a ground cooling ejector shutoff valve (number 3 in the illustration) and the ejector nozzle (number 15). Find these two parts on the illustration shown.

Note that bleed air is tapped from the hot air duct before it goes in the primary section of the heat exchanger and is directed to the ground cooling ejector shutoff valve.

When this valve is open, engine bleed air is directed to the ejector nozzles. The ejector nozzles are found in the heat exchanger ram air outlet.

As the engine bleed air passes through the ejector nozzles it causes a low pressure area directly behind the nozzles. This low-pressure area helps to draw ram air across the heat exchanger. This will cause cooling (ram) air to flow over the heat exchanger, thereby increasing the cooling efficiency during ground operation.

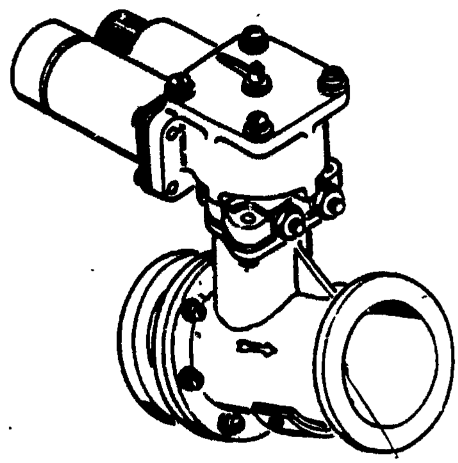


Fill in the blanks to complete the following statements.

1. During ground operation, ram airflow across the heat exchanger is caused by opening the ground cooling ____________ ____________.

2. The ground cooling ejector assembly consists of a ground cooling ejector ____________ ____________ and an ejector ________.

The ground cooling ejector shutoff valve, shown below, is a motor operated, butterfly type of valve.



This valve controls the bleed air going to the ejector nozzles.

This valve is controlled by a switch on the landing gear handle. When the handle is in the gear down position, 28V DC power is directed to the landing gear auxillary relay. This energizes the relay which will route power to the open side of the valve and move the valve to the open position. When the valve is open, bleed air flows through the ejector nozzles.

When the landing gear handle is in the gear up position, the landing gear auxillary relay de-energizes and routes the power to the closed side of the valve. This will move the valve to the closed position and stop the air going to the ejector nozzles. In this way, the ejector assembly only operates when the landing gear handle is down, which is mainly during ground operation.

Fill in the blanks to complete the following statements.

1. The unit that controls the airflow to the ground cooling ejector nozzles is the ground cooling __________ __________ __________.

2. The ground cooling ejector shutoff valve is controlled by the switch on the __________ __________ __________.

3. For the ground cooling ejection system to operate, the landing gear handle must be __________ (up/down).

1294

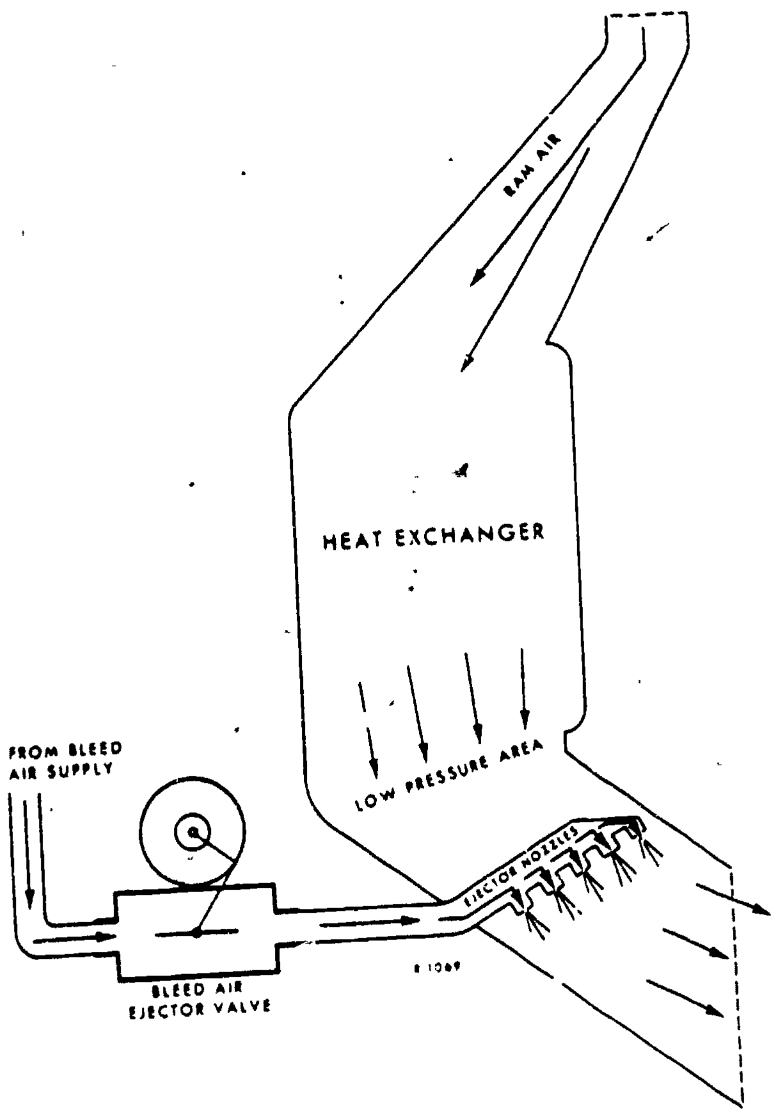
Frame 9

The principle of operation of the ejector nozzle is similar to a fan. A fan accelerates the movement of air by the design of the fan blades. As the fan moves the air it causes a low pressure area behind the fan. This causes more air to move toward the fan which results in a continuous movement of air behind the fan as well as in front of the fan.

The ejector nozzle assembly consists of several small air outlets (ejecto nozzles). As the high-pressure air from the bleed air system is forced out through each of the ejector nozzles, it moves rapidly due to the high-pressure. This rapid movement of the air surrounds each of the nozzles.

The air movement causes a low pressure area behind the nozzles (similar to the operation of a fan). This causes the cooler outside air to move from the ram air inlet, across the heat exchanger, and be discharged at the ram air outlet.

Note the flow of air through the ejector and the heat exchanger in the illustration.



53

Fill in the blanks to complete the following statements.

1. Ram air is drawn across the heat exchanger by ejecting ______ air through the ejector nozzles.

2. When bleed air is ejected through the ejector nozzles, it causes a ______ ______ area behind the nozzles.

1296

Frame 10

Match the units listed in Column "B" with the statements given in Column "A."

	Column A		Column B
1._____	Directs engine bleed air to the ejector nozzles.	A.	Pressure Regulator and Shutoff Valve.
2. _____	Serves as a shutoff valve for the cabin air conditioning system.	B.	Heat Exchanger.
3. _____	Causes a low-pressure area in the heat exchanger ram air outlet.	C.	Ground Cooling Ejector Shutoff Valve.
4. _____	Opened only when the landing gear handle is in the gear down position.	D.	Ground Cooling Ejector Nozzles.
5. _____	Regulates system air pressure at 62 psi.		
6. _____	Transfers heat from the bleed air to the ram air.		
7. _____	Actuated by air pressure and controlled by a solenoid.		

Complete the following statements.

8. When the solenoid of the bleed air pressure regulator and shutoff valve is energized, the valve will __________ (open/close).

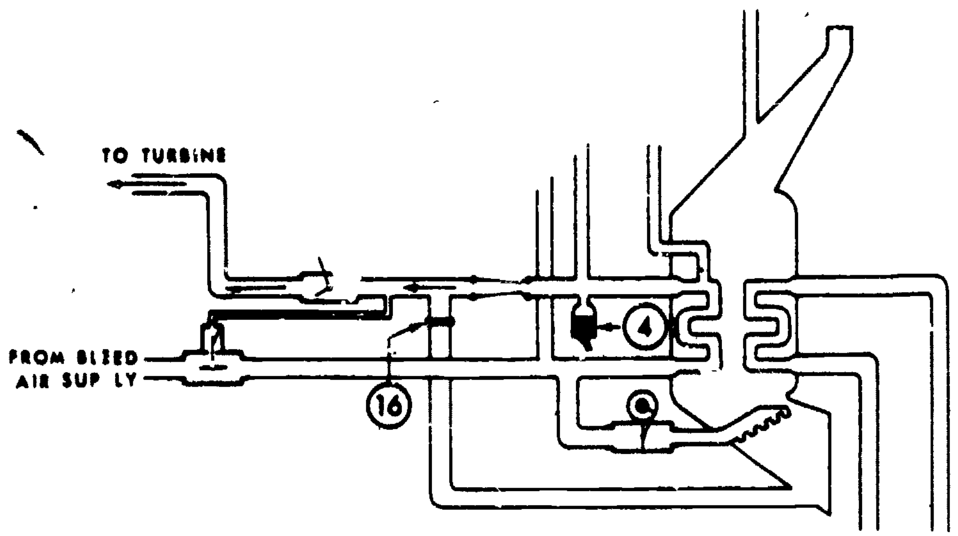
9. The solenoid controls the pressure regulator and shutoff valve by controlling air pressure to the ___ ___ __________.

10. The pressure regulator and shutoff valve controls air __________ in the air conditioning system, and also serves as a __________ valve.

55

After the air is initially cooled by the primary section of the heat exchanger, it flows to the turbine assembly. The pressure of this air will be sensed by two safety devices which protect the system from damage caused by excessive pressure.

These two devices are the turbine overspeed pressure switch (number 4 in the illustration below) and the rupture disc (number 16). Notice the location of these two components in the illustration below.



The purpose of the rbine overspeed pressure switch is to alert the pilot of an excessive pressure condition by turning on a warning light in the cockpit. Should the pressure continue to build up, the rupture disc will blow out (rupture) and relieve the excessive pressure overboard.

Fill in the blanks to complete the following sta ements.

1. The two safety devices that are used to protect the system from damage caused by excessive pressure are the turbine overspeed __________ __________ and the __________ __________.

2. Should the pressure of the air going to the turbine become excessive, the turbine __________ __________ __________ will turn on a warning light.

1298

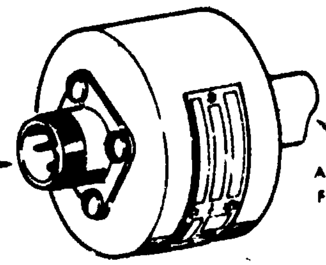
Frame 12

You should recall from frames 3 and 4 that the pressure regulator and shutoff valve is designed to keep pressure going to the turbine assembly at 62 psi. But, if this unit fails, the pressure could exceed 62 psi.

If the pressure gets too high it could cause the turbine to overspeed and cause damage to the heat exchanger or ducting. However, this pressure increase would be sensed by the turbine overspeed pressure switch.

The turbine overspeed pressure switch, shown below, is a sealed unit with electrical and air connections.

When the pressure reaches 100 psi, the pressure switch will complete an electrical circuit turning on the TURBINE OVERSPEED warning light in the cockpit. This will tell the pilot that the system pressure is too high.



The cause for the system pressure being too high could be a fault in the pressure regulating part of the pressure regulator and shutoff valve. It would not be regulating system pressure at 62 psi, but letting system pressure exceed 100 psi causing the switch to make contact, and thus, turning the warning light ON.

To prevent damage to the system, the pilot must do one of two things. He can reduce the engine throttle setting which will reduce the system pressure, or he can turn the air conditioning system off.

Remember, that the turbine overspeed pressure switch does not prevent the turbine from overspeeding, but it is used to alert the pilot of an overspeed condition.

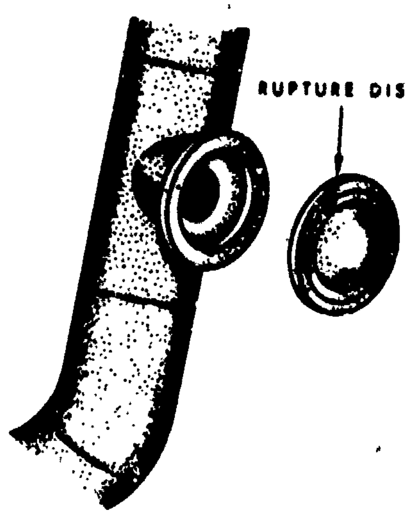
Fill in the blanks to complete the following statements.

1. When air pressure going to the turbine assembly reaches 100 psi, a warning light is turned ON by the __________ ______________ __________ __________.

2. If the turbine overspeed warning light comes ON, damage to the system is prevented by the __________ reducing the throttle setting.

3. The turbine overspeed warning light coming ON indicates a malfunctioning __________ __________ __________ __________ __________ __________ __________.

The rupture disc, illustrated below, is designed to rupture at 100 psi. During an overspeed condition if the system pressure is not reduced soon enough, or if it cannot be reduced for some reason, and pressure continues to build up, the rupture disc, will rupture at 100 psi and allow system pressure to bleed overboard thru the heat exchanger.



The pressure buildup would be caused by a malfunction in the regulating portion of the pressure regulator and shutoff valve.

This would require that you, as a maintenance man, to remove and replace the pressure regulator and shutoff valve and the rupture disc.

Note in the illustration in frame 11, that when the disc (16) ruptures, the system air will flow thru a duct and out thru the heat exchanger ram air outlet.

Fill in the blanks to complete the following statements.

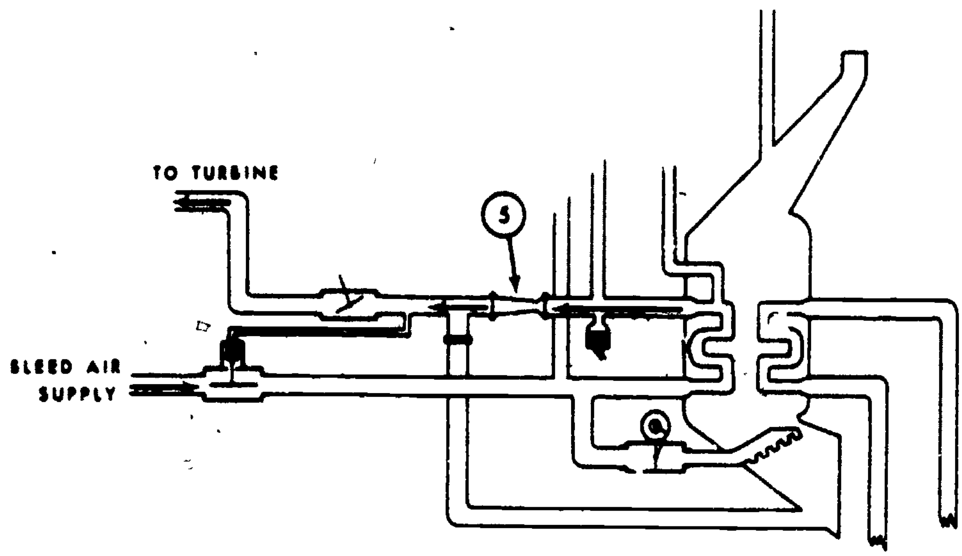
1. If the pressure of the air going to the turbine should exceed 100 psi, the ____________ _________ will rupture.

2. If the rupture disc should rupture, the bleed air is discharged through the heat exchanger __________ __________ ____________.

1300

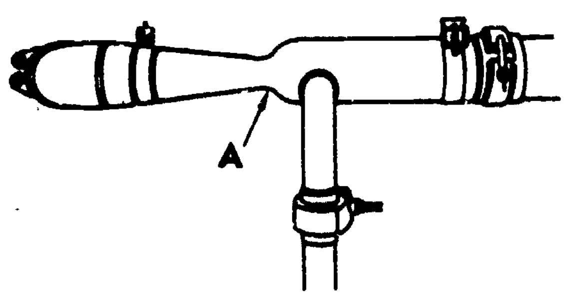
Frame 14

The air that flows from the heat exchanger to the turbine assembly passes through a flow limiting venturi (number 5 in the illustration shown).



The flow limiting venturi serves two roles in the system. First, the venturi stops surges from getting to the turbine assembly by smoothing out the airflow as it passes through the venturi. Second, it stops a complete loss of air pressure if the rupture disc should fail. This will insure some air pressure for operation of the auxiliary air systems.

The flow limiting venturi is shown below. It is similar to a section of ducting except that part of this unit is smaller (note the section where arrow "A" is pointing). This is called the throat of the venturi.



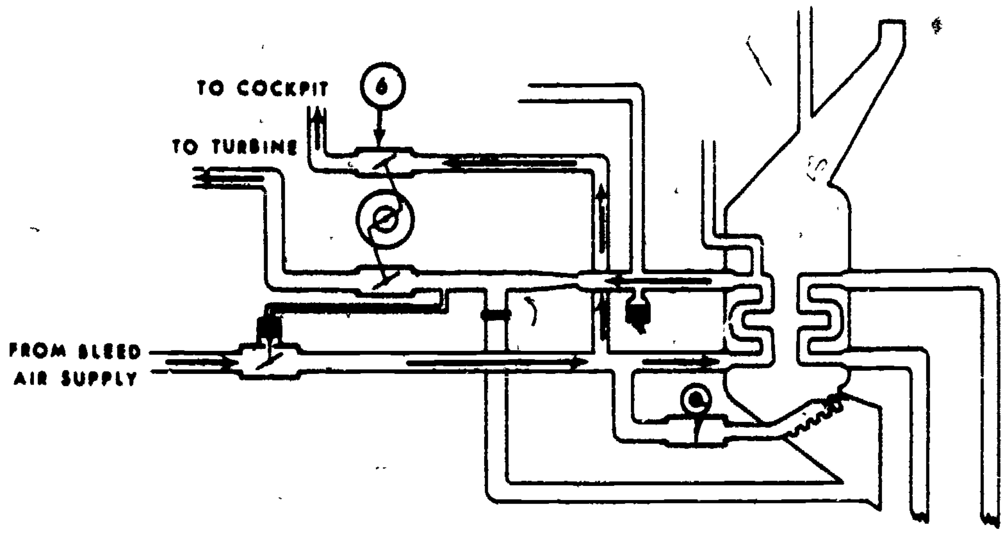
Because the throat is smaller, the venturi will curb (restrict) the amount of air that can pass through it. By limiting the airflow through it, it will smooth out any pressure surges.

Fill in the blanks to complete the following statements.

1. Pressure surges are prevented from reaching the turbine assembly by the flow ______________ ______________.

2. When the rupture disc ruptures, a complete loss of upstream pressure is prevented by the __________ __________ ______________.

The partially cooled air from the primary section of the heat exchanger flows through the flow limiting venturi, then up to the cabin dual temperature mixing valve (number 6 in the illustration below).



The cabin dual temperature mixing valve controls the amount of hot and cold air going to the cockpit. Locate this valve in the illustration below.

Notice that this valve is a dual port valve; that is, it has two ports for air to flow through. Notice on the illustration that air can flow from the heat exchanger through one of the ports to the turbine assembly. This port is called the cold air port.

Also notice that airflow from a tapoff (marked A) on the hot air duct can flow through the opposite port. This port is called the hot air port.

When the cold air port is closed and the hot air port is open, all of the airflow to the cockpit will bypass the heat exchanger and turbine assembly. This provides maximum hot air to the cockpit.

When the cold air port is open and the hot air port is closed, all of the airflow to the cockpit flows through the heat exchanger and turbine assembly. This provides maximum cold air to the cockpit.

When both ports are partially open a mixture of hot and cold air is delivered to the cockpit.

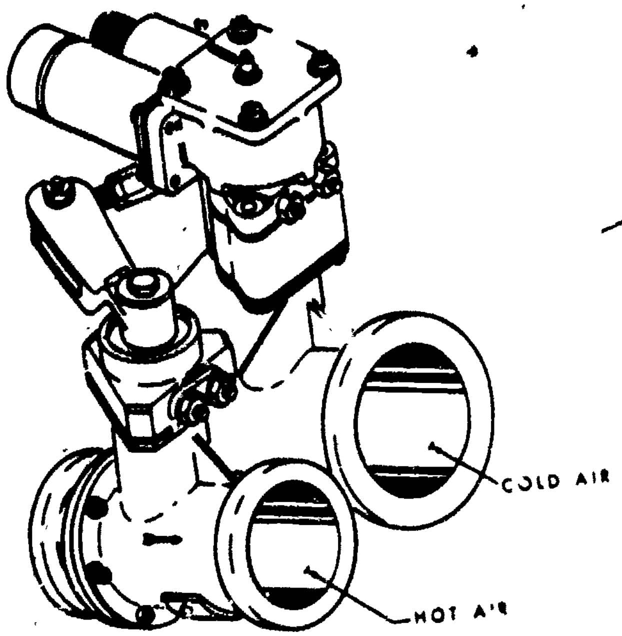
Fill in the blanks to complete the following statements.

1. The unit that mixes the hot and cold air to control cockpit temperature is the cabin ________ ____________ __________ ________.
2. To obtain maximum hot air for the cockpit, the cold air port is __________ (closed/open), and the hot air port is _________ (closed/open).

1302

Frame 16

The cabin dual temperature mixing valve, illustrated below, is a dual butterfly, motor operated valve.



Note that both butterflies are actuated by the same motor.

The butterflies are connected together by a mechanical linkage.

When the cold air butterfly moves toward closed, the hot air butterfly moves toward open.

When the cold air butterfly moves toward open, the hot air butterfly moves toward closed.

This valve can be controlled manually by the temperature control switch or automatically by the temperature controller. Actual control of this valve will be explained later in this text.

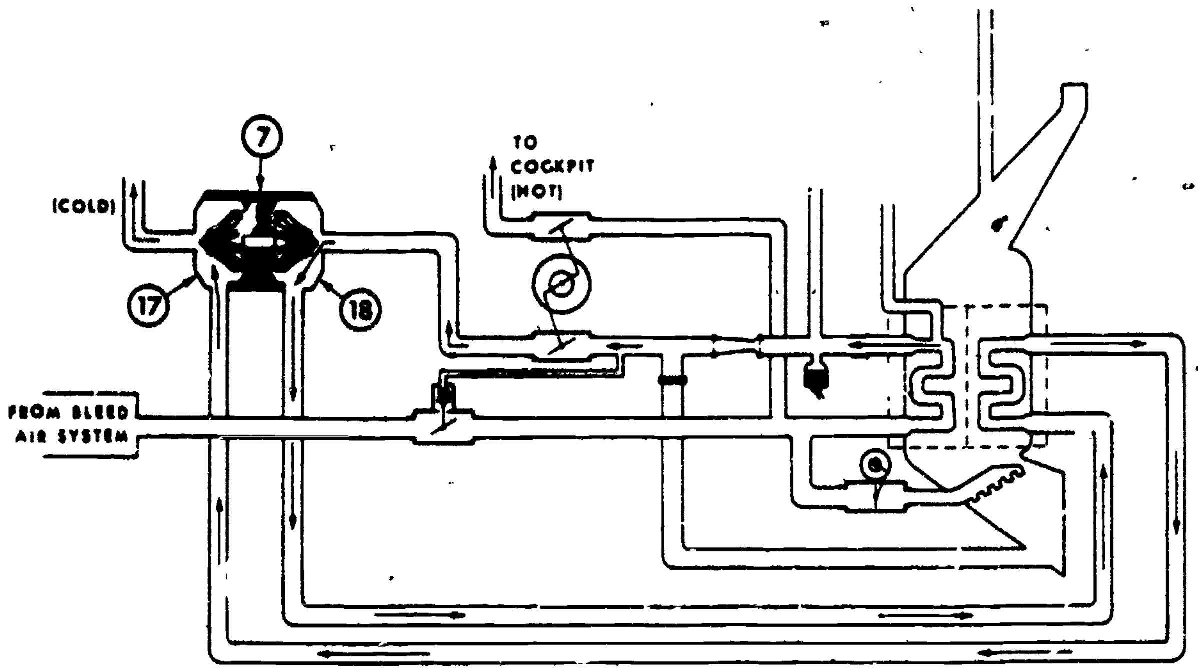
Fill in the blanks to complete the following statements.

1. When both ports of the cabin dual temperature mixing valve are partially open, a mixture of ________ and ________ air will be delivered to the cockpit.

2. The cabin dual temperature mixing valve is actuated by an electric ________.

3. The butterflies of the cabin dual temperature mixing valve are connected by a ________ ________.

From the facts you gained on the trainer aircraft air conditioning system, you have no doubt guessed that the turbine assembly (number 7 in the illustration shown) is much the same as the turbine fan assembly.



This is half true. That is, it does cool air by rapid expansion and by converting heat energy to mechanical energy. But, instead of having a fan and a turbine, this assembly has two turbines. It has an expansion turbine (number 17) and a compressor turbine (number 18).

Let's use the illustration shown to trace the airflow through the turbine assembly so that we can break down this unit's operation.

The air from the primary section of the heat exchanger flows through the compressor turbine where its pressure is increased. From the compressor turbine, the air flows to the secondary section of the heat exchanger, and from there to the expansion turbine.

As the air flows through the expansion turbine, the pressure of the air will cause this turbine to rotate (turn). Since the expansion turbine and the compressor turbine are on a common shaft, the compressor turbine also rotates.

Fill in the blanks to complete the following statements.

1. The turbine assembly consists of a ______________ turbine and an __________________ turbine.
2. The air flowing through the compressor turbine is from the _____________ section of the heat exchanger.
3. The air flowing through the expansion turbine is from the __________________ section of the heat exchanger.

1304
Frame 18

It's important to note at this point that even though the air flows thru the compressor turbine first, this does not cause the turbines to turn. The air that flows through the expansion turbine will cause the turbines to turn, or we can say the expansion turbine drives the compressor turbine.

For the expansion turbine to drive the compressor turbine, it must use energy. This energy is in the form of heat energy from the partially cooled bleed air.

In the course of driving the turbines, the heat energy is changed to mechanical energy.

By using the heat energy, the temperature of the air that flows through the expansion turbine is cut down.

In addition to using heat energy, the pressure of the air is rapidly decreased (expanded) which also helps to decrease the temperature.

Through this process of converting heat energy to mechanical energy, and rapidly expanding the air, the turbine assembly is able to deliver extremely cold air to the cockpit if it is needed.

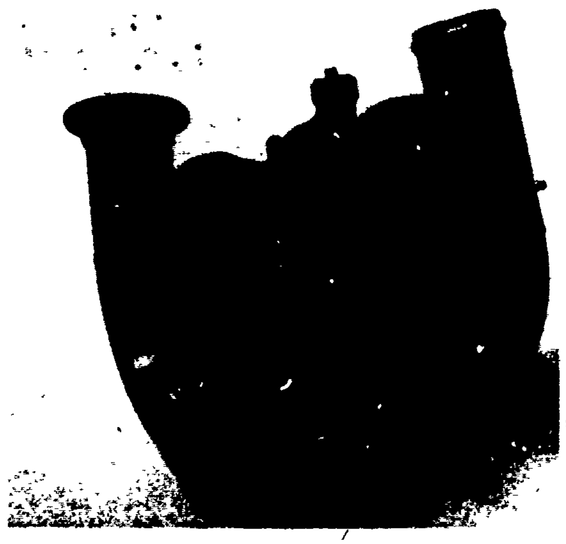
Fill in the blanks to complete the following statements.

1. The compressor turbine is driven by the __________ ______________.

2. The turbine assembly cools the partially cooled bleed air by rapid ______________ and by converting __________ energy to ______________ energy.

The compressor turbine actually serves several purposes. It compresses the partially cooled air from the primary section of the heat exchanger. In doing so it puts a workload on the expansion turbine. The workload uses the energy from the bleed air and helps to keep the turbines from overspeeding.

The trubine assembly is illustrated below. This will help you to become familiar with the external appearance of this unit.



Fill in the blanks to complete the following statements.

1. The compressor turbine serves three purposes, they are;

   a. Helps to keep the turbine from ___________________.

   b. Uses energy from the bleed air by putting a ______________ on the expansion turbine.

   c. Serves to ________________ the partially cooled air.

1306

Frame 20

You may be wondering why the compressor turbine is used to compress the air that was partially cooled by the primary section of the heat exchanger. Note on the illustration shown, that air from the primary section of the heat exchanger is also used for the rain removal system.

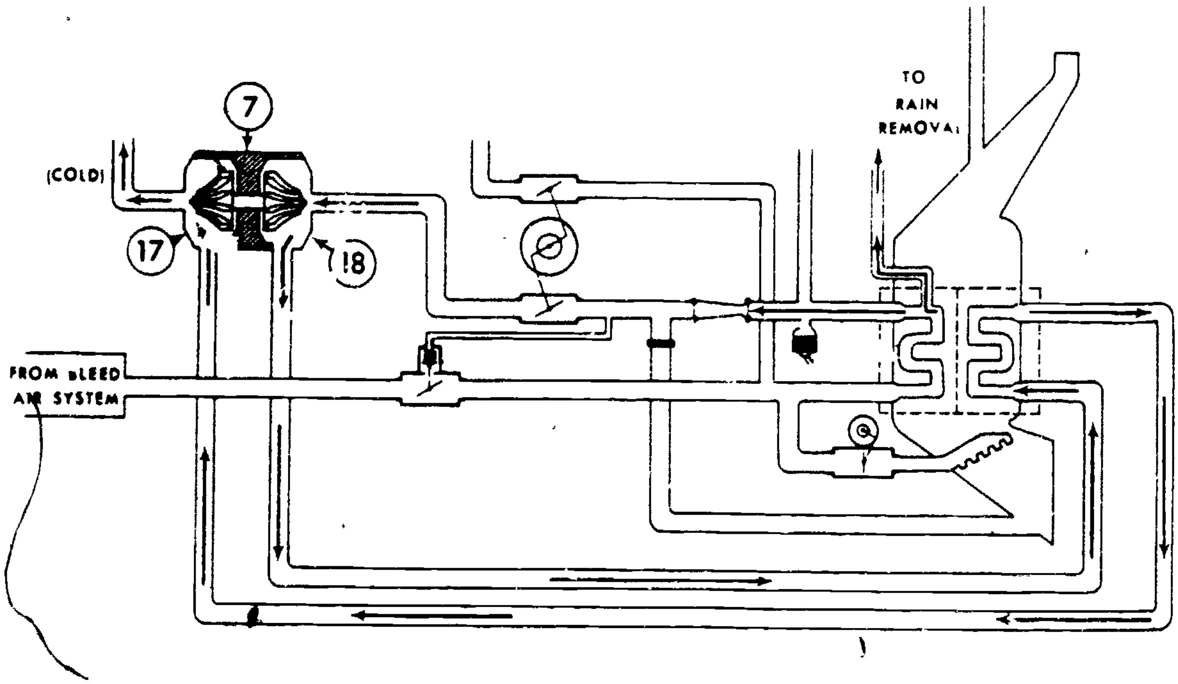
When the rain removal system is at work, it causes the pressure going to the turbine assembly to be cut down. Also, this aircraft is designed for operating at extremely high altitudes where the outside pressure is very low.

When the outside pressure is low, the air that comes from the bleed air system will also be low and could be less than the normal 62 psi.

For an expansion turbine to work efficiently, it needs air with enough pressure to turn it at very high RPMs. If the pressure should become too low, this would not be possible. This is where the compressor turbine comes in. It increases the pressure so that the expansion turbine will operate efficiently.

Of course when the pressure is increased, the temperature is also increased. Notice that the air from the compressor turbine is routed to the secondary section of the heat exchanger where its partially cooled again.

From the secondary section of the heat exchanger it goes to the expansion turbine for final cooling.



Fill in the blanks to complete the following statements.

1. The bleed air from the bleed air system is first cooled by the ______________ section of the heat exchanger.

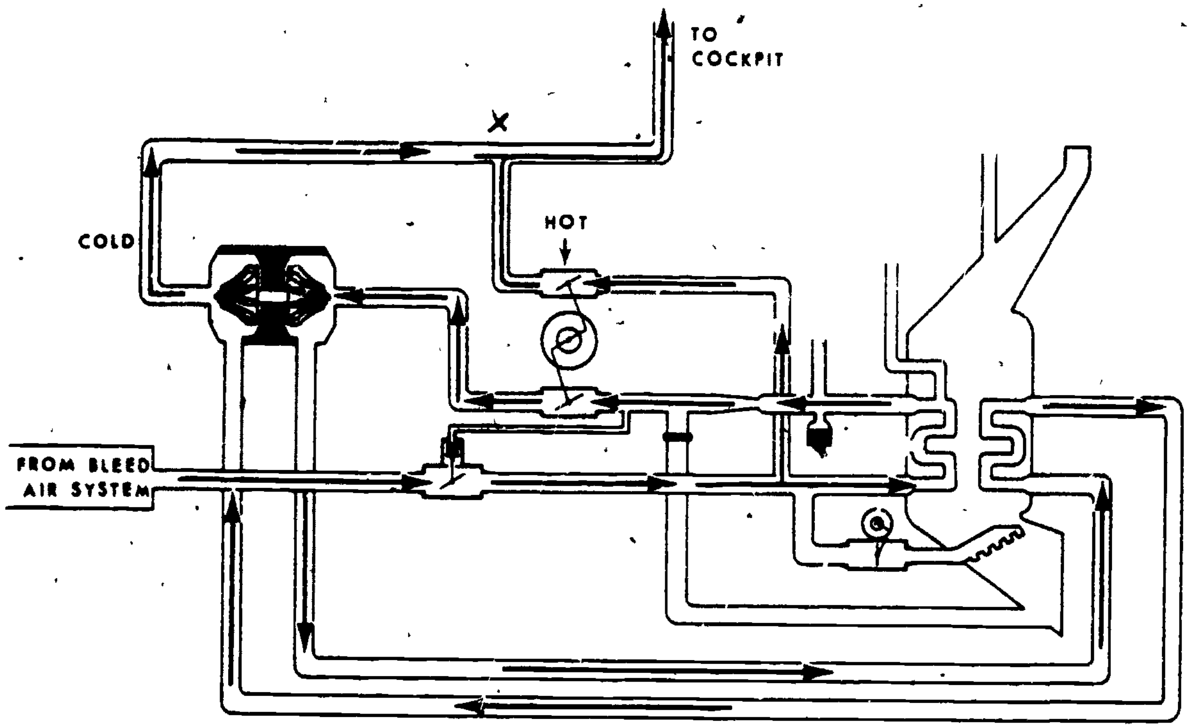
2. After the bleed air is cooled by the primary section of the heat exchanger it is compressed by the ______________ ______________.

3. The air from the compressor turbine is partially cooled by the ______________ section of the heat exchanger, and then further cooled by the ______________ ______________.

4. The reason for compressing the air with the compressor turbine is to increase the pressure so the _______________ turbine will operate more _______________.

Frame 21

The temperature of air depends on the position of the cabin dual temperature mixing valve. Let's follow the airflow for the various temperature conditions on the illustration shown.



When maximum cold air is needed, the cold air port opens and the hot air port closes. This will cause all of the air to flow through the heat exchanger and turbine assembly before it goes to the cockpit. Note the path of air flow through the heat exchanger and turbine assembly on the illustration shown.

When maximum hot air is received, the cold air port is closed and the hot air port is open. This will cause all of the air to bypass the heat exchanger and turbine assembly. Note the path of airflow from the hot air duct, and through the hot air port of the dual temperature mixing valve.

When an intermediate temperature selection is needed, only part of the air will flow through the heat exchanger and turbine assembly. Part of the air bypasses these units. The hot and cold air then mixes at point "X," and flows from there to the cockpit. The arrows on the illustration below shows the air being mixed.

NO RESPONSE REQUIRED

1308

Frame 22

Match the units in Column "B" with the statements given in Column "A," by placing the letter from Column "B" in the blanks provided.

Column A	Column B
1. _____ Consists of an expansion turbine and a compressor turbine.	A. Turbine overspeed pressure switch.
2. _____ Motor operated dual butterfly valve.	B. Rupture disc.
3. _____ Smoothes out pressure surges.	C. Turbine assembly.
4. _____ A safety device to relieve excessive pressure.	D. Flow limiting venturi.
5. _____ Senses an overpressure condition and turns on a warning light.	E. Cabin dual temperature mixing valve.

Circle the number of the <u>true</u> statements.

6. The turbine assembly cools air by rapid expansion and by converting heat energy to mechanical energy.

7. The compressor turbine ~~drives the~~ expansion turbine.

8. When the cold air port of the cabin dual temperature mixing valve is open, the hot air port is closed.

9. To receive maximum hot air in the cockpit, both the hot air port and the cold air port of the cabin dual temperature mixing valve will be open.

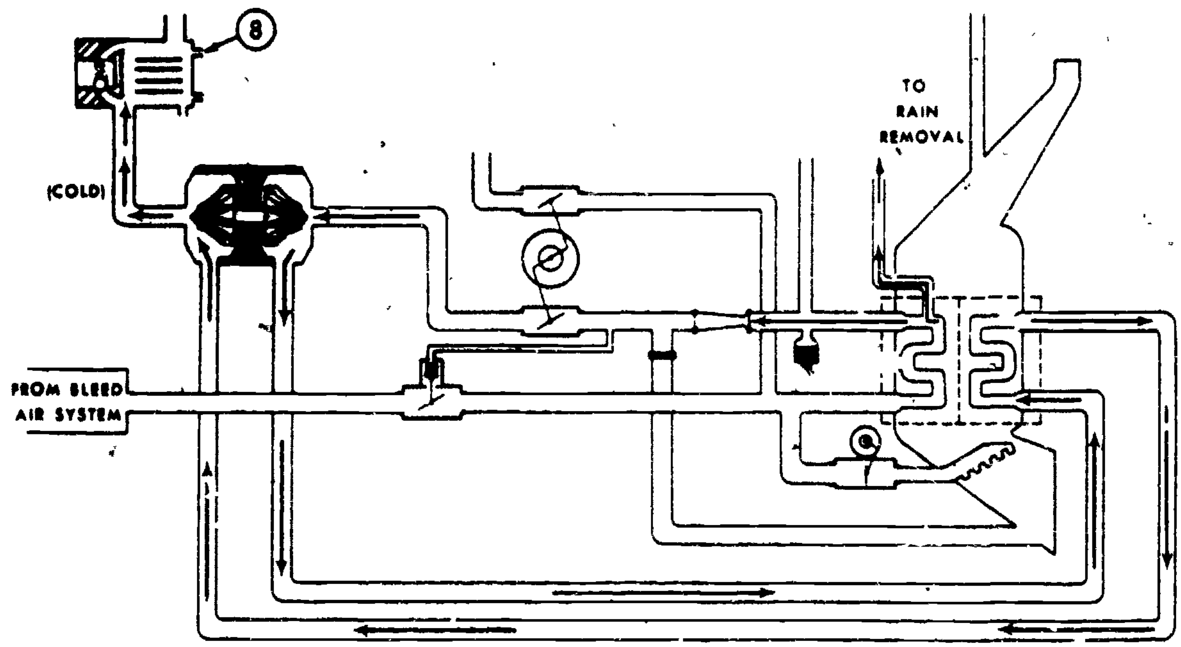
10. Before the air enters the expansion turbine, it must first pass through the primary section of the heat exchanger, the compressor turbine, and the secondary section of the heat exchanger.

11. The cabin dual temperature mixing valve is actuated by an electric motor.

The cold air flows from the expansion turbine to a water separator (number 8 in the illustration). The water separator removes any excess moisture.

You may be wondering, why is it necessary to remove the excess moisture. Cold air will not hold as much moisture as hot air. As a result, when air is cooled, the moisture will tend to condense.

This condensed moisture will appear as a mist or fog, or even as snow if the air is cooled close to the freezing point. Fog coming from the air conditioning outlets in an aircraft can be dangerous as it may be mistaken for smoke and it also would make it difficult for the pilot to see.



Fill in the blanks to complete the following statements.

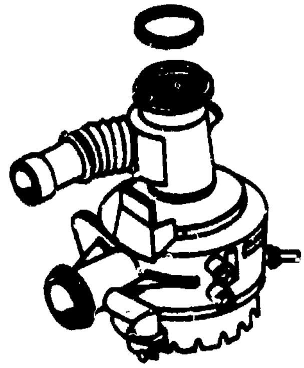
1. Excess moisture is removed by the __________ ______________.

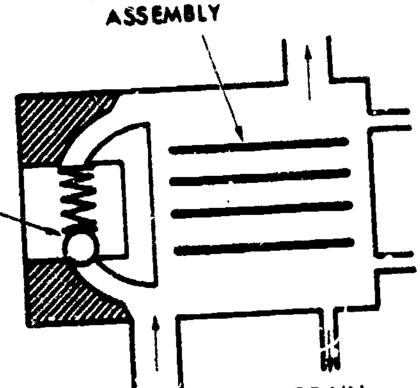
2. The only air that passes through the water separator is the _______ air from the ____________ ______________.

1310

Frame 2.

The water separator is shown below. It contains a condensor assembly and a bypass valve. This is shown in the schematic in figure B, of the illustration.





The condensor assembly will cause the excess moisture to condense into water droplets within the water separator. The water is then drained overboard through the water separator drain.

The bypass valve will allow the air to bypass the condensor assembly in case the condensor become obstructed due to dirt or ice. The air that will pass through the water separator is cold, and can be below the freezing point of water. The water condenses on the condensor assembly, and if the air temperature is below freezing, ice will form on the condensor. Should this happen, the pressure on the inlet side will go up, overcoming the spring tension that's holding the bypass valve closed. This will open the bypass valve, permitting the air to bypass the condensor. This will insure a flow of conditioned air when the condensor becomes obstructed.

Fill in the blanks to complete the following statements.

1. The water separator contains a ______________ assembly and a ______________ valve.

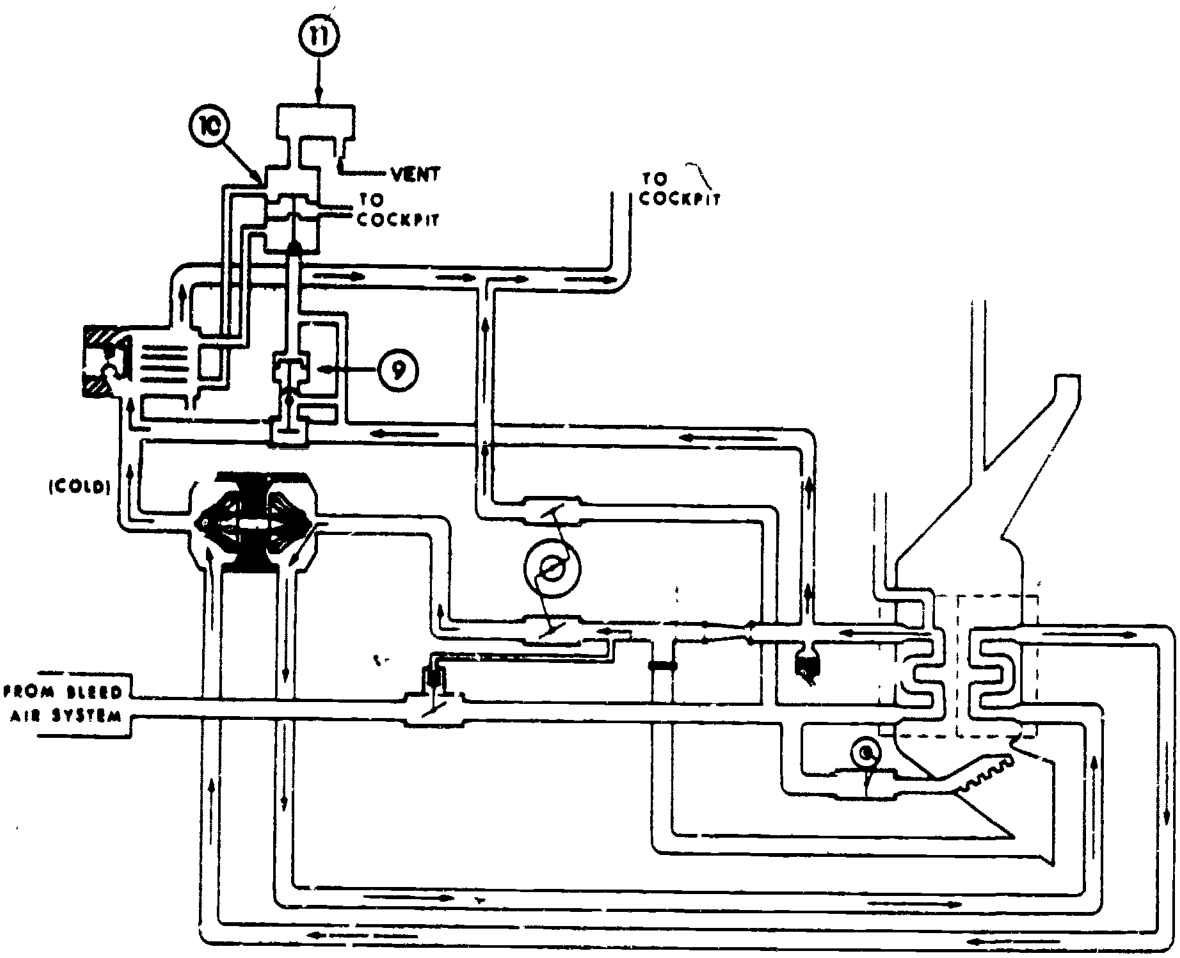
2. The water separator bypass valve is held closed by ______________ ______________.

3. The water separator bypass valve is opened by ______________ ______________.

69

Under normal conditions, the bypass valve would stay closed as the water separator system incorporates an anti-icing system to prevent ice from clogging the condensor assembly.

The water separator anti-ice system is shown in the illustration below. This system includes an anti-ice valve (number 9), an anti-ice controller (number 10), and a lag chamber (number 11).



The anti-ice valve opens to allow some warm air to enter the water separator whenever ice starts to form on the water separator condensor. Notice the path of airflow through the anti-ice valve.

The anti-ice controller senses the icing condition and controls the opening and closing of the anti-ice valve.

The lag chamber aids in smoother operation of the anti-ice valve by absorbing rapid fluctuations in pressure.

Fill in the blanks to complete the following statements.

1. The water separator anti-ice system consists of an anti-ice ______________, and anti-ice _____________, and a lag chamber.

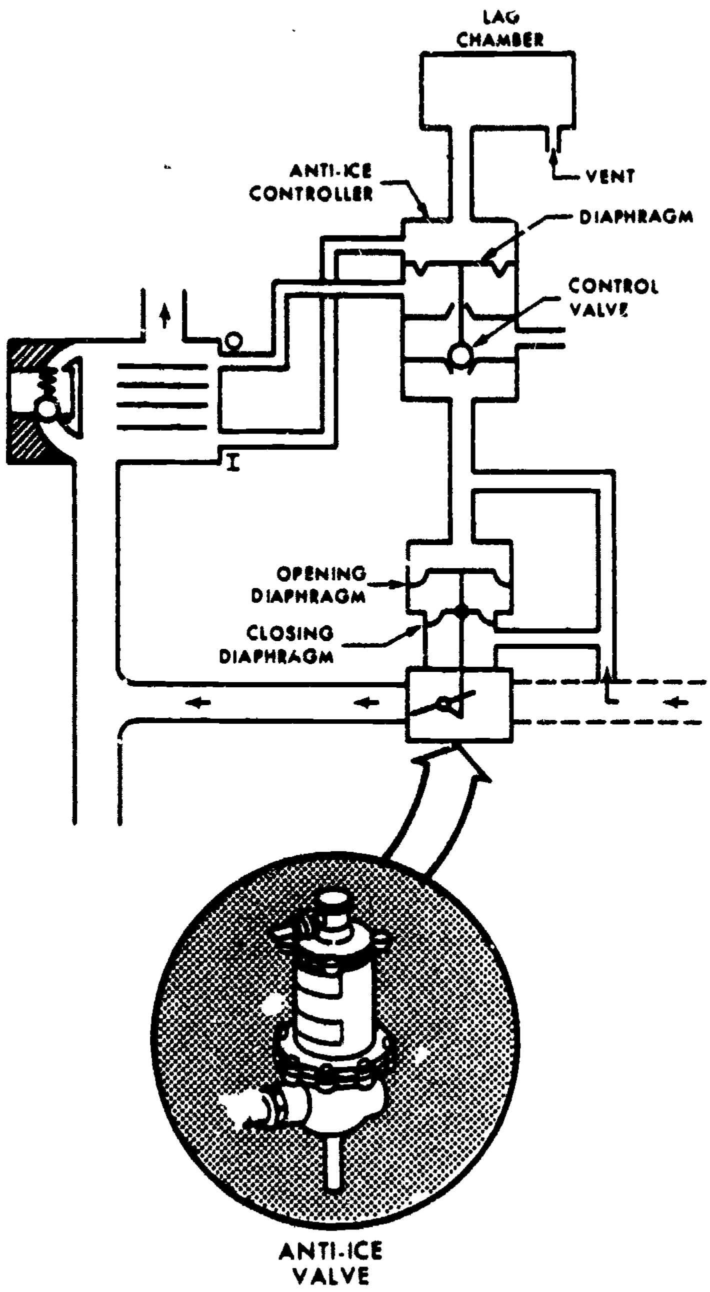
1312

Frame 25 (Cont'd)

2. The anti-ice system prevents clogging of the water separator by allowing __________ air to enter the water separator.

3. The partially cooled (warm) air used for water separator anti-icing is taken from the ________________ section of the heat exchanger.

The illustration below shows the water separator and the anti-ice system. Note that this system is operated pneumatically. Now let's trace the airflow through the system to see how the anti-ice valve will be opened and closed.



The anti-ice valve actuator has two diaphragms, an opening diaphragm (top) and a closing diaphragm (bottom).

1314

Frame 26 (Cont'd)

The opening diaphragm has a larger diameter than the closing diaphragm. This means it has a larger area.

Air pressure from the primary section of the heat exchanger goes in the actuator below the closing diaphragm and on the top of the opening diaphragm. This will place an equal pressure on both diaphragms. But, the opening diaphragm has a larger area, so the force that tries to open the valve will be greater than the force that tries to close the valve. This will cause the valve to open.

The opening and closing of the anti-ice valve is alone by controlling the pressure on the opening diaphragm. This is done by the anti-ice controller.

Note the line from the anti-ice valve to the controller. If the control valve, in the controller is closed as shown, the pressure will buildup on the opening diaphragm of the anti-ice valve. This opens the valve.

If the control valve is open, the pressure going to the opening diaphragm will flow around the control valve and out the vent line to the cockpit. Under this condition, there will be no pressure buildup on the opening diaphragm and the anti-ice valve will stay closed.

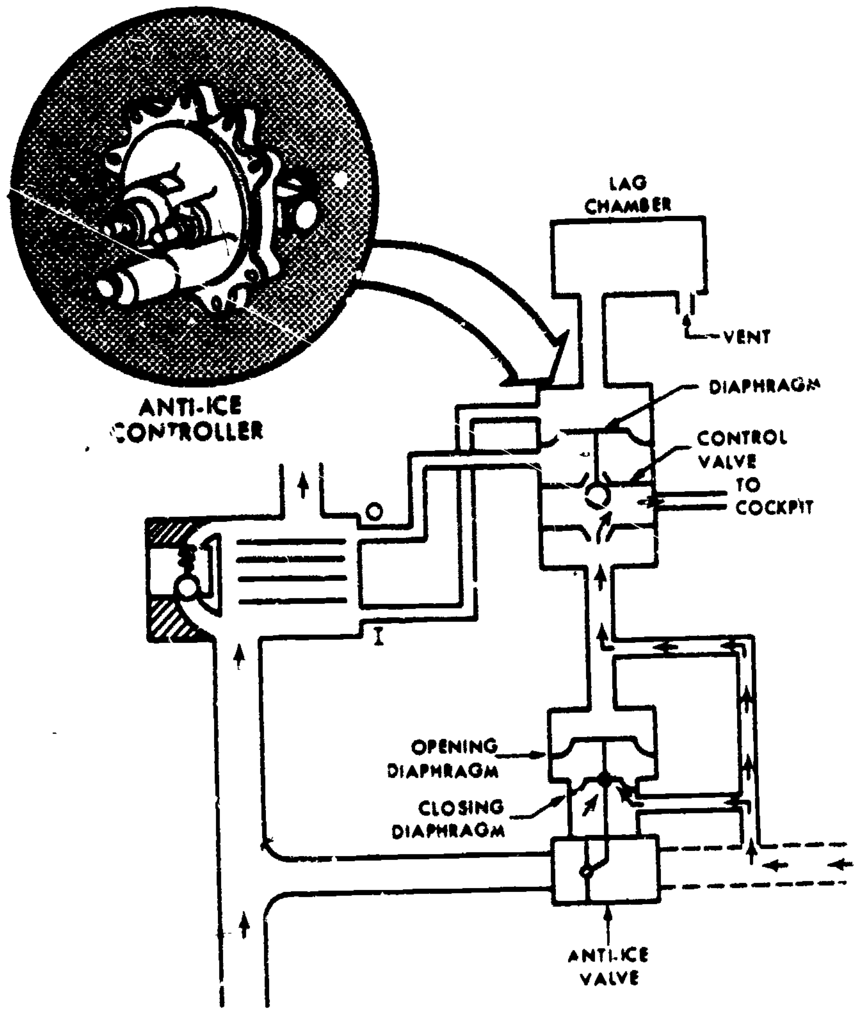
Fill in the blanks to complete the following statements.

1. The water separator anti-ice valve is operated ________________ (pneumatically/electrically).

2. The water separator anti-ice valve is controlled by the ____________ ____________________.

3. If the control valve in the anti-ice controller is open, the anti-ice valve will be ____________ (open/closed).

Now let's see how the controller will sense ice to direct the opening and closing of the anti-ice valve. Note the points marked O and I on the water separator illustration shown. These are sensing lines.



The line marked I will sense inlet pressure and the line marked O will sense outlet pressure. If there is no restriction (no ice), the pressure in these two sensing lines will be the same.

Now look at the diaphragm inside the controller. The diaphragm controls the position of the control valve which, in turn, controls the pressure on the opening diaphragm of the anti-ice valve.

With the same pressure in the two sensing lines, the pressure that comes in the controller will also be the same on each side of the diaphragm. Now note that the inlet pressure also goes to the lag chamber.

The lag chamber has a small bleed port (vent) where the inlet pressure can vent overboard. This will result in a lower pressure on the top of the

1316

Frame 27 (Cont'd)

controller diaphragm. The outlet pressure will force the diaphragm up holding the control valve open. This vents the pressure from the opening diaphragm, keeping the anti-ice valve closed.

Fill in the blanks to complete the following statements.

1. The anti-ice controller senses icing of the water separator by sensing a difference of ________________ in the water separator.

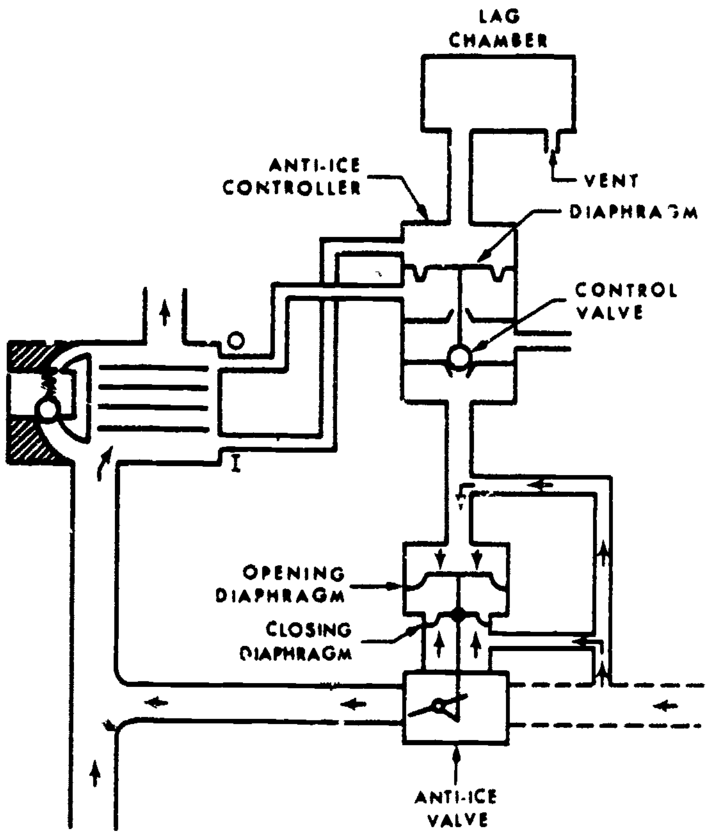
2. If the water separator inlet and outlet pressures are equal, the control valve in the anti-ice controller will be __________ (open/closed) and the anti-ice valve will be ___________ (open/closed).

When ice forms on the condensor, the flow of air through the water separator will be restricted. This will cause the inlet pressure to become greater than the outlet pressure.

The higher inlet pressure will force the controller diaphragm down which will move the control valve down. This stops the venting of air from the anti-ice valve opening diaphragm.

The pressure buildup on the opening diaphragm will open the anti-ice valve. The valve will stay open until the ice is removed and the pressure in the water separator equalizes.

The illustration below shows the anti-ice controller and anti-ice valve as it would be with ice on the water separator condensor.

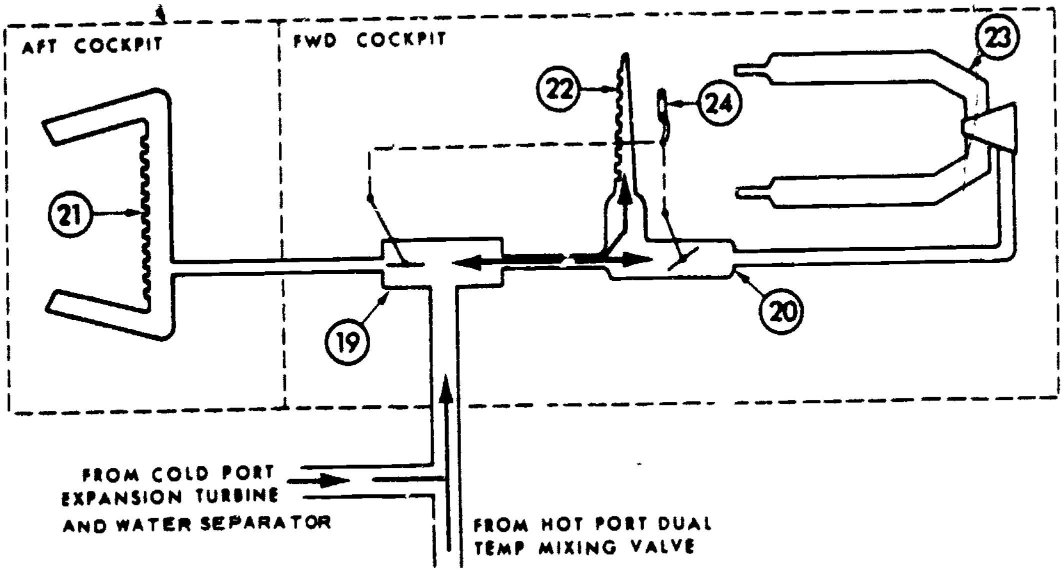


Fill in the blanks to complete the following statements.

1. If the water separator inlet pressure is greater than the outlet pressure, it will cause the anti-ice valve to _______ (open/close).
2. During operation of the air conditioning system, when full cold is demanded, excessive moisture (fog and snow) comes from the air outlets. This indicates a defective anti-ice ________ or anti-ice ___________.
3. If the water separator anti-ice system fails to operate and allow ice to accumulate on the condensor, the _____________ valve will open to allow airflow to the cockpit.

Frame 29

The cold air from the water separator will mix with hot air from the dual temperature mixing valve and then flow to the cockpit. The air that flows to the cockpit flows through a Cabin Air Inlet Valve (number 19 in the illustration shown) and a Foot Heat and Defog Valve (number 20).



These two valves are controlled by the Foot Heat and Defog Lever (number 24 in the illustration).

The cabin air inlet valve controls the amount of air going to the aft cockpit diffuser (number 21).

The foot heat and defog valve controls the air going either to the foot heat outlets (number 22) in the forward cockpit or to the windshield defogging tubes (number 23).

Find these parts in the illustration shown and note the path of airflow.

When windshield defogging is required, the cabin air inlet valve restricts the airflow going to the aft cockpit. The foot heat and defog valve directs the air to the windshield and, at the same time, reduces the airflow to the foot heat outlets.

Fill in the blanks to complete the following statements.

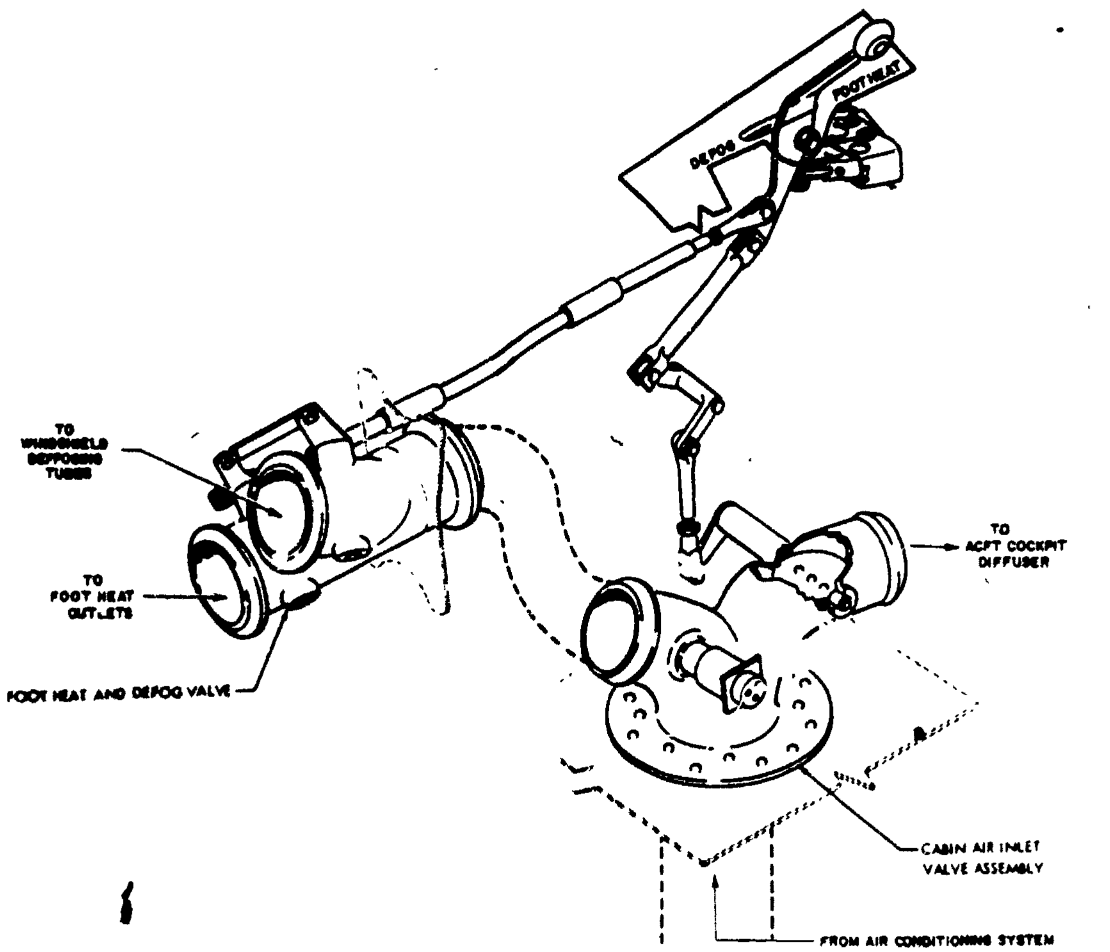
1. The unit that controls the amount of air going to the aft cockpit diffuser is the __________ __________ __________ valve.

2. The unit that directs the air to either the foot heat outlets or the defogging tubes is the __________ __________ and __________ valve.

The cabin air inlet valve and the foot heat and defog valve are connected to one manual control lever by mechanical linkage. This lever is called the <u>Foot Heat and Defog Lever</u>.

The foot heat and defog lever has two positions; they are the FOOT HEAT position and the DEFOG position.

The illustration below shows the valves, lever, and mechanical linkage.



Fill in the blanks to complete the following statements.

1. The positions of the foot heat and defog control lever are ________ ______________ and ______________.

2. The foot heat and defog valve and the cabin air inlet valve are connected to the same control ____________ by ___________ linkage.

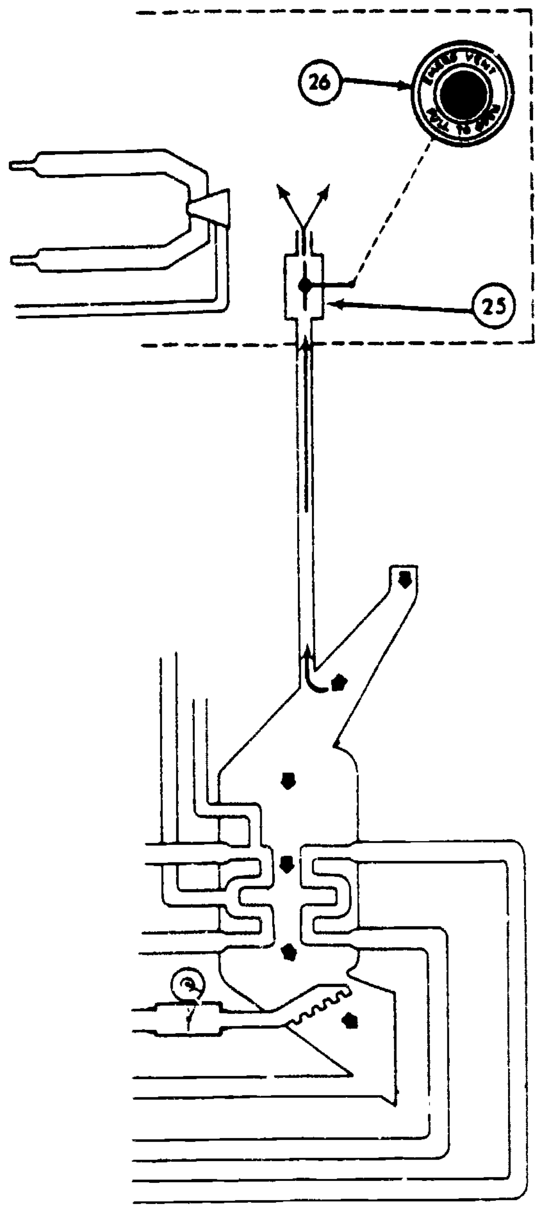
3. The foot heat and defog control lever controls the foot heat and defog valve and the __________ __________ ____________ valve.

Frame 31

If the air conditioning system fails to work while the aircraft is in flight, the pilot must have a means of receiving ventilating air.

It should be brought to mind that on the trainer aircraft air conditioning system a ram air valve was used for this purpose.

A ram air valve (number 25 in the illustration below) is also used on the fighter aircraft for this purpose.



Note in the illustration that air is tapped from the heat exchanger <u>ram air inlet</u> and ducted to the ram air valve in the cockpit.

When the ram air valve is open, the cabin air conditioning system is turned off. When the ram air valve is closed, the cabin air conditioning system is on.

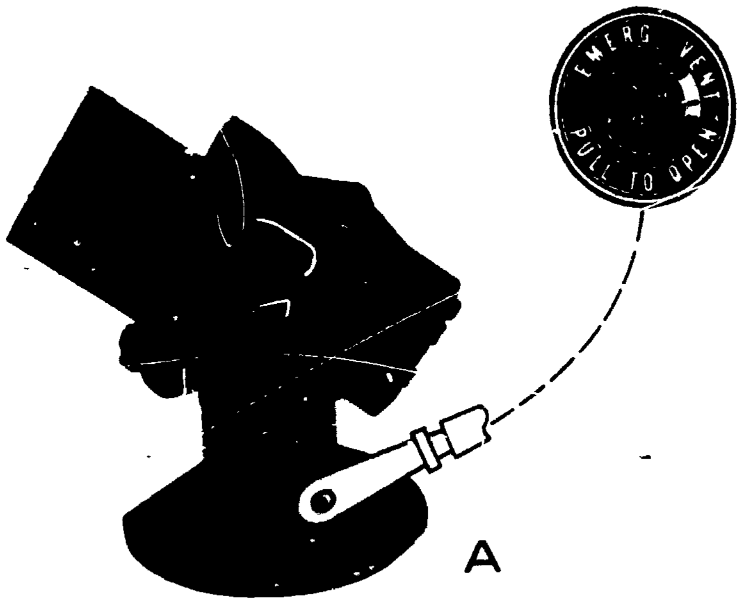
The <u>emergency vent knob</u> (number 26) controls the ram air valve and also the on and off action of the cabin air conditioning system.

Fill in the blanks to complete the following statements.

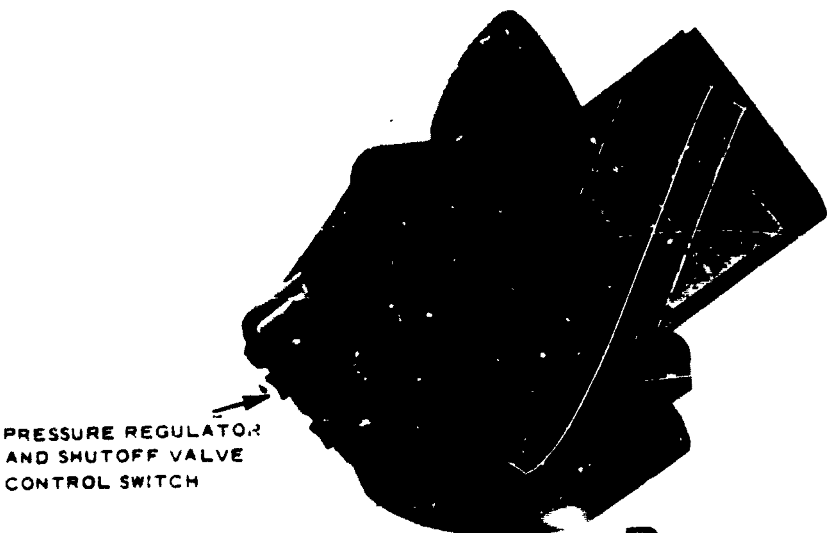
1. When emergency ventilation of the cockpit is desired, the ________ ____________ valve can be opened.

2. The ram air valve is controlled by the ________ ________ ________.

Illustration "A" shows the ram air valve. This valve is actuated mechanically by a cable connected to the emergency vent knob.



A



B

When the emergency vent knob is pulled out, it opens the ram air valve and also actuates a switch which shuts off the cabin air conditioning system.

Illustration "B" shows the switch as it is installed on the valve. When the emergency vent knob is pushed in, the ram air valve closes. This also completes a circuit through the switch to operate the air conditioning system.

Fill in the blanks to complete the following statements.

1. The ram air valve is controlled by the ____________ ____________ ____________.

2. The switch on the ram air valve controls the ______ ____________ system.

3. When the emergency vent knob is pulled out, the air conditioning system will be ________ (on/off).

1324

Frame 33

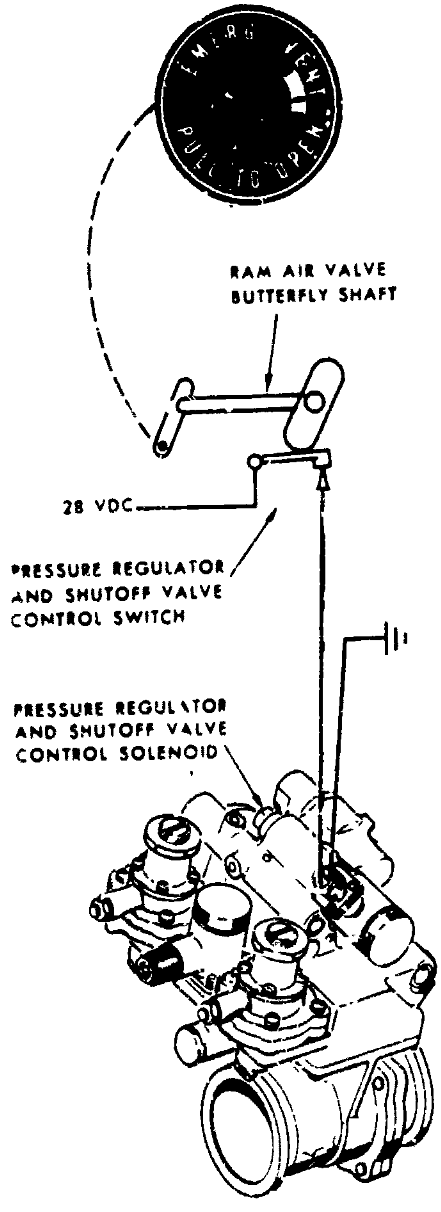
The emergency vent knob serves as the master control for the air conditioning and ventilation systems.

Recall from frame 4 that the pressure regulator and shutoff valve is controlled by a solenoid.

When the emergency vent knob is pushed in, the switch on the ram air valve directs 28-volts DC to energize this solenoid.

When the emergency vent knob is pulled out, the switch disconnects the electrical power from the solenoid.

Notice this control circuit in the illustration below.



Bleed Air Pressure Regulator
and Shutoff Valve

Remember, when the solenoid is energized the pressure regulator and shutoff valve is open, and when the solenoid is de-energized, the valve closes.

Fill in the blanks to complete the following statements.

1. The switch on the ram air valve controls the air conditioning system by controlling the ____________ on the pressure regulator and shutoff valve.

2. With air pressure in the bleed air system and the emergency vent control knob pushed in, the bleed air pressure regulator and shutoff will be ____________ (open/closed).

3. The solenoid on the bleed air pressure regulator and shutoff valve is controlled by a switch activated by the ____________ ____________.

1326
F ame 34

Match the units listed in Column "B" with the statements given in Column "A" by placing the letter from Column "B" in the blanks provided.

Column A		Column B
1. _____ Controls the ram air valve and the pressure regulator and shut-off valve.	A.	Cabin air inlet valve
2. _____ Allows ram air to enter the cockpit for emergency ventilation.	B.	Foot heat and defog valve
3. _____ Senses an icing condition in the water separator.	C.	Water separator
4. _____ Opens to direct warm air to the water separator for ice removal.	D.	Anti-ice valve
5. _____ Removes excess moisture from the conditioned air.	E.	Anti-ice controller
6. _____ Directs the conditioned air to either the foot heat outlets or the defog tubes.	F.	Emergency vent knob
7. _____ Directs conditioned air to the aft cockpit outlets when the control lever is in the foot heat position.	G.	Ram air valve

85

The units described in the preceding frame were either used to condition the bleed air or to control the bleed airflow for some specific purpose. The cabin dual temperature mixing valve controls the mixing of hot and cold air. But, how does the pilot actually control this valve?

Under normal conditions the pilot only has to select the temperature he desires and the control system will automatically control the valve. However, there are provisions for the pilot to manually control the temperature should the automatic system fail.

Fill in the blanks to complete the following statements.

1. The temperature control valves control temperature by mixing ______ and ______________ air.

2. The two methods of controlling the temperature of the air entering the cockpit are ______________________ or _________________.

1328
Frame 36

The illustration below shows a schematic diagram of the temperature control system. This system consists of the following components. The numbers correspond to the numbers on the diagram.

1. Temperature Control Panel

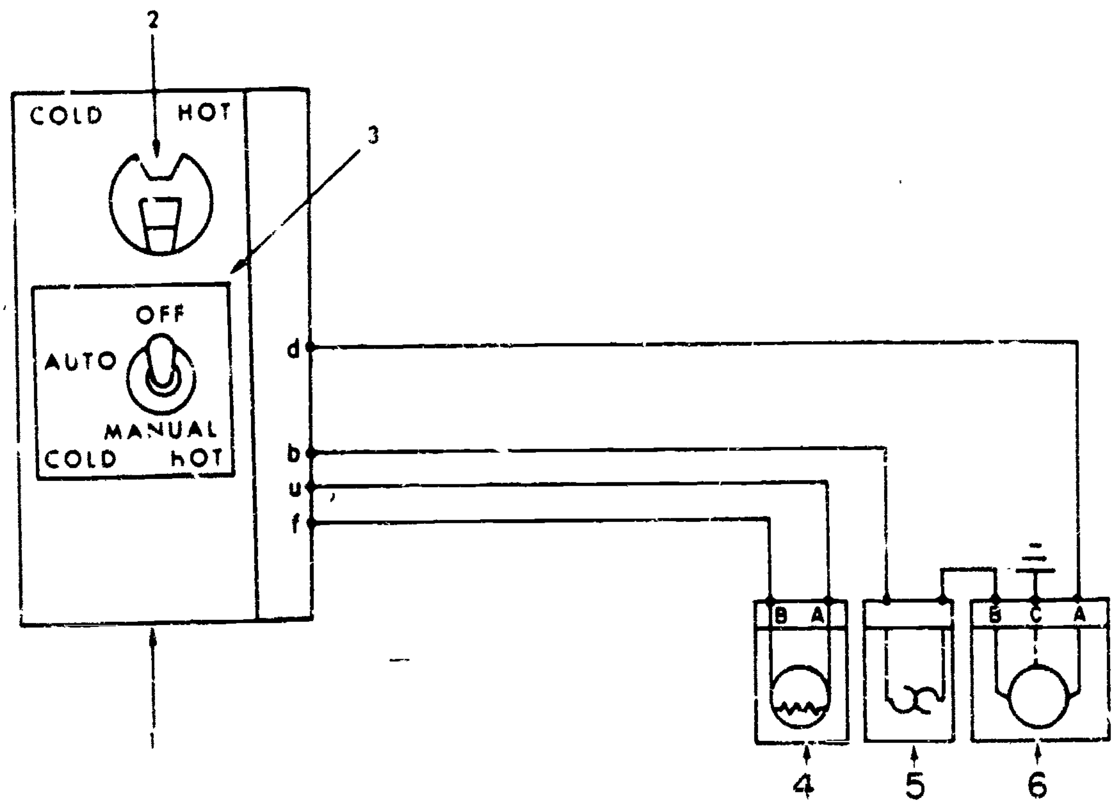
2. Temperature Selector (rheostat)

3. Temperature Control Switch

4. Cabin Temperature Sensor

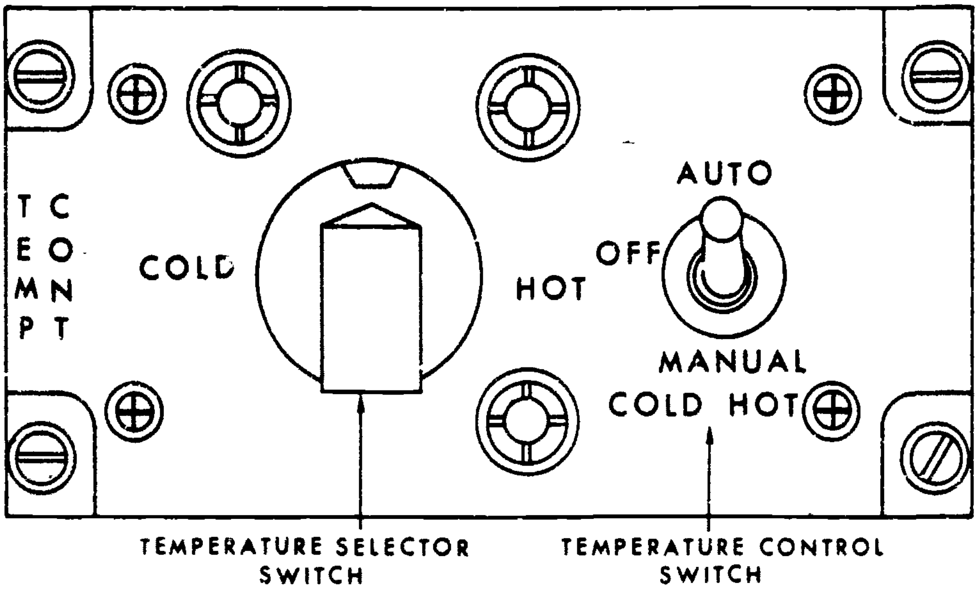
5. Cabin Manual Temperature Limiter

6. Cabin Dual Temperature Mixing Valve



NO RESPONSE REQUIRED

The temperature control panel is the main controlling unit in this system. It controls the temperature of the air entering the cockpit. The temperature control panel shown contains the temperature control switch, temperature selector switch, and a magnetic amplifier type temperature controller. (The magnetic amplifier circuit is the same one you studied in the lesson on magnetic amplifiers.)



The temperature control switch is used to select the mode of operation. The modes of operation are AUTO and MANUAL. The switch has four positions; AUTO, MANUAL HOT, MANUAL COLD, and OFF. The temperature selector switch is used to select the desired temperature during automatic operation.

Fill in the blanks to complete the following statements.

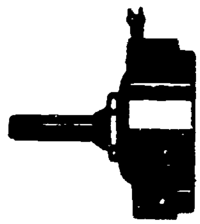
1. The temperature controller, temperature selector switch, and temperature control switch are each part of the ______________ ______________ ______________.

2. The temperature control panel controls the temperature for the ________________.

3. When the temperature control switch is in AUTO mode, the desired temperature can be selected by using the ______________ ______________ switch.

1330
Frame 38

The temperature selector switch is used to select the temperature for the cockpit. Remember temperature selectors are actually variable resistors, and are frequently called "temperature control rheostats." This unit is illustrated below.



Fill in the blanks to complete the following statements.

1. The temperature selector switch consists of a ______________.

2. The temperature selector switch is used to select the temperature for the ______________.

89

To control cockpit temperature automatically, requires a means of sensing the air temperature. This is the purpose of the cabin temperature sensor.

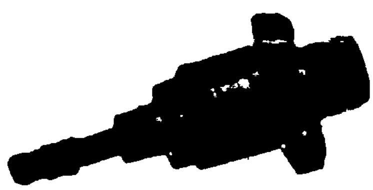
The sensor is located in the cabin air inlet valve (refer to frame 30). It senses the temperature of the air entering the cockpit.

The cabin temperature sensor and the cabin rheostat each form a part of the cabin temperature control bridge circuit.

The cabin sensor has a negative coefficient of resistance. An increase in air temperature causes a decrease in sensor resistance.

This, in turn, sets up a signal on the bridge circuit that will cause the temperature control panel to position the cabin dual temperature mixing valve for more cold air.

An increase in sensor resistance will call for hot air. The cabin sensor is shown in the illustration below.



Cabin Temperature Sensor

Fill in the blanks to complete the following statements.

1. A decrease in air temperature at the cabin air inlet valve will cause the cabin temperature sensor resistance to ____________.

2. When the temperature of the air entering the cockpit changes, the cabin ______ ____________ ____________ sends a signal to the temperature control panel.

3. The cabin sensor has a ____________ coefficient of resistance.

Frame 40

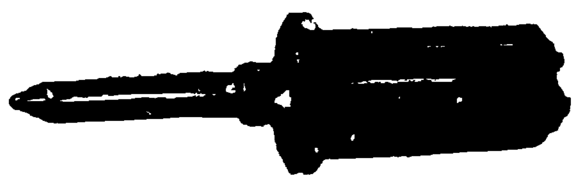
While in normal operation the cockpit temperature is controlled automatically. However, if the automatic system fails, the pilot can control the system manually.

In manual operation if more cold air is needed, the pilot holds the temperature control switch to manual cold. This will cause the cabin dual temperature mixing valve to move toward closed.

If more hot air is needed, the pilot holds the temperature control switch in manual hot which will cause the cabin dual temperature mixing valve to move toward open.

When manual hot is used it is possible to cause an excessive amount of hot air to flow through the system. This in turn could cause damage within the system due to overheating.

A safety device is used to prevent this. This unit is the cabin manual temperature limiter. It is a normally closed thermoswitch. This part is shown below.



Cabin Manual Temperature Limiter

The switch contacts are closed under all normal conditions. But, should the temperature of the air flowing through the air conditioning ducting exceed a preset temperature (220°F), then the switch contacts will open. This opens the electrical circuit going to the hot side of the cabin dual temperature mixing valve. This will stop the valve from going any further toward hot. The valve will only run toward the cold position.

Fill in the blanks to complete the following statements.

1. During manual operation, if more cold air is desired, the pilot must hold the _____ __________ ________________ switch to MANUAL COLD.

2. The unit that prevents the system from becoming too hot during manual operation is the cabin _____________ ____________________ __________________.

Match the units listed in Column "B" with the statements given in Column "A." Place the letter that corresponds to the unit in the blanks provided in Column "A."

Column A		Column B	
1. ____	Used to select either AUTO or MANUAL modes for controlling temperature.	A.	Temperature Control Panel
2. ____	Used to select the desired temperature during AUTO mode.	B.	Temperature Selector Switch
3. ____	Contains a magnetic amplifier type temperature controller.	C.	Temperature Control Switch
4. ____	Senses cockpit temperature during automatic operation.	D.	Cabin Temperature Sensor
5. ____	Prevents the cabin air conditioning system from becoming too hot during manual operation.	E.	Cabin Manual Temperature Limiter
6. ____	Controls the mixing of hot and cold air for cockpit temperature control.	F.	Cabin Dual Temperature Mixing Valve

1334

Frame 42

The preceding frames on temperature control have described the temperature control components and given their purpose. The electrical circuits for control of this system will be given in the next text.

As you work with the temperature control system you should be aware of the difference between the manual temperature control system and the automatic temperature control system.

What is this difference? The automatic temperature control system consists of the following components: Temperature control panel (temperature controller and rheostat), and the temperature sensor. These components control the cabin dual temperature mixing valve <u>only</u> during automatic operation.

When using manual mode, the temperature mixing valve is controlled directly by the temperature control switch. The cabin dual temperature mixing valve is the only common component to both the AUTO and MANUAL systems.

In other words, the automatic and manual systems work independently and problems in one system do not necessarily affect the other. This will be an important point to remember when you start performing system troubleshooting in your next lessons.

NO RESPONSE REQUIRED

Before continuing with this lesson, inform your instructor that you are going to the lab to look at the trainer. Now, report to the lab. Inform the lab instructor that you would like to look at trainer 3305, F-4C Environmental Systems. Using this trainer, perform the steps listed below.

1. Locate the following items.

    a. Bleed Air Pressure Regulator and Shutoff Valve.

    b. Ground Cooling Ejector Shutoff Valve.

    c. Turbine Overspeed Pressure Switch.

    d. Cabin Dual Temperature Mixing Valve.

    e. Foot Heat and Defog Valve.

    f. Emergency Vent Knob.

    g. Ram Air Valve (Emergency Vent Air Inlet Valve).

    h. Temperature Controller.

        (1) Temperature Control Switch.

        (2) Temperature Selector Switch.

    i. Cabin Temperature Sensor.

    j. Cabin Manual Temperature Limiter.

    k. Foot Heat and Defog Lever.

    Note: Were you able to locate each item? If not, ask the lab instructor for assistance.

2. Trace the airflow for cabin air conditioning.

    a. Start in the lower left corner and trace from the air source to the bleed air pressure regulator and shutoff valve. From the shutoff valve, trace the airflow to the ground cooling ejector shutoff valve and to the main heat exchanger.

    b. From the heat exchanger follow the orange line going to the pressure switch, through the flow limiting venturi, through the cabin dual temperature mixing valve and to the cooling turbine assembly. This air is entering the <u>compressor</u> turbine.

    c. From the compressor turbine follow the red line to the heat exchanger and the orange line back to the expansion turbine. This path provides cold air.

1336

Frame 43 (Cont'd)

d. Go back to the pressure regulator and shutoff valve. Trace the dark red line going to the cabin dual temperature mixing valve hot air port. Trace airflow from the mixing valve to the point where the air from the hot air port and the air from the expansion turbine join (mix). The air flowing from this point, through the blue line, goes to the cabin. This is temperature controlled, conditioned air.

e. Trace the blue line to the cabin air inlet valve. From here the air can flow to the aft cockpit diffuser and to the forward cockpit foot heat outlets. If the foot heat and defog lever is positioned to the DEFOG position (right) the air will flow through the windshield and canopy defog ducts only.

4. Before answering the questions below, report back to your classroom.

Place a T (True) in the blanks to indicate which statements are True, and an F (False) to indicate a false statement.

_____ a. The ram air valve is actuated by the emergency vent knob.

_____ b. The switch located on the ram air valve controls the bleed air pressure regulator and shutoff valve solenoid.

_____ c. The foot heat and defog lever actuates the butterflies in the cabin air inlet valve only.

_____ d. The pressure regulator and shutoff valve is actuated by a pneumatic actuator.

Part I

Using the illustration on foldout number 1, (attached to the back of this text), match the names of the components listed below with the components shown on the illustration. Place the letter that identifies the component in the blank space provided opposite the name.

1. _____ Ground Cooling Ejector Nozzle

2. _____ Trubine Overspeed Pressure Switch

3. _____ Cabin Dual Temperature Mixing Valve

4. _____ Pressure Regulator and Shutoff Valve

5. _____ Ground Cooling Ejector Valve

6. _____ Rupture Disc (location)

7. _____ Water Separator

8. _____ Foot Heat and Defog Valve

9. _____ Anti-ice Controller

10. _____ Anti-ice Valve

11. _____ Compressor Turbine

12. _____ Expansion Turbine

13. _____ Ram Air Valve

14. _____ Lag Chamber

15. _____ Flow Limiting Venturi

16. _____ Heat Exchanger (primary section)

17. _____ Heat Exchanger (secondary section)

18. _____ Cabin Air Inlet Valve

1338
Frame 44 (Cont'd)

Part II

Using foldout number 1, match the component with it's operation as given below. Place the letter that identifies the component in the blank space opposite the statements.

1. _____ Through the use of solenoids, diaphragms, and air pressure, it regulates air flow going to the air conditioning system at 62 psi.

2. _____ It has one motor that positions two butterflies in response to temperature changes thereby controlling the mixing of hot and cold air for cockpit use.

3. _____ A butterfly valve that is moved by mechanical linkage to the open position when emergency ventilating air is needed.

4. _____ Made up of several small outlets that will cause engine bleed air to create a low pressure area in the heat exchanger ram air exhaust and increase the ram air flow across the heat exchanger.

5. _____ Uses the principle of decreasing air pressure and increasing air velocity across it's throat to stop air surges going into the turbine and prevent a complete loss of air flow if the rupture disc cracked open.

6. _____ A butterfly valve controlled by diaphragms and operated by air pressure to the open position to prevent freezing of the water seperator.

7. _____ A motor operated butterfly valve that will be opened when the landing gear are down to allow bleed air to flow through the ground ejector nozzles.

8. _____ A butterfly valve that is opened by mechanical linkage to let air into the aft cockpit diffuser.

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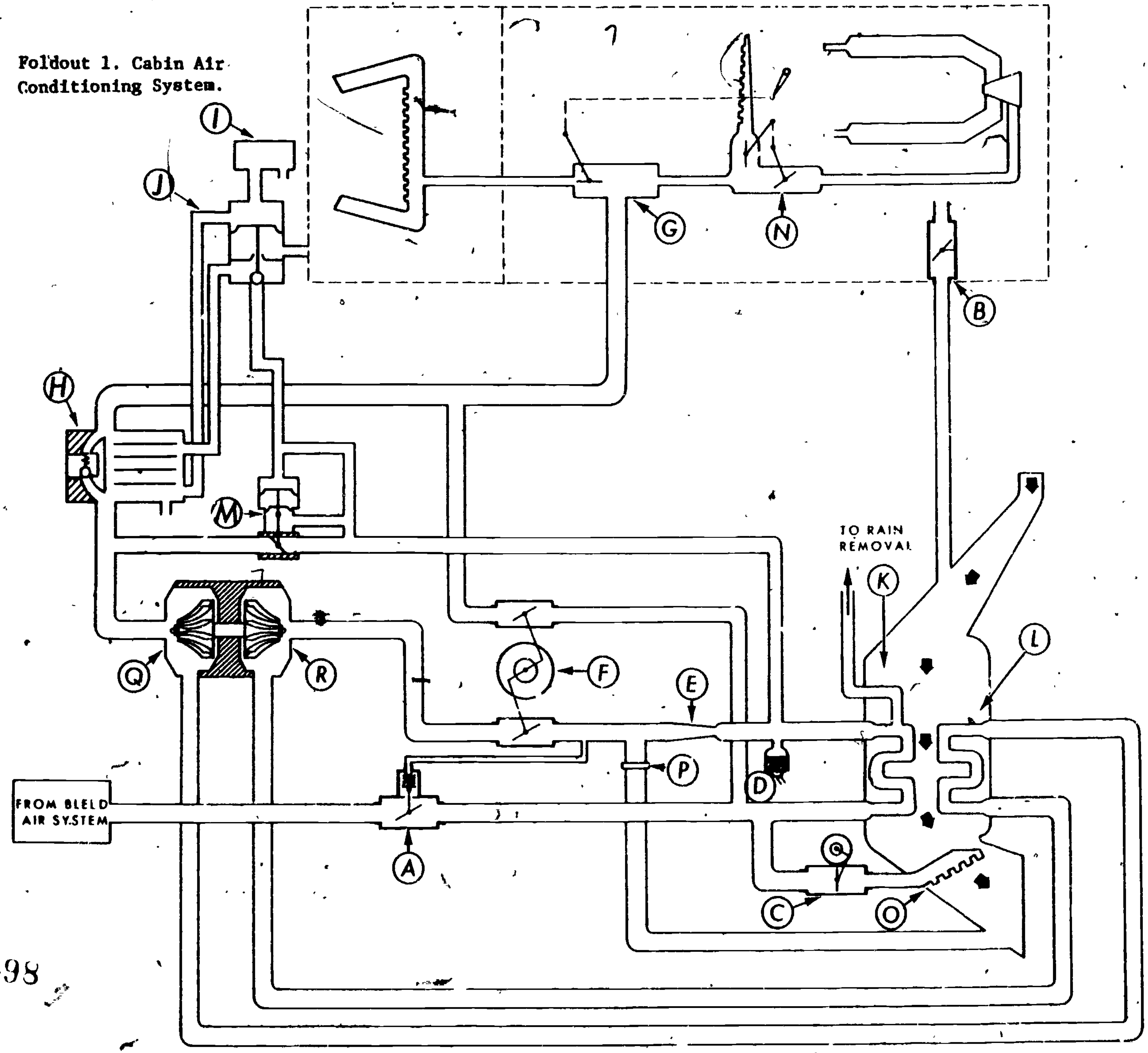
Foldout 1. Cabin Air Conditioning System.



1340

Correct Responses to the Frames

Frame 1
1. windshield, canopy
2. electronic
3. crew
4. engines

Frame 3
1. shutoff valve
2. pressure regulator

Frame 4
1. solenoid
2. air pressure
3. air pressure, electrical
4. pressure regulator shutoff valve

Frame 5
1. primary, secondary
2. primary

Frame 6
1. cockpit, rain
2. ram
3. secondary

Frame 7
1. ejector valve
2. shutoff valve, nozzle

Frame 8
1. ejector shutoff valve
2. landing gear handle
3. down

Frame 9
1. bleed
2. low pressure

Frame 10

1. C	6. B
2. A	7. A
3. D	8. open
4. C	9. pneumatic actuator
5. A	10. pressure, shutoff

Frame 11
1. pressure switch, rupture disk
2. overspeed pressure switch

Frame 12
1. turbine overspeed pressure switch
2. pilot
3. bleed air pressure regulator and shutoff valve

Frame 13
1. rupture disc
2. ram air outlet

Frame 14
1. limiting venturi
2. flow limiting venturi

Frame 15
1. dual temperature mixing valve
2. closed, open

Frame 16
1. hot, cold
2. motor
3. mechanical linkage

Frame 17
1. compressor, expansion
2. primary
3. secondary

Frame 18
1. expansion turbine
2. expansion, heat, mechanical

Frame 19
1. a. overspeeding
   b. workload
   c. compress

Frame 20
1. primary
2. compressor turbine
3. secondary, expansion turbine
4. expansion, efficiently

Frame 22

1. C	6. T	11. T
2. E	7. F	
3. D	8. T	
4. B	9. F	
5. A	10. T	

Frame 23
1. water separator
2. cold, expansion turbine

Frame 24
1. condensor, bypass
2. spring tension
3. air pressure

Frame 25
1. controller, valve
2. warm
3. primary

Frame 26
1. pneumatically
2. anti-ice controller
3. closed

Frame 27
1. pressure
2. open, closed

Frame 28
1. open
2. valve, controller
3. bypass

Frame 29
1. cabin air inlet
2. foot heat, defog

Frame 30
1. foot heat, defog
2. lever, mechanical
3. cabin air inlet

Frame 31
1. ram air
2. emergency vent knob

Frame 32
1. emergency vent knob
2. air conditioning
3. off

Frame 33
1. solenoid
2. open
3. emergency vent knob

Frame 34
1. F 5. C
2. G 6. I
3. E 7. A
4. D

Frame 35
1. hot, cold
2. automatically, manually

Frame 37
1. temperature control panel
2. cockpit
3. temperature selector

Frame 38
1. rheostat
2. cockpit

Frame 39
1. increase
2. temperature sensor
3. negative

Frame 40
1. temperature control
2. manual temperature limiter

Frame 41
1. C 4. D
2. B 5. E
3. A 6. F

Frame 43
1. T
2. T
3. F
4. T

Frame 44
Part I
1. O 10. M
2. D 11. R
3. F 12. Q
4. A 13. B
5. C 14. I
6. P 15. E
7. H 16. K
8. N 17. L
9. J 18. G

Part II
1. A 5. E
2. F 6. M
3. B 7. C
4. O 8. G

1342

WORKBOOK
3ABR42331-WB-201

Technical Training

Aircraft Environmental System Repairman

FIGHTER CABIN AIR CONDITIONING SYSTEM WIRING DIAGRAM

20 April 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

1343

Environmental Pneudraulics Branch 3ABR42331-WB-201
Chanute AFB, Illinois

FIGHTER CABIN AIR CONDITIONING SYSTEM WIRING DIAGRAM

OBJECTIVES

1. Identify cabin air conditioning system component operation with a minimum of 80% accuracy.

2. Using a wiring diagram identify causes of eight of ten given air conditioning system troubles.

EQUIPMENT

	Basis of Issue
Tape and Tape Player	1/student
Workbook 3ABR42331-WB-201	1/student

PROCEDURE

Information on the purpose and operation of the fighter air conditioning system components and the procedures for you to follow when using this workbook are given by tape recorded instructions. As you listen to the recording you will be given information on the air conditioning system operation and directions to follow for tracing the electrical circuits. Listen to the recording until the speaker tells you to turn it off. The speaker will tell you when you are to trace a circuit or to answer questions given in the workbook. Your instructor will show you how to install the tape and how to operate the tape player. Pay close attention to all directions that you are given on the tape. When tracing circuits or answering questions in this workbook, if your responses are incorrect, restudy the information or reverse the tape and listen to the instructions again. After completing this lesson you will be required to solve ten problems which are given at the back of the text. If you are ready to begin, and the instructor has already briefed you, turn on the tape player.

Supersedes 3ABR42231-WB-201, 24 October 1972.
OPR: 3370TTG
DISTRIBUTION: X
3370TTGTC - 600; TTVSR - 1

Fill in the blanks to complete the following statements.

1. The bleed air pressure regulator and shutoff valve is controlled by the ________________ ________________ ________________.

2. When the emergency vent knob is pushed in, the bleed air pressure regulator is ________________ (energized/deenergized).

3. The bleed air pressure regulator controls airflow to the ________________ ________________ ________________ system.

4. The ground cooling ejector shutoff valve is actuated open when the landing gear handle is placed in the ________________ ________________ position.

5. The ground cooling ejector shutoff valve requires ________________ ________________ ________________ to operate.

6. The ground cooling ejector shutoff valve is actuated closed when the landing gear handle is placed in the ________________ ________________ ________________ position.

Turn on the tape recorder.

7. The temperature control system has an ________________ and ________________ mode of operation.

8. The magnetic amplifiers, transistors, temperature control switch, and temperature selector switch are located in the ________________ ________________.

1345

9. If the resistance of the sensor goes down, the automatic temperature control circuit will call for ______________________ air.

10. The cabin temperature sensor is used only when in the ______________________ mode of temperature control.

11. The cabin temperature sensor makes up part of the ______________________ circuit.

12. The cabin manual temperature limiter will affect operation of the ______________________
______________________.

13. The cabin manual temperature limiter is a normally ______________________ (open/closed) switch.

Turn the tape recorder ON.

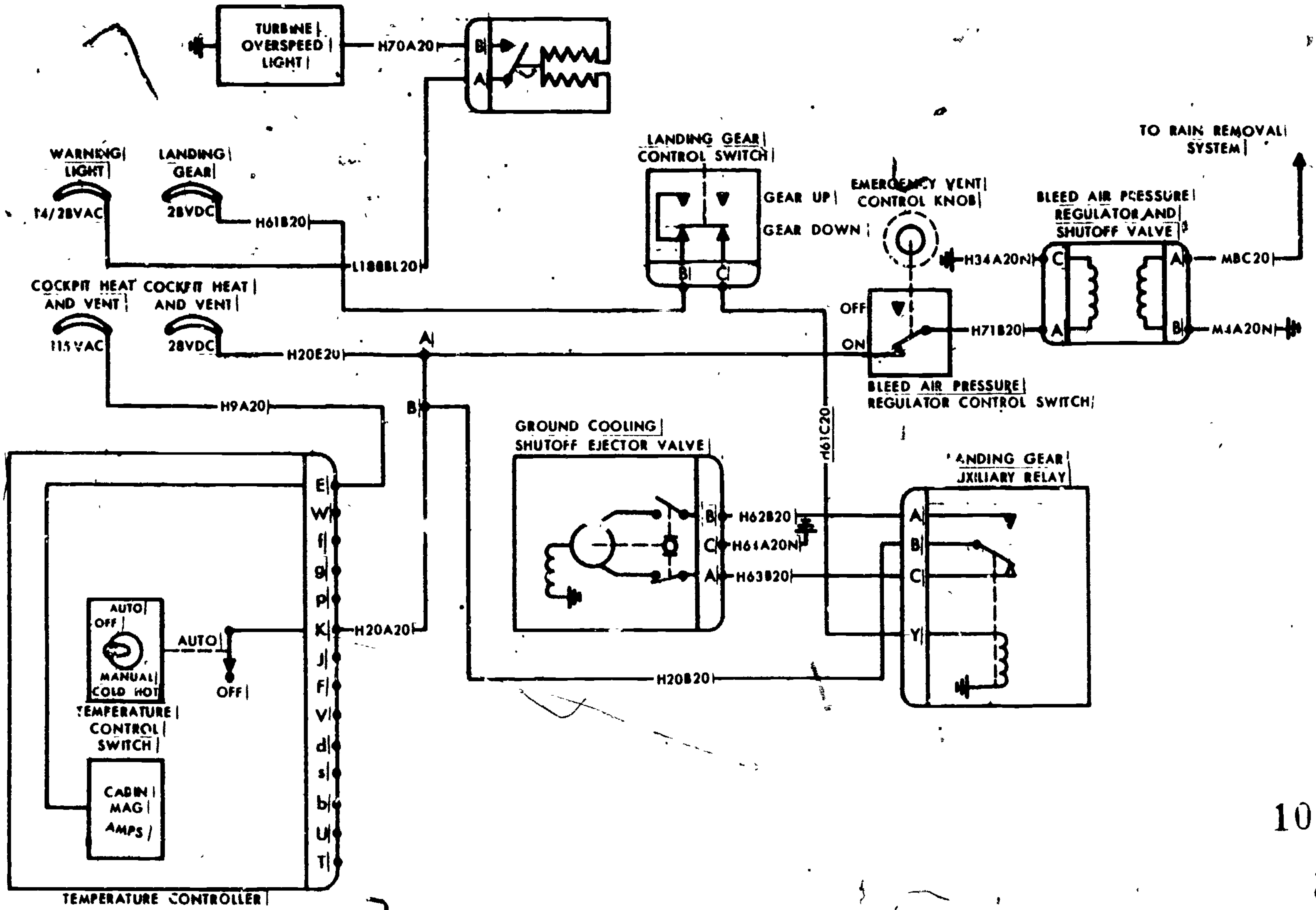


Figure 1. Power Supply Circuits.

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1346

1. AC power is needed only when using ______________________ mode of temperature control.

2. The ground cooling ejector shutoff valve opens when the landing gear handle is in the

______________ ______________ position.

3. __________ __________ __________ power is supplied to the temperature control switch.

4. If wire number H20A20 were open, it would cause the ______________ ______________ to be inoperative.

5. If wire number H20B20 were open, it would affect the ______________ ______________

______________ ______________ ______________.

6. If wire number H9A20 were open, it would affect the ______________ mode of operation.

7. The entire system is inoperative, the most probable cause will be an open in wire number ________.

8. If wire number H61C20 were open, the valve that would be affected is the __________ __________

______________ ______________ ______________ and it would run ______________.

9. If wire number H71B20 were open, the bleed air pressure regulator and shutoff valve would

______________ (open/close).

After tracing the circuits on figure 5, turn the tape recorder ON.

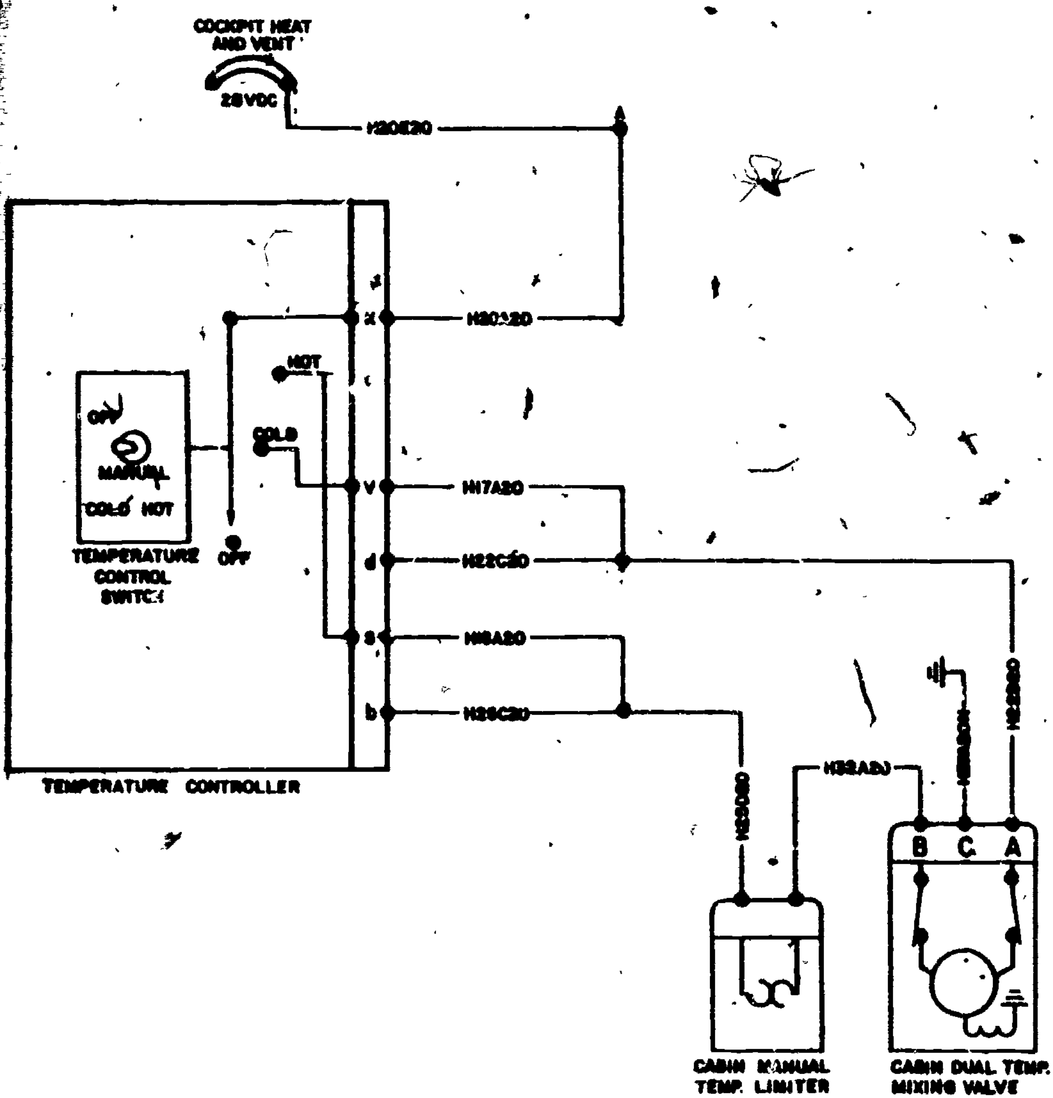

Figure 2. Cabin Mixing Valve, Manual Circuits.

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1. When the temperature control switch is placed in manual hot or cold, ________________ volts DC is supplied to the cabin dual temperature mixing valve.

2. If wire number H25D20 were open, the cabin dual temperature mixing valve could only be run to the ________________ or ________________ position.

3. If wire number H22D20 were open, only manual ________________ could be selected.

4. The cabin temperature limiter is a normally ________________ switch.

5. The cabin dual temperature mixing valve failed to open or close, one probable cause would be wire number ________________ or ________________.

After tracing the circuits on figure 5, turn the tape recorder ON.

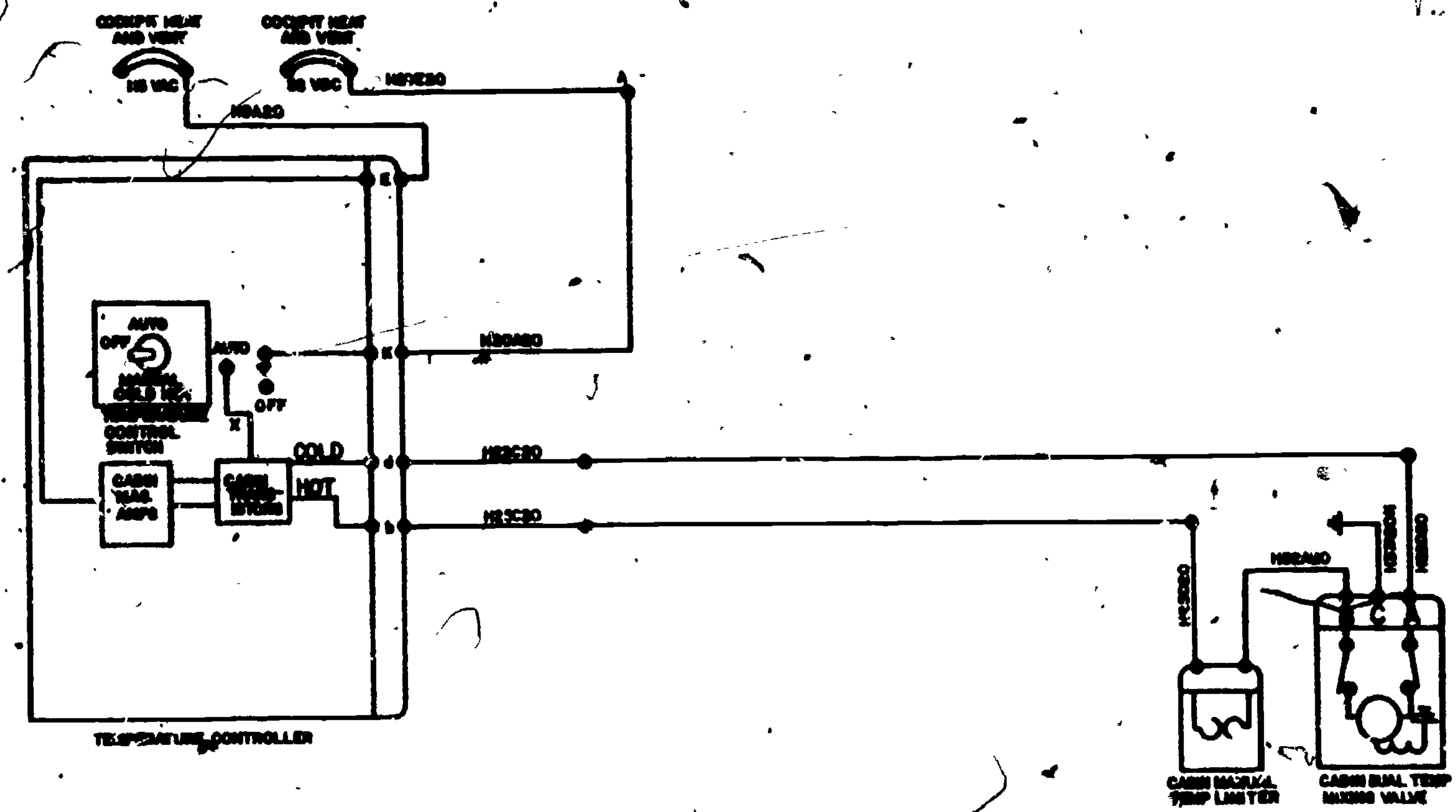

Figure 3. Cabin Mixing Valve, Automatic Circuits.

1. In automatic, the cabin temperature mixing valve receives power when the ____________ transistors are conducting.

2. The cabin transistors receive DC power when the temperature control switch is placed in

____________ position.

3. In order for the system to operate in automatic, 115 volts must be applied to the ____________

____________.

4. If the cabin manual temperature limiter were open, the valve that would be affected would be the

____________.

5. If wire number H22C20 were open, the cabin temperature could only go to the ____________ position.

6. If the wire were open at junction point X, ____________ temperature control would be inoperative.

7. The signal that determines if the hot or cold transistors will conduct in the automatic mode comes

from the ____________ circuit.

After tracing the circuits on figure 5, turn the tape recorder ON.

1. The pilot can automatically change the temperature in the cabin by changing the position of the

______________________ ______________________ ______________.

2. The cabin temperature sensor senses the temperature of the air ______________________ (entering/leaving) the cabin area.

3. An open in the sensor circuit will cause the system to call for ______________________ air.

4. A short in the temperature selector-circuit will cause the system to call for ______________________ air.

Turn the tape recorder ON.

11

1353

Listed below are fifteen (15) questions pertaining to the wiring diagram you have just completed. Follow the directions for each part. When you have completed, turn the tape recorder on.

Place a T for True or an F for False in the blank provided for each statement.

____ 1. The automatic and manual temperature control switch is used to select the desired temperature in automatic.

____ 2. AC and DC power is required to operate the cabin temperature control system in the automatic mode.

____ 3. Only DC power is required to operate the temperature control system in manual mode.

____ 4. The cabin manual temperature limiter has a positive coefficient of resistance.

____ 5. The ground cooling ejector valve helps draw ram air to flow across the heat exchanger when the aircraft is on the ground.

For questions 6 through 10 below, fill in the blanks.

6. A sensing element in which the resistance goes down when the temperature goes up is said to have a ____________________ coefficient of resistance.

7. The cabin transistors will conduct when using the ____________ ____________ mode.

8. The cabin temperature sensor has a ____________________ coefficient of resistance.

9. A short in a negative coefficient element would cause a ____________________ resistance in the element. This would cause a demand for ____________________ air.

10. ____________________ and ____________________ power is needed for automatic operation of the cabin system.

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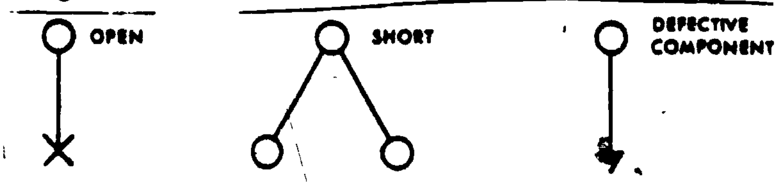
Select the description from column B and place in the blank beside the component it best describes.

	A		B
____11.	Temperature control switch	a.	Contains the selectors and switches for operation of the cabin temperature control system.
____12.	Landing gear control switch	b.	Controls the maximum temperature in the sys.
____13.	Temperature controller	c.	Supplies power to the cabin dual temp mixing valves.
____14.	Cabin temperature sensor	d.	Controls the operation of the ground cooling ejector shutoff valve.
____15.	Cabin manual temp limiter	e.	Controls the operation of the bleed air pressure regulator and shutoff valve.
		f.	Has a negative coefficient of resistance.

1355

Match the following malfunctions with the numbered troubles on the diagram (figure 4).



A._____ Ground cooling ejector shutoff valve will not open.

B._____ No automatic operation of the cabin temperature control systems. Manual control works OK.

C._____ Cabin temperature goes full hot when the control switch is placed in AUTO.

D._____ No bleed air available to the air conditioning system.

E._____ No operation of the cabin temperature control valve in automatic or manual.

F._____ Full cold air to the cabin in automatic even when selecting hot.

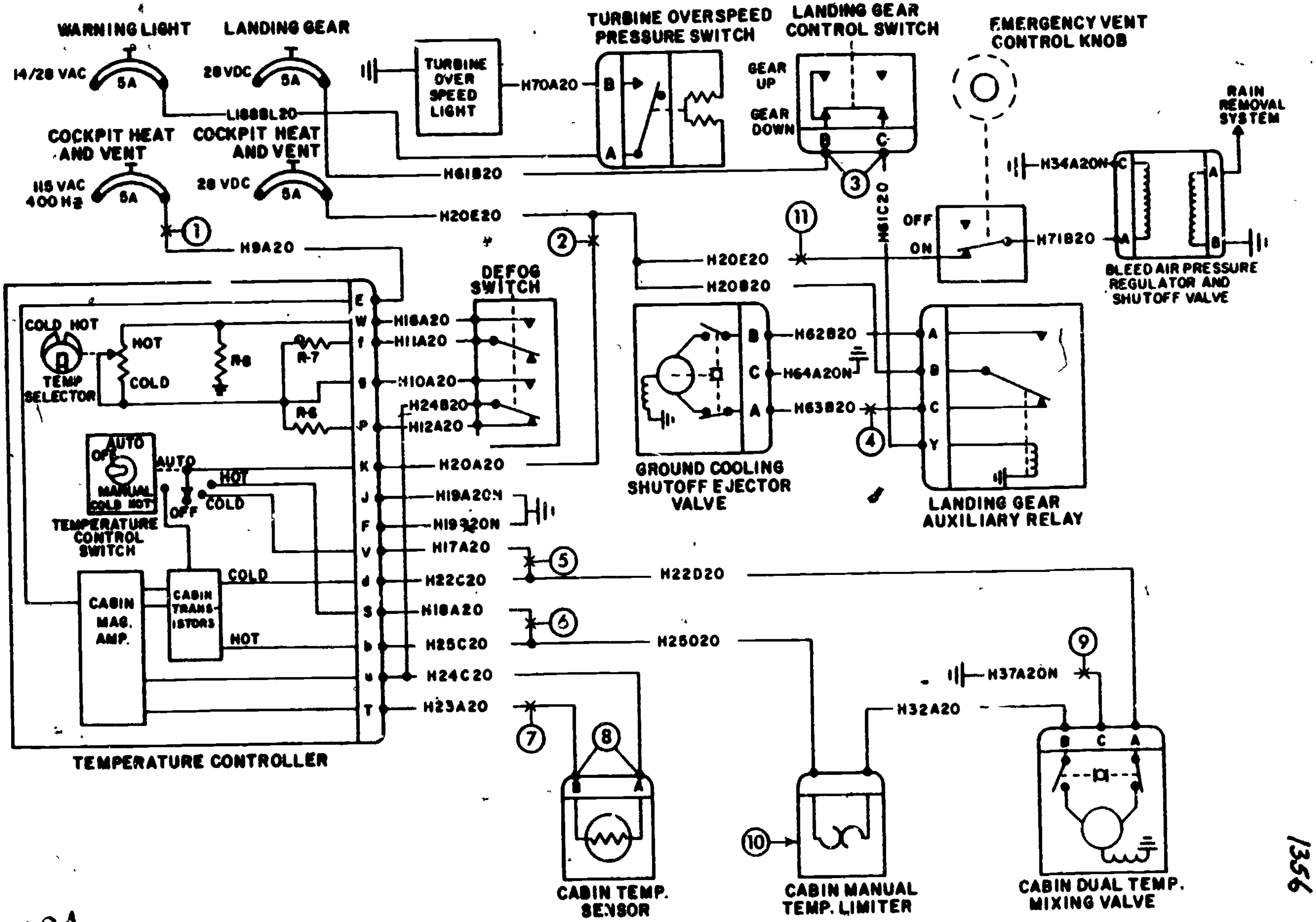
G._____ Ground cooling ejector shutoff valve will not close in flight.

H._____ Unable to get hot air in either AUTO or MANUAL modes.

I._____ The cabin dual temperature mixing valve will not operate when the temp control switch is placed in manual Cold. Automatic works OK.

This completes your study of the Fighter Wiring Diagram. Turn on the tape recorder for the correct answers. Make any corrections necessary before continuing with the next text.

123



15

1356

Figure 4. Wiring Diagram Fighter Air Conditioning System.

1357

16

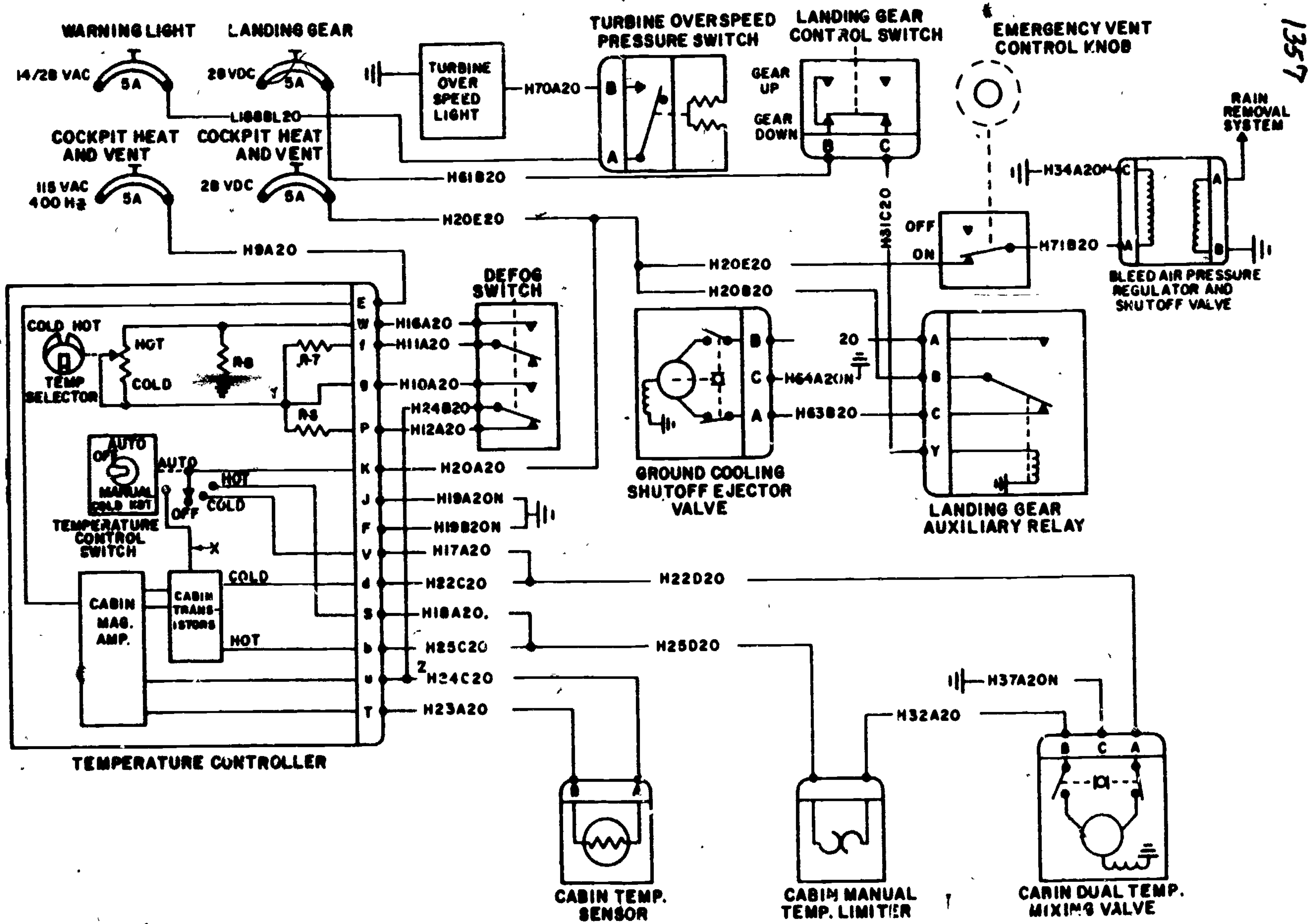


Figure 5. Wiring Diagram Fighter Air Conditioning System.

1358

WORKBOOK
3ABR42331-WB-201A

Technical Training

Aircraft Environmental Systems Mechanic

FIGHTER CABIN AIR CONDITIONING SYSTEM TROUBLESHOOTING

30 November 1976

USAF SCHOOL OF APPLIED AEROSPACE SCIENCES
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

1359

Environmental Pneudraulics Branch 3ABR42331-WB-201A
Chanute AFB, Illinois

FIGHTER CABIN AIR CONDITIONING SYSTEM TROUBLESHOOTING

OBJECTIVE

Using a multimeter and wiring diagram, perform an operational check and troubleshoot the bleed air and cabin air conditioning system trainer, locating 7 out of 9 troubles correctly.

EQUIPMENT

	Basis of Issue
Trainer 3305, Fighter Air Conditioning	1/student
Multimeter AN/PSM-6	1/student

PROCEDURE

1. Remove all of your jewelry. Report to the lab instructor and inform him of the lesson on which you are working. The instructor will assign you to a trainer and provide the necessary materials.

2. This workbook is presented in two sections. Section 1 is to familiarize you with the components of the cabin air conditioning system and to prepare you for performing the operational check and troubleshooting. Section 2 contains the steps for operationally checking the system and the malfunctions that you are to troubleshoot. Perform each step as directed on the following pages.

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3370 TTG/TTM - 250; TTVSR - 1

SECTION 1. CABIN AIR CONDITIONING SYSTEM COMPONENTS

1. Location and identification of system components.

a. Using the trainer and the illustration in figure 1, locate each of the numbered items. Write the name of each of these numbered items in the blank space. As you locate each component, notice the check point near the component that is used for checking the electrical circuitry.

(1) ____________________

(2) ____________________

(3) ____________________

(4) ____________________

(5) ____________________

(6) ____________________

(7) ____________________

(8) ____________________

(9) ____________________

(10) ____________________

COMPARE YOUR ANSWERS TO THOSE ON PAGE 5.

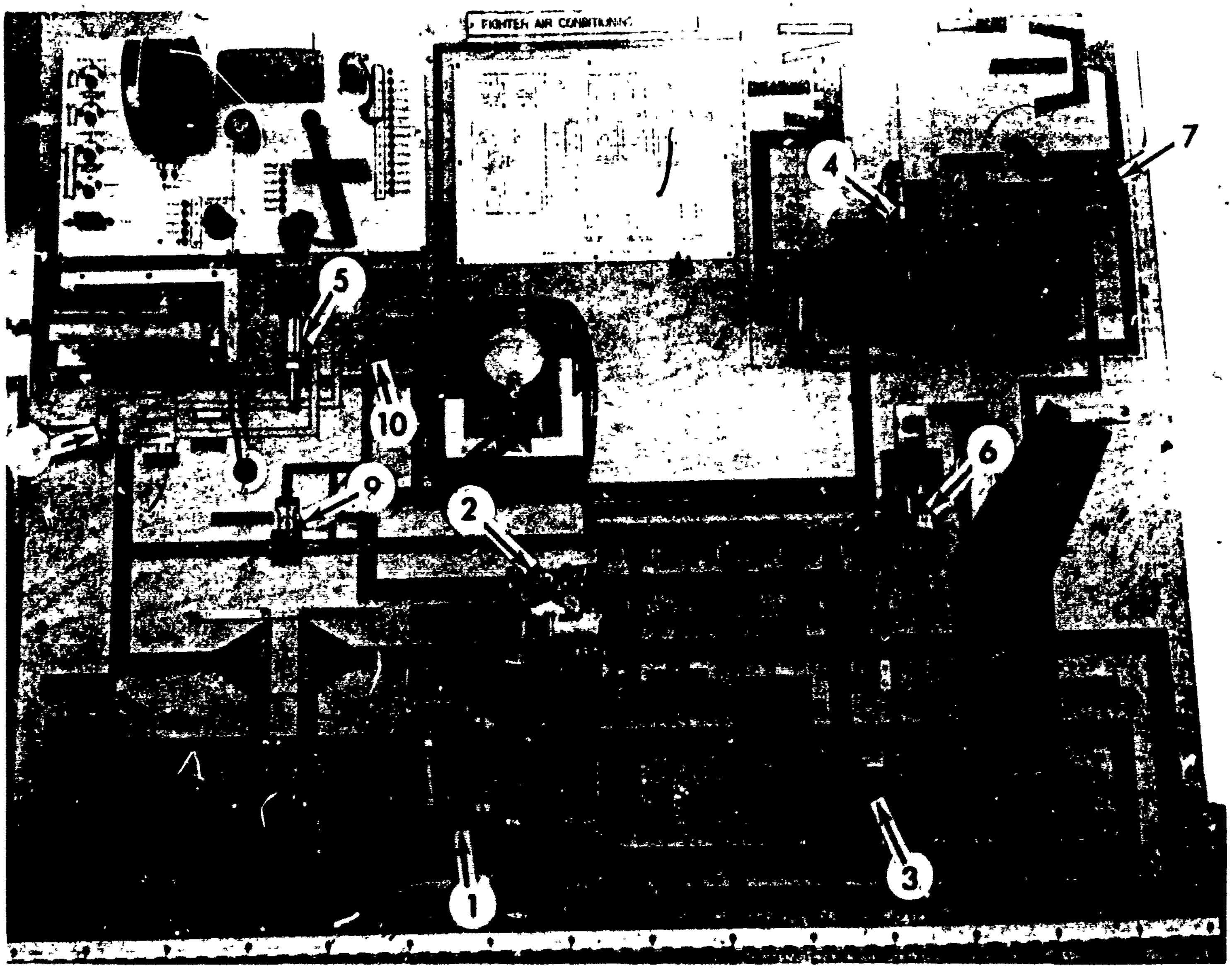

Figure 1. Fighter Air Conditioning Trainer.

Answers to location and identification step 1a.

(1) Bleed air pressure regulator and shutoff valve.

(2) Cabin dual temperature mixing valve.

(3) Ground cooling ejector shutoff valve.

(4) Cabin temperature sensor.

(5) Cabin manual temperature limiter.

(6) Turbine overspeed pressure switch.

(7) Emer air inlet valve.

(8) Water separater.

(9) Anti-ice valve.

(10) Anti-ice controller.

b. Using the trainer and figure 2, locate each of the numbered items. Write the names of each item in the blank space. As you locate the items notice the check points for checking the electrical circuit.

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

(7) ______________________________

(8) ______________________________

(9) ______________________________

(10) ______________________________

(11) ______________________________

(12) ______________________________

COMPARE YOUR ANSWERS TO THOSE ON PAGE 7.

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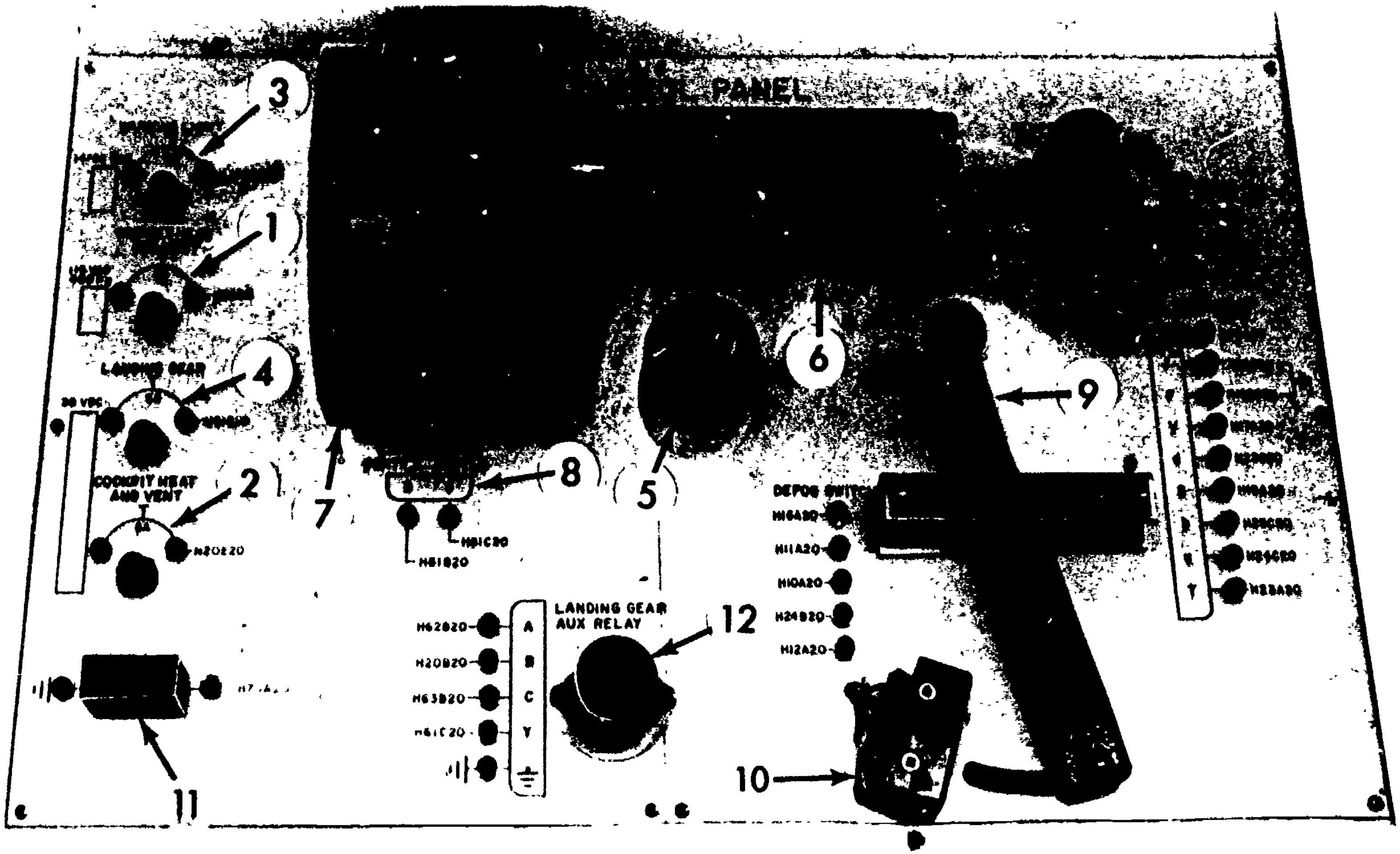


Figure 2. Fighter Air Conditioning Trainer.

Answers to location and ident[illegible] step 1b.

(1) Cockp t heat and vent rcuit breaker; 115 VAC.

(2) Cockpit heat and vent circuit breaker; 28 VDC.

(3) Warning light circuit breaker.

(4) Landing gear circuit breaker.

(5) Emergency vent knob.

(6) Temperature control panel.

(7) Landing gear handle.

(8) Test point for the landing gear control switch.

(9) Footheat and defog lever.

(10) Defog switch.

(11) Cabin turbine overspeed warning light.

(12) Landing gear auxiliary relay.

2. Trainer preparation.

a. Place all trouble switches to t[illegible] [illegible]T position. These switches are located at the left end of the trainer.

b. Push in the following circuit breakers:

(1) Cockpit heat and vent; 11[illegible] VAC.

(2) Cockpit heat and vent; 28 VDC.

(3) Warning lights.

(4) Landing gear.

c. Insure the remaining circuit breakers are pulled out.

d. Place the switches to the NORMAL positions as listed below.

(1) Emergency vent knob ---------- Pushed in.

(2) Landing gear lever ----------- Down.

(3) Defog lever ----------------- Footheat.

(4) Temperature control switch --- Auto.

(5) Temperature selector --------- Cold.

e. Place the power switches to the ON position. These switches are located on the left side of the trainer.

3. Trainer Operation.

a. During the following steps you will operate each component of the cabin air conditioning system. When a switch or lever is actuated be sure to notice which of the valves operate and the valve position. Actuate each switch as directed. From your observation of the trainer operation, complete each of the statements by circling the correct word.

STEP 1. Bleed air pressure regulator and shutoff valve, and emer vent air inlet valve operation.

(1) Pull out the emergency vent knob.

(a) The bleed air pressure regulator and shutoff valve (opens/closes).

(b) The emer air inlet valve (opens/closes).

(2) Push in the emergency vent knob.

(a) The bleed air pressure regulator and shutoff valve (opens/closes).

(b) The emer air inlet valve (opens/closes).

(3) If the bleed air pressure regulator and shutoff valve fails to operate, it indicates a defective valve or an open electrical circuit.

STEP 2. Ground cooling ejector shutoff valve operation.

(1) Place the landing gear handle in the GEAR UP position. The ground cooling ejector shutoff valve (opens/closes).

(2) Move the landing gear handle to the GEAR DOWN position. The ground cooling ejector shutoff valve (opens/closes).

STEP 3. Cabin temperature control system; manual operation.

(1) Place the temperature control switch to MANUAL HOT. The cabin dual temperature mixing valve (opens/closes).

Note: This can be determined by observing the valve position indicator located on the valve body.

(2) Place the temperature control switch to MANUAL COLD.

(3) If the temperature control valve fails to operate it indicates that the valve is defective or there is an open in the 28 VDC electrical circuit.

STEP 4. Cabin temperature control system; automatic operation.

(1) Place the temperature control switch to AUTO, then rotate the temperature selector to HOT. The cabin dual temperature mixing valve moves toward (open/close).

(2) Rotate the temperature selector to COLD. The cabin dual temperature mixing valve moves toward (open/close).

(3) If the automatic temperature control system fails to operate, it indicaates an open in the 115-volt AC power circuit to the controller.

(4) If the temperature sensor or wiring to the sensor is SHORTED, the temperature mixing valve will go full (open/close).

(5) If the temperature sensor or wiring to the sensor is OPEN, the temperature mixing valve will go full (open/close).

STEP 5. Return all switches to the NORMAL position as indicated in paragraph 2d and place trainer power switches to OFF.

COMPARE THE ANSWERS THAT YOU HAVE SELECTED TO THOSE GIVEN BELOW.

STEP 1.	(1) (a) closes	(1) (b) opens	
	(2) (a) opens	(2) (b) closes	
STEP 2.	(1) closes	(2) opens	
STEP 3.	(1) closes	(2) opens	
STEP 4.	(1) close (2) open	(4) open	(5) close

If your answers do not agree, check with the instructor. If your answers agree, then the trainer is operating correctly.

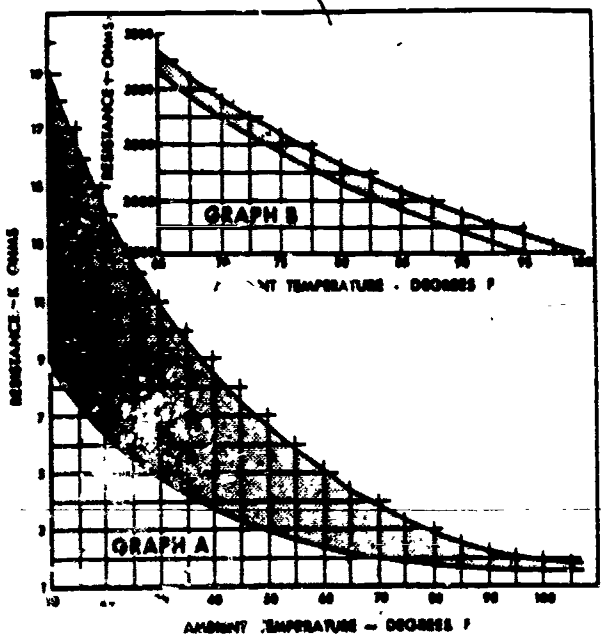
4. Sensor Resistance.

a. Prior to maintaining a temperature control system you should determine the normal resistance values of the sensors. This can be done by referring to the technical order or by measuring a known good sensor.

b. Measure the resistance of the cabin temperature sensor. To meausre resistance, the circuit must be isolated. To isolate the sensor on the trainer, disconnect the AN connector attached to the temperature control panel. With this disconnected you can measure the sensor resistance from the cabin temperature sensor check point. The resistance of the cabin sensor is ______________.

c. Ask the instructor for the ambient temperature of the lab area ________.

1367 d. The graph illustrated in figure 3 shows the normal sensor resistance. This is the same type of graph you will use on the flight line. Determine the resistance range for the cabin sensor. Is the measured resistance of the sensor within the range given on the graph? (yes/no). If your answer was no, ask the instructor for assistance.



NOTES

1. FOR ANY GIVEN TEMPERATURE, RESISTANCE MUST FALL WITHIN SHADED AREA.

2. GRAPH A, USE FOR ... ING SENSORS AND LIMITERS WHEN INSTALLED IN AIRCRAFT.

3. GRAPH B, USE ONLY WHEN SENSOR OR LIMITER IS REMOVED FROM THE AIRCRAFT AND IS PLACED IN A CONTROLLED TEMPERATURE ENVIRONMENT (e.g. SUBMERGE UNIT IN WATER THAT IS TEMPERATURE CONTROLLED).

Figure 3. Temperature Sensor Resistance Graph.

Instructions for using the temperature sensor resistance graph.

On graph A, locate the vertical line for ambient temperature. Follow this line up to the shaded area, then follow the horizontal lines to the left to determine the range of the resistance in "K" ohms. "K" = 1,000 ohms.

Example: If the temperature is 65°F, then the resistance range should be between 2200 ohms and 4500 ohms.

SECTION 2. CABIN AIR CONDITIONING SYSTEM
OPERATIONAL CHECK AND TROUBLESHOOTING

OPERATIONAL CHECK

1. The steps that you performed in paragraph 3a of Section 1 involved operating each component in the cabin air conditioning system. They determined if each component was operating properly and are called operational checks.

2. The chart below formalizes the procedure for performing operational checks in an outline form. To insure that you are familiar with this procedure, turn the trainer power switches ON and perform each of the steps. After you are sure you understand the operational check procedure, then continue to the troubleshooting part of this lesson.

Positioning the Control Devices	Operating Valve	Valve Position
Pull out the emergency vent knob	Bleed air pressure regulator and shutoff valve Emer Air inlet valve	CLOSED OPEN
Push in the emergency vent knob	Bleed air pressure regulator and shutoff valve Emer Air inlet valve	OPEN CLOSED
Move the landing gear handle to the GEAR UP position	Ground ejector valve	CLOSED
Move the landing gear handle to the GEAR DOWN position	Ground ejector valve	OPEN
Place the temperature control switch to MANUAL HOT	Cabin dual temperature mixing valve	CLOSED
Place the temperature control switch to MANUAL COLD	Cabin dual temperature mixing valve	OPEN
Place the temperature control switch to AUTO. Rotate the temperature selector to HOT.	Cabin dual temperature mixing valve	Travels toward CLOSED
Rotate the temperature selector to COLD	Cabin dual temperature mixing valve	Travels toward OPEN

Operational Check Procedure Chart

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TROUBLESHOOTING

1. For each trouble, perform an operational check to determine the malfunctioning component; place a statement in the "discrepancy" block of the troubleshooting response sheet.

2. Using a wax pencil, trace the electrical circuit that operates or controls the malfunctioning component.

3. Use a multimeter to locate the cause of the trouble.

Note: When measuring voltage, be sure the meter is set to the correct voltage range. Make sure that you have the negative (black) lead to ground. Ground on the trainer is any connection with a ground (—|||) symbol. When checking the manual temperature control system, be sure to hold the temperature control switch to either hot or cold. When measuring resistance, <u>be sure the trainer power switch is off, and the meter is set at OHMS. Use the OHM portion of the multimeter only to check sensors and their circuits.</u>

4. Record the cause of the trouble in the "cause" block of the troubleshooting response sheet.

5. The trouble switch that you are to use for each problem is listed on the side of the discrepancy block. There are 12 problems for you to troubleshoot. We will go through trouble number 1 to show you how to arrive at the correct answer.

Trouble Switch #1

1. Place trouble switch #1 to the <u>IN</u> position.

2. Perform an operational check. Use the operational check chart, on page 11, if needed.

3. As you went through the operational check you found the cabin mixing valve would not operate in automatic. Make the following statement in the discrepancy block of the troubleshooting response sheet for trouble #1.

"Cabin mixing valve will not operate in automatic."

4. Since the cabin mixing valve will not operate in automatic hot or cold, what part of the circuit would affect automatic operation of the system? The DC and AC power supplies are necessary for both auto and manual.

5. If the problem were in the DC power supply, then the valve would not operate in manual. This leaves the AC power supply.

6. Trace the AC power supply from the 115V AC cockpit heat and vent circuit breaker to the temperature control panel.

Note: 28 vol[illegible] supply is required to operate the valve. The 115V AC supply is required for operation of the cabin magnetic amplifiers.

7. Check the AC power supply with the multimeter. Make sure your meter is set at the correct voltage. Check for voltage at pin "E" of the temperature control panel. You did not get a voltage indication, did you?

8. Now, check for voltage at the 115V AC cockpit heat and vent circuit breaker. There is voltage at this point. This means there must be an open in wire H9A20.

9. Record your findings in the "cause" block of trouble switch #1, on the troubleshooting response sheet.

"Open in wire H9A20."

10. You have completed trouble #1 so place that trouble switch to the OUT position and continue with troubles number 2 through 10. Be sure to record the malfunction in the "discrepancy" block and the cause of the malfunction in the "cause" block of the troubleshooting response sheet.

11. After you have completed trouble number 10, return this workbook to your lab instructor to have him grade it. If you did not locate the required amount of troubles correctly, your instructor will tell you where you made your error(s) and have you redo those troubles. If you accomplished this objective correctly, your instructor will sign the objective as completed and assign you the next project.

INSTRUCTOR

Please check off the student's accomplishment of the following items. These items are part of the objective(s) of this lesson.

ITEM	UNSAT.	SAT.
Practices general housekeeping consistent with safety and fire prevention.		
Practices safe work habits and procedures.		
Follows precautions while working around danger areas.		
Use of test meter.		

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TROUBLESHOOTING RESPONSE SHEET

TROUBLE SWITCH NUMBER	DISCREPANCY	CAUSE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

WHEN COMPLETED, REPORT TO THE INSTRUCTOR.

Instructor's signature showing satisfactory completion of this objective:

____

PROGRAMMED TEXT
3ABR42331-PT-202

Technical Training

Aircraft Environmental Systems Mechanic

RAIN REMOVAL SYSTEM

23 September 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

1373

FOREWORD

This programmed text was prepared for use in the 3ABR42331 Aircraft Environmental Systems Mechanic Course. The materials contained herein were validated with students from the subject course. At least 90% of the students taking this text achieved or surpassed the criteria established in the lesson objectives. The average time for completion of this text was 5 hours 40 minutes.

OBJECTIVE

Relate each rain removal system component to its operation with a minimum of 80% accuracy.

INSTRUCTIONS

This programmed text is presented in two parts.

PART I is the actual component operation. The text presents this material in small steps called frames. After each frame you are asked to respond to questions in some manner. Read the material carefully and accomplish what each frame directs you to do. The correct answers are given at the top of the next frame or as specified. If you have answered each response correctly, continue on to the next frame. If you are incorrect, read the material again and correct your answers before continuing.

PART II of the text is the electrical wiring diagram for the rain removal system. You will be required to trace each circuit. After you have traced the circuits, you will be required to analyze the wiring diagram by selecting the trouble number found on the wiring diagram and placing it along side the trouble. After completing the troubles, have your instructor check your answers. It is important that you understand the wiring diagram in order to understand the operation of the system so you can correctly troubleshoot the trainer when you go to the lab. If you have any questions, ask your instructor for assistance.

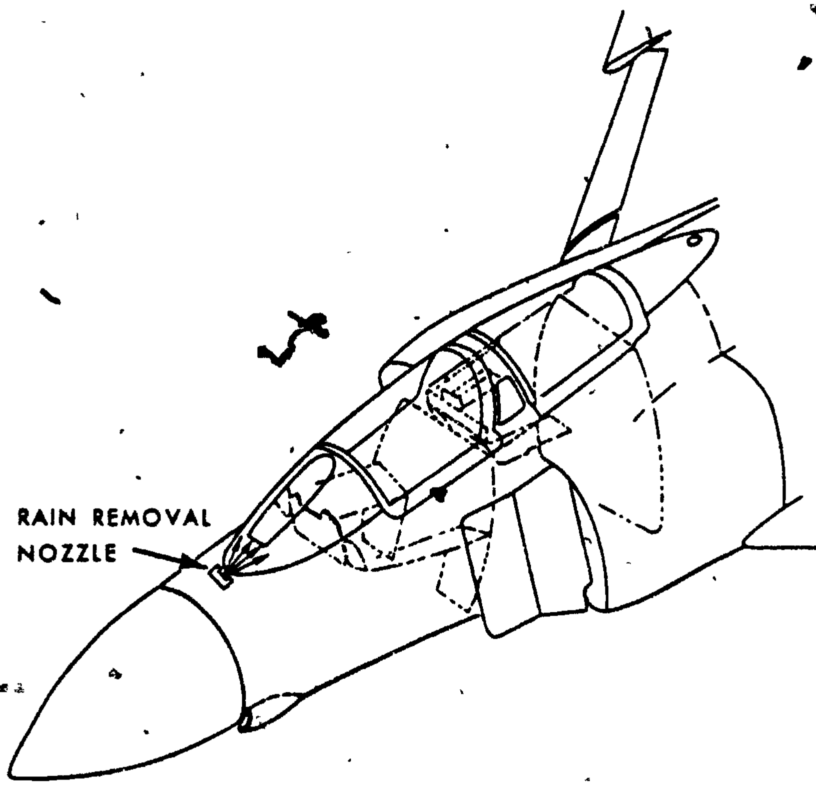
Supersedes 3ABR42231-PT-202, 30 July 1974.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 400; TTVSR - 1

PART I

Frame 1

The purpose of the rain removal system is similar to the purpose of the windshield wipers on an automobile. The system keeps the windshield clear of rain. This is done by blowing a mixture of hot air and partially cooled air over the windshield. The air will break up the rain particles and turn them away from the windshield.

During this lesson you will be studying the system used on a fighter type aircraft. In this system the air for the rain removal is discharged through a nozzle (outlet). The nozzle is put at the base of the center windshield. Notice the rain removal nozzle location below.



Complete the following statements.

1. The purpose of the rain removal system is to keep the ____________________ clear of rain.

2. The rain removal system allows ______________ to blow over the windshield.

3. The rain removal nozzle directs air over the ______________ windshield.

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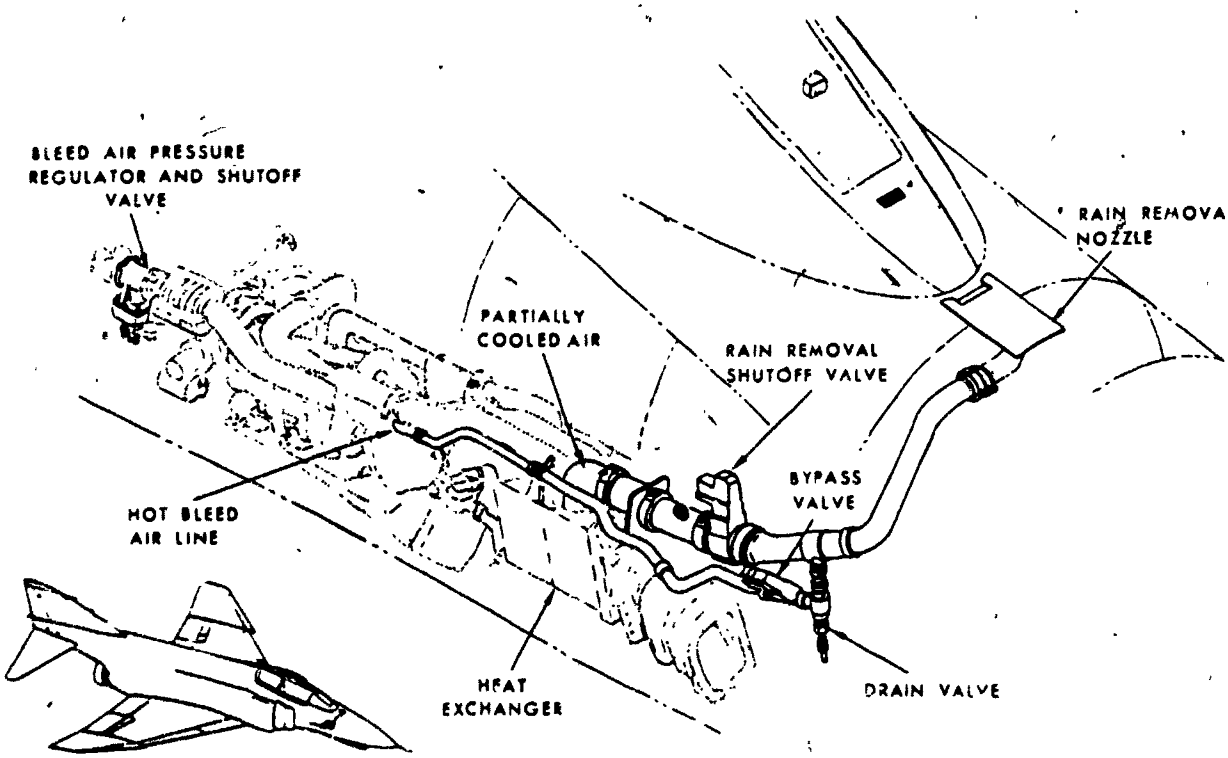
Answers to Frame 1: 1. windshield 2. air 3. center

Frame 2

The rain removal system gets air from the cabin refrigeration unit. This air is a mixture of hot bleed air and partially cooled bleed air.

The partially cooled air is drawn from the primary section of the refrigeration unit heat exchanger. The hot bleed air is drawn from the unit's hot bleed air duct.

The dark lines in the sketch show the rain removal system. Note the large duct that carries the partially cooled air from the heat exchanger. The smaller duct takes the hot air from the refrigeration unit hot bleed air duct.



Fill in the blanks to complete the following statements.

1. The rain removal system receives partially cooled air from the ______________ ______________________________.

2. The air discharged from the rain removal nozzle is a mixture of partially ______________________ air and hot ______________________ air.

3. The rain removal system receives hot bleed air from the ______________ ______________ ______________ ______________.

Answers to Frame 2: 1. heat exchanger 2. cooled bleed
3. refrigeration unit hot bleed air duct

Frame 3

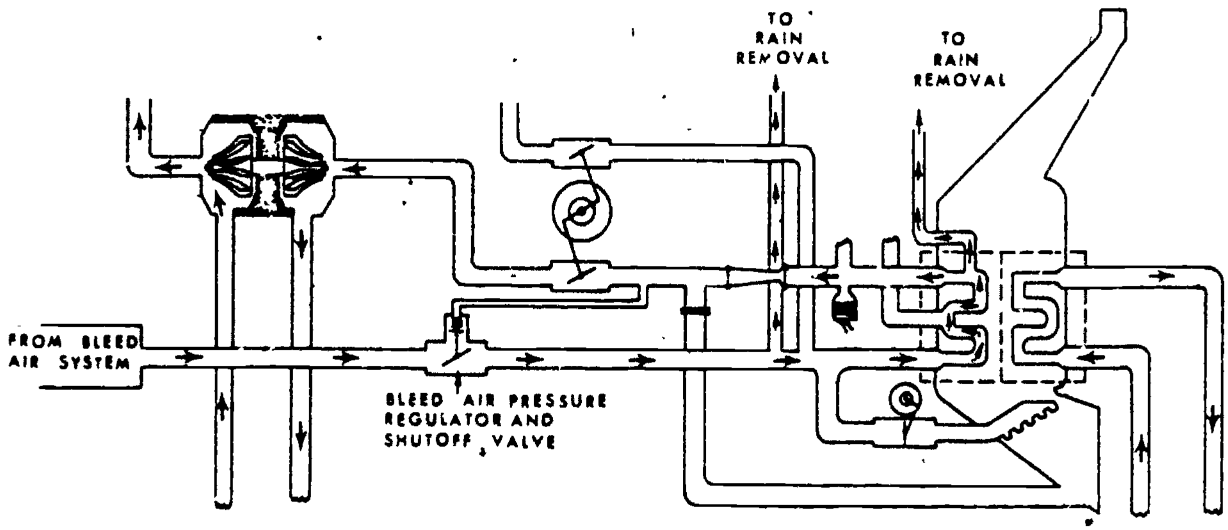
Remember the fighter cabin air conditioning system? Air flow through the cabin refrigeration unit is regulated by the bleed air pressure regulator and shutoff valve.

ir used for the rain removal system is taken from the refrigeration unit. The pressure of this air is regulated by the bleed air pressure regulator and shutoff valve.

Trace the airflow on the sketch below. Start at the point marked FROM BLEED AIR SYSTEM. Follow the arrows through the bleed air pressure regulator and shutoff valve.

Note the first tapoff going to the rain removal system. This is the hot bleed air tapoff.

Then, follow the arrows through the primary part of the heat exchanger and note the second tapoff going to the rain removal system. This is the partially cooled air tapoff.



Fill 'e blanks to complete the following statements.

1. To operate the rain removal system, the bleed air pressure regulator and shutoff valve must be ____________________ (open/closed).

2. The bleed air pressure regulator and shutoff valve is part of the cabin ____________________________ unit.

3. The partially cooled air used for rain removal is cooled by the ____________________________ section the cabin refrigeration unit heat exchanger.

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Answers to Frame 3: 1. open 2. refrigeration 3. primary

Frame 4

Before going into the operation of the rain removal system, let's re iew some information about the bleed air pressure regulator and shutoff valve.

Do you recall the fighter cabin air conditioning system? This system has a solenoid controlled, pneumatically (air) actuated valve. The solenoid that will open and close the valve is controlled by the emergency vent knob.

When the knob is pushed IN, the solenoid is energized allowing the valve to open. When the knob is pulled OUT, the solenoid will deenergize, and the valve will close.

The air for the rain removal is tapped off downstream of the pressure regulator and shutoff valve. This valve then must be open when using the rain removal system.

Fill in the blanks to complete the following statements.

1. Opening and closing of the pressure regulator and shutoff valve is controlled by a ________________________.

2. The bleed air pressure regulator and shutoff valve is actuated open by ________________________ pressure.

3. The main solenoid on the bleed air pressure regulator and shutoff valve is controlled by the ________________ ________________ knob.

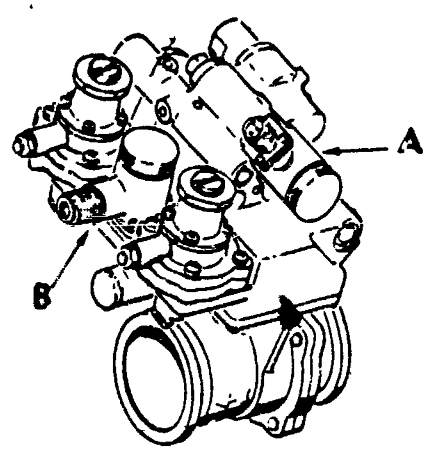
Answers to Frame 4: 1. solenoid 2. air 3. emergency vent

Frame 5

The bleed air pressure regulator and shutoff valve has two solenoids: The main control solenoid (A) and a low pressure solenoid (B).

For normal air conditioning, only the main control solenoid is energized. In this condition, the bleed air is turned on and its pressure is regulated to 62 psi.

When rain removal is required, the low pressure solenoid must also be energized. This reduces the pressure of the bleed air (for both air conditioning and rain removal) to 40 psi.



Fill in the blanks to complete the following statements.

1. Opening and closing of the pressure regulator and shutoff valve is controlled by the ____________ (main solenoid/low pressure solenoid).

2. When the rain removal system is ON, the low pressure solenoid is ____________ (energized/deenergized).

3. When the rain removal system is ON, pressure to the air conditioning system is ____________ (reduced/increased).

Answers to Frame 5: 1. main solenoid 2. energized 3. reduced

Frame 6

The sketch on this page is a simplified schematic of the rain removal system. The bleed air pressure regulator and shutoff valve and the heat exchanger are actually part of the cabin refrigeration unit. These are put in the system sketch. They are also related to the rain removal system as explained in the previous frames.

The rain removal system consists of the following four components.

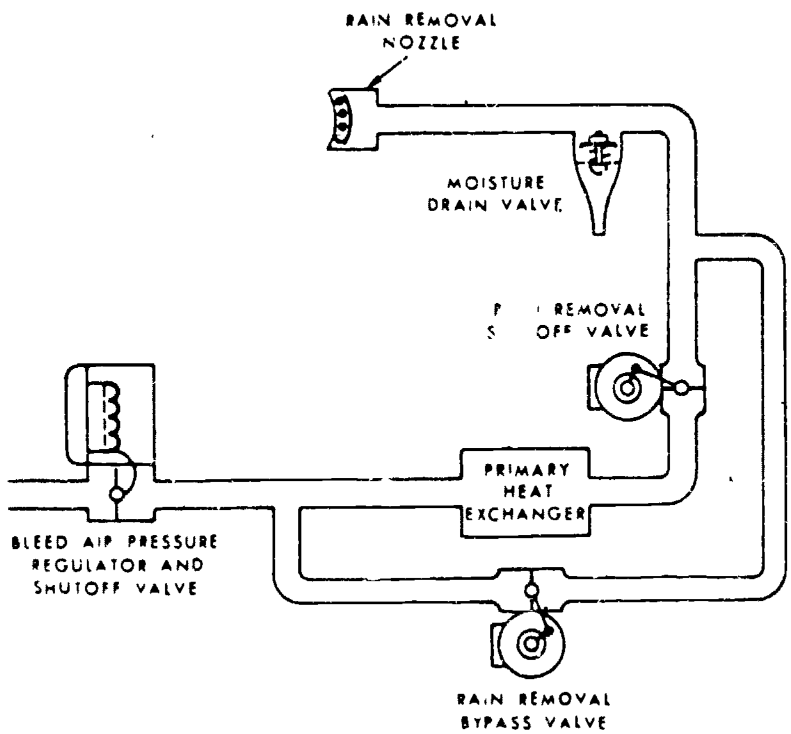
1. Rain removal shutoff valve.

2. Rain removal bypass valve.

3. Rain removal drain valve.

4. Rain removal nozzle.

Notice each of these components in the system illustration below.



Fill in the blanks to complete the following statements.

1. The rain removal bypass valve controls the flow of ________________ (hot/partly cooled/cold) air.

2. The rain removal shutoff valve controls the flow of ____________________ (hot/partly cooled/cold) air.

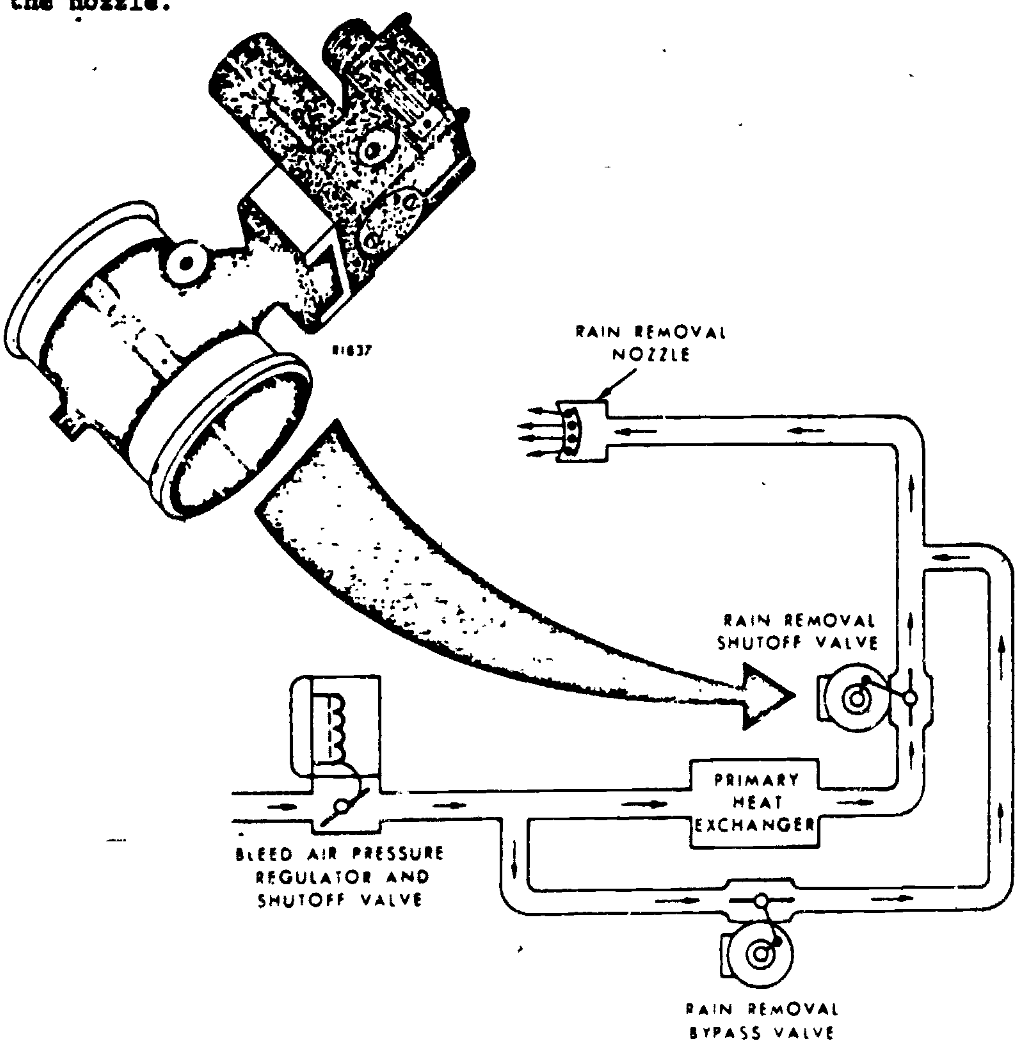
Answers to Frame 6: 1. hot 2. partly cooled

Frame 7

The rain removal shutoff valve, shown, controls the flow of partially cooled bleed air from the heat exchanger to the rain removal nozzle. This is a butterfly type valve.

The valve is actuated by a 28 volt DC motor. The opening and closing of this valve is controlled by the rain removal switch, which is located in the cockpit.

When the rain removal switch is ON, 28 volt DC power is directed to the motor. The valve then moves to the open position. This allows the partially cooled bleed air to flow through the valve and then to the nozzle.



Fill in the blanks to complete the following statements.

1. The rain removal shutoff valve is actuated by a 28 volt DC ________________.

2. The rain removal shutoff valve controls the flow of ________ ________________ ________________ ________________.

3. The rain removal shutoff valve is controlled by the ________________ ________________ switch.

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Answers to Frame 7: 1. motor 2. partly cooled blee! air.
3. rain removal

Frame 8

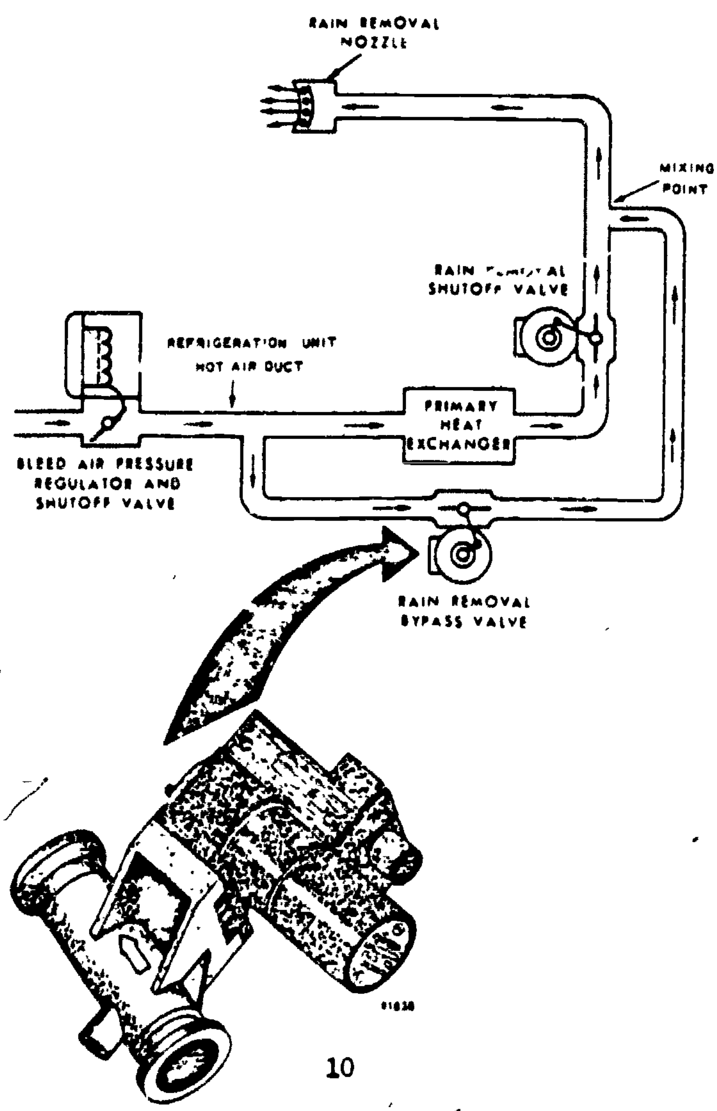
The rain removal bypass valve, shown below, controls the hot bleed air going to the rain removal nozzle from the hot air duct. This is also a butterfly type valve.

The valve is actuated by a 28 volt DC motor. The opening and closing of this valve is also controlled by the rain removal switch.

When the rain removal switch is ON, the valve will open. The valve then allows hot bleed air to flow to the mixing point. At this point, hot bleed air is mixed with the partially cooled air.

The air flowing to the nozzle is a mixture of the partiall/ cooled air and the hot bleed air. The bypass valve increases the volume and temperature of the rain removal air.

Notice the airflow of partially cooled and hot bleed air in the illustration.



Fill in the blanks to complete the following statements.

1. The hot bleed air going to the rain removal nozzle is controlled by the ______________________________ ____________________________.

2. The air flowing to the rain removal nozzle is a mixture of ______________ ________________ air and ______________ ____________________ air.

3. The rain removal bypass valve is actuated by a ______________ ___________ __________________ ______ ____________.

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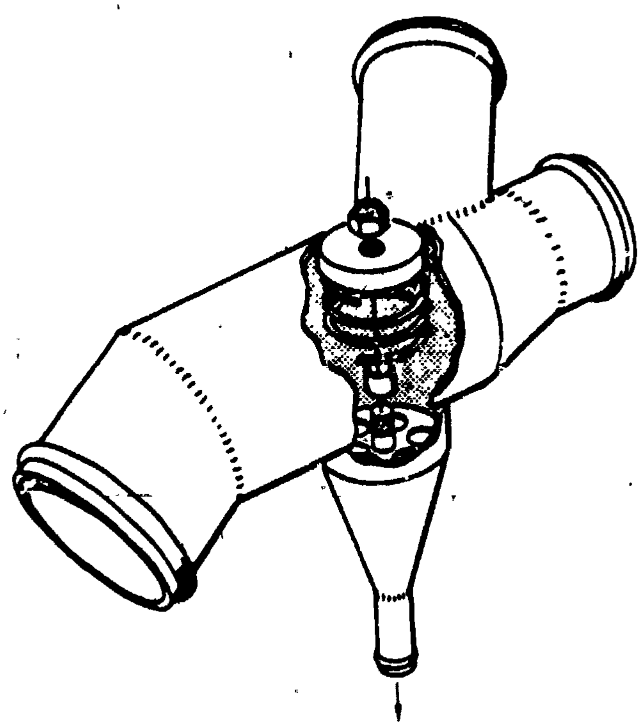
Answers to Frame 8: 1. bypass valve 2. partly cooled hot bleed
3. 28 volt DC motor

Frame 9

When the system is not operating, the drain valve is held open by a spring. When the rain removal system is turned ON, air pressure in the duct will overcome the spring and force the drain valve CLOSED.

This allows the water to drain out when the system is turned OFF. It also closes the drain opening to prevent a loss of air when the system is ON.



Fill in the blanks to complete the following statements.

1. The rain removal drain valve is opened by a ______________.

2. The rain removal drain valve is closed by __________
______________.

Answers to Frame 9: 1. spring 2. air pressure

Frame 10

The illustration below, shows the complete system with the rain removal switch in the ON position. A schematic of the electrical circuitry is also shown.

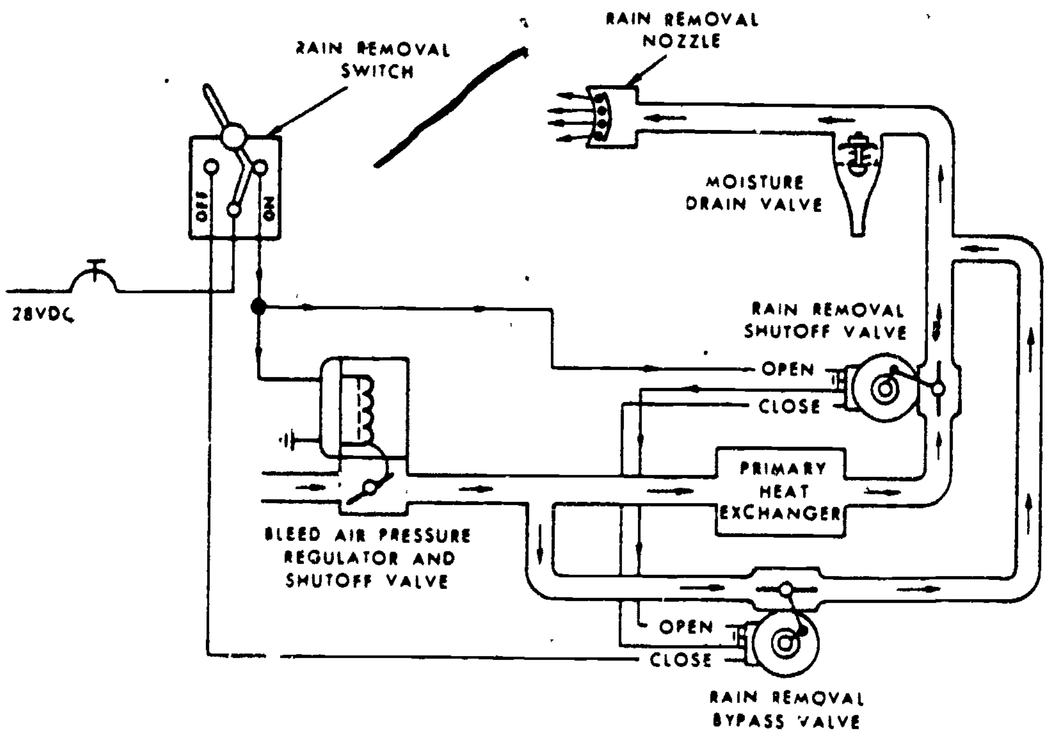
Trace the path for electrical current flow when this system is turned ON. Current flows from the circuit breaker, through the rain removal switch.

From the switch, current then flows to the low pressure solenoid on the bleed air pressure regulator and shutoff valve. This cuts down the air pressure going to the air conditioning system.

Current is also directed to the OPEN windings of the rain removal shutoff valve motor. This operates the rain removal shutoff valve to the OPEN position.

When the valve reaches the full open position, it moves a limit switch. The limit switch is inside the valve motor. The switch stops current flow to the rain removal shutoff valve.

This limit switch then directs the current flow to the rain removal bypass valve motor. Current then flows through the OPEN windings of the rain removal bypass valve motor, opening the valve.



Notice the operating sequence. The sequence will be important when troubleshooting the system. When the rain removal switch is turned to ON, the rain removal shutoff valve will open first.

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Frame 10 (Continued)

The rain removal bypass valve will then OPEN. The rain removal shutoff valve must be fully open before the bypass valve will start to open.

The rain removal valves are sequenced this way to prevent a rapid temperature increase of the windshield. A rapid increase of temperature could distort or damage the windshield.

Fill in the blanks to complete the following statements.

1. When the rain removal switch is turned on, the low pressure solenoid will be ______________________.

2. When the rain removal switch is turned on, the valve that opens first is the rain removal ______________________ ______________.

3. The rain removal bypass valve will open only after the rain removal shutoff valve is fully ______________________.

4. When the rain removal switch is turned on, the air pressure going to the air conditioning system is __________________.

Answers to Frame 10: 1. energized 2. shutoff valve 3. open
4. reduced

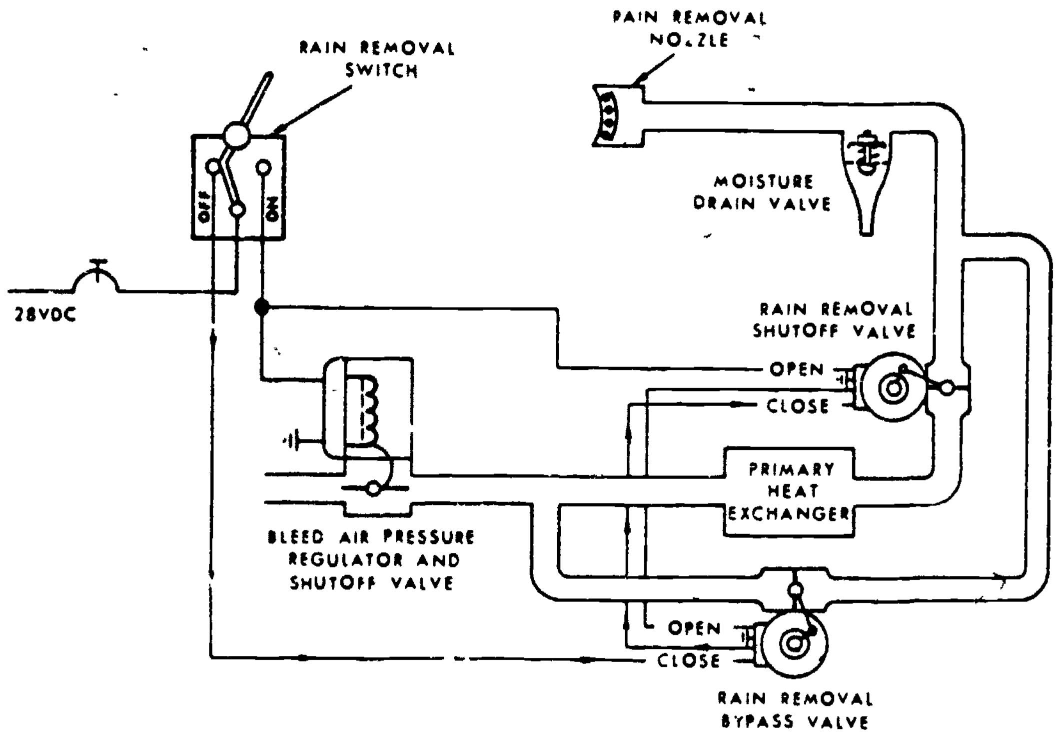
Frame 11

The sketch shows the system with the rain removal switch in the OFF position. Again there is a sequence of operation of the valves.

Moving the switch to OFF will open the circuit going to the low pressure solenoid on the bleed air pressure regulator and shutoff valve. This deenergizes the solenoid. The regulator is then allowed to control pressure at the higher setting for normal air conditioning.

With the switch OFF, current flows from the circuit breaker, through the OFF contact of the switch. From the switch, current flows to the close windings of the rain removal bypass valve motor. This operates the bypass valve to the closed position.

When the bypass valve reaches fully closed, a limit switch stops the current flow to the bypass valve motor. Current flow is then directed to the CLOSE windings of the rain removal shutoff valve motor. This operates the rain removal shutoff valve to the closed position.



Did you notice the sequence of valve operation? When the switch is turned to OFF, the bypass valve closes first, then the shutoff valve closes. This is opposite from the sequence when the switch was turned ON.

Frame 11 (Continued)

Fill in the blanks to complete the following statements.

1. When the rain removal switch is placed to OFF, the low pressure solenoid is ______________________________.

2. Placing the rain removal switch to OFF, directs electrical power to close the rain removal ________________ ________________ first.

3. The rain removal shutoff valve closes only after the rain removal bypass is fully ________________________.

Answers to Frame 11: 1. deenergized 2. bypass valve 3. closed

Frame 12

Answer the following statements true (T) or False (F).

_____1. The purpose of the rain removal system is to keep the canopy clear of rain.

_____2. The rain removal shutoff valve controls the flow of partially cooled air.

_____3. The partially cooled air for rain removal is tapped from the secondary section of the heat exchanger.

_____4. For the bleed air pressure regulator and shutoff valve to open, the emergency vent knob must be pushed in.

_____5. The volume and temperature of the rain removal air is increased when the rain removal bypass valve is opened.

_____6. The rain removal shutoff and bypass valves are both actuated by a 28 volt DC motor.

_____7. The rain removal drain valve is held open by a spring and closed by air pressure.

_____8. For the rain removal bypass valve to open, the rain removal shutoff valve must be fully open.

_____9. The rain removal bypass valve closes after the shutoff valve has closed.

_____10. The rain removal shutoff valve and the rain removal bypass valve are controlled by the rain removal switch.

Answers to Frame 12: 1. F 2. T 3. F 4. T 5. T 6. T 7. T 8. T 9. F 10. T

Frame 13

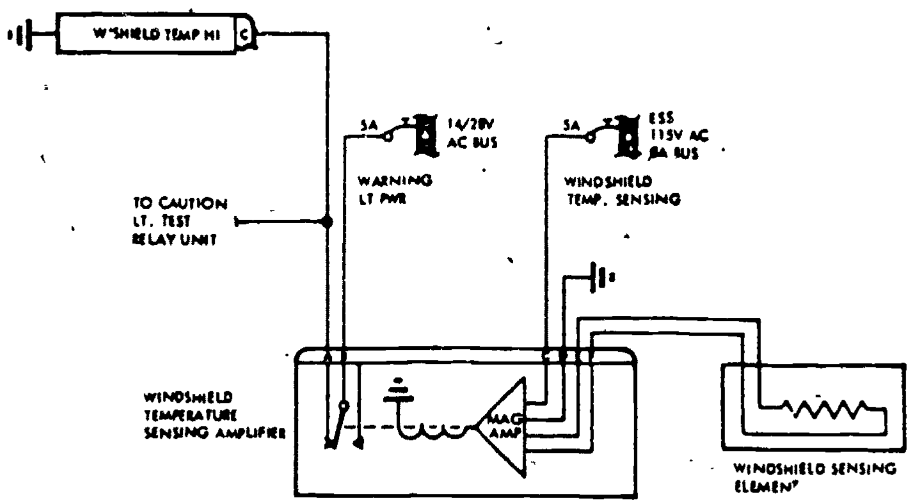
The rain removal system does not have a means of controlling the air temperature automatically. There is a system to warn the pilot when the windshield temperature is raised to a point where it could cause damage to the windshield panel. This is the windshield temperature overheat warning system. When an overheat condition exists, the pilot reduces the temperature by turning the rain removal system OFF.

The windshield temperature overheat warning system, consists of the following components. Locate these components in the illustration shown below.

Windshield Temperature Sensing Amplifier

Windshield Temperature Sensing Element

Windshield Temperature High Warning Light



Fill in the blanks to complete the following statements.

1. Excessively hot air would probably ________________ the windshield.

2. The temperature of the rain removal air ________________ (is/is not) controlled automatically.

3. A ______________________ ____________________ tells the pilot that his windshield is getting too hot for safety.

Answers to Frame 13: 1. damage 2. is not
3. warning light or warning system

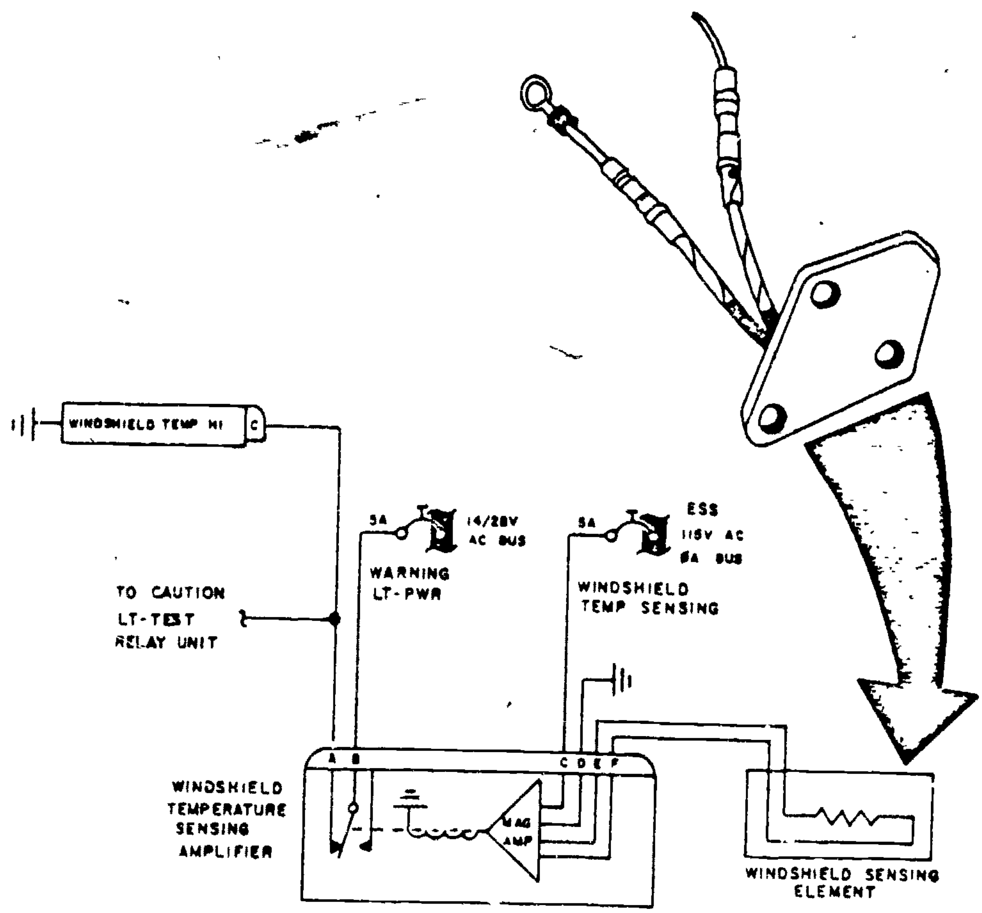
Frame 14

The windshield temperature sensing element (sensor), shown below, is mounted on the lower part of the windshield. The element will sense the temperature of the windshield.

This sensing element has a positive coefficient of resistance. As the temperature increases, the resistance of the sensing element also increases.

When the windshield temperature reaches 260°F, the increase in sensor circuit resistance sends a signal to the windshield temperature sensing amplifier.

The sketch shows the windshield temperature sensing element. Also shown is the relationship of the sensor to the other units in the windshield temperature sensing circuit.



1391

Frame 14 (Continued)

Complete the following statements.

1. The windshield temperature sensing element senses the temperature of the ________________.

2. The windshield temperature sensing element has a ________________ coefficient of resistance.

3. When the windshield temperature decreases, the resistance of the sensing element ________________.

Answers to Frame 14: 1. windshield 2. positive 3. decreases

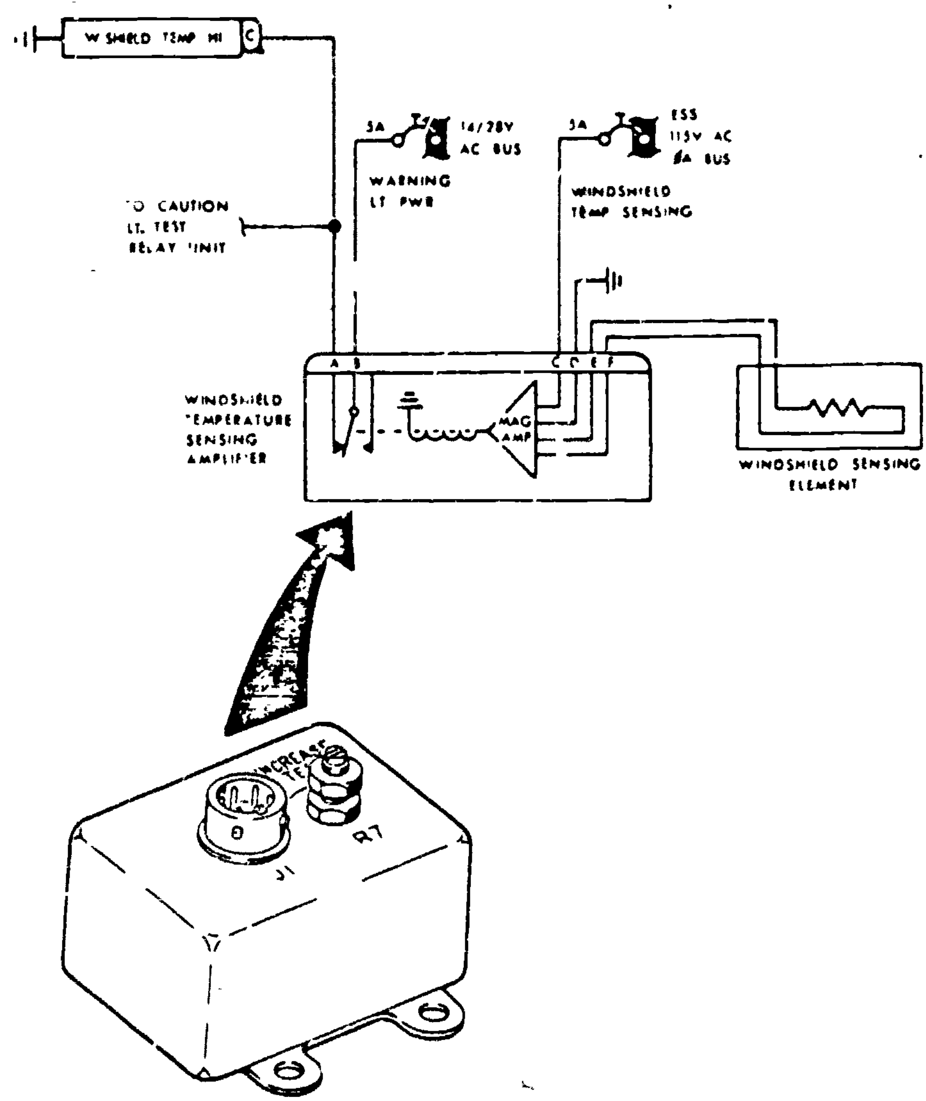
Frame 15

The windshield temperature sensing amplifier, shown below holds a magnetic amplifier, and a relay. The magnetic amplifier requires 115V AC power to operate and energize the relay.

During normal windshield temperatures, the magnetic amplifier allows current to flow through the relay coil, energizing the relay. This keeps the relay contacts open.

When the windshield temperature reaches 260°F, the signal from the sensor stops the magnetic amplifier from conducting. Current flow to the relay coil is stopped. The relay then de-energizes and allows the contacts to close.

When the relay contacts close, current flows from the warning light power circuit breaker through the relay contacts. Current then flows to the <u>windshield temperature HI</u> warning light.



1393

Frame 15 (Continued)

Fill in the blanks to complete the following statements.

1. The windshield temperature sensing amplifier contains a ______________________ amplifier.

2. The 115 volt AC power is required to operate the ___________ amplifier.

3. The signal for operation of the magnetic amplifier is from the windshield temperature ______________________.

4. The magnetic amplifier controls the operation of a ______________________.

5. When the windshield temperature reaches 260°F, the windshield temperature sensing amplifier will turn on the warning ______________________.

Answers to Frame 15: 1. magnetic 2. magnetic 3. sensing element
4. relay 5. light

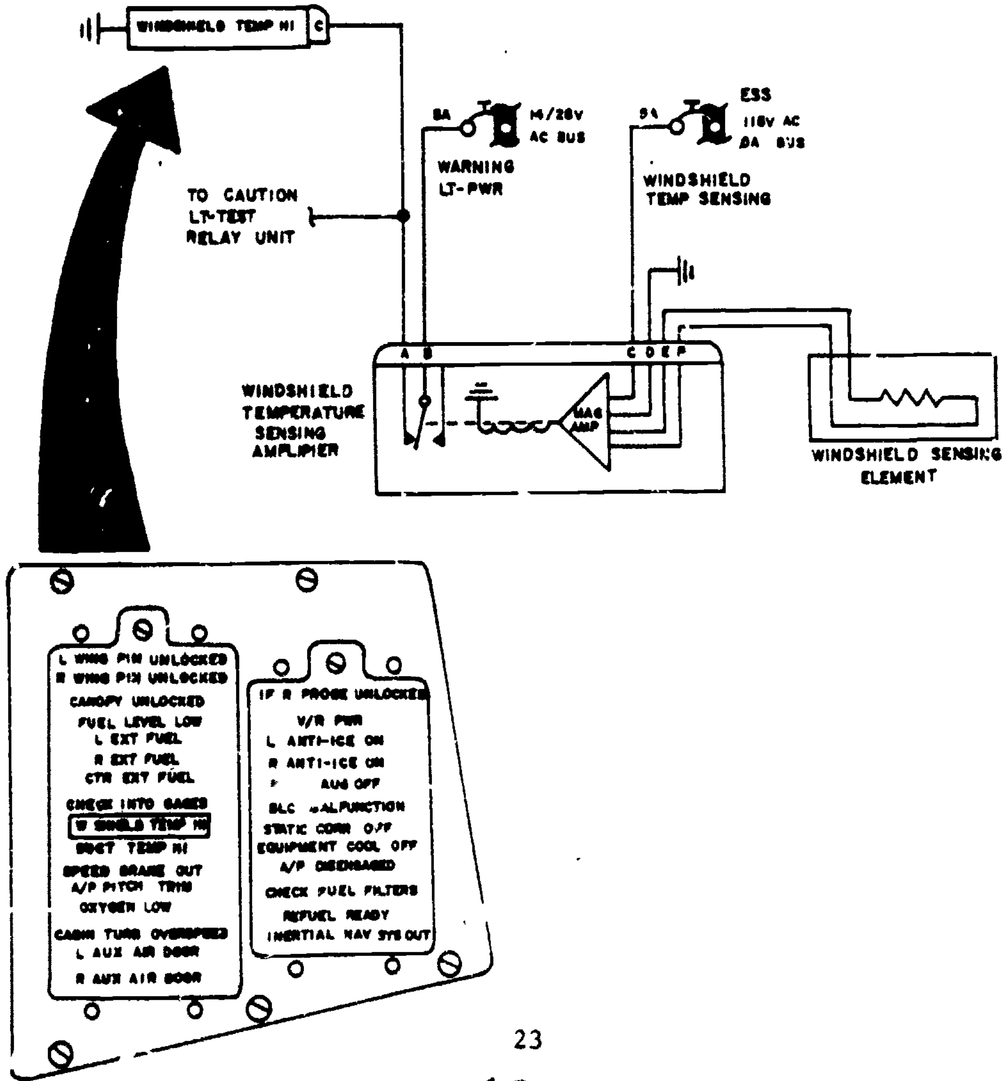
Frame 16

When the windshield temperature reaches 260°F the WINDSHIELD TEMP Hi warning light, shown below, lights to warn the pilot.

When this happens, the pilot must turn the rain removal system OFF. After the windshield temperature drops, the warning light will go OFF. The pilot can turn the rain removal system back ON.

There is no means for automatically controlling rain removal temperature. The pilot must control the temperature manually. The windshield temperature warning system tells the pilot if the windshield temperature is too hot.

The sketch below shows the circuit with the warning light on (temperature above 260°F). Notice the path for current flow from the warning light power circuit breaker to the light. When the temperature again <u>drops below</u> 260°F, the magnetic amplifier will conduct. The amplifier energizes the relay and opens the contacts. This will stop current flow to the light.



1395

Frame 16 (continued)

Fill in the blanks to complete the following statements.

1. The rain removal temperature is controlled by the ____________________.

2. The purpose of the windshield temperature overheat warning system is to warn the pilot when the ________________ ________________ is above 260°F.

3. When the WINDSHIELD TEMP HI warning light comes on, the pilot must turn off the ________________ ________________ ________________.

Answers to Frame 16: 1. pilot 2. windshield temperature
3. rain removal system

Frame 17

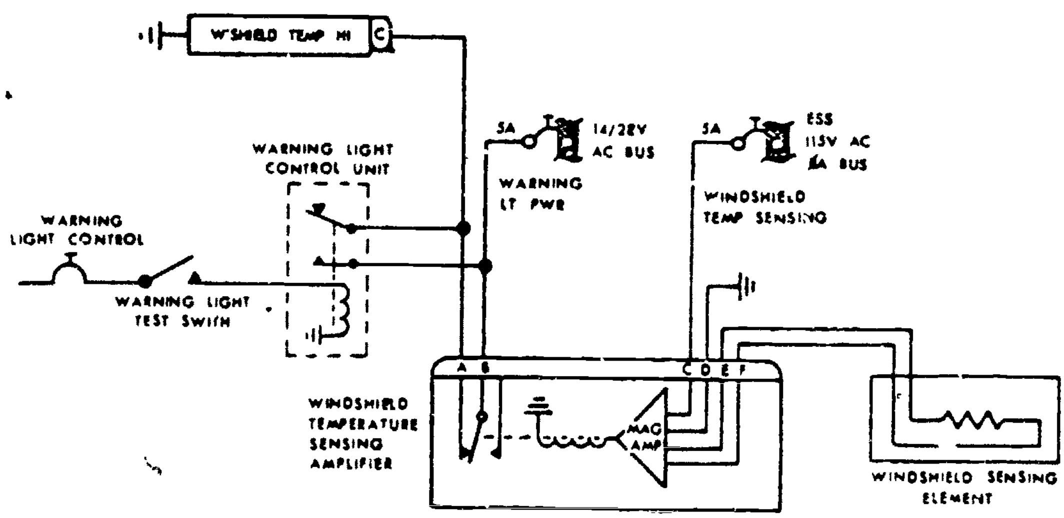
A warning light system is of no value unless we are sure it will work properly. The pilot can test the warning light system before each flight. He uses a warning light test switch.

The sketch shows the warning light test circuit is used to test the WINDSHIELD TEMP HI warning light.

When the warning light test switch is closed (test position), current flows from the warning light control circuit breaker to the warning light control unit. This energizes a relay in the control unit. With the relay energized, current flows from the warning light power circuit breaker, through the relay contacts and to the light.

Place the warning light test switch in the test position. If the warning light comes ON, the pilot knows the circuit and the light bulb are working properly. If the light does not come on, it indicates a defect in the circuit or a burned out light bulb.

The warning light test switch illustrated, shows testing of only one light. On the actual aircraft, this switch will test several warning light systems.



Fill in the blanks to complete the following statements.

1. The warning light control unit is used for ____________ the warning light system.

2. When checking the rain removal system, you can determine if the warning light circuit is operating properly by using the ____________ ____________ ____________ switch.

1397

Answers to Frame 17: 1. testing 2. warning light test

Frame 18

Match the units listed in column "B" with the statements given in column "A" by placing the letter from column "B" in the blanks provided.

Column A	Column B
_____1. Allows the water to drain out when the system is off.	A. Rain removal bypass valve
_____2. Senses the temperature of the center windshield.	B. Low pressure solenoi
_____3. Controls the flow of partially cooled air from the heat exchanger.	C. Windshield temperatu sensing amplifier
_____4. Contains a magnetic amplifier and controls a relay which turns on the warning light.	D. Rain removal drain valve
_____5. Controls the hot bleed air going to the rain removal nozzle.	E. Windshield temperatu sensing element
_____6. Reduces the pressure of the bleed air for both air conditioning and rain removal to 40 psi.	F. Rain removal shutoff valve
_____7. Warns the pilot that the windshield temperature is too high.	G. Windshield temp hi warning light

Answers to Frame 18: 1. D 2. E 3. F 4. C 5. A 6. B
7. G

Frame 19

Open foldout 1 at the back of this text. This is the wiring diagram you will use for analyzing the electrical circuits of the rain removal system. It is also used for troubleshooting the system on the trainer.

The wiring diagram includes the rain removal valve control circuits, the windshield temperature sensing circuits, and the warning light test circuit. To help you understand the system operation, we will trace each of these circuits.

RAIN REMOVAL VALVE CONTROL CIRCUIT

Use a <u>RED</u> pencil. Using your RED pencil, trace the circuit from the 28 volt DC rain removal circuit breaker to pin E of the circuit breaker panel (J/P315B).

From pin E on J/P315B, trace to pin D of the rain removal switch over wire # M6A20. Then trace into the center contact of the switch. This circuit provides power for valve operation.

Use a <u>BLUE</u> pencil. Using your BLUE pencil, draw the rain removal switch to ON. Trace the circuit from the ON contact to Pin E of the switch (J/P204).

Now, trace from pin E of the switch, following wire # M8D20 to pin A of the pressure regulator and shutoff valve. Then trace through the low pressure solenoid to pin B and from pin B, trace over wire # M4A20N to ground.

This circuit energizes the low pressure solenoid which reduces the air conditioning system pressure.

Go back to the point where wire # M8C20 taps off of wire # M8D20. Trace down to pin A of the rain removal shutoff valve.

Then trace through the limit switch and the valve motor to pin E (J/P105). Then trace from pin E over wire # M9A20N to ground. This circuit operates the rain removal valve to the open position.

As the shutoff valve reaches full open, the open limit switch moves to the opposite position. This opens the circuit to the motor and also completes the circuit between pins A and C. Both on J/P105.

Also, as the shutoff valve reaches the full open position, the CLOSE limit switch moves to the opposite position.

Trace the open limit switch so the circuit is complete from pins A to C of the shutoff valve. Draw the close limit switch to the opposite position, to complete the circuit from pin B to the close side of the shutoff valve. DO NOT trace any farther than the closed side of the motor at this time.

1399

Frame 19 (Continued)

Trace the circuit from pin C of the shutoff valve over wire # M16A20 to pin A of the bypass valve (J/P104).

From pin A of the bypass valve, trace through the OPEN limit switch and the valve motor to pin C (J/P104), and then trace over wire # M18A20N to ground.

Current flow through this circuit, operates the bypass valve to the open position.

When the bypass valve is full open, both, the OPEN and CLOSE limit switches change to the opposite position which stops the motor from running any farther.

Notice that when you place the rain removal switch ON, the shutoff valve opened first, then the bypass valve opened. Also that the low pressure solenoid energized.

The circuits you have traced so far, reduce air pressure from the pressure regulator and shutoff valve and opens the rain removal shutoff and bypass valves. This allows airflow to the rain removal nozzle.

Use a GREEN pencil. Using your green pencil, draw the rain removal switch to the OFF position. Notice that this opens the circuit to the low pressure solenoid on the bleed air pressure regulator and shutoff valve.

This action, deenergizes the low pressure solenoid and the bleed air pressure regulator can now regulate air pressure at the higher setting.

Now, trace from the OFF contact to pin F (J/P204) on the rain removal switch. Then trace from pin F over wire # M7A20 to pin B on the bypass valve.

You should remember that when the bypass valve reached the full open position both the OPEN and CLOSED limit switches moved to the opposite position.

Trace from pin B of the bypass valve, through the CLOSE limit switch and then through the valve motor to Pin C. Then trace from pin C over wire # M18A20N to ground.

This will operate the bypass valve to the closed position. As the valve reaches the full closed position, both the open and close limit switches move back to the original positions.

This means that the bypass valve will stop operating, and current will flow from pin B to pin D (J/P104).

1400

Still using your GREEN pencil, draw the open limit switch to the motor contacts and the close limit switch to the opposite position.

Trace the circuit from pin B to pin D. Then trace from pin D (J/P104) over wire # 17A20 to pin B of the shutoff valve (J/P105).

The closed limit switch has already been moved to the closed position, so current can flow from pin B through the limit switch and the valve motor to pin E.

From pin E, trace current flow over wire # M9A20N to ground. This will operate the shutoff valve to the closed position.

Notice that when the system is turned OFF, the low pressure solenoid deenergizes, the bypass valve closed first, <u>then</u> the shutoff valve closed. This is just the opposite of the way the valves opened.

NO RESPONSE REQUIRED

1401

Frame 20

There are five statements listed below that refer to the circuit you have just traced. Read each statement, then analyze the circuit to determine if the statement is true (T) or false (F).

_____1. An open in wire number M6A20 would cause the rain removal system to be inoperative.

_____2. With an open in wire number M16A20, the rain removal bypass valve would fail to open.

_____3. With an open in wire number M7A20, the rain removal bypass valve will not open.

_____4. With an open in wire number M17A20, the rain removal shutoff valve cannot be closed.

_____5. An open in the low pressure solenoid (wire number M4A20N) would cause the bleed air pressure regulator and shutoff valve to stay closed.

Answers to Frame 20: 1. T 2. T 3. F 4. T 5. F

Frame 21

Use an ORANGE pencil. Trace the windshield temperature overheat warning circuits on foldout 1. Start at the 115 volt AC windshield temperature sensing circuit breaker.

Trace from the circuit breaker to pin H on the circuit breaker panel (J/P315B).

Then trace from pin H over wire # H56A20 to pin G on terminal strip (J/P387).

Trace from pin G on J/P387 over wire # H56B20 to junction point FC5 and then continue over wire # H56C20 to pin C of the windshield temperature sensing amplifier (J/P201).

Now trace from pin C into the amp and then back out of the amp to pin D of the Sensing Amplifier (J/P201).

Trace from pin D (J/P201) over wire # H55A20N to ground.

This circuit provides 115 volts AC power for the operation of the windshield temperature sensing amplifier. If the windshield temperature is below 260°F, the relay will be energized.

Now we're going to trace the windshield temperature sensor circuit.

Using your orange pencil, start by tracing from pin E (J/P201) of the windshield temperature sensing amplifier over wire # H58A20 to the windshield sensor.

Then trace through the sensor and back to pin F (J/P201) of the windshield temperature sensing amplifier over wire # H57A20.

When the temperature increases to 260°F, the resistance of the sensor will have increased to the point at which the magnetic amplifier stops conducting. This will deenergize the relay. Draw the relay to the deenergized position.

Use a YELLOW pencil. Trace the circuit from the 14/28 volt AC warning light circuit breaker to pin A on the circuit breaker panel (J/P315B).

Then trace from pin A on the circuit breaker panel over wire # H188A20 to junction AC19.

Now trace from junction AC19 over wire # H188B20 to pin E of J/P387. Continue from pin E over wire # H188C20 to pin B of the windshield temperature sensing amplifier (J/P201).

The relay is deenergized, so current will flow through the contact to pin A on J/P201.

From pin A trace over wire # H60B20 to pin F on J/P387.

1403

Frame 21 (Continued)

Then trace from pin F over wire # H60C20 to the junction point. From here current will flow over wire # H60D20 to pin C of the warning light (J/P265).

Continue on into the light to it's ground. This circuit turns on the warning light.

The relay inside the windshield temperature sensing amplifier is controlled by the magnetic amplifier. The amplifier receives its signal from the windshield sensor.

When the windshield temperature reaches an overheat condition (above 260°F), the resistance of the sensor increases. This increase in resistance causes the amplifier to deenergize the relay. This relay then allows power to flow to the warning light, which in turn lights the warning light.

No response required, continue with the next frame.

WARNING LIGHT TEST CIRCUIT

Use a BROWN pencil. The remaining circuit to trace on foldout 1 is the warning light test circuit. This circuit enables the pilot to test the warning light circuit for proper operation.

To trace this circuit, start at the 28 volt DC warning light control circuit breaker. Trace from the circuit breaker to pin D of the circuit breaker panel (J/P315B).

Then trace from pin D over wire # L4CA20 to pin N of the warning light test switch.

Draw the switch to the test position. Trace from pin N through the switch to pin P.

Trace from pin P over wire # L50A20 to junction FC1.

Trace from junction FC1 over wire # L50B20 to pin B on the warning light control unit (J/P207B).

Trace through the relay to pin A. Then trace from pin A over wire # L82A20N to ground.

This will energize the relay in the warning light control unit, pulling the contact to the right. Draw the relay to the energized position.

Trace current from junction point AC19 over wire # L188B20 to pin P on the warning light control unit (J/P207B).

Because the relay is energized, current will flow from pin P through the contacts to pin R on J/P207B. Trace this circuit.

Now trace from pin R over wire # H60A20 to the first junction point. At the junction point, wire # H60A20 turns into wire # H60D20.

Continue tracing from the junction point over wire # H60D20 to pin C on the warning light (J/P265) and then to ground.

The warning light test circuit you have just traced will test the wiring to the light and also the light bulb itself. The circuit will not test the windshield temperature sensing amplifier.

Complete the following statement.

1. The warning light test circuit ____________ (will/will not) tell you if the windshield temperature sensor and sensing amplifier are indicating accurately.

1405

Answers to Frame 22: 1. will not

Frame 23

The statements listed below refer to the circuits that you have just traced. Read the statement, then analyze the circuit to determine if the statement is either true or false.

_____1. If the 115V AC circuit breaker were pulled (open), the warning light would remain on.

_____2. If the 14/28V AC circuit breaker were pulled (open), the warning light would not operate.

_____3. An open in wire number H58A20 would cause the warning light to come on.

_____4. An open in wire number H60D20 would cause the warning light to remain on.

_____5. A short between wires H60A20 and L188B20 would cause the warning light to remain on.

_____6. An open in wire number H56B20 would cause the warning light to remain on.

Answers to Frame 23: 1. T 2. T 3. T 4. F 5. T 6. T

Frame 24

Open foldout 2 located at the back of this text. The circled numbers on this diagram indicates an open in the circuit Read each of the problems given below and select the circled number or numbers that could cause the trouble. Place the number or numbers that you select in the blank spaces provided opposite each problem.

1. ____ ____ The WINDSHIELD TEMP HI warning light remains on with the rain removal switch off (temperature below 260°F).

2. ____ ____ When the rain removal switch is placed to the ON position, the air conditioning system pressure does not change and there is no airflow from the rain removal nozzle.

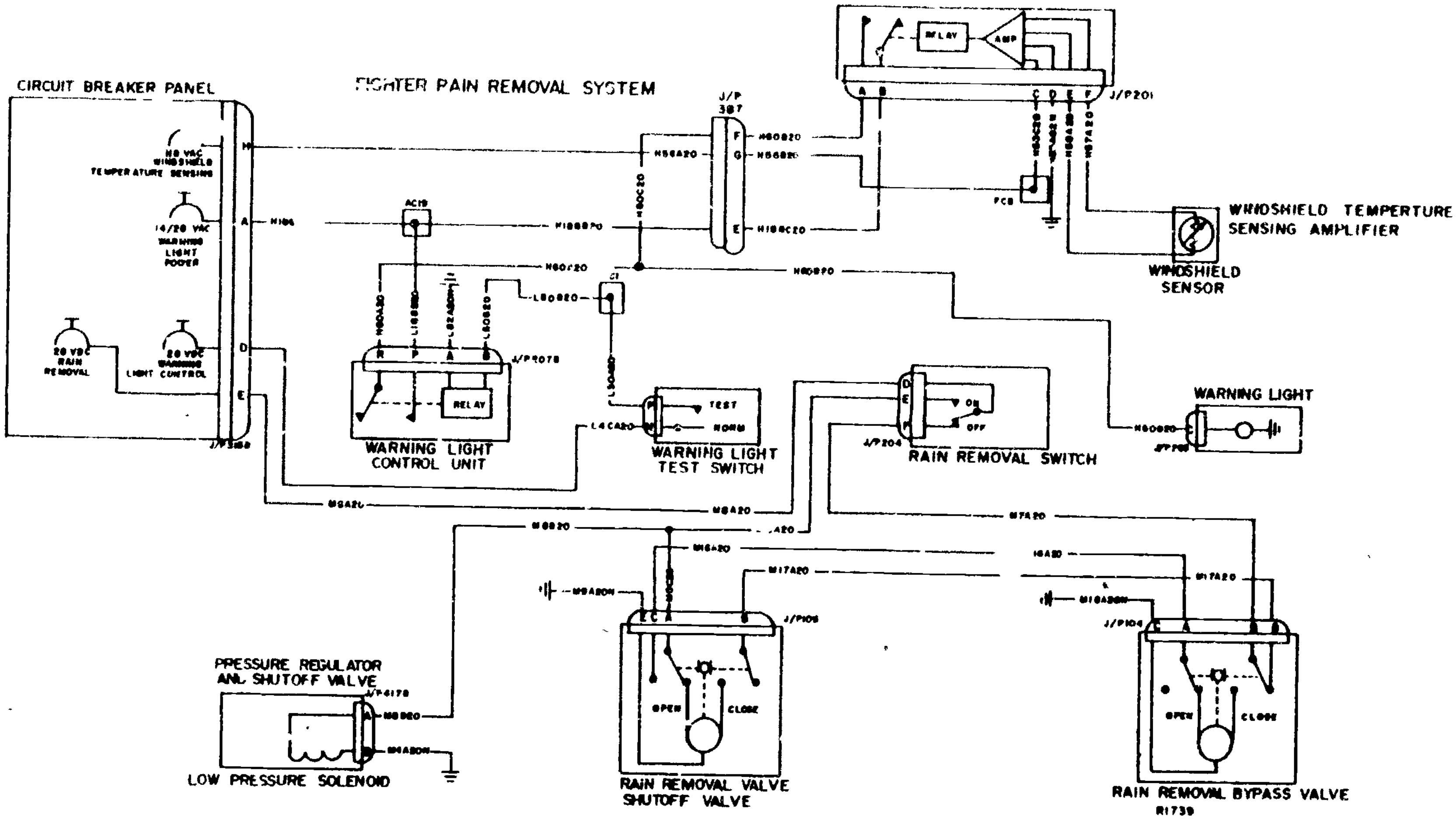
3. ____ ____ ____ The rain removal shutoff valve opens normally, but the rain removal bypass valve fails to open.

4. ____ The WINDSHIELD TEMP TEMP HI warning light is inoperative.

5. ____ ____ ____ The rain removal bypass valve closes normally, but the rain removal shutoff valve will not close.

6. ____ The rain removal valves opened normally, but when the rain removal switch is placed to OFF, both valves remain open.

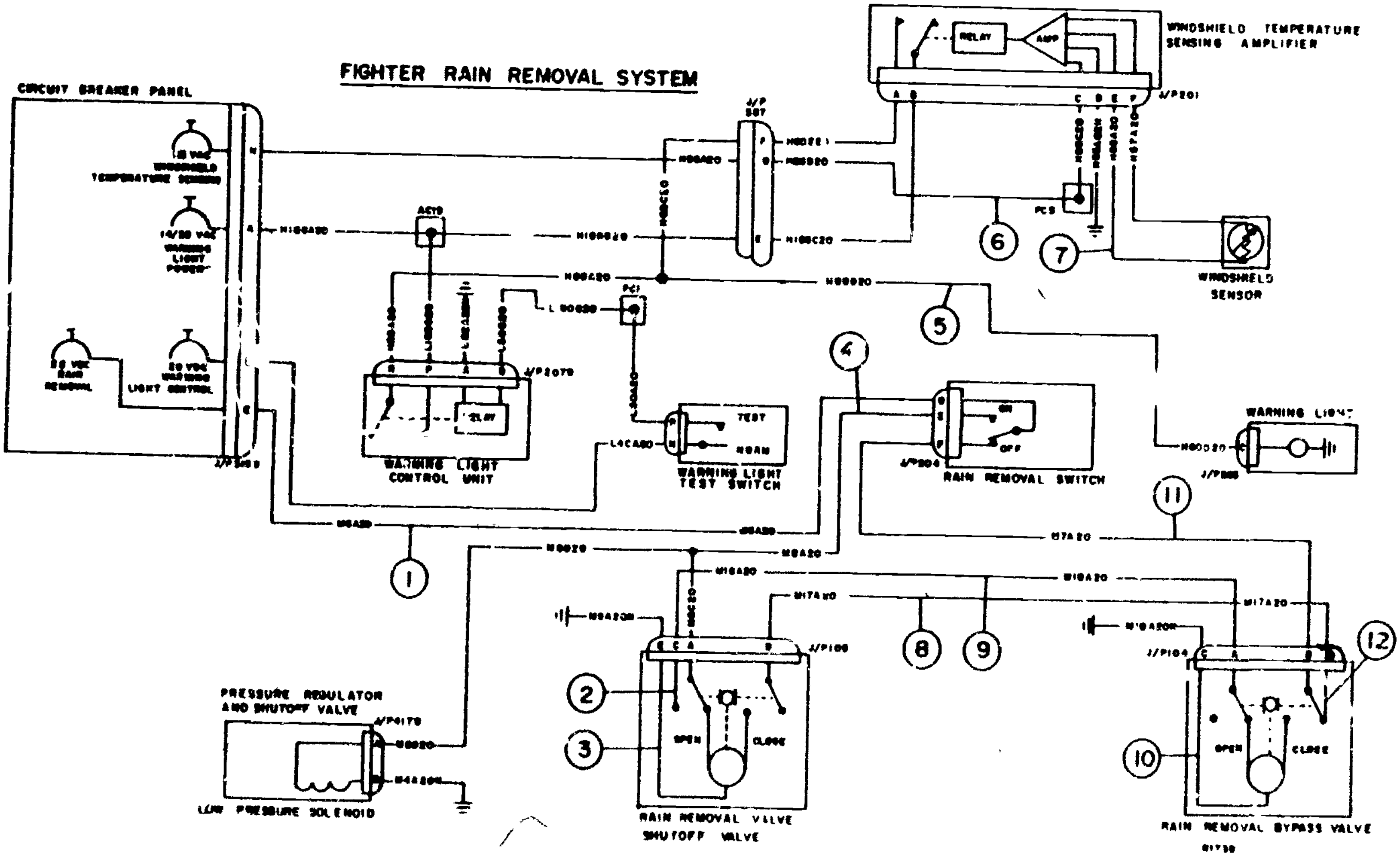
Your instructor will check your answers for correctness. Rework those problems that you have not solved correctly.



Foldout 1. Rain Removal System.

1407

1408



Foldout 2. Rain R moval System.

1409

WORKBOOK

3ABR42331-WB-202

Technical Training

Aircraft Environmental Systems Mechanic

RAIN REMOVAL SYSTEM TROUBLESHOOTING

1 July 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

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1410

Environmental Pneudraulics Branch
Chanute AFB, Illinois

3ABR42331-WB-202

RAIN REMOVAL SYSTEM AND TROUBLESHOOTING

OBJECTIVE

Using a multimeter and wiring diagram, perform an operational check and troubleshoot the rain removal system trainer, locating the cause of six out of eight troubles correctly.

EQUIPMENT

	Basis of Issue
Trainer 3336, Rain Removal System	1/student
Multimeter AN/PSM-6	1/student

PROCEDURE

1. Remove all of your jewelry. Report to the lab instructor and inform him of the lesson on which you are working. The instructor will assign you to a trainer and provide the necessary equipment.

2. This workbook is presented in two sections. Section 1 is to familiarize you with the components of the rain removal system trainer. Section 2 contains the steps for operationally checking the systems and the malfunctions that you are to troubleshoot. Perform each step as directed on the following pages. If you do not understand any part be sure to ask the instructo for assistance.

SECTION 1. RAIN REMOVAL SYSTEM TRAINER COMPONENTS

1. Locate each of the following items on the trainer. The names of the items are listed near each component.

a. Bleed air pressure regulator and shutoff valve.

Note 1: This is the pressure regulator and shutoff valve that controls air for cabin air conditioning. The controls that energize the main solenoid are not on this trainer. Since we are only concerned with the rain removal system, the only part of this regulator that will operate is the low pressure solenoid.

b. Rain removal shutoff valve.

c. Rain removal bypass valve.

Supersedes 3ABR42231-WB-202, 9 February 1973.
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d. Windshield temperature sensor.

e. Windshield temperature sensing amplifier.

f. Warning lt cont 28V DC circuit breaker.

g. Warning lt pwr 14/28V AC circuit breaker.

h. Rain removal 28V DC circuit breaker.

i. Windshield temp sensing 115V AC circuit breaker.

j. Rain removal switch.

k. Warning light test switch.

l. Overheat simulator switch.

Note 2: This switch is used to simulate a temperature rise above 260°F. When the switch is placed in the simulated overheat position it increases the resistance in the sensor circuit causing the windshield temperature sensing amplifier to turn on the warning light.

2. Trainer preparation.

a. Place all trouble switches to the OUT position. These switches are located on the right end of the trainer.

b. Push in all circuit breakers.

c. Place the rain removal switch to the OFF position.

d. Place the trainer power switches to the ON position. These switches are located on the left end of the trainer.

3. Trainer operation.

During each of the following steps you will operate each component of the rain removal and windshield temperature warning systems. When a switch is actuated be sure to notice which of the valves operate and the valve position. Actuate each switch as directed. From your observation of the trainer operation, complete each of the following statements by circling the correct word.

STEP 1. Rain removal system operation.

(1) Place the rain removal switch to ON.
The rain removal valve (opens/closes).
The rain removal bypass valve (opens/closes).
The pressure regulator and shutoff valve low pressure solenoid (energizes/deenergizes).

1412

Note 3: Since we do not have airflow through the system you cannot observe the decrease in flow to determine whether or not the low pressure solenoid is operating. However, you can check to determine if the solenoid is energizing as follows: Remove the AN electrical connector by unscrewing it from the solenoid valve. As you remove the connector you should hear an audible click as the solenoid deenergizes. Then replace the electrical connector, listening closely as you do so. You should hear the click as the solenoid is energized. Try this several times to be sure you recognize the audible sound of the solenoid energizing and deenergizing.

(2) Place the rain removal switch to OFF.
The rain removal bypass valve (opens/closes).
The rain removal shutoff valve (opens/closes).

STEP 2. Windshield temperature overheat warning system operation.

(1) Hold the windshield temperature sensor simulated overheat switch to simulated overheat position.

The WINDSHIELD TEMP HI warning light is (on/off).

(2) Release the simulated overheat switch.

The WINDSHIELD TEMP HI warning light is (on/off).

STEP 3. WINDSHIELD TEMP HI warning light test circuit operation.

(1) Hold the warning light test switch to TEST.

The WINDSHIELD TEMP HI warning light is (on/off).

(2) Release the warning light test switch.

The WINDSHIELD TEMP HI warning light is (on/off).

STEP 4. Place the trainer power switches to OFF.

COMPARE THE ANSWERS THAT YOU HAVE SELECTED TO THOSE GIVEN BELOW.

Answers to trainer operation statements.

STEP 1. (1) opens.
opens.
energizes.

(2) closes.
closes.

STEP 2. (1) on.
(2) off.

STEP 3. (1) on
(2) off.

If your answers do not agree, check with the instructor. If your answers agree, then the trainer is operating correctly.

4. Sensor resistance.

a. Knowing the normal resistance value of the sensor will be helpful when troubleshooting the system.

b. To measure the resistance of the sensor, the circuit must be isolated. To isolate the sensor circuit, disconnect the AN connector from the windshield temperature sensing amplifier. With this disconnected you can measure the sensor resistance from the check point, pins E and F at the temperature sensing amplifier. Using the multimeter, measure the resistance of the sensor.

The sensor resistance is______________.

c. Ask the instructor for the ambient temperature in the lab area.

Temperature is____________________________.

d. The graph, illustrated in figure 1 below, shows the normal sensor resistance. Using the graph, determine the resistance range for the sensor at the present ambient temperature in the lab. Is the measured resistance of the senso within the range given on the graph? (yes/no).

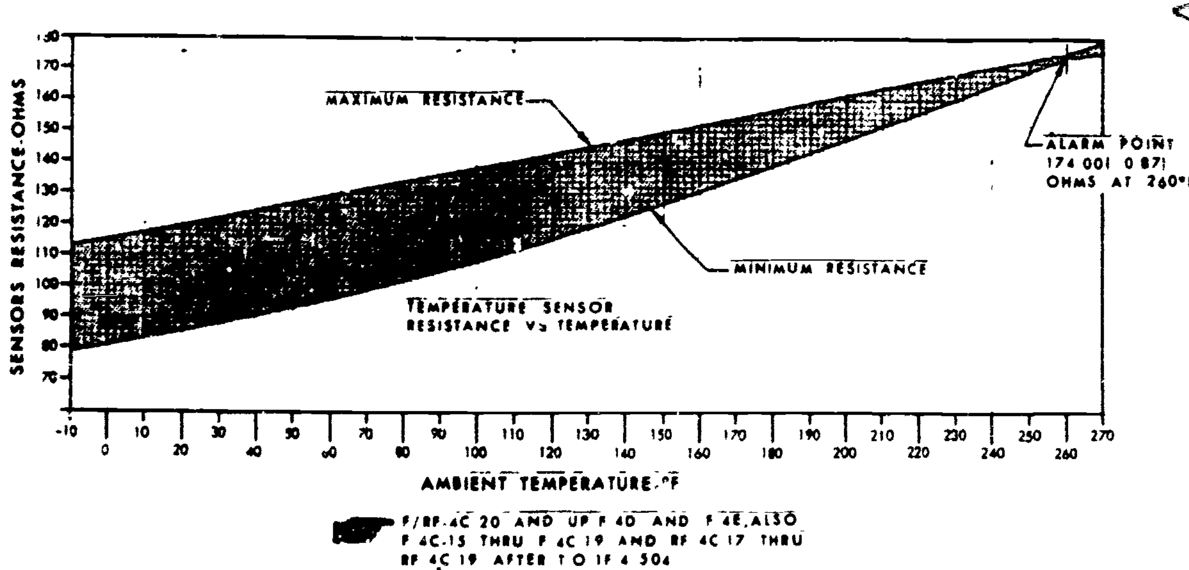

Figure 1. Windshield Temperature Sensor Resistance Graph.

Instructions for using the temperature sensor resistance graph.

Locate the vertical line for the ambient temperature. Follow this line up to the shaded area, then follow the horizontal lines to the left to determine the resistance range in ohms. The measured resistance should be within this range.

Example: If the temperature is 120°F, then the resistance should be between 112 and 142 ohms.

1414

SECTION 2. OPERATION AND TROUBLESHOOTING

OPERATIONAL CHECK

1. The steps that you performed in paragraph 3a of Section 1 involved operating each component in the rain removal and windshield temperature overheat warning systems. They determine if each component was operating properly and are called operational checks.

2. The chart below formalizes the operational check procedures in an outline form. With troubleshooting, you will be required to perform an operational check for each trouble. To insure that you are familiar with the procedure, turn on the trainer power switches and perform an operational check using the outline below. After you have completed the operational checks, continue with the troubleshooting part of this lesson.

Switch Positioning	Operating Valve or Light	Valve Position and Light Indication
Place the rain removal switch to ON.	Rain removal shutoff valve Rain removal bypass valve Low pressure solenoid WINDSHIELD TEMP HI Light	OPEN OPEN Energized* OFF
Place the rain removal switch to OFF.	Rain removal bypass valve Rain removal shutoff valve Low pressure solenoid WINDSHIELD TEMP HI light	CLOSED CLOSED Deenergized* OFF
Place the windshield temperature sensor simulating switch to simulated overheat. Hold in position.	WINDSHIELD TEMP HI light	ON
Release the sensor simulating switch.	WINDSHIELD TEMP HI light	OFF
Place the warning light test switch to TEST. Hold in position.	WINDSHIELD TEMP HI Light	ON
Release the warning light test switch.	WINDSHIELD TEMP HI light	OFF

*See Note 3

TROUBLESHOOTING

1. Perform an operational check for each trouble to determine the malfunctioning component or components.

2. Using a waxed pencil, trace the electrical circuits that operate or control the malfunctioning component.

3. Use the multimeter to locate the cause of the trouble.

Note 4: When measuring voltage, be sure the meter is set to the correct voltage range. Make sure you have the negative (black) lead to ground. This trainer does not have a common ground point, use any one of the valves for ground. Be sure the trainer power switches are OFF and the meter is set at OHMS when checking resistance.

4. Some of the troubles in this system are located inside of the component. For these troubles you should determine exactly which part of the internal circuit is causing the trouble. On the rain removal shutoff valve, rain removal bypass valve, and the low pressure solenoid there is a "J" section and a "P" section on the AN connector. The "P" section is for checking circuits coming to the component. The "J" section is used for checking the internal condition of the valve.

5. Use the trouble switches indicated on the troubleshooting answer sheet provided on the last page of this worksheet. The troubleshooting answer sheet has three columns. The first column contains the trouble switch numbers. The second column, marked discrepancy, is for you to record the malfunction. In this column state the name of the component and the condition, such as: "bypass valve won't open." In the third column, marked cause, state if it is an open or short in the circuit and the location (wire number or between two certain pins), such as: "open between pins B and E of the bypass valve."

6. We will go through trouble number 3 to show you how to arrive at the correct answer.

a. Place trouble switch number 3 to the IN position.

b. Perform an operational check. Use the operational check procedure chart, figure 2.

c. During the operational check you found the rain removal shutoff valve would not open and also the rain removal bypass valve would not open. Make the following statement in the discrepancy column for trouble switch number 3.

"Rain removal system inoperative, valves will not open."

d. When you performed the operational check you should have also noticed the low pressure solenoid on the bleed air pressure regulator and shutoff valve is energizing when the rain removal switch is ON. Knowing this is very helpful in our trouble analysis process.

e. Since there is power to the solenoid, this tells us that we do have 28-volts DC through the rain removal switch to the solenoid. Our problem must be in the circuit after the junction of wires M8A20 and M8C20. Trace the circuit from the junction to pin A of the rain removal shutoff valve (wire number M8C20), through the open side of the motor, to pin E, and through wire number M9A20N to ground.

f. Since the rain removal shutoff valve will not open, the trouble must be in the circuit traced. But why doesn't the rain removal bypass valve open? ....Remember the rain removal shutoff valve has to open all the way before the bypass valve will open.

g. Use the multimeter and check for 28-volts DC at pin A of the rain removal shutoff valve. You should read voltage at this point. Since we do have power to the valve, the trouble must be in the ground circuit or internally in the valve. Use the ohmmeter to verify this conclusion.

h. Turn the power switches OFF, and disconnect the AN connector from the rain removal shutoff valve. Check for continuity from pin E to ground. You should read continuity (zero resistance). Since this circuit is good, the trouble must be in the valve.

i. Check for continuity between pins A and E of the valve motor. Be sure to check the circuit going through the valve motor. This is done by using check point J103. If this circuit is good you should read continuity, but it will be something greater than zero because of the resistance of the motor windings. If the circuit is open the meter will read infinity. What indication did you receive? You should have an infinity reading. There is an open in this circuit. Make the following statement in the cause column of the answer sheet.

"Open between pins A and E of the rain removal valve."

j. You have completed trouble number 3. Replace the AN connector to the rain removal shutoff valve, and place trouble switch 3 to the OUT position. Place trouble switch number 1 to the IN position, perform an operational check and continue with the troubleshooting. Be sure to record your findings for each problem.

TROUBLESHOOTING ANSWER SHEET

TROUBLE SWITCH NUMBER	DISCREPANCY	CAUSE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

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INSTRUCTOR

Please check off the students accomplishment of the following items: These items are part of the objective(s) of this lesson.

ITEM	UNSAT	SAT
Practices General Housekeeping consistent with safety and fire prevention.		
Practices safe work habits and procedures.		
Follows precautions while working around danger areas.		
Use of Test Meter		

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PROGRAMMED TEXT
3ABR42331-PT-203

Technical Training

Aircraft Environmental Systems Mechanic

EQUIPMENT AIR CONDITIONING SYSTEM

27 February 1979

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3370 Technical Training Group
Chanute Air Force Base, Illinois

1420

FOREWORD

This programmed text was prepared for use in the 3ABR42331 instructional system. The materials contained herein have been validated using students enrolled in the 3ABR42331 course. Ninety percent of the students taking this text either achieved or surpassed the criteria called for in the lesson objective. The average student required 5 hours to complete the text.

OBJECTIVE

After completion of this programmed text, you will associate each equipment air conditioning component to its operation with a minimum of 80% accuracy.

INSTRUCTIONS

This programmed text presents information in small steps called "frames." After each frame you are asked to respond to the information in some way. Read the material and make your response. Compare your answers with the correct answers given on the top of the next frame. If you find you are incorrect, reread the frame to get the correct information. If you are right, and you understand the information presented in that frame, proceed on to the next frame. DO NOT skip ahead unless the text directs you to do so.

Remember, you are not graded on how fast you go. You will, however be required to take an appraisal on the material to determine what you have learned.

Supersedes ST 3ABR42331-PT-203, 14 July 1978; 3ABR42331-PT-202, 16 August 1977.
OPR: 3370 TCHTG
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3370TCHTG/TTGU-P - 400; TTVSA - 1

In this text we will cover the operation of the third air conditioning system. The first one was the system on the trainer aircraft. It was the basic air conditioning system. The second one was the cabin system on the more complex fighter aircraft.

The third system is also on the fighter aircraft. It is known as the equipment air conditioning system. As its name implies, it is an air conditioning system for the equipment.

Now you're asking yourself, "What equipment?" Well, certain electronic equipment on the aircraft will get hot during continuous operation. This can be compared to a radio or TV set. If you leave the set on for awhile, you can feel the heat coming from the back of the set. You can imagine how much damage this heat could do if it was allowed to increase. You can see that if a small air circulating fan were mounted inside your TV, the TV tubes would last longer. This will give you an idea as to why it would be beneficial to have a complete air conditioning system just for cooling the electronic equipment in an aircraft.

Here are three good reasons for having an equipment cooling system.

1. Extends component life (makes them last longer).
2. Prevents critical resistors from changing their value.
3. Prevents heat damage to equipment located in the same area, such as electrical wiring, fuel lines, etc.

Fill in the blanks to complete the following statements.

1. Keeping electronic components cool will make the components ____________ ____________.
2. The equipment cooling system is used to cool ____________ equipment.
3. The main purpose of the equipment air conditioning system is to remove the ____________ generated by certain electronic equipment.

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Answers to Frame 1: 1. last longer 2. electronic 3. heat

Frame 2

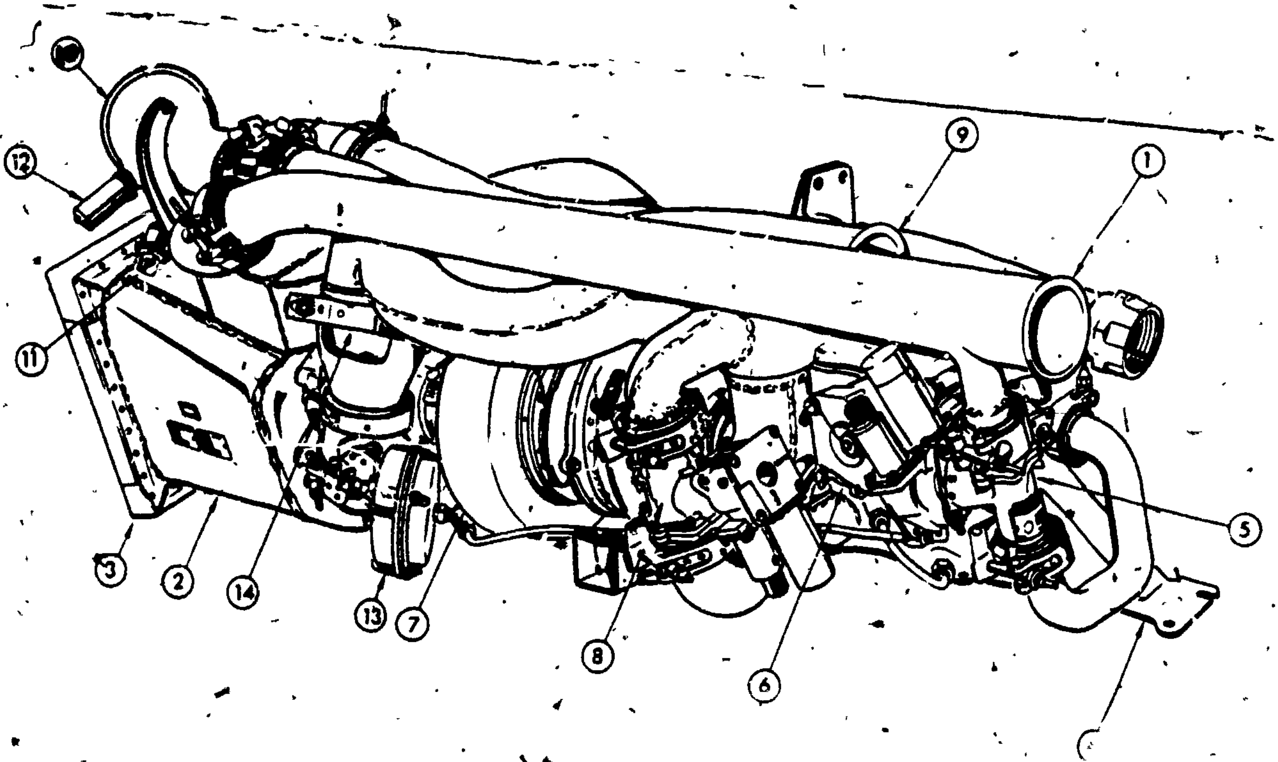
The air conditioning components for the equipment air conditioning system are grouped into an assembly called the "EQUIPMENT REFRIGERATION UNIT." This unit is often referred to as the air conditioning package.

The illustration on the opposite page shows the equipment refrigeration unit. The numbered arrows point to the major components and to the air inlet and outlets. These items, with corresponding numbers are listed below.

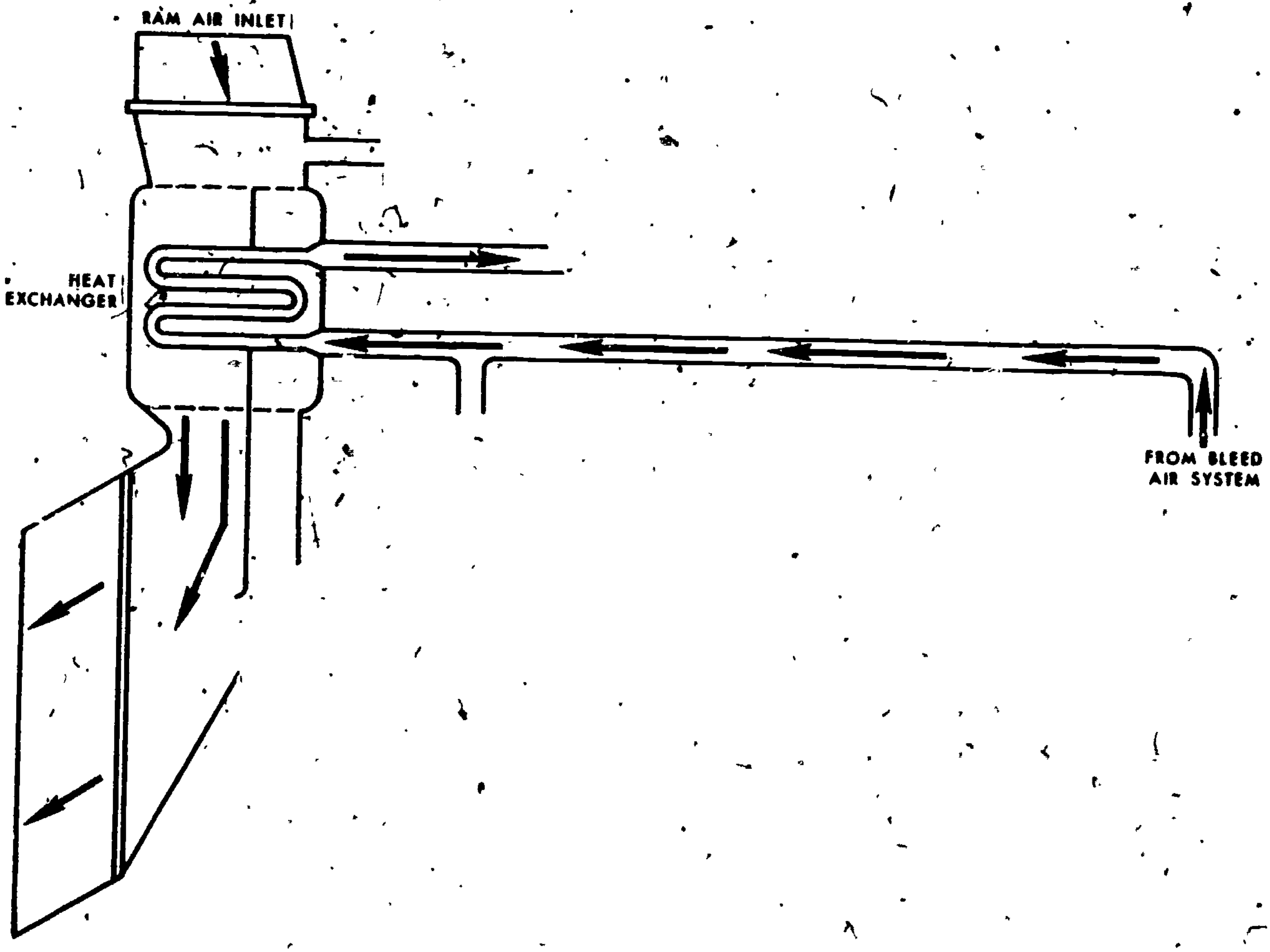
1. Engine bleed air inlet duct
2. Heat exchanger
3. Ram air inlet duct
4. Ram air outlet duct
5. Ground cooling ejector shutoff valve
6. Pressure regulator and shutoff valve
7. Turbine assembly
8. Turbine bypass valve
9. Equipment air outlet duct
10. Radar compartment air outlet
11. Temperature sensor
12. Temperature limiter
13. Ram air shutoff valve
14. Ram air check valve

In the frames that follow, each of these components will be described. As each component is described, you should refer back to the illustration of the refrigeration unit. This will help you see how each component makes up part of this system.

NO RESPONSE REQUIRED



1. Engine bleed air inlet.
2. Heat exchanger.
3. Ram air inlet duct.
4. Ram air exit duct.
5. Ground cooling ejector shutoff valve.
6. Pressure regulator and shutoff valve.
7. Turbine assembly.
8. Turbine bypass valve.
9. Equipment air outlet duct.
10. Radar compartment air outlet duct.
11. Temperature sensor.
12. Temperature limiter.
13. Ram air shutoff valve.
14. Ram air check valve.


RAM AIR INLET
HEAT EXCHANGER
FROM BLEED AIR SYSTEM

In several of the following frames, small schematic diagrams will be used to show you how the air flows through this system. These diagrams are simplified and will show only a part of the system. As you progress through the text, components will be added until the system is complete.

For example, the diagram on page 6 shows only the flow of air from the bleed air system to the heat exchanger. By following the airflow on these diagrams, it should make it easier for you to see how each component fits into this system.

From your studies of the trainer and fighter type aircraft cabin air conditioning systems, you should recall that the source of air for the air conditioning systems is from the engine bleed air system. Remember, this is hot high pressure air.

In the previous systems that you studied, the first unit in the system was the shutoff valve. Well, the equipment system is different. The first unit in this system is the <u>heat exchanger</u>. A system shutoff valve is used, but in this system, it's located after the heat exchanger.

Follow the arrows in the diagram and notice that the bleed air flows to the heat exchanger. This is an <u>air-to-air type heat exchanger</u>, similar to the cabin system heat exchanger. The bleed air flows <u>through</u> the tubes of the heat exchanger. Ram air flows in the ram air inlet, <u>over</u> the tubes and out the ram air outlet.

The heat from the bleed air is transferred to the ram air and carried overboard through the ram air outlet. The heat exchanger is the <u>first</u> stage of cooling for this system. The bleed air leaving the heat exchanger is referred to as "partially cooled air."

Remember, the ram air flows across the heat exchanger for cooling. It <u>does not</u> mix with the bleed air.

Fill in the blanks to complete the following statements.

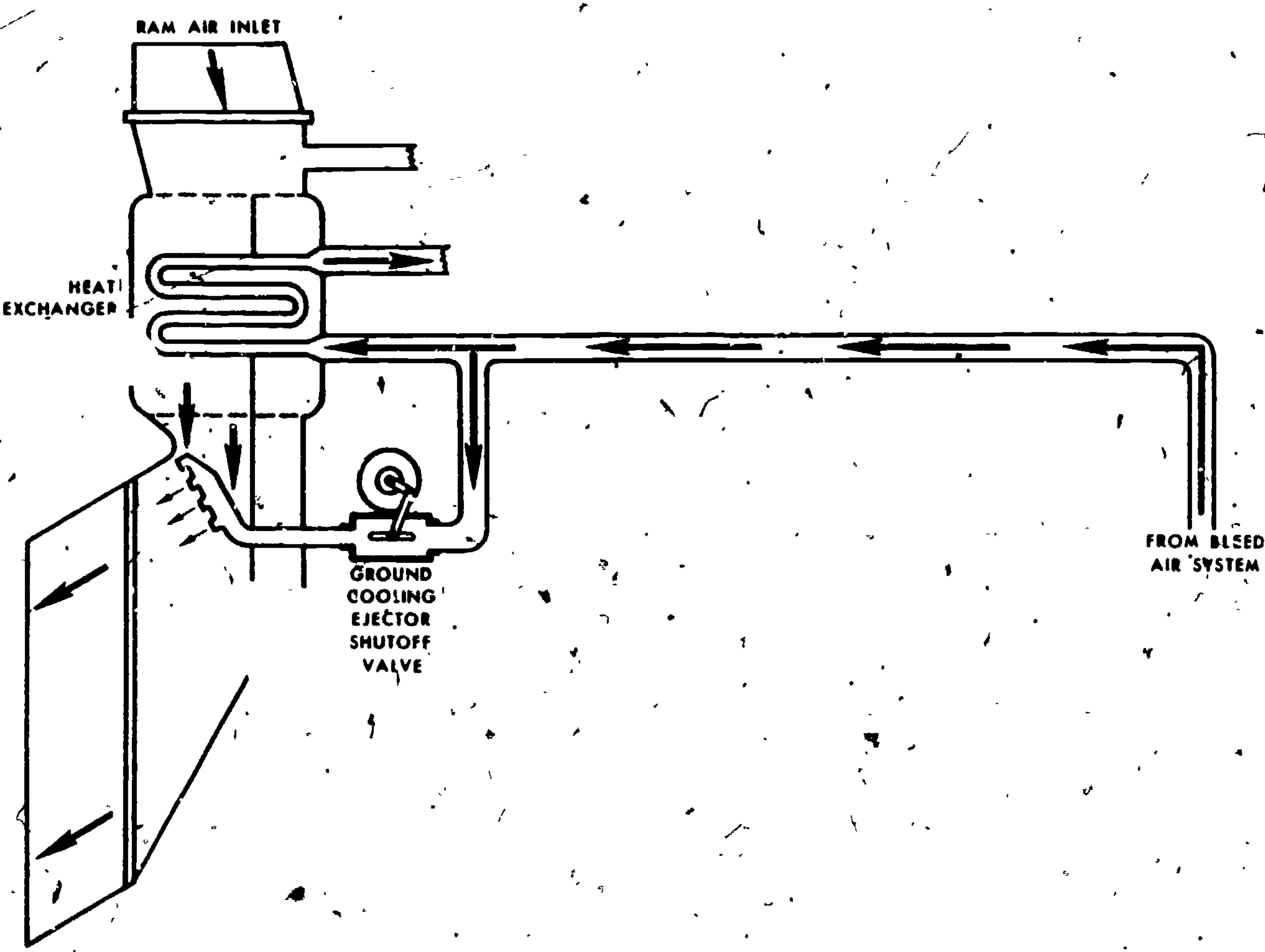
1. The unit that partially cools the bleed air is the ________ ____________________.

2. The heat exchanger is the ______________ stage of cooling.

3. The source of air for the equipment air conditioning system is the _________ __________ system.

4. As the bleed air passes through the heat exchanger, the heat is removed by the __________ ___________.

5. The engine bleed air leaving the heat exchanger is called ____________ ______ _____ air.


RAM AIR INLET
HEAT EXCHANGER
GROUND COOLING EJECTOR SHUTOFF VALVE
FROM BLEED AIR SYSTEM

1427

Answers to Frame 3: 1. heat exchanger 2. first 3. bleed air
4. ram air 5. partially cooled

Frame 4

During flight, the forward movement of the aircraft provides sufficient ram airflow for heat exchanger operation. However, when the aircraft airspeed is low or the aircraft is on the ground, ram airflow stops. Naturally, if there is no cooling ram airflow, heat exhanger efficiency is lost.

Remember, on the cabin system, a ground cooling ejector assembly was used to pull ram air across the heat exchanger. The equipment system also has a ground cooling ejector assembly that serves the same purpose and operates the same way. The ejector assembly consists of a ground cooling ejector shutoff valve and an ejector nozzle.

In the illustration on page 8, notice that bleed air is tapped from the hot air duct before it enters the heat exchanger. This air is directed to the ground cooling ejector shutoff valve.

When the landing gear handle is placed to the gear down position, a microswitch on the gear handle directs electrical power to the open side of the valve. The ground cooling ejector shutoff valve then moves to the open position. This allows the bleed air to spray out of the ejector nozzle.

This action, you should recall, causes air to be pulled in the ram air inlet, thereby creating a "ram" air action across the heat exchanger. This action lets the heat exchanger operate as if it were actually getting cooling air by ram action.

Fill in the blanks to complete the following statements.

1. The ground cooling ejector assembly consists of a ground cooling ejector ________ ________ and an ejector ________.

2. The ground cooling ejector shutoff valve is controlled by a switch on the ________ ________ ________.

3. Directing bleed air through the ejector nozzle causes ________ air to flow over the heat exchanger tubes.

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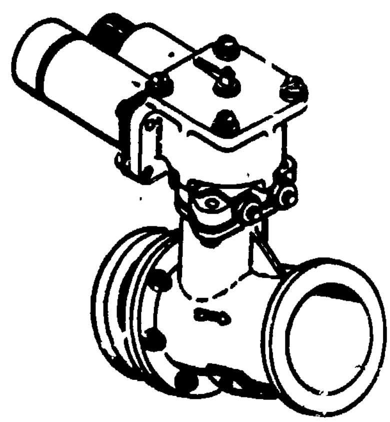
Answers to Frame 4: 1. <u>shutoff valve nozzle</u> 2. <u>landing gear handle</u> 3. <u>ram</u>

Frame 5

The equipment system ground cooling ejector shutoff valve, illustrated below, is identical to the ground cooling ejector shutoff valve used in the cabin air conditioning system.

It is a butterfly type valve, actuated by a 28 volt DC motor. The valve has a position indicator (pointer) that shows when the valve is open or closed.



Fill in the blanks to complete the following statements.

1. The unit that controls the airflow to the ground cooling ejector nozzle is the ground cooling ________________ ________________ ____________.

2. For the ground cooling ejector assembly to operate, the landing gear handle must be ________________ (up/down).

3. The ground cooling ejector shutoff valve is actuated by a ________ V DC ____________.

4. When the landing gear handle is in the gear up position, 28V DC is directed to ____________ (open/close) the ground cooling ejector shutoff valve.

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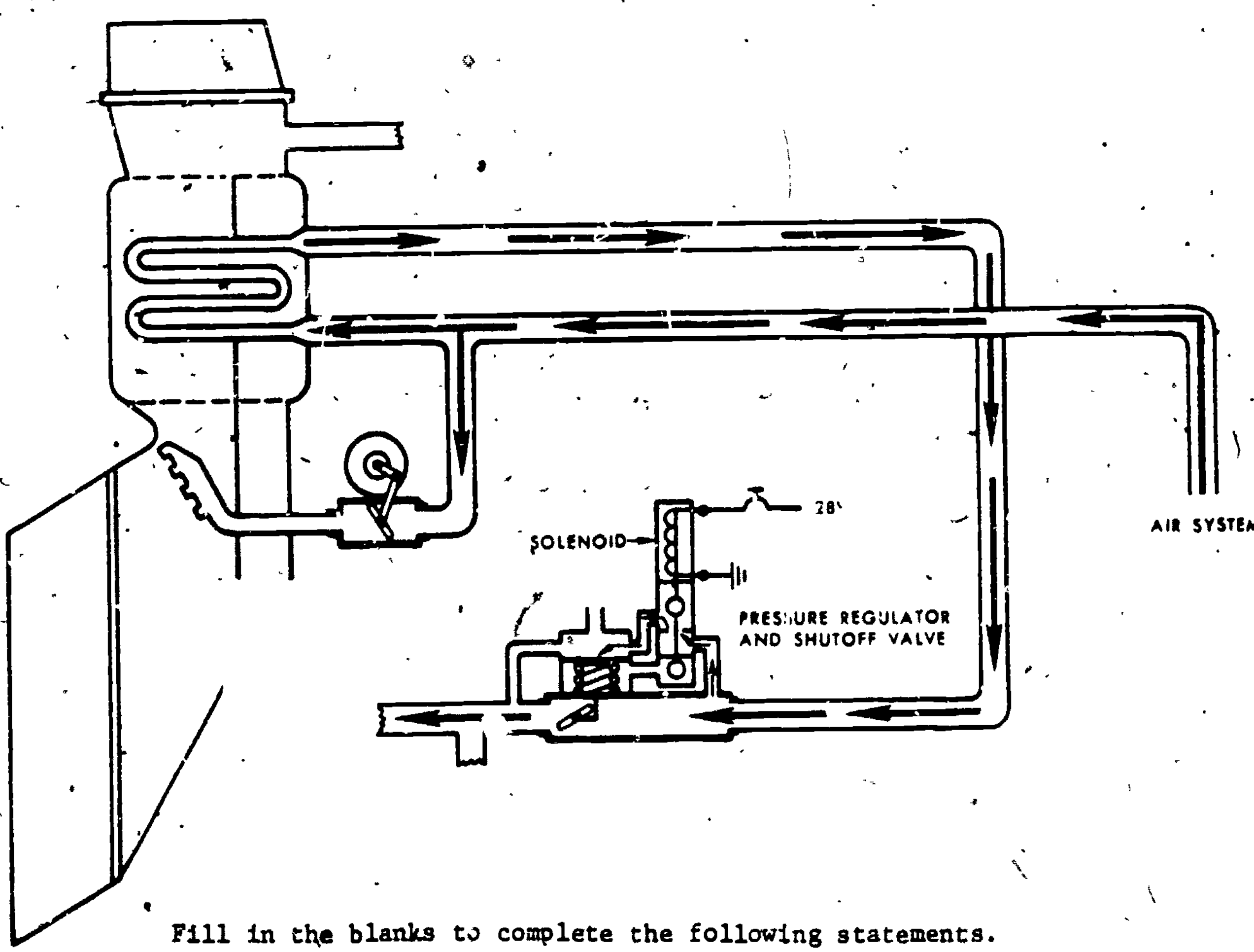
Answers to Frame 5: 1. ejector shutoff valve 2. down 3. 28, motor
4. close

Frame 6

After the air is partially cooled by the heat exchanger it goes to the pressure regulator and shutoff valve. The illustration below shows the pressure regulator and shutoff valve. The arrows show the bleed airflow through the heat exchanger and pressure regulator and shutoff valve.

The equipment system pressure regulator and shutoff valve is similar to the cabin system pressure regulator and shutoff valve. Remember, it served two purposes. The equipment system pressure regulator and shutoff valve also serves two purposes.

The two purposes are just as the name implies, that is, to serve as a control for stopping or starting the system, and for regulating the pressure going through the equipment air conditioning system. The pressure is regulated at 106 psi.



Fill in the blanks to complete the following statements.

1. The unit that controls the pressure of the partially cooled air is the ____________ ____________ and shutoff valve.

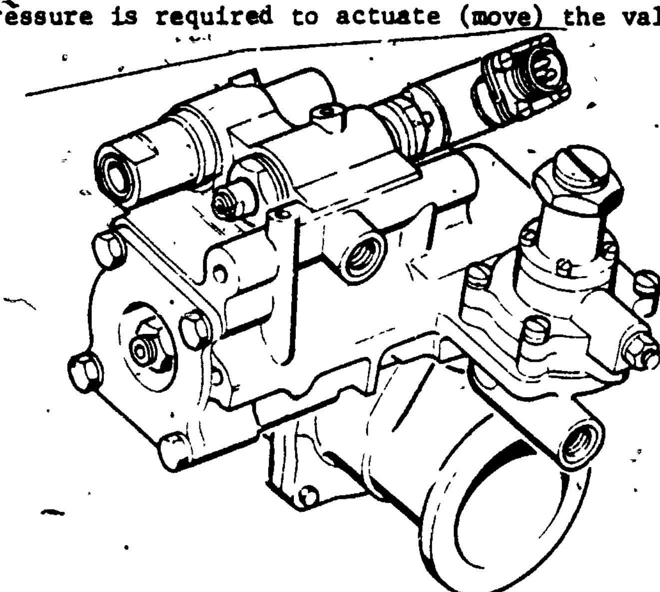
2. The unit used to shutoff the equipment air conditioning system is the ________ ________ ____ _____ __________.

Answers to Frame 6: 1. pressure regulator 2. pressure regulator and shutoff valve

Frame 7

The pressure regulator and shutoff valve, shown below, is a solenoid controlled, air actuated valve.

This means electrical power is required to energize the solenoid and air pressure is required to actuate (move) the valve open.



Referring back to the illustration in frame 6, note that air is tapped off upstream of the butterfly and sent through the solenoid to the valve actuator.

When the solenoid is energized, as shown, this air is sent to the top of the actuator which forces the actuating piston down. This opens the valve.

When the solenoid is deenergized, air is vented from the top of the actuator which will let the spring close the valve. However, air is also sent from the solenoid to the bottom of the actuator where it aids the spring and insures positive closing of the valve.

When the valve opens, the downstream pressure builds up to 106 psi. This pressure is sensed by a pressure control device on the valve. The pressure control device causes the valve to maintain a partially open position, sufficient to maintain the 106 psi through the system.

The illustration in frame 6 also shows a basic electrical schematic for solenoid operation. Notice that power goes directly from the circuit breaker to the solenoid. There is no control switch for turning the system on or off.

Under normal conditions, when electrical power is applied to the aircraft, the pressure regulator and shutoff valve solenoid will be energized. Then as the engines are started and bleed air is available, the equipment air conditioning system will start operating automatically.

If it is desired to shut this system off, the equipment cooling circuit breaker can be pulled. This will stop electrical current going to the solenoid, causing the solenoid to deenergize, closing the pressure regulator and shutoff valve.

Fill in the blanks to complete the following statements.

1. The pressure regulator and shutoff valve is controlled by a ________________ and actuated by ____________________ ________________.

2. When the solenoid is deenergized, the valve is closed by ________________ tension and ____________ ____________.

3. When the engines are operating, to turn off the equipment air conditioning system, the ____________ ____________ must be pulled.

4. Operation of the pressure regulator and shutoff valve, requires ____________ ____________ and ____________ power.

5. The pressure regulator and shutoff valve will maintain a constant pressure of _____ psi.

Answers to Frame 7: 1. solenoid air pressure 2. spring air pressure

3. circuit breaker 4. air pressure 28V DC

5. 106

Frame 8

The sketch below shows the partially cooled air flowing to the turbine inlet of the turbine assembly. The turbine assembly is the second and final stage of cooling for this system.

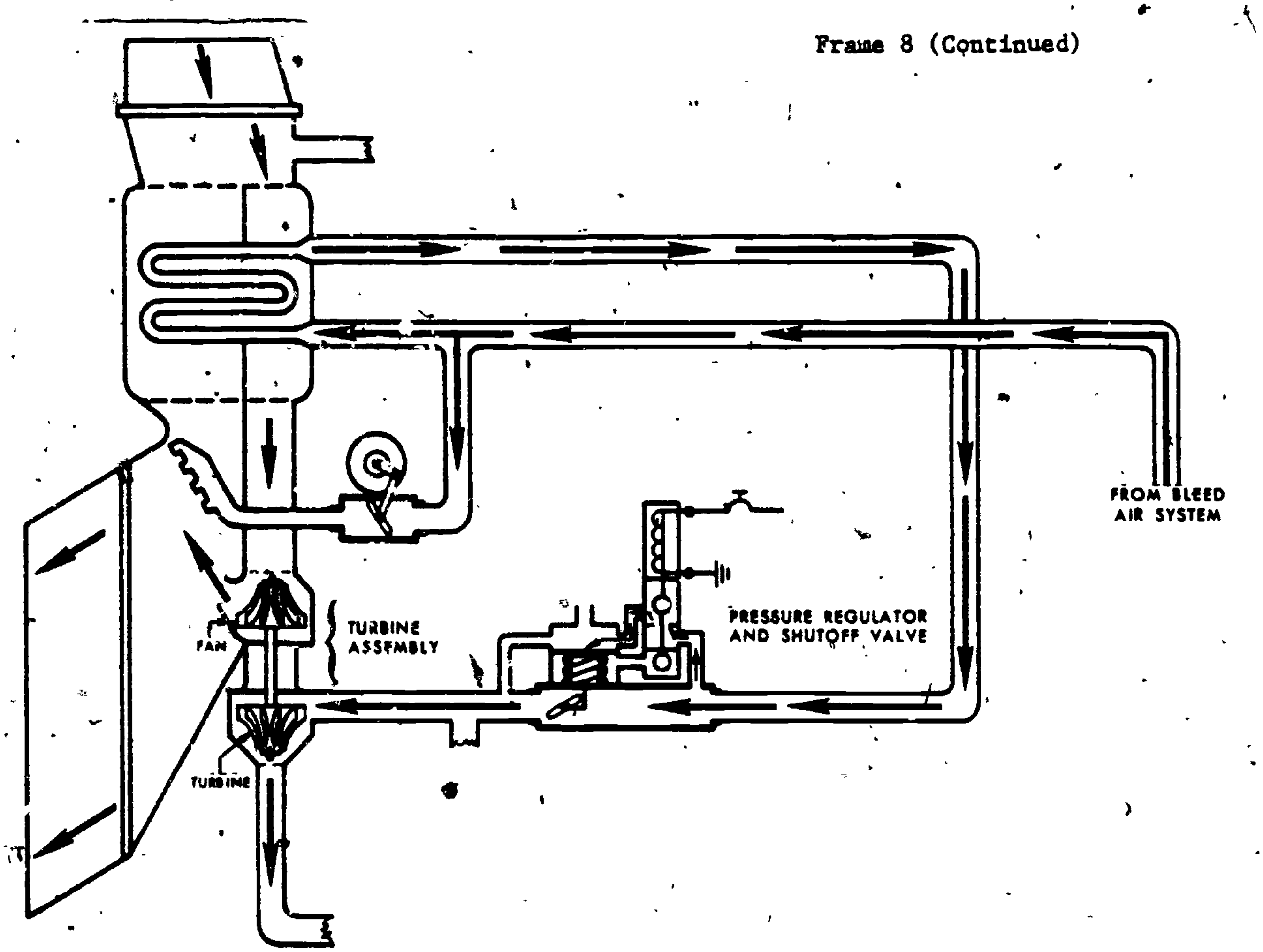
The partially cooled bleed air is piped to the inlet of the turbine assembly. This air spins the turbine, lets go of its heat energy, and comes out of the turbine outlet as very cold air. The operation of this turbine assembly is the same as those you have studied previously.

As the air goes in the turbine inlet, it passes through several small nozzles which direct the air to the turbine wheel. This will cause the turbine wheel to spin and will result in rapid expansion of the air. When air is expanded, the temperature drops. This process of cooling the air is known as rapid expansion.

Note in the sketch that the turbine and fan are connected by a shaft. As the turbine wheel spins it also turns the fan. The fan pulls ram air in through the ram air inlet, and over the heat exchanger tubes.

The ram air passes through the fan and is discharged overboard. In this process the fan is putting a workload on the turbine. By putting a workload on the turbine, the fan is taking energy from the turbine. This takes the heat energy from the air and converts it to mechanical energy. By putting a workload on the turbine, the fan also helps to keep the turbine from overspeeding.

Frame 8 (Continued)



Fill in the blanks to complete the following statements.

1. The partial cooled air contains energy in the form of ____________ energy.

2. When the air drives the turbine and fan, the heat energy is changed to ____________ energy.

3. The turbine assembly cools air by __________ __________ and by changing ____________ energy to ______________ energy.

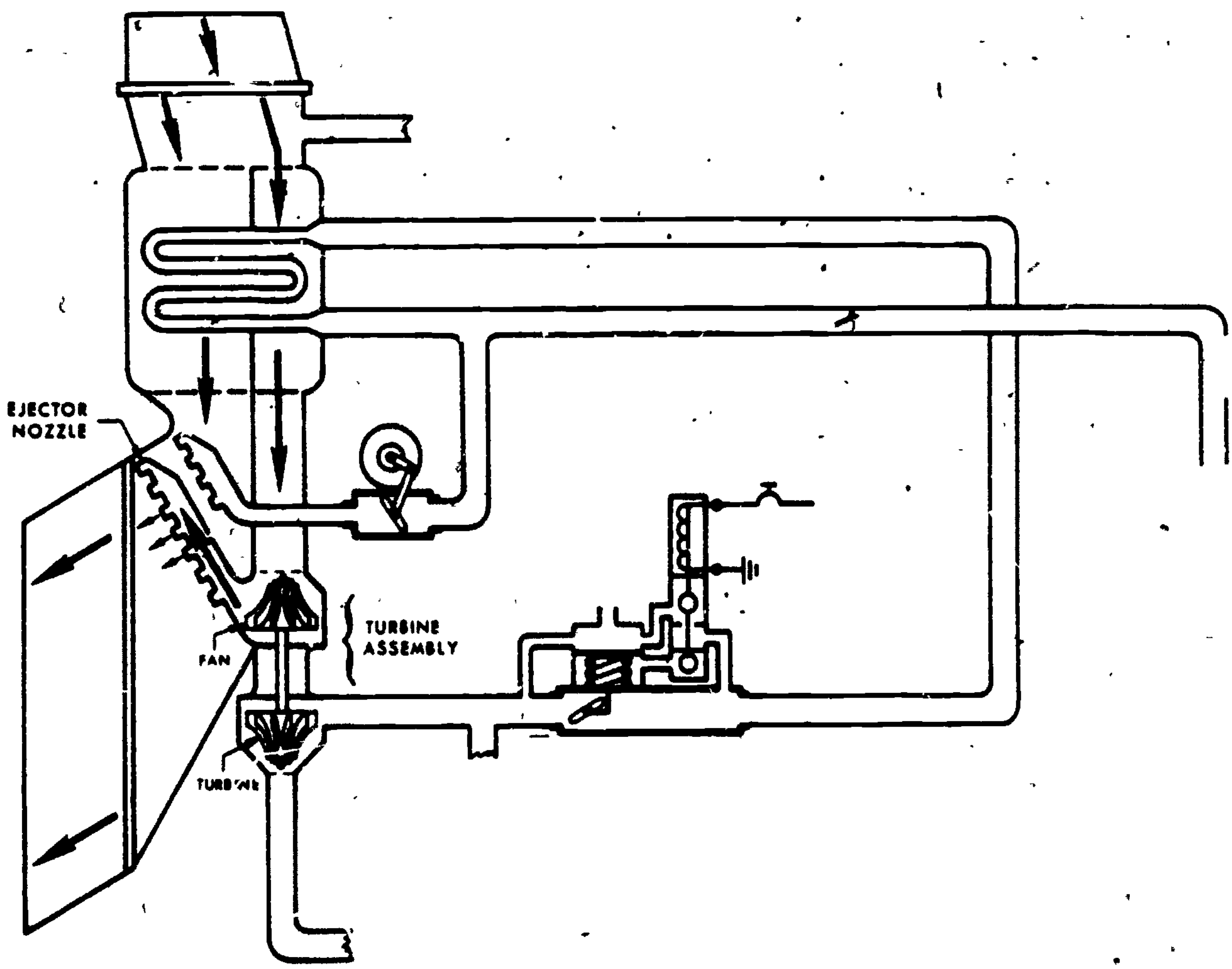
4. The fan pulls ____________ air over the heat exchanger tubes.

Answers to Frame 8: 1. heat 2. mechanical 3. rapid expansion heat mechanical 4. ram

Frame 9

The sketch below shows a second ejector nozzle. Note how the air from the fan is directed through this nozzle. The action of the fan and this ejector nozzle increases the ram airflow across the heat exchanger.

The fan pulls ram air across the heat exchanger, and as this air is discharged through the fan ejector nozzles, it causes a low pressure area behind the nozzle assembly. The low pressure area then causes air to be pulled in through the ram air inlet and across the heat exchanger.



Fill in the blanks to complete the following statements.

1. The fan and ejector nozzle help to pull ________ ________ across the heat exchanger.

2. The airflow across the heat exchanger is increased when the aircraft is on the ground and in flight by the ________ and ________ ________.

Answers to Frame 9: 1. ram air 2. fan ejector nozzle

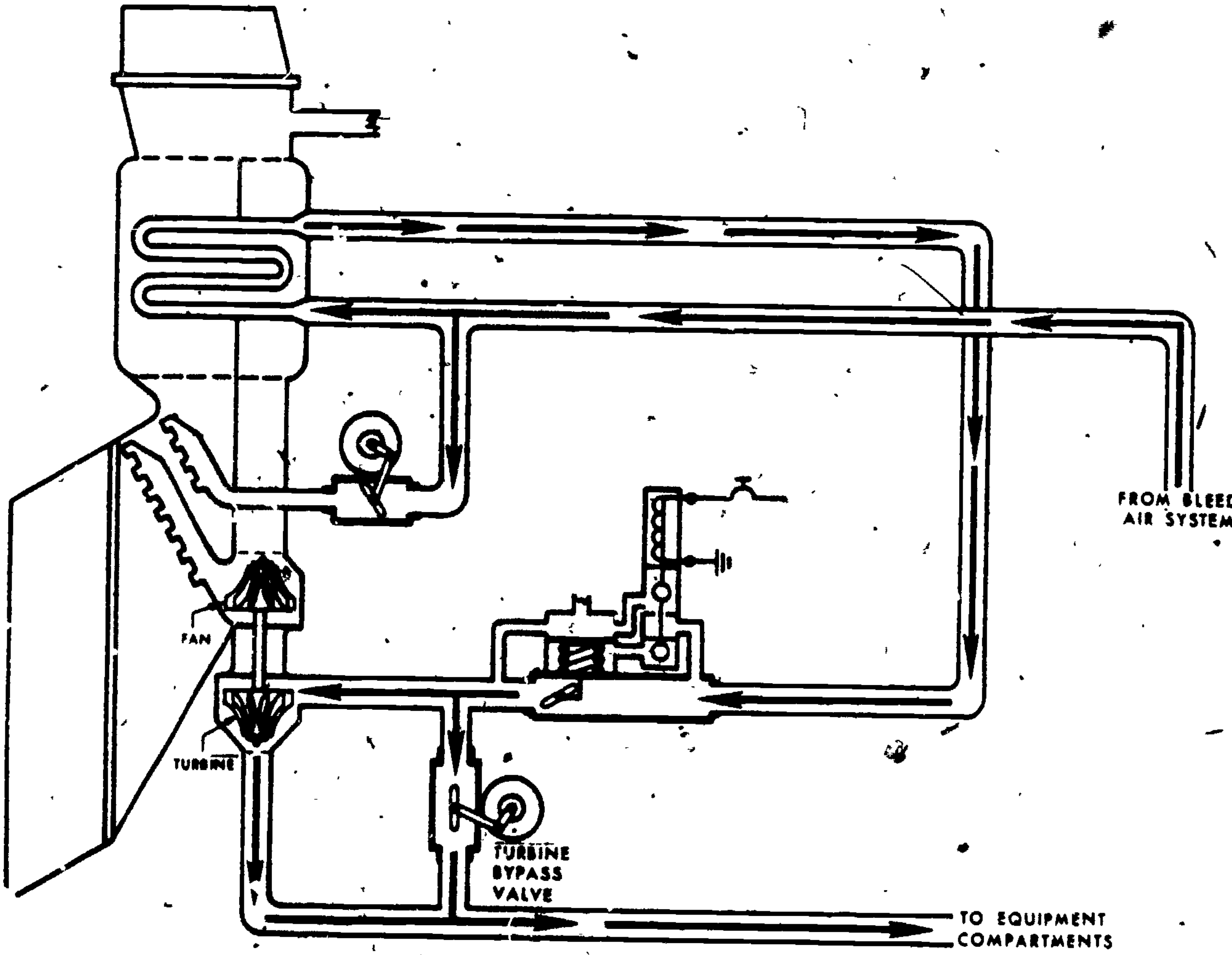
Frame 10

In the system that we have assembled so far, we can get only cold air. From the previous systems that you have studied, you should recall that temperature can be controlled by mixing the hot and cold air together. Let us see how it is done in this system.

In the sketch shown, a turbine bypass valve has been added. The purpose of this valve is to control the temperature of the conditioned air going to the electronic equipment compartments. It does this by either directing the partially cooled air in or by bypassing the turbine.

If the system calls for cold air, the valve starts to close, directing more air to the turbine. Now the electronic compartments get cold air.

If the system calls for hotter air, the bypass valve opens and air bypasses the turbine. Now the electronic equipment compartments get warm air. The desired temperature is kept by mixing the cold air from the turbine and the warm air from the turbine bypass valve.



Frame 10 (Continued)

Fill in the blanks to complete the following statements.

1. The temperature of the air entering the equipment compartments is controlled by the position of the ______ ______ ______.

2. When the turbine bypass valve is fully closed, the air entering the equipment compartments will be ______ (cold/hot).

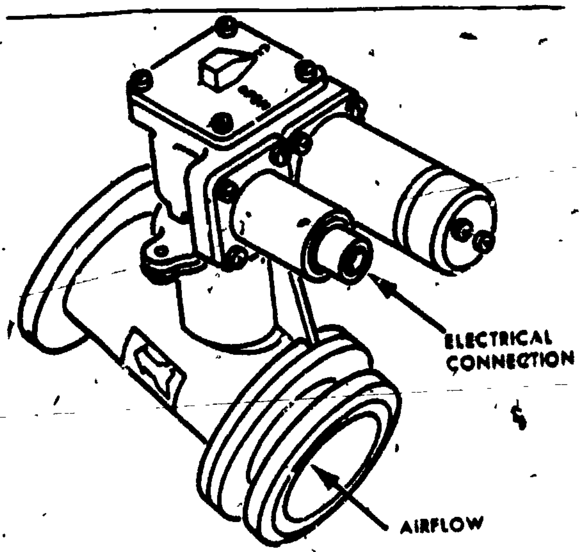
3. If the system calls for warmer air, the turbine bypass valve will move toward the ______ (open/closed) position.

Answers to Frame 10: 1. turbine bypass valve 2. cold 3. open

Frame 11

The turbine bypass valve is shown below. This is a butterfly type valve, actuated by a 28 volt DC motor.

A position indicator is found at the top of the actuator. The position indicator shows the position of the butterfly and is marked OPEN-CLOSED.



Remember, when the valve is OPEN, the system is getting maximum hot air.

When the valve is closed, the system will receive maximum cold air.

Control of this valve is fully automatic. There is no manual control of this system as there is in the cabin system.

Fill in the blanks to complete the following statements.

1. The turbine bypass valve is actuated by a ______________ ______________ ______________.

2. When the turbine bypass valve is installed on the refrigeration unit, the position of the butterfly can be determined by observing the ______________ ______________.

3. Operation of the turbine bypass valve is completely ______________.

4. The desired temperature is maintained in the electronic compartments by mixing ______________ and ______________ air.

5. Any time the equipment air conditioning system is on, operation of the turbine bypass valve is fully ______________.

1438 Answers to Frame 11: 1. 28V DC motor 2. position indicator 3. automatic 4. hot, cold 5. automatic

Frame 12

This frame is designed to check your understanding of the information that has been given so far. You are to fill in the blanks to correctly complete each of the following statements. Completing the statements may require one or more words. Try to complete each statement without looking back. Then check your answers at the back of the text. If your answers are incorrect, then back up and reread the frame that gave the information.

1. The first stage of cooling is the ________ ________.

2. As the bleed air flows through the heat exchanger, the heat is transferred to the ________ ________.

3. The unit that helps to pull ram air across the heat exchanger when the aircraft is on the ground is the ________ ________ ________ ________.

4. The ground cooling ejector shutoff valve is controlled by the ________ ________ ________.

5. The ground cooling ejector shutoff valve is actuated by a ________ ________.

6. The unit that controls system pressure at 106 psi is the ________ ________ ________ and ________ ________.

7. The pressure regulator and shutoff valve is ________ controlled and ________ actuated.

8. The pressure regulator and shutoff valve is held closed by ________ ________ and ________ ________.

9. The pressure regulator and shutoff valve will open when the solenoid is ________.

10. The second stage of cooling for the equipment system is the ________ ________.

11. The unit that directs bleed air either into or around the turbine assembly is the ________ ________ ________.

12. The turbine assembly is driven by ________ ________.

13. Temperature control is accomplished by mixing ________ and ________ ________.

14. During flight, the units that help to pull ram air across the heat exchanger are the ________ and ________ ________ nozzles.

15. With the turbine bypass valve closed, if the system fails to deliver cold air, either in flight or on the ground, a probable defective unit would be the ________ ________.

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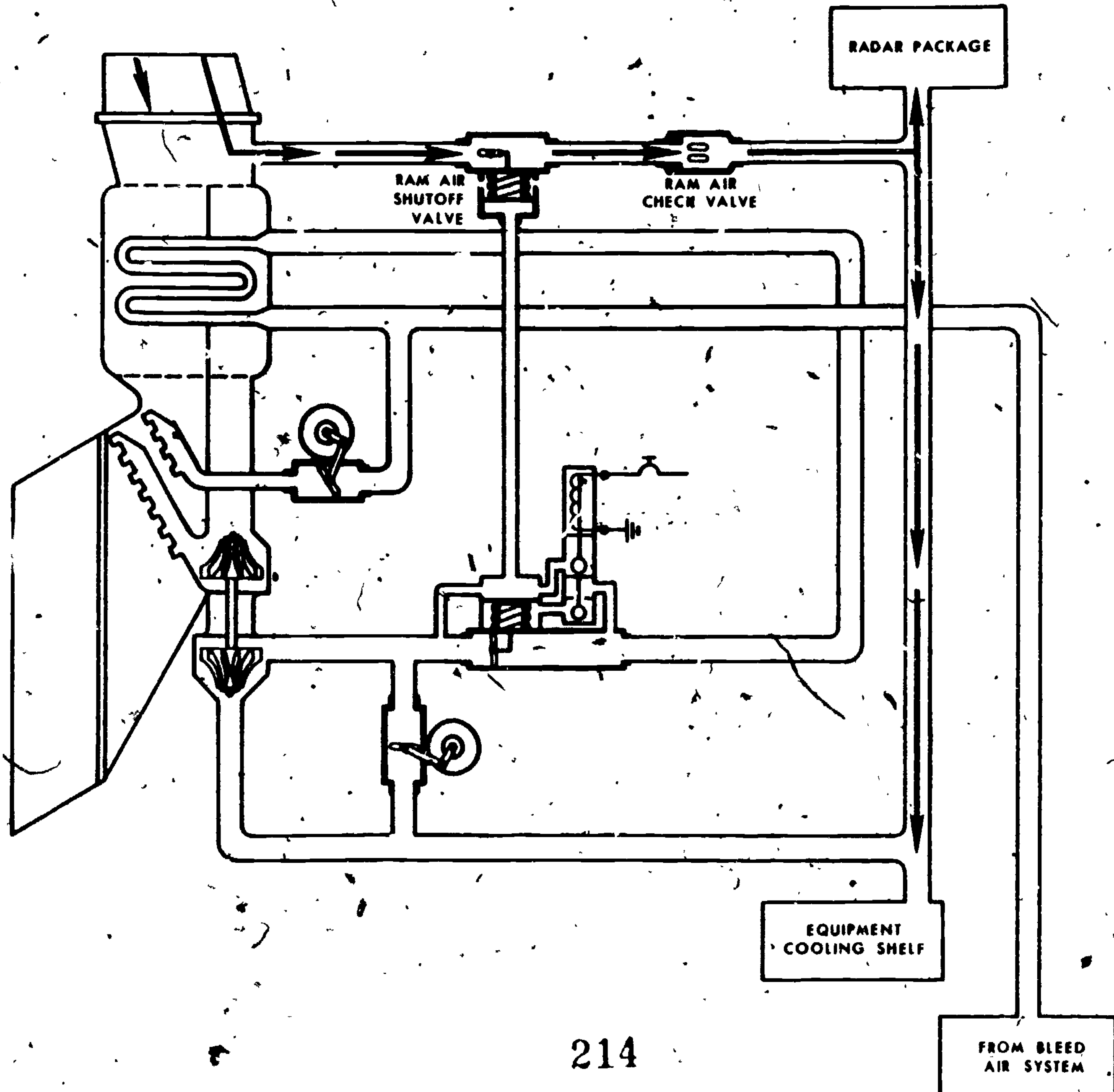

RADAR PACKAGE
RAM AIR SHUTOFF VALVE
RAM AIR CHECK VALVE
EQUIPMENT COOLING SHELF
FROM BLEED AIR SYSTEM

Answers to Frame 12: 1. heat exchanger 2. ram air 3. ground cooling ejector assembly 4. landing gear handle 5. 28V DC motor 6. pressure regulator and shutoff valve 7. solenoid air 8. spring tension air pressure 9. energized 10. turbine assembly 11. turbine bypass valve 12. bleed air 13. hot and cold air 14. fan fan ejector 15. turbine assembly

Frame 13

Like any other system, there is always the chance of a malfunction that would cause the air conditioning system to be inoperative. For example, the pressure regulator and shutoff valve could fail to work and stay closed, or the system could overheat due to the loss of the turbine assembly or the bypass valve.

In any case, this would stop the flow of conditioned air to the electronic compartments. However, it is important that some form of cooling air be available to prevent complete failure of the electronic equipment.

In case of failure of the air conditioning system, a ram air shutoff valve is provided that will open automatically and allow ram air to flow through the electronic equipment compartments. This is an emergency way to get some cooling airflow.

The sketch on the opposite page shows the ram air shutoff valve and a ram air check valve added to our system. The check valve will be explained in a later frame.

The ram air shutoff valve will be open any time the pressure regulator and shutoff valve is closed. Notice that when the ram air valve is open, ram air can flow from the ram air inlet, through the ram air shutoff valve and to the electronic compartments.

Control of the ram air valve is completely automatic. During normal operation of the air conditioning system, the ram air valve will be held closed by air pressure from the pressure regulator and shutoff valve. If there is no bleed air in the system, or if the pressure regulator and shutoff valve is deenergized, the ram air valve will be opened by spring tension.

Fill in the blanks to complete the following statements.

1. In case of failure of the air conditioning system, the electronic equipment will be cooled by ________ ________.

2. The unit that opens and allows ram air to enter the electronic compartments is the ________ ________ ________ ________.

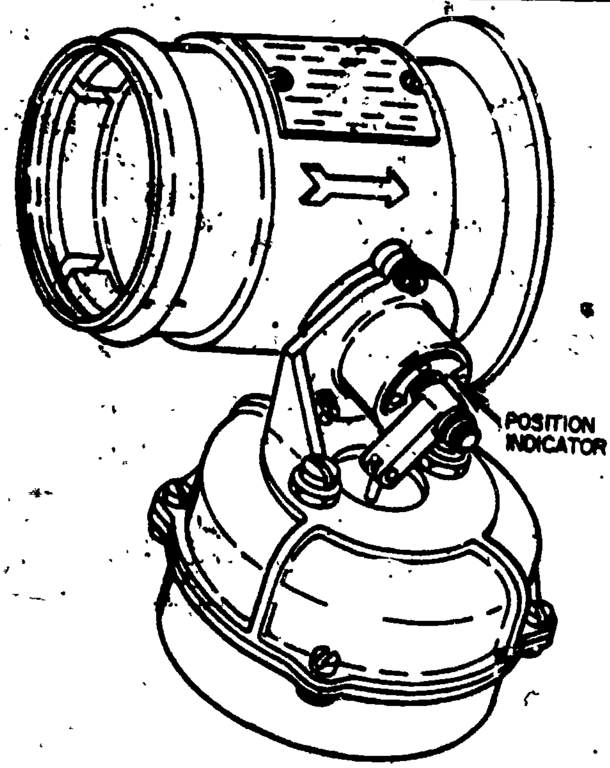
3. Any time the pressure regulator and shutoff valve is closed the ram air valve will be ________.

1442

Answers to Frame 13: 1. ram air 2. ram air shutoff valve 3. open

Frame 14

The ram air valve is shown below. It is made up of a pneumatic actuator and a butterfly type valve. It is spring loaded open and closed by air pressure.



We said in the previous frame that the ram air valve is controlled automatically. We also said previously that the pressure regulator and shutoff valve is controlled automatically.

The ram air valve is controlled by the pressure regulator and shutoff valve. Now let's see how operation of the pressure regulator and shutoff valve controls both of these valves automatically.

Look back at the sketch in frame 13 and note the air control line going from the pressure regulator and shutoff valve to the ram air valve actuator.

When the solenoid on the pressure regulator and shutoff valve is energized, it allows air pressure to enter the top of the pressure regulator and shutoff valve, opening this valve. At the same time, this air pressure is directed by the small air control line to ram air valve actuator. This pressure will overcome the spring tension, closing the ram air shutoff valve. This is normal operation; the pressure regulator and shutoff valve is open and the ram air valve is closed. The system is receiving conditioned air.

However, if a malfunction causes the pressure regulator and shutoff valve to close, or if the equipment cooling circuit breaker is pulled, no conditioned air will be available. Also since the solenoid is deenergized, no air will enter the small control line to the ram air valve, so the valve will be spring loaded open. When the ram air valve opens, ventilating air flows into the electronic compartments for cooling.

Notice that this sequence operation depended only on whether or not the solneoid on the pressure regulator and shutoff valve was energized or not. Also notice the absence of electrical connections to the ram air valve. The ram air valve is strictly pneumatically closed and spring loaded open.

This valve also has a position indicator to show when the valve is open or closed. The position indicator is located on the end of the actuator shaft, and is marked OPEN-CLOSED.

Fill in the blanks to complete the following statements.

1. The ram air shutoff valve is opened by __________ __________.

2. Opening and closing of the ram air shutoff valve is controlled by the __________ __________ and __________ __________.

3. The ram air shutoff valve is held closed by __________ __________.

4. The position of the ram air shutoff valve can be determined by observing the __________ __________.

1444

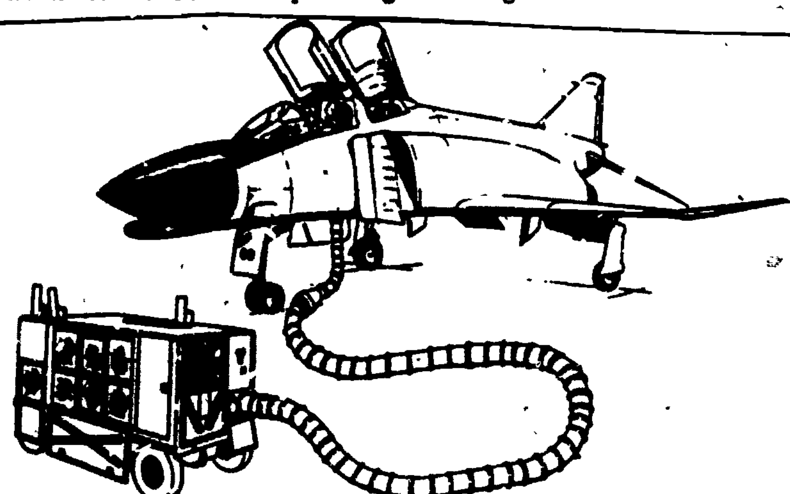
Answers to Frame 14: 1. spring tension 2. pressure regulator and shutoff valve 3. air pressure 4. position indicator

Frame 15

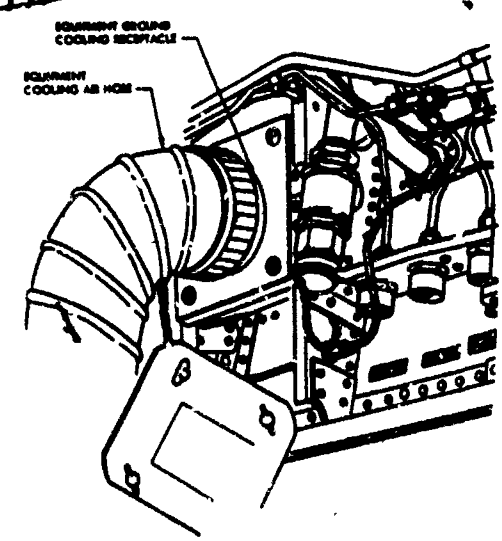
The illustration below shows a portable ground air conditioning unit being used to cool the electronic equipment compartments. The portable air conditioning unit is used when the electronic equipment is operated for ground checking.

You may be wondering, why not use the electronic equipment air conditioning system to cool the equipment? It could be used. But remember, for the electronic equipment air conditioning system to operate, the engines must be operated to supply the air.

By using the ground cooling cart instead of operating the engines, we will save the fuel required to operate the engines and also save the maintenance cost of repairing the engines.



A ground cooling connection is provided. This connection allows a ground cooling cart to cool the electronic equipment compartment when the engine(s) are not running.



Equipment Ground Cooling Connections

Fill in the blanks to complete the following statement.

1. The unit which is used to cool the equipment during ground operation without running the engines is the ____________ ____________ ____________ ____________.

1445

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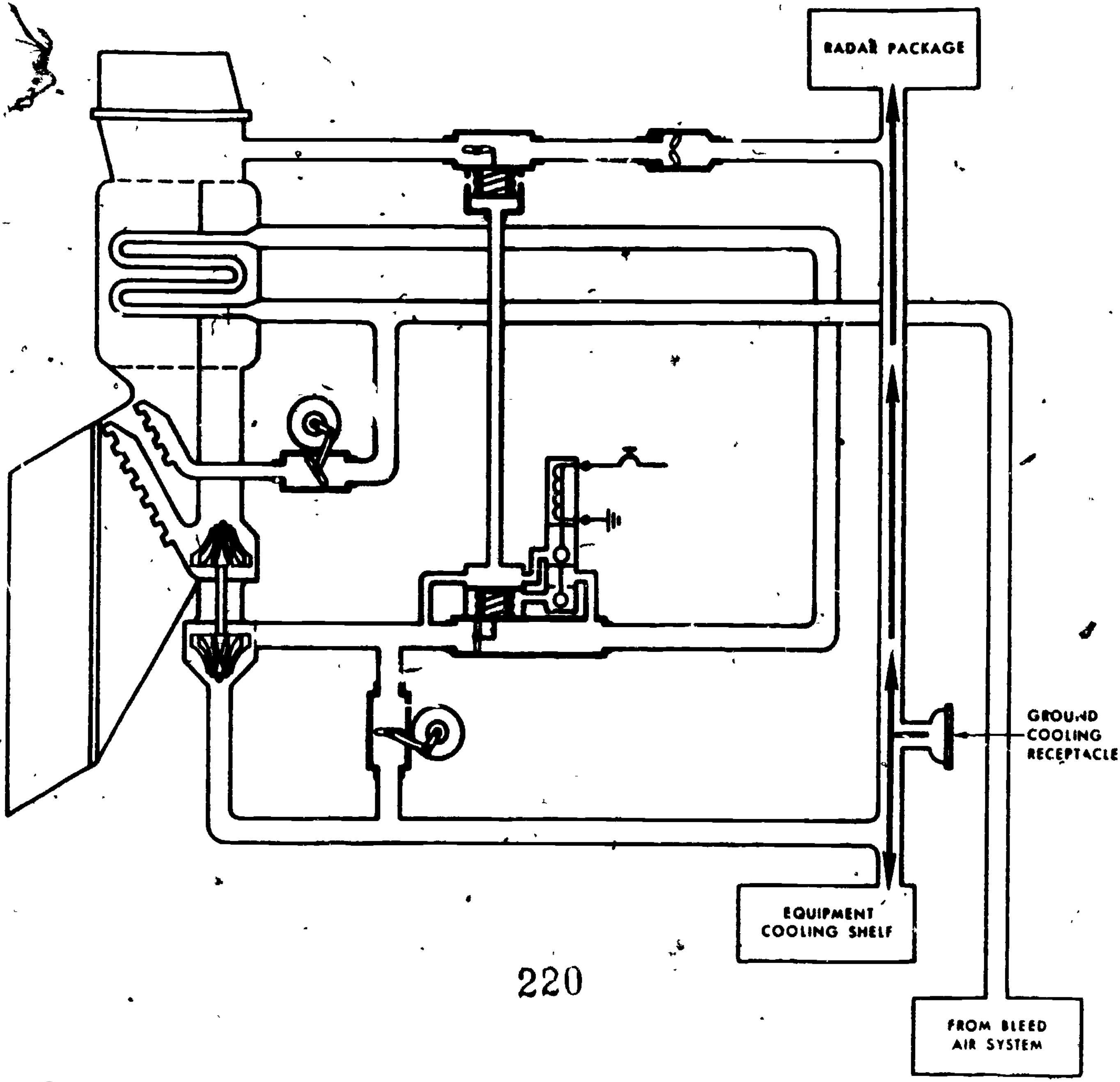

RADAR PACKAGE
GROUND COOLING RECEPTACLE
EQUIPMENT COOLING SHELF
FROM BLEED AIR SYSTEM

Answers to Frame 15: 1. ground air conditioning unit

Frame 16

Now we come to the purpose of the check valve that we identified in frame 13. The check valve stops a loss of air when using the ground air conditioning unit.

The sketch on the opposite page shows the flow of air from the ground cooling receptacle. Note that if the check valve was not in the system, this air would flow out through the ram air inlet.

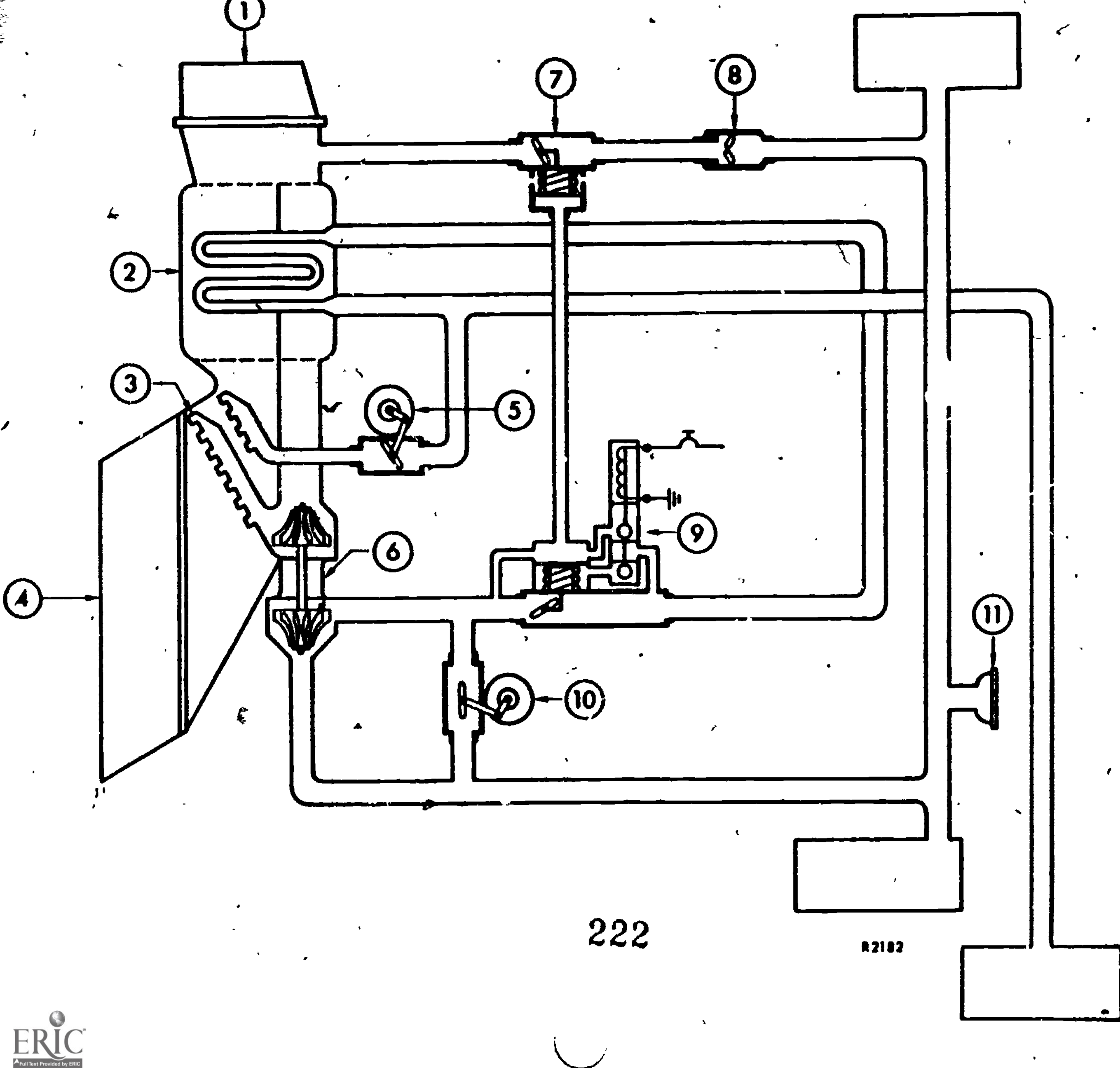
Why doesn't the ram air valve stop the air flow?..... Remember, if the pressure regulator and shutoff valve is closed, the ram air valve is open. When the air from the ground air conditioning unit tries to flow through the check valve it will close, preventing a loss of our cooling air.

The ram air check valve is a dual flapper type, similar to those used in the bleed air system. Normal (ram) airflow opens the valve and a reverse airflow closes the valve.

Fill in the blanks to complete the following statements.

1. When using the ground air conditioning unit, the unit that prevents a loss of air through the ram air inlet is the
______________ ______________.

2. When using the ground air conditioning unit, the ram air valve will be ____________ (open/closed).


1
2
3
4
5
6
7
8
9
10
11
R2182

Answers to Frame 16: 1. check valve 2. open

Frame 17

Using the system diagram on page 30, place the number in the blank opposite the statement below that correctly matches the information given in the statements.

Note: Several of the numbers will be used more than once.

_____1. Ram air shutoff valve.

_____2. Bleed air pressure regulator and shutoff valve.

_____3. Ground cooling ejector shutoff valve.

_____4. Ground cooling receptacle.

_____5. Ram air inlet.

_____6. Fan ejector nozzle.

_____7. Turbine bypass valve.

_____8. Heat exchanger.

_____9. Ram air outlet.

_____10. Turbine assembly.

_____11. Ram air check valve.

_____12. Allows bleed air to flow through the ground ejector nozzle when the aircraft is on the ground.

_____13. Prevents a loss of cooling air when using a ground cooling unit.

_____14. Connection for a ground cooling unit.

_____15. Regulates pressure at 106 psi.

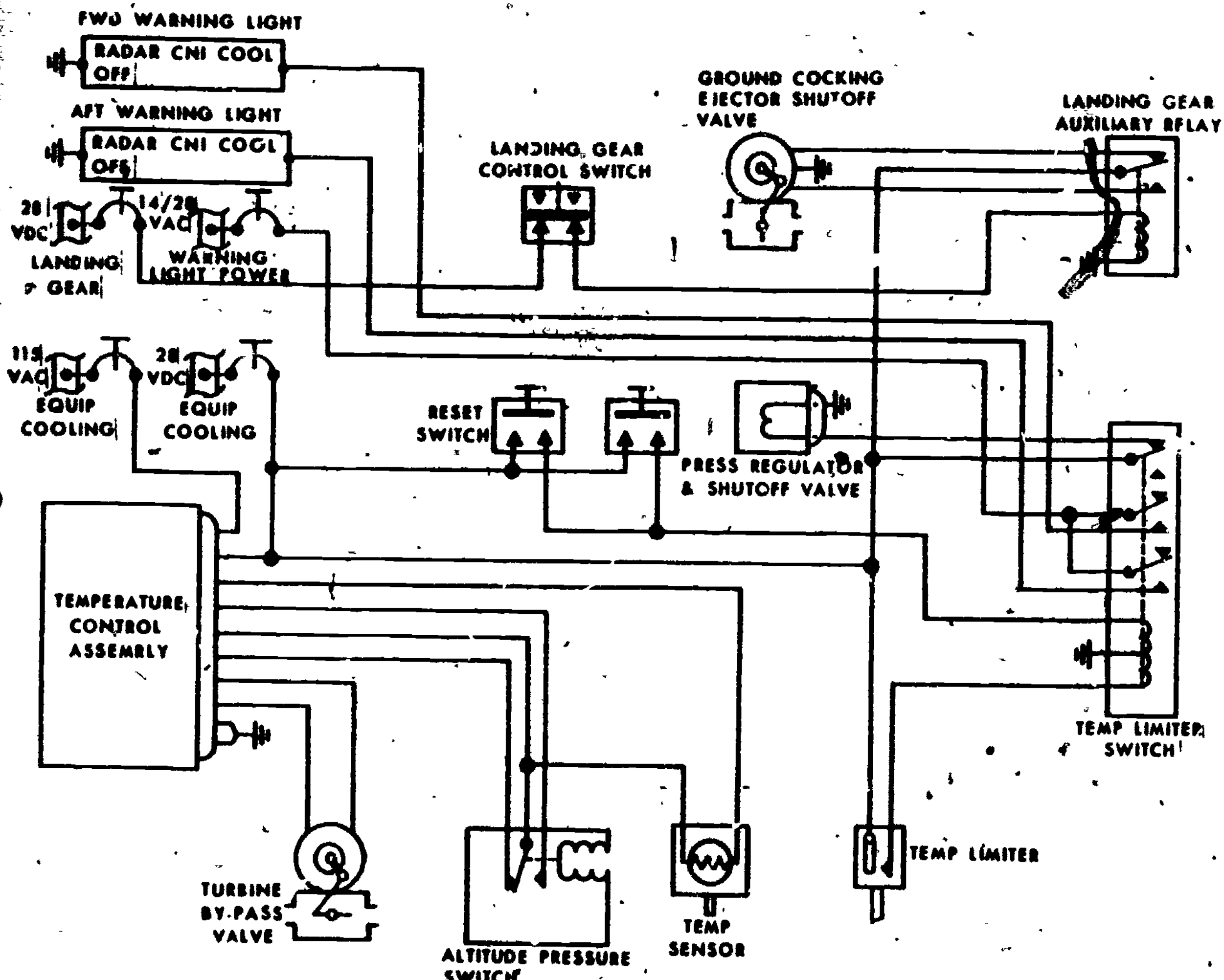
_____16. Controls the mixing of hot and cold air.

_____17. Helps to pull ram air through the heat exchanger during either flight or ground operation.

_____18. Opens to allow ram air to enter the system for emergency cooling.

_____19. Cools the air by rapid expansion and converting heat energy to mechanical energy.

_____20. Transfers heat from the bleed air to the ram air.


FWD WARNING LIGHT
RADAR CNI COOL OFF
AFT WARNING LIGHT
RADAR CNI COOL OFF
28 VDC
14/28 VAC
LANDING GEAR
WARNING LIGHT POWER
115 VAC
EQUIP COOLING
28 VDC
EQUIP COOLING
LANDING GEAR CONTROL SWITCH
GROUND COCKING EJECTOR SHUTOFF VALVE
LANDING GEAR AUXILIARY RELAY
RESET SWITCH
PRESS REGULATOR & SHUTOFF VALVE
TEMPERATURE CONTROL ASSEMBLY
TEMP LIMITER SWITCH
TURBINE BY-PASS VALVE
ALTITUDE PRESSURE SWITCH
TEMP SENSOR
TEMP LIMITER

Answers to Frame 17: 7 1. 9 2. 5 3. 11 4. 1 5.

3 6. 10 7. 2 8. 4 9. 6 10.

8 11. 5 12. 8 13. 11 14. 9 15.

10 16. 3 17. 7 18. 6 19. 2 20.

Frame 18

The previous frames have shown the path of airflow for the hot air, cold air, a mixture of hot and cold air, and for ventilating (ram) air. It has also been said that this system operates automatically. But, for this system to operate automatically, it needs electrical power to energize the pressure regulator and shutoff valve, to operate the motor on the ground cooling ejector valve, and to operate and control the turbine bypass valve.

The illustration on page 32 shows the electrical schematic for the equipment air conditioning system. The electrical units include the following:

Temperature Control Assembly.

Temperature Sensor.

Temperature Limiter.

Altitude Pressure Switch.

Temperature Limiter Switch.

Pilot's Reset Switches.

Landing Gear Auxiliary Relay.

Landing Gear Control Switch.

RADAR CNI COOL OFF Lights.

Find each of these units on the schematic. These are the controlling units for this system. The warning lights serve to warn the pilot of an overheat condition. following frames will explain the function of each of these components.

NO RESPONSE REQUIRED

1452

Frame 19

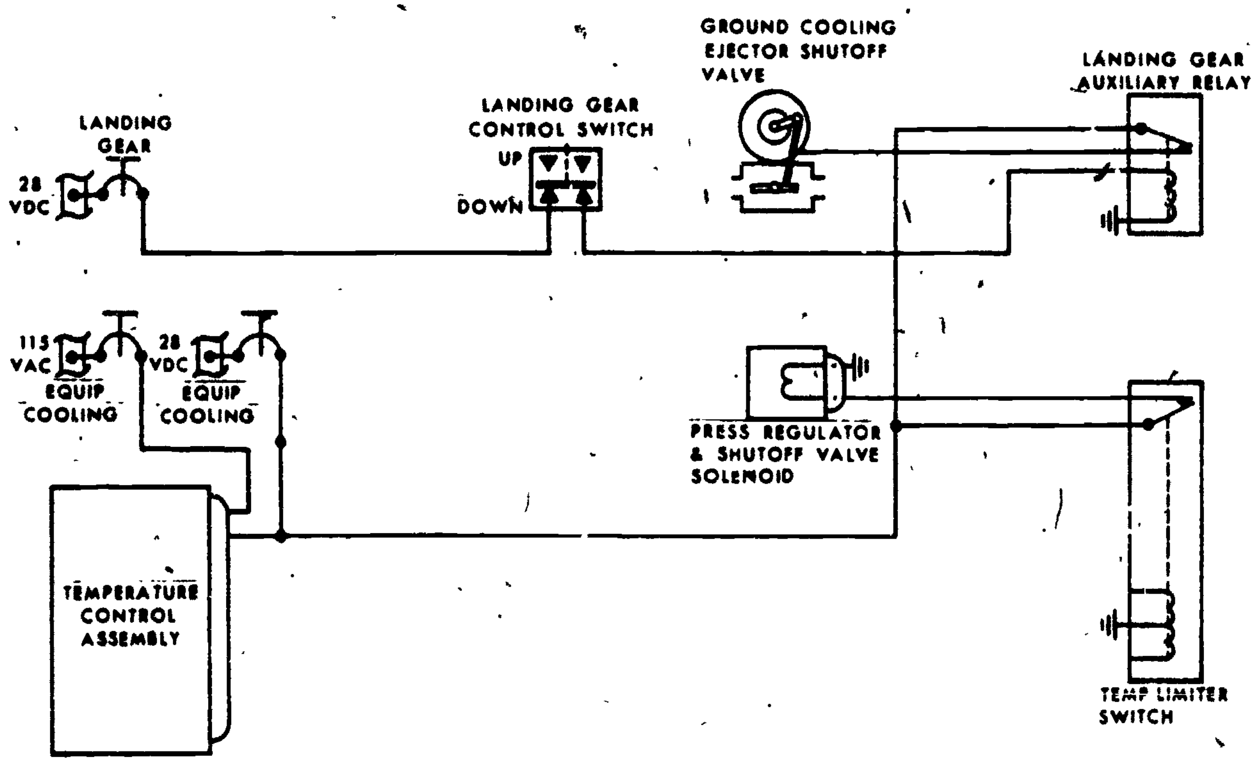
Remember, in the frame that explained the pressure regulator and shutoff valve it was said that this valve automatically opens any time electrical power and air pressure are applied to the aircraft. Also remember that if the aircraft is on the ground, the ground cooling ejector shutoff valve will be open.

The sketch shows the circuit from the 28V DC equipment cooling circuit breaker to the pressure regulator and shutoff valve and to the ground cooling ejector shutoff valve.

Note in this sketch that current goes from the 28V DC equipment cooling circuit breaker, through the temperature limiter switch (relay), to the pressure regulator and shutoff valve.

The temperature limiter switch contacts are normally in the up position as shown. Also note that current goes up through the landing gear auxiliary relay contact to the ground cooling ejector shutoff valve. The landing gear auxiliary relay is controlled by the switch on the landing gear handle.

Current also goes from the 28V DC and 115V AC equipment cooling circuit breakers to the temperature control assembly.



226

Fill in the blanks to complete the following statements.

1. When electrical power is applied to the aircraft, the pressure regulator and shutoff valve solenoid will be ______________ (energized/deenergized).

2. The pressure regulator and shutoff valve solenoid is energized by ______________ (28V DC/115V AC).

3. When the landing gear handle is in the gear down position, the landing gear auxiliary relay will be ______________ (energized/deenergized).

4. When the landing gear handle is in the gear down position, the ground cooling ejector shutoff valve will be ______________ (open/closed).

5. The voltage required to operate the ground cooling ejector shutoff valve is ______________.

1454

Answers to Frame 19: 1. energized 2. 28V DC 3. energized 4. open 5. 28V DC

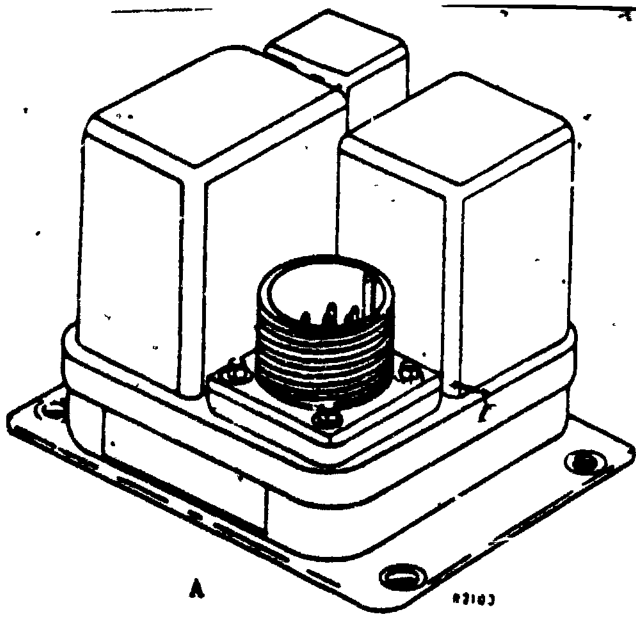
Frame 20

The illustrations below show the temperature control assembly. The temperature control assembly automatically controls the position of the turbine bypass valve, thus maintaining the proper temperature in the equipment compartments.

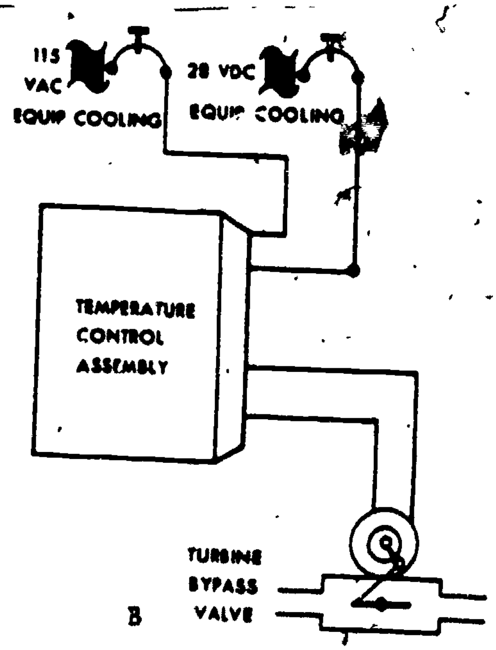
Remember, this system has no manual control. The temperature control assembly will automatically maintain the temperature in the equipment compartments at 85°F from sea level to 25,000 feet, and at 40°F for altitudes above 25,000 feet. How and why there are two temperature ranges will be explained later in the text.

Illustration A shows an external view of the temperature control assembly. This unit contains the magnetic amplifiers, transistors and a part of the bridge circuit that is used to control the position of the turbine bypass valve.

Illustration B shows the temperature control assembly connected electrically to the turbine bypass valve. Remember, the temperature control assembly controls the bypass valve by interpreting the resistance signal to the bridge circuit and allowing power to go to the hot or cold side of the valve.



A



B

228

Fill in the blanks to complete the following statements.

1. The temperature control assembly automatically controls temperature by controlling the ________________ ________________ ________________.

2. The electrical power requirements for operation of the temperature control assembly are ________________ and ________________.

3. Temperature of the equipment compartments is controlled ________________.

1456

Answers to Frame 20: 1. turbine bypass valve 2. 28V DC & 115V AC 3. automatically

Frame 21

Before we go on, let's review some of the basic facts and principles about temperature sensors.

Different types of materials offer different amounts of resistance. Metals have low resistance whereas glass and rubber have high resistance. In most conductors (copper, aluminum, silver, iron, etc.) the resistance increases with an increase in temperature. These materials are said to have a positive temperature coefficient. The resistance of carbon and liquids decreases with an increase in temperature. These materials are said to have a negative temperature coefficient.

The temperature sensor is a specially designed resistor. Its resistance changes any time the temperature of the air around it changes. The manner in which the sensor changes resistance depends on its "temperature coefficient." That is: if the TEMPERATURE of the air across the sensor increases and the RESISTANCE of the sensor also increases, the sensor has a POSITIVE TEMPERATURE COEFFICIENT OF RESISTANCE. It follows then that with a POSITIVE COEFFICIENT the resistance will decrease if the temperature of the air decreases. The point is, they increase together and decrease together. On the other hand, if the TEMPERATURE increases and the sensor's RESISTANCE decreases at the same time, it has a Negative Coefficient. This also means the sensor's resistance will increase as the temperature decreases.

Mark the following statements true or false on your response sheet.

_____1. Heating a piece of copper wire will cause its resistance to decrease.

_____2. Glass has very high resistance.

_____3. All materials increase in resistance when heated.

Complete the statements by using the word increases or decreases.

POSITIVE COEFFICIENT	NEGATIVE COEFFICIENT
1. If temperature increases, the resistance ___________.	3. If temperature increases, the resistance ___________.
2. If temperature decreases, the resistance ___________.	4. If temperature decreases, the resistance ___________.

1457

Answers to Frame 21: 1. F 2. T 3. F

1. increases
2. decreases
3. decreases
4. increases

Frame 22

Remember that the equipment temperature sensor forms part of the bridge circuit. Its purpose is to sense the temperature of the air going to the equipment compartment. This is done by sending a signal to the controller in the form of a resistance signal.

Here is how it is done. The sensor contains a resistance element which changes resistance with changes in temperature. This resistance element forms one leg of the bridge circuit in the equipment temperature controller. This sensing element has a negative coefficient of resistance. This means that as the air temperature around the sensor goes up the resistance value of the sensor goes down, and as the temperature around the sensor goes down, the resistance value of the sensor goes up. When the input signal (RESISTANCE SIGNAL) is received by the controller the change in resistance in that leg of the bridge circuit will unbalance the bridge. Based on this input signal (CHANGE IN RESISTANCE) the controller directs electrical power out to the turbine bypass valve. The electric motor will move the turbine bypass valve to the required position and maintain the temperature desired in the equipment compartment.

The illustration below may help you remember the basic facts about temperature sensors.

NEGATIVE COEFFICIENT SENSOR

TEMPERATURE AROUND THE SENSOR INCREASES	RESISTANCE OF THE SENSOR DECREASES	SYSTEM TEMPERATURE WILL GO COLD.
TEMPERATURE AROUND THE SENSOR DECREASES	RESISTANCE OF THE SENSOR INCREASES	SYSTEM TEMPERATURE WILL GO HOT.

NO RESPONSE

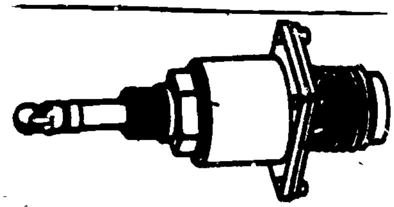
1459

Figure 23

Now that we have reviewed the basic principles and operation of sensors, we can see what part the equipment temperature sensor plays in maintaining the correct temperature in the equipment compartment.

Since the temperature is controlled automatically, there must be a means of sensing the temperature of the conditioned air going to the equipment compartments. We use the equipment temperature sensor to do this.

The equipment system temperature sensor is shown in illustration A. Notice that this sensor looks the same as the cabin system sensor, however, they are not interchangeable because the equipment sensor has a different resistance value from the cabin sensor.

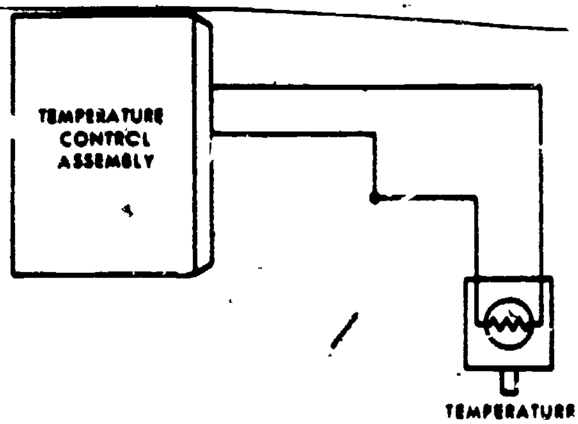


A

The temperature sensor contains a temperature sensitive resistance element. The sensing element has a negative coefficient of resistance. In this respect it is the same as the cabin system sensor.

The equipment system temperature sensor is located in the conditioned air duct between the refrigeration unit and the equipment compartments.

Illustration B shows the circuit going to the temperature control assembly. As the temperature changes, the resistance changes. This causes a signal to be sent to the temperature control assembly. This resistance signal will unbalance the bridge circuit and the temperature controller will direct electrical power to the turbine bypass valve.



B

Fill in the blanks to complete the following statements.

1. The temperature of the air going to the equipment compartments is sensed by the ________________ ________________.

2. An increase in air temperature in the contitioned air duct will cause the resistance of the temperature sensing element to ________________.

3. A change in resistance of the temperature sensing element will cause a signal to be sent to the ________________ ________________ ________________.

1460

Answers to Frame 23: 1. temperature sensor 2. decrease
3. temperature control assembly

Frame 24

When explaining the task of the temperature control assembly it was said that it automatically keeps 85°F from sea level to 25,000 feet, and 40°F above 25,000 feet. At this point you may be asking, why change the temperature, and how is the temperature changed automatically?

The reason for changing the temperature is due to the moisture in the air. Below 25,000 feet, there is more moisture in the air than at the higher altitudes. It is necessary to keep the high temperature to stop the moisture from condensing and causing corrosion. Above 25,000 feet, there is very little moisture in the air, so the lower temperature is used.

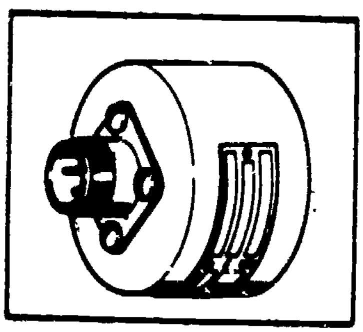
How can the temperature be changed automatically at a specific altitude? This is the task of the altitude pressure switch.

The altitude pressure switch is shown in sketch A. This unit contains an aneroid and a microswitch. The aneroid senses atmospheric pressure and controls the position of the switch contacts.

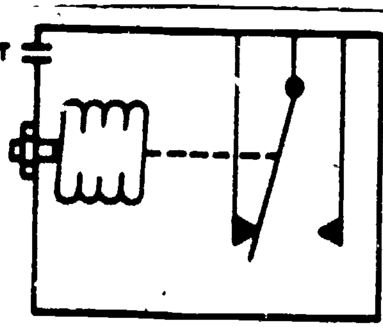
Below 25,000 feet, where the atmospheric pressure is higher, the aneroid will hold the switch in one position as shown in sketch B. As the aircraft goes above 25,000 feet, the atmospheric pressure decreases and allows the aneroid to move the switch contacts to the opposite position as shown in sketch C.

When the switch changes the resistance value in the bridge circuit, this causes the system to maintain the lower temperature above 25,000 feet.

A

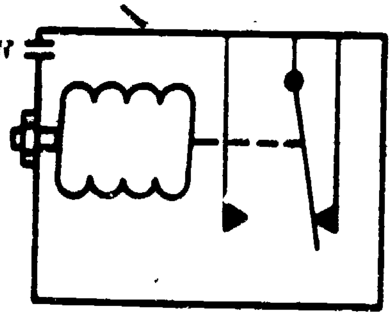


B



BELOW 25,000 FEET

C



ABOVE 25,000 FEET

Fill in the blanks to complete the following statements:

1. As the aircraft goes above 25,000 feet, the resistance value of the bridge circuit is changed by the ______________ ______________.
2. The altitude pressure switch contains an ______________ and a ______________.
3. The altitude pressure switch senses ______________ ______________.
4. As the aircraft increases altitude, the surrounding atmospheric pressure ______________ (increases/decreases).
5. The atmosphere above 25,000 feet contains ______________ (more/less) moisture than at sea level.

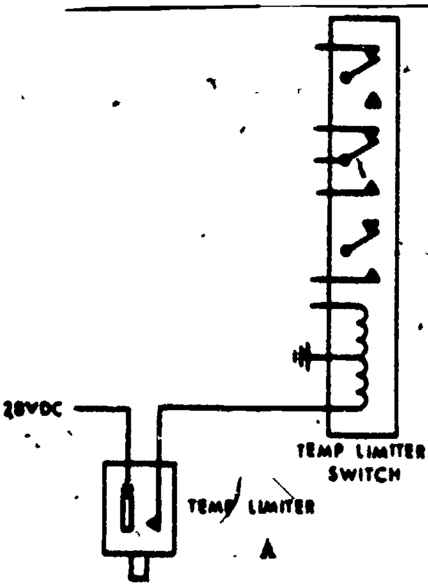
1462

Answers to Frame 24: 1. altitude pressure switch 2. aneroid microswitch 3. atmospheric pressure 4. decreases 5. less

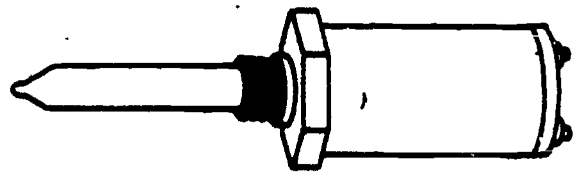
Frame 25

Under normal conditions, the temperature sensor senses the temperature and sends signals to the temperature control assembly. The temperature control assembly then positions the bypass valve to keep the proper temperature.

But what happens if the bypass valve should fail in the open position or if the sensor had an open? The system would give only hot air. In a very short time this would cause an overheat condition.



A



B

The temperature limiter and the temperature limiter switch work together to stop damage to the system from an overheat condition. When the temperature in the conditioned air outlet duct reaches 150°F, the two parts will cause the air conditioning system to shut off and a warning light to come on. A schematic of these two parts is shown in sketch A.

Sketch B shows the temperature limiter. This is a normally open temperature sensing switch. This type of switch is called a thermoswitch. When the temperature is below 150°F, the contacts will be open. When the temperature exceeds 150°F, the contacts will close.

Remember, this is not a sensor, it is a switch that is actuated by heat.

Fill in the blanks to complete the following statements:

1. Damage due to an overheat condition is prevented by the ________________ ________________ and the temperature limiter switch.

2. The temperature limiter is a thermo ________________.

3. The equipment system temperature limiter is normally ________________ (open/closed).

4. When the air in the conditioned air duct reaches an overheat condition, the temperature limiter will ________________ (open/close).

Answers to Frame 25: 1. temperature limiter 2. switch
3. open 4. close

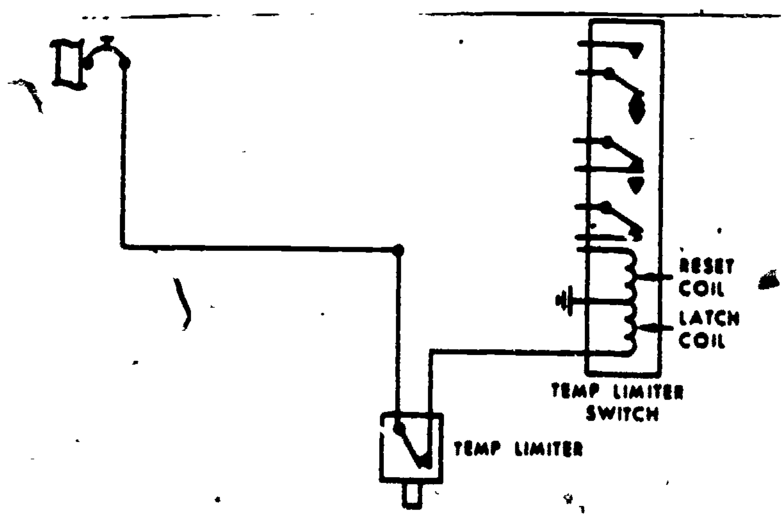
Frame 26

The sketch below shows the temperature limiter linked to the coil of the temperature limiter switch. The temperature limiter switch is a relay. In fact, it is two relays built in one. One coil is wrapped about the core, then a second coil is wrapped over the first, but in the opposite direction.

The bottom coil is called the latch coil, and the top coil is called the reset coil. Current flow through the latch coil will energize the relay to pull the contacts down. Current flow through the reset coil will deenergize the relay to move the contacts up.

At the time of normal operation, both coils are actually deenergized, but the relay is made so that the contacts will stay in the up position. When the temperature exceeds 150°F, the temperature limiter contacts will close, directing current flow through the latch coil.

This pulls the contacts down. When the contacts move down, it will stop the flow of conditioned air and turn on two warning lights. The sketch shows the temperature limiter contacts closed, and the latch coil energized.



Fill in the blanks to complete the following statements:

1. When an overheat condition occurs, the temperature limiter switch will be energized by the ______________ coil.

2. Current flow to the latch coil of the temperature limiter switch is controlled by the ______________ ______________.

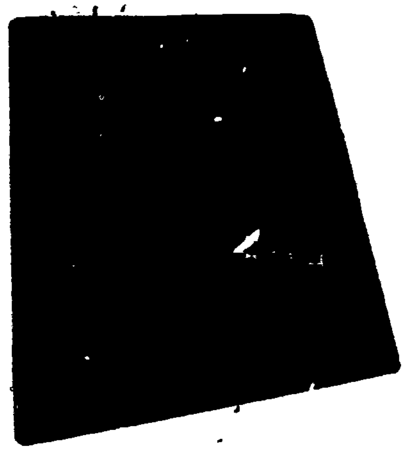
Answers to Frame 26: 1. latch 2. temperature limiter

Frame 27

The sketch below shows one of the warning light panels and the RADAR CNI COOL OFF light.

The abbreviation CNI means communication navigation instruments.

.his is the purpose of the electronic equipment that we are cooling.

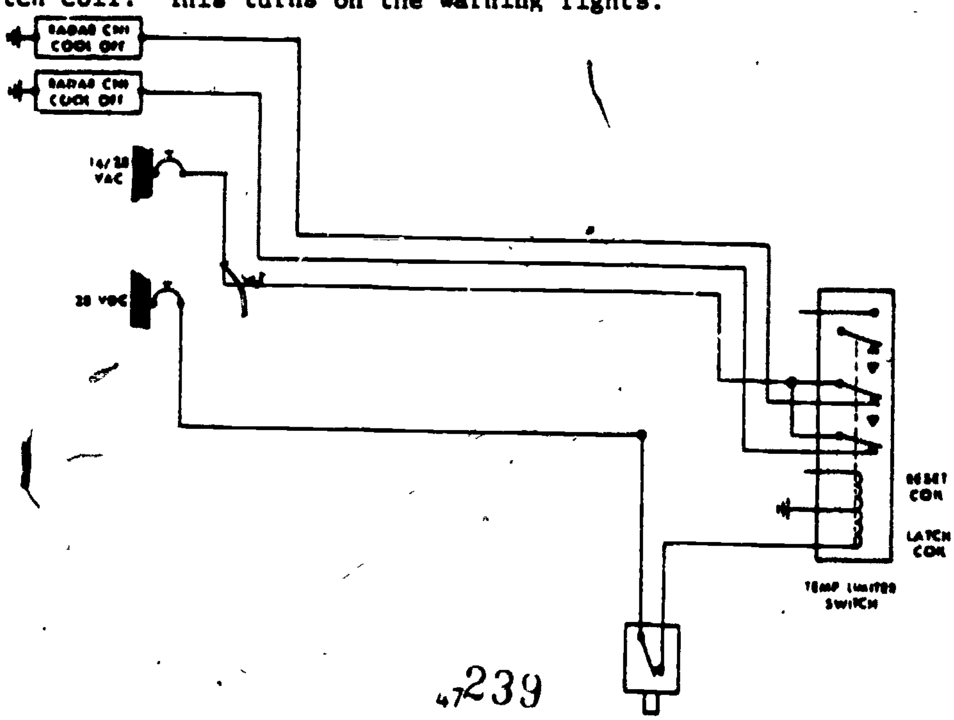


Warning Panel.

There are two RADAR CNI COOL OFF lights in this system. One warning light is on the pilot's panel (forward cockpit) and the other is located on the radar pilot's panel (aft cockpit).

These lights will light any time there is an overheat condition in the equipment air conditioning system. The sketch below shows the circuit for the warning lights.

In this sketch, the temperature limiter is closed, energizing the latch coil. This turns on the warning lights.



Frame 27 (Continued)

Fill in the blanks to complete the following statements:

1. The purpose of the RADAR CNI COOL OFF lights is to warn the pilot of an ______________ ______________.

2. The RADAR CNI COOL OFF lights are turned on when the ______________ coil of the temperature limiter switch is ______________.

240

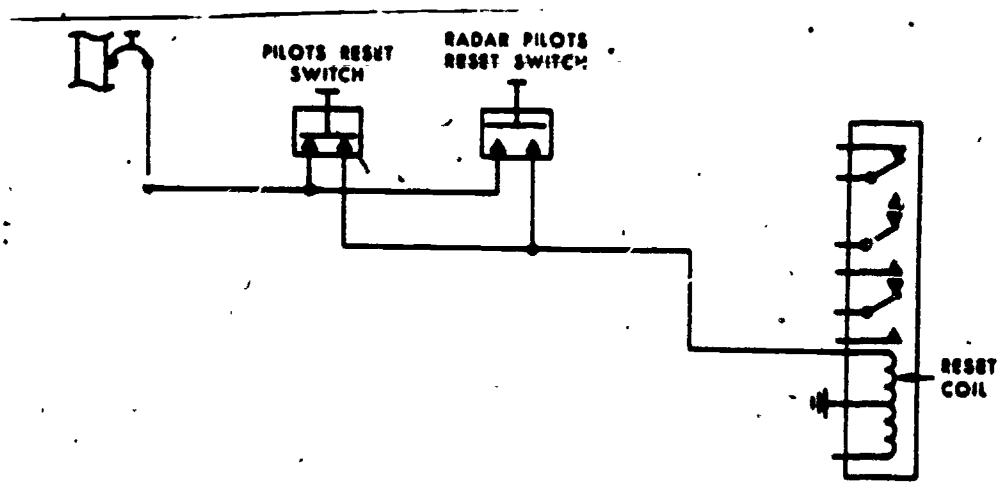
Answers to Frame 27: 1. overheat condition 2. latch energized

Frame 28

After an overheat condition has occurred, the system will not reset automatically. A reset button is used to restart the system. The reset button completes a circuit to energize the reset coil. This pulls the contacts up.

There are two reset buttons. One reset button is located in the forward cockpit, and one in the aft cockpit. This enables either pilot to reset the system.

This sketch shows the reset circuit. When either reset button is pushed in, current will flow to the reset coil, energizing the relay to the up position. The relay will stay in this position until the system overheats again.



Fill in the blanks to complete the following statements:

1. To restart the system after an overheat condition, the pilot must press the ______________ ______________.

2. Current is directed to the reset coil of the temperature limiter switch by the ______________ ______________.

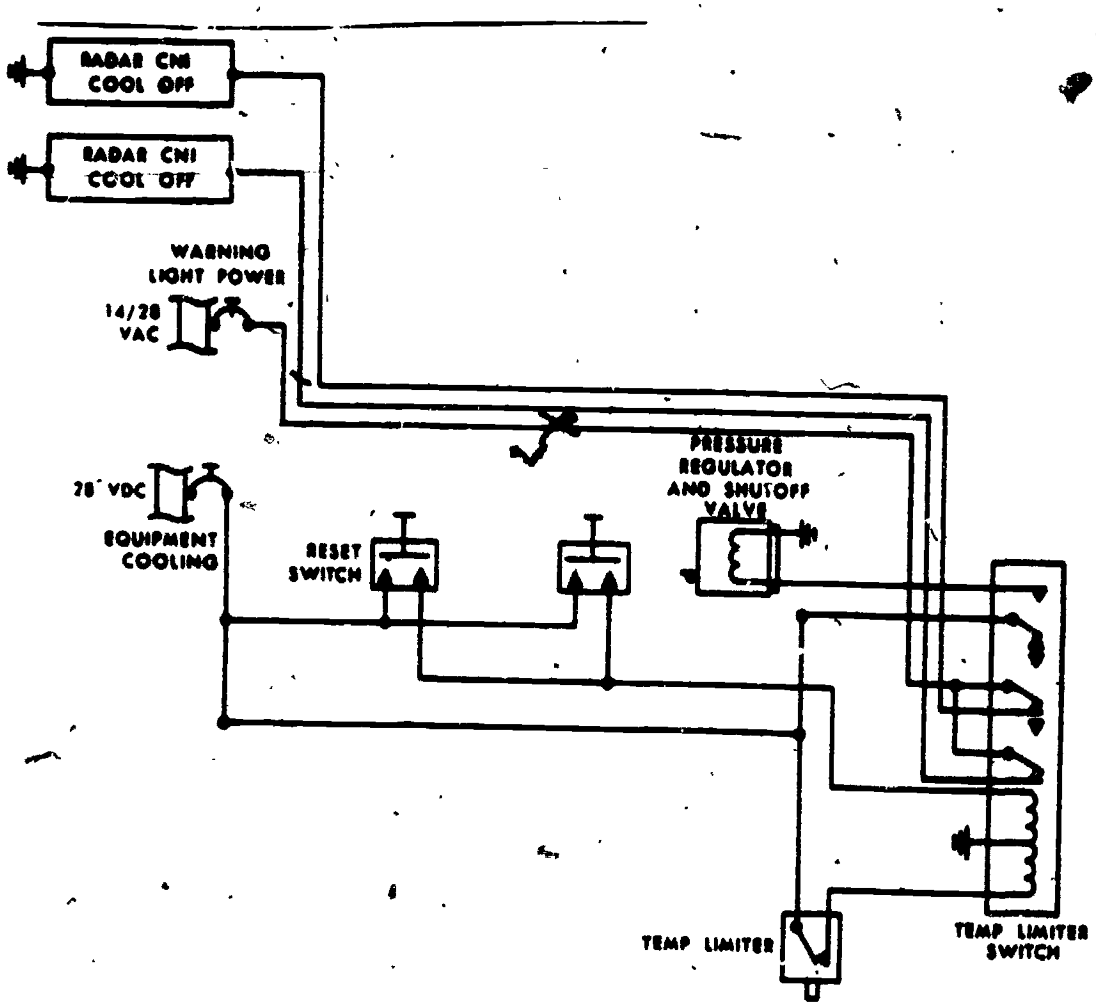
1468

Answers to Frame 28: 1. reset button 2. reset button

Frame 29

The sketch in this frame shows the temperature limiter, temperature limiter switch, warning lights, and reset buttons. Notice that when the temperature limiter switch contact moves down, it completes the circuit to turn on the warning lights.

Also, notice that this opens the circuit going to the pressure regulator and shutoff valve solenoid. This deenergizes the solenoid causing the valve to close which stops the flow of conditioned air.



When the conditioned airflow stops, will the equipment compartments receive any cooling air?....Yes, they will receive ram air. Remember, any time the bleed air pressure regulator and shutoff valve closes, the ram air valve opens.

Now let's summarize what happens when the system overheats (temperature exceeds 150°F). First the temperature limiter contacts close; this energizes the latch coil of the temperature limiter switch. This causes the relay contacts to move down, turning on the warning lights and shutting the air conditioning system off. When the system shuts off, the ram air valve opens.

After the temperature cools below 150°F, the system can be reset by pressing either reset button.

Fill in the blanks to complete the following statements, or circle the correct answer.

1. If an overheat condition occurs, the pressure regulator and shutoff valve will be ________________.

2. When an overheat condition occurs, will the air conditioning system be shut off? ________________ (yes/no).

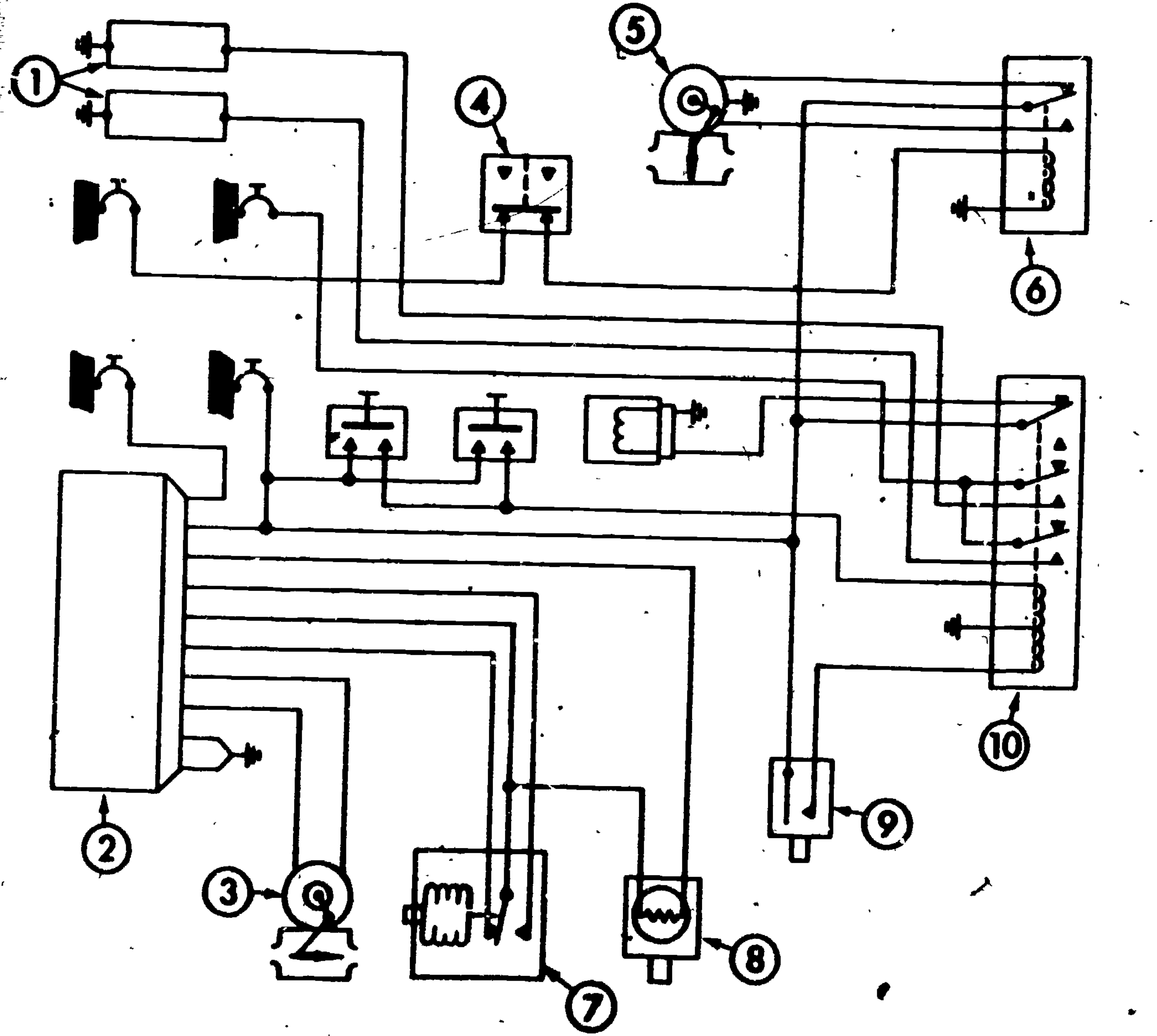
3. If an overheat condition occurs, will the electronic equipment receive any cooling air? ________________ (yes/no). If your answer was yes, then where will the cooling air come from? ____

4. What must the pilot do to restart the system after an overheat condition has occurred and the system has cooled off?

____

5. When the temperature of the air going to the equipment compartments overheats, how is the pilot informed?

____


1
2
3
4
5
6
7
8
9
10

Answers to Frame 29: 1. closed 2. yes 3. yes through the ram air valve 4. press the reset button 5. by the warning lights

Frame 30

Using the diagram on the opposite page, select the number for the component that matches the statement listed below.

_____1. Automatically controls the position of the turbine bypass valve.

_____2. Causes the temperature in the equipment compartments to decrease to 40°F when the aircraft goes above 25,000 feet.

_____3. Warns the pilot of an overheat condition.

_____4. Has a negative coefficient of resistance.

_____5. Energized when the landing gear handle is in the gear down position.

_____6. Closes when the temperature exceeds 150°F.

_____7. When energized by the temperature limiter, turns on the warning lights and shuts off the air conditioning system.

_____8. Opens when the landing gear handle is in the gear down position.

_____9. Directs partially cooled bleed air either into or around the turbine.

Answers to Frame 30: 2 1. 7 2. 1 3. 8 4. 6 5. 9 6. 10 7. 5 8. 3 9.

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Environmental Pneudraulics Branch 3ABR42331-WB-203
Chanute AFB, Illinois

EQUIPMENT AIR CONDITIONING SYSTEM WIRING DIAGRAM

OBJECTIVES

Using a wiring diagram, identify 14 causes for the 10 given equipment air conditioning system troubles.

EQUIPMENT

	Basis of Issue
Tape and Tape Player	1/student

INSTRUCTIONS

Information on the purpose of the Equipment Air Conditioning System components and the procedures for you to follow when using this workbook are given by tape recorded instructions. As you listen to the recording, you will be given the air conditioning system operation and directions to follow for tracing the electrical circuits. Listen to the recording until the speaker tells you to turn it off. The speaker will tell you when you are to trace a circuit or answer questions given in the workbook. Your instructor will show you how to install the tape and how to operate the tape player. Pay close attention to all directions that are given on the tape. When tracing circuits or answering questions in this workbook, if your responses are incorrect, restudy the information or reverse the tape and listen to the instructions again. After completing this lesson you will be required to solve 10 of the 14 problems which are given at the back of the text. If you are ready to begin, and the instructor has already briefed you, turn on the tape player.

Supersedes 3ABR42231-WB-203, 7 November 1972.
OPR: 3370TTG
DISTRIBUTION: X
3370TGTC - 400; TTVSR - 1

SECTION 1. PURPOSE OF COMPONENTS

Using the diagram (foldout 2 at the back of this package) and the information give on the tape, fill in the blanks to complete the following statements.

1. When electrical power is applied to the aircraft, the bleed air pressure regulator and shutoff valve solenoid is ______________ (energized/deenergized).

2. The solenoid on the bleed air pressure regulator and shutoff valve requires __________ volts DC for operation.

3. The ground cooling ejector shutoff valve will open when the landing gear handle is in the __________ __________ position.

4. The landing gear control switch is mounted on the __________ __________ __________.

5. The ground cooling ejector shutoff valve requires __________ volts DC to operate.

6. The landing gear auxiliary relay is energized when the landing gear handle is in the __________ __________ position.

TURN ON THE TAPE RECORDER

7. The temperature sensor has a __________ (negative/positive) coefficient of resistance.

8. An increase in air temperature will cause the temperature sensor resistance to __________.

9. The turbine bypass valve is operated by a __________ volt DC motor.

10. The voltage requirements for operation of the temperature control assembly are __________ and __________.

11. The temperature control assembly contains __________ amplifiers and transistors.

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12. The resistance signal from the temperature sensor is sent to the ________ ________ ________.

13. When the aircraft goes above 25,000 feet the equipment system temperature is ________ by the ________ ________ switch.

14. The reason that a higher temperature is maintained in the equipment compartments below 25,000 feet is due to the ________ in the air.

15. The altitude pressure switch senses ________ pressure.

TURN ON THE TAPE RECORDER

16. When the latch coil is energized, the temperature limiter switch causes the pressure regulator and shutoff valve solenoid to ____ _____ (energize/deenergize).

17. The units that make up the overheat warning circuit are the temperature ________, temperature ________ ________ and the ________ ________ ________ ________ warning lights.

18. After an overheat condition has occurred, it is necessary to press one of the ________ switches in order to restart the air conditioning system.

19. The inlet air temperature limiter is a normally ________ thermoswitch.

TURN ON THE TAPE RECORDER

20. When electrical power is applied to the aircraft, the solenoid on the pressure regulator and shutoff valve is ________.

21. The ground cooling ejector shutoff valve is controlled by the ________ ________ ________.

22. When the aircraft is below 25,000 feet, the temperature is maintained at ________.

23. The conditioned air temperature is sensed by the ____________

____________ ____________ ____________.

24. The two different temperature ranges are controlled by the

____________ ____________ ____________.

25. When the temperature ____________ the sensor resistance will decrease.

26. During flight, if the equipment system conditioned air temperature exceeds 150° F (overheats), the pressure regulator and shutoff valve will be ____________.

27. The purpose of the RADAR CNI COOL OFF lights is to inform the pilot of an ____________ ____________.

28. An overheat condition is sensed by the ____________ ____________

____________ ____________.

29. The latch coil of the inlet air temperature limiter is energized when the system ____________.

<u>TURN ON THE TAPE RECORDER</u>

SECTION 2. TEMPERATURE CONTROL CIRCUIT

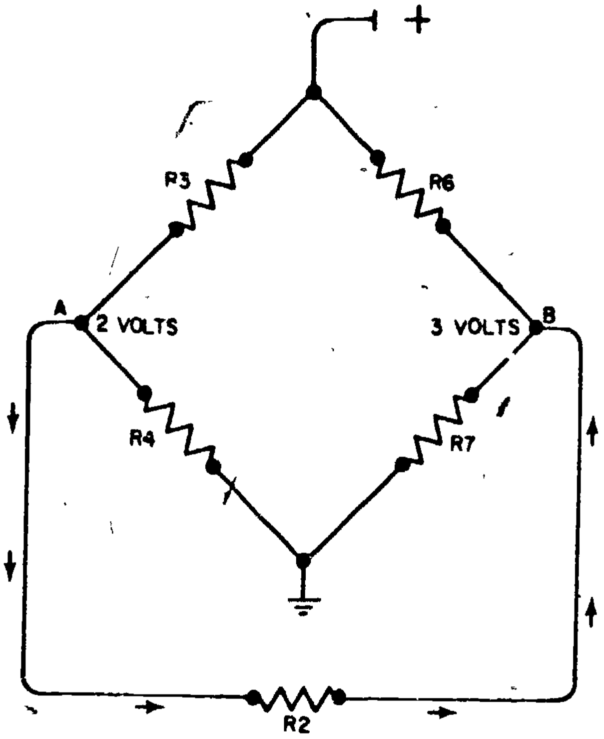

Figure 1.

1. Temperature control of the equipment air conditioning system is completely __________.

2. Current flows through an electrical circuit only if there is a difference in __________ __________.

3. In the circuit illustrated, if the voltage at points A and B were the same, would there be any current flow through resistor R2?

________________.

TURN ON THE RECORDER

4. The difference in voltage potential across a bridge circuit is dependent on the __________ __________ across the resistors.

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5. In a series circuit with three equal resistors and a 6-volt source, the voltage drop across each resistor will be ________ volts.

6. The voltage potential at point B in figure 3 below is _____ volts.

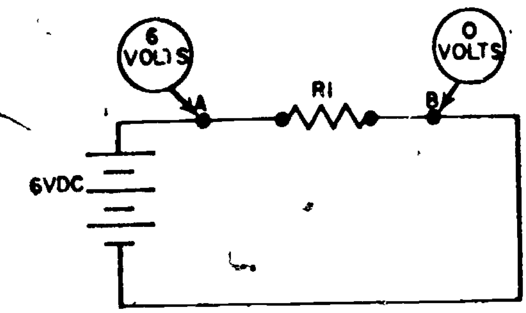

Figure 2.

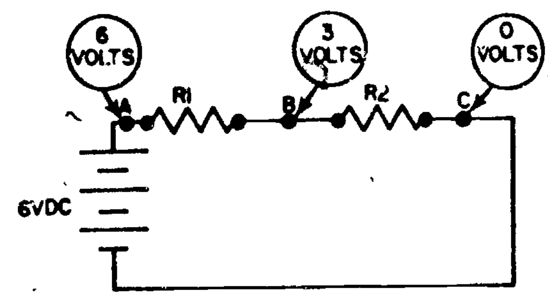

Figure 3.

TURN ON THE TAPE RECORDER

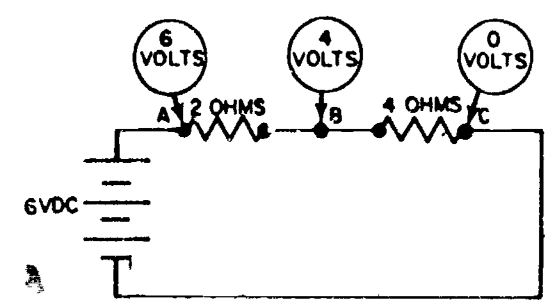

Figure 4.

1479

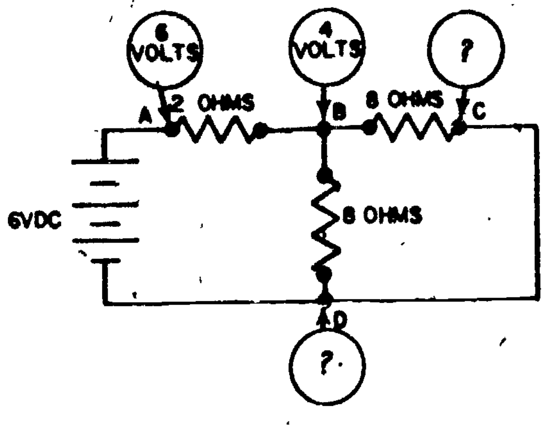

Figure 5.

Refer to figure 5 to complete statements 7 through 10.

7. The voltage potential between points B and D is ________ volts.

8. The voltage drop across the 2-ohm resistor is ________ volts.

9. The two 8-ohm resistors are ________ (series/parallel).

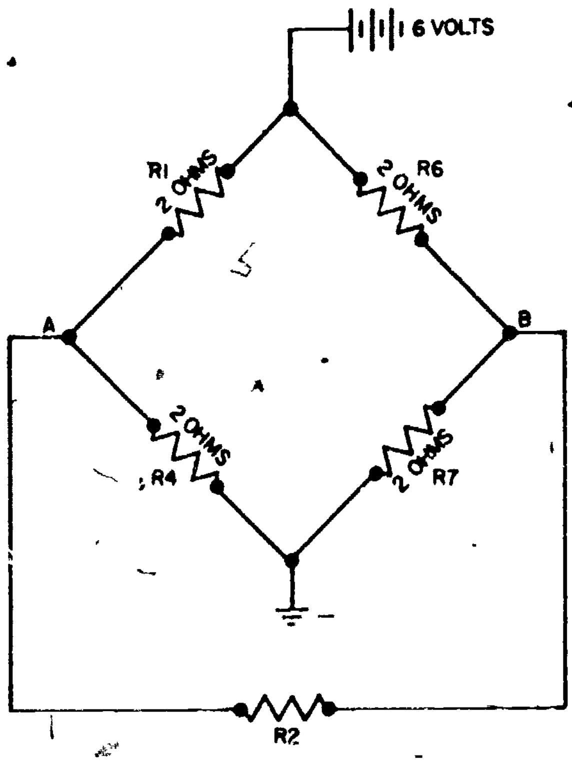

Figure 6.

10. The voltage potential between poi s B and C is _________ volts.

TURN ON THE TAPE RECORDER

Refer to figure 6 to complete statements 11 and 12.

11. If R4 contained less resistance than R1, the voltage potential at point A would be _________ (less/more) than the voltage potential at point B.

12. If R1 contained less resistance than R4, would there be current flow through resistor R2? _________.

TURN ON THE TAPE RECORDER

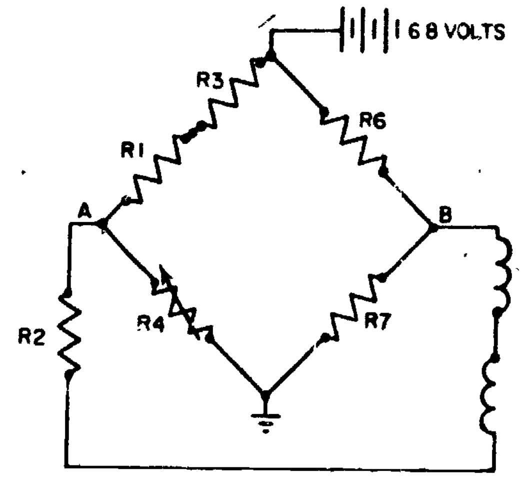

Figure 7.

Refer to figure 7 to complete statements 13, 14, and 15.

13. When the bridge circuit is balanced, the resistance of R4 will be equal to the resistance of _________ plus _________.

14. When the bridge is balanced the voltage at points A and B will be _________.

15. If the voltage drop across resistor R4 is less than the voltage drop across the combined resistance of R1 and R3, the bridge will be _________.

TURN ON THE TAPE RECORDER

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Refer back to figure 7 to complete statements 16 and 17.

16. If the resistance of R4 is less than the combined resistance of R1 and R3, the voltage potential will be greater at point

__________.

17. If the resistance of R4 is less than the combined resistance of R1 and R3, current will flow through the two coils from point

________ to point ________.

TURN ON THE TAPE RECORDER

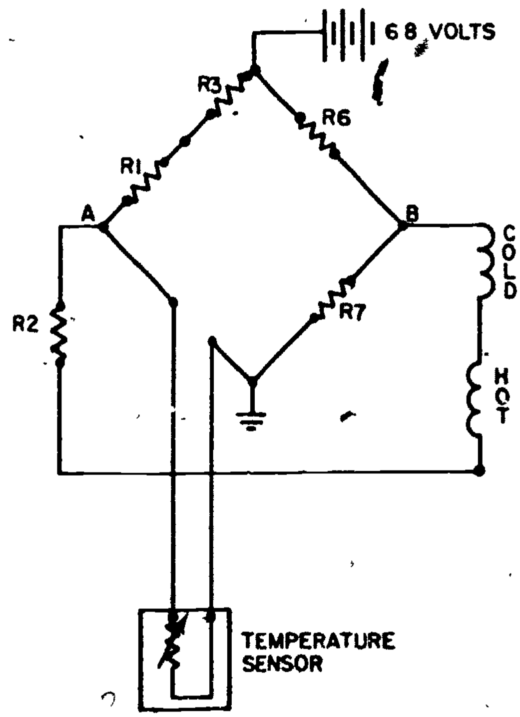

Figure 8.

Refer to figure 8 to complete statements 18 through 23. Keep in mind the question "What happens when the air gets too warm?" as you complete each of these statements.

18. The sensor resistance ________.

19. The voltage drop across the sensor will be ________ than the voltage drop across the combination R1 and R3.

20. The largest voltage potential will be at point ________.

21. Current will flow from point ________ to ________.

22. This will cause the ________ transistors to conduct.

23. The turbine bypass valve will ________.

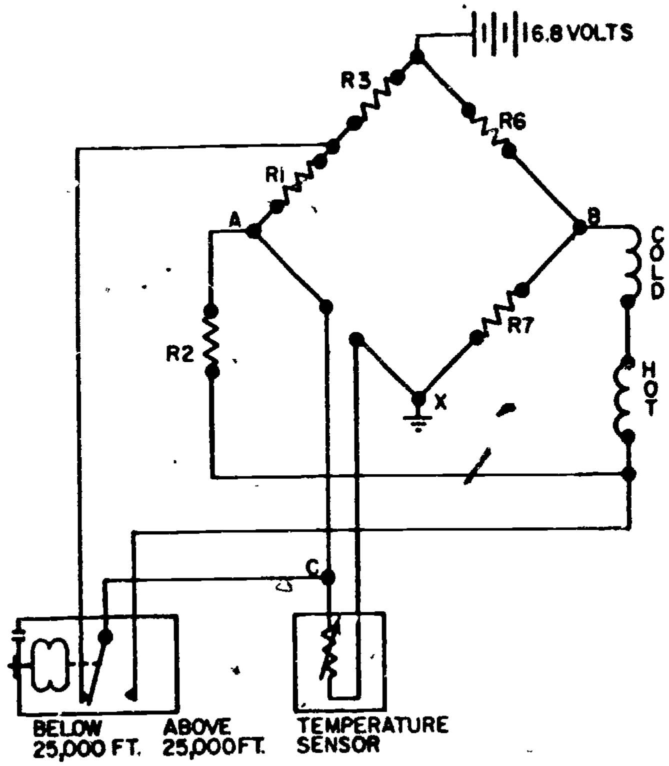

Figure 9.

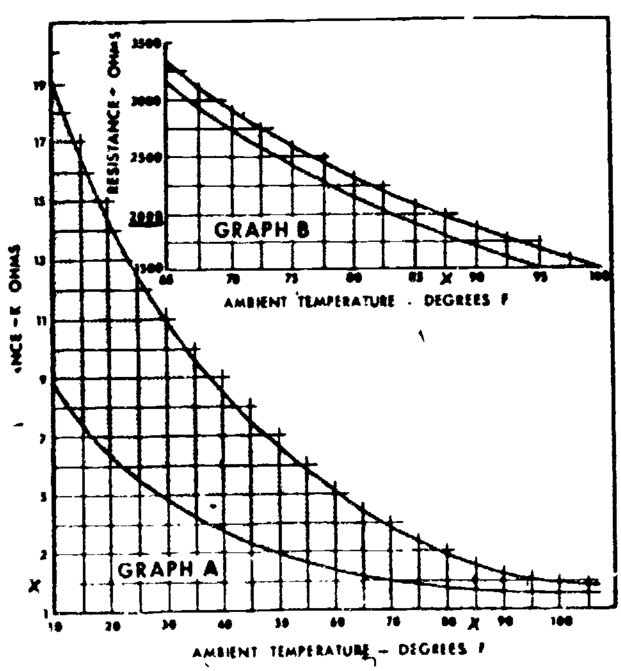

Figure 10.

1483

TURN ON THE TAPE RECORDER

Refer to figures 9 and 10 to complete statements 24 through 31.

24. If the temperature drops below 85°F, the sensor resistance will ______________.

25. If the sensor resistance increases, the voltage potential will be greater at point __________.

26. When current flows from point B to A, it will cause the ____________ transistors to conduct.

27. If the temperature goes above 85°F, the voltage potential will be greater at point ____________.

28. Current flow from point A to point B will cause the ____________ transistor to conduc

29. The unit that causes the temperature to change from 85°F to 40°F when the aircraft goes above 25,000 feet is the __________ __________ __________.

30. When the aircraft is below 25,000 feet, the resistance in series with the sensor is resistor __________.

31. Should the temperature in the equipment air conditioning system drop to 70°F, the sensor resistance will be approximately ________ ohms. Would this cause the bridge to be unbalanced? ____________.

TURN ON THE TAPE RECORDER

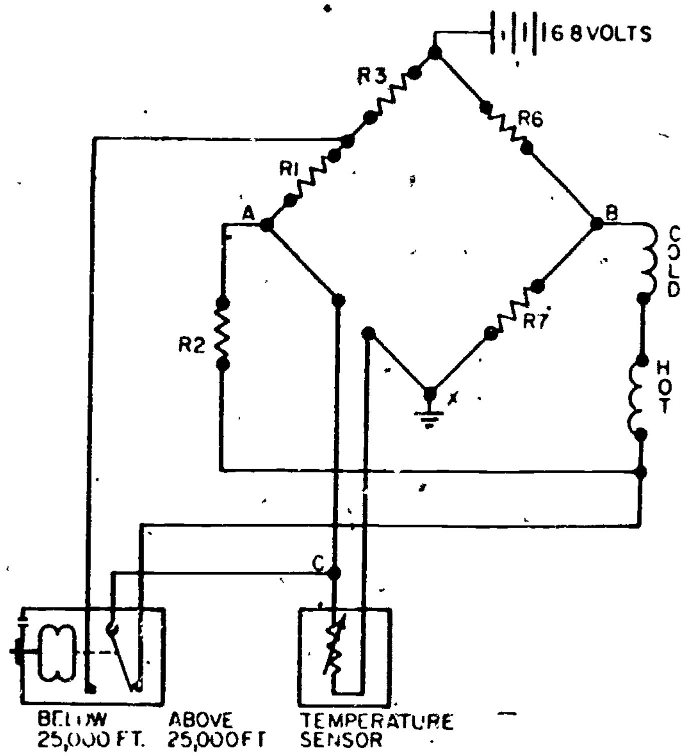

Figure 11.

Refer to figure 11 to complete statements 32 through 34.

32. When the aircraft is above 25,000 feet, the resistors in series with the sensor are resistors __________ and __________.

33. The altitude pressure switch controls the temperature by changing the __________ values in the bridge circuit.

34. Resistor R1 is bypassed when the aircraft is __________ (above/below) 25,000 feet.

TURN ON THE TAPE RECORDER

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SECTION 3. SYSTEM OPERATION

Answer statements 1 through 5 by circling the word opposite each of the statements that identifies the condition of the component when electrical power is first applied to the aircraft. Use figure 12 as an aid in determining the condition of the component.

1. Ground cooling ejector shutoff valve (open/closed).

2. Landing gear auxiliary relay (energized/deenergized).

3. Pressure regulator and shutoff valve solenoid (energized/deenergized).

4. Temperature limiter switch (energized/deenergized).

Referring to figure 12, complete statements 5 through 7.

5. An open in wire number H53A20 will cause the __________ __________ __________ to be inoperative.

6. An open in wire number G31A20 will cause the __________ __________ __________ __________ __________ to stay closed.

7. An open in wire number H48F20 will cause the __________ __________ __________ __________ valve to be inoperative and also the ground cooling ejector shutoff valve to be __________.

On the large diagram, Foldout 2, use your red pencil and trace in all of the circuits that you just traced on figure 12.

<u>TURN ON THE TAPE RECORDER</u>

Refer to figure 13 to complete statements 8 through 13.

8. When the voltage potential is lower at point A than at point B, it will cause the turbine bypass valve to operate toward the __________ position.

9. A short between pins A and B of the inlet air temperature sensor will cause the turbine bypass valve to operate toward the __________ position.

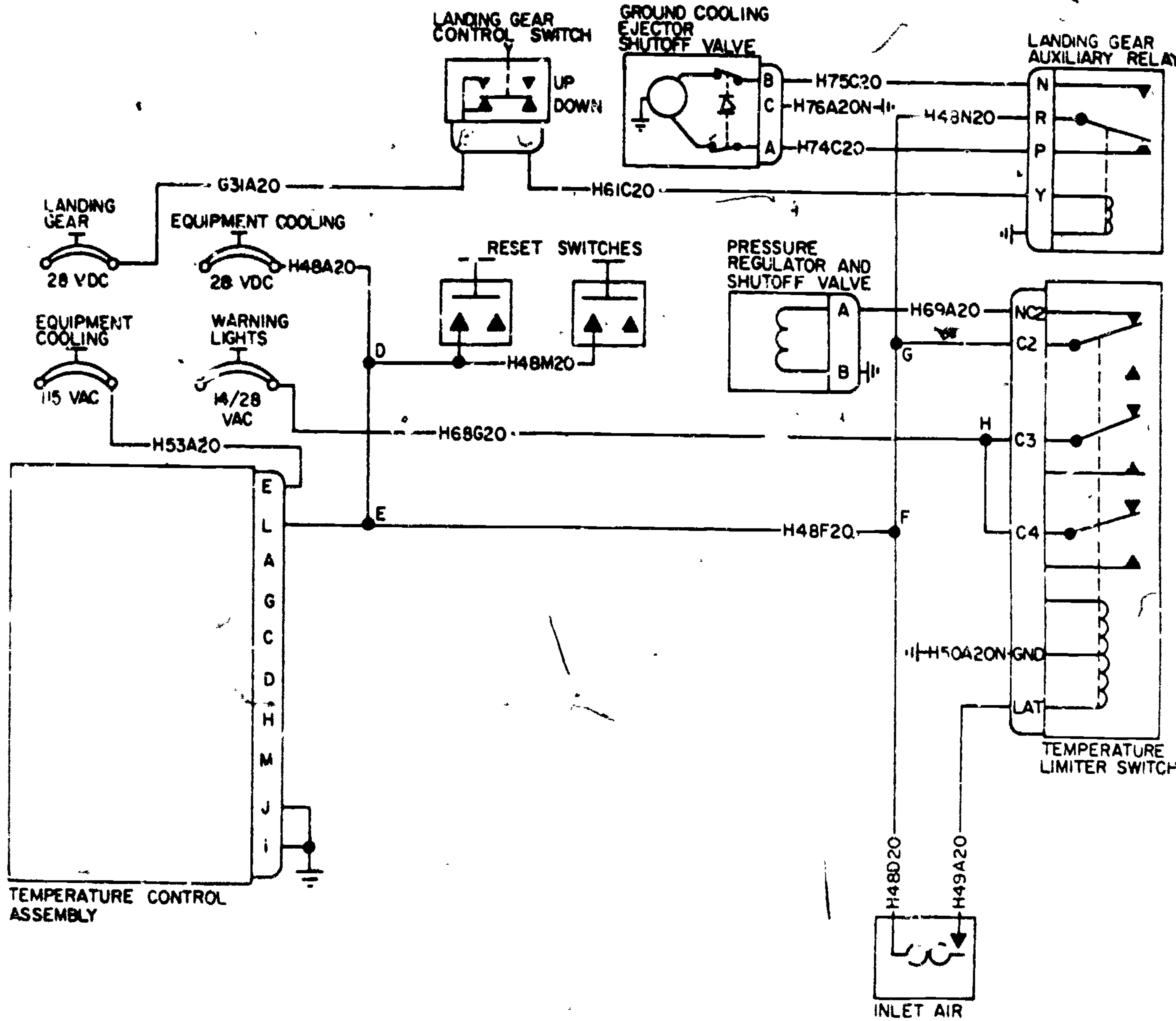
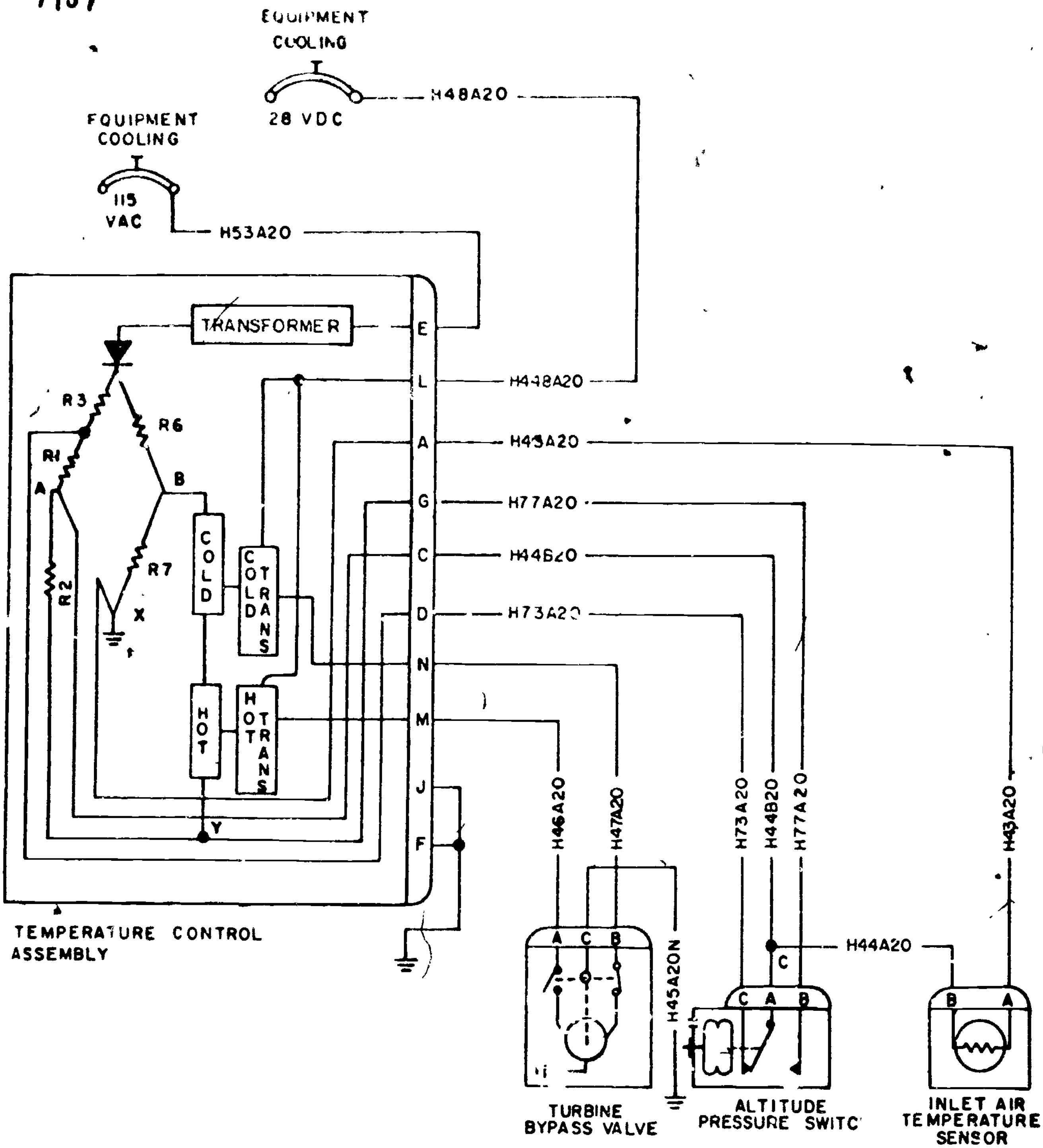

LANDING GEAR CONTROL SWITCH
UP
DOWN
GROUND COOLING EJECTOR SHUTOFF VALVE
LANDING GEAR AUXILIARY RELAY
H75C20
H76A20N
H48N20
H74C20
G31A20
H61C20
LANDING GEAR
28 VDC
EQUIPMENT COOLING
28 VDC
H48A20
RESET SWITCHES
PRESSURE REGULATOR AND SHUTOFF VALVE
H69A20
EQUIPMENT COOLING
115 VAC
WARNING LIGHTS
14/28 VAC
H48M20
H68G20
H53A20
H48F20
H50A20N
TEMPERATURE LIMITER SWITCH
TEMPERATURE CONTROL ASSEMBLY
H48D20
H49A20
INLET AIR TEMPERATURE LIMITER

Figure 12.

1487



TEMPERATURE CONTROL COLD BELOW 25000 FEET

Figure 13.

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10. An open in wire number H47A20 will cause the turbine bypass valve to be inoperative when demanding ________ air.

11. When cold air is demanded, the turbine bypass valve operates toward the ________ (open/closed) position

12. When the aircraft is below 25,000 feet, resistor ________ is in series with the inlet air temperature sensor. This causes the system to maintain ________ degrees.

13. When the aircraft is above 25,000 feet, resistors ________ and ________ are in series with the inlet air temperature sensor. This causes the system to maintain ________ degrees.

On the large diagram, Foldout 2, use your blue pencil and trace in all of the circuits that you just traced on figure 13.

TURN THE TAPE RECORDER ON

Refer to figure 13 to complete statements 14 through 18.

14. When the voltage potential is greater at point A than at point B, it will cause the turbine bypass valve to operate toward the ________ position.

15. An open in the inlet air temperature sensor will cause the turbine bypass valve to operate toward the ________ position.

16. An open in wire number H46A20 will cause the turbine bypass valve to be inoperative when demanding ________ air.

17. When hot air is demanded, the turbine bypass valve operates toward the ________ (open/closed) position.

18. An open in wire number H73A20 will cause the turbine bypass valve to operate to the full ________ position when the aircraft is ________ (above/below) 25,000 feet.

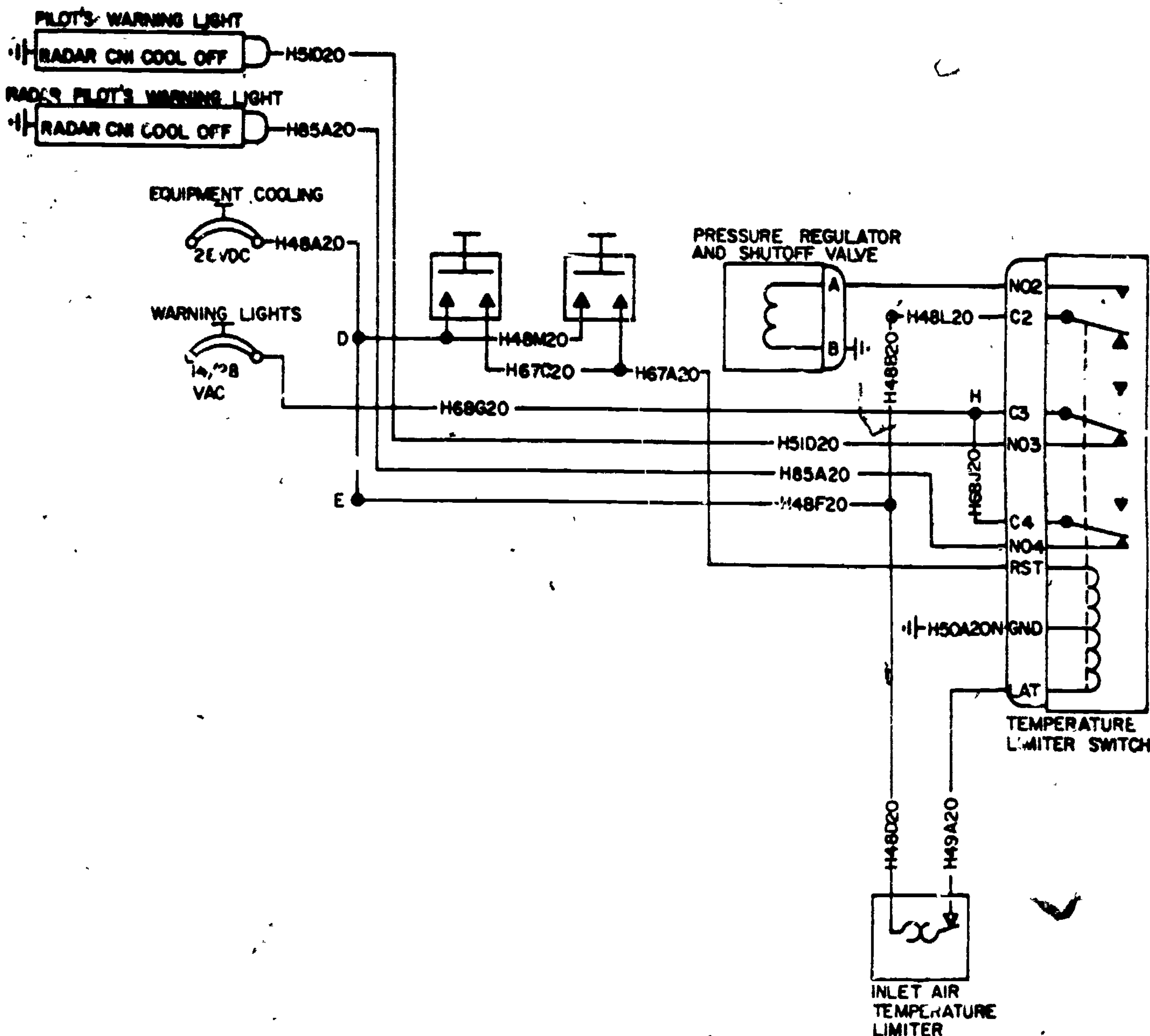
PILOT'S WARNING LIGHT
RADAR CNI COOL OFF
H51D20
RADAR PILOT'S WARNING LIGHT
RADAR CNI COOL OFF
H85A20
EQUIPMENT COOLING
28 VDC
H48A20
WARNING LIGHTS
14/28 VAC
D
H48M20
H67C20
H67A20
H68G20
H51D20
H85A20
H48F20
E
PRESSURE REGULATOR AND SHUTOFF VALVE
A
B
H48L20
H48B20
H
H68J20
NO2
C2
C3
NO3
C4
NO4
RST
H50A20N
GND
LAT
TEMPERATURE LIMITER SWITCH
H48D20
H49A20
INLET AIR TEMPERATURE LIMITER

Figure 14.

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On the large diagram, Foldout number 2, use your orange pencil and trace in all of the circuits that you just traced on figure 13. Be sure to use colored arrows on the circuit between points A and B to indicate direction of current flow for the system when demanding hot air.

TURN ON THE TAPE RECORDER

Refer to figure 14 to complete statements 19 through 23.

19. The inlet air temperature limiter is a normally __________ thermoswitch.

20. The inlet air temperature limiter closes at __________ degrees.

21. When the inlet air temperature limiter closes, it energizes the __________ coil of the temperature limiter switch.

22. An open in wire number H68G20 will cause the __________ __________ to be inoperative.

23. If the air conditioning system is inoperative and both warning lights remain on, the trouble is a short in the __________ __________ __________ __________.

On the large diagram, Foldout number 2, use your purple pencil and trace all of the circuits that you just traced on Figure 14.

TURN ON THE TAPE RECORDER

Refer to Foldout number 2 to complete statements 24 and 25.

24. After an overheat condition, a __________ __________ must be pressed in order to restart the equipment air conditioning system.

25. When either reset switch is pressed, it energizes the __________ coil of the temperature limiter switch.

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SECTION 4. TROUBLE ANALYSIS

Open foldout number 1, page 27. There are 16 numbers on this diagram indicating troubles in the electrical circuits. The troubles are either opens (x) or shorts (⌒) in the circuits.

The statements below give the condition for a trouble in the system. Read the statement then analyze the diagram to determine the possible cause or causes. Place the number or numbers in the blanks provided that would cause the trouble.

_____ 1. With the landing gear handle in the GEAR DOWN position the
_____ ground cooling ejector shutoff valve will not open.
_____

_____ 2. When the equipment air conditioning system temperature exceeds 150°F, the pressure regulator and shutoff valve closes, but the warning lights do not come on.

_____ 3. The temperature control system is inoperative and the bypass
_____ valve remains in a partially open position.

_____ 4. The equipment air conditioning system temperature exceeds 150°F, but the air conditioning system does not shut off and the warning lights do not come on.

_____ 5. After an overheat condition the system cannot be reset.

_____ 6. With the engines operating (aircraft setting on the ground)
_____ there is no airflow through the equipment air conditioning system.

_____ 7. The turbine bypass valve stays in the full hot position.
_____

_____ 8. The equipment air conditioning system goes full cold when the aircraft is below 25,000 feet, but operates normally above 25,000 feet.

____9. The turbine bypass valve stays in the full cold position.

____

____10. The ground cooling ejector shutoff valve opens normally but will not close.

Please check with the instructor after you finish this section.

Instructor's Initials Showing Completion by Student ____________

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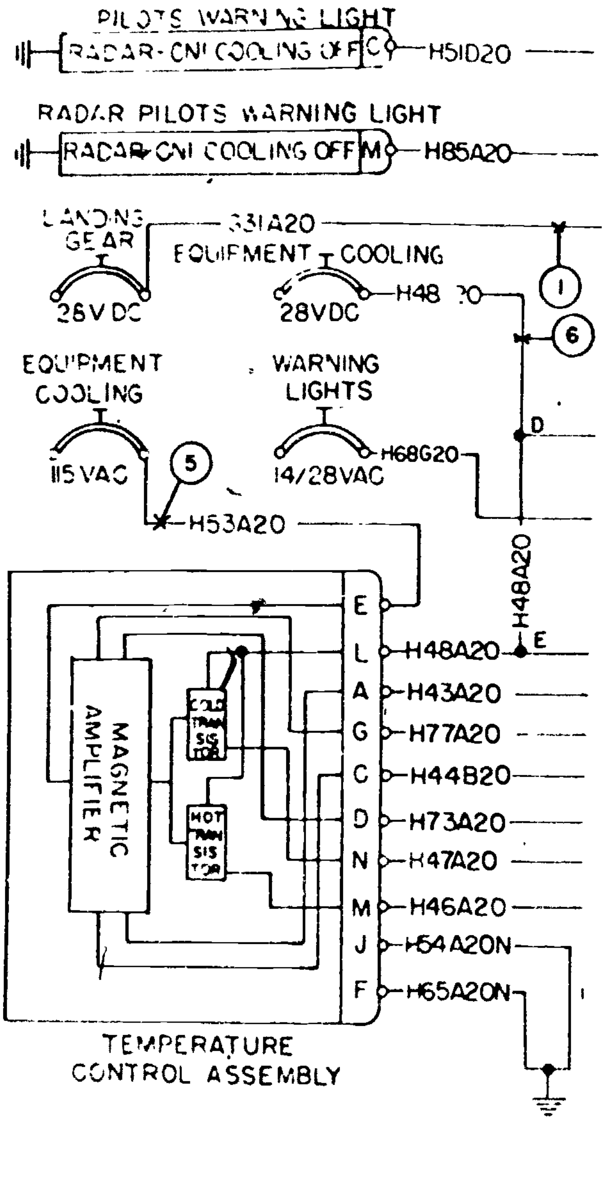
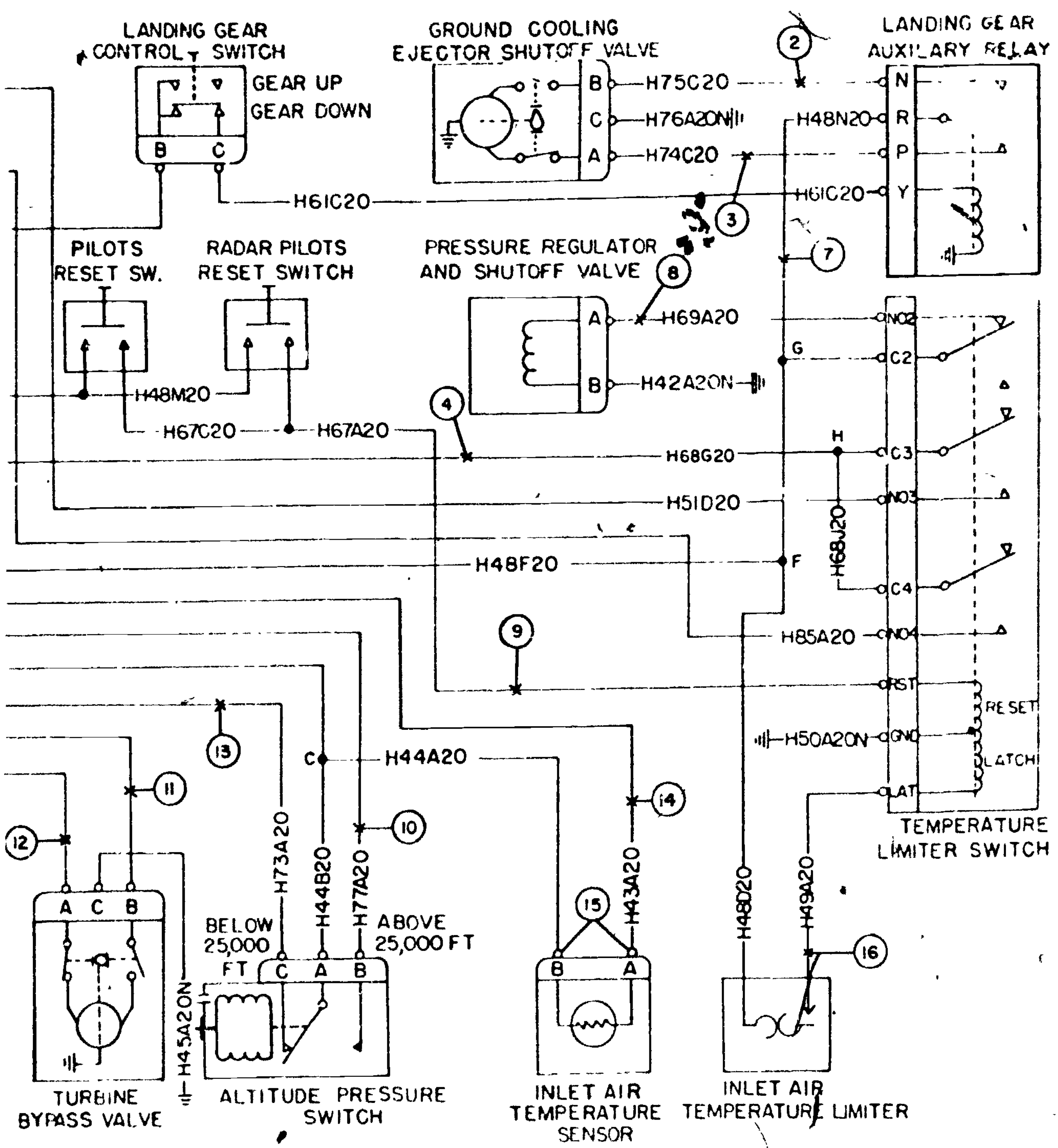
WIRING



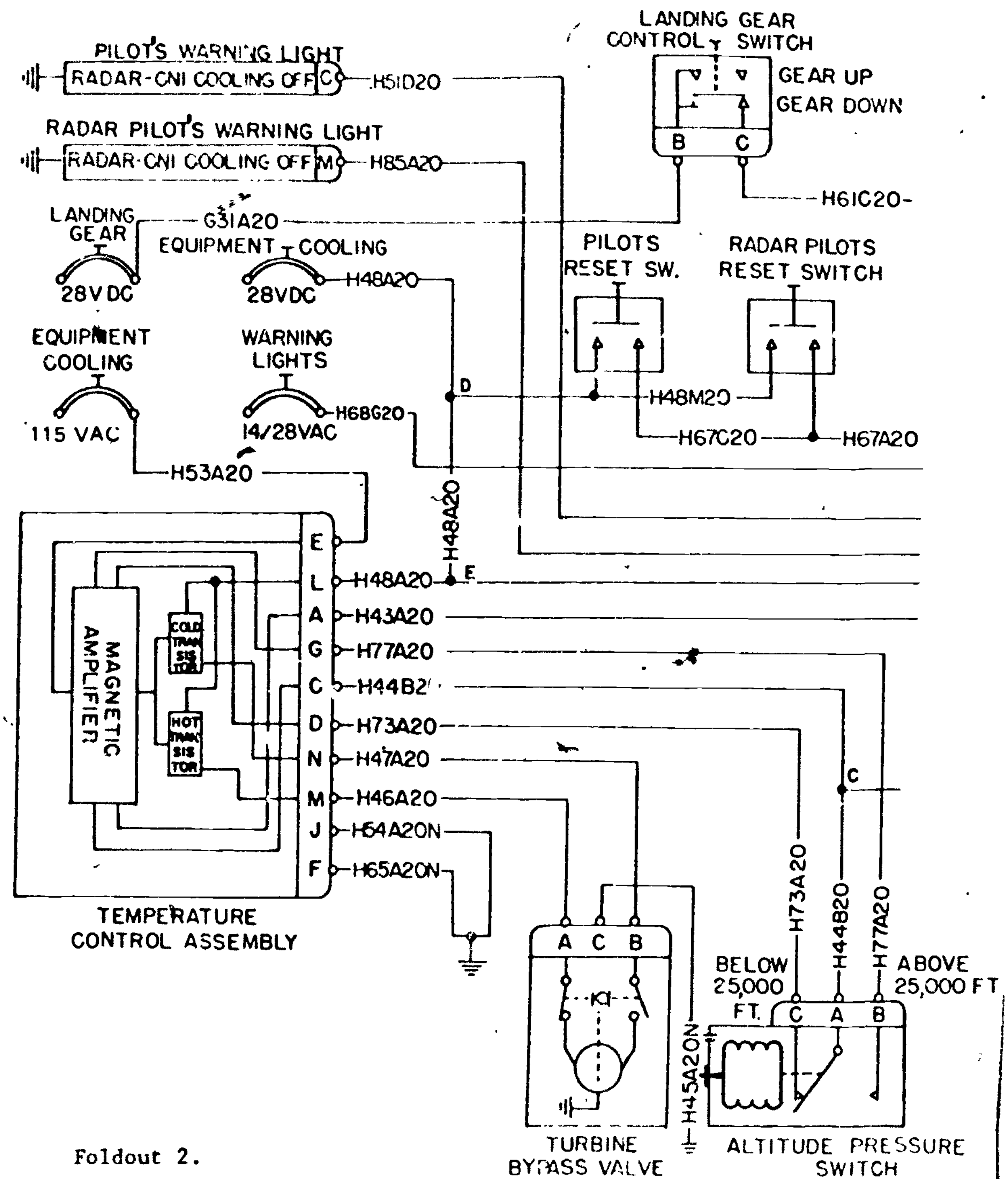
Foldout 1. Section 1

DIAGRAM—EQUIPMENT SYSTEM FIGHTER AIR CONDITIONING



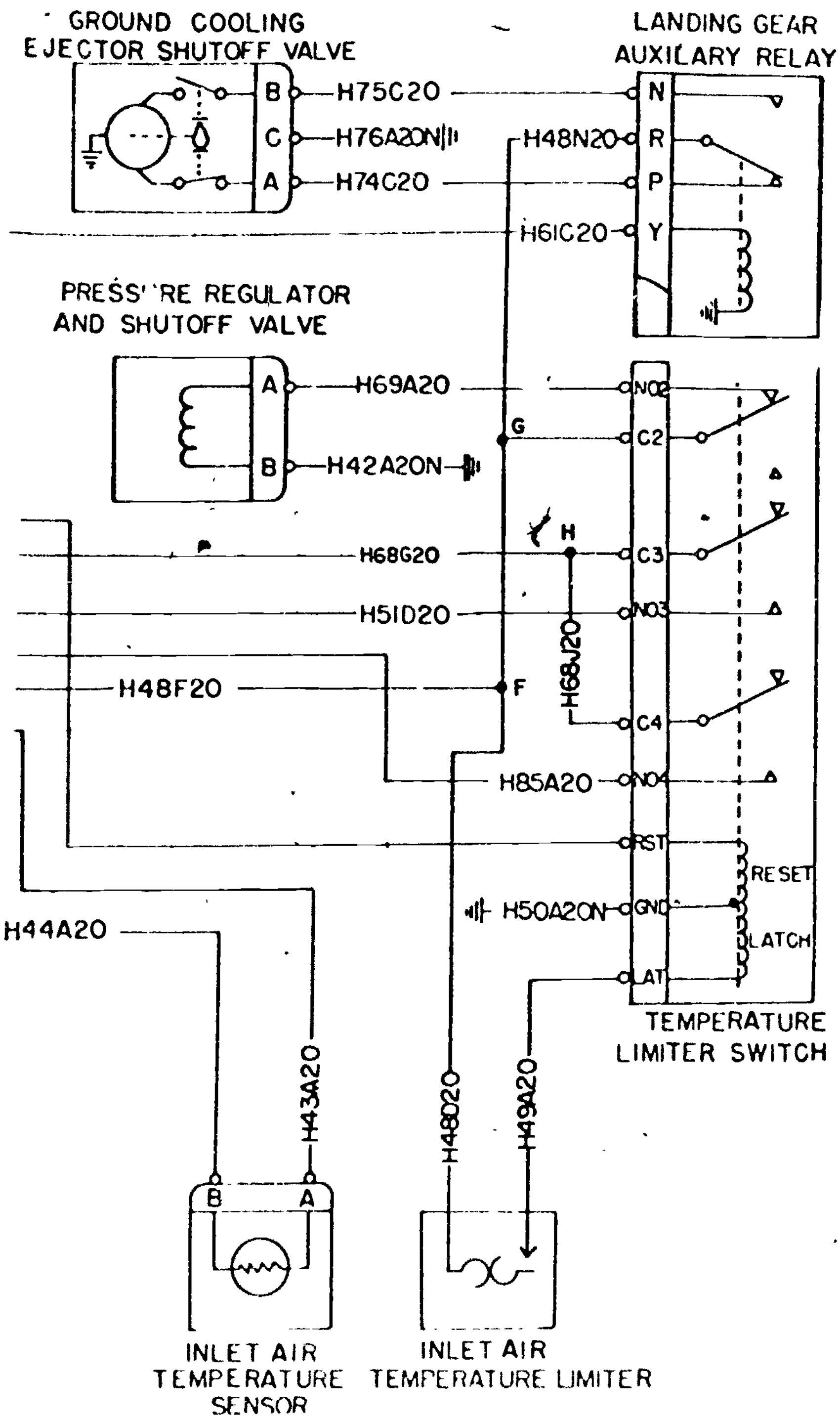
Foldout 1. Section 2

WIRING DIAGRAM—EQUIPMENT SYSTEM



Foldout 2.
Section 1.

FIGHTER AIR CONDITIONING



Foldout 2. Section 2

1497

WORKBOOK
3ABR42331-WB-203A

Technical Taining

Aircraft Environmental Systems Mechanic

EQUIPMENT AIR CONDITIONING SYSTEM TROUBLESHOOTING

15 February 1979

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3370 Technical Training Group
Chanute Air Force Base, Illinois

Designed for ATC Course Use.

Do Not Use on the Job.

1498

Environmental Pneudraulics Branch
Chanute AFB, Illinois

3ABR42331-WB-203A

EQUIPMENT AIR CONDITIONING SYSTEM TROUBLESHOOTING

OBJECTIVE

Using a multimeter and wiring diagram, perform an operational check and troubleshoot the equipment air conditioning system trainer, locating 7 out of 9 troubles correctly.

EQUIPMENT

	Basis of Issue
Trainer 3305, Fighter Air Conditioning	1/student
Multimeter, AN/PSM-37A	1/student

PROCEDURE

1. Be sure all your jewelry is removed. Report to the lab instructor. Tell him the lesson on which you are working. The instructor will assign you to a trainer and give you the necessary materials.

2. This workbook is in two sections. Section 1 is to familiarize you with the location and operation of the components of the equipment air conditioning system. Section 2 gives the steps you will use to make an operational check of the system and also lists the malfunctions that you are to troubleshoot. Do each step as directed.

SECTION 1. EQUIPMENT AIR CONDITIONING SYSTEM COMPONENTS

1. Location and Identification of the System Components.

a. Use figure 1 to locate each of the numbered items on the trainer. Write the name of each of the numbered components in the spaces following. As you locate each item, notice the electrical checkpoints next to them. These checkpoints are used for checking the electrical circuitry when troubleshooting.

Supersedes 3ABR42331-WB-203A, 8 September 1977.
OPR: 3370 TCHTG
DISTRIBUTION: X
3370 TCHTG/TTGU-P - 300; TTVSA - 1

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

(7) ______________________________

(8) ______________________________

(9) ______________________________

Check your responses with the answers on page 11.

b. Locate the following items on the trainer.

(1) Radar cooling reset buttons.

(2) Radar CNI COOLING OFF lights.

(3) Warning light circuit breaker.

(4) Landing gear circuit breaker.

(5) Equipment cooling 115V AC circuit breaker.

(6) Equipment cooling 28V DC circuit breaker.

(7) Temperature sensor simulator rheostat.

(8) Temperature limiter simulator switch.

(9) Altitude pressure switch simulator.

Note: On the trainer Simulator Control Panel there is a guarded switch next to a rheostat. You will use this switch and a multimeter when checking the resistance of the sensor.

When the switch is in the NORMAL position, the temperature sensor is in the circuit and is controlling system temperature. During troubleshooting if you want to check the actual sensor circuit, you must have this switch in the NORMAL position.

When the switch is in the TEST position, the simulating rheostat is in the circuit. It is used to simulate sensor resistance changes for checking the proper operation of the temperature control assembly and the turbine bypass valve.

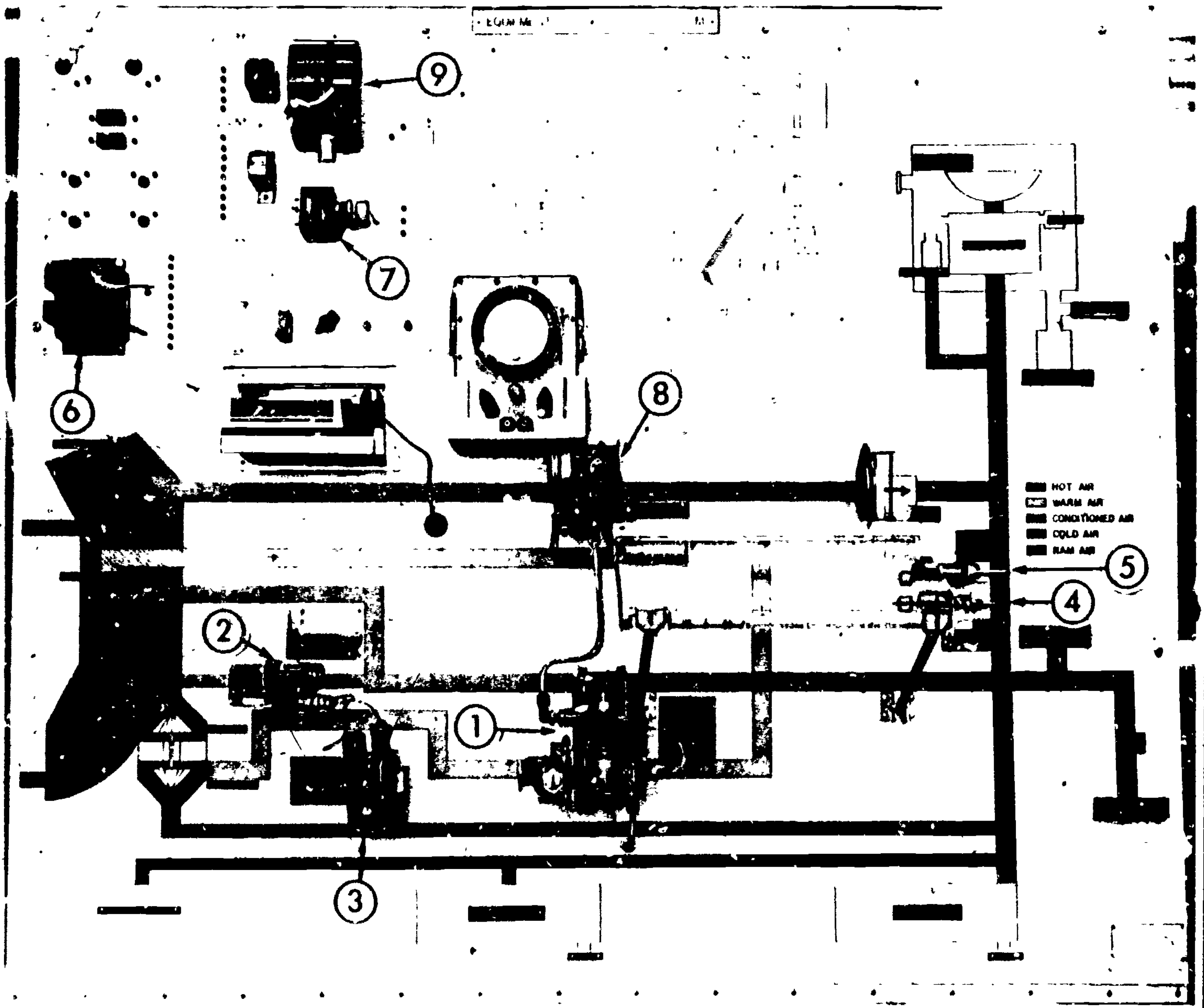


Figure 1.

2. Trainer Preparation.

a. Place all trouble switches to the OUT position. These switches are located at the left side of the trainer.

b. Push in the following circuit breakers:

(1) Landing Gear 28V DC.

(2) Equipment Cooling 28V DC.

(3) Equipment Cooling 115V AC 400hz.

(4) Warning Lights 14/28V AC.

c. Place the landing gear handle in the GEAR DOWN position.

d. Place the sensor simulator switch to the NORMAL position.

e. Place the trainer power switches to the ON position. These switches are located on the left side of the trainer.

3. Trainer Operation.

By following the steps listed below, you will operate each component of the equipment air conditioning system. Whenever a switch or lever is used, be sure to notice which of the valves operated and position of the valve after it has stopped. From your observation of the trainer operation, complete each of the statements by circling the correct word.

STEP 1. Bleed air pressure regulator and shutoff valve and ram air valve operation.

a. Pull the equipment cooling 28V DC circuit breaker out.

(1) The pressure regulator and shutoff valve (opens/closes).

(2) The ram air valve (opens/closes

b. Push the equipment cooling 28V DC circuit breaker in.

(1) The pressure regulator and shutoff valve (opens/closes).

(2) The ram air valve (opens/closes).

STEP 2. Ground cooling ejector shutoff valve operation.

a. Place the landing gear handle in the GEAR UP position.

1502

(1) The ground cooling ejector shutoff valve (opens/closes).

b. Place the landing gear handle in the GEAR DOWN position.

(1) The ground cooling ejector shutoff valve (opens/closes).

STEP 3. Temperature control system (turbine bypass valve) operation.

a. Since this system is completely automatic, you will have to simulate temperature changes in the duct. This is done by using the sensor simulating rheostat. Turn the sensor simulating rheostat clockwise to the full cold position. Place the guarded selector switch to the TEST position.

(1) The turbine bypass valve (opens/closes).

b. Turn the sensor rheostat counterclockwise to the full Hot position.

(1) The turbine bypass valve (opens/closes).

c. Return switch to normal position.

STEP 4. Temperature limiter operation.

a. Place the temperature limiter simulator switch to the OVERHEAT position.

(1) The pressure regulator and shutoff valve (opens/closes).

(2) The ram air valve (opens/closes).

(3) The CNI COOLING OFF warning lights are (on/off).

b. Place the temperature limiter simulator switch to the normal position. Did the pressure regulator and shutoff valve or the ram air valve operate? (Yes/No).

c. Press either reset button.

(1) The pressure regulator and shutoff valve (opens/closes).

(2) The ram air valve (opens/closes).

(3) The CNI COOLING OFF lights are (on/off).

4. Sensor Resistance.

a. Before you can make an operational check or troubleshoot the system, the normal resistance value of the sensor must be determined. To make this resistance measurement, the sensor circuit must be isolated. To isolate the sensor circuit, disconnect the AN connector attached to the temperature control assembly. With the connector disconnected you will measure only the sensor resistance at the sensor checkpoints. The checkpoints are lettered A and C on the temperature control assembly test panel.

Note: The sensor simulating selector switch must be in the NORMAL position.

b. The resistance of the sensor is ____________________. The resistance value should be between 1500 and 3000 ohms.

SECTION 2. OPERATION AND TROUBLESHOOTING

Operation

1. By following the steps in Section 1, you became familiar with the operation of each component in the system.

2. Before you can troubleshoot you must know what is and what is not working properly in the system. To do this you must perform an operational check. The operational check procedure chart (figure 2), lists the planned steps that are used to make an operational check of the system. Use this chart to become familiar with each step. After you are sure you can make an operational check, continue to the troubleshooting section. Remember, you will need to make an operational check for each trouble. DO NOT depend on your memory. Use the checklist to be 100% sure.

Note: The equipment air conditioning temperature control system is fully automatic. This makes it necessary to simulate the operation of the equipment sensor circuit, when you make an operational check or troubleshooting the system on the trainer. This must be done before the sensor resistance is checked.

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POSITIONING CONTROL DEVICE	OPERATING VALVE OR LIGHT	VALVE POSITION
Pull out the equipment cooling 28V DC circuit breaker	Pressure regulator and shutoff valve Ram air valve	Closed Open
Push in the equipment cooling 28V DC circuit breaker	Pressure regulator and shutoff valve Ram air valve	Open Closed
Move the landing gear handle to the GEAR UP position	Ground Ejector valve	Closed
Move the landing gear handle to the GEAR UP position	Ground Ejector valve	Open
Place the sensor simulator switch to test. Rotate the sensor simulator rheostat to full counterclockwise	Turbine Bypass valve	Open
Rotate the sensor simulator rheostat to full clockwise	Turbine Bypass valve	Closed
Place sensor simulator switch to NORMAL	Turbine Bypass valve	Open
Place altitude pressure switch to above 25,000 FT	Turbine Bypass valve	Closed
Place altitude pressure switch to below 25,000 FT	Turbine Bypass valve	Open
Place temperature limiter simulator switch to overheat	Pressure regulator and shutoff valve Ram air valve CNI cool off light	Closed Open On
Place temperature limiter simulator switch to NORMAL	No valve action	
Press either reset button	Pressure regulator and shutoff valve Ram air valve CNI cool off light	Open Closed Off

Figure 2. Operational Check Procedure Chart.

Troubleshooting

1. Before going through an actual trouble, let's check the turbine bypass valve circuits to see the normal indications and to learn the procedure for troubleshooting the system.

a. Use the wiring diagram mounted on the trainer to trace the circuits required to operate the temperature control assembly. Trace from the equipment cooling 28V DC circuit breaker to pin L of the temperature control assembly. Trace from the equipment cooling 115V AC circuit breaker to pin E of the temperature control assembly. Trace from pins J and F of the temperature control assembly to ground. This circuit provides the necessary power for operation of the temperature control assembly.

b. Place the sensor simulator switch to the TEST position.

c. Turn the sensor simulator rheostat full CLOCKWISE. This simulates an increase in air temperature. A signal is sent by the rheostat to the control assembly demanding cold air. This will cause the COLD transistors to conduct.

d. Use the trainer diagram to trace the COLD CIRCUIT from pin N of the temperature control assembly to pin B of the turbine bypass valve.

e. Use the multimeter to check the voltage at pin B of the turbine bypass valve checkpoint. The voltage should be 24 to 28 volts. Did you get the correct voltage reading? __________

Note: When measuring voltage, be sure the meter is set to the correct voltage range. Make sure that you have the negative (black) lead to ground. Ground on the trainer is any point marked with a ground (—|||) symbol. Only use the OHM portion of the multimeter to check the sensor and the sensor circuit.

Caution: <u>All power to the trainer must be OFF before you use the multimeter as an OHMMETER to check a circuit.</u>

f. Turn the sensor simulator rheostat full COUNTERCLOCKWISE. This simulates a decrease in air temperature. A signal is sent by the rheostat to the temperature control assembly demanding hot air. This will cause the HOT transistors to conduct.

g. Use the trainer diagram to trace the HOT circuit from pin M of the temperature control assembly to pin A of the bypass valve.

h. Check the voltage at pin A of the turbine bypass valve checkpoint. The voltage should be between 24 to 28 volts. Did you get the correct voltage reading? __________

i. Return sensor simulator to normal position.

1506

2. There are 12 malfunctions for you to troubleshoot. The trouble switch you are to use for each problem is identified on the Troubleshooting Response Sheet.

3. For each problem, perform an operational check to find out which component is malfunctioning. Enter a description of the malfunction in the discrepancy block of the troubleshooting response sheet.

4. Trace the electrical circuits that operate or control the malfunctioning component.

5. Use the multimeter to locate the cause of the trouble.

6. Enter in the discrepancy block of the Troubleshooting Response Sheet a description of the cause of the malfunction.

7. The first trouble will be analyzed and solved with you. You will do the rest of the troubles on your own.

a. Place trouble switch number 1 to the IN position.

b. Perform an operational check using the chart in figure 2.

c. As you went through the operational check, you should have found that the turbine bypass valve did not operate.

d. Make the following statement in the discrepancy block of the Troubleshooting Response Sheet for Trouble Switch Number 1 NOW.

"Turbine bypass valve did not operate"

e. Since the bypass valve will not operate to either position, the trouble must be in a wire or component that is common to both the hot and cold circuits. Which electrical circuit would cause this problem? --- The DC and AC power supply circuits. --- Use the trainer diagram to trace the AC and DC power supply circuits from the circuit breaker to the temperature control assembly.

f. Check the DC power supply circuit with the multimeter. You should get a voltage reading.

g. Check the AC power supply circuit. You did not get a reading, did you? This means there is an open in wire H53A20.

h. Make the following statement in the malfunction cause block of the Troubleshooting Response Sheet for Trouble Switch Number 1 NOW.

"Open in wire H53A20"

i. Place trouble switch number 1 to the OUT position and continue with problems 2 through 12. Use the Troubleshooting Response Sheet to record the malfunction and malfunction cause for each problem.

8. The lab instructor will constantly be evaluating your progress. After you have completed this troubleshooting section check your answers with the lab instructor.

The correct responses to the location and identification of system components:

(1) Bleed Air Pressure Regulator and Shutoff Valve.
(2) Ground Cooling Ejector Shutoff Valve.
(3) Turbine Bypass Valve.
(4) Temperature Sensor.
(5) Temperature Limiter.
(6) Temperature Control Assembly.
(7) Altitude Pressure Switch.
(8) Ram Air Valve.
(9) Landing Gear Handle.

The correct responses to Trainer Operation.

STEP 1.

a.(1) closes
  (2) opens
b.(1) opens
  (2) closes

STEP 2.

a. closes
b. opens

STEP 3.

a. closes
b. opens

STEP 4.

a.(1) closes
  (2) opens
  (3) on
b. no
c.(1) opens
  (2) closes
  (3) off

If your answers do not agree, check with your instructor. If your answers agree, then the trainer is operating properly.

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TROUBLESHOOTING RESPONSE SHEET

TROUBLE SWITCH NUMBER	DISCREPANCY	CAUSE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

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PROGRAMMED TEXT

3ABR42331-PT-204

Technical Training

Aircraft Environmental Systems Mechanic

TEMPERATURE CONTROL SYSTEM TESTER

8 September 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

DO NOT USE ON THE JOB

1510

FOREWORD

This programmed text was prepared for use in the 3ABR42331, Aircraft Environmental Systems Mechanic Course. The materials herein were validated with students from the subject course. At least 90% of the students achieved or surpassed the criteria established in the objectives. The average time for completion of this text was 6 hours.

OBJECTIVES

Associate the name of the controls on the Temperature Control System Tester (AN/PSM-21) with its purpose/function with a minimum of 80% accuracy.

INSTRUCTIONS

This programmed text presents information and procedures in small steps called frames. Within each frame, you will be directed to complete some statements or answer questions. Read the material presented, then respond on the response sheet. DO NOT MARK IN THIS TEXT. After you have made your response, compare your answers with the correct answers given on the top of the next frame, or as otherwise noted. If your answer is incorrect, restudy the frame to get the information correct. If necessary, you may go back to check information previously given, but do not skip ahead.

Supersedes 3ABR42231-PT-204, 29 July 1974.
OPR: 3370TTG
DISTRIBUTION: X
3370TTGTC - 300; TTVSR - 1

Frame 1

During this lesson you will be using the AN/PSM-21A air conditioning system tester to perform an analysis of a fighter type aircraft air conditioning system. The AN/PSM-21A is designed for use on the F4 type aircraft only. There are, however, several different air conditioning system testers used in the Air Force. They are usually designed for use on one specific type of aircraft. The use and general operating procedure are similar on all of them. By learning to use the AN/PSM-21A tester you will have a general understanding of system testers. By following instructions given in the technical order, you should be able to use this and other system testers.

Complete the following statements.

1. The air conditioning system tester used on the F4 type aircraft is the AN/_________.

2. When using an air conditioning system tester, you should always follow the instructions given in the applicable __________ _____________.

1512

CORRECT RESPONSES TO FRAME 1: 1. AN/PSM-21A 2. Technical Order.

Frame 2

Open the foldout at the back of this text. This foldout shows an illustration of the AN/PSM-21A tester. This tester is used for performing a checkout, or troubleshooting the temperature control systems on the F4 type aircraft. The tester will check the operation of the temperature control units in either the cabin or equipment air conditioning system. The tester can be used to check the complete temperature control system at the aircraft. can also be used in the shop to bench check and repair each individual component.

Complete the following statements.

1. The AN/PSM-21A tester can be used to check the __________ system, and the __________ system.

2. The AN/PSM-21A tester can be used to bench check the cabin temperature __________ __________ or the equipment system __________ control assembly.

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CORRECT RESPONSES TO FRAME 2: 1. cabin equipment 2. control panel temperature.

Frame 3

The cabin temperature control system units can be checked using the tester at the aircraft. The purpose of each check is given for each unit.

1. Cabin Temperature Control Panel

This unit is checked for a signal output from the cabin magnetic amplifier section to the cabin dual temperature mixing valve. The signal output is based on signals applied to the bridge circuit by a rheostat which is part of the tester. This rheostat simulates the cabin temperature sensor.

2. Cabin Temperature Sensor

This unit is checked for proper resistance in relation to ambient temperature.

3. Cabin Dual Temperature Mixing Valve

The tester checks the valve motor for operation and the valve for full travel.

Complete the following statements.

1. Increasing or decreasing the resistance in one leg of the cabin bridge circuit will cause a signal through the magnetic amplifier to be sent to the cabin ____________, ________ ________________ ____________.

2. Changes in resistance in the bridge are simulated by a ____________ on the tester.

3. The cabin temperature sensor is checked for proper ____________.

1514

CORRECT RESPONSES TO FRAME 3: 1. dual temperature mixing valve 2. rheostat 3. resistance.

Frame 4

The equipment air conditioning system units can be checked at the aircraft using the tester checks for each of the following units. The purpose of each check is given for each unit.

1. Temperature Control Assembly

This unit is checked for proper signal output from the magnetic amplifier to the turbine bypass valve (temperature control valve). The tester rheostat simulates the equipment temperature sensor. When the resistance in the bridge is changed with the rheostat, a signal is sent through the temperature control assembly to the turbine bypass valve.

2. Temperature Sensor

This unit is checked for proper resistance in relation to ambient temperature.

3. Turbine Bypass Valve

The tester checks the valve motor for operation and the valve for full travel.

Complete the following statements.

1. The AN/PSM-21A checks the equipment temperature control assembly for proper ________ output.

2. When checking the equipment air conditioning system at the aircraft with the AN/PSM-21A, the turbine bypass valve is checked for ____________ operation and full travel.

1515

CORRECT RESPONSES TO FRAME 4: 1. signal 2. motor.

Note: Before operating the tester you need to be familiar with the controls that you will be using. Use the sketch shown in figure on page 17 to complete Frames 5 through 13. Observe the name of the item given at the beginning of each frame, then find the item in the sketch. Next read the information given and complete the statements. The answers to this group of frames are given on the page following Frame 13.

Frame 5

AC AND DC AIRCRAFT POWER LIGHTS

1. One light is marked __________ VAC and one light is marked __________ VDC. These lights indicate when electrical power is available to the tester..

Frame 6

SELECTOR SWITCH S1

1. The two positions of this selector switch are marked __________ system and __________ system. This switch is used to select the system being tested.

Frame 7

SELECTOR SWITCH S2

1. The two positions of this selector switch are marked __________ __________ __________ and __________ __________ __________. This switch is used to connect the sensor simulator to the system being tested.

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Frame 8

SELECTOR SWITCH S3

1. The two positions of this selector switch are marked _______ _________ _________ and _______ _______ ________. This switch is used to select the altitude range when testing the equipment air conditioning system.

Frame 9

SENSOR SIMULATOR

1. This is a potentiometer (rheostat) that is used to simulate the temperature sensor. With this potentiometer you can apply various resistance values to the bridge circuit. The ranges of this potentiometer are marked __________ and __________.

Frame 10

RESISTANCE MONITOR

The resistance monitor includes two push button switches marked SENSOR and LIMITER and two connecting points for the AN/PSM-6 multimeter leads. These are marked TP5 and TP6. (TP means test point.) When testing the system you connect the multimeter leads to TP5 and TP6. Then by pressing the switch marked SENSOR you can read the resistance of the SENSOR SIMULATOR.

Note: This does not check the resistance of the actual sensor. This indicates how much resistance is required to obtain a cold or hot signal.

1. To obtain a cold signal you would have to ______________(increase/decrease) resistance.

2. When checking the system, with the multimeter leads connected to test points TP5 and TP6, the resistance indicated on the meter is the resistance of the ______________ . ______________.

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AMP OUTPUT LIGHTS (Amplifier output lights)

1. There are four amplifier output lights. They are marked ___________, ___________, ___________, and ___________. These lights indicate the signal output from the cabin temperature control panel or the equipment system temperature control assembly, depending on which system you are checking. These lights will also indicate valve operation by indicating when the valve has reached full travel. DS1 and DS2 are used when checking the cabin or equipment air conditioning systems. The lights will pulse or burn steadily. This is actually the signal received from the temperature control assembly. While the valve is in travel, both lights will be on. When the valve reaches full travel one light will stay on and the other will be out. When checking the system this is how you can tell if the valve is running from full travel hot to full travel cold.

> Note: DS3 and DS4 are used when checking the suit system. This system is no longer in use therefore you will not be using these lights.

---

2. The signal output from the cabin magnetic amplifier and an indication of full travel of the cabin dual temperature mixing valve will be indicated by lights ___________ and ___________.

3. The signal output from the equipment temperature control assembly and an indication of full travel of the equipment system bypass valve will be indicated by lights ___________ and ___________.

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Frame 12

SENSOR TP1, TP2, TP3, TP4

Test points TP3 and TP4 are used when testing the cabin temperature sensor for correct resistance. When the AN/PSM-6 multimeter leads are inserted in the test points, the resistance of the sensor is read on the multimeter. When connected the tester isolates the sensor. This means you can test the resistance of the sensor without turning off the system. TP1 and TP2 are used when checking the resistance of the equipment system temperature sensor.

1. With switch S1 in the CABIN SYSTEM position, and the multimeter leads in test points TP 3 and TP4, you will be reading the resistance of the __________ __________ sensor on the multimeter.

Note: Switch S1 has no EQUIPMENT SYSTEM position. So, you cannot put your multimeter leads into TP3, TP4, TP5 or TP6 to check the equipment system sensor. Therefore, S1 will remain in the cabin system position when you use TP1 and TP2 to check the equipment system sensor in the TP1 and TP2 check points.

Frame 13

SELECTOR SWITCH S6

Later in this text, when you are actually using the tester, the technical order instruction charts refer to this switch as the EXTERNAL METER switch. Although this switch is not marked with this nomenclature, we will use this name when referring to this switch.

1. The three positions of this switch are marked __________, __________, and __________ __________. During normal checkout procedures of the system, this switch will remain OFF. It is placed to the FLT LINE position only when checking sensor resistance through test points TP1, TP2, TP3 and TP4. It is spring loaded away from the FLT LINE position. When checking sensor resistance it must be held to the FLT LINE position. The switch can only be held to this position for a maximum of 4 seconds. The BENCH position is used when bench testing the temperature control assemblies in the shop. It is not necessary to hold the switch to the BENCH position as it is not spring loaded away from this position.

2. The external meter switch is used when checking __________ resistance.

3. The external meter switch should not be held in the FLT LINE position for more than __________.

CORRECT RESPONSES TO FRAMES 5 through 13.

Frame 5. 1. 115 VAC 28 VDC.

Frame 6. 1. CABIN SYSTEM SUIT SYSTEM.

Frame 7. 1. CABIN TEMP SIMULATED SUIT TEMP SIMULATED.

Frame 8. 1. ABOVE 25,000 FT SIMULATED BELOW 25,000 FT SIMULATED.

Frame 9. 1. COLD HOT.

Frame 10. 1. decrease 2. sensor simulator.

Frame 11. 1. DS1, DS2, DS3, DS4.

2. DS1 and DS2.

3. DS1 and DS2.

Frame 12. 1. cabin temperature.

Frame 13. 1. BENCH, OFF, FLT LINE.

2. sensor.

3. 4 seconds.

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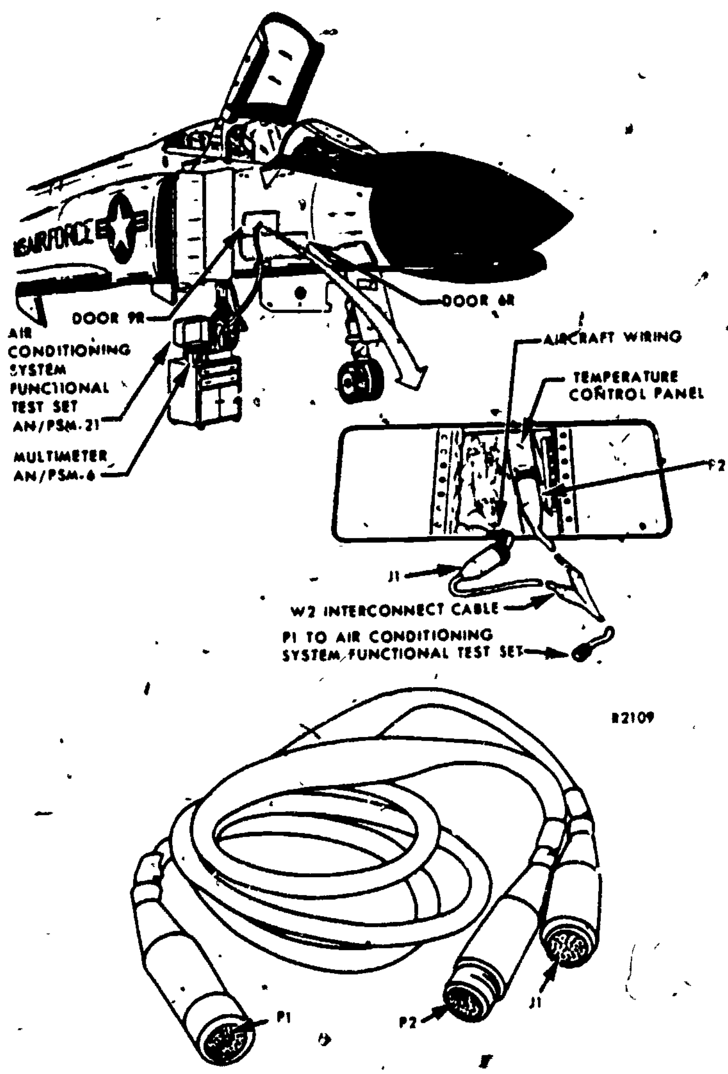
Frame 14

Special cables are used to connect the tester to the temperature control assemblies and to the aircraft wiring. The figure shows the cable used when testing the cabin temperature control system. The cable has three straight AN connectors marked P1, P2, and J1. The large connector (P1) connects to the test set at the point marked AMPLIFIER CONTROL. Connector J1 connects to the aircraft wiring connector. P2 connects to the cabin temperature control panel.



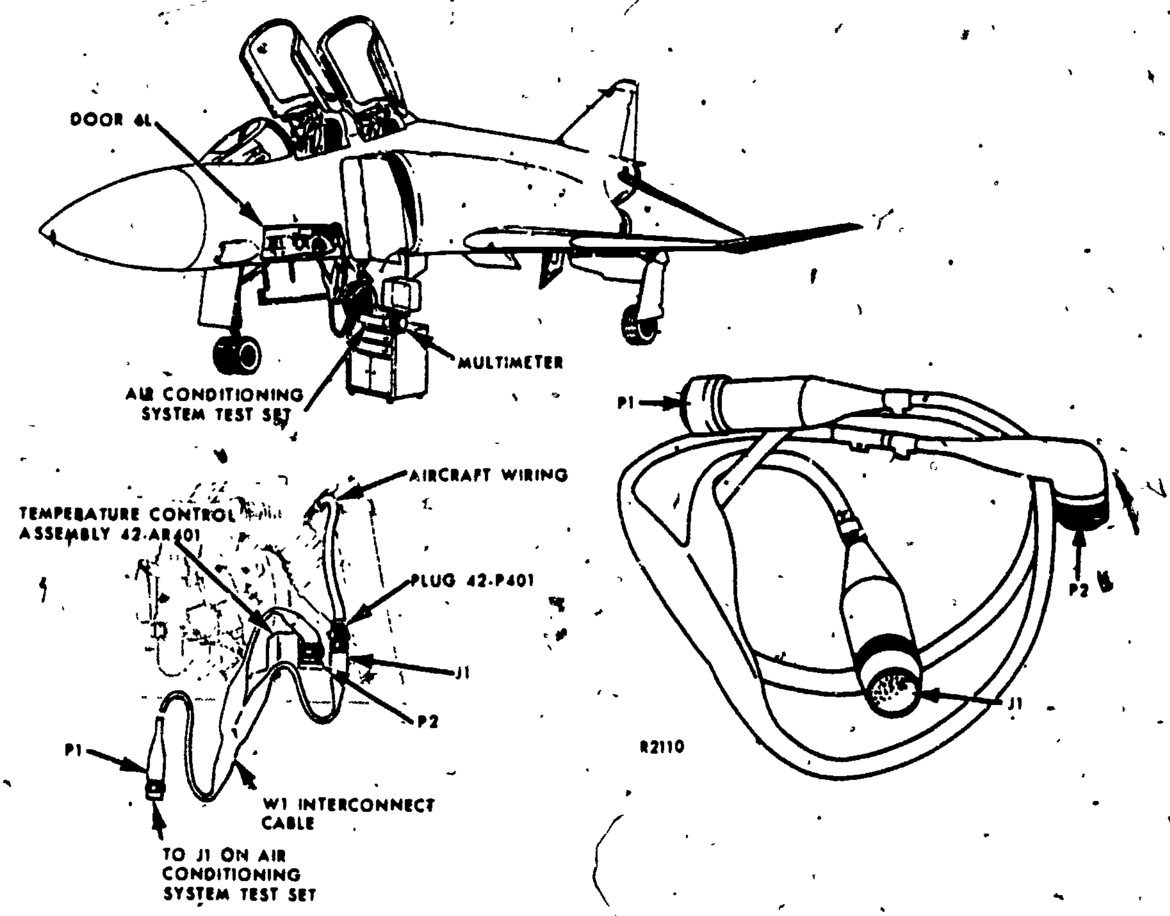
Complete the following statements.

1. The cable connects to the tester, the aircraft wiring harness and the temperature ____________ ______________.

CORRECT RESPONSES TO FRAME 14: 1. control panel.

Frame 15

A separate cable is used when checking the equipment temperature control system. This cable is shown in the figure. This cable has two straight AN connectors (P1 and J1) and one L shaped AN connector (P2). The large connector (P1) connects to the test set at the point marked AMPLIFIER CONTROL. The L shaped connector (P2) connects to the equipment temperature control assembly. Connector J1 connects to the aircraft wiring.



Complete the following statements.

1. When testing either the cabin or equipment system, the AN connector marked P1 is connected to the tester at the point marked ________ ________.

2. The AN connector marked J1 of the test cable is connected to the ________ ________.

3. The notable difference between the cable used for testing the cabin system and the cable used for testing the equipment system is the L shaped connector on the ________ system cable.

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CORRECT RESPONSES TO FRAME 15. 1. <u>amplifier control</u> 2. <u>aircraft wiring</u> 3. <u>equipment</u>.

Frame 16

Before you use the AN/PSM-21A to test the F4 aircraft air conditioning system it's necessary that you become familiar with some of the differences in models of this aircraft. The original temperature control assemblies used on the F4 aircraft consisted of magnetic amplifier controlled <u>relays</u>. The relays directed electrical current to the temperature control valve. The valve is identified as a cabin dual temperature mixing valve, or an equipment system bypass valve. On the later model F4 aircraft, and on some of the earlier models the temperature assemblies have been modified. The <u>modified assemblies</u> have magnetic amplifier controlled <u>transistors</u>. The transistors direct current to the temperature control valves. Remember, a transistor can be used to serve the same purpose as a relay.

Two types of temperature control valves are used. One has the relay type temperature control assemblies. The other has transistor type temperature control assemblies.

The procedures for using the tester are different for the two types of systems. It is important that you determine which type of temperature control assembly and valve you are testing. This is real easy to determine. The relay type assemblies are <u>black</u>. The valve used with this system has a <u>black</u> motor. The transistor type assemblies and motors are <u>white</u>.

Complete the following statements.

1. The temperature control assemblies used on the F4 aircraft use either relays or __________ to direct electrical current to the temperature (mixing) valves.

2. The transistor type temperature control assemblies are colored __________.

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CORRECT RESPONSES TO FRAME 16: 1. transistors 2. white

Frame 17

Match the units listed in column "B" with the statements given in column "A" by placing the letter from column "B" in the blanks provided.

COLUMN A	COLUMN B
______1. Indicates how much resistance is required to obtain a cold or hot signal from the temperature control panel.	A. AC Light
______2. Rheostat used to simulate the temperature sensor.	B. Selector Switch S3
______3. Used when testing the equipment temperature sensor for correct resistance readings.	C. Amp Output Lights
______4. Indicates when 115V AC power is available.	D. TP5 and TP6
______5. Used to select the system being tested. Cabin or Suit System.	E. Resistance Monitor
______6. Used only when checking sensor resistance through Test Points TP1, TP2, TP3, and TP4.	F. Selector Switch S6
______7. Used to connect the sensor simulator to the system being tested.	G. Selector Switch S2
______8. Indicates 28V DC power is available.	H. DC Light
______9. Used to select the altitude range when testing the Equipment Air Conditioning System.	I. Sensor TP1 and TP2
______10. Indicates the signal output from the Cabin or Equipment Temperature Control Assemblies.	J. Sensor Simulator
______11. Test points used when testing the systems and using the resistance monitor.	K. Selector Switch S1
______12. Used when testing the cabin temperature sensor for correct resistance readings.	L. Sensor TP3 and TP4

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CORRECT RESPONSES TO FRAME 17:

1. E
2. J
3. I
4. A
5. K
6. F
7. G
8. H
9. B
10. C
11. D
12. L

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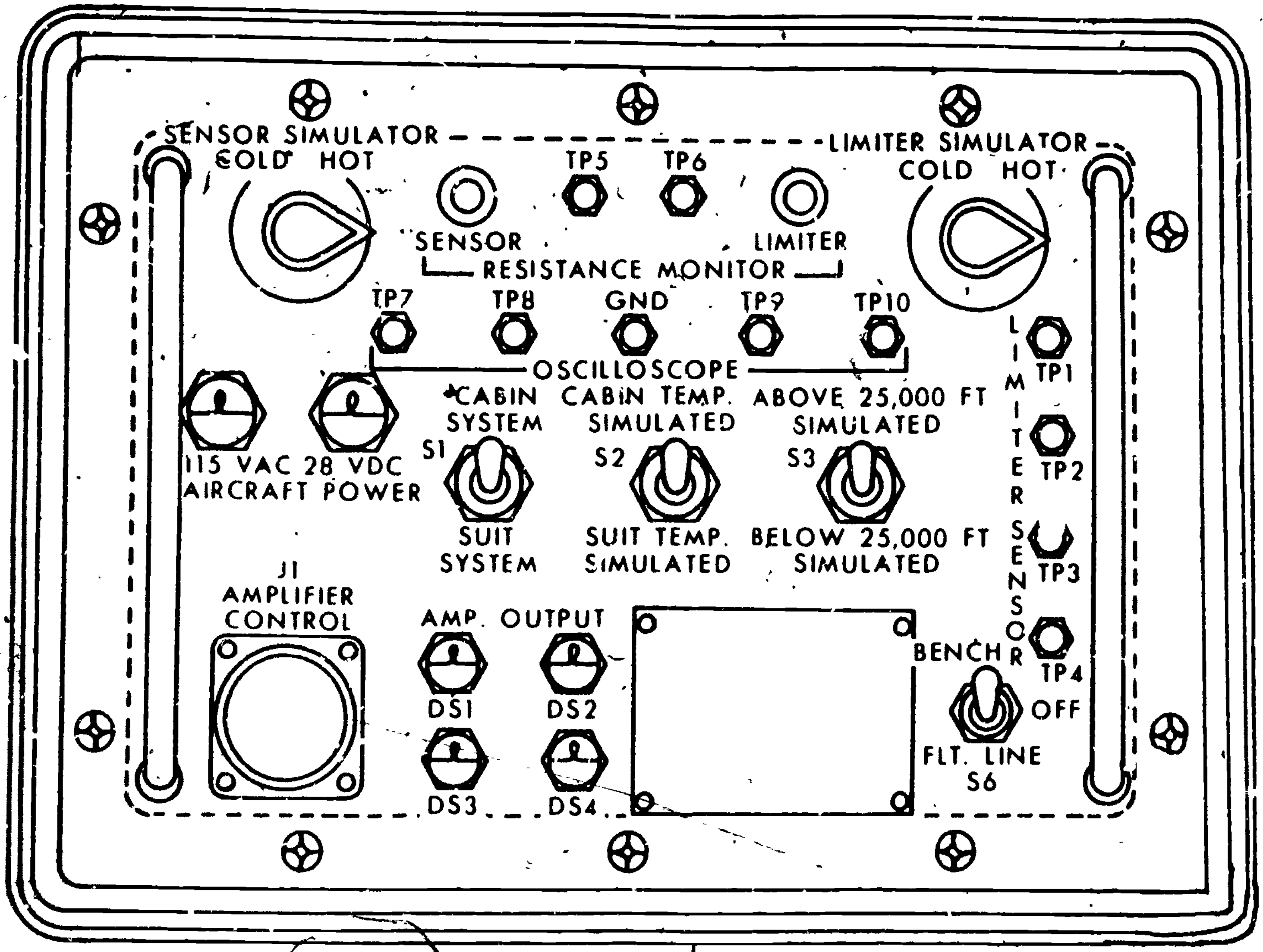
AN/PSM-21 Air Conditioning Tester for the F-4C, D, and E.

17



AIR CONDITIONING SYSTEM
TEST SET AN/PSM-21A

1526

RESPONSE SHEET 3ABR42331-PT-204

TEMPERATURE CONTROL SYSTEM TESTER

Frame 1

1. ____________
2. ____________
   ____

Frame 2

1. ____________
   ____
2. ____________
   ____
   ____

Frame 3

1. ____________
   ____
   ____
   ____
2. ____________
3. ____________

Frame 4

1. ____________
2. ____________

Frame 5

1. ____________
   ____

Frame 6

1. ____________
   ____

Frame 7

1. ____________
   ____
   ____
   ____
   ____
   ____

Frame 8

1. ____________
   ____
   ____
   ____
   ____
   ____

Frame 9

1. ____________
   ____

Frame 10

1. ____________
2. ____________
   ____

Frame 11

1. ____________
   ____
   ____
   ____
2. ____________
   ____
3. ____________
   ____

Frame 12

1. ____________
   ____

Frame 13

1. ____________
   ____
   ____
   ____
2. ____________
3. ____________

Frame 14

1. ____________
   ____

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RESPONSE SHEET 3ABR42331-PT-204

Frame 15

1. ______________

____

2. ______________

____

3. ______________

Frame 16

1. ______________

2. ______________

Frame 17

1. ________

2. ________

3. ________

4. ________

5. ________

6. ________

7. ________

8. ________

9. ________

10. ________

11. ________

12. ________

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WORKBOOK

3ABR42331-WB-204

Technical Training

Aircraft Environmental Systems Mechanic

TEMPERATURE CONTROL SYSTEM TESTING

24 February 1977

USAF SCHOOL OF APPLIED AEROSPACE SCIENCES
3370th Technical Training Group
Chanute Air Force Base, Illinois

1529

Environmental Pneudraulic Branch
Chanute AFB, Illinois

3ABR42331-WB-204

TEMPERATURE CONTROL SYSTEM TESTER

OBJECTIVE

Using a temperature control tester and multimeter, perform an operational check and troubleshoot the cabin and equipment air conditioning systems trainer, correctly locating 3 out of 4 of the assigned troubles.

EQUIPMENT

	Basis of Issue
Tester AN/PSM-21A, Temperature Control System	1/2 students
Trainer 3305, Fighter Air Conditioning System	1/2 students
Multimeter	1/student

INFORMATION

Performing an operational analysis (checkout) of the system requires that you use a CHECKOUT PROCEDURE CHART. There is a chart for the cabin system and one for the equipment system. The laboratory instructor will assign you the proper chart at the work station. Look at how the charts are arranged and learn how to follow the instructions. Below is a typical chart for the cabin system.

PROCEDURE	NORMAL INDICATION	REMEDY FOR ABNORMAL INDICATION
3. TEMPERATURE CONTROL PANEL FOOT HEAT CHECK		
a. Place switch S1 to CABIN SYSTEM position.		
b. Place switch S2 to CABIN TEMP SIMULATED position.		
c. Place switch S3 to BELOW 25,000 FT SIMULATED position.		
d. Set the SENSOR SIMULATOR to HOT.		

Supersedes 3ABR42231-WB-204, 1 August 1974.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 300; TTVSR - 1

e. Set the FOOT HEAT/DEFOG lever to the FOOT HEAT position.	AMP OUTPUT lamp DS1 comes ON and DS2 lamp goes OUT.	Replace the temperature control panel.
	The cabin dual temperature mixing valve pointer moves to the OPEN position.	Replace the cabin dual temperature mixing valve.

The chart is divided into three sections; PROCEDURE, NORMAL INDICATION, and REMEDY FOR ABNORMAL INDICATION. To use the chart start at the top and read from left to right. Place the appropriate switches in the positions designated and observe for normal indications. Example: start by placing switches S1 to CABIN SYSTEM position and S2 to the CABIN TEMP SIMULATED position. Switch S3 is moved to the BELLOW 25,000 FT SIMULATED position. Then set the SENSOR SIMULATOR to HOT and the FOOT HEAT/DEFOG to the FOOT HEAT position. The normal indication should be, AMP OUTPUT lamp DS1 comes on and DS2 lamp goes OUT. The cabin dual temperature mixing valve pointer moves to the OPEN POSITION. Column three states a remedy for any abnormal indication. This procedure is followed throughout the complete checkout.

Complete the following statements.

1. When performing the steps of the sample checkout, switch S1 should be moved to the _________ _________ position; switch S2 to the _________ _________ _________ position, and switch S3 to the _________ _________ _________ _________ position.

2. When performing the temperature control panel foot heat check the FOOT HEAT/DEFOG lever should be placed in the _________ _________ position.

3. Column three shows a _________ for any _________ _________.

PROCEDURE

Remove your jewelry and report to the laboratory instructor. The instructor will provide the necessary test equipment and assign you to a trainer. You will be directed to perform an analysis of either a CABIN SYSTEM or an EQUIPMENT SYSTEM.

If you are assigned to test the CABIN SYSTEM use the checkout procedure chart given in SECTION I, Page 5. The checkout procedure chart given in SECTION II, Page 9 is used to test the EQUIPMENT SYSTEM.

1531

When using the SENSOR SIMULATOR to obtain specific resistance values, MOVE IT VERY SLOWLY. This unit is very sensitive; a small movement will cause a large change in resistance.

CORRECT RESPONSES TO STATEMENTS:

1. CABIN SYSTEM

   CABIN TEMP SIMULATED

   BELOW 25,000 FT SIMULATED

2. FOOTHEAT.

3. REMEDY, ABNORMAL INDICATION

1532

SECTION I

Cabin System

PROCEDURE	NORMAL INDICATION	REMEDY FOR ABNORMAL INDICATION
1. PREPARATION a. Connect the test set cable W2 to the trainer wiring and temperature control panel. b. Connect the multimeter to test set TP5 and TP6 jacks. c. Set the FOOT HEAT/DEFOG lever to the DEFOG position. d. Set the temperature control panel AUTO/MANUAL switch to the OFF position. e. Apply external electrical power to the trainer. f. Sensor simulator in "MID-POSITION."		

Note: Lights which glow dimly or flicker faintly when specified as OUT, do not indicate a malfunction.

2. TEMPERATURE CONTROL PANEL DEFOG CHECK

a. Set and hold the temperature control panel AUTO/MANUAL switch to the HOT position.	a. Test set DS2 light comes ON and DS1 light remains OUT. Cabin dual temperature mixing valve pointer moves to the CLOSE position. (Look at indicator on valve.)	a. Replace the temperature control panel. Replace the cabin dual temperature mixing valve.

b. Set and hold the AUTO/MANUAL switch to the COLD position.	b. Test set DS2 light goes OUT and DS1 light comes ON. Cabin dual temperature mixing valve pointer moves to the OPEN position.	b. Replace the temperature control panel. Replace the cabin dual temperature mixing valve.
c. Set the AUTO/MANUAL switch to the AUTO position and the temperature control selector to the HOT position.		
d. Set the test switches and controls as follows: S1 CABIN SYSTEM S2 CABIN TEMP SIMULATED S3 ABOVE 25,000 FT SIMULATED	d. Test set DS1 light goes OUT and DS2 light comes ON. Cabin dual temperature mixing valve pointer moves to the CLOSED position.	d. Replace the temperature control panel. Replace the cabin dual temperature mixing valve.
e. Press the test set RESISTANCE MONITOR SENSOR switch and adjust the SENSOR SIMULATOR until the multimeter reads 240 ohms.	e. DS2 light remains OUT and DS1 light remains OUT or PULSING.	e. Replace the temperature control panel.
f. Increase the SENSOR SIMULATOR until DS2 light starts to PULSE.	f. Multimeter reads 255 to 310 ohms.	f. Replace the temperature control panel.
g. Increase the SENSOR SIMULATOR until DS2 light comes ON STEADY.	g. Cabin dual temperature mixing valve pointer moves to the CLOSED position.	g. Replace the cabin dual temperature mixing valve.
h. Press the RESISTANCE MONITOR SENSOR switch and decrease the SENSOR SIMULATOR until the multimeter reads 300 ohms.	h. DS1 light remains OUT and DS2 light remains OUT or PULSING.	h. Replace the temperature control panel.
i. Decrease the SENSOR SIMULATOR until the DS1 light starts to PULSE.	i. Multimeter reads 235 to 295 ohms.	i. Replace the temperature control panel.

3. TEMPERATURE CONTROL PANEL FOOT HEAT CHECK		
a. Set the SENSOR SIMULATOR to the HOT position.		
b. Set the FOOT HEAT/DEFOG lever to the FOOT HEAT position.	b. DS1 light comes ON and DS2 light goes OUT.	b. Replace the temperature control panel.
	Cabin dual temperature mixing valve pointer moves to the OPEN position.	Replace the cabin dual temperature mixing valve.
c. Press the RESISTANCE MONITOR, SENSOR switch and decrease the SENSOR SIMULATOR until the multimeter reads 1400 ohms.	c. DS1 light remains OUT or PULSING and DS2 light remains OUT.	c. Replace the temperature control panel.
d. Increase the SENSOR SIMULATOR until DS2 light starts to PULSE.	d. Multimeter reads 1350 to 1735 ohms.	d. Replace the temperature control panel.
e. Decrease the SENSOR SIMULATOR until DS2 light goes OUT and DS1 starts to PULSE.	e. Multimeter reads 1350 to 1725 ohms.	e. Replace the temperature control panel.
f. Increase the SENSOR SIMULATOR until DS2 light comes ON STEADY and DS1 light goes OUT.	f. Multimeter reads 5648 to 5928 ohms.	f. Replace the temperature control panel.
g. Decrease the SENSOR SIMULATOR until DS1 light comes ON STEADY.	g. Multimeter reads 384 to 624 ohms.	g. Replace the temperature control panel.
4. CABIN TEMPERATURE SENSOR CHECK		
a. Connect the multimeter to the test set TP3 and TP4 jacks.		
b. Set S1 switch to the CABIN SYSTEM position.		
c. Set S2 switch to the CABIN TEMP SIMULATED position.		
d. Set S6 switch to the FLT LINE position for NO MORE THAN 4 seconds, observe the multimeter and record the resistance.		

e. Plot resistance versus ambient temperature using figure 1.	e. Resistance shall fall within the shaded area.	e. Replace the cabin temperature sensor.

Complete the following statements.

1. If you received an infinity reading on the multimeter during this check it would indicate ______________ (A SHORT or AN OPEN) in the sensor or the sensor circuit.

2. With switch S1 in the CABIN SYSTEM position, switch S2 in the CABIN TEMP SIMULATED position, and the EXTERNAL switch (S6) DEPRESSED, the multimeter reads "0". This indicates ____________ (A SHORT or AN OPEN) in the cabin sensor.

ANSWERS TO PROCEDURE 4: Have your instructor verify your answers.

1. an open 2. a short

At this time turn to the trouble list at the back of this book. Accomplish the four troubles under the "CABIN SYSTEM" section. The instructor may assist you on one of these problems.

After you have completed this trouble list you have completed this lesson. If you had difficulty performing any of the steps, ask your instructor for assistance. If not, turn to page 9 and complete the EQUIPMENT SYSTEM lesson.

SECTION II

Equipment System

PROCEDURE	NORMAL INDICATION	REMEDY FOR ABNORMAL INDICATION
1. PREPARATION a. Disconnect connector 42P401 from temperature control assembly 42AR401. b. Connect P1 of cable W1 (MDE32876-13) to the Amplifier Control J1 of the test set (AN/PSM-21A), connect P2 of cable W1 to the temperature control assembly and J1 of cable W1 to connector 42P401. c. Connect the multimeter to TP5 and TP6 of the test set. d. Set the test set switches and controls as follows: SENSOR SIMULATOR Mid-position LIMITER SIMULATOR Mid-position S1 CABIN SYSTEM S2 CABIN TEMP SIMULATED S3 BELLOW 25,000 FT SIMULATED S6 OFF e. Apply external electrical power to the trainer.		

Note: Dimly lighted or flickering lights are considered OUT.

2. <u>CHECKOUT</u>		
a. Momentarily press the RESISTANCE MONITOR SENSOR switch and adjust the SENSOR SIMULATOR for a multimeter indication of 2150 ohms.	a. If lights DS1 and and DS2 pulse, disregard the indication.	
b. Decrease the SENSOR SIMULATOR until DS1 light light starts to PULSE. Press the RESISTANCE MONITOR SENSOR switch.	b. Multimeter indicates 1765 to 2245 ohms. DS2 light is OUT.	b. Replace temperature control assembly. Replace the temperature control assembly.
c. Increase the SENSOR SIMULATOR until DS1 and DS2 lights stop PULSING, then increase further until DS2 light just starts to PULSE. Press the RESISTANCE MONITOR SENSOR switch.	c. Multimeter indicates 1850 to 2370 ohms. DS1 light is OUT.	c. Replace the temperature control assembly. Replace the temperature control assembly.
d. Decrease the SENSOR SIMULATOR until DS1 light just illuminates STEADY. Press the RESISTANCE MONITOR SENSOR switch.	d. Multimeter indicates 430 to 805 ohms. Turbine bypass valve position pointer indicates the valve is OPEN. (After SENSOR switch is pressed.)	d. Replace the temperature control assembly. Replace the temperature control assembly.
e. Increase the SENSOR SIMULATOR until DS2 light just illuminates STEADY. Press the RESISTANCE MONITOR SENSOR switch.	e. Multimeter indicates 3888 to 6448 ohms. Turbine bypass valve position pointer indicater the valve is OPEN.	e. Replace the temperature control assembly. Replace the temperature control assembly.
f. Position S3 switch to the ABOVE 25,000 FT SIMULATED position,	f. Turbine bypass valve position pointer indicates the valve is OPEN.	f. Replace the temperature control assembly.
g. Momentarily press the RESISTANCE MONITOR SENSOR switch and adjust the SENSOR SIMULATOR for a multimeter indication of 5700 ohms.	If DS1 and DS2 lights PULSE, disregard the the indication.	

h. Adjust the SENSOR SIMULATOR until DS1 and DS2 lights are OUT. Press the RESISTANCE MONITOR SENSOR switch.	h. Multimeter indicates 5110 to 6420 ohms. Turbine bypass valve position pointer indicates valve is OPEN.	h. Replace the temperature control assembly. Replace the temperature control assembly.
i. Increase the SENSOR SIMULATOR until DS2 light just starts to PULSE. Press the RESISTANCE MONITOR SENSOR switch.	i. Multimeter indicates 5200 to 6420 ohms.	i. Replace the temperature control assembly.
j. Decrease the SENSOR SIMULATOR until DS1 light just starts to PULSE. Press the RESISTANCE MONITOR SENSOR switch.	j. Multimeter indicates 5150 to 6335 ohms.	j. Replace the temperature control assembly.
3. <u>SENSOR RESISTANCE CHECK</u> a. Connect the multimeter leads to TP1 and TP2 jacks of the test set. b. Place the SENSOR SIMULATING selector switch, located on the front of the trainer, to the NORMAL position. c. Perform a resistance check of the equipment system temperature sensor.		

Note. The external meter switch is the switch marked S6 (BENCH, OFF, FLT LINE). Depress means to hold it to the FLT LINE position. Do not hold it in this position longer than 4 seconds.

Complete the following statements.

1. The resistance reading for the SENSOR is __________ ohms.

2. Use figure 1 to compare your readings to the value given on the chart with the present ambient temperature. Ask your instructor for the ambient temperature. Is the SENSOR resistance value within the tolerance given in the chart? ________ (YES/NO)

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3. If you receive an infinity reading on the multimeter during this check it indicates ____________ (A SHORT or AN OPEN) in the SENSOR or sensor circuit.

4. During this check, if the multimeter reads 0 ohms it indicates ____________ (A SHORT or AN OPEN) in the sensor or sensor circuit.

ANSWERS TO PROCEDURE 3: Have your instructor verify your answers to statements 1 and 2.

3. an open 4. a short

At this time turn to the trouble list at the back of the book. Accomplish the four troubles under the "EQUIPMENT SYSTEM" section. instructor may assist you on one of these problems.

After you have completed the trouble list you have completed this lesson. If you had difficulty performing any of the steps, ask your instructor for assistance. If not, report to the instructor.

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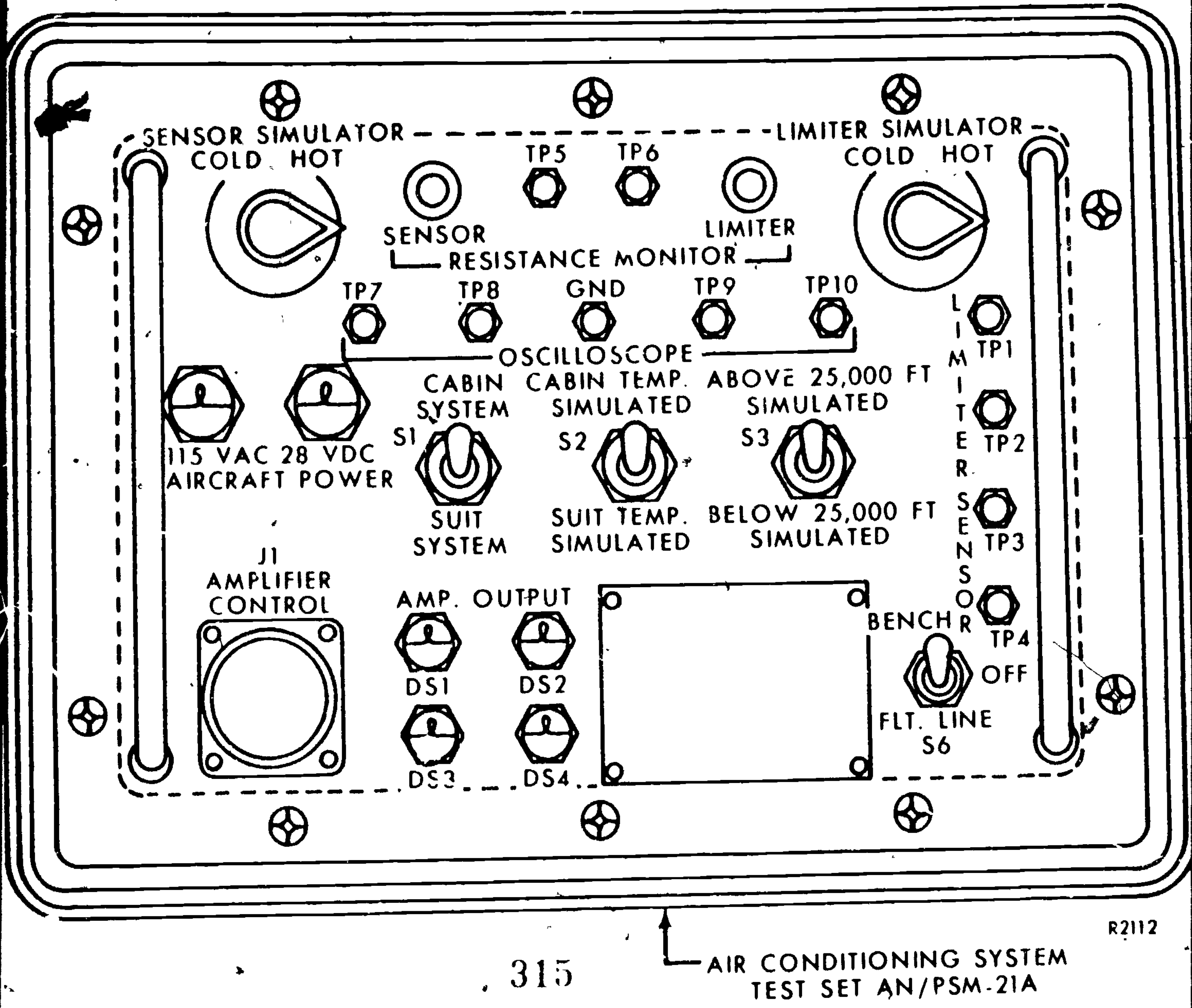
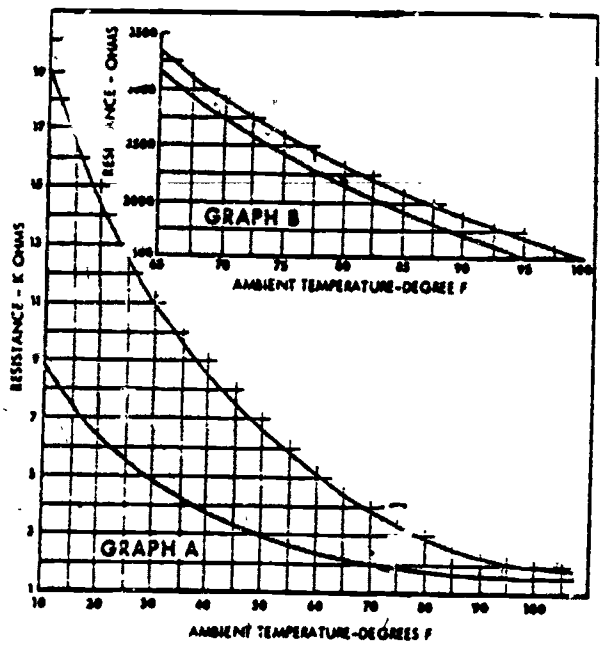


Foldout 1. AN/PSM-21 Air Conditioning Tester for the F-4C, D, and E.

1541



NOTES:

1. FOR ANY GIVEN TEMPERATURE, RESISTANCE MUST FALL WITHIN SHADED AREA.

2. GRAPH "A", USE FOR CHECKING SENSORS AND LIMITERS WHEN INSTALLED IN AIRCRAFT.

3. GRAPH "B", USE ONLY WHEN A SENSOR OR LIMITER IS REMOVED FROM THE AIRCRAFT AND IS PLACED IN A CONTROLLED TEMPERATURE ENVIRONMENT (e.g. SUBMERGE UNIT IN WATER THAT IS TEMPERATURE CONTROLLED).

Figure 1.

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	CABIN SYSTEM	
SWITCH	MALFUNCTIONING COMPONENT	CONDITION
1		
4		
7		
11		

	EQUIPMENT SYSTEM	
SWITCH	MALFUNCTIONING COMPONENT	CONDITION
1		
3		
6		
12		

1543

INSTRUCTOR

Please check off the students accomplishment of the following items. These items are part of the objective(s) of this lesson.

ITEM	UNSAT.	SAT.
Practices General Housekeeping consistent with safety and fire prevention.	____	____
Practices safe work habits and procedures.	____	____
Follows precautions while working around danger areas.	____	____
Use of Tester.	____	____

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PROGRAMMED TEXT
3ABR42331-PT-206

Technical Training

Aircraft Environmental Systems Mechanic

BOMBER BLEED AIR SUPPLY SYSTEM

15 September 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

1545

FOREWORD

This programmed text was prepared for use in the 3ABR42331 Aircraft Environmental Systems Mechanic Course. The materials contained herein were validated using students from the subject course. At least 90% of the students taking this text achieved or surpassed the criteria established in the lesson objectives. The average time for completion of this text was 3 hours and 50 minutes.

OBJECTIVES

1. Relate the name of the bleed air system component to its operation with a minimum of 80% accuracy.

2. Select the safety precautions that are involved in the maintenance of the bleed air system without error.

INSTRUCTIONS

This programmed text presents information in small steps called frames. After each step you are asked to complete a statement, match some statements, or respond to the information presented in some other way. Read the material presented and make your response as directed by the frame. After you have made your response, compare your answers with the correct answers found on the top of the next frame. Any time you respond incorrectly, reread the frame to get the information correctly. Write the correct response next to your original response and then proceed to the next frame. If necessary you may go back to check a fact or principle, but do not skip ahead unless you are told to do so.

Use this simple rule: READ---RESPOND---CONFIRM---ADVANCE.

YOU WILL not be graded on how fast you complete this material. You will be tested later on what you have learned.

Supersedes 3ABR42231-PT-211, 31 August 1970.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 400; TTVSR - 1

The engine bleed air supply system is used to supply hot pressurized engine bleed air to the cabin air conditioning system, the air conditioning ram airscoop, and engine nacelle anti-icing systems, the hydraulic reservoirs, and engine starters.

This bleed air is taken from the last stage of engine compression on each engine. The pressure, temperature, and flow of engine bleed air is dependent upon the engine throttle settings and air demand.

Answer each of the following statements as either true (T) or false (F).

_____1. Hot pressurized air is taken from the middle stage of the aircraft's engines.

_____2. The last stage of compression on each engine provides hot pressurized bleed air.

_____3. The engine throttle settings will determine the pressure, temperature and the flow of the bleed air in the system.

1547

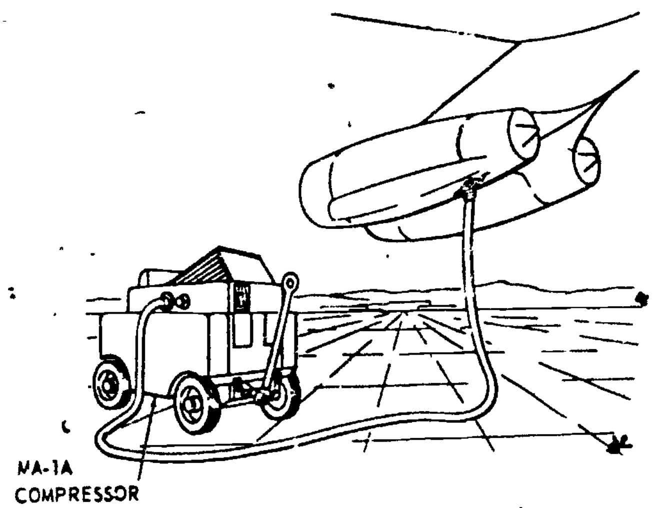
Answers to Frame 1: 1. F 2. T 3. T

Frame 2

A ground air cart, the MA-1A, is shown in the sketch below. It is used to start the planes engines, ground check the bleed air supply system and ground check the air conditioning system.

The MA-1A is connected to the engine by a ground service receptacle and this will be explained to you in the next frame.

The sketch shows the ground air cart connected to an aircraft.



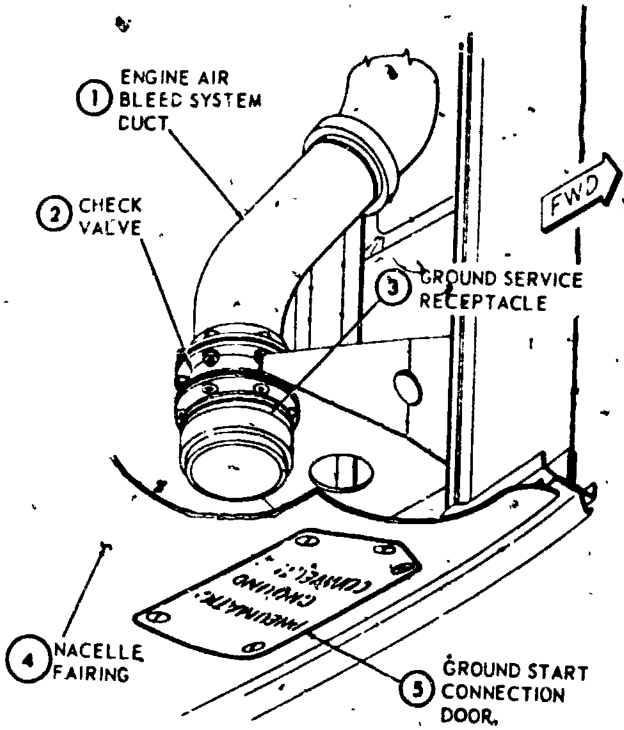
Answer each of the following statements as either true (T) or false (F).

_____ 1. The ground air cart used to start aircraft engines is the MA-1A.

_____ 2. The MA-1A compressor can also be used to ground check both the bleed air and air conditioning systems.

Answers to Frame 2: 1. T 2. T

Frame 3



The numbered items are in the sketch above.

One bleed air ground service receptacle (#3) is found in the bottom of each engine nacelle fairing (#4). This receptacle serves as a quick disconnect to permit a ground air cart to be connected to the engine bleed air system duct (#1).

The receptacles are identified by the external marking "PNEUMATIC GROUND CONNECTION" (#5).

A ground service receptacle check valve (#2) is put between the ground service receptacle and the engine bleed air system duct.

The check valve is used to prevent a reverse airflow in the system. The check valve will be open if the MA-1A is supplying air to the engine and will close when the engine starts to supply the bleed airflow.

Match the number in the sketch with the statement below and place the number of your choice on the blank line provided.

1. _____ Permits an external air source to be connected to the engine bleed air system.

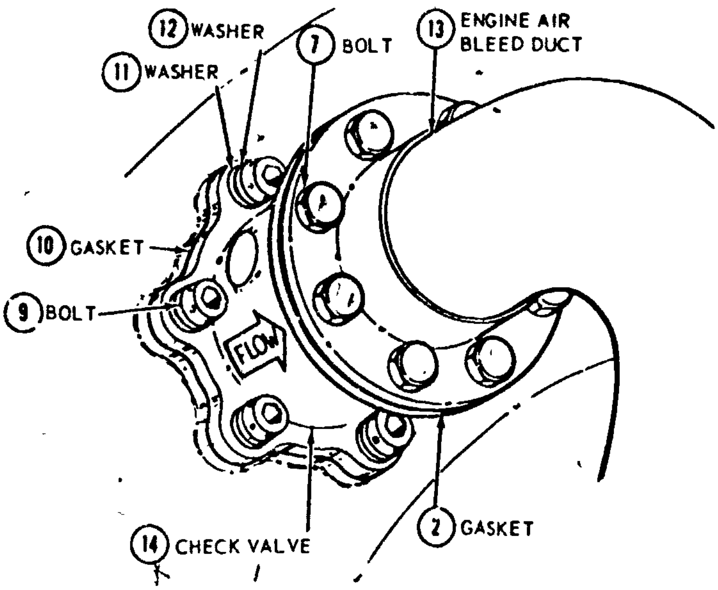
2. _____ Installed between the ground service receptacle and the engine bleed air system duct to prevent a reverse air flow.

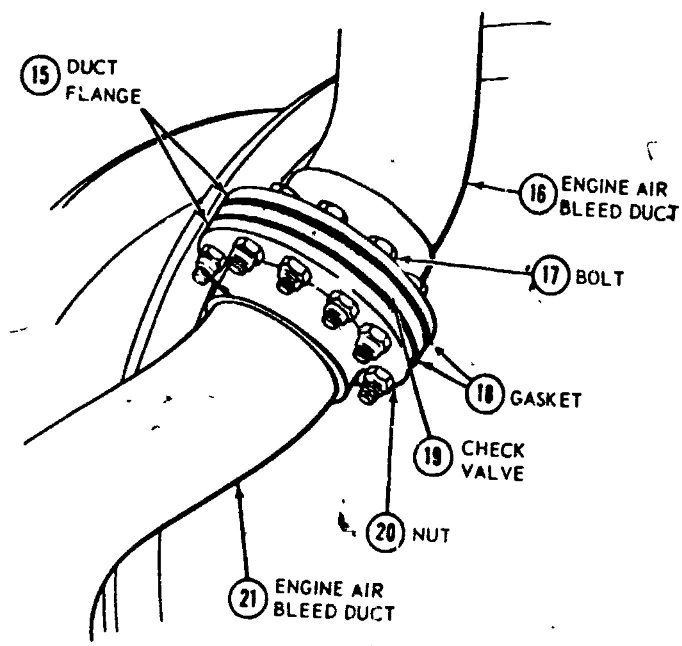
3. _____ Must be closed when the engine is supplying the air pressure.

15491

Answers to Frame 3: 1. 3 2. 2 3. 2

Frame 4





Engine bleed air flapper type check valves are installed on the bleed air system ducting to prevent a reverse airflow within the system.

During normal airflow, the check valves are in the open position. If a reverse airflow should start, the check valve will rotate to the closed position.

Note: The sketch shows two check valves installed in the bleed air system ducting. Both valves prevent a reverse flow of air in the bleed air system.

The engine bleed air ducts, also shown in the sketch are used to convey the hot engine bleed air to it's point of use. These ducts are thin walled tubes made of corrosion resistant steel.

Complete the following statements by writing in the correct word or words.

1. ______________ check valves are installed in the engine bleed air ducting.

2. The bleed air check valves will allow ______________ to flow out of the engine compressor and will ______________ if air tries to flow into the engine compressor.

3. The ______________ are used to carry the engine bleed air to its point of use.

4. The bleed air ducts are made of thin-walled ______________.

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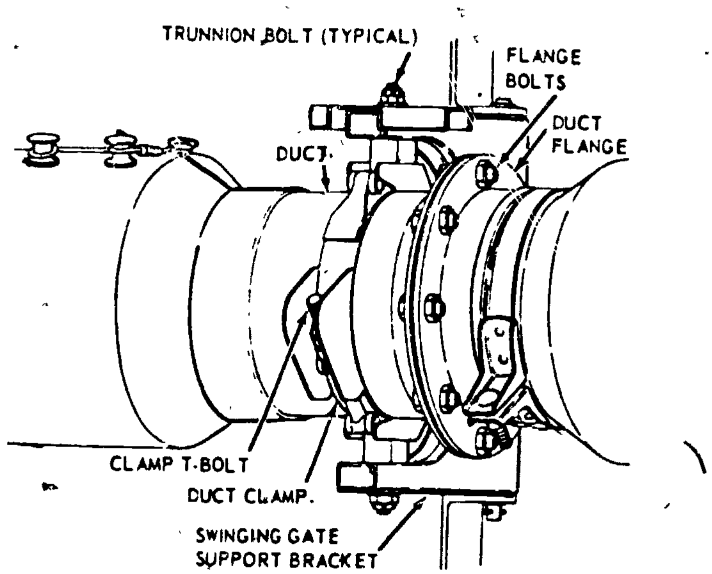
Answers to Frame 4: 1. flapper type 2. hot high pressure air, rotate closed
3. bleed air ducts
4. corrosion resistant steel

Frame 5

The engine bleed air ducts are supported by either single or double hinged swinging gate type supports, as shown in the sketch.

The supports allow for a pivoting action to take place during expansion and contraction of the duct.



Answer each of the following questions as either true (T) or false (F).

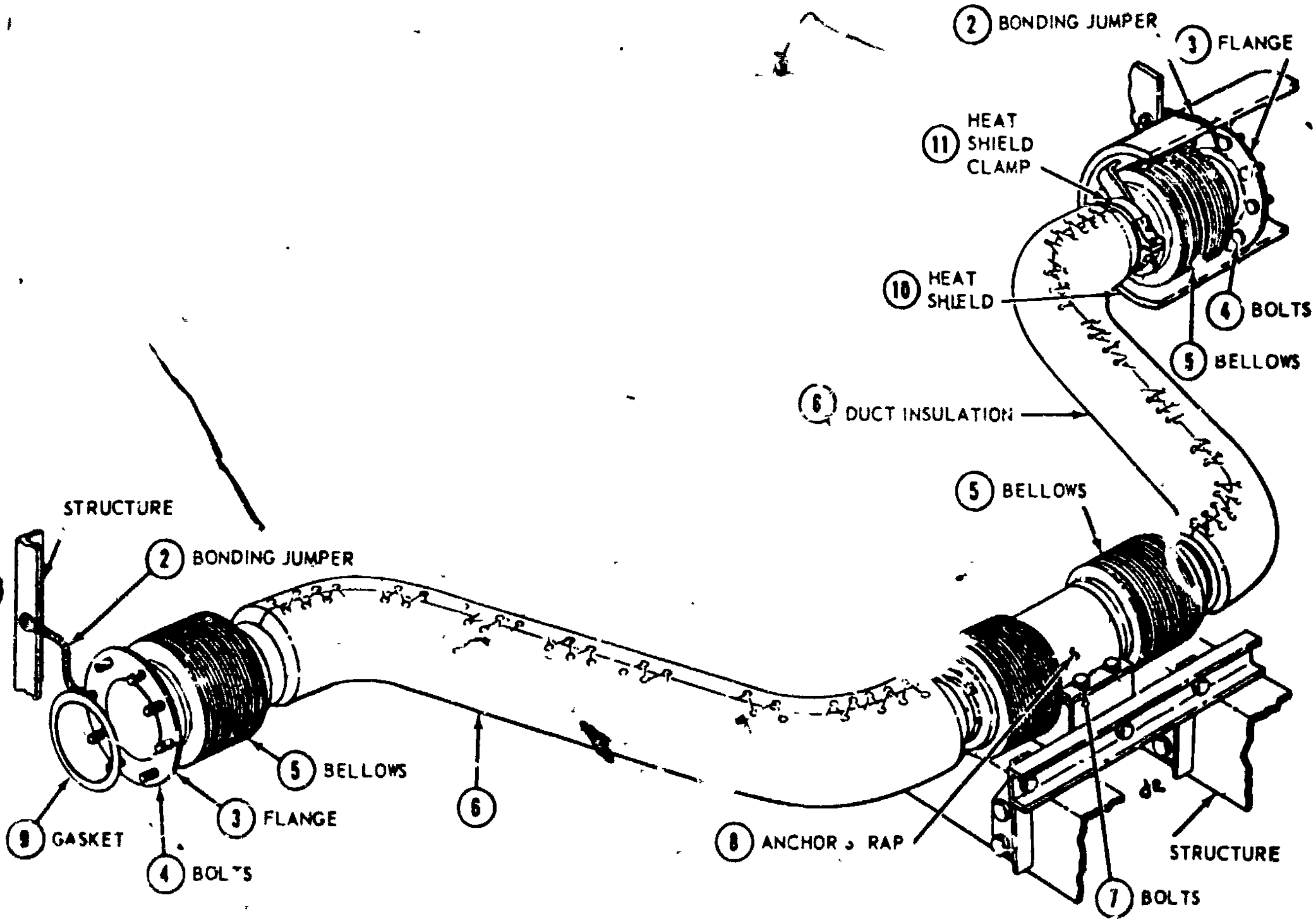
_____1. The swinging gate type support brackets will allow a pivot action to take place during expansion and contraction of the duct.

_____2. Only a single hinged swinging gate type support is used.

Answers to Frame 5: 1. T 2. F

In addition to the swinging support, a bellows assembly (5) acts as a universal joint to a[illegible] for thermal expansion.

In addition, this bellows assembly compensates for twisting and bending movements of the aircraft structure.



Complete the following statements by placing the correct word or words in the space provided.

1. The universal joints used in the wing ducts compensate for the ducts ______________________.

2. Engine bleed air ducts are made of ______________________.

1553

Answers to Frame 6: 1. Thermal Growth 2. corrosion resistant steel

Frame 7

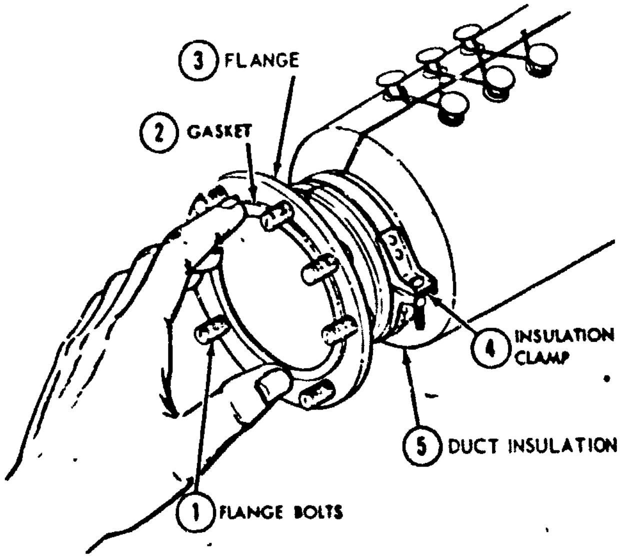
Match the component part in column B with the statement in column A that best describes that part.

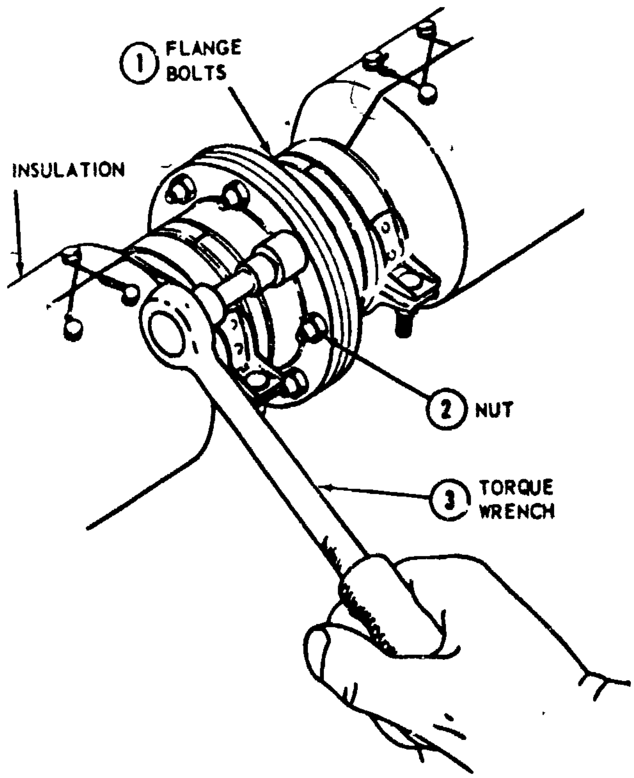
Column A		Column B
____1.	Permits an external air source to be connected to the engine air bleed system duct.	a. Last stage of compression on jet engine.
____2.	Provides hot high pressure air for use by the air conditioning system.	b. MA-1A compressor.
____3.	Used in the wing ducts to compensate for thermal growth of the ducts.	c. Pneumatic ground connection.
____4.	Will allow hot high pressure air to flow out of the engine compressor but will close if air tries to flow into the compressor.	d. Engine bleed air check valve.
____5.	Can be used to start aircraft engines or ground check the bleed air and air conditioning systems.	e. Swinging gate type support.
____6.	Allows a pivot action to take place during expansion and contraction of the duct.	f. Universal joints.

1554

Answers to Frame 7: 1. c 2. a 3. f 4. d 5. b 6. e

Frame 8





The engine bleed air ducts are made in various lengths to make it easier to remove and replace them.

The illustrations show the bolted flange method of connecting duct sections together. A gasket is put in between the two parts of the duct to prevent leakage.

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Frame 8 (Continued)

A new gasket that is free of creases, imperfections, and foreign material should be put in any time a section of duct is installed.

The bolts should be tightened in gradual steps on opposite alternate diameters with a torque wrench to technical order specifications.

Answer each of the following questions as either true (T) or false (F).

_____1. For easier removal and replacement, ducts are made in various lengths.

_____2. Each time a section of duct is removed and replaced a new gasket should be installed.

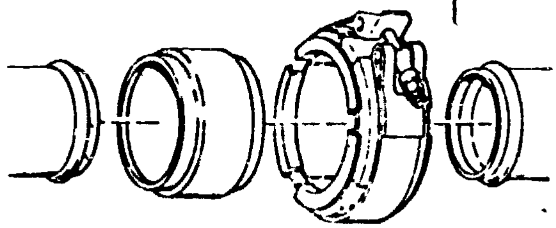
_____3. A torque wrench should be used to tighten the nuts on the flange bolts according to technical order specifications.

Answers to Frame 8: 1. T 2. T 3. T

Frame 9

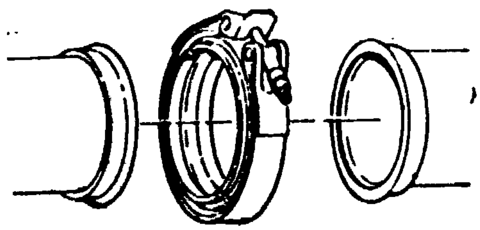
Two more ways of connecting ducts together are shown in the sketch.

The Marman Channel Band coupling is used to couple cold air ducts together in the air conditioning system.



Marman Channel Band Coupling.

The Marman V Band couplings can also be used to clamp components of the system to the ducts.



Marman V Band Coupling.

On both couplings, the nut on the T-bolt should be tightened with a torque wrench.

Mark the letter in front of your choice.

1. T-bolts on both couplings should be tightened with a/an

   a. open end wrench.
   b. box-end wrench.
   c. socket wrench.
   d. torque wrench.

2. The Marmen Channel Band coupling is used on

   a. hot engine bleed air ducts.
   b. cold and hot air ducts.
   c. cold air ducts.
   d. hot air ducts.

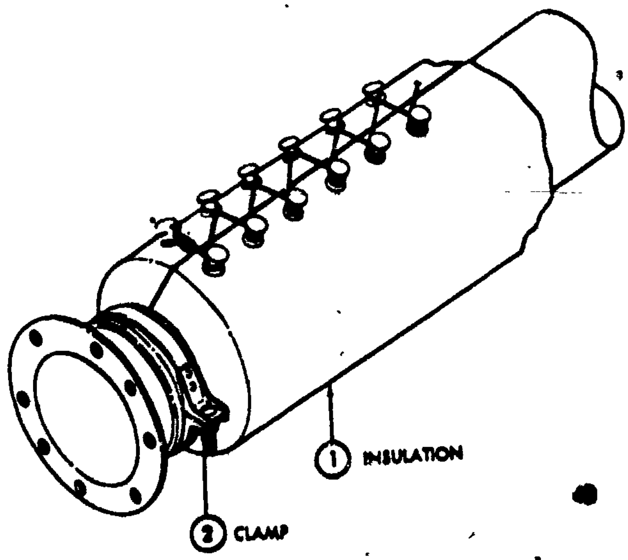
1557

Answers to Frame 9: 1. d 2. c

Frame 10

Engine bleed air ducts in most areas are covered by metal foil insulation. This insulation is used to cut down heat loss from the ducts, prevent damage to the structure and equipment next to the hot air ducts, and help keep them from burning those coming in contact with the ducts.

The insulation is secured around the ducts with safety wire lacing as shown in the sketch.



Complete the following statements by writing in the word or words on the lines provided.

1. ____________________ placed around the ducts will prevent damage to the structure and equipment adjacent to the ducts.

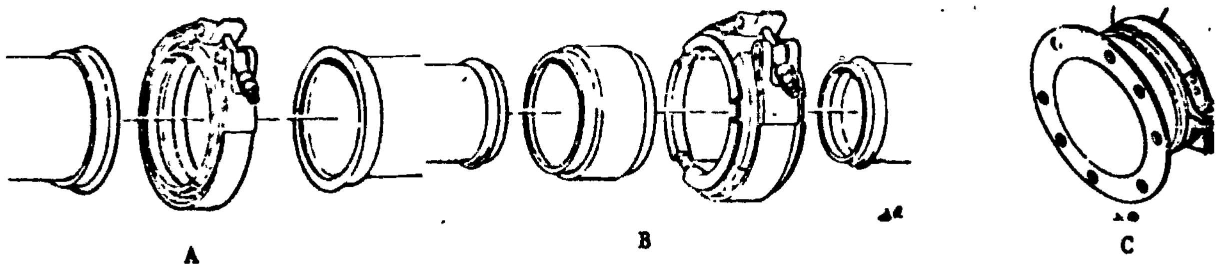
2. ____________________ is used to secure the insulation around the ducts.

3. The insulation material used on the hot air ducts is ____________________.

Answers to Frame 10: 1. Insulation 2. Wire lacing. 3. metal foil

Frame 11

Place the letter under each of the following schematics in the blank space alongside the correct name.



_____ 1. Bolted Flange Connection.

_____ 2. Channel Band Coupling.

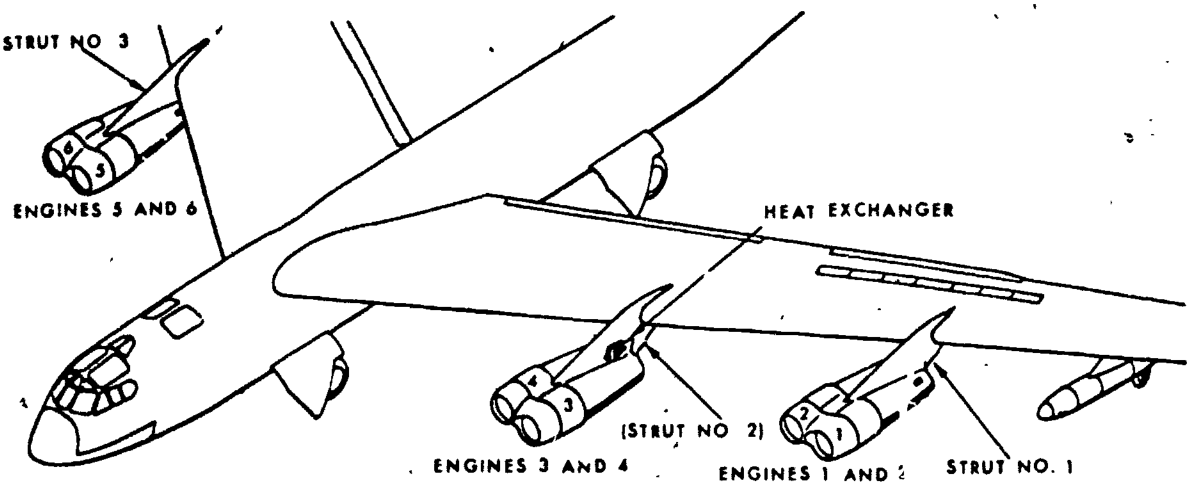
_____ 3. V Bank Coupling

1559

Answers to Frame 11: 1. c 2. b 3. a

Frame 12

Engine bleed air for air conditioning and pressurization is normally supplied by engines 3 and 4 in strut number two. During an emergency when air is not available from strut number 2, strut number 3 with engines 5 and 6 will supply the engine bleed air. The relative positions for the struts and engines mentioned are shown in the illustration.



Match the statements in column B to the correct component in column A.

_____1. Engines Number 5 and 6.

_____2. Strut Number 2.

_____3. Strut Number 3.

_____4. Engines Number 3 and 4.

A. Normal source of bleed air.

B. Emergency source of bleed air.

Answers to Frame 12: 1. B 2. A 3. B 4. A

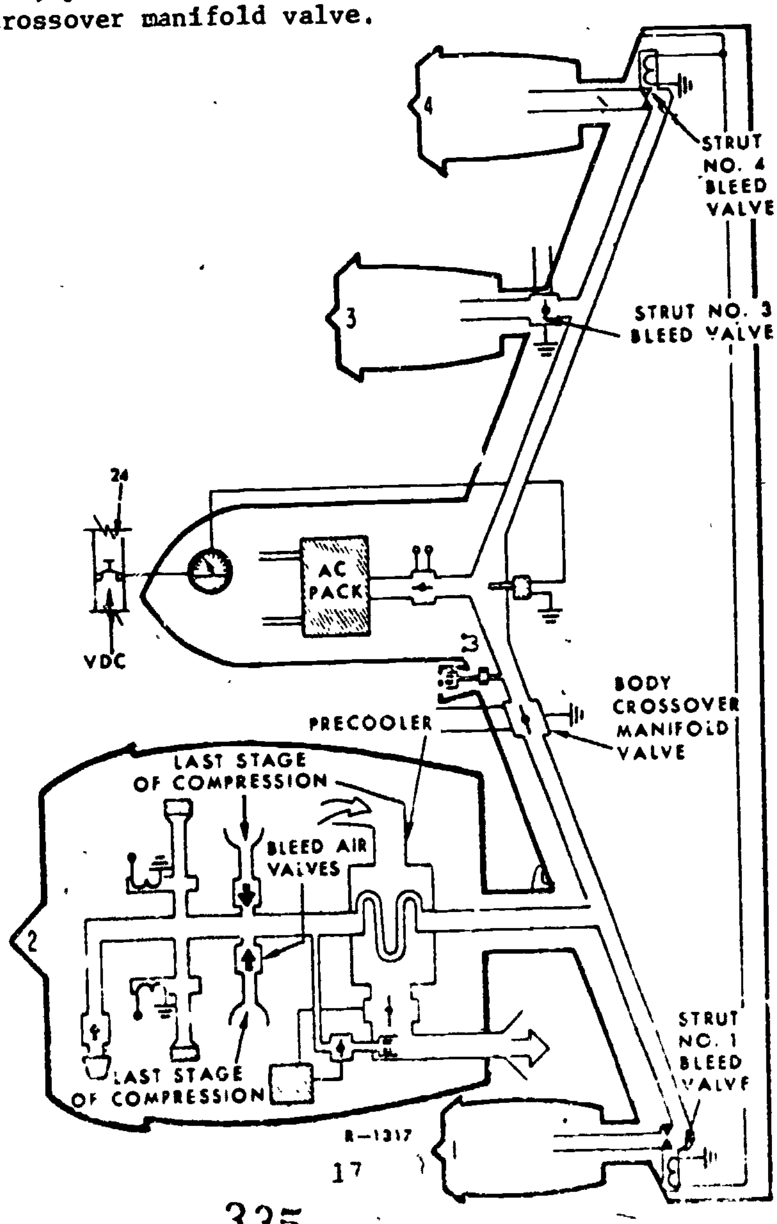
Frame 13

The illustration is a schematic of the bleed air system. Engine bleed air is taken from the last stage of compression on engines 3 and 4 of strut number two, during normal operation of the air conditioning system.

This air passes through the precooler in strut number 2 into the wing manifold and then through the body crossover manifold valve to the air conditioning package.

During emergency operation of the air conditioning system, bleed air is taken from the last stage of compression on engines 5 and 6. It passes through strut number 3 bleed valve into the wing manifold and then to the air conditioning package.

On the schematic shown below, note the position of the bleed air check valves, precooler, struts number 1, 3, and 4 bleed valves, and the body crossover manifold valve.



Frame 13 (Continued)

Answer each of the following questions as either true (T) or false (F).

____ 1. Bleed air for normal operation of the air conditioning system is taken from the last stage of compression on engines 5 and 6.

____ 2. Strut number 3 is used to supply an emergency source of bleed air for air conditioning.

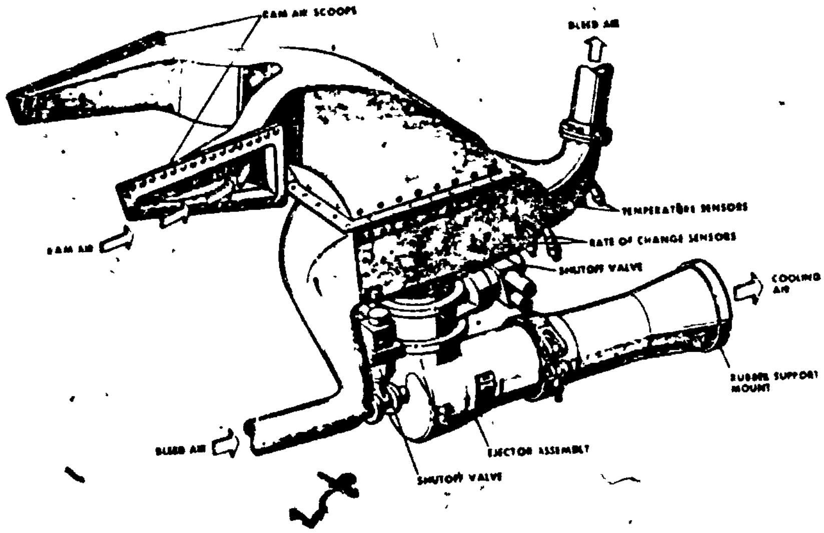
____ 3. The precooler is mounted in strut number two.

Answers to Frame 13: 1. F 2. T 3. T

Frame 14

The heat exchanger (precooler), shown in the sketch is in strut no. 2. The precooler reduces the engine bleed air temperature from 740°F to a discharge temperature that will not be more than 475°F.

Cooling of the engine bleed air is done by directing the bleed air through a heat exchanger core while ram air is flowing across the core. This action transfers the heat from the bleed air to the ram air and then sent overboard.



HEAT EXCHANGER

Complete the following statements by writing the correct words on the lines provided.

1. The precooler is mounted in ____________________.

2. The precooler transfers the heat of the bleed air to ____________________.

1563

Answers to Frame 14: 1. strut number 2 2. ram air

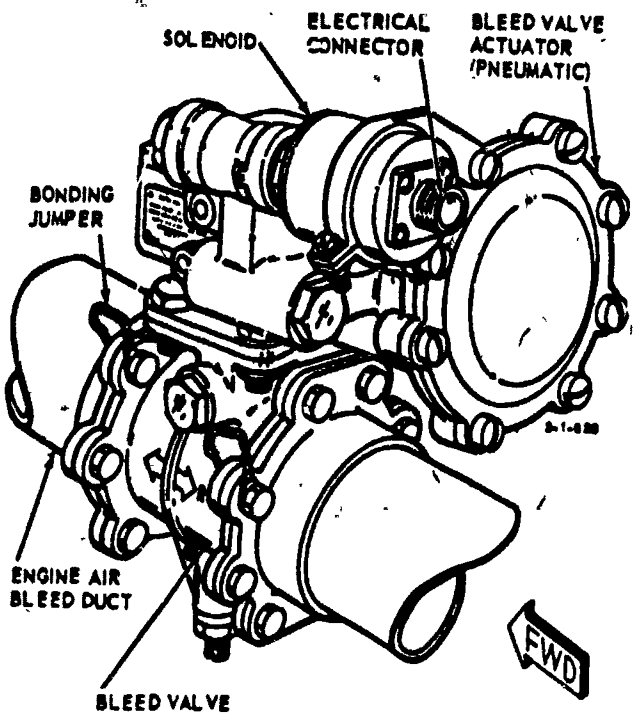
Frame 15

The bleed air valves that are installed in struts number 1 and 4, as shown in the sketch, are identical units. They need a combination of DC voltage for control and air pressure for operation.

These valves are solenoid controlled and air actuated. These valves have a fail safe feature which will cause the valves to close any time electrical power is lost.

The only time that struts number 1 and 4 bleed valves are opened are during engine start, or when an operational check of the bleed air valves is required.

CAUTION!!! - Struts number 1 and 4 cannot be used as a source of bleed air for air conditioning. Both valves are controlled by the manifold valve switch.



Complete the following statements.

1. Strut number 1 and 4 bleed valves are electrically controlled and ____________________ operated.
2. Strut number 1 and 4 bleed valves are fail safe __________.
3. Strut number 1 and 4 bleed valves __________ when electrical power is lost.
4. To start the aircraft's engines, strut number 1 and 4 bleed valves ____________________.
5. Strut number 1 and 4 bleed valves ____________________ when an operational check of the bleed valves is required.

338

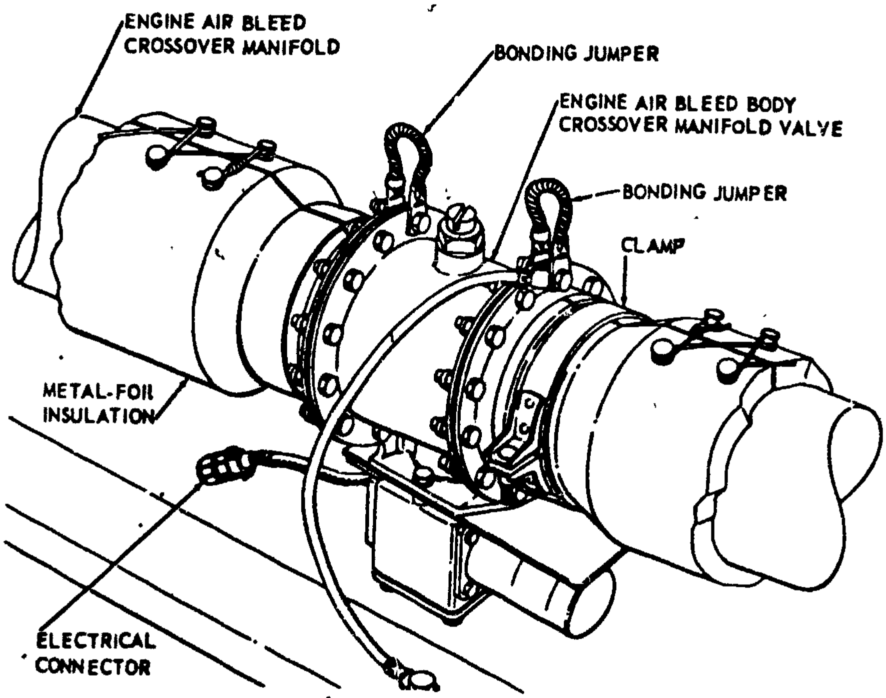
Answers to Frame 15: 1. air 2. closed, 3. will close
4. must be open 5. can be opened

Frame 16

The engine bleed air body crossover manifold valve is located in the left wing bleed air system manifold. This valve is operated by a 118 volt AC motor.

This valve is opened to allow engine bleed air to flow from strut #2 to the cabin air conditioning system during normal system operation. The body crossover manifold valve will also be opened during starting of the aircraft's engines.

The body crossover manifold valve is controlled by the Bleed Selector Switch or the manifold valve switch.



Mark the letter in front of your choice.

1. The body crossover valve is operated by

   a. air pressure.
   b. a hydraulic motor.
   c. a 24V DC motor.
   d. a 118V AC motor.

2. During normal operation of the air conditioning system, engine bleed air is received from strut number

   a. 1
   b. 2
   c. 3
   d. 4

1565

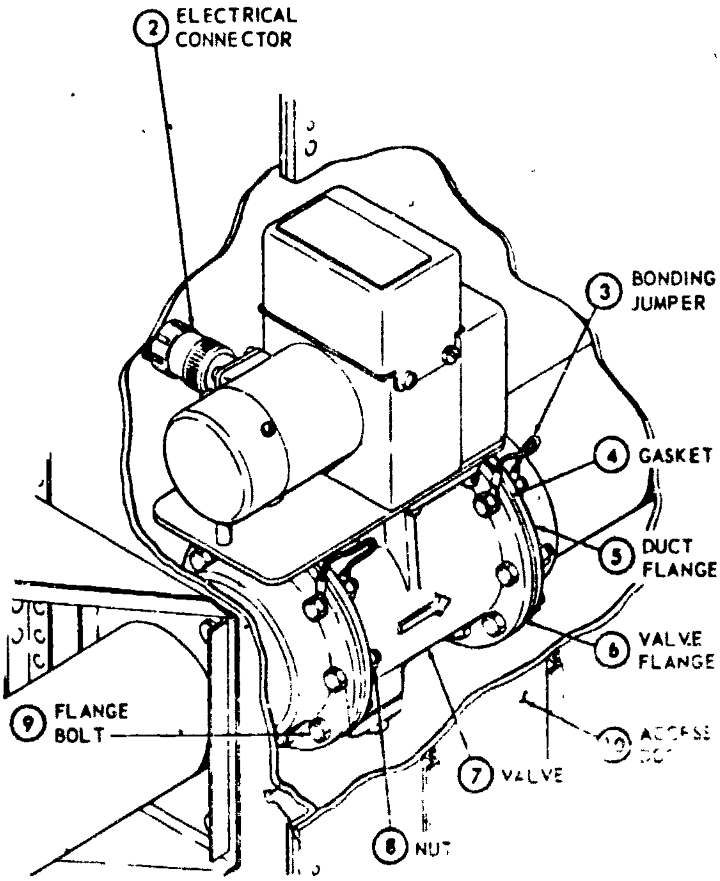
Answers to Frame 16: 1. d 2. b

Frame 17

Strut number 3 bleed valve is a 118 volt AC motor driven butterfly-type valve.

The valve is normally closed and can be controlled with either the bleed selector switch or the manifold valve switch.

The valve is opened for starting engines or to supply emergency bleed air for the cabin air conditioning system.



Answer each of the following statements as either true (T) or false (F).

_____1. Strut number 3 bleed valve is powered by a 118 volt AC motor.

_____2. Strut number 3 is used to supply emergency bleed air for the cabin air conditioning system.

_____3. Strut number 3 bleed valve is opened to start the aircraft's engines.

_____4. To supply emergency bleed air for the cabin air conditioning, strut number 3 bleed valve must be opened.

_____5. The manifold valve switch or the bleed selector switch can control strut number 3 bleed valve.

1567

Answers to Frame 17: 1. T 2. T 3. T 4. T 5. T

Frame 18

Match the component parts in column B to the statement that best describes that part in column A.

Column A

_____1. Reduces the engine bleed air temperature from 740°F to 475°F.

_____2. Provides an emergency source of bleed air for air conditioning system operation.

_____3. Will be opened to start aircraft engines and provide the air conditioning system with bleed air from the normal source.

_____4. Is used as the normal source of bleed air for air conditioning and pressurization.

_____5. Will be opened only to start aircraft engines.

_____6. Will be opened to start aircraft engines or supply emergency bleed air for cabin air conditioning.

Column B

A. Strut No. 2

B. Strut No. 3

C. Precooler

D. Struts No. 1 & 4 bleed valve

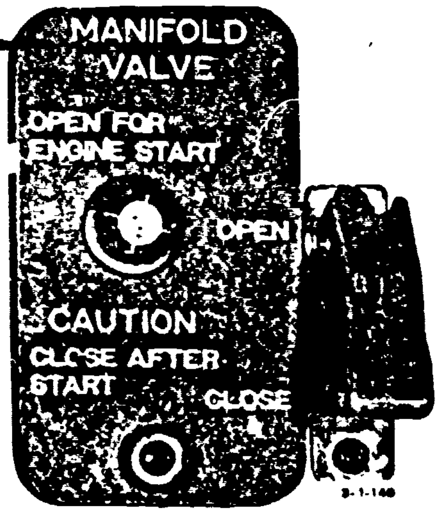
E. Body crossover manifold valve

F. Strut No. 3 bleed valve

Answers to Frame 18: 1. C 2. B 3. E 4. A 5. D
6. F

Frame 19

The manifold valve switch, in the illustration, is used to open all the bleed air valves only during engine starting.



MANIFOLD VALVE SWITCH

Complete the following statements by filling in the blanks provided.

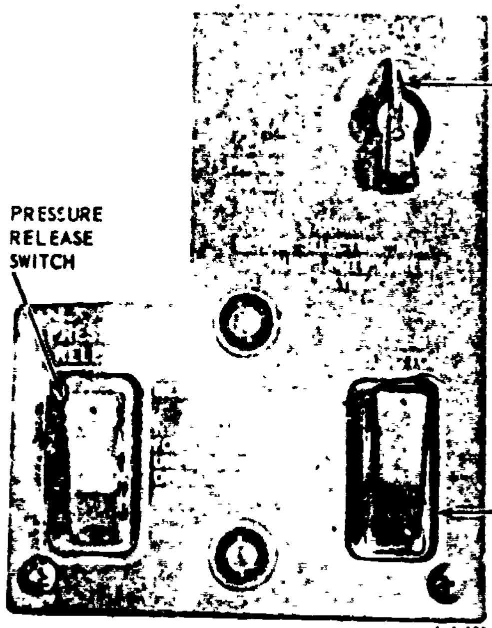
1. The manifold valve switch has two positions ________________.

2. Lifting the cap and pressing the manifold valve switch to the open position will open the body crossover valve, strut No. 3 bleed valve, and ________________________________.

3. The manifold valve switch is used ___________________________.

Answers to Frame 19: 1. open and close
2. struts No. 1 and 4 bleed valve
3. only during engine start

Frame 20



AIR CONDITIONING AISLE STAND PANEL

The engine bleed air system controls also consists of a cabin pressure master switch and a bleed selector switch as shown in the sketch above. The cabin pressure master switch has four positions: RAM, OFF, 7.45 psi, and COMBAT 4.50 psi.

The bleed selector switch has two positions, NORMAL and EMERGENCY. The position of the bleed selector switch determines the availability of the engine bleed air from either strut number 2 or 3 for air conditioning and pressurization.

Answer each of the following statements as either true (T) or false (F).

_____1. The four positions on the cabin pressure master switch are ram, Off, 7.45 psi, and Combat 4.50 psi.

_____2. The two positions on the bleed selector switch are Normal and emergency.

_____3. The availability of engine bleed air from either strut number 2 or 3 is determined by the position of the bleed selector switch.

Answers to Frame 20: 1. T 2. T 3. T

Frame 21

Using the switch position table shown below, complete each of the following statements.

SWITCH POSITION

AIR ROUTE	CABIN PRESSURE MASTER SWITCH	MANIFOLD VALVE SWITCH	BLEED SELECTOR SWITCH
Any strut to all other struts	RAM or OFF	OPEN	NORMAL or EMERG
No. 3 strut to air conditioning pack	7.45 PSI or COMBAT 4.5 PSI	CLOSED	EMERG
No. 2 strut to air conditioning pack	7.45 PSI or COMBAT 4.5 PSI	CLOSED	NORMAL
Individual strut only	RAM or OFF	CLOSED	NORMAL or EMERG

CAUTION

- To prevent excessive bleed air manifold temperatures which could result in a fire hazard, do not operate any engines other than No. 3 or 4 above 80% rpm with the manifold valve switch open.
- Do not exceed 246° C (475° F) when operating engine No. 5 or 6 with MANIFOLD VALVE switch in CLOSE position and BLEED SELECTOR switch in EMERG position.

1. To get air from strut number 2 the air conditioning system, the manifold valve switch is closed, the bleed selector switch will be in the ______________ position, and the cabin pressure master switch will be in the 7.45 or 4.50 psi position.

2. To get air to go from any strut to all the other struts during engine starting, the cabin pressure master switch is in the OFF or RAM position, the manifold valve switch is in the ______________________ position and the bleed selector switch will be in normal or emergency.

1571

Answers to Frame 21: 1. NORMAL 2. OPEN

Frame 22

Using the switch position chart as a guide, write down the bleed air system control positions for each of the following situations.

SWITCH POSITION

AIR ROUTE	CABIN PRESSURE MASTER SWITCH	MANIFOLD VALVE SWITCH	BLEED SELECTOR SWITCH
Any strut to all other struts	RAM or OFF	OPEN	NORMAL or EMERG
No. 3 strut to air conditioning pack	7.45 PSI or COMBAT 4.5 PSI	CLOSED	EMERG
No. 2 strut to air conditioning pack	7.45 PSI or COMBAT 4.5 PSI	CLOSED	NORMAL
Individual strut only	RAM or OFF	CLOSED	NORMAL or EMERG

CAUTION

- To prevent excessive bleed air manifold temperatures which could result in a fire hazard, do not operate any engines other than No. 3 or 4 above 80% rpm with the manifold valve switch open.
- Do not exceed 246° C (475° F) when operating engine No. 5 or 6 with MANIFOLD VALVE switch in CLOSE position and BLEED SELECTOR switch in EMERG position.

1. To start aircraft engines with a ground cart connected to strut No. 2 the switch positions will be:

   a. Cabin Pressure Master Sw. ______________

   b. Manifold Valve Sw. ______________

   c. Bleed Selector Sw. ______________

2. To get bleed air for the air conditioning system from the normal source the switch positions are:

   a. Cabin Pressure Master Sw. ______________

   b. Manifold Valve Sw. ______________

   c. Bleed Selector Sw. ______________

3. To get bleed air for the air conditioning system from the emergency source the switch positions are:

   a. Cabin Pressure Master Switch: ______________________

   b. Manifold Valve Switch: ______________________

   c. Bleed Selector Switch: ______________________

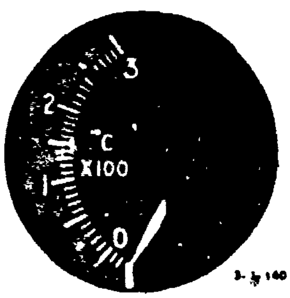
1573

Answers to Frame 22: 1. a. RAM or OFF b. OPEN c. NORMAL or EMERGENCY
2. a. 7.45 psi or Combat 4.5 b. CLOSED
c. NORMAL
3. a. 7.45 psi or Combat 4.5 psi b. CLOSED
c. EMERGENCY

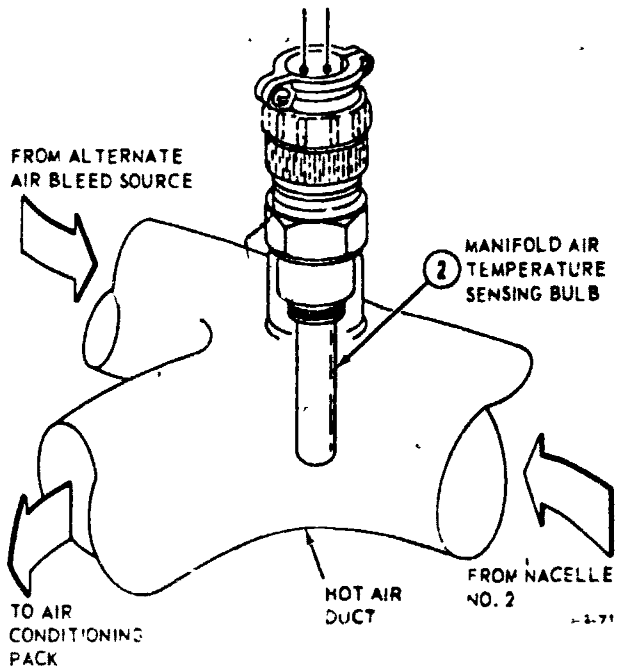
Frame 23

A manifold air temperature indicator and sensing bulb, shown in the sketch indicates the air temperature in the bleed air system. The indicator is scaled in degrees from -20° to +300°C (-4° to +575°F) and is red lined at 246°C (475°F) for maximum operating temperature.

Resistance of the temperature bulb varies with temperature changes. The indicator, is located on the copilot's auxiliary side panel and the manifold air temperature bulb is located in the engine air bleed supply system duct.



MANIFOLD TEMPERATURE INDICATOR



Answer each of the following statements as either true (T) or false (F).

_____1. A manifold air temperature indicating system is used to indicate the air temperature in the bleed air system.

_____2. The indicator is red lined at 246°C.

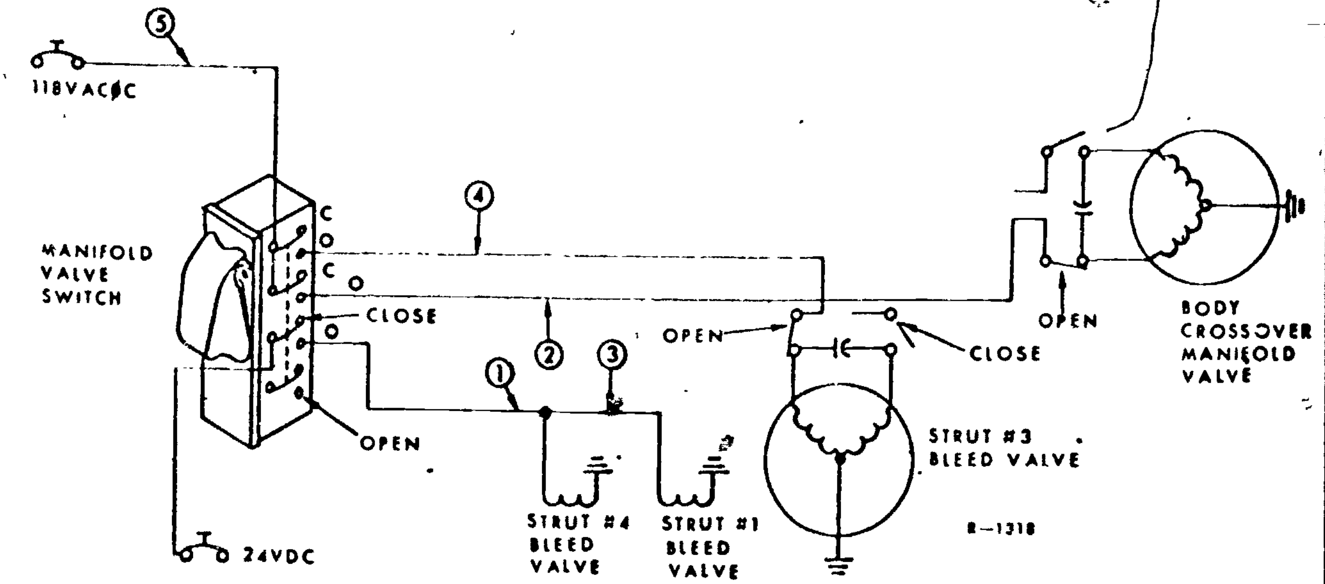
_____3. The temperature of the air flowing through the bleed air system will vary the resistance of the sensing bulb.

1574

Answers to Frame 23: 1. T 2. T 3. T

Frame 24

Using the illustration as a guide, trace the electrical circuits and complete the following statements by placing the word or words in the blank spaces that would make the statement true.



1. Strut No. 1 and Strut No. 4 bleed valves are supplied with _________ volts.

2. The body crossover manifold valve and strut No. 3 bleed valve are supplied with ____________ volts.

3. When the manifold valve switch is placed in the open position, all the _______________ air valves will open.

4. If the open wire indicated by the symbol (1) existed in the electrical circuit, both Strut No. ________ and Strut No. ________ bleed valves will not open.

5. If the open wire indicated by the symbol (2) existed in the electrical circuit the _____________________________ _________________ valve will not open.

6. If the open wire indicated by the symbol (4) existed in the electrical circuit _____________________________ _________________ valve will not open.

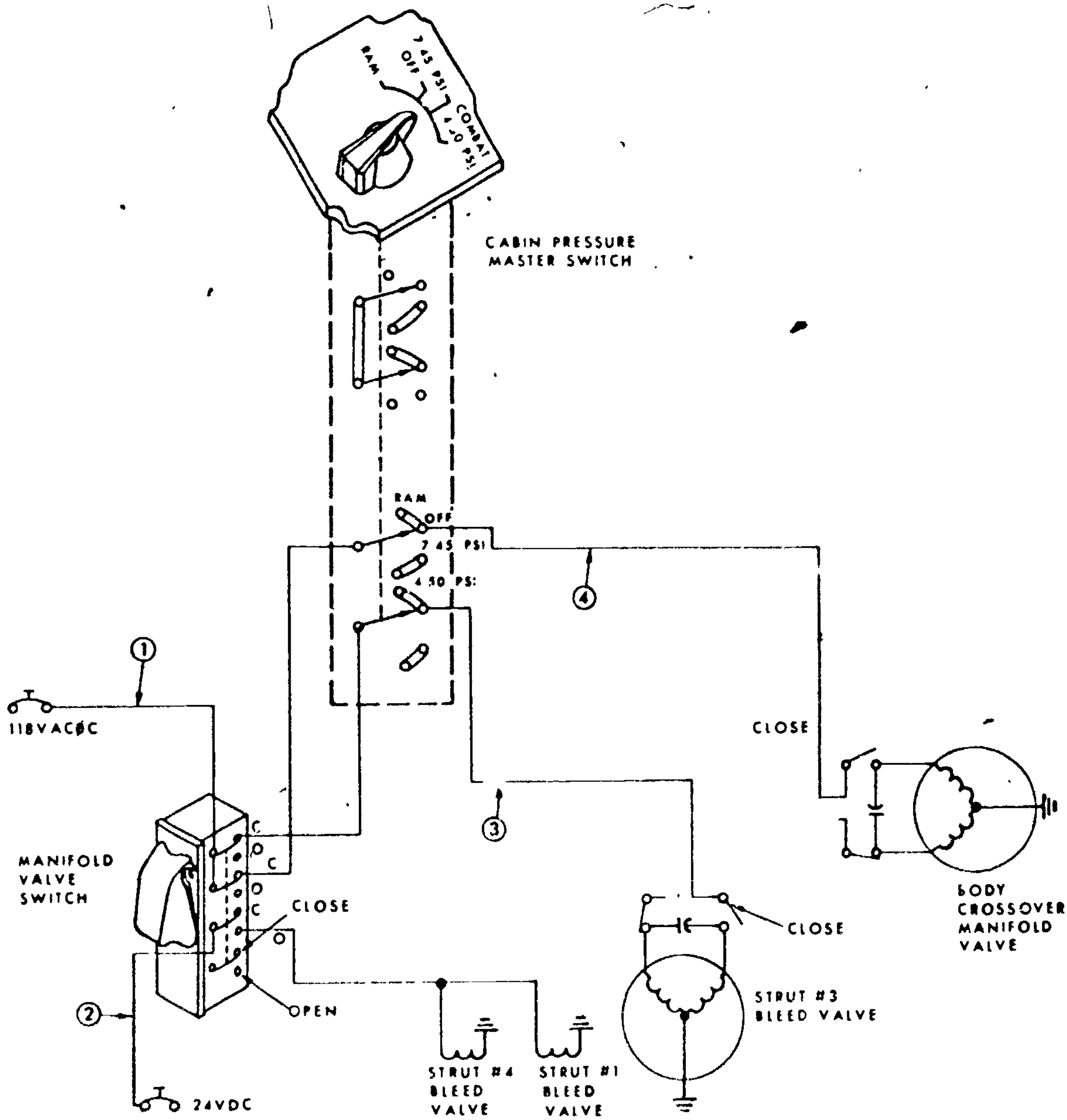
349

1575

Answers to Frame 24: 1. 24 2. 118 3. bleed 4. 1 and 4
5. Body crossover manifold valve
6. Strut No. 3 Bleed Valve

Frame 25

Using the illustration shown as a guide, trace the electrical circuits and complete the following statements by placing the word or words in the blanks spaces that would make the statement true



350

1. When manifold valve switch is placed in the closed position, all the _______________ air valves will close.

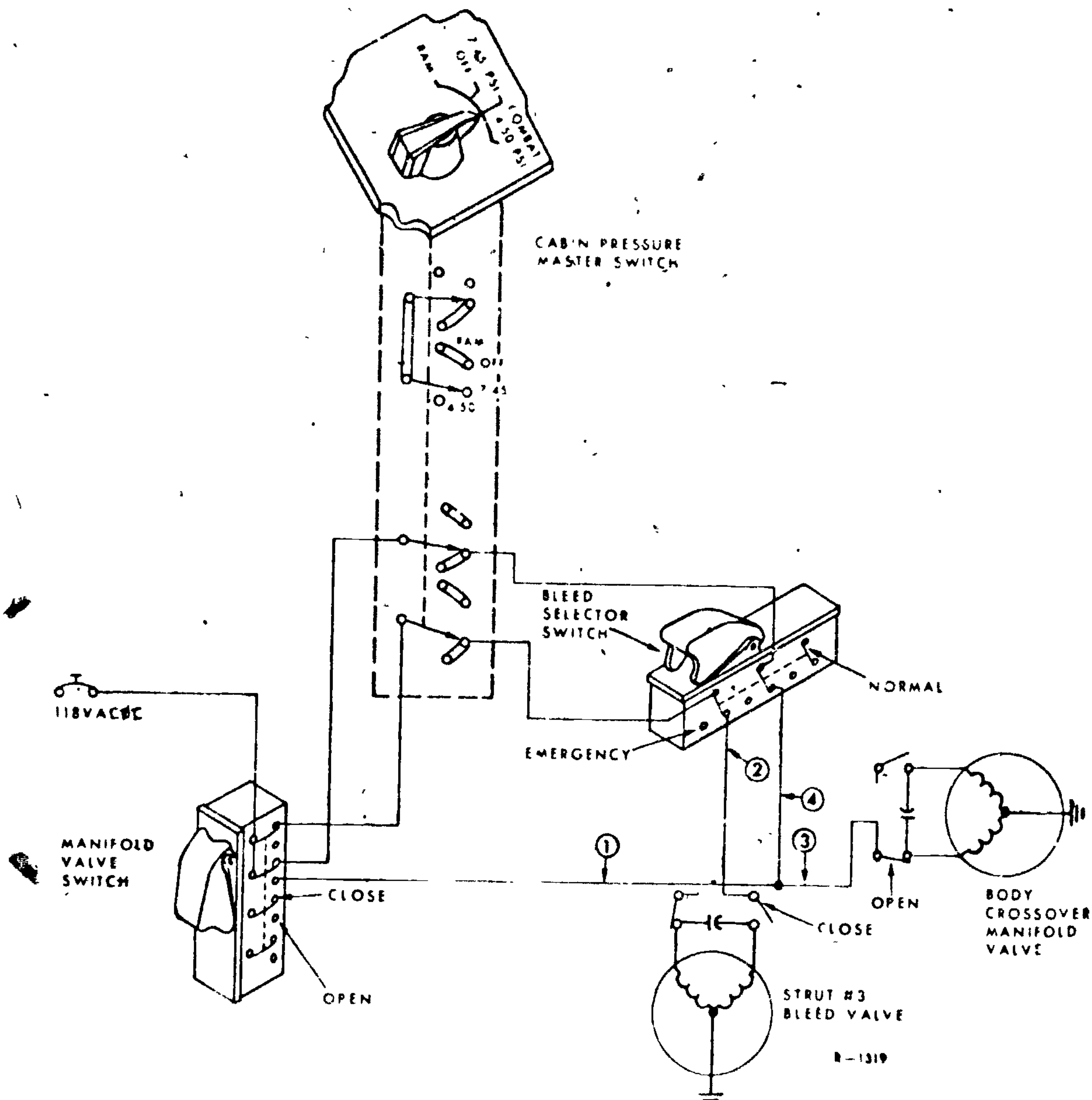
2. If the open wire indicated by the symbol (3) existed in the electrical circuit, Strut No. 3 bleed valve will not ____________________.

3. If the open wire indicated by the symbol (4) existed in the electrical circuit the ______________ ________________ ____________ ____ valve will not close.

Answers to Frame 25: 1. bleed 2. close 3. body crossover manifold valve

Frame 26

With the switches on the circuit shown in the following positions, complete each statement written below with the word or words that will make each statement true.



Switch Positions:

Manifold Valve
Switch-Closed
Cabin Pressure
Master Sw.
7.45 psi
Bleed Selector
Switch Normal

1. Strut No. 3 bleed valve will be ______________.

2. The body crossover manifold valve will be ______________.

3. With the body crossover valve open, hot high pressure air will be received from Strut No. ____________.

4. If the open electrical circuit indicated by the symbol (4) existed, the body crossover manifold valve would not open when the ____________ ______________ switch was positioned.

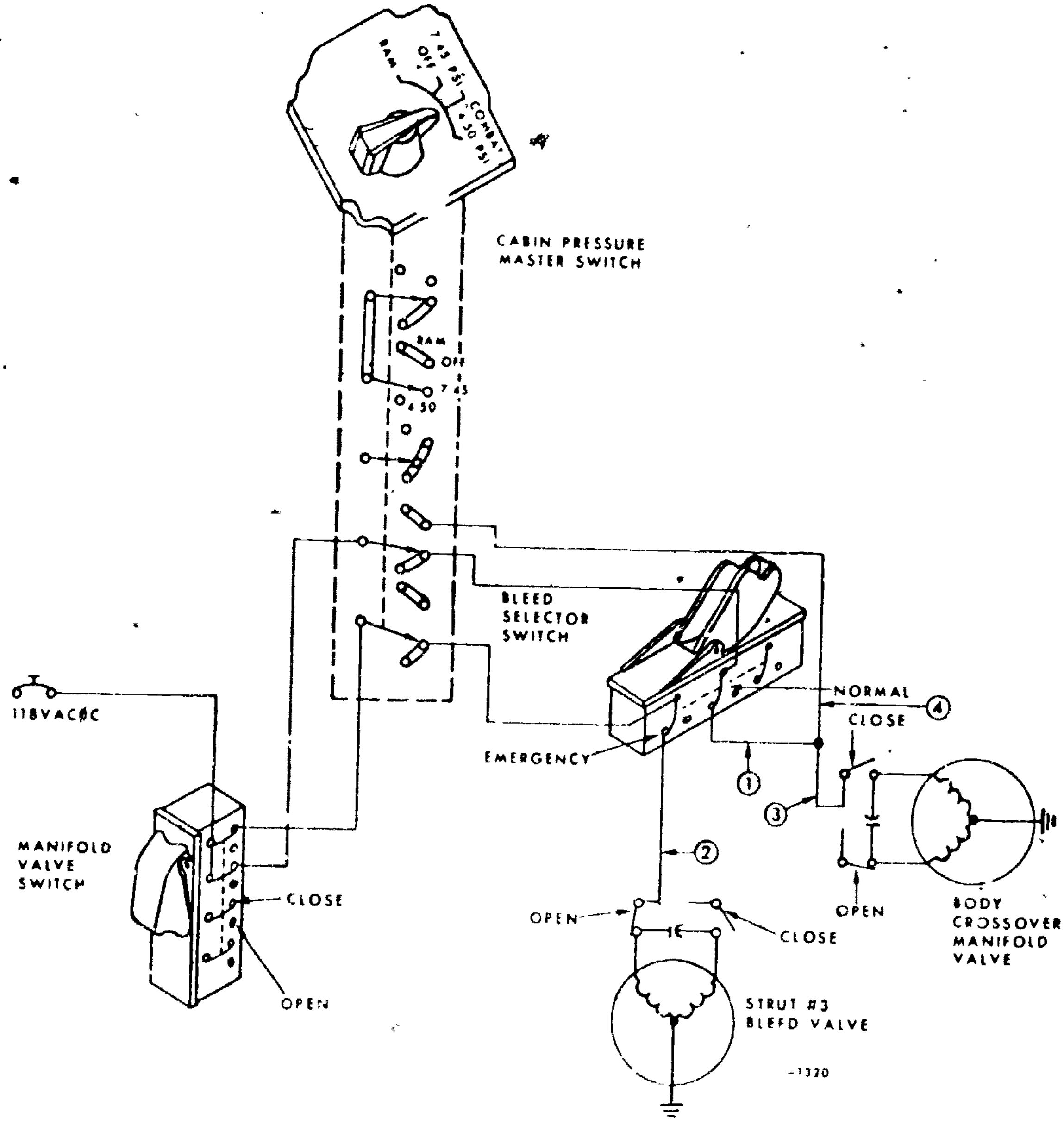
5. If the open electrical circuit indicated by the symbol (3) existed, the ____________ ____________ ______________ valve would not open when the bleed selector switch was in normal or the manifold valve switch was in the normal position.

1579

Answers to Frame 26: 1. closed 2. open 3. two 4. bleed selector 5. body crossover manifold

Frame 27

With the switches in the circuit shown in the following positions, complete each statement written below with the word or words that make each statement true.



354

Switch Positions:

Manifold Valve
Sw---Closed.
Cabin Pressure
Master Sw---
7.45 psi
Bleed Selector
Sw--Emergency

1. With the switch positions shown above, Strut No. 3 bleed valve will ______________.

2. With the switch positions shown above, the body crossover manifold valve will __________ _____.

3. If the open wire indicated by the symbol (1) existed, in the electrical circuit, the __________ ______________ ________________ valve will not close.

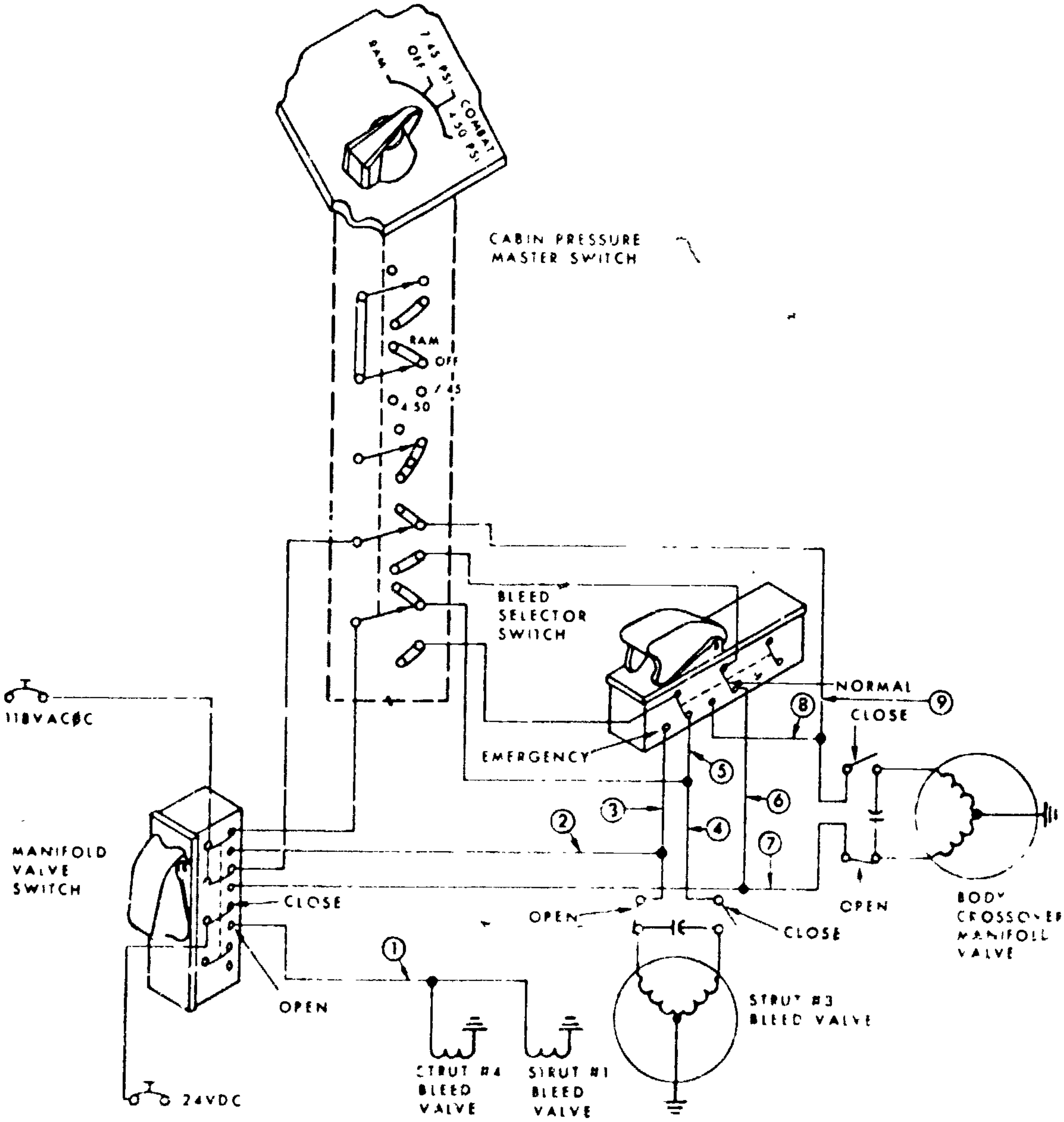
4. If the open wire indicated by the symbol (2) existed in the electrical circuit, the Strut No. 3 bleed valve will not ________ ________.

1581

Answers to Frame 27: 1. open 2. close 3. body crossover manifold
4. open

Frame 28

Using the illustration shown as a guide, complete each of the following statements with the word or words that will make each statement true.



1. If the open electrical circuit indicated by circle (1) was in the circuit, both Strut No. 4 bleed valve and Strut No. 1 valve would not ________.

356

2. If the open circuit indicated by circle (2) and the manifold valve switch were placed in the open position, Strut No. 3 bleed valve would not __________.

3. If the open electrical circuit indicated by circle (5) was in the circuit, Strut No. 3 bleed valve will not __________ when the bleed selector switch was in the normal position.

4. If the open electrical circuit indicated by circle (6) was in the circuit, the body crossover manifold valve would not __________ with the bleed selector switch in the normal position.

Answers to Frame 28:

1. Open
2. open
3. close
4. open

1583

PROGRAMMED TEXT
3ABR42331-PT-206A

Technical Training

Aircraft Environmental Systems Mechanic

BOMBER AIR CONDITIONING SYSTEM

25 April 1979

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3370 Technical Training Group
Chanute Air Force Base, Illinois

1584

FOREWORD

This programmed text was prepared for use in the 3ABR42331 Aircraft Environmental Systems Mechanic Course. The materials contained herein were validated with students from the subject course. At least 90% of the students taking this text achieved or surpassed the criteria established in the lesson objectives. The average time for completion of this text was 4 hours and 20 minutes.

OBJECTIVES

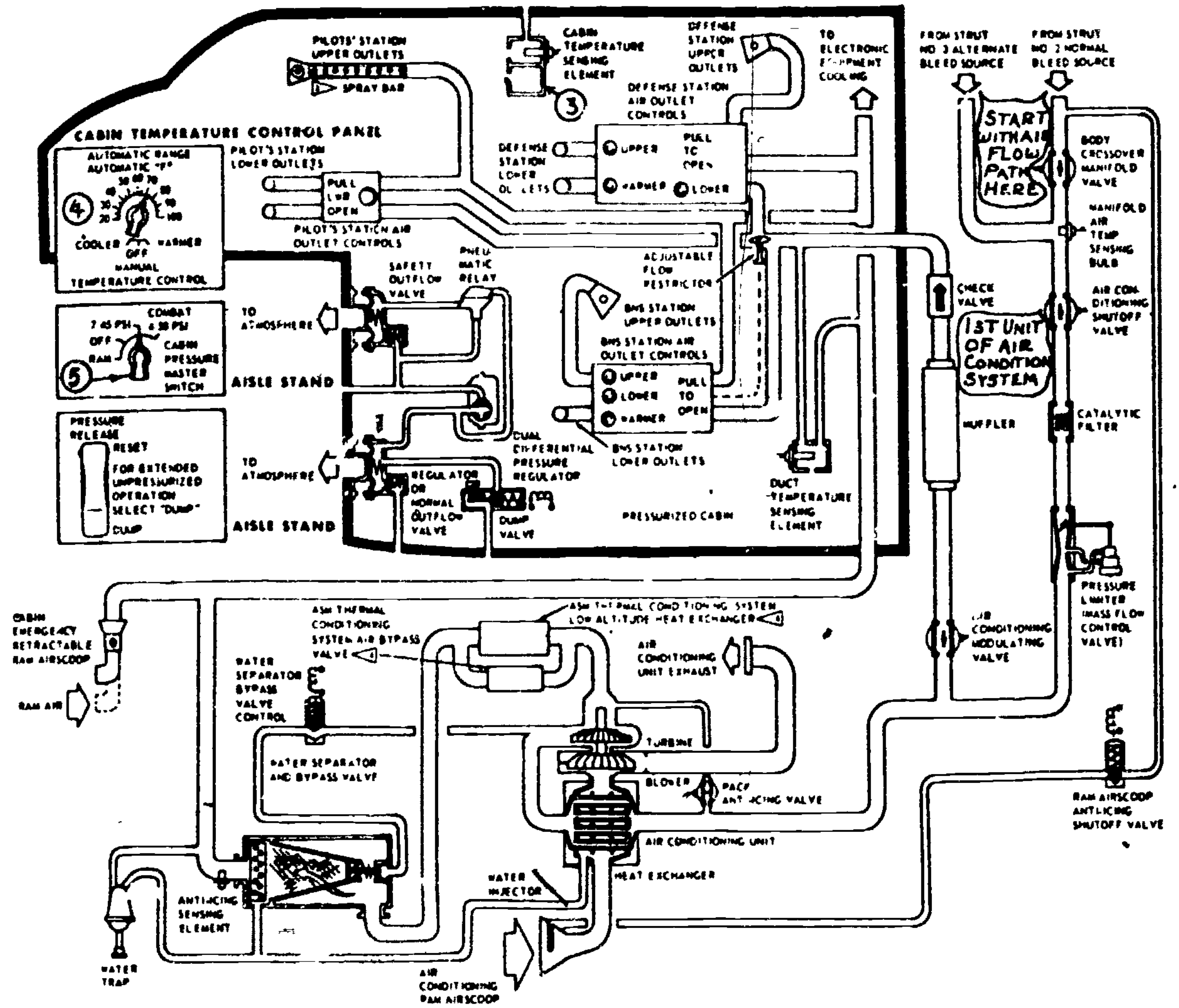
Relate the name of each cabin air conditioning system component to its operation with a minimum of 80% accuracy.

INSTRUCTIONS

This program text presents information in small steps called "frames." After each step you are asked to select the correct statement, match a statement, or respond in some other way to the information presented. Read the material presented and make your response as directed by the instructions. Compare your response with answers found on the next page or pages. If you are wrong, read the frame again, and then write the correct response next to your previous answer.

Supersedes 3ABR42331-PT-206A, 26 September 1977.
DISTRIBUTION: X
3370 TCHTG/TTGU-P - 300; TTVSA - 1

Shown below is a schematic of the Bomber Air Conditioning System. This programmed text will go through the nomenclature (name) and purpose of each component part of the system beginning with the Air Conditioning System Shutoff Valve. Look over the schematic to find the source of bleed air and to get an idea where each part is located.



Refer to the schematic above and place the letter T in the blank space before each of the following statements that are true.

_____1. The normal source of bleed air is Strut No. 2.

_____2. The alternate (emergency) source of bleed air is Strut No. 3.

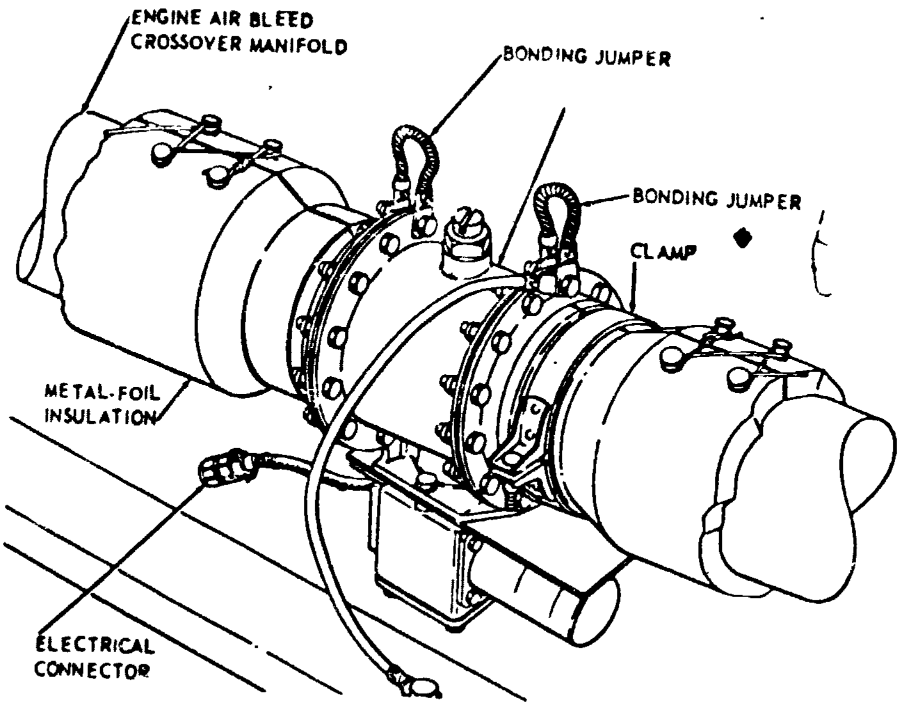
_____3. The Air Conditioning System Shutoff Valve is used to open and close the bleed air supply line going to the air conditioning system.

1586

Answers to Frame 1: 1. T 2. T 3. T

Frame 2

The first valve in the Bomber Air Conditioning System is the Air Conditioning Shutoff Valve. This valve is driven by a single-phase 118 volt A-C motor. This valve has two purposes. First, the valve opens to let engine bleed air into the air conditioning system for normal system operation. Second, this valve closes to shut off airflow to the air conditioning system when the system is not in use or in case of an emergency.



Fill in the blanks to complete the following statements.

1. The first valve in the Bomber Air Conditioning system is the __________ ____________________ ____________ valve.

2. The Air Conditioning Shutoff valve ________________ to allow bleed air to flow into the ______________________ ______________ ________________ system.

. The air conditioning shutoff valve ____________________ to stop bleed air flow into the Air Conditioning System.

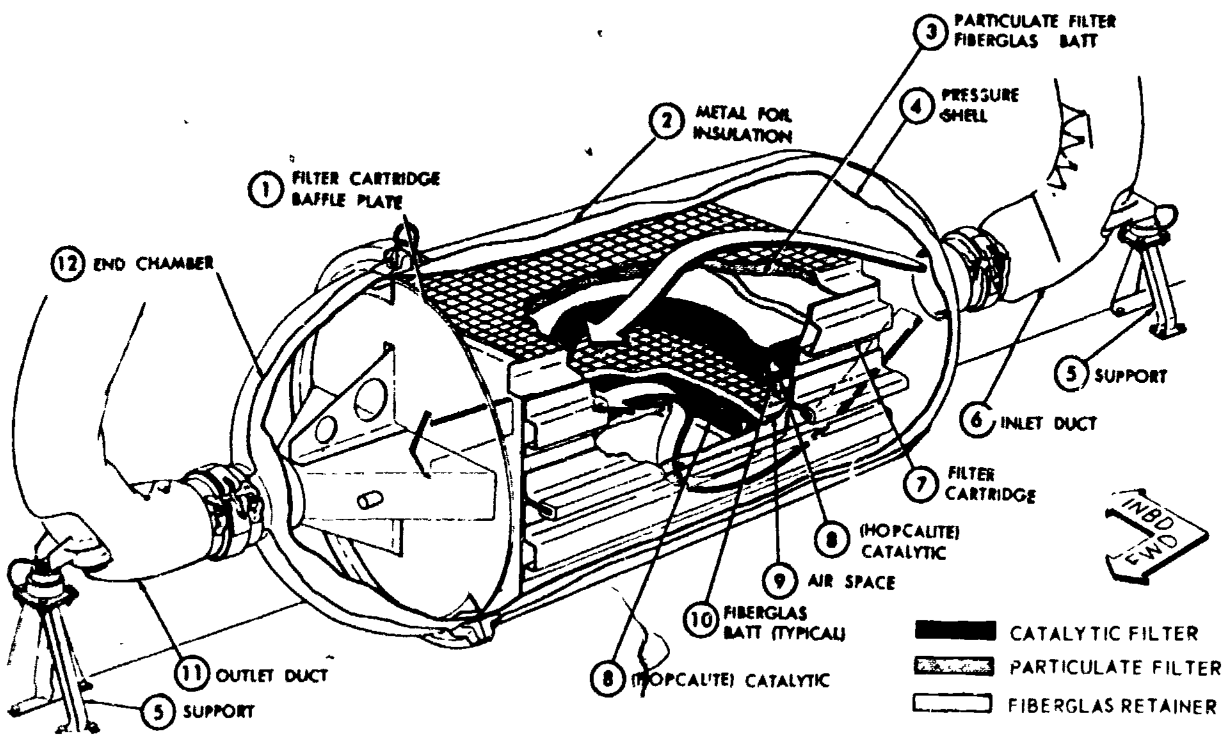
Answers to Frame 2: 1. air conditioning shutoff
2. opens cabin air conditioning 3. closes

Frame 3

The Catalytic Filter, shown below, is the next unit in the sequence of airflow. The filter is installed to remove contamination in the air supply.

There are two types of filter elements (8). The catalytic elements consists of a granular substance (Hopcalite) which is held in place between the screens and fiberglas. There are two of these elements in the filter, which turn any obnoxious gases and vapors into harmless products.

There are also two particulate elements (3), one on each side of the filter unit, these elements screen out any solid particles.



Answer the statements as either True or False.

_____1. Any obnoxious gases and vapors such as fuels and oil fumes are turned into harmless products by the catalytic element.

_____2. Two catalytic elements and one particulate element are installed in the filter.

_____3. The overall purpose of the catalytic filter is to remove contamination of any sort from the air supply.

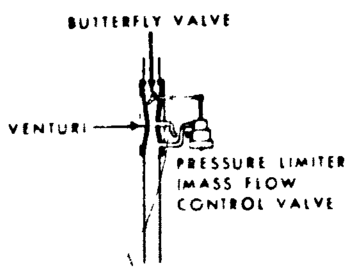
1588

Answers to Frame 3: 1. T 2. F 3. T.

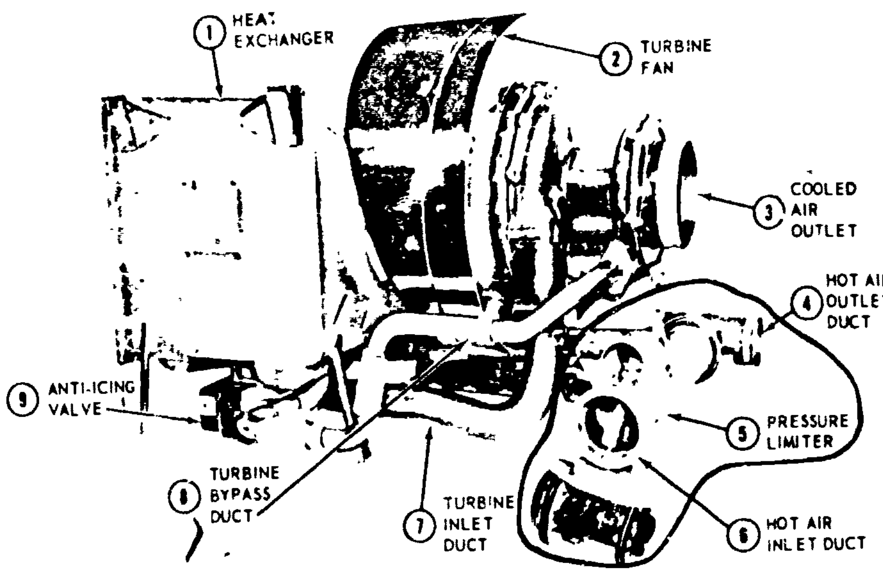
Frame 4

The Pack Pressure Limiter (5), shown in the picture below, keeps an even airflow through the air conditioning system. This valve will regulate system airflow to approximately 140 lbs per minute.

Go back to page 3 of this text and look at your air conditioning schematic. You will notice that airflow from the pack pressure limiter flows in two directions. Airflow from one direction flows to the heat exchanger. Air flow from the other direction flows to the air conditioning modulating valve. First, we will discuss airflow to the heat exchanger.



R-42



Circle the number of the statement that best describes the purpose of the pack pressure limiter.

1. The pack pressure limiter maintains the rated airflow capacity of the air conditioning system at approximately 140 lbs per minute.

2. The pack pressure limiter maintains a constant flow of ram air into the air conditioning system.

Answer to Frame 4: 1

Frame 5

Write the letter of the component found in column B in the appropriate space provided to the left of the purpose in column A.

Column A		Column B
_____1.	Regulates the system airflow to approximately 140 pounds per minute.	a. Air Conditioning System Shutoff Valve
_____2.	Used to open and close the air supply line going to the air conditioning system.	b. Particulate Element
_____3.	Changes any obnoxious gases and vapors into harmless products.	c. Catalytic Element
_____4.	Removes solid particles from the air.	d. Pack Pressure Limiter
_____5.	Normal source of bleed air.	e. Strut No. 3
_____6.	Emergency source of bleed air.	f. Strut No. 1
		g. Strut No. 2

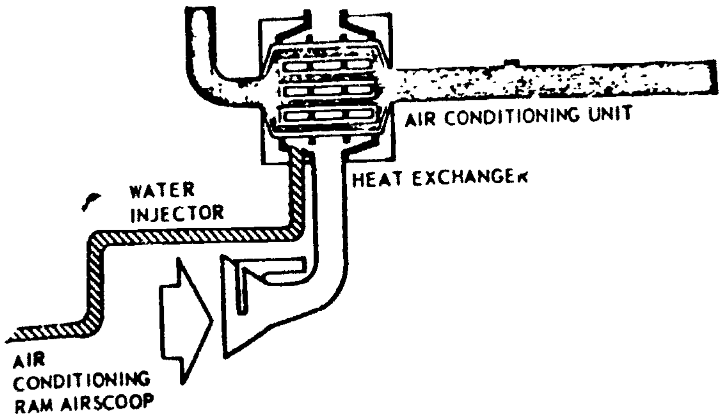
1590

Answers to Frame 5: 1. d 2. a 3. c 4. b 5. g 6. a

Frame 6

A heat exchanger, shown in the schematic below, is used to cool the engine bleed air. The air conditioning ram air scoop is in the leading edge of the left wing.

Engine bleed air flowing through the heat exchanger is cooled by ram air entering the pack at the ram air inlet (shown in the sketch). The ram air which flows across the heat exchanger core cools the bleed air by transferring heat energy from the bleed ai to the ram air. Additional cooling is accomplished by the water injector, which will be described to you in Frame 12.



Place the letter T in the blank space before each of the following that are true statements.

_____1. The heat exchanger cools the engine bleed air by transferring heat energy from the bleed air to the ram air.

_____2. Ram air from a scoop in the leading edge of the left wing circulates around the tubes of the heat exchanger.

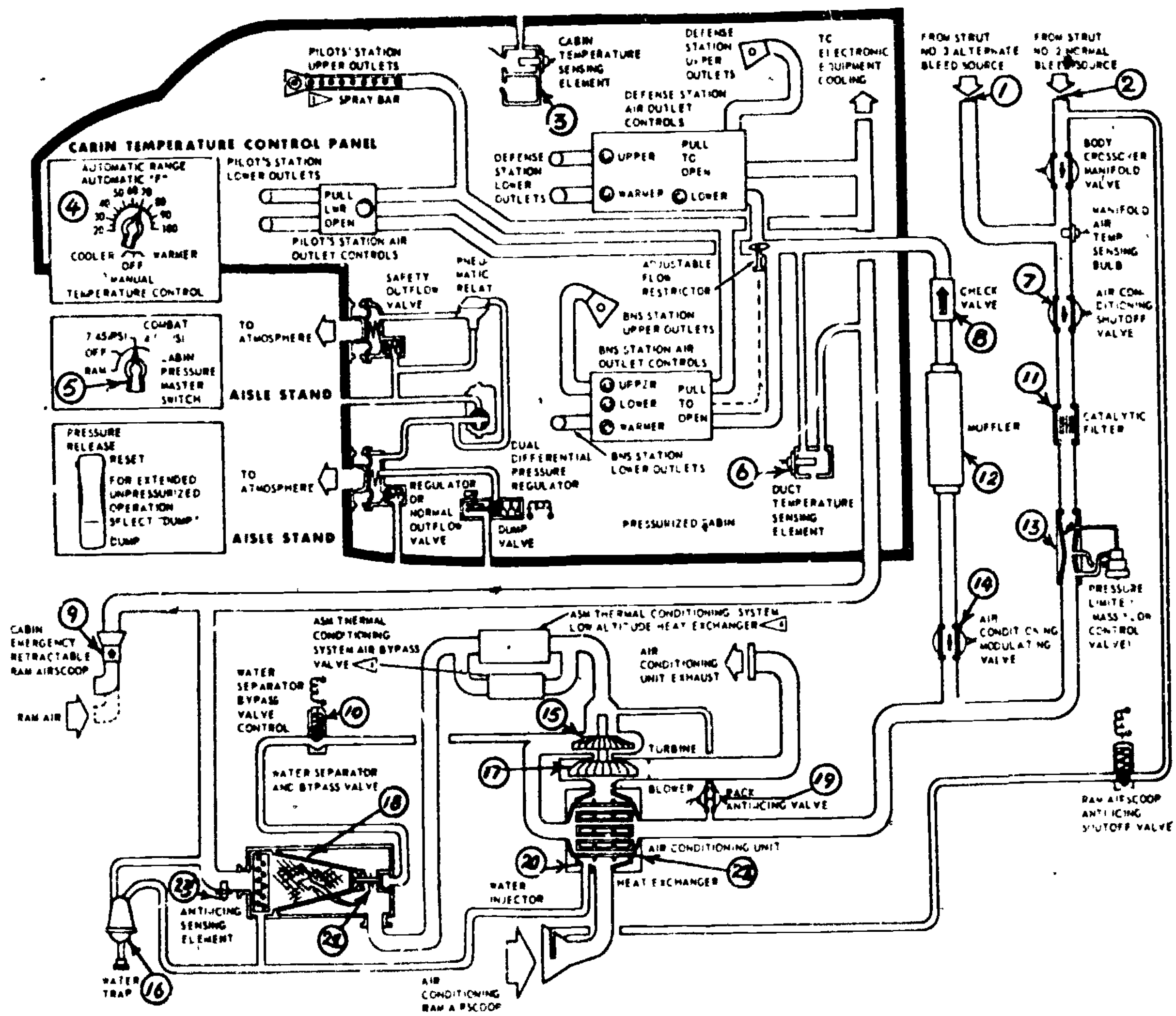
_____3. If the ram air scoop becomes blocked, the flow of ram air would stop. This would cause the engine bleed air to leave the heat exchanger at the same temperature at which it entered.

1591

Answers to Frame 6: 1. T 2. T 3. T

Frame 7

Match each purpose given below with a component in the illustration and write the number from the illustration in the space provided.



____1. Used to open and close the air supply line going to the cabin air conditioning system.

____2. Regulates the system airflow to approximately 140 pounds per minute.

____3. Cools the engine bleed air by transferring heat energy from the bleed air to ram air.

____4. Removes any contamination such as solid particles and obnoxious gases from the air.

____5. Normal source of engine bleed air.

____6. Emergency source of bleed air.

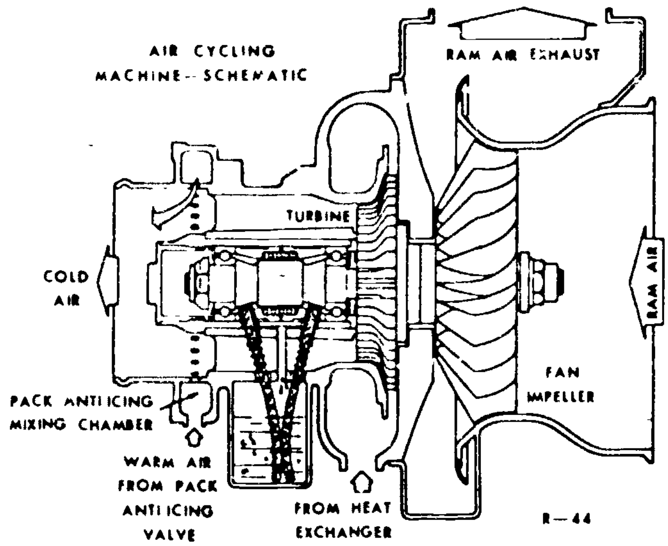
366

1592

Answers to Frame 7: 1. 7 2. 13 3. 22 4. 11 5. 2 6. 1

Frame 8

The Air Conditioning Pack Turbine Fan Assembly, shown in the sketch, will give maximum cooling of bleed air. The turbine cools the engine bleed air by converting heat energy to mechanical energy and by rapid expansion. The fan provides a load to prevent over-speeding of the turbine. The fan is driven by the expansion turbine.



Place the letter T alongside each of the following that are true statements.

_____1. The turbine wheel cools the engine bleed air by converting heat energy to mechanical energy and by rapid expansion.

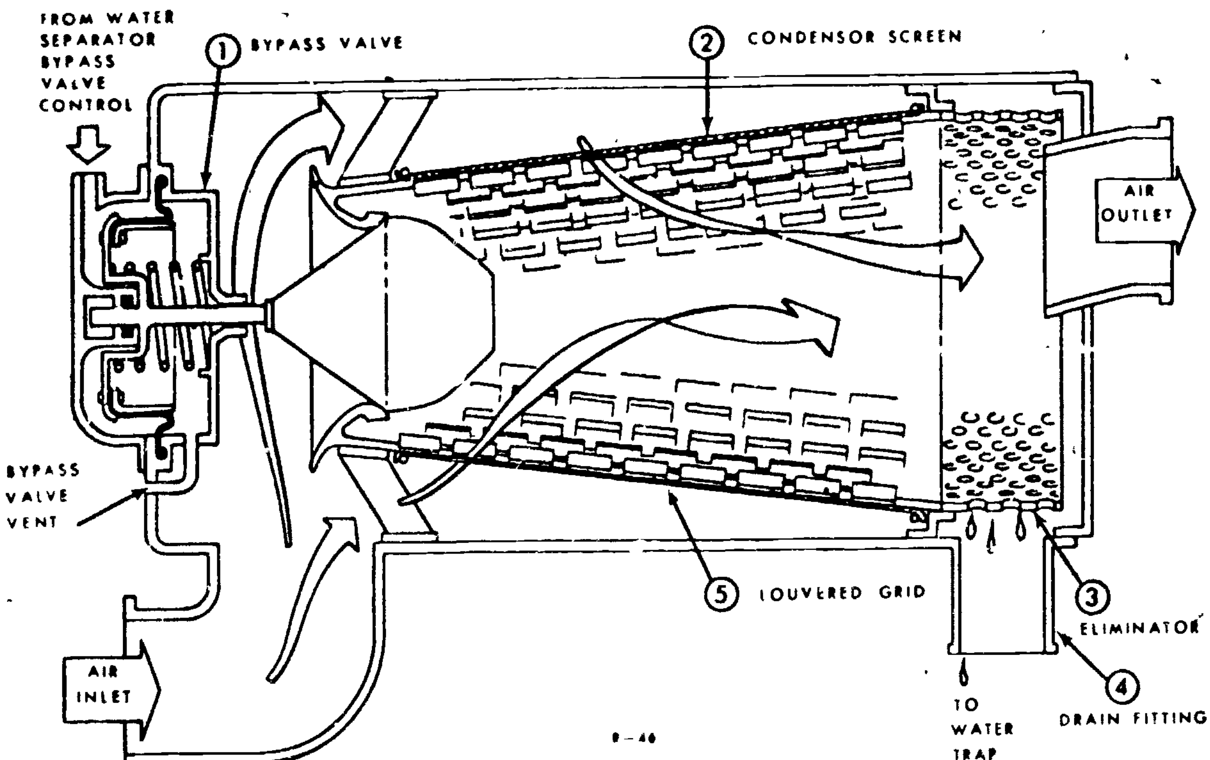
_____2 The fan provides a load to prevent overspeeding of the turbine and circulates ram air through the heat exchanger.

_____3. The maximum temperature drop of the bleed air takes place across the turbine.

_____4. The engine bleed air cooled by the turbine comes from the ram air scoop in the leading edge of the left wing.

The cold air which is being discharged from the turbine will then flow into the water separator. The water separator takes the moisture out of the air, which will reduce fogging or snowing in the cabin.

As the cooled air enters the water separator it flows through a condensor screen (2) made of a fiberglass fabric. The condensor screen is mounted on a cone-shaped grid (5) with louvered openings. In passing through the screen, water vapor is condensed into droplets which pass into the eliminator (3) and are thrown rapidly outward by the rotating force caused by the air passing through the louvered grids.



Circle the letter of the statement that best describes the purpose of the water separator.

A. The water separator removes moisture from the heat exchanger ram discharge air.

B. The water separator removes moisture from the cooled turbine discharge air and, thus, reduces fogging or snowing in the control cabin.

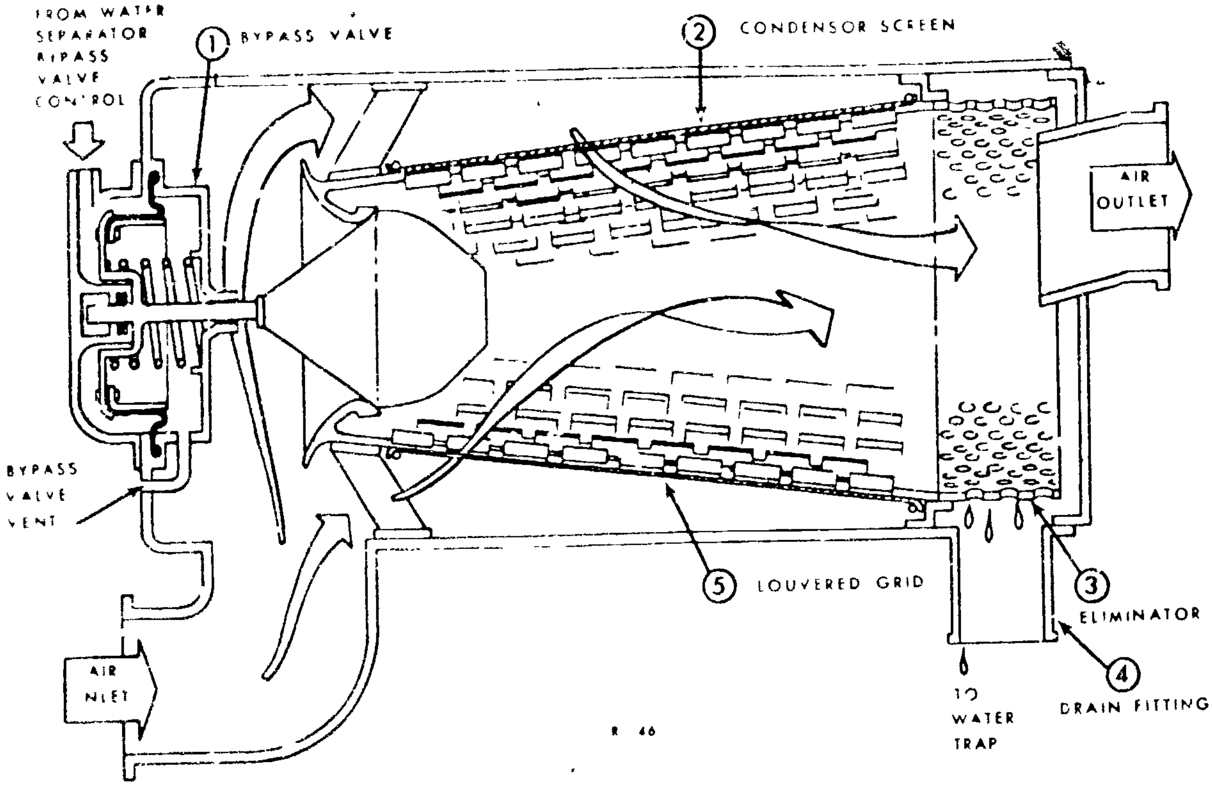
C. The water separator removes moisture from the ram air entering the cabin.

1594

Answer to Frame 9: b

Frame 10

The water separator bypass valve (1) is a part of the water separator. The valve is used to bypass the water separator condenser screen under two conditions. Above 36,000 feet, the bypass valve will open to allow the cooled ir to bypass the condenser screen; the bypass valve will also open if the condenser screen gets iced up or clogged.



Place the letter T alongside each of the following that are true statements.

____ 1. The water separator condenser screen is bypassed at altitudes above 36,000 feet because of the lack of moisture in the air.

____ 2. Icing or clogging of the condenser screen will cause a higher than normal pressure differential across the screen that will open the bypass valve.

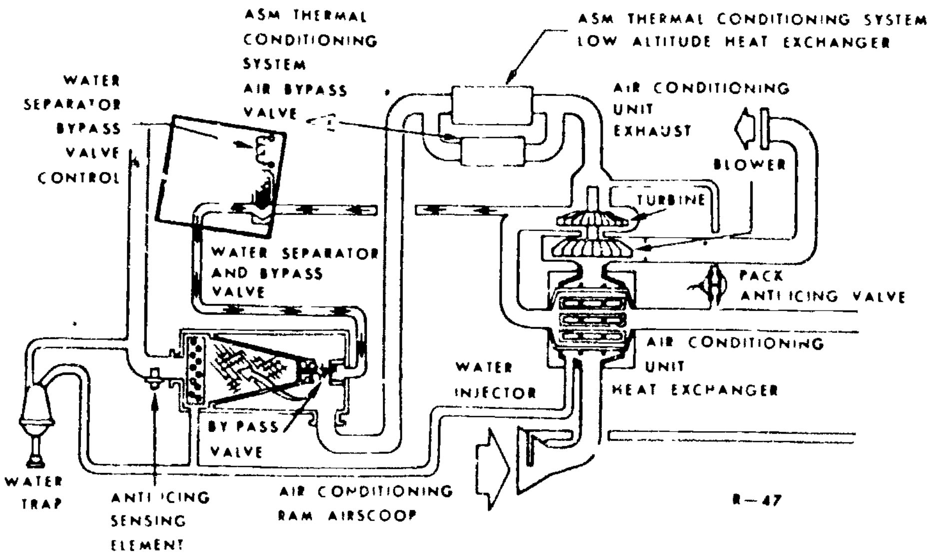
____ 3. The bypass valve is installed in the air outlet end of the water separator.

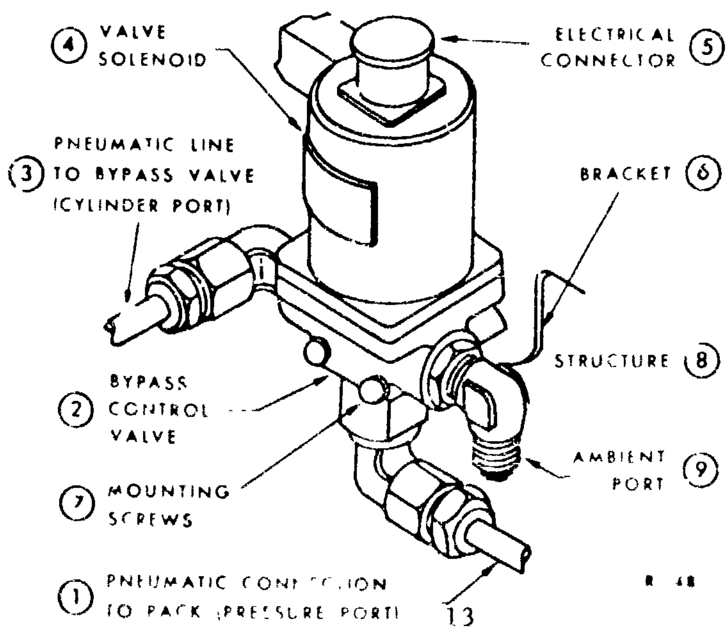
____ 4. Opening the bypass valve forces the cooled air through the screen instead of letting the cooled air go around the screen.

Answers to Frame 10: 1. T 2. T 3. F 4. F

Frame 11

When the air conditioning system is on and the aircraft is flying above 36,000 feet, the water separator bypass valve control opens. When the valve is energized, it opens to permit bleed air pressure to flow from a port at the top of the air conditioning pack to the control chamber of the water separator bypass valve, opening the bypass valve. Cooled air, while bypassing the condenser screen, then flows through the water separator. The water separator bypass valve control is a solenoid operated air valve. Refer to the two illustrations shown and then read each statement on the next page and place the letter T beside each of the true statements.





1596

Frame 11 (Continued)

_____1. The water separator bypass valve control is a solenoid operated air valve.

_____2. The water separator bypass valve control will permit high pressure air to flow from a port on the air conditioning pack to the control chamber of the water separator bypass valve and force the bypass valve open.

_____3. Opening the water separator bypass valve will allow cooled air to bypass the water separator condenser screen.

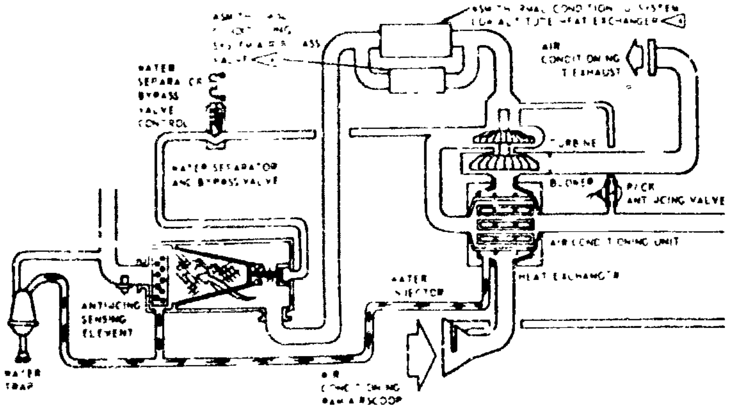
Answers to Frame 11: 1. T 2. T 3. T

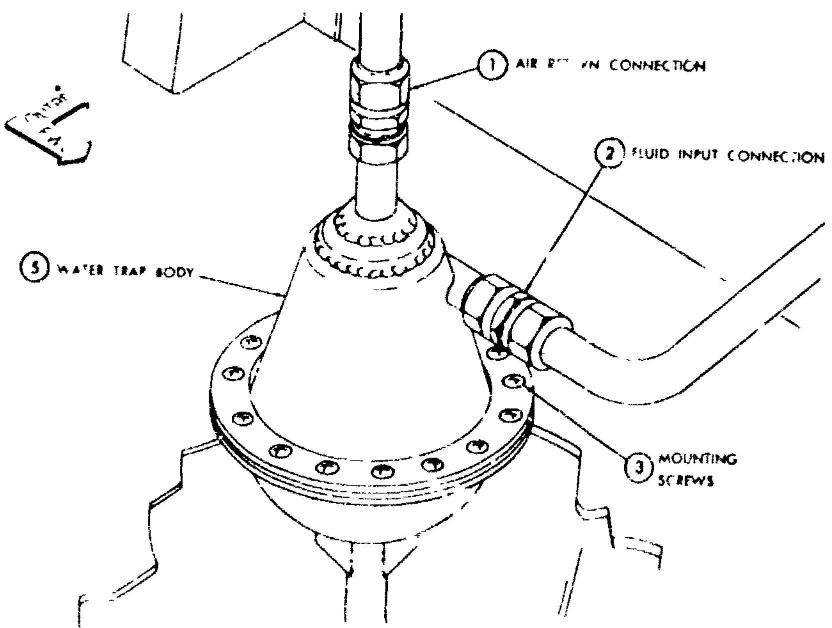
Frame 12

The moisture from the water separator will flow in two separate directions as shown by the arrows on the schematic.

The water injector shown sprays water over the heat exchanger coils to provide additional cooling of the engine bleed air.

The water trap is a float actuated drain valve. The trap is used to let the separated water be removed from the system without the loss of air.





Refer to the illustration shown, then read each statement below and place the letter T beside each statement that is true.

___1. Additional cooling of the engine bleed air is provided by the water injector.

___2. The separated moisture will flow to the water trap and the water injector.

1598

Frame 12 (continued)

______3. The water trap is electrically operated.

______4. The water trap is a float operated drain valve.

______5. The removal of the separated water without the loss of air is performed by the water trap.

______6. The water injector sprays the water over the heat exchanger coils in the ram air portion of the heat exchanger.

Answers to Frame 12: 1. T 2. T 3. F 4. T 5. T 6. T

Review Quiz

Write the letter of the component found in column B in the appropriate space provided to the left of the purpose in column A.

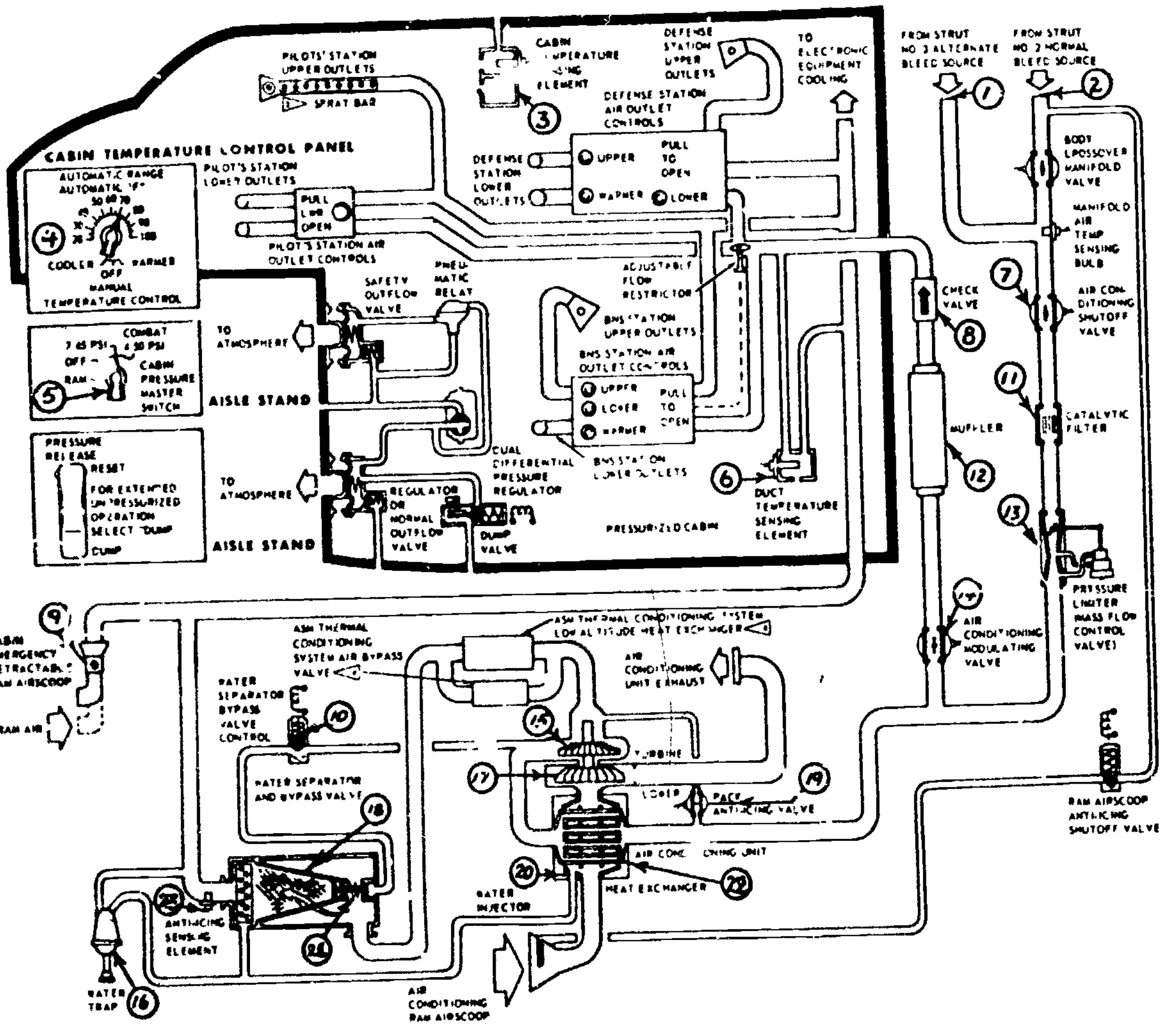
	Column A		Column B
_____1.	Sprays moisture over the heat exchanger coils and provides additional cooling of the engine bleed air.	a.	Turbine wheel
_____2.	Cools the engine bleed air by rapid expansion and converting heat energy to mechanical energy.	b.	Fan Impeller
_____3.	Permits the removal of the separated water without the loss of air.	c.	Water Separator
_____4.	Removes moisture from the pack air output and thus reduces fogging or snowing in the cabin.	d.	Condenser Screen
_____5.	Provides a load for the turbine to prevent overspeeding and circulates ram air through the heat exchanger.	e.	Louvered Grid
_____6.	Permits air pressure to flow from a port on top of the air conditioning pack to the control chamber of the water separator bypass valve.	f.	Water Separator Bypass Valve
_____7.	Condenses the water vapor into water droplets.	g.	Water Separator Bypass Valve Control
_____8.	Opens above 36,000 feet to allow cooled air to bypass the condenser screen.	h.	Water Injector
_____9.	Opens to bypass the condenser screen when the screen becomes plugged or frozen.	i.	Water Trap

1600

Answers to Frame 13: 1. h 2. a 3. i 4. c 5. b 6. g 7. d
8. [illegible] 9. f

Frame 14

Match each purpose given below with a component in the sketch and write the number from the sketch in the appropriate space near each purpose.



_____ 1. Sprays moisture over the heat exchanger coils and provides additional cooling of the engine bleed air.

_____ 2. Cools the engine bleed air by rapid expansion and converting heat energy to mechanical energy.

_____ 3. Permits the removal of the separated water without the loss of air.

_____4. Removes moisture from the pack air output and, thus, reduces fogging or snowing in the control cabin.

_____5. Provides a load for the turbine to prevent overspeeding and circulates ram air through the heat exchanger.

_____6. When energized open, permits air pressure to flow from a port on top of the air conditioning pack to the control chamber of the water separator bypass valve.

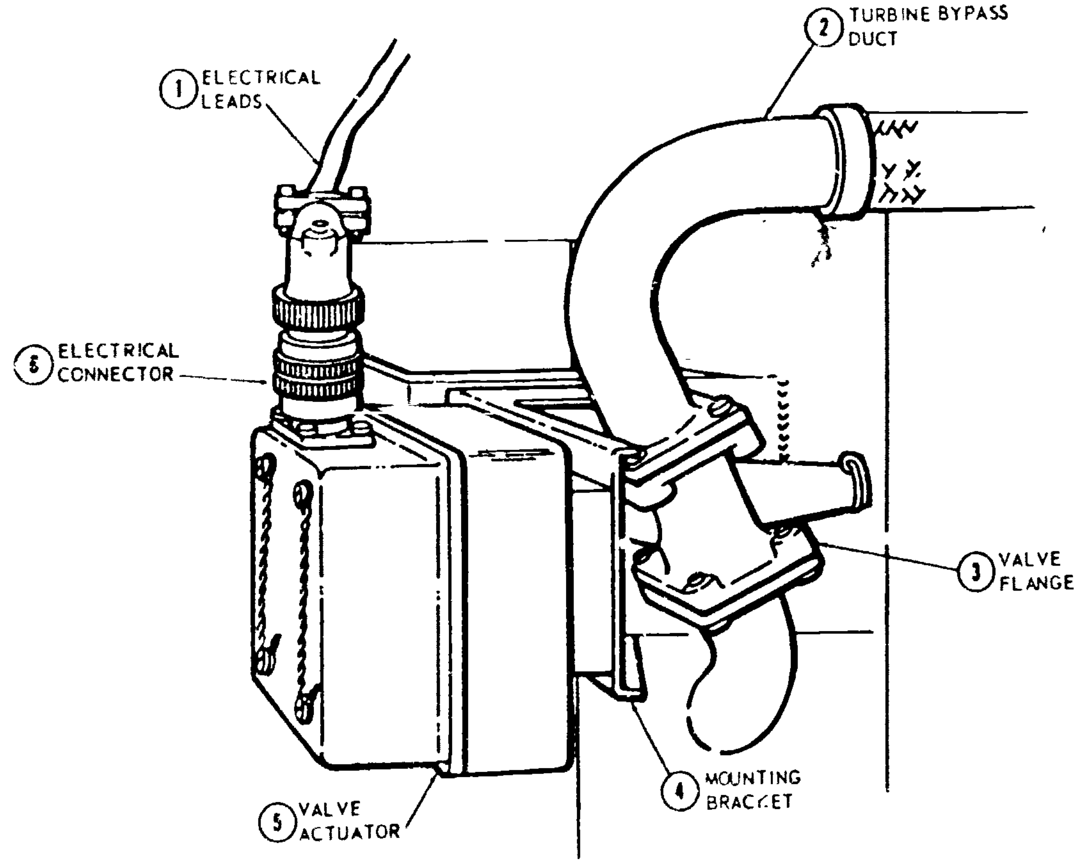
_____7. Will open when the condenser screen becomes plugged or frozen or at altitudes above 36,000 feet.

1602

Answers to Frame 14: 1. 20 2. 15 3. 16 4. 18 5. 17 6. 10 7. 21

Frame 15

The pack anti-icing valve, as shown in the sketch, is mounted on the air conditioning pack. The purpose of this valve is to keep pack output temperatures from dropping below the freezing point. This valve is controlled by the pack anti-icing sensing element and the pack temperature controller. When the valve is opened, warm air will flow into the turbine discharge. Above 36,000 feet, the valve is closed by actuation of the aneroid pressure switch. The valve is powered by a 118 volt AC motor.



Pack Anti-Icing Valve

Place the letter T beside each of the following statements that are true.

_____1. By keeping the pack output temperatures above the freezing point, the anti-icing valve will keep the water separator from freezing.

_____2. The pack anti-icing valve is controlled by the pack anti-icing sensing element and the pack temperature controller.

_____3. The pack anti-icing valve will control the flow of warm air.

_____4. Above 25,000 feet, the pack anti-icing valve is closed by the aneroid pressure switch.

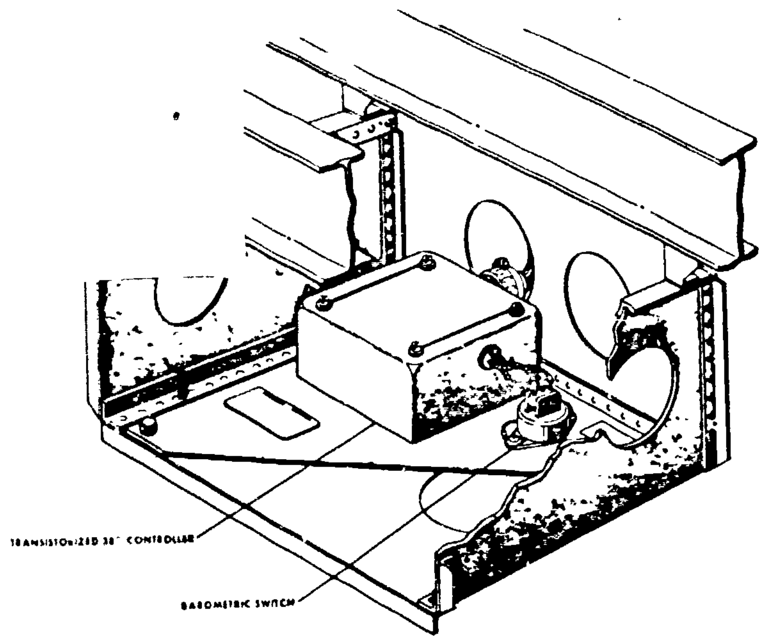
_____5. The pack anti-icing valve is closed above 36,000 feet by an aneroid pressure switch because there is very little moisture in the air.

1604

Answers to Frame 15: 1. T 2. T 3. T 4. F 5. T

Frame 16

The air conditioning pack temperature (38°F) controller regulates the action of the pack anti-ice valve. This unit opens the valve when the pack discharge air drops below 3°C (38°F).



AIR CONDITIONING PACK 38° CONTROLLER

Place the letter T beside each of the following statements that are true.

_____1. The 38°F controller will open the pack anti-ice valve to let warm air enter the turbine discharge if the pack output temperature is 36°F.

_____2. If the pack output temperature was at 40°F, the pack temperature controller would close the pack anti-ice valve.

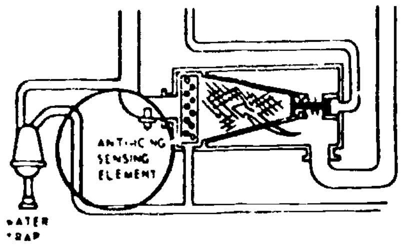
_____3. By regulating the action of the pack anti-ice valve, the 38°F controller controls the pack output temperature and tends to keep it at 38°F.

_____4. The pilot must select the temperature he would like to have maintained in the turbine discharge duct. Once selected, the 38°F controller positions the pack anti-ice valve to maintain that temperature.

Answers to Frame 16: 1. T 2. T 3. T 4. F

Frame 17

The pack anti-icing sensing element is located in the cold air outlet duct of the water separator. The anti-icing sensing element has a negative coefficient of resistance. It is connected to the pack temperature (38°F) controller. The sensing element is used with the 38°F controller to regulate the opening and closing of the pack anti-icing valve. Place the letter T beside each of the following statements that are true.



_____1. If the temperature around the sensing element increased, the resistance of the sensing element would decrease.

_____2. If the temperature around the sensing element dropped to 36°F the resistance of the sensing element would increase and the 38°F controller would open the pack anti-icing valve.

_____3. Increasing the air temperature in the water separator outlet to 40°F would decrease the resistance of the sensor and cause the 38°F controller to open the pack anti-icing valve.

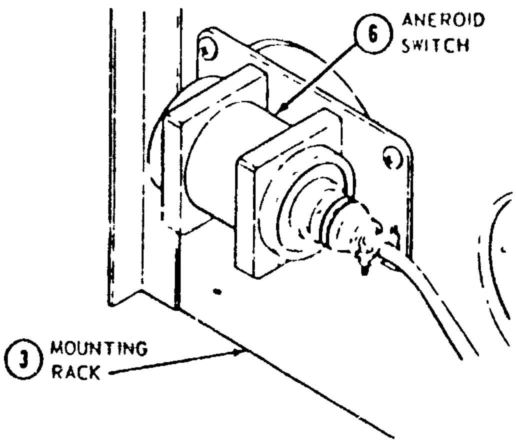
_____4. By sensing the temperature of the air in the water separator outlet, the anti-icing sensing element keeps the water separator from freezing.

1606

Answers to Frame 17: 1. T 2. T 3. F 4. T

Fr 8

The aneroid pressure switch is normally closed. It moves to the open position at 36,000 (±2,000) feet pressure altitude. When the altitude pressure switch opens, it energizes the water separator bypass valve control and closes the pack anti-icing valve.



Place the letter T beside each of the following statements that are true.

_____1. The aneroid pressure switch opens, it energizes the water separator bypass valve control at 36,000 feet and closes the pack anti-ice valve.

_____2. Since there is very little moisture in the air at altitudes above 36,000 feet and the water separator is being bypassed, the aneroid pressure switch closes the pack anti-icing valve.

_____3. The aneroid pressure switch moves to the open position by the atmospheric pressure at 36,000 feet.

Answers to Frame 18: 1. T 2. T 3. T

Frame 19

Review Quiz

Place the letter of the unit in column B alongside the purpose that corresponds to it in column A.

Column A	Column B
____1. Has a negative coefficient of resistance.	a. Pack Anti-icing Valve
____2. Keeps the pack output temperature above the freezing point.	b. Air Conditioning Pack 38° Controller
____3. Actuates to the open position at 36,000 feet pressure altitude.	c. Anti-icing Sensing Element
____4. Controls the action of the pack anti-ice valve.	d. Aneroid Pressure Switch
____5. When open, admits relatively warm air into the turbine discharge.	
____6. Closes the pack anti-ice valve above 36,000 feet.	
____7. Energizes the water separator bypass valve control above 36,000 feet.	
____8. Opens the pack anti-ice valve when pack output temperature falls below 38°F.	
____9. Works in conjunction with temperature controller to regulate the action of the pack anti-ice valve.	

1608

Answers to Frame 19: 1. c 2. a 3. d 4. b 5. a 6. d 7. d 8. b 9. c

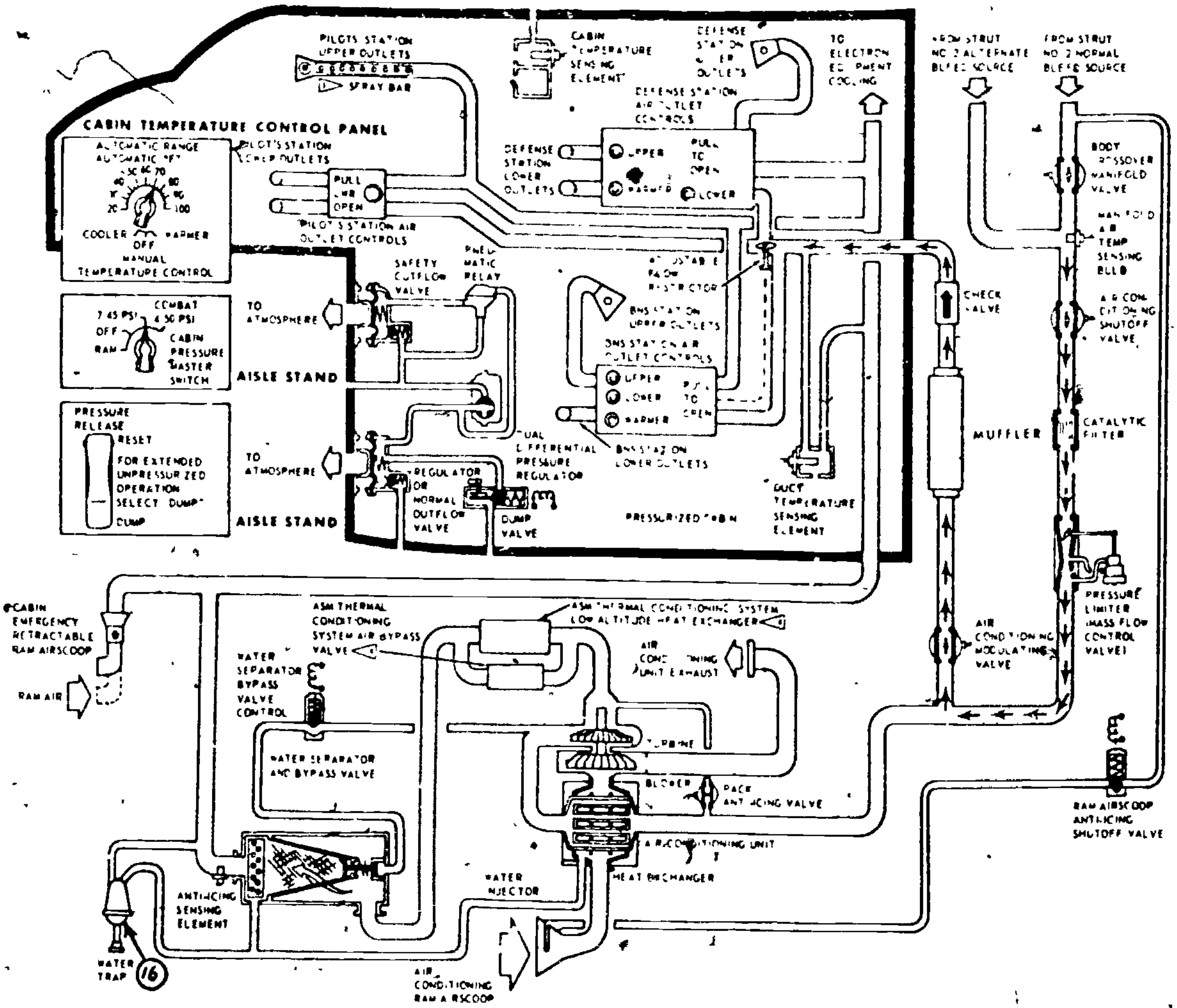
Frame 20

Three parts make up the 38°F control system. These parts are the pack anti-icing valve, air conditioning pack temperature controller, and the air conditioning pack anti-icing sensing element.

Place a circle around the number of the component parts that are included in the pack anti-icing system.

1. Pack pressure limiter.
2. Aneroid pressure switch.
3. Water separator bypass valve.
4. Pack anti-icing valve.
5. Water trap.
6. Anti-icing sensing element.
7. Catalytic filter.
8. Air conditioning system shutoff valve.
9. Turbine.
10. Blower.
11. Heat exchanger.
12. 38°F temperature controller.
13. Water separator.

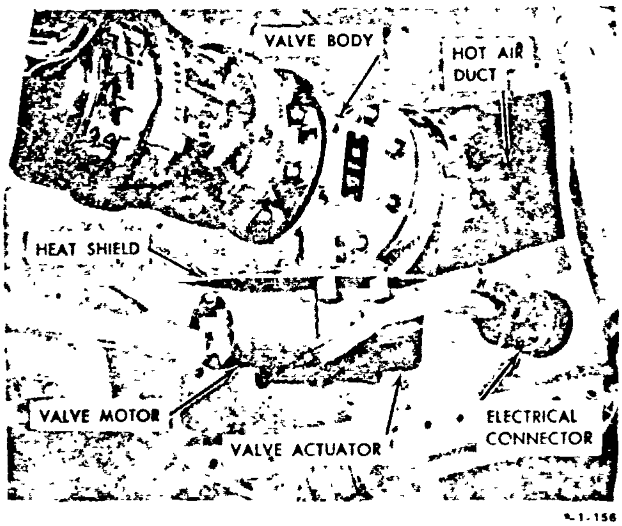
Now let us follow the path of airflow shown by the arrows in the schematic below. This path will deliver hot air to the cabin area. We shall discuss each of the units individually in the next few frames.



No Response Required

1610

The air conditioning modulating valve controls the temperature of the crew compartment by varying the amount of the hot air entering the cabin. Opening the valve increases the flow of hot air to the cabin, while closing the valve decreases the amount of hot air going to the cabin. This valve can be controlled automatically by the cabin temperature regulator or manually by the cabin temperature control switch.



Air Conditioning System
Modulating Valve

Place the letter T beside each of the following statements that are true.

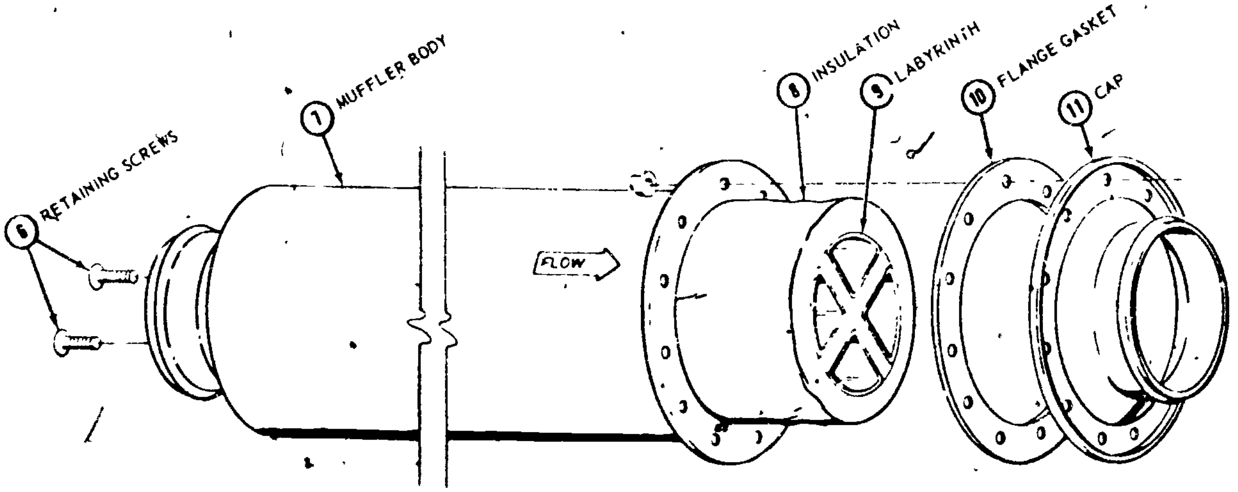
_____1. To increase the temperature of the crew compartment, the air conditioning modulating valve is opened.

_____2. To decrease the temperature of the crew compartment, the air conditioning modulating valve is closed.

_____3. By varying the position of the air conditioning modulating valve, the amount of hot air going to the cabin is varied.

_____4. The air conditioning modulating valve is controlled manually by the cabin temperature regulator and automatically by the cabin temperature control switch.

The hot air muffler is in the hot air line leading into the cabin. This muffler is used to absorb valve noise and to prevent noise transmission through the air conditioning ducts to the crew compartment.



Place the letter T beside each of the following statements that are true.

_____1. A malfunctioning muffler could cause the air coming in from the crew outlets to be very noisy.

_____2. The muffler is mounted in the hot air line leading to the heat exchanger.

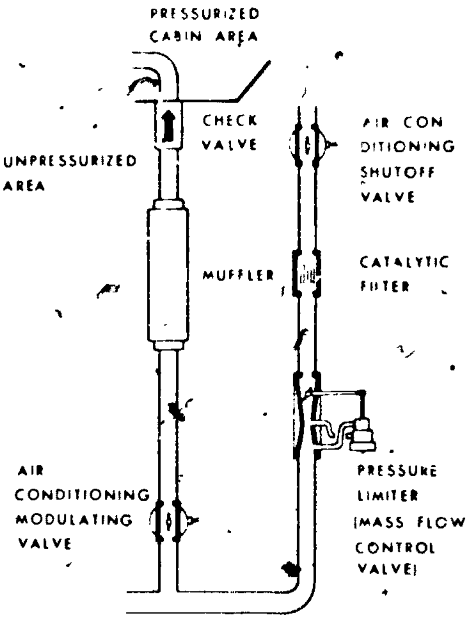
1612

Answers to Frame 23: 1. T 2. F

Frame 24

The check valve, shown in the schematic on the right, prevents the possibility of rapid cabin depressurization due to a failure of a duct or coupling outside the pressurized area of the airplane.

The check valve will allow air to flow only in one direction and the arrow on the valve indicates the direction of airflow.



R—49

Refer to the schematic shown, then read each of the statements below and place the letter T in the blank space beside each statement that is true.

______1. The check valve will allow airflow in one direction only.

______2. The check valve would prevent rapid cabin depressurization if one of the clamps on the muffler failed.

______3. The arrow on the check valve denotes the direction of outflow.

______4. The check valve would prevent rapid cabin depressurization if the duct between the catalytic filter and pressure limiter was defective.

387

Answers to Frame 24: 1. T 2. T 3. T 4. T

Frame 25

Place the letter of the unit in column B alongside the purpose that corresponds to it in column A.

Column A		Column B
______1.	This unit is used to absorb valve noise and prevent its transmission through ducts to the cabin area.	a. Air Conditioning System Modulating Valve
______2.	Controls the temperature of the crew compartment by varying the amount of hot air admitted to the cabin.	b. Hot Air Muffler
______3.	Prevents the possibility of rapid cabin depressurization due to failure of a duct or coupling outside the pressurized area of the aircraft.	c. Check Valve

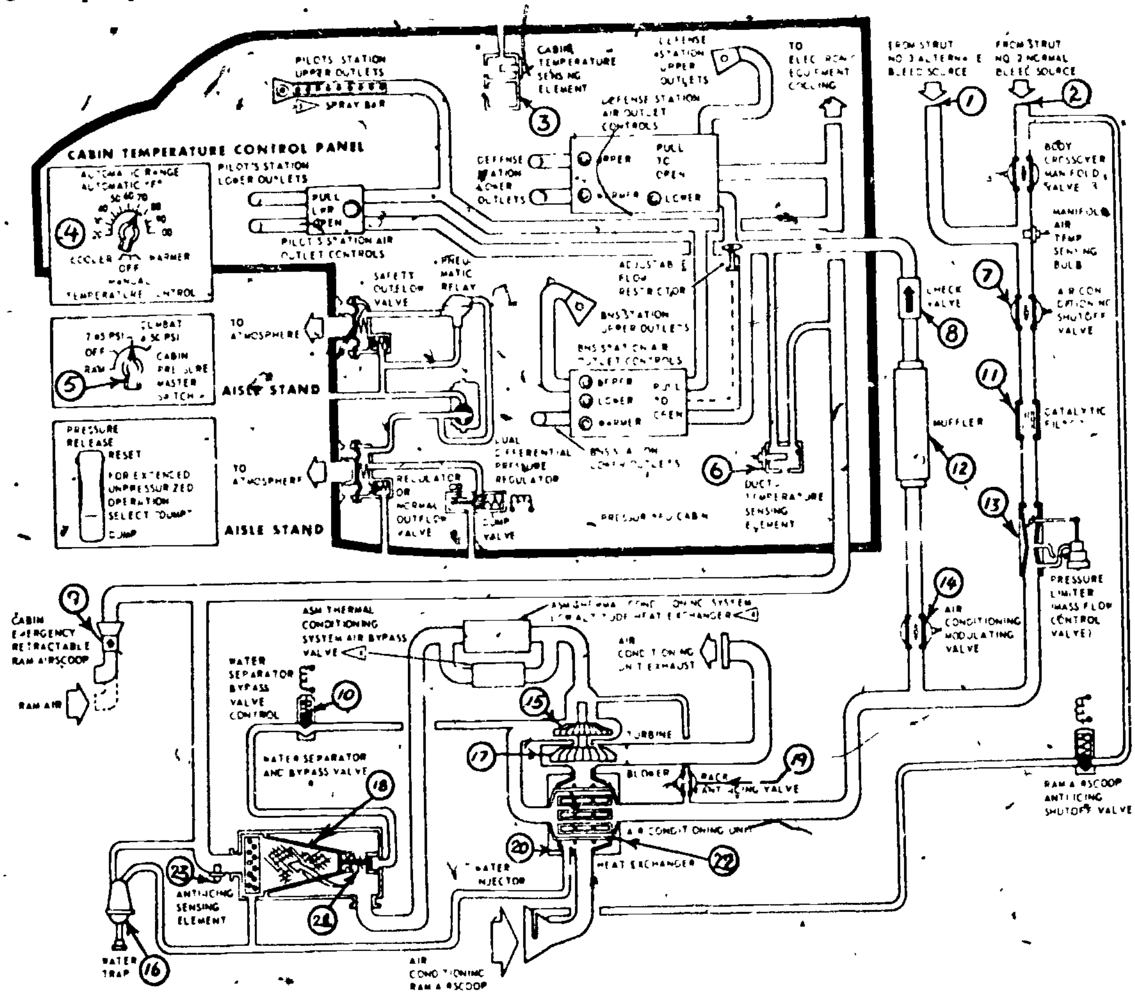
388

1614

Answers to Frame 25: 1. b 2. a 3. c

Frame 26

Match each purpose given below with a component in the sketch and write the number from the sketch in the appropriate space near each purpose.



_____ 1. Prevents turbine output temperature from dropping below freezing point, downstream from the turbine which could cause an ice build-up.

_____ 2. Regulates the action of the pack anti-icing valve in conjunction with the 38°F controller.

_____ 3. This unit is a variable resistance temperature sensing element with a negative coefficient of resistance.

_____ 4. Controls the temperature of the crew compartment by varying the amount of hot air admitted to the cabin.

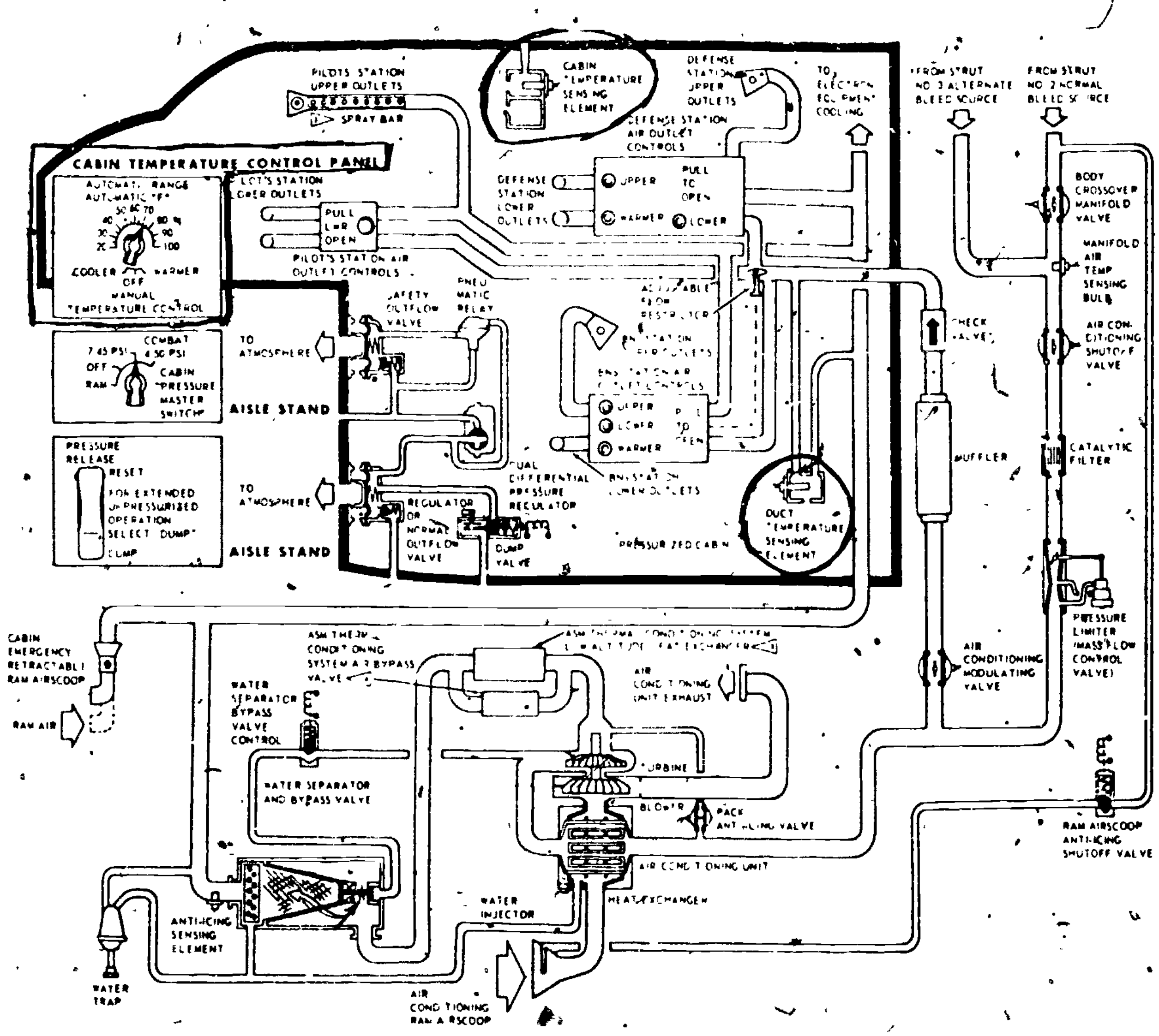
_____ 5. Absorbs valve noise and prevents noise transmission through the ducts to the cabin area.

_____ 6. Prevents the possibility of rapid cabin depressurization due to a failure of a duct or coupling outside the pressurized area of the aircraft.

Answers to Frame 26: 1. <u>19</u> 2. <u>23</u> 3. <u>23</u> 4. <u>14</u> 5. <u>12</u> 6. <u>8</u>

Frame 27

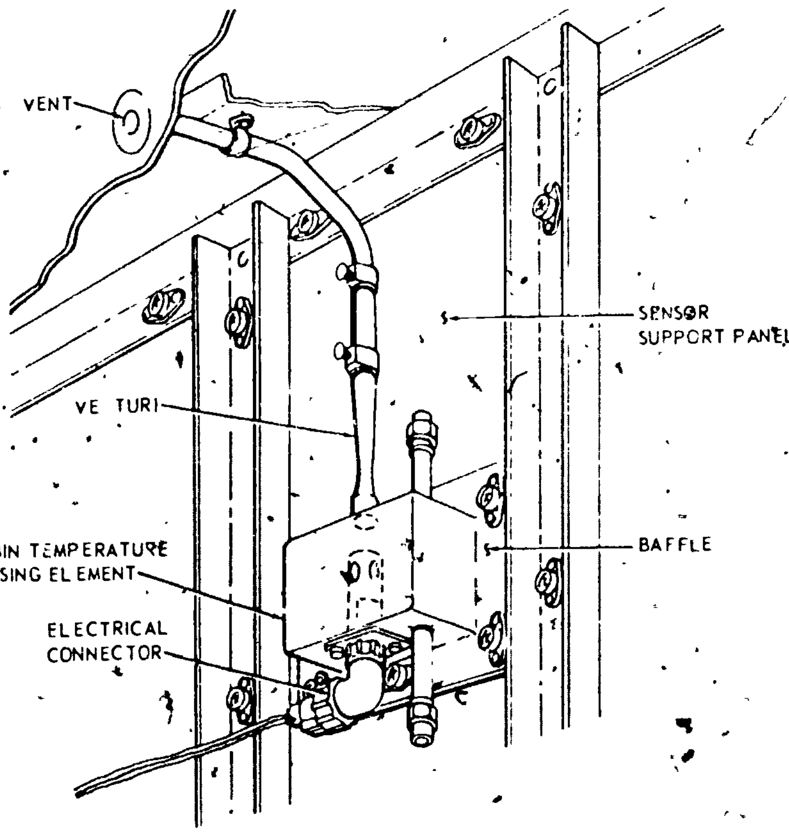
The next few frames will cover the units outlined by the circles in the schematic shown below. The cabin regulator (not shown) will also be discussed.



No Response Required

1676
Frame 28

The cabin temperature sensing element senses the temperature of the air in the cabin. Find the vent in the sketch. This vent is flush with the outside skin of the plane. The vent is used to draw cabin air over the cabin sensing element. The venturi restricts cabin airflow over the sensing element. This sensing element has a negative coefficient of resistance.



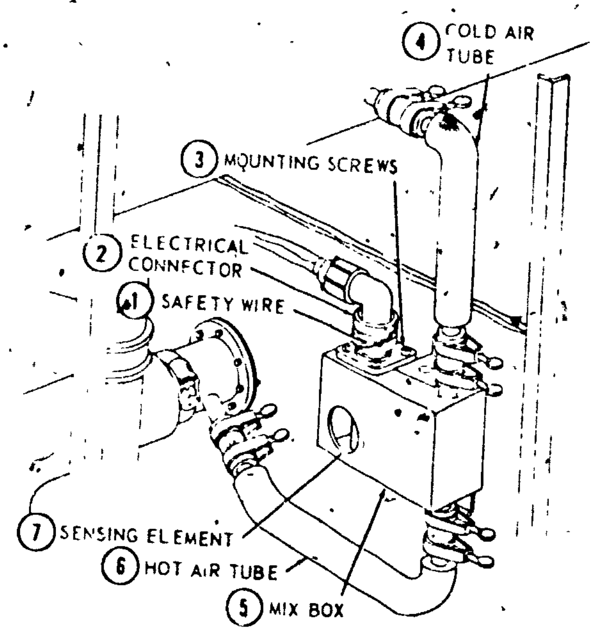
Place the letter T beside each of the following statements that are true.

_____1. An increase in temperature in the cabin will cause the resistance of the sensor to decrease.

_____2. An increase in cabin temperature will cause the resistance of the sensor to increase.

_____3. The cabin sensor installation is vented to the atmosphere to make sure there is an airflow over the sensing element.

The duct temperature sensing element senses the temperature in the two main ducts which are downstream of the muffler and the water separator. It provides signals to the electronic cabin temperature regulator for the control of the air conditioning system modulating valve. The element contains two sensors one with a rapid response, the other with a slow response. These sensors have a positive temperature resistance coefficient.



Place the letter T beside each of the following statements that are true.

_____ 1. Increasing the amount of hot air entering the mix box will increase the resistance of the sensing element.

_____ 2. The term positive temperature-resistance coefficient means that as the temperature surrounding the duct temperature sensing element increases, the resistance of the sensors will increase.

_____ 3. Two sensors can be found in the duct temperature sensing element; one with a fast response and one with a slow response.

_____ 4. The cabin temperature regulator receives signals from the duct temperature sensing element and varies the position of the air conditioning modulating valve.

_____ 5. Airflow from the two main ducts, which are downstream of the muffler and water separator, flows across the duct temperature sensing element.

1618

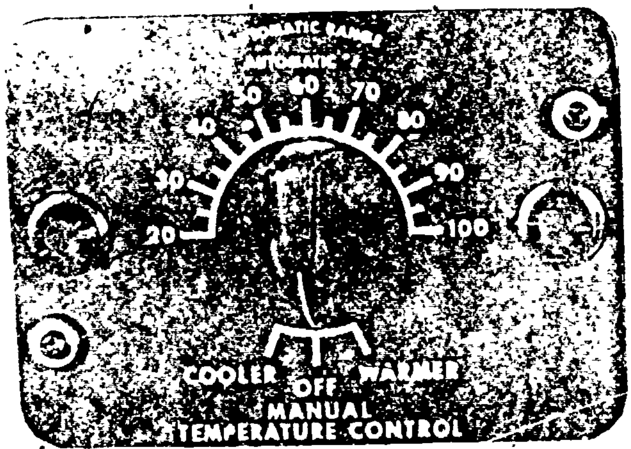
Answers to Frame 29: 1. T 2. T 3. T 4. T 5. T

Frame 30

The temperature control selector is used to vary the temperature of the cabin air inflow. The selector has two ranges, automatic and manual.

When in automatic, the electronic regulator controls the temperature automatically with this selector setting. In this automatic position the temperature control selector becomes part of the temperature regulator bridge circuit.

Should the regulator malfunction, an override can be accomplished by turning the selector to manual range and holding it in the cooler or warmer position until the incoming air is at the desired temperature.



TEMPERATURE CONTROL SELECTOR

Read each statement below, refer to the illustration and then place the letter T beside each of the statements that are true.

_____1. If the temperature selector was in the 70° position, the cabin temperature regulator would control the temperature and the selector would be in the automatic range.

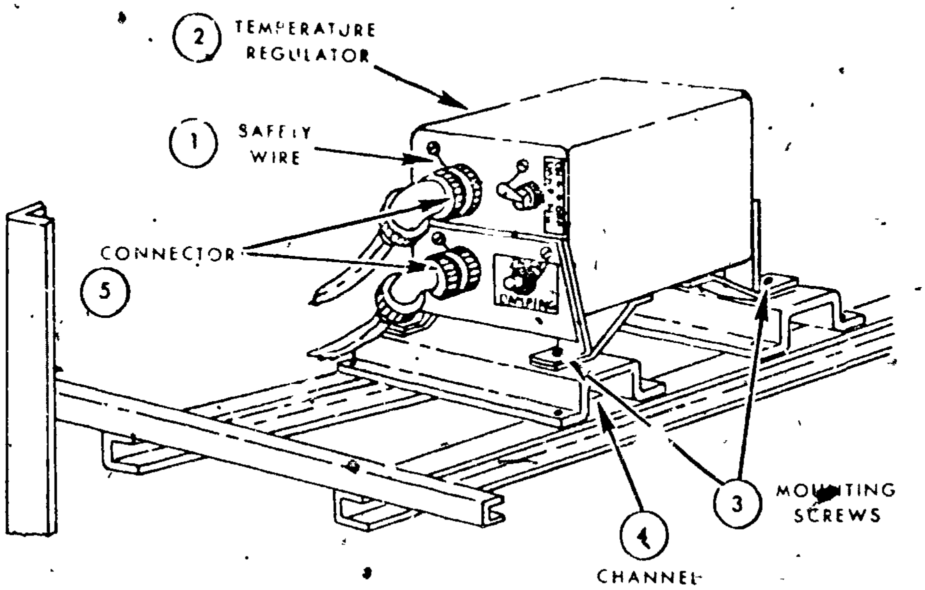
_____2. The "cooler" and "warmer" positions on the selector are the manual positions and are used if any portion of the automatic system fails.

_____3. While the temperature selector is in the automatic range, it becomes part of the temperature regulator bridge circuit and rotating it will unbalance the bridge circuit.

_____4. Changing the position of the temperature control selector in either the automatic or manual range will vary the temperature of the air entering the cabin.

_____5. The cabin temperature selector is used only during automatic operation of the temperature control system.

The cabin temperature regulator (2) is an electronic control. Its function is to automatically keep the cabin temperature at the value selected. Circuit damping adjustments are accessible on the front cover of the regulator. The regulator is supplied with 24V DC to 28V DC and 118 volt, single phase, 400 Hz power.



Place the letter T beside each of the following statements that are true.

_____1. The cabin temperature regulator requires two sources of power, 28V AC and 118V single phase 60 cps AC for operation.

_____2. The cabin temperature regulator will ma[...] the cabin temperature at the valve selected by var[...] the position of the air conditioning modulating valve.

_____3. Dampening adjustments can be found on the front cover of the regulator.

1620

Answers to Frame 31: 1. F 2. T 3. T

Frame 32

The cabin temperature sensor, duct temperature sensor, temperature control selector, temperature regulator, and the air conditioning modulating valve are the component parts of the automatic cabin temperature control circuit. This automatic temperature control circuit is designed to maintain the cabin temperature at the value selected by the pilot.

Circle the number of the component parts that make up the cabin temperature control system from the following list.

1. Anti-ice sensor
2. 38°F temperature controller
3. Duct temperature sensor
4. Cabin temperature regulator
5. Pack anti-ice valve
6. Air conditioning modulating valve
7. Temperature control selector

Answers to Frame 37: 4, 5, 7, 8

Review Quiz

Place the letter of the unit in column B alongside the purpose that corresponds to it in column A.

	Column A		Column B
____1.	Automatically maintains the cabin temperature at the value selected.	a.	Cabin Temperature Sensing Element
____2.	Senses the temperature of the air in the cabin.	b.	Venturi
____3.	Used to select the temperature of the cabin air.	c.	Duct Temperature Sensing Element
____4.	Senses the temperature in the two main ducts which are down stream of the muffler and water separator.	d.	Temperature Control Selector
____5.	Installed in cabin sensor vent line to restrict the airflow to the atmosphere.	e.	Cabin Temperature Regulator
____6	Has a negative coefficient of resistance.		
____7.	Has two resistors in the same housing.		
____8.	Has a high positive coefficient of resistance.		
____9.	Has two ranges, automatic and manual.		
____10.	Can be turned to manual to override the temperature regulator if a malfunction appeared in the automatic control.		

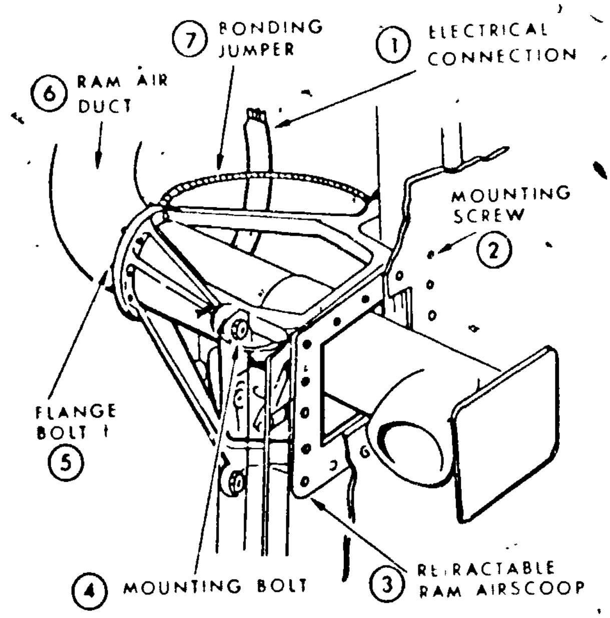
1622

Answers to Frame 33: 1. e 2. a 3. d 4. c 5. b 6. a
7. c 8. c 9. d 10. d

Frame 34

The air conditioning emergency retractable ram air scoop is used to provide an emergency source of ram air for cooling and ventilation of the crew compartment and for cooling the electronic equipment. The scoop is used only in case of emergency.

When the scoop is in the closed position, it is flush with the aircraft skin. A flapper type check valve within the scoop prevents airflow from the cabin through the scoop when the cabin is in the normally pressurized condition.



Place the letter T beside each of the following statements that are true.

_____1. When the scoop is closed, it is in the retracted position and flush with the aircraft skin.

_____2. The flapper type check valve within the scoop prevents a loss of airflow from the cabin when the cabin is pressurized and the scoop is retracted.

_____3. The scoop is opened when it is extended.

_____4. The cabin area can be cooled and ventilated during an emergency by the ram air obtained from the ram air scoop.

_____5. The electronic equipment located in the crew compartment can be cooled during an emergency by the ram air obtained from the ram air scoop.

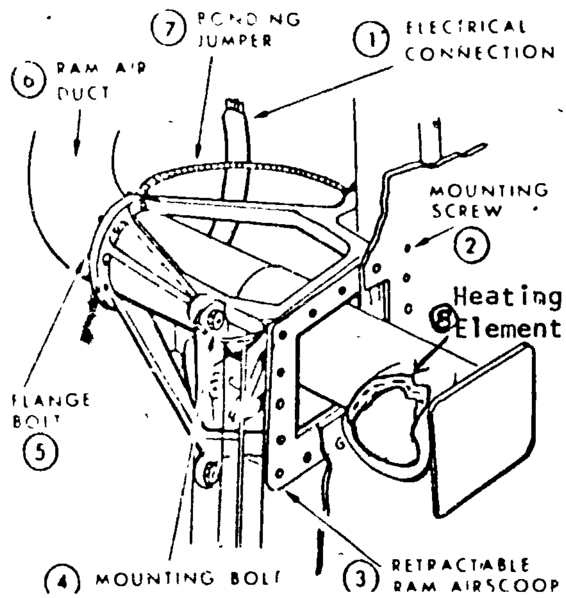
1623

Answers to Frame 34: 1. T 2. T 3. T 4. T 5. T

Frame 35

The air conditioning system emergency retractable ram air scoop motor is equipped with a time delay circuit. This circuit cycles the scoop to be extended for one minute and to be retracted for 12 to 15 seconds. This cycling is used for de-icing the scoop any time that the scoop anti-icing circuit is energized.

There is a heating element around the inlet scoop, which keeps the ice from freezing to the scoop and the retraction of the scoop scrapes the ice off.



Place the letter T beside each of the following statements that are true.

_____ 1. The timer motor causes ice, loosened by the anti-icing air scoop heating elements, to be scraped free from the air scoop.

_____ 2. The timer motor is energized only when the air scoop anti-icing circuit is energized.

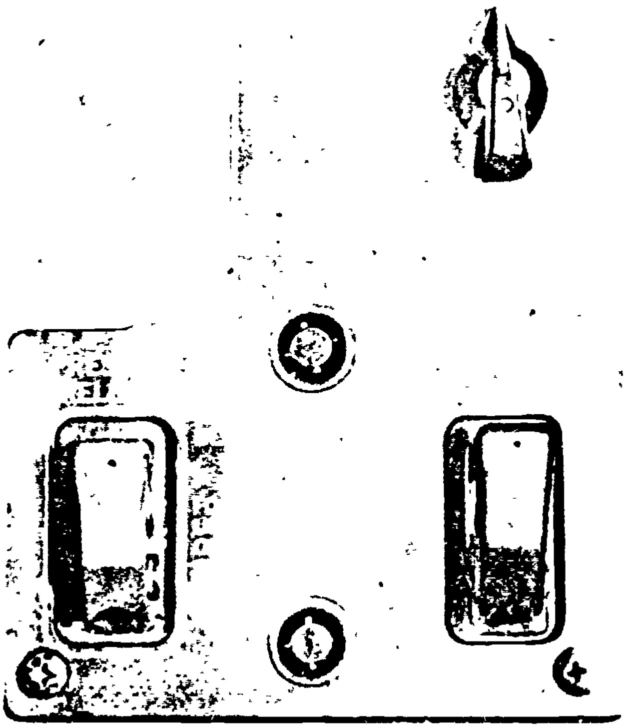
_____ 3. The timer motor will cause the air scoop to extend for one minute and retract for 12-15 seconds when it is energized by the air scoop anti-icing circuit.

1624

Answers to Frame 35: 1. T 2. T 3. T

Frame 36

The cabin pressure master switch has four positions. In the "Ram" position the ram air scoop is extended and the air conditioning system shutoff valve is closed, stopping all the bleed air flowing to the air conditioning system. In the "OFF" position the ram air scoop is retracted and the air conditioning shutoff valve is closed. In the "7.45 psi" position, the cabin air conditioning system shutoff valve is open allowing bleed air to flow into the air conditioning system and receive normal pressurization. When the switch is placed to the "4.50 psi" or "Combat" position the cabin air conditioning system shutoff valve is open. The cabin pressurization then drops to a lower setting in case of a rapid depressurization during combat.



Place the letter of the switch positions in column B alongside the correct purpose for that switch position in column A.

Column A	Column B
_____1. Retracts the ram air scoop and closes the air conditioning system shutoff valve.	a. Ram
	b. Off
_____2. Extends the ram air scoop and closes the air conditioning system shutoff valve.	c. 7.45 psi or Combat 4.50
_____3. Retracts the ram air scoop and opens the air conditioning system shutoff valve.	

Answers to Frame 36: 1. b 2. a 3. c

Frame 37

Place the letter of the unit or cabin pressure master switch position from column B in the blank space alongside the purpose that corresponds to it in column A.

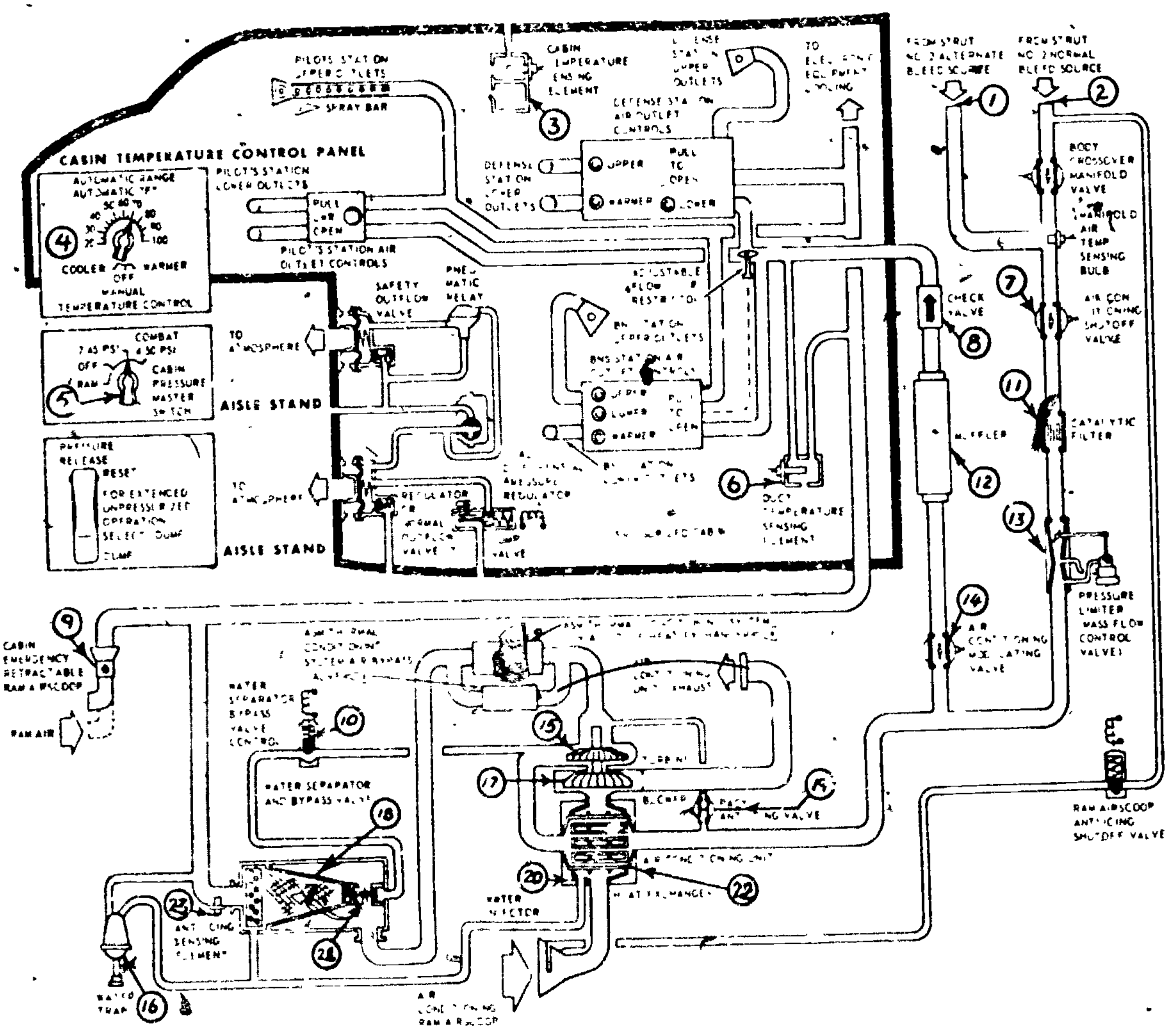
Column A		Column B
____1. Extends the ram air scoop and closes the air conditioning systems shutoff valve.	a.	Retractable Ram Air Scoop
____2. Causes the ram air scoop to retract and extend when the anti-icing circuit is turned on.	b.	Retractable Ram Air Scoop Flapper Valve
____3. Retracts the ram air scoop and closes the air conditioning system shutoff valve.	c.	Retractable Ram Air Scoop Timer Motor
____4. Provides an emergency source of ram air for cooling and ventilation of the crew compartment and for cooling electronic equipment located in the crew compartment.	d.	Ram Position
____5. Prevents airflow from the cabin through the scoop when the aircraft is pressurized and the scoop is retracted.	e.	Off Position
____6. Retracts the ram air scoop and opens the air conditioning system shutoff valve.	f.	7.45 psi or Combat 4.50 psi Position

1626

Answers to Frame 37: 1. d 2. c 3. e 4. a 5. b 6. f

Frame 38

Match each purpose given below with a component in the sketch and write the number from the sketch in the appropriate space near each purpose.



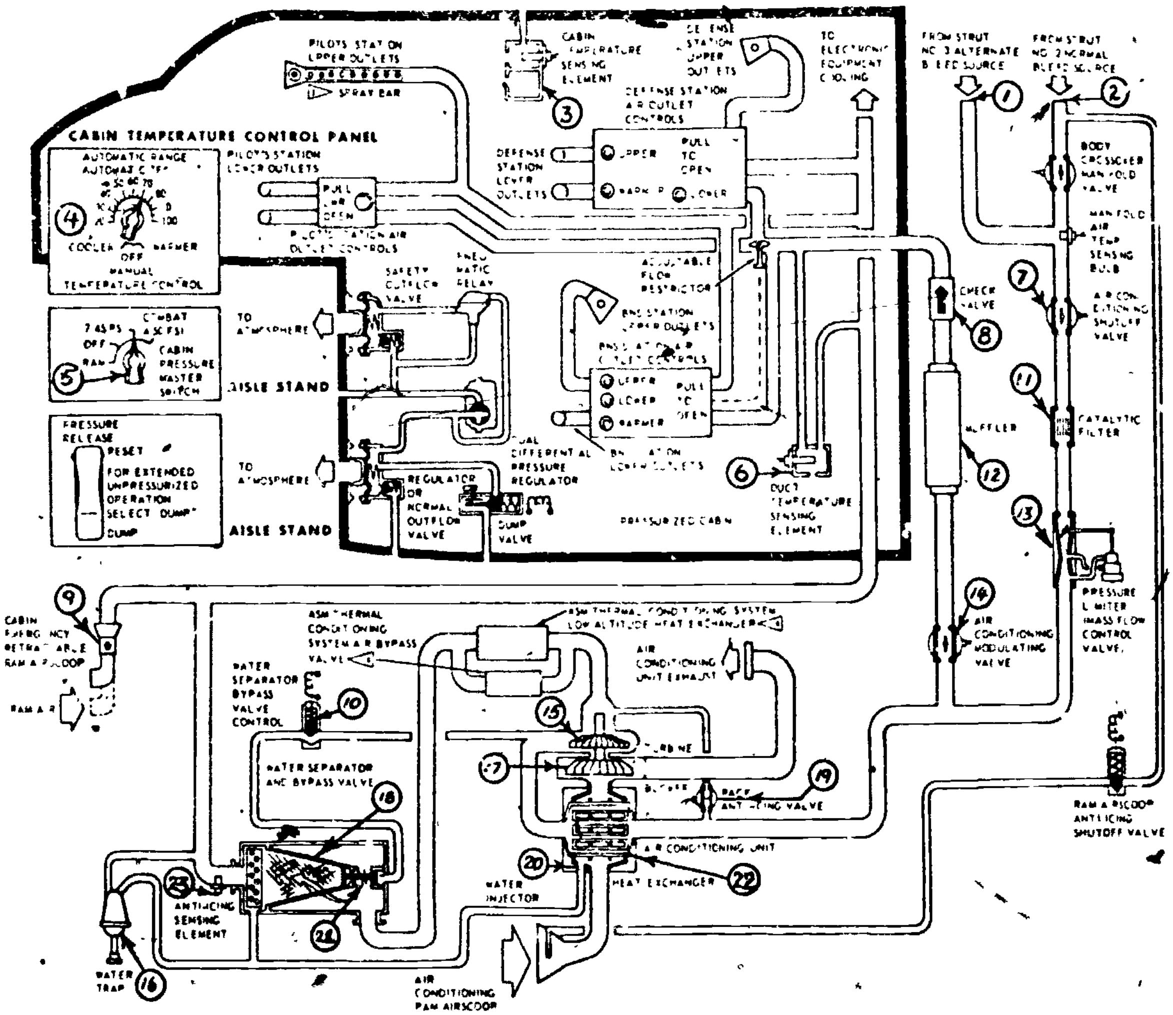
_____1. Senses the temperature of the air in the cabin.

_____2. Senses the temperature of the air in the two main ducts which are downstream of the muffler and water separator.

_____3. Used to vary the temperature of the cabin air inflow.

_____4. Provides an emergency source of ram air for cooling and ventilation of the crew compartment and for cooling electronic equipment found in the crew compartment.

Match each purpose given below with a component in the sketch. Write the number from the sketch in the appropriate space near each purpose.



_____ 1. The ram position at this switch extends the ram air scoop and closes the air conditioning system shutoff valve.

_____ 2. In the 7.45 position or the 4.50 psi position this switch will retract the ram air scoop and open the air conditioning system shutoff valve.

_____ 3. This sensing element has a negative coefficient of resistance.

_____ 4. This sensing element has a positive coefficient of resistance.

_____ 5. Has a manual override in case the automatic system fails.

1628

Answers to Frame 39: 1. 5 2. 5 3. 3 4. 6 5. 4

Frame 40

Select the group of component parts that make up the 38°F control system.

Group A	Group B	Group C
Pack Anti-Ice Sensor	Cabin Sensor	Pack Anti-Ice Sensor
Pack Anti-Icing Valve	Duct Sensor	Cabin Sensor
Pack 38°F Temperature Controller	Modulating Valve	Pack Anti-Icing Valve
	38°F Temperature Controller	Cabin Temperature Controller

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Answer to Frame 40: Group A

Frame 41

Select the group of component parts that make up the cabin temperature control system.

Group A	Group B	Group C
Pack Anti-Ice Sensor	Cabin Sensing Element	Pack Anti-Ice Sensor
Pack Anti-Icing Valve	Duct Sensing Element	Duct Sensing Element
38°F Temperature Controller	Modulating Valve	Modulating Valve
	Cabin Temperature Controller	Temperature Control
	Temperature Control	38°F Temperature Controller

1630

Answer to Frame 41: Group B

Frame 42

Match each purpose given below with a component in the figure on the following page and write the number from the figure in the appropriate space near each purpose.

_____1. The normal source of engine bleed air.

_____2. The emergency source of engine bleed air.

_____3. Regulates the system airflow to approximately 140 lbs per minute.

_____4. Used to open and close the air supply line going to the cabin air conditioning system.

_____5. Cools the engine bleed air by transferring heat energy from the bleed air to the ram air.

_____6. Removes any contamination, such as solid particles and obnoxious gases, from the air.

_____7. Prevents the possibility of rapid depressurization due to a failure of a duct or coupling outside the pressurized area.

_____8. Controls the temperature of the crew compartment by varying the amount of hot air admitted to the cabin.

_____9. Absorbs valve noise and prevents noise transmission through the ducts to the cabin area.

_____10. Admits warm air to the turbine outlet to prevent the pack output temperature from dropping below the freezing point.

_____11. Cools the engine bleed air by rapid expansion and converting heat energy to mechanical energy.

_____12. Sprays moisture over the heat exchanger coils and provides additional cooling of the engine bleed air.

_____13. Provides a load for the turbine to prevent overspeeding and circulates ram air through the heat exchanger.

_____14. When energized by the aneroid pressure switch, permits air pressure to flow from a port on top of the air conditioning pack to the control chamber of the water separator bypass valve.

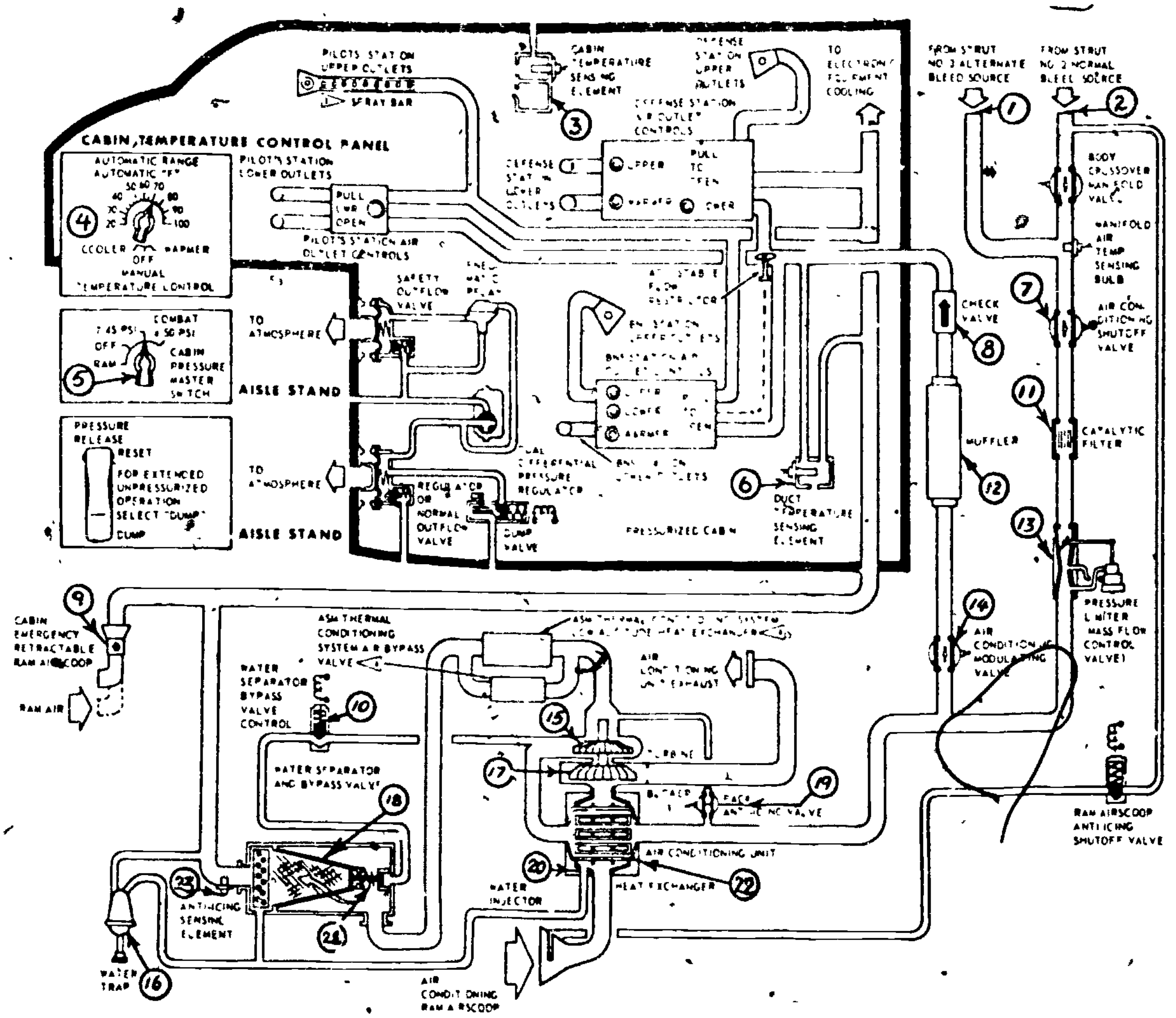
_____15. Removes moisture from the pack air output and, thus, reduces fogging and snowing in the control cabin.

_____16. Provides an emergency source of ram air for cooling and ventilation of the crew compartment.

_____17. Permits the removal of the separated water without the loss of air.

_____18. Will open when the condenser screen of the water separator becomes clogged or frozen over with ice or at altitudes above 36,000 feet.

Illustration for Frame 42



1632

Answers to Frame 42:

1. 2
2. 1
3. 13
4. 7
5. 22
6. 11
7. 8
8. 14
9. 12
10. 19
11. 15
12. 20
13. 17
14. 10
15. 18
16. 9
17. 16
18. 21

1633

WORKBOOK

3ABR42331-WB-206

Technical Training

Aircraft Environmental Systems Mechanic

BOMBER AIR CONDITIONING SYSTEM WIRING DIAGRAM

1 July 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

1634

Environmental/Pneudraulics Branch 3ABR42331-WB-206
Chanute AFB, Illinois

BOMBER AIR CONDITIONING SYSTEM WIRING DIAGRAM

OBJECTIVE

Using a wiring diagram, identify eight (8) causes for the ten(10) given air conditioning system troubles.

EQUIPMENT

	Basis of Issue
Tape and Tape Player	1/student
Colored Pencil Set	1/student

INSTRUCTIONS

This is an adjunct workbook to be used in conjunction with a taped lesson.

Information on the purpose and operation of the bomber air conditioning system components and the procedures for you to follow when using this workbook are given by tape recorded instructions. As you listen to the recording you will be given information on the air conditioning system operation and directions to follow for tracing and analyzing electrical circuits. Listen to the recording until the speaker tells you to turn it off. The speaker will tell you when to trace a circuit or to answer the questions given in this workbook.

Your instructor will show you how to install the tape and how to operate the tape recorder. Pay close attention to all instructions that are given to you on the tape. When tracing circuits or answering questions in this workbook, if your response is incorrect, restudy the information or reverse the tape and listen to the instructions again. There are five exercises in this workbook. Each has to do with a different circuit. Unfold and refer to figure 1 located in the back of this workbook. The circuits you are to trace are listed in the lower left corner of figure 1. The color code you are to use for tracing each circuit is shown in the block before each circuit. Follow instructions carefully and if you miss a point reverse the tape and listen to the directions again. The wiring diagram used in this project is the same one you will use for trouble-shooting this system on the trainer. If you don't understand the circuit <u>after tracing</u>, check with the instructor.

NOTE: In this diagram we are tracing current from the circuit breakers to the component's ground. This is not the way current flows, but it is the easiest because of so many ground points in the diagram. Actually this is the opposite of electron flow. REMEMBER this note when using any wiring diagram.

TURN ON THE RECORDER AND FOLLOW THE INSTRUCTIONS OF THE SPEAKER.

Supersedes 3ABR42231-WB-205, 5 May 1975.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 600; TTVSR - 1

409

EXERCISE 1

Fill in the blanks to complete the following statements.

1. The bomber air conditioning and pressurization electrical systems utilize both __________ and __________ current.

2. The cabin pressure master switch has __________ sections and __________ positions.

3. The four positions of the cabin pressure master switch are __________, __________, __________ and __________.

4. Current from a circuit breaker marked TR BUS is __________ current.

5. When one contact lever of the cabin pressure master switch is moved to a certain position, they all move to the __________ __________ __________.

6. Struts 1 and 4 bleed valves require __________ (28VDC/118VAC) for operation.

7. The manifold valve switch has __________ contact levers.

8. Current for operating the cabin air conditioning system is controlled by the __________ __________ __________ switch.

9. Current used for operating the cabin air conditioning shutoff valve is __________ (28VDC/118VAC).

10. Current from the three circuit breakers marked 118/205 VAC, is a __________ __________ type of current.

For th orrect answers turn on e tape recorder and proceed with the lesson.

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EXERCISE 2

Fill in the blanks to complete the following statements:

1. The manifold valve switch is placed in the open position for __________ __________.

2. Struts 1 and 4 bleed valves are electrically controlled by a __________ and actuated by __________ __________.

3. The cabin pressure master switch is in the ______ (on/off) position when starting the aircraft engines.

4. Strut 2 is the __________ (normal/emergency) source and strut 3 is the __________ (normal/emergency) source of bleed air for the air conditioning and pressurization system.

5. For normal operation of the cabin air conditioning system, the manifold valve switch is in the __________ (open/close) position, the cabin pressure master switch in the __________ (RAM/OFF/7.45/4.50) position and the bleed selector switch in the __________ (normal/emergency) position.

6. If wire number H11B20V were open, the cabin air conditioning shutoff valve would not __________ (open/close) when the cabin pressure master switch is placed in an off or ram position.

7. The cabin air conditioning shutoff valve is actuated by a __________ __________ (118 VAC/28VAC) motor.

8. The body crossover manifold valve did not open for engine start or normal air conditioning; this could be caused by an open in wire number __________.

9. The air conditioning shutoff valve did not close when the cabin pressure masterswitch is placed to the off position; this could be caused by an open in wire number __________.

For the correct answers to these questions turn on the tape recorder and check your answers.

EXERCISE 3

Fill in the blanks to complete the following statements from Exercises 4 and 5.

1. With the bleed selector switch in emergency and all other switches in normal, the body crossover manifold valve will __________ and the strut number 3 bleed valve will __________.

2. Bleed air for emergency air conditioning and pressurization is taken from __________ __________ bleed valve.

3. An open in wire H8E20V would cause the strut number 3 bleed valve to remain in the __________ (open/close) position.

4. The retractable ram air scoop remained open after the cabin pressure master switch was placed to an air conditioning position; this could be caused by an open in wire __________.

5. If wire H47A20N were open the pressure dump control valve solenoids would remain __________ (energized/deenergized).

6. During operation of the air conditioning system in normal there is no airflow from the outlets; this could be caused by a defective __________ __________ __________ valve.

7. If the air conditioning system fails, __________ __________ is used to ventilate the cabin.

8. When the cabin pressure master switch is in the ram position, the __________ __________ __________ will energize to open the retractable ram air scoop.

9. The body crossover manifold valve controls the flow of engine bleed air from strut number __________.

10. The switch used to select normal and emergency operation is the __________ __________ switch.

For the answers to the preceeding questions turn on the recorder and check your answers.

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EXERCISE 4

Use figure 1 to answer the following questions. Mark only the statements that are true.

_____1. When the pressure release switch is put to the dump position the cabin pressure regulator changes pressurization to 4.50 psi.

_____2. In emergency the body crossover valve will close and the strut number 3 bleed valve will open.

_____3. If wire H14A20 leading from the cabin air conditioning controller circuit breaker were broken there would be no temperature control.

_____4. With the manifold valve switch open, all bleed air valves are open or will open with air pressure.

_____5. When the cabin pressure master switch is placed in "ram" the cabin pressure regulator receives power to dump pressure.

_____6. With the bleed selector switch in normal, the body crossover manifold valve is open and strut number 3 bleed valve is closed.

_____7. If the cabin air conditioning shutoff valve will close but will not open, a probable cause could be wire H11B20V being broken.

_____8. With the cabin pressure master switch in the "off" position, the cabin air condition shutoff valve will close.

_____9. In the 7.45 or 4.50 position the cabin pressure master switch will provide power to BOTH the temperature control relay and the temperature control panel.

_____10. If the manual cold wire were broken at pin G on connector P-712 there would still be automatic cold operation.

_____11. A short between pin D and pin C of the fast duct will call for hot air.

_____12. The strut number 1 and number 4 bleed valve circuit breaker also provides power for the body crossover manifold valve.

_____13. All the cabin pressure master switches, shown in figure 1, are mechanically linked.

_____14. The 4.50 position of the master switch is used to change cabin pressurization.

_____15. Above 36,000 feet the anti-ice valve is closed and the water separator bypass valve is open.

For the correct answers to these questions turn on the tape recorder.

EXERCISE 5

Use figure 2 to answer the following ten questions. Placed on the diagram are circled numbers indicating a system trouble. These are either open wires, indicated by an X, or a short, indicated by a line. For the problem given in the questions, select the answer that would cause the trouble. Draw a circle around your choice of a, b, c, or d.

1. With all control switches in their proper positions, engine bleed air is not available to the air conditioning package. Which trouble would cause this malfunction?

   a. 4
   b. 5
   c. 10
   d. 11

2. Temperature control is inoperative in auto and manual cold. Which trouble would cause this malfunction?

   a. 3
   b. 6
   c. 9
   d. 12

3. In automatic the cabin temperature goes full cold and remains. Which trouble could cause this malfunction?

   a. 1
   b. 7
   c. 8
   d. 10

4. Cannot dump cabin pressure by using master switch or pressure release switch. Which trouble could cause this malfunction?

   a. 2
   b. 5
   c. 6
   d. 8

5. In automatic the cabin temperature goes full hot and remains. Which trouble could cause this malfunction?

   a. 4
   b. 9
   c. 10
   d. 12

6. There is no power available to energize the temperature control relay when the master switch is in the 7.45 or 4.50 position. Which trouble could cause this malfunction?

   a. 1
   b. 3
   c. 8
   d. 11

7840

7. The ram air scoop will not open when the master switch is placed in the ram position. Which trouble could cause this malfunction?

   a. 2
   b. 4
   c. 6
   d 9

8. Cabin temperature control is inoperative in auto <u>and</u> manual selection. Which trouble could cause this malfunction?

   a. 3
   b. 5
   c. 7
   d. 11

9. In automatic the cabin temperature goes full cold and remains. Which trouble could cause this malfunction?

   a. 1
   b. 8
   c. 10
   d. 12

10. Cabin pressure cannot be changed when the master switch is moved from the 7.45 to the 4.50 position. Which trouble could cause this malfunction?

   a. 4
   b. 6
   c. 8
   d. 9

For the correct answers to these problems consult your instructor.

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PURPLE	POWER CIRCUIT
GREEN	NORMAL SOURCE OF AIR
YELLOW	EMERGENCY SOURCE OF AIR
RED	ENGINE START
BLACK	RAM VENT
ORANGE	AUTO COLD
BLUE	MANUAL HOT

Figure 1. Section 1.

1642

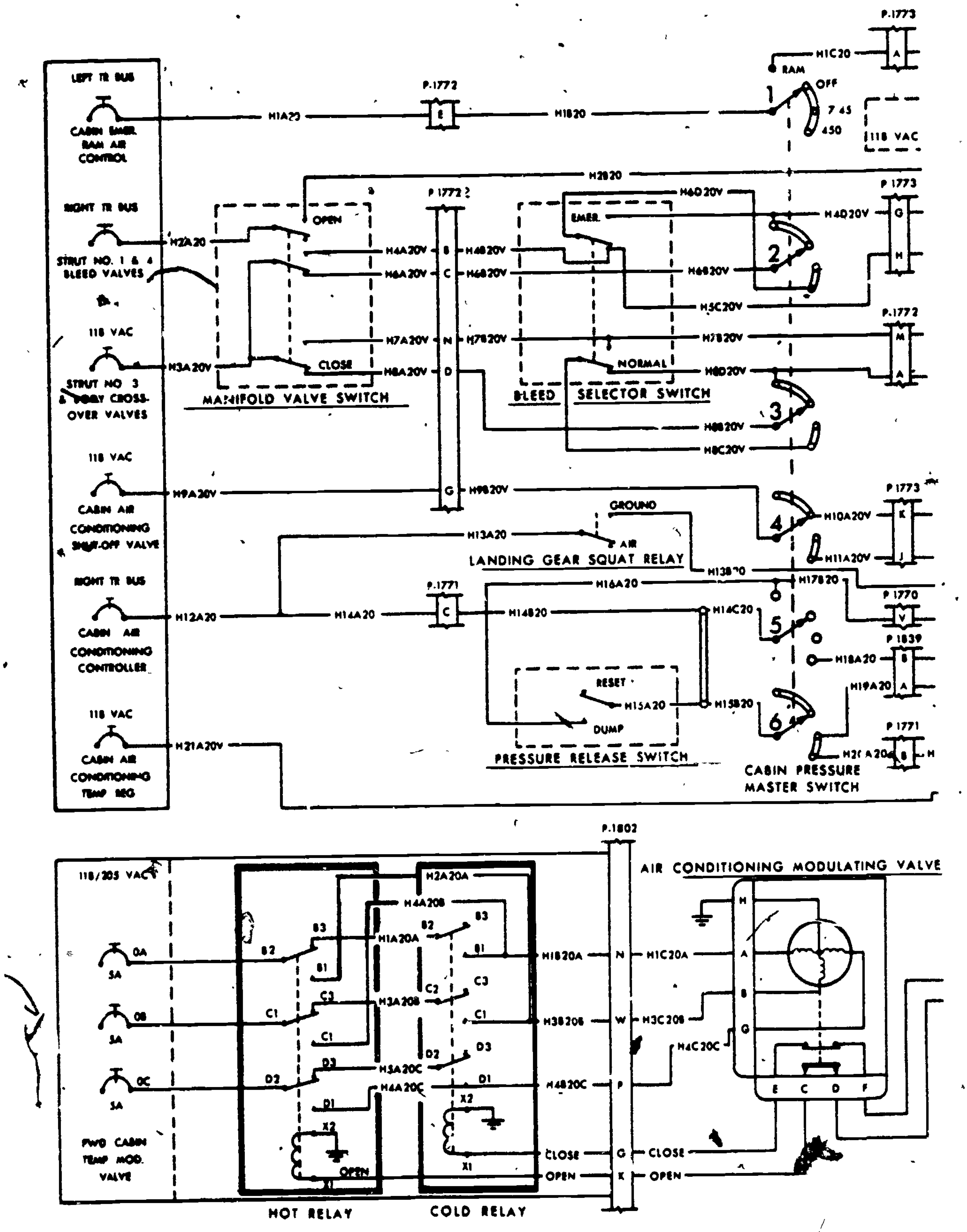
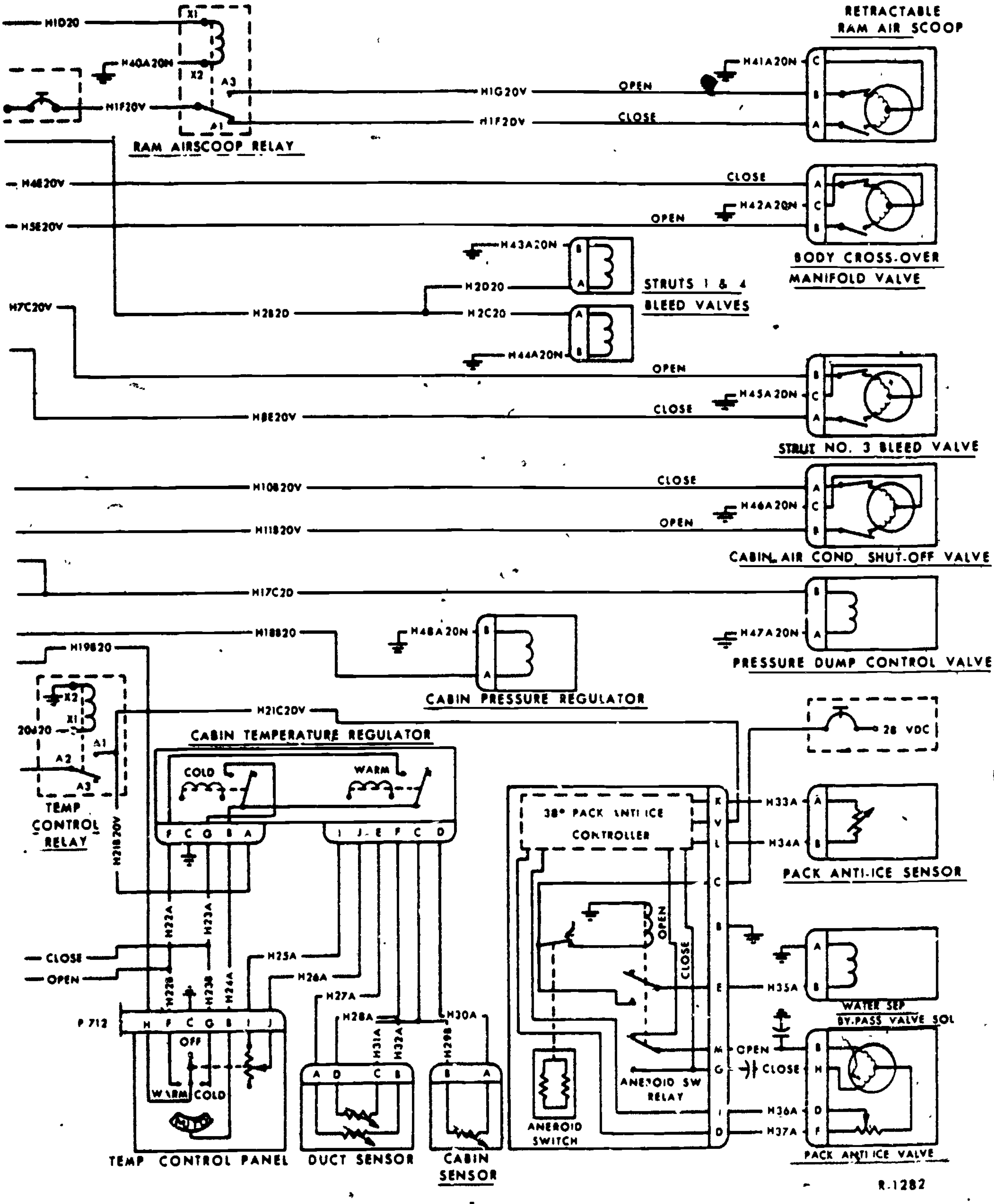


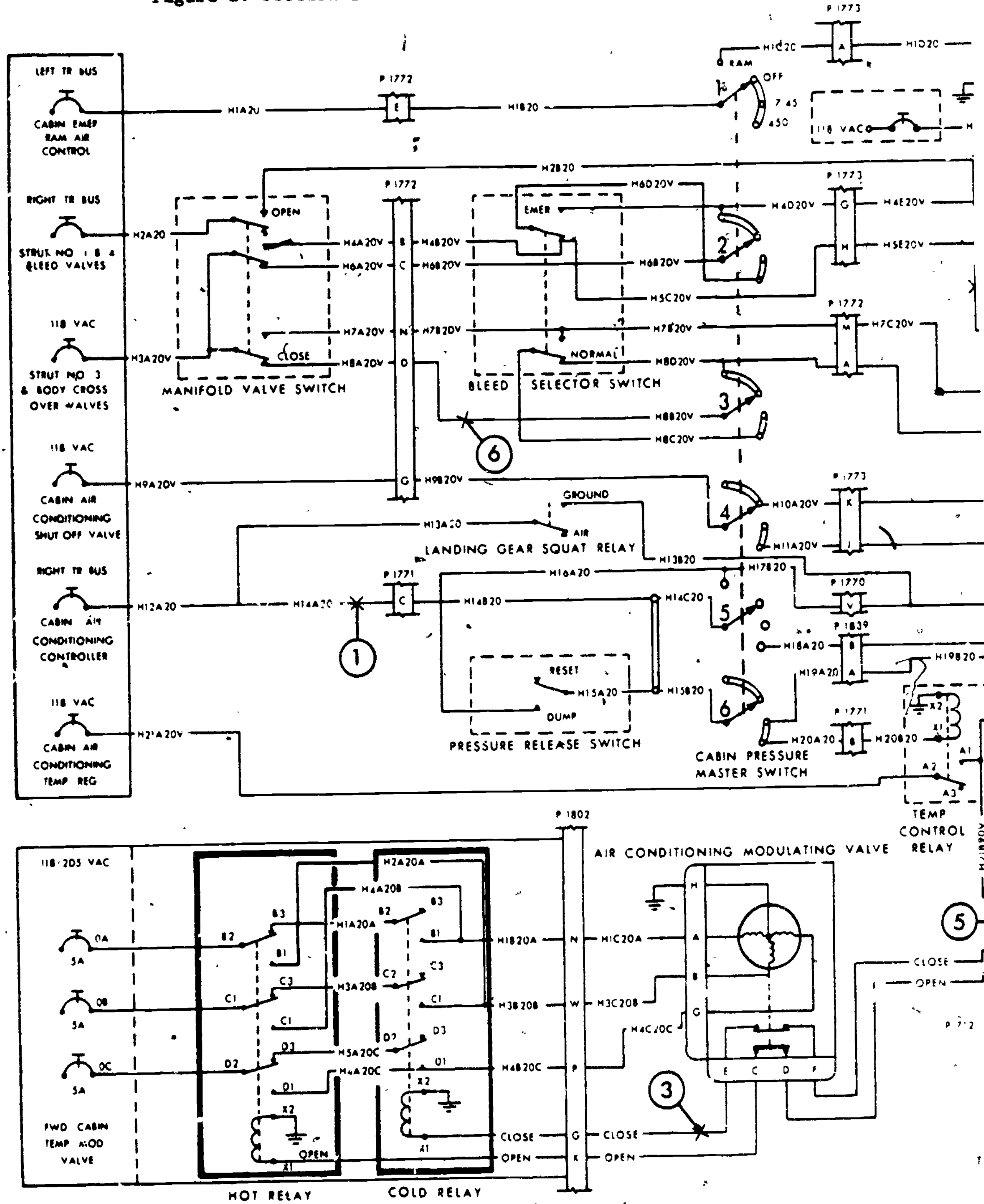
Figure 1. Section 2.



Section 3.
Figure 1. Bomber Air Conditioning Control Circuits.

1644

Figure 2. Section 1.



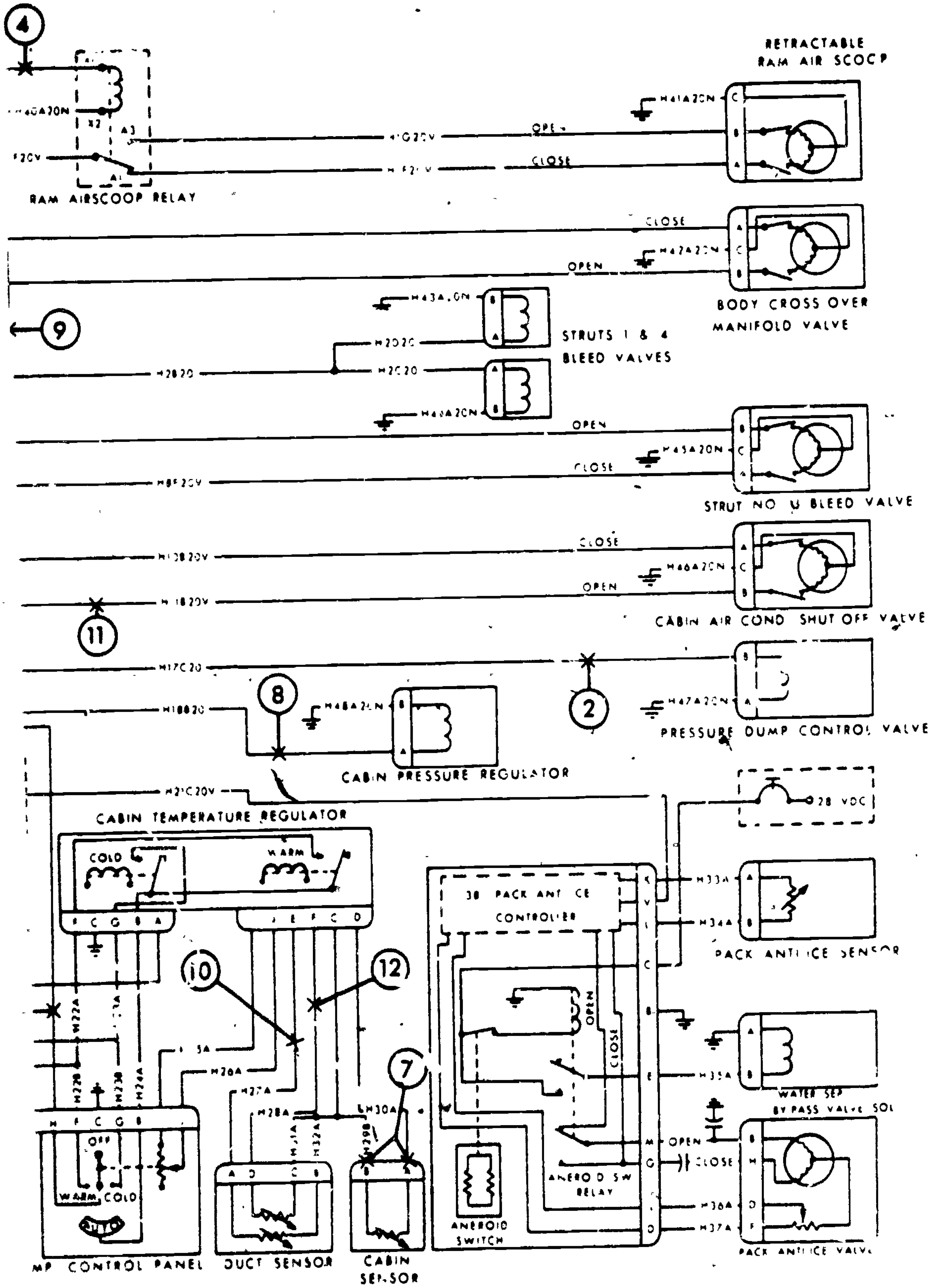


Figure 2. Bomber Air Conditioning Control Circuits.

Section 2. 11

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WORKBOOK

3ABR42331-WB-206A

Technical Training

Aircraft Environmental System Mechanic

BOMBER AIR CONDITIONING SYSTEM TROUBLESHOOTING

6 July 1978

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

Environmental Pneudraulics Branch
Chanute AFB, Illinois

BOMBER AIR CONDITIONING SYSTEM TROUBLESHOOTING

OBJECTIVE

Using a multimeter and wiring diagram, perform an operational check and troubleshoot the bleed air and cabin air conditioning system trainer, locating a minimum of 11 out of 14 troubles correctly.

EQUIPMENT

	Basis/of Issue
Trainer 3018, Bomber Air Conditioning	1/student
Multimeter	1/student

PROCEDURES

1. Remove all of your jewelry. Report to the lab instructor and inform him of the lesson on which you are working. The instructor will assign you to a trainer and provide the necessary materials.

2. This workbook is presented in two sections. Section 1 is to familiarize you with the components of the bomber air conditioning system and prepare you for performing the operational check and troubleshooting. Section 2 contains the steps for operational checking these systems and the malfunctions that you are to troubleshoot. Perform each step as directed on the following pages.

1649

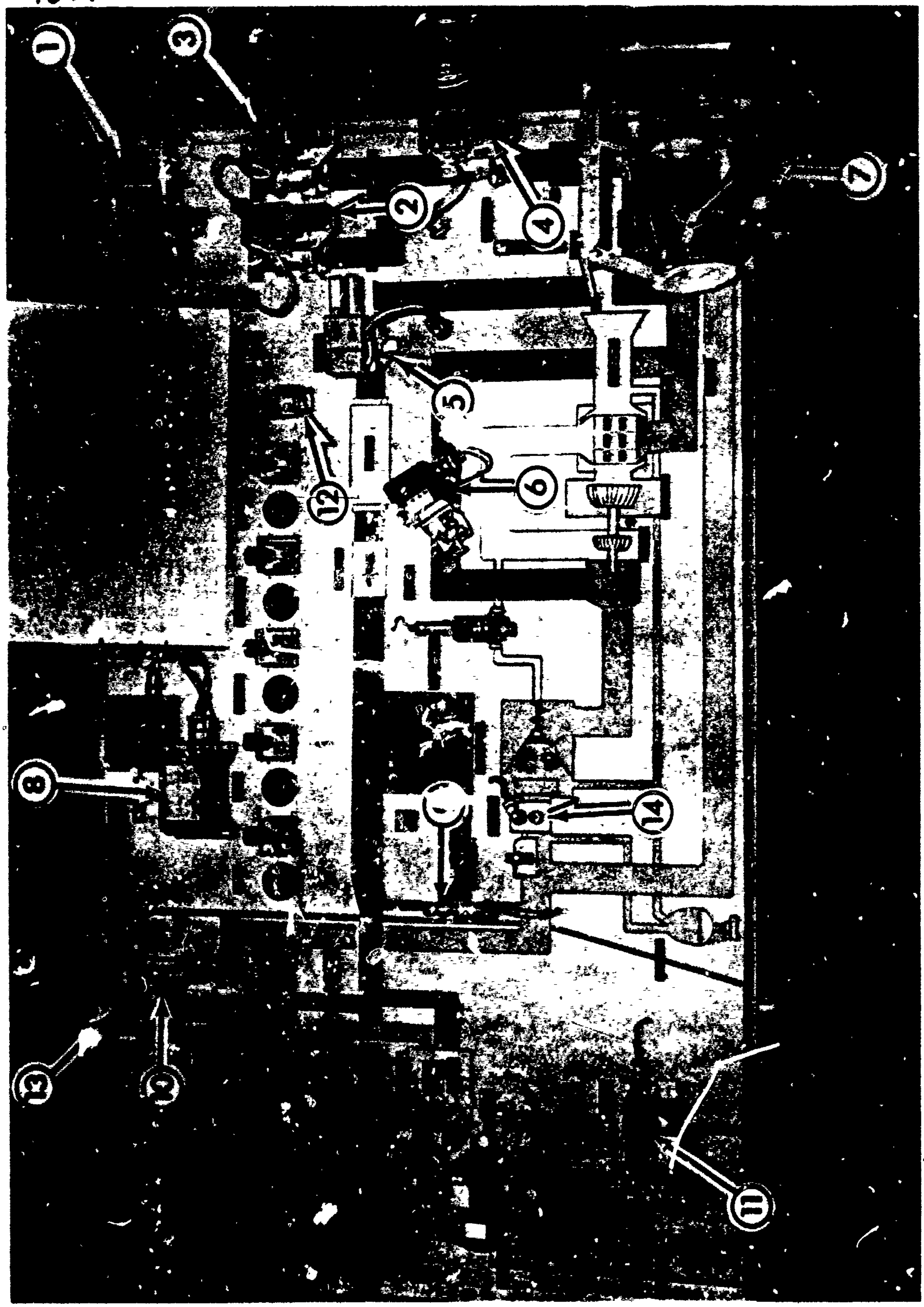

Figure 1. Bomber Air Conditioning.

1650

SECTION 1. BOMBER AIR CONDITIONING SYSTEMS COMPONENTS

1. Location and identification of system components.

a. Using the trainer and the illustration in figure 1, locate each of the numbered items. Write the name of each of these numbered items in the blank spaces below. As you locate each component, notice the check point near the component that is used for checking the electrical circuitry.

(1)________________________________

(2)________________________________

(3)________________________________

(4)________________________________

(5)________________________________

(6)________________________________

(7)________________________________

(8)________________________________

(9)________________________________

(10)________________________________

(11)________________________________

(12)________________________________

(13)________________________________

(14)________________________________

Compare your answers to those on the following page.

1651

Answers to location and identification step 1a.

(1) #1 and #4 Strut Bleed Valve.

(2) #3 Strut Bleed Valve.

(3) Body Crossover Valve.

(4) Air Conditioning Shutoff Valve.

(5) Hot Air Modulating Valve.

(6) Pack Anti-ice Valve.

(7) Ram Air Scoop.

(8) Temperature Control Box.

(9) Duct Temperature Sensor.

(10) Cabin Temperature Sensor

(11) Dump Control Valve.

(12) Altitude Pressure Switch.

(13) Landing Gear Squat Switch.

(14) Anti-ice Sensor Rheostat.

b. Using the trainer and figure 2, locate each of the numbered items. Write the names of each item in the blank spaces. As you locate the items notice the check point for checking the electrical circuit.

(1)____

(2)____

(3)____

(4)____

(5)____

Compare your answers to those on the following page.

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1652

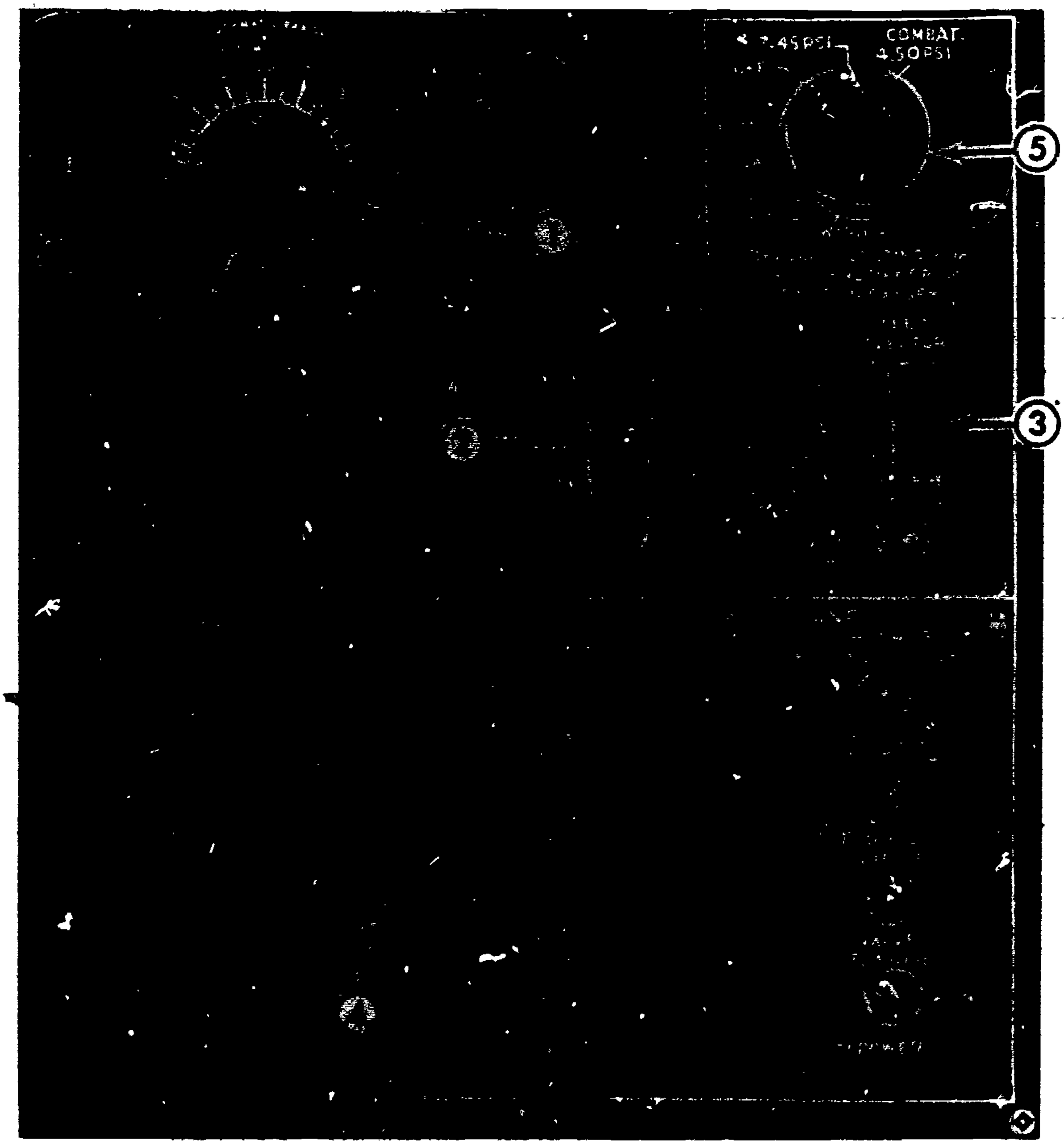

Figure 2.

1653 Answers to location and identification step 1b

(1) Temperature Control

(2) Pressure Release Switch

(3) Bleed Selector Switch

(4) M nifold Valve Switch

(5) Cabin Pressure Master Switch

2. Trainer Preparation

a. Place all trouble switches to the OUT position. These switches are located at the left end of the trainer.

b. Place the following switches to the normal positions as listed below.

(1) Cabin Pressure Master Switch------------------OFF

(2) Manifold Valve Switch--------------------------CLOSED

(3) Bleed Selector Switch--------------------------NORMAL

(4) Temperature Control Switch---------------------OFF

(5) Pressure Release Switch------------------------RESET

(6) Landing Gear Squat Switch----------------------AIRBORN

c. Place the trainer power switch to the ON position. This switch is located on the upper left side of the trainer.

3. Trainer operation

a. During the following steps you will operate each component of the bomber air conditioning system. When a switch is actuated be sure to notice which of the valves operate and the valve position. Actuate each switch as directed. From your observation of the trainer operation, complete each of the statements by circling the correct word.

STEP 1. Bleed air for engine start only

(1) Manifold valve switch OPEN

(a) #1 and #4 Bleed valve (energizes/deenergizes)

Note: Since we do not have air flow through the system you cannot observe the operation of 1 and 4 Strut Bleed Valves. However, you can check to determine if the solenoid is energized as follows: Remove the AN connector by unscrewing it from the solenoid valve. As you remove the connector you should hear an audible click as the solenoid is deenergized. Try this several times to be sure you recognize the audible sound of the solenoid energizing and deenergizing.

(b) Body crossover valve (opens/closes)

(c) #3 Strut bleed valve (opens/closes)

(2) Manifold valve switch CLOSED

(a) #1 and #4 Bleed valve (energizes/deenergizes)

(b) Body crossover valve (opens/closes)

(c) #3 Strut bleed valve (opens/closes)

(3) If the valve or valves fail to operate, it indicates a defective valve(s) or an open electrical circuit.

STEP 2. Cabin air conditioning system

(1) Cabin pressure master switch ---- 7.45 or 4.50

(a) Body crossover valve (opens/closes)

(b) #3 Strut bleed valve (opens/closes)

(c) Air conditioni shutoff valve (opens/closes)

(2) If the valve or valves fail to operate, it indicates a defective valve(s) or an open electrical circuit.

STEP 3. Cabin temperature control system; manual operation

(1) Place the cabin temperature control switch to MANUAL COOLER. The modulating valve (opens/closes)

(2) Place the cabin temperature control switch to MANUAL WARMER. The modulating valve (opens/closes)

(3) If the modulating valve fails to operate it indicates that the valve is defective or there is an open in the 28 VDC electrical circuit.

STEP 4. Cabin temperature control system; automatic operation

(1) Place the cabin temperature control switch in the 20°F position. The modulating valve (opens/closes)

(2) Place the cabin temperature control switch in the 100°F position. The modulating valve (opens/closes)

(3) If the automatic temperature control system fails to operate, this indicates an open in the 115 VAC power circuit to the controller.

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STEP 5. Bl elector switch

(Place the bleed selector switch to the emergency position

(a) #3 strut bleed valve (opens/closes)

(b) Body crossover valve (opens/closes)

(c) Air conditioning shutoff valve (opens/closes/remains the same)

(2) Place the bleed selector switch to the normal position

(a) #3 strut bleed valve (opens/closes)

(b) Body crossover valve (opens/closes)

(c) Air conditioning shutoff valve (opens/closes/remains the same)

STEP 6. Pressure release operation

(1) Place the pressure release switch to the DUMP position

(a) Cabin air conditioning shutoff valve (opens/closes/remains the same)

(b) Pressure dump control valve solenoid (energizes/deenergizes)

(2) Place the pressure release switch to the RESET position

(a) Cabin air conditioning shutoff valve (opens/closes)

(b) Pressure dump control valve solenoid (energizes/deenergizes)

(3) Place the cabin pressure master switch to the ram position

(a) Cabin air conditioning shutoff valve (opens/closes)

(b) Body crossover manifold valve (opens/closes)

(c) Pressure dump control valve solenoid (energizes/deenergizes)

(d) Ram air scoop (opens/closes)

(4) Place the cabin pressure master switch to the 7.45 or 4.50 position.

(a) Cabin air conditioning shutoff valve (opens/closes)

(b) Body crossover manifold valve (opens/closes)

(c) Pressure dump control valve solenoid (energizes/deenergizes)

(d) Ram air scoop (opens/closes)

(5) Place the landing gear squat switch to the "Ground" position

(a) Pressure dump control valve solenoid (energizes/deenergizes)

(6) Place the landing gear squat switch to the Airborn position

7656

(a) Pressure dump control valve solenoid (energizes/deenergizes)

STEP 7. Pack anti-icing system operation

Note: The anti-ice sensor rheostat, located near the water separator is used to simulate a temperature change around the sensor.

(1) Rotate the anti-icing sensor rheostat to the full clockwise position.

(a) Pack anti-icing valve (opens/closes)

(2) Rotate the anti-icing sensor rheostat to the full counterclockwise position.

(a) Pack anti-icing valve (opens/closes)

Note: The altitude switch, located in the upper right portion of the trainer is used to simulate altitudes above and below 36,000 feet.

(3) Place the altitude switch to the ABOVE 36,000 feet position

(a) Pack anti-icing valve (opens/closes)

(b) Water separator bypass valve solenoid (energizes/deenergizes)

(4) Place the altitude switch to the BELOW 36,000 feet position

(a) Pack anti-icing valve (opens/closes)

(b) Water separator bypass valve solenoid (energizes/deenergizes)

COMPARE THE ANSWERS THAT YOU HAVE SELECTED TO THOSE GIVEN BELOW.

Answers to trainer operation statements.

STEP 1. (1) energize
open
open
close

(2) deenergizes
close
close
close

STEP 2. (1) open
close
open

STEP 3. (1) close
(2) open

STEP 4. (1) close
(2) open

STEP 5. (1) opens
closes
remains the same

(2) closes
opens
remains the same

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STEP 6:

(1) remains the same
energize

(2) closes
deenergize

(3) closes
closes
energize
open

(4) open
opens
deenergize
closes

(5) energize

(6) deenergize

STEP 7:

(1) close

(2) open

(3) close
energize

(4) open
deenergize

434

1658

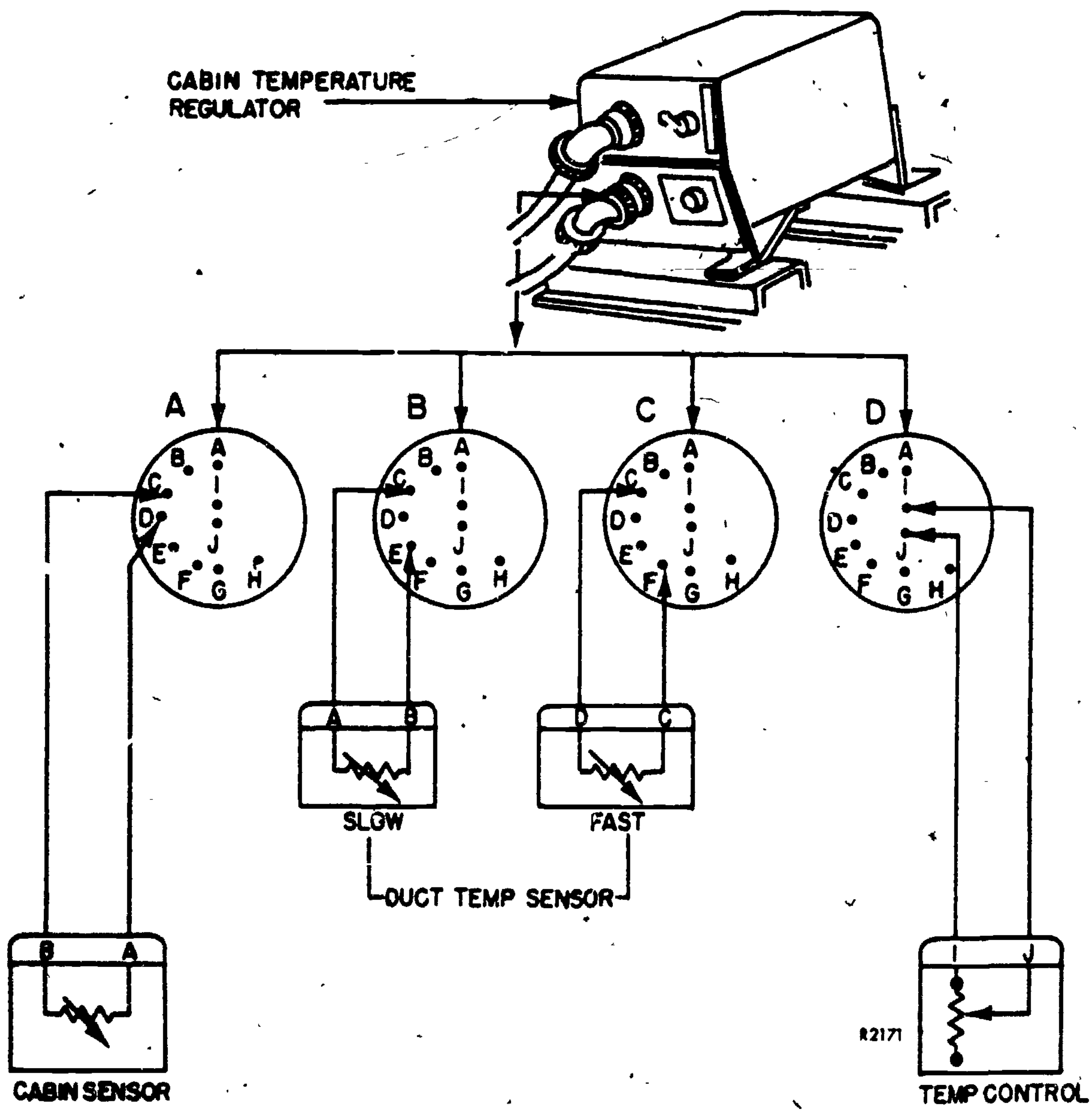

Figure 3.

4. Sensor Resistance

a. Knowing the normal resistance value of the sensors will be helpful when troubleshooting. This is determined by referring to the technical order or by measuring a sensor that is known to be good.

b. To measure the resistance of the cabin and duct sensors, disconnect the lower AN connector on the temperature regulator as shown in figure 3. This is the AN connector nearest to the trainer. In figure 3 the AN connector is shown in four separate illustrations; A, B, C, and D. This is done to make it easier for you to see how to check the sensor circuit. Keep in mind that this is ONE connector.

> Note: When checking resistance of the sensors, make sure the trainer power is off and you have the meter on ohms. When checking the cabin sensor, set your range selector to RX100 and when checking the duct sensor, set your range selector to RX10. Be sure you zero your meter before making any resistance checks.

c. Illustration A in figure 3 shows where to connect the meter for reading cabin sensor resistance. Check this resistance. Record the reading in the space below. Using illustrations B and C, measure the resistance of the duct sensor. Record your readings in the spaces below.

CABIN SENSOR resistance ______________________ ohms.
SLOW DUCT SENSOR resistance ____________________ ohms.
FAST DUCT SENSOR resistance ____________________ ohms.

d. Ask the lab instructor for the ambient temperature. ____°f.

e. Now that you have completed your sensor resistance check, you need to determine if the resistance is correct. Normally this is done by referring to temperature-resistance graphs in the applicable aircraft technical order. However, we have reproduced these graphs for you to use. Figure 4 is the temperature-resistance graph for the cabin sensor and figure 5 is the temperature-resistance graph for the duct sensor. Using these graphs, determine if your sensor resistance readings are correct.

1660

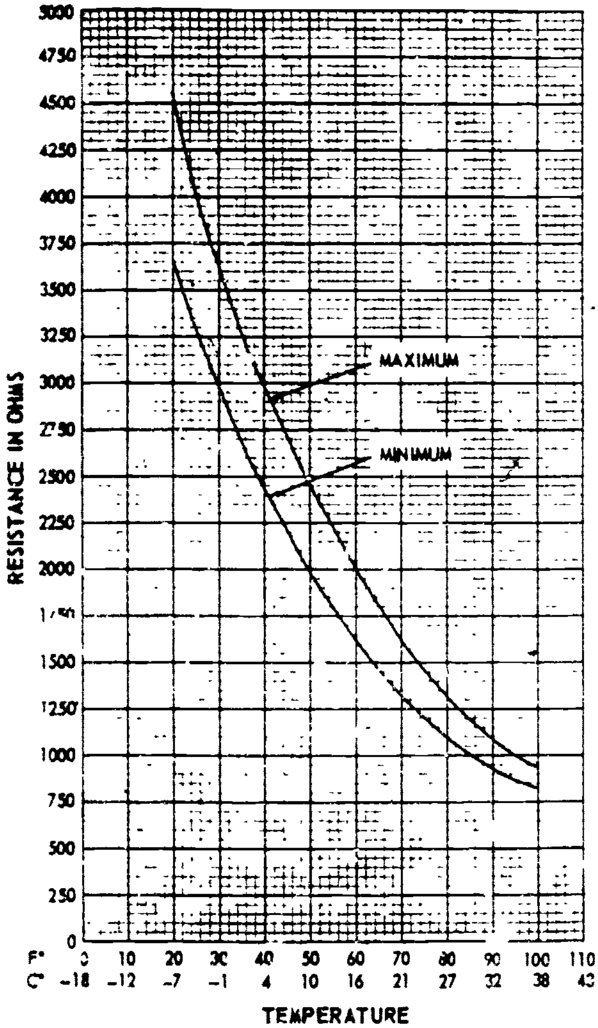

Figure 4. Cabin Temperature Sensing Element Resistance.

f. Instructions for using the CABIN temperature sensor resistance graph.

Locate the vertical lines for ambient temperature. Follow this line up to where it meets the minimum line. Then follow the horizontal lines to the left to determine the resistance in OHMS. The measured resistance should be within this range.

EXAMPLE: If the temperature is 64°F then the resistance should be between 1500 and 1875 ohms.

437

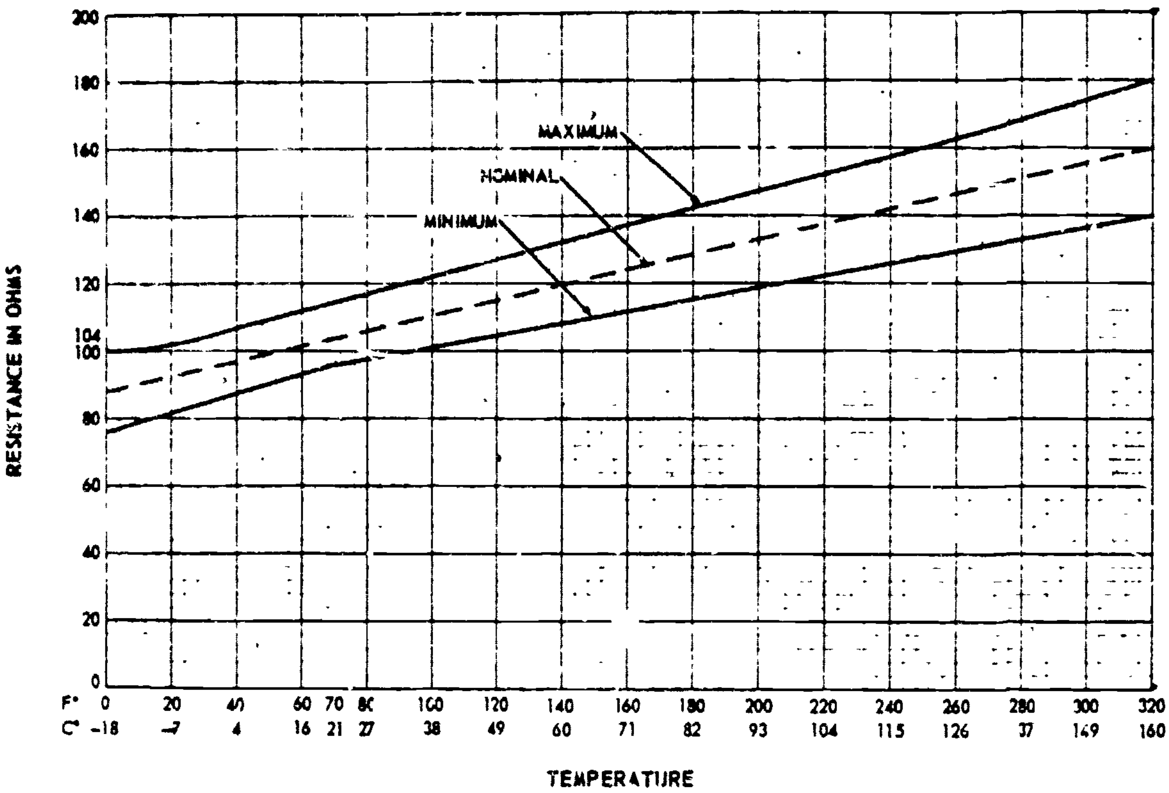

Figure 5. Duct Temperature Sensing Element Resistance.

g. Instructions for using the DUCT temperature sensor resistance graph (figure 5.)

Locate the vertical lines for ambient temperature. Follow this line up to where it meets the minmum line. Then follow the horizontal lines to the left to determine the resistance in OHMS. The measured resistance should be in this range. The fast and slow sensors should be the same.

EXAMPLE: If the temperature is 70°F, then the resistance should be between 96 and 114 OHMS.

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5. Rheostat Resistance

a. Illustration D in figure 3 shows the pin connections for checking the temperature control rheostat. Place the meter leads in pins J and T, then rotate the temperature control rheostat from 20°f to 100°f. The pointer on the meter will move from left to right indicating that the temperature control rheostat is operating properly.

b. Set the temperature control rheostat at 70°f. Read the resistance and record your reading below.

Temperature control rheostat resistance ____________ ohms.

c. You should have read between 300 and 500 ohms.

Note: If your readings were all correct, then continue to the operational check. If your readings were incorrect, then ask the instructor for assistance.

SECTION 2. BOMBER AIR CONDITIONING SYSTEM OPERATIONAL CHECK AND TROUBLESHOOTING

OPERATIONAL CHECK

1. The steps that you performed in paragraph 3a of Section 1 involved operating each component in the bomber air conditioning system. They determined if each component was operating properly and are called operational checks.

2. Chart 1 on the next page formalizes the procedures for performing operational checks in outline form. To insure that you are familiar with this procedure, turn the trainer power switches ON and perform each of the steps. After you are sure you understand the operational check procedure, then continue to the troubleshooting part of this lesson. You will be required to perform a complete operational check for each trouble.

Positioning the control device	Operating Valve	Valve Position
Manifold Valve switch OPEN	All Bleed Valves	OPEN
Manifold Valve switch CLOSED	All Bleed Valves	CLOSED
Cabin pressure master switch 7.45 or 4.50 position	Body crossover valve Air conditioning shutoff valve	OPEN OPEN
Place the temperature control switch to MANUAL COOLER	Modulating valve	CLOSED
Place the temperature control switch to MANUAL WARMER	Modulating valve	OPEN
Place the temperature control to AUTO 20°F	Modulating valve	CLOSED
Place the temperature control to AUTO 100°F	Modulating valve	OPEN
Place bleed selector to the EMERGENCY position	#3 strut bleed valve Body crossover valve	OPEN CLOSED
Place bleed selector to the NORMAL position	#3 strut bleed valve Body crossover valve	CLOSED OPEN
Place the pressure release switch to DUMP	Pressure dump control valve	ENERGIZE
Place the pressure release switch to RESET	Pressure dump control valve	DEENERGIZE
Place the cabin pressure master switch to RAM	Air conditioning shutoff valve Pressure dump control valve Ram air scoop	CLOSE Energize OPEN
Place the cabin pressure master switch to 7.45 or 4.50	Air conditioning shutoff valve Pressure dump control valve Ram air scoop	OPEN DEENERGIZE CLOSE
Place landing gear squat switch to GROUND position	Pressure dump control valve	Energize
Place landing gear squat switch to AIRBORN position	Pressure dump control valve	Deenergize
Rotate sensor rheostat full CLOCKWISE	Pack anti-icing valve	CLOSE
Rotate sensor rheostat full COUNTERCLOCKWISE	Pack anti-icing valve	OPEN
Place altitude switch to ABOVE 36,000 feet	Pack anti-icing valve	CLOSE
Place altitude switch to BELOW 36,000 feet	Pack anti-icing valve	OPEN

Chart 1. Operational Check Procedure Chart.

Troubleshooting

1. For each trouble, perform an operational check to determine the malfunctioning component. After you determine the malfunction, then place a statement in the "discrepancy" block of the attached troubleshooting answer sheet, that describes the malfunction.

2. Using a waxed pencil, trace the electrical circuits that operate or control the malfunctioning component.

3. Use the multimeter to locate the cause of the trouble.

Note: When measuring voltage, be sure the meter is set to the correct voltage range. Make sure that you have the negative (black) lead to ground. Ground on the trainer is located to the left of the AN/PSM-6 multimeter bracket. When checking the manual control system, be sure to hold the temperature control switch to either cooler or warmer. When measuring resistance, be sure the trainer power switch is OFF, and the meter is set at ohms. Use the OHM portion of the multimeter only to check sensors and their circuits.

4. Record the cause of the trouble in the corresponding cause block of the troubleshooting answer sheet.

5. The trouble switch that you are to use for each problem is listed on the top line of the discrepancy block. There are 17 problems for you to troubleshoot. We will go through number 1 to show you how to arrive at the correct answer.

Note: During this exercise you will not use trouble switches numbered 2, 13, 17. Since this trainer does not have check points for the valves, it will be necessary to remove the electrical connector from the components in order to check for power with your meter.

TROUBLE NUMBER 1

1. Place number 1 trouble switch to the IN position.

2. Perform an operational check, using the operational check procedure chart.

3. As you went through the operational check you found that the air conditioning shutoff valve did not open. This means that no conditioned air was available when the master switch was put to the 7.45 or 4.50 position. Make the following statement in the discrepancy block of the troubleshooting answer sheet for trouble switch No. 1.

"Air conditioning shutoff valve will not open when the master switch was put in the 7.45 or 4.50 position."

4. The first step would be to determine which valve or valves would give you this condition. Moving the cabin pressure master switch to the 7.45 or 4.50 position, the cabin air conditioning shutoff valve should have moved to the OPEN position, but you will notice that it does not. Trace the circuit that would be affected.

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5. When tracing the circuit you will notice that it requires 115 VAC to operate the cabin air conditioning shutoff valve. Check the AC power with the multimeter. Make sure your meter is set for the correct voltage. Your first check on the trainer will be at P-1772 point "G." You should read 115 VAC. The next check will be at P-1773 point "J." Again you should read 115 VAC. Now remove the electrical connector from the cabin air conditioning shutoff valve. Check voltage at pin "B." You will notice that there is no voltage at this point. This would mean that you have an OPEN in wire H11B20V.

6. Record your findings in the cause block of the troubleshooting answer sheet. Open in wire H11B20V.

7. You have completed trouble number 1, so place that switch to the out position and continue with troubles 3 through 20. Be sure to record the malfunction in the discrepancy block and the cause in the cause block of the troubleshooting answer sheet.

Note: OMIT PROBLEMS 2, 13, 17.

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TROUBLESHOOTING ANSWER SHEET

TROUBLE SWITCH NUMBER	DISCREPANCY	CAUSE
1		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
14		
15		
16		
18		
19		
20		

Note: On completion of the troubleshooting exercise, report to the lab instructor.

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WORKBOOK

3ABR42331-WB-207

Technical Training

Aircraft Environmental Systems Mechanic

DECADE RESISTOR FUNCTIONS AND WINDSHIELD TEMPERATURE AMPLIFIER BENCH CHECK

12 December 1978

CHANUTE TECHNICAL TRAINING CENTER (ATC)
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

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ATC FORM 214 (JAN 78) OBSOLETES ATC FORMS 214, MAY 68, 522, NOV 63 AND 523, MAY 71 STANDARD COVERSHEET

1663

Environmental Pneudraulic Branch
Chanute AFB Illinois 61868

3ABR42331-WB-207
7 July 1978

DECADE RESISTOR FUNCTIONS AND WINDSHIELD TEMPERATURE AMPLIFIER BENCH CHECK

OBJECTIVES

Using a bench test adapter, decade box, and windshield temperature amplifier, bench check and adjust the windshield temperature amplifier to the specified values.

EQUIPMENT

	Basis of Issue
Bench Test Adapter	1/student
Decade Box	1/student
Windshield Temperature Amplifier	1/student
Workbook 3ABR42331-WB-207	1/student

INSTRUCTIONS

Remove all jewelry, then report to the lab and inform the lab instructor of the lesson that you are working on. The lab instructor will provide you with all the equipment needed to complete this lesson.

This workbook is divided into three parts. Part I consists of four exercises dealing with decade resistor functions. Part II, Preliminary Exercises, gives you three exercises to complete prior to doing Part III, Bench Check and Calibration. These exercises are designed to aid you in understanding the equipment you will need and use to do the task. Read all the information presented in these exercises and follow the instructions given to complete them. After you have made your responses to the exercise, compare them with the correct answers found on the bottom of the next page. If your answers are incorrect, restudy the exercises to see where you made your mistakes. Part III, Bench Check and Calibration Procedures, takes you through the step-by-step procedures required to bench check and calibrate a windshield control unit. Follow each step as you perform the task. Your responses to the bench check and calibration procedures will be checked by your lab instructor

Supersedes 3ABR42331-WB-207, 7 July 1978.
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PART I

Exercise 1

When testing the windshield temperature amplifier, the <u>decade box is used to simulate the windshield temperature sensor</u>. The decade box is designed to provide accurate resistance values when testing electrical devices. Look at the decade box as its description and controls are reviewed.

1. Notice that it contains nine knobs for selecting the desired resistance values. Each of the nine knobs controls a resistance unit inside the box.

2. Also notice that each of the nine knobs has a scale marked from 0 to 10.

3. These knobs can be used to select any value of resistance from .1 to 10 meg ohms. You can also increase or decrease resistance in steps of .1, 1, 10, 100, 1000, 10000, 100000, 1 meg, and 10 meg ohms.

4. The selection of specific resistance values on the decade box is explained in the following steps.

   a. Starting with the bottom right side scale (.1 scale), the first knob is used to select tenths of an ohm. The scale is marked in increments of .1 ohm. The maximum resistance that can be selected with this knob is 1 ohm.

   b. The second knob is used to select units of 1 ohm This scale is marked off in 1 ohm increments. The maximum resistance that can be selected with this knob is 10 ohms.

   c. The third knob is used to select tens of ohms and is marked off in increments of 10 ohms each. The maximum resistance that can be selected with this knob is 100 ohms.

   d. The fourth knob is used to select hundreds of ohms and is marked off in increments of 100 ohms each. The maximum resistance that can be selected with this knob is 1000 ohms.

   e. The fifth knob is used to select thousands of ohms and is marked off in increments of 1000 ohms each. The maximum resistance that can be selected with this knob is 10,000 ohms.

   f. The sixth knob is used to select ten thousands of ohms, and is marked off in increments of 10,000 ohms each. The maximum resistance that can be selected with this knob is 100,000 ohms.

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g. The seventh knob is used to select hundred thousands of ohms, and is marked off in increments of 100,000 ohms each. The maximum resistance that can be selected with this knob is 1,000,000 ohms.

h. The eighth knob is used to select millions of ohms and is marked off in increments of 1,000,000 ohms. The maximum resistance that can be selected with this knob is 10,000,000 ohms.

i. The ninth knob is used to select ten million ohms and is marked off in increments of 10,000,000 ohms each. The maximum resistance that can be selected with this knob is 100,000,000 ohms.

Fill in the blanks to complete the following statements:

1. The decade box is used when bench testing the windshield temperature amplifier to simulate the ________ ______ ______________ ____________.

2. The decade box contains nine ______________ units.

3. Each of the nine resistance units the decade box has a scale that is marked in increments from 0 to ______________.

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Exercise 2

Notice the two connections at the top of the decade box. These connections consist of two insulated binding posts.

1. The two insulated posts are used to connect the decade box in the circuit being tested.

2. The resistance that you select on the decade box is set between the two insulated posts. For example, if you set the 1 ohm knob to 5, the 10 ohm knob to 5, and the 100 ohm knob to 5, you will have 555 ohms present between the two insulated posts.

Fill in the blanks to complete the following statements:

1. The resistance selected by knobs is available between the two __________________ posts.

2. With each selector knob set at 0, the resistance of the two insulated posts will be __________________ ohms.

3. With each selector knob set at 1, the resistance at the two insulated posts will be __________________ ohms.

Answers to Exercise 1: 1. windshield temperature sensor 2. resistance 3. 10

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Exercise 3

On pages 7, 8, and 9 are seven illustrations of the decade box.

Notice that the pointers in each illustration are pointing to certain numbers, indicating specific resistance values.

To give you practice in selecting specific resistance values on the decade box, set the pointers on your decade box as shown in each illustration. Then determine the resistance value and record it in the blank space below the illustration.

Illustration number 1 has been completed as an example. When you have completed all seven of the decade box resistance settings, check your answers with the answers on page 11 to see if you are correct.

If you are incorrect, ask the instructor for assistance. If your answers are correct, continue to Exercise 4.

Answers to Exercise 2: 1. insulated 2. zero (0) 3. 11,111,111.1

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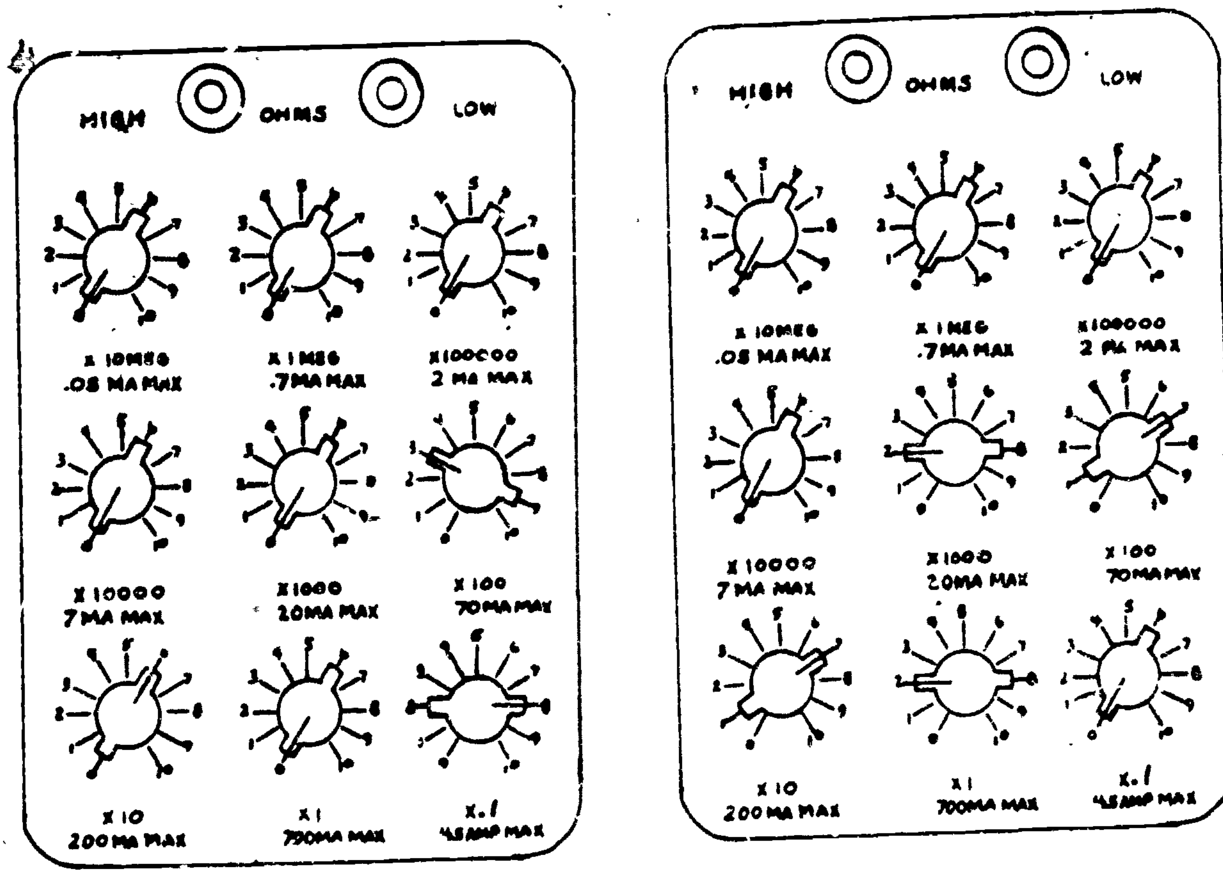
1673

1 2



1. 360.8

2. ______________

Figure 1

450

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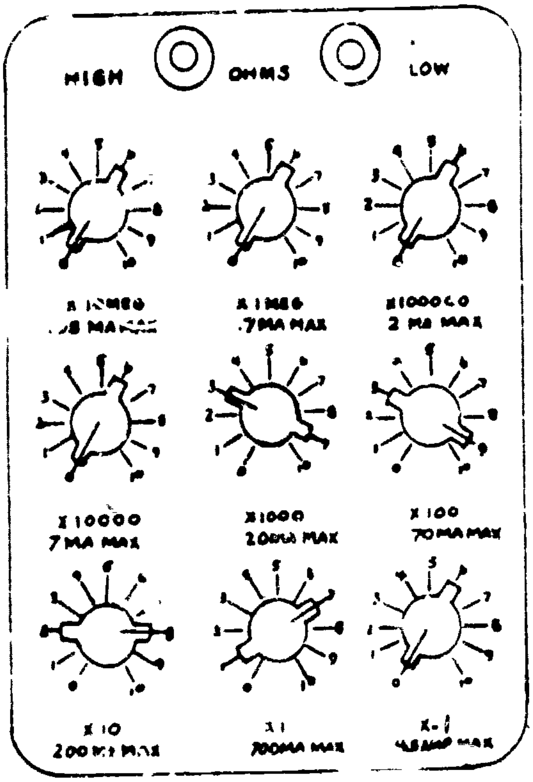
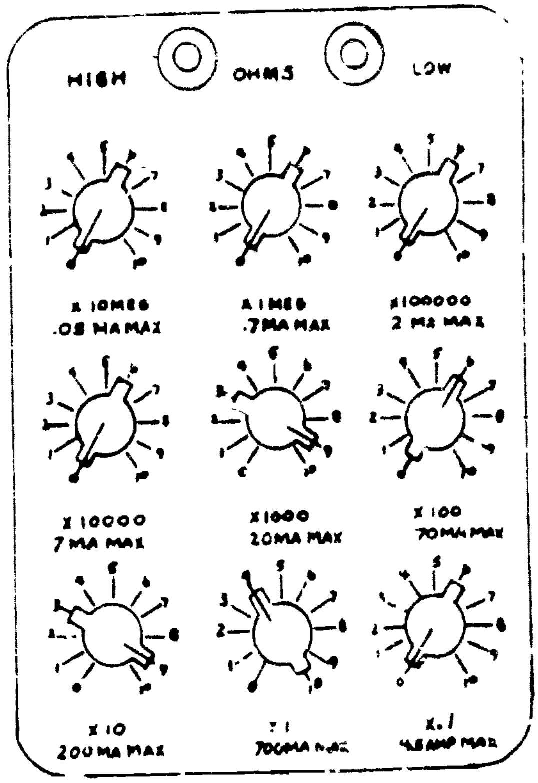
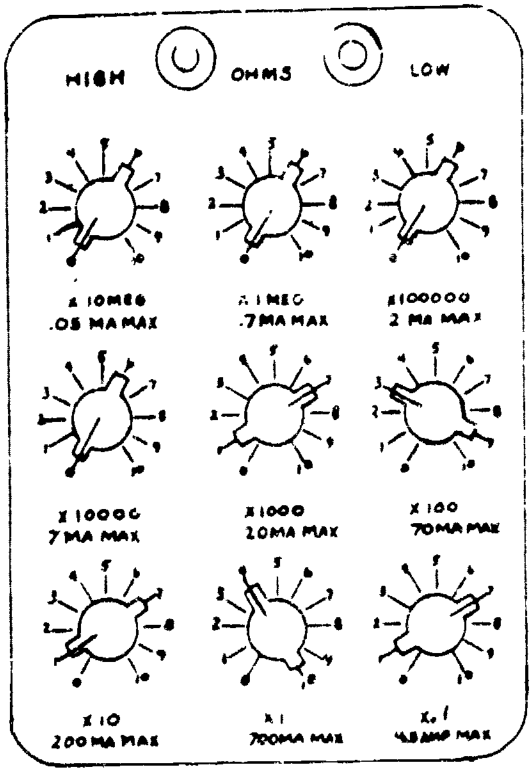




3.

4.

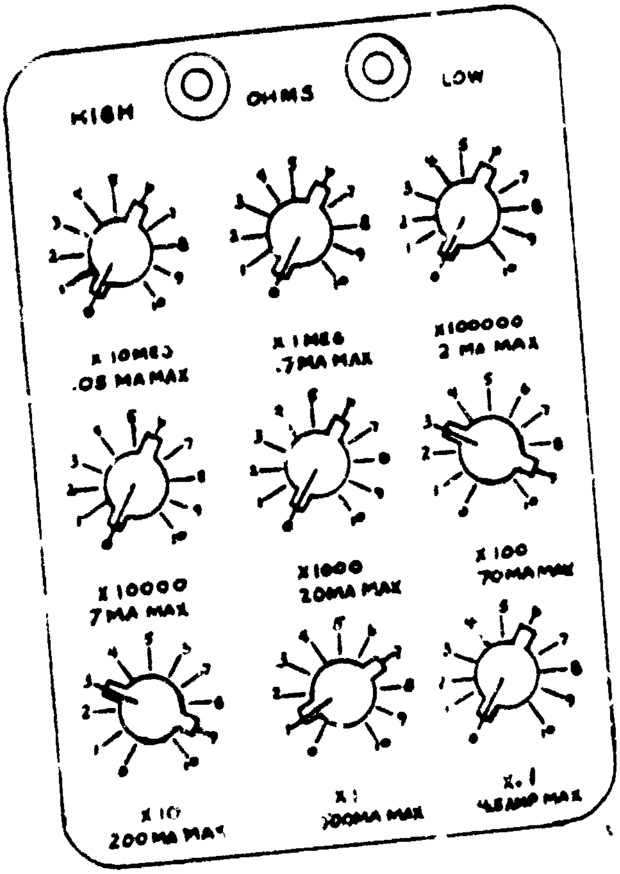
5.



3. ______________ 4. ______________ 5. ______________

Page 2 of Figure 1

6.



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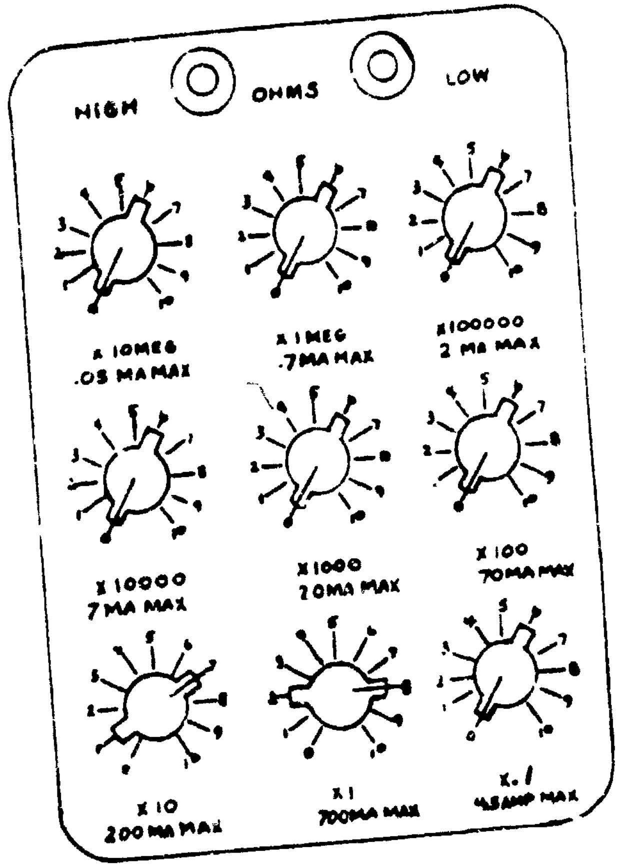

7. ______________________

6. ______________________

Page 3 of Figure 1

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Exercise 4

The resistance you select on the decade box can be either increased or decreased in steps as desired.

For example, when performing the bench test, you will be required to decrease resistance in one ohm steps. This may sound simple, but it can be very confusing unless you understand the procedure.

1. Using the decade box provided, make each of the settings as the procedure is explained. As an example, we will start with 505 ohms and decrease in one ohm steps to 490 ohms.

2. This procedure is shown by the illustrations in Figure 2.

a. Set the knobs on the decade box to obtain 505 ohms. Note Illustration A.

b. To decrease resistance in one ohm steps, start by turning the knob on the one ohm scale back toward zero, one step at a time, until it reads 0. You now have 500 ohms. Note Illustration B, Figure 2.

c. Before you can decrease the resistance any further you must change the resistance to read 500 ohms on a combination of other scales that will allow you to continue decreasing by only one ohm at a time. This can be done by setting the knob on the hundred ohm scale back to 4. Now set the ten ohm scale up to 9, and the one ohm scale up to 10. Make these settings on your decade box. Note Illustration C. Notice that with this combination you still have 500 ohms.

d. Now you can continue decreasing in one ohm steps by turning the one ohm knob back toward zero, in one ohm steps, until it reads 0. This decreases the resistance to 490 ohms. Note Illustration D.

e. Should you be required to reduce to a lower value, you could set the ten ohm scale to 8 and the one ohm scale to 10; this would still be 490 ohms. Notice Illustration E. From this you could reduce in one ohm steps down to 480 ohms. Notice Illustration F. This process can be continued allowing you to reduce resistance in one ohm steps as desired. This procedure can be applied to any value.

To practice decreasing resistance in one ohm steps, set your decade box to 401 ohms. Then decrease in one ohm steps to 387 ohms. As you do this, follow procedures b through e above and fill in the blanks to indicate the decade box settings.

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Exercise 4 (cont'd)

1. The decade was set at 409Ω by placing the 100 ohm selector at ______ and the 1 ohm selector at ______.

2. Start to decrease the decade to 387 ohms by turning the ______ ohm selector counterclockwise to ______. This leaves ______ ohms on the decade.

3. To continue reducing, change selectors so the 100 ohm selector is at ______ and the ______ ohm selector is at 9 and the 1 ohm selector is at ______.

4. Continue reducing by turning the ______ ohm selector toward 0 until the total resistance is ______ ohms, then turn the 10 ohm selector to ______ and the 1 ohm selector back to ______. This still leaves 390 ohms. Now turn the 1 ohm selector until the total value is 387 ohms.

Answers to Exercise 3: 1. <u>360.8</u> 2. <u>2772.0</u> 3. <u>3987.0</u> 4. <u>9694.0</u>
5. <u>7314.7</u> 6. <u>331.0</u> 7. <u>78.0</u>

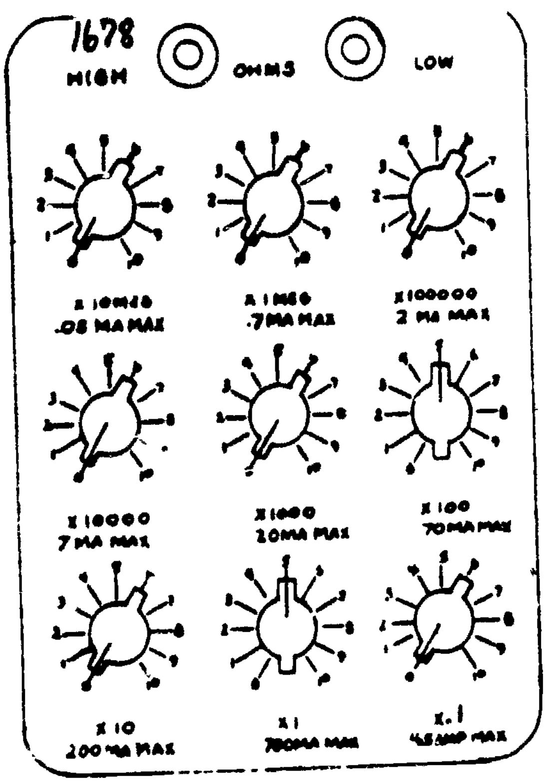

Illustration A 505 Ω

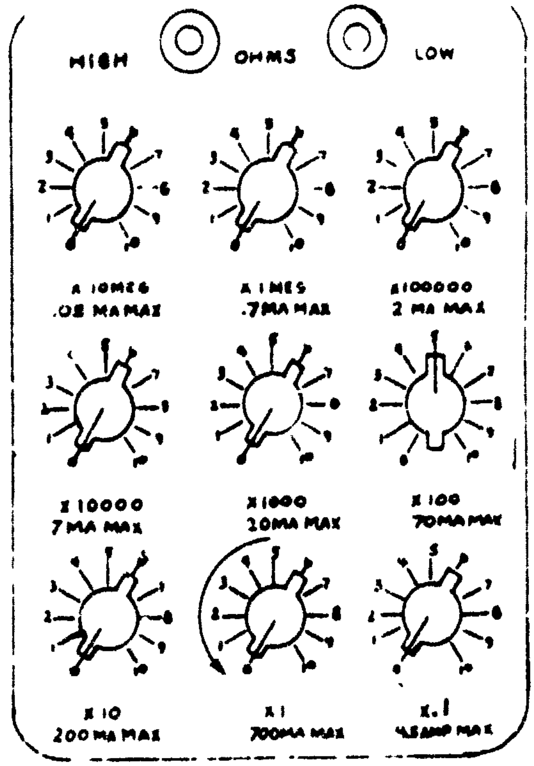

Illustration B 500 Ω

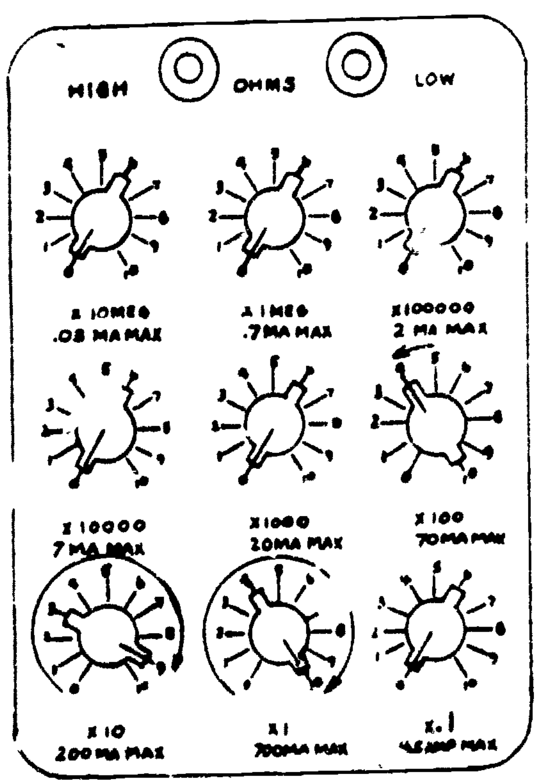

Illustration C 500 Ω

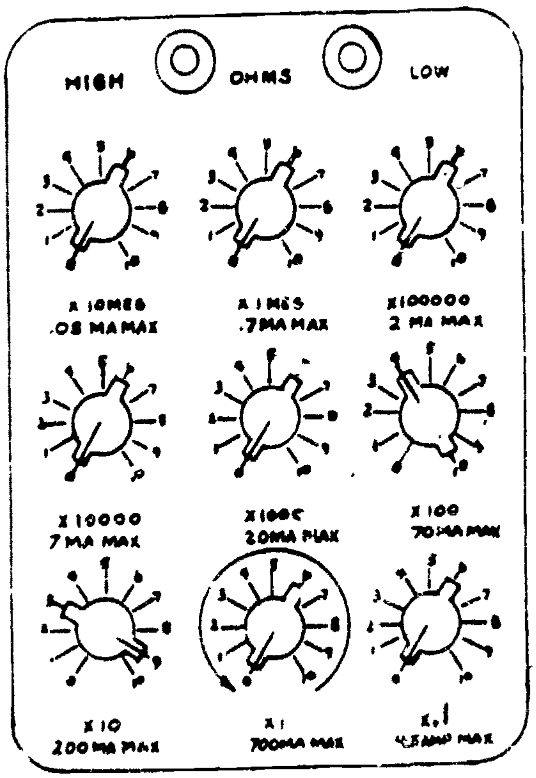

Illustration D 490 Ω

Figure 2

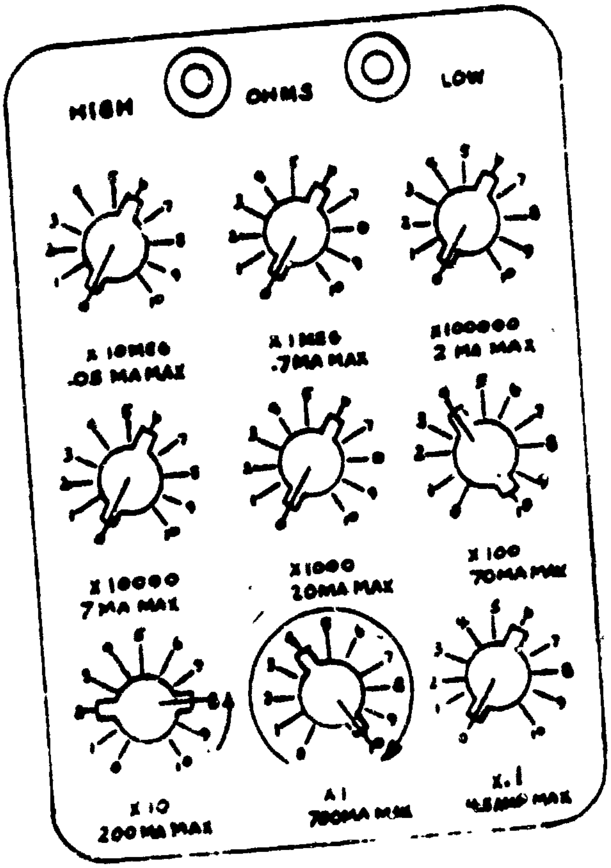

Illustration E <u>490 Ω</u>

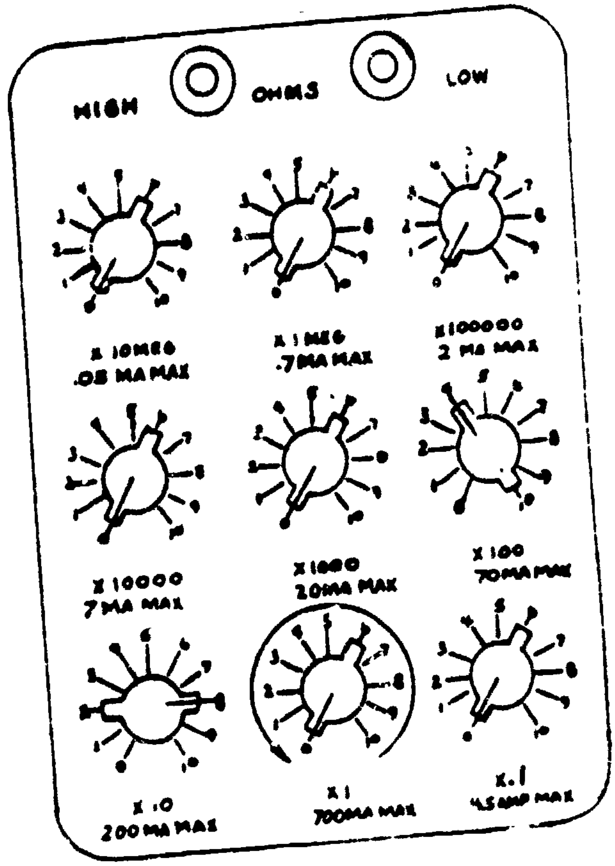

Illustration F <u>480 Ω</u>

Figure 2 (Cont'd).

Answers to Exercise 4: 1. 1, <u>9</u> 2. <u>1</u>, <u>0</u>, <u>400</u> 3. <u>3</u>, <u>9</u>, <u>10</u>
4. <u>1</u>, <u>390</u>, <u>8</u>, <u>10</u>

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PART II, PRELIMINARY EXERCISES

Exercise 1

From your studies of the rain removal system on the fighter aircraft, you should recall that a warning light was used to inform the pilot of an overheat condition on the windshield.

You should also recall that this warning light was controlled by a windshield temperature sensing amplifier.

A schematic diagram of the warning light circuit is illustrated in Figure 1.

During normal operation, the high temperature warning light will remain off. If the temperature exceeds a safe operating condition (260°F on the windshield), the high temperature warning light will come on.

Notice that there is 115 volts AC power through the amplifier. The amplifier will then keep the relay energized as long as the temperature is normal. Also notice that 14/28 volts AC power is used to turn on the warning light when an overheat condition occurs.

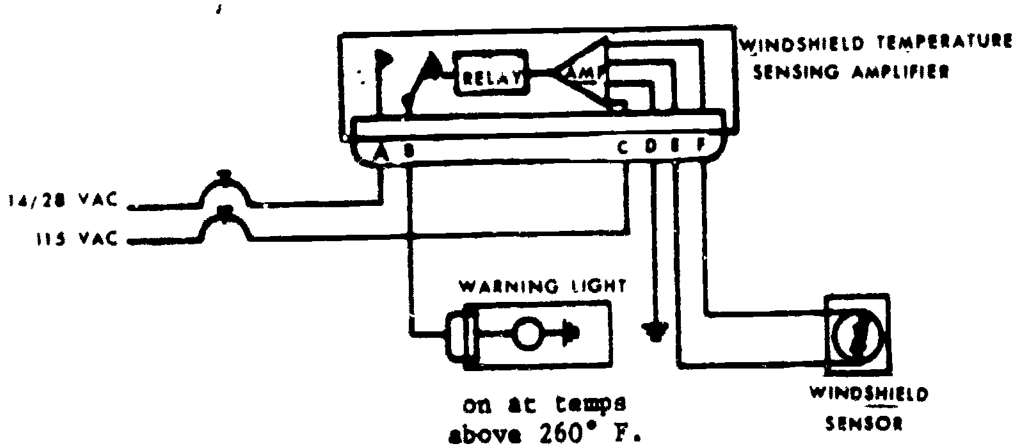

Figure 1.

Fill in the blanks to complete the following statements. Use Figure 1 to help you.

1. During normal operation of the rain removal system, the windshield high temperature warning light should remain ______________ (on/off).

2. The windshield high temperature warning light is controlled by the ______________ ______________ ______________ ______________

3. The windshield temperatur high warning light will come on if the windshield temperature exceeds ________________.

4. For operation, the windshield temperature overheat warning system requires ____________ volts AC and ____________ volts AC.

5. During normal operation of the rain removal system, the relay in the windshield temperature sensing amplifier will be ________________ (energized/deenergized).

6. The warning light will come on when the relay is ________________ (energized/deenergized).

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Exercise 2

The windshield temperature sensor has a positive coefficient. At normal temperature, 70° to 80°F, the sensor resistance is approximately 100 ohms.

At 260°F, the resistance of the sensor is approximately 174 ohms. When the sensor resistance reaches 174 (± 1.5) ohms, it will cause the amplifier to deenergize the relay. This will turn the warning light on.

From this we should note that to bench check the sensing amplifier, we can simulate the sensor with a decade box. When we apply 174 ohms, the warning light should come on.

When you bench test the sensing amplifier you will also notice that a very low resistance will turn the warning light on. Normally any resistance value below approximately 70 ohms or above approximately 174 ohms will turn on the warning light. In other words, sensor resistance values between approximately 70 and 174 ohms will keep the relay energized.

For each of the following resistances determine if the warning light would be on or off and place your conclusion in the blank space.

Resistance	Light
1. 69 ohms	________
2. 125 ohms	________
3. 180 ohms	________
4. 95 ohms	________
5. 110 ohms	________

Answers to Exercise 1: 1. off 2. windshield temperature sensing amplifier 3. 260°F 4. 115 and 14/28V AC 5. energized 6. deenergized

459

1683

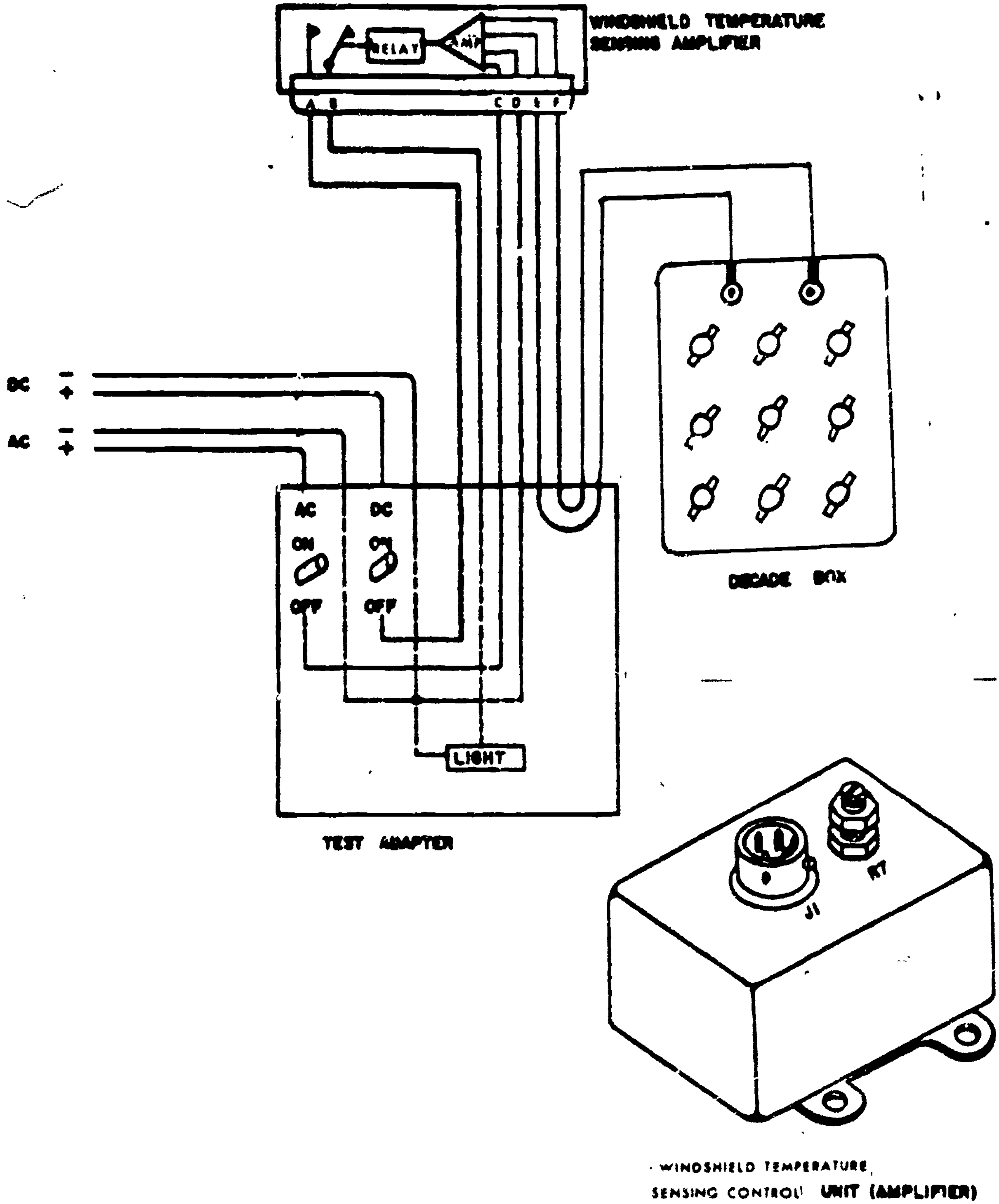


Figure 2.

1684

Exercise 3

To perform the bench test requires a bench test adapter, decade box, and a windshield temperature sensing amplifier P/N 6032. You should have these on the work bench. Look at Figure 2 as the following areas are covered.

1. The test adapter is used to connect the windshield temperature sensing control unit to the 28V DC and 115V AC, 400-Hertz power supplies, and to the decade box.

2. The test adapter provides a means of controlling the AC and DC power and houses the warning light.

3. The decade box is used to apply various resistance values during the test procedure. This simulates the windshield temperature sensor.

> Note: This system, when installed on the aircraft, uses 14/28V AC for warning light operation. However, for this setup we will use 28V DC for warning light operation.

4. R7 on the windshield temperature sensing amplifier is a variable resistor and is used to calibrate the amplifier.

Fill in the blanks to complete the following statements:

1. The electrical power required to bench test the windshield temperature sensing amplifier is ______________ and ______________.

2. During bench test, resistance is applied to the windshield temperature sensing amplifier by the ______________ ______________.

3. The windshield temperature sensing amplifier can be calibrated by adjusting ______________________________.

Answers to Exercise 2: 1. on 2. off 3. on 4. off 5. off

PART III, BENCH CHECK AND CALIBRATION PROCEDURES

The following steps will guide you in connecting the windshield temperature sensing control unit to the test adapter and performing the steps of the bench test and calibrate the control unit:

1. Connecting the winshield temperature sensing control unit to the test adapter.

a. Connect the small AN electrical connector from the test adapter to J1 of the windshield temperature sensing amplifier.

b. Connect the adapter leads to the decade box.

c. The decade box should be set at 0 ohms.

d. The 28 V DC and 115V AC power switches on the test adapter should be OFF.

e. Connect the 28 V DC and 115V AC power cables to the proper power receptacles on the wall.

2. Bench test procedure.

a. Place the 28 V DC switch to ON. The high temperature warning light will be on/off _______________.

b. Set the decade box to 71 ohms. The warning light shall remain on.

c. Place the 115V AC power switch to on. The warning light will go on/off_______________.

d. Set decade box to 170 ohms. Increase resistance one ohm per second until the light comes on. Resistance when the light comes on shall be 174 (± 1.5 ohms). Resistance when the light came on was _______________.

e. Increase resistance to 200 ohms. The warning light shall remain on/off _______________.

f. Decrease resistance slowly until the warning light goes off. Resistance shall not be less than 1.5 ohms or more than 25 ohms below resistance that caused the light to come on in step d above. (Example: If the resistance when the light comes on in 175 ohms, it should go off at not greater than 173.5 ohms or less than 155 ohms.) The light went off at _______________ ohms.

1686

g. Decrease the resistance to 70 ohms. Decrease one ohm per second until the light comes on. The light shall come on at 50 ($\pm$ 20) ohms and remain on at all values less than 30 ohms. The light came on at ________________ ohms.

h. Increase the resistance at one ohm per second until the light goes out. The light shall go out at 50 (+20) ohms. The light went out at ________________ ohms.

i. Set resistance at 80 ohms. The light shall go out. Break the resistance circuit (remove one wire from the decade box). The light shall come on. Reconnect the resistance circuit; the light shall go out.

> Note: If the warning light does not operate per test procedures, then perform the calibration procedure outlined in step 3a.

3. Calibrat' .

a. Set the decade box at 174 ($\pm$ 1.5) ohms. Carefully turn R7 full clockwise (note: do not force R7, turn to only finger tight), then slowly turn R7 counterclockwise until the light just comes on.

b. Repeat the bench test procedure steps 2a through 2i.

Check with the lab instructor for the correct answers.

Instructor's Initials ____________

Answers to Exercise 3: 1. 28V DC and 115V AC 2. decade box 3. R7

463

1687

SERVICE TEST
PROGRAMMED TEXT
3ABR42331-PT-208

Technical Training

Aircraft Environmental Systems Mechanic

CARGO AIRCRAFT ENGINE BLEED AIR SYSTEM

20 June 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

1688

OBJECTIVE

Associate the name of each cargo bleed air component to its operation with 80% accuracy.

INSTRUCTIONS

As you progress through this text, you will be accomplishing the following tasks:

1. Identifying the purpose of the cargo aircraft bleed air system.

2. Associating the functions of the bleed air system components to their names.

3. Tracing through the bleed air system electrical control circuit to determine system operation.

4. Identifying the procedures for maintaining the bleed air system. These tasks will aid you in accomplishing the objective for this lesson.

The text presents this material in small steps called "frames." After each frame you are asked to respond by completing statements, matching statements, or by selecting the true statement. Read the material carefully before making the responses. The correct answers to the questions are given at the back of the text. If you select the correct answers, continue to the next frame. If you are incorrect, read the material again and correct your answers before continuing.

Supersedes 3ABR42231-PT-207, 30 January 1973.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 300, TTVSR - 1

In previous systems that you have studied, the hot engine bleed air was used for several purposes. On the cargo aircraft that you will be studying in this lesson, engine bleed air is also used for several purposes. These purposes are as follows.

1. Air conditioning and pressurizing the cabin (flight deck) and the cargo compartment.

2. Starting engines.

3. Defogging the windshield.

4. Preheating the engine compartments (nacelle). This is used when operating in extreme cold climates.

5. Driving an air turbine motor (ATM). An ATM is a unit that provides electrical power for emergency operation or for ground operation. The unit consists of a turbine, driven by bleed air, that drives an alternator.

6. Anti-icing the leading edges of the wings and empennage (tail section).

7. Anti-icing the engine air intake scoop and guide vanes.

8. Anti-icing the radome. (The radome covers the radar unit that protrudes from the nose of the aircraft.)

9. Anti-icing the urinal drains.

Fill in the blanks to complete the following statements.

1. Air for air conditioning the cabin and cargo caompartment is supplied from the engine ______________ ______________ system.

2. The aircraft engines are started by using ______________.

3. Anti-icing of the aircraft wing leading edges is accomplished by using hot ______________ ______________ ______________.

4. Hot engine bleed air is used for anti-icing the engines air ______________ ______________ and ______________ vanes.

1690
Frame 2

The cargo aircraft that you will be studying in this lesson has four engines. Bleed air is taken from all four engines. The air is still taken from the last stage of compression. However, the last stage of compression on this aircraft is the 14th stage.

A ground air cart can also be used on this aircraft for starting engines and for operating the various systems when the aircraft is on the ground.

The cargo aircraft is also equipped with a Gas Turbine Compressor (GTC). The GTC is a small jet engine that is mounted in the left wheel well. This unit is only used to supply bleed air for ground operation. The GTC can be started by electrical power from the aircraft battery. Then the bleed air from the GTC can be used to start the aircraft engines, or to operate any of the systems normally operated by bleed air.

Fill in the blanks to complete the following statements.

1. The three sources of the bleed air for the cargo aircraft are the ______ ______, ______ ______ ______ compressor, and ______ ______ cart.

2. During ground operation, bleed air can be supplied by a ______ ______ cart, by a gas turbine ______, or by the engines.

3. The purpose of the GTC is to supply ______ air during ______ ______ operation only.

Figure 1 shows the bleed air system for the left wing and fuselage, the right wing is the same as the left wing. The system consists of sections of stainless steel ducting, engine bleed air shutoff valves, and wing isolation valves.

Locate the valves in figure 1. The system of ducting that carries the bleed air to its point of use is frequently called the bleed air manifold. The bleed air is taken from each of the four engines and carried to the various systems by the bleed air manifold.

Fill in the blanks to complete the following statements.

1. The bleed air system consists of ________ ________ ducting, engine bleed air ________ ________, and wing ________ valves.

2. During flight, air for anti-icing is provided by ________ (1, 2, 3, 4,) engines.

3. During flight, air for air conditioning is provided by ________ (1, 2, 3, or 4) engines.

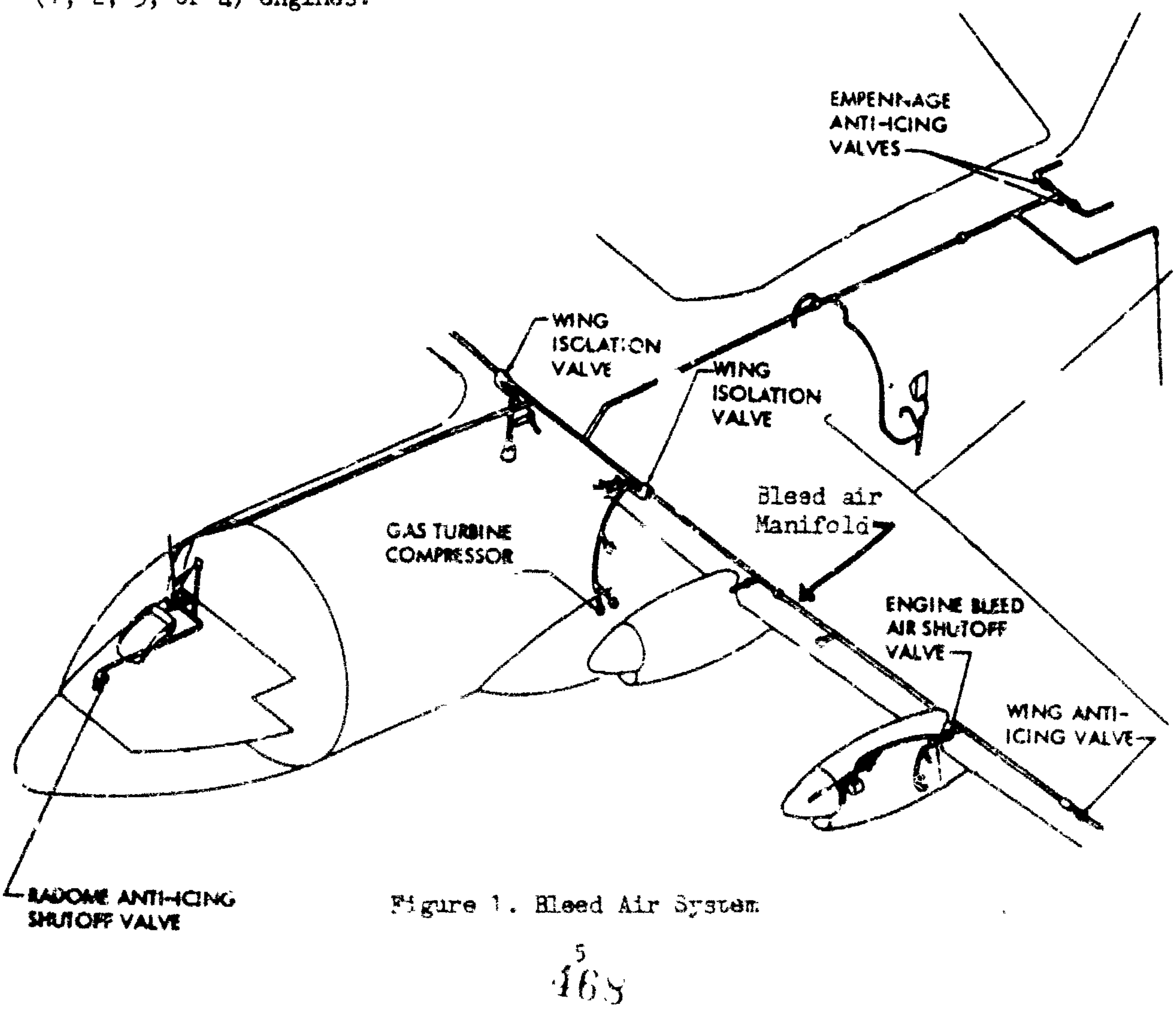


Figure 1. Bleed Air System

1692

Frame 4

Bleed air can also be supplied to the bleed air manifold by a GTC, (gas turbine compressor). The GTC is installed in the left wheel well. The GTC installation is shown in figure 2. Again, it's only purpose is to supply bleed air to the bleed air manifold. It is only used for operating the system while the aircraft is on the ground.

Fill in the blanks to complete the following statements.

1. To perform a ground operational check of a system requiring bleed air, the air can be supplied by either a ground __________ __________, __________ __________ compressor or by the aircraft __________.

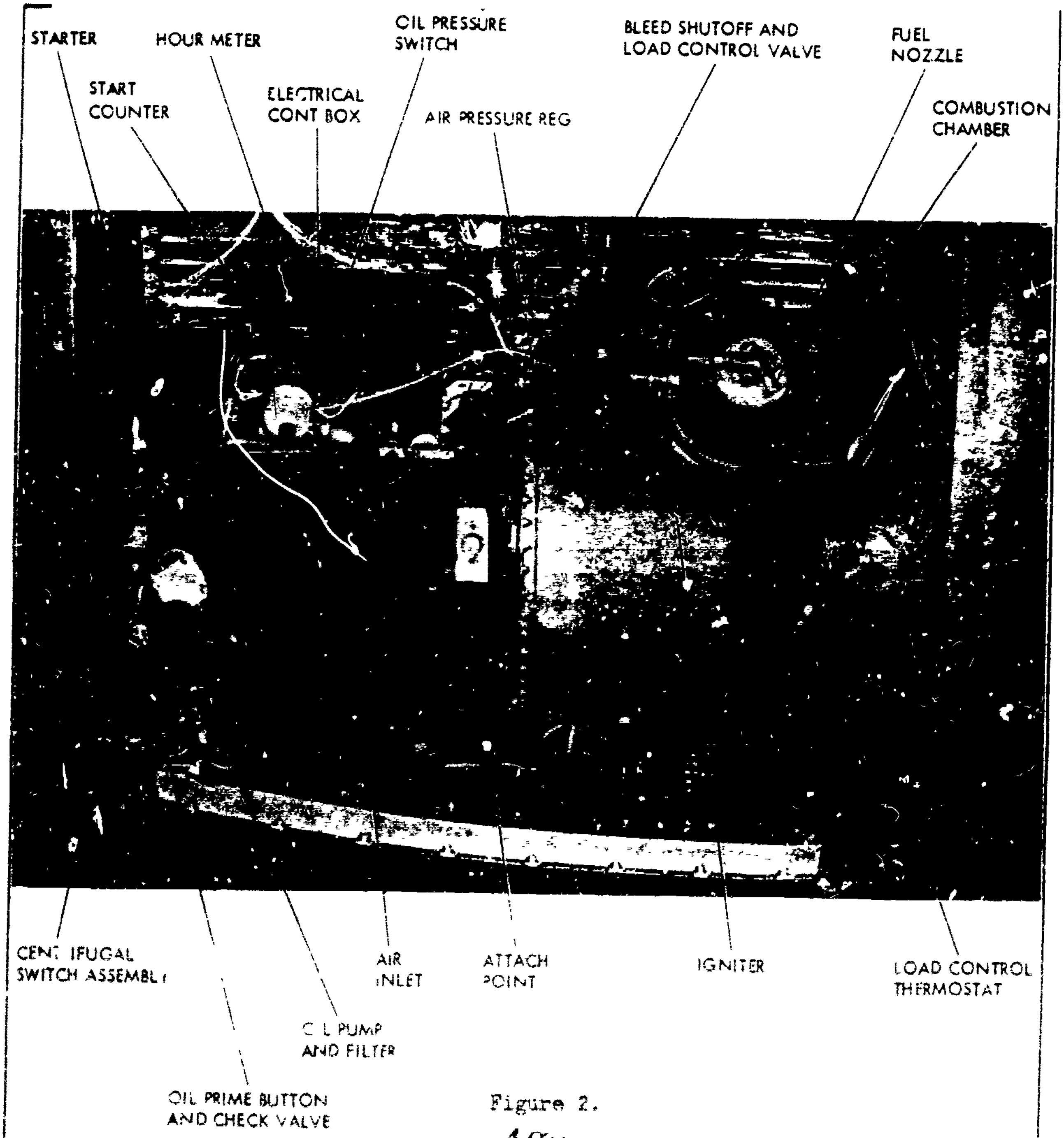


Figure 2.

We stated in frame 2 that air could be supplied to the bleed air manifold by a ground air cart. Figure 3 below shows the MA-1A ground air supply cart.

The only purpose of this unit is to supply bleed air to the bleed air manifold.

This bleed air can be used to start the aircraft engines or it can be used to operate the air conditioning, engine preheat, or anti-icing systems when performing ground operational checks.

The MA-1A ground air cart contains a small jet engine, and the necessary controls for operation and control of the unit.

As an Environmental Systems Mechanic, you may be required to operate this unit. If you are required to operate this unit, you will be trained on the operating procedures after you are assigned to a maintenance organization.

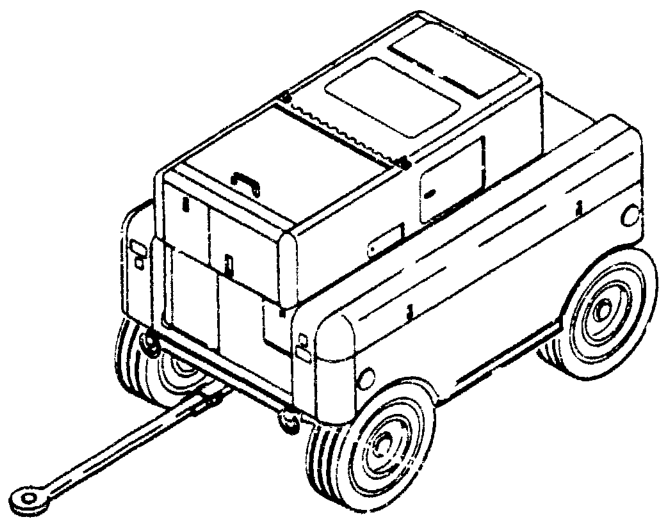


Figure 3.
MA-1A Ground Air Cart

Fill in the blanks to complete the following statement.

1. To perform a ground operational check of a system requiring bleed air you can use a ______________ ______________ ______________ as a source of air.

Frame 6

Figure 4 shows a schematic of the bleed air system. The air from the 14th stage of compression flows through a check valve, then to the engine bleed air shut off valve. This is illustrated for engine number 1, all four engines are the same.

During normal operation all four engine bleed air shutoff valves are open. This allows the bleed air from all four engines to flow into the bleed air manifold.

This means that during in-flight operation, the bleed air for air conditioning or anti-icing systems is normally supplied by all four engines.

The bleed air from the engines can also be used to operate the systems while the aircraft is on the ground. However, it is usually easier to use the GTC or ground air cart when performing ground operational checks.

Also notice the two wing isolation valves shown in the illustration. These valves are used to isolate either the left or right side of the bleed air manifold.

The wing isolation valves are normally open at all times. If a severe leak develops, the wing isolation valves are used to close that portion of the system.

For example, if a leak develops in the ducting between engines number 1 and number 2, the number 1 and number 2 engine bleed air shutoff valves would be closed, and the left wing isolation valve would be closed.

This would remove all airflow from the left manifold, but still permit air from the right engines to be used for air conditioning and pressurization.

Notice that check valves are located at each point where it is necessary to prevent a reverse flow of air. They are located at each engine, at the ground air connection, and at the GTC.

Fill in the blanks to complete the following statements.

1. Air for the bleed air system is supplied by the ______________ or the ______________ ______________ compressor, or a ______________ ______________ cart.

2. The air from the engines is controlled by an engine ______________ ______________ ______ ______________ valve.

3. Check valves are used at each ______________, at the ground air ______________, and at the ______________ ______________ ______________.

4. If a leak should develop in the right wing area, this section of the manifold can be closed off by closing the ______________ ______________ valve.

5. During normal in-flight operations, air for air conditioning and anti-icing is supplied by ______________ ______________ engines.

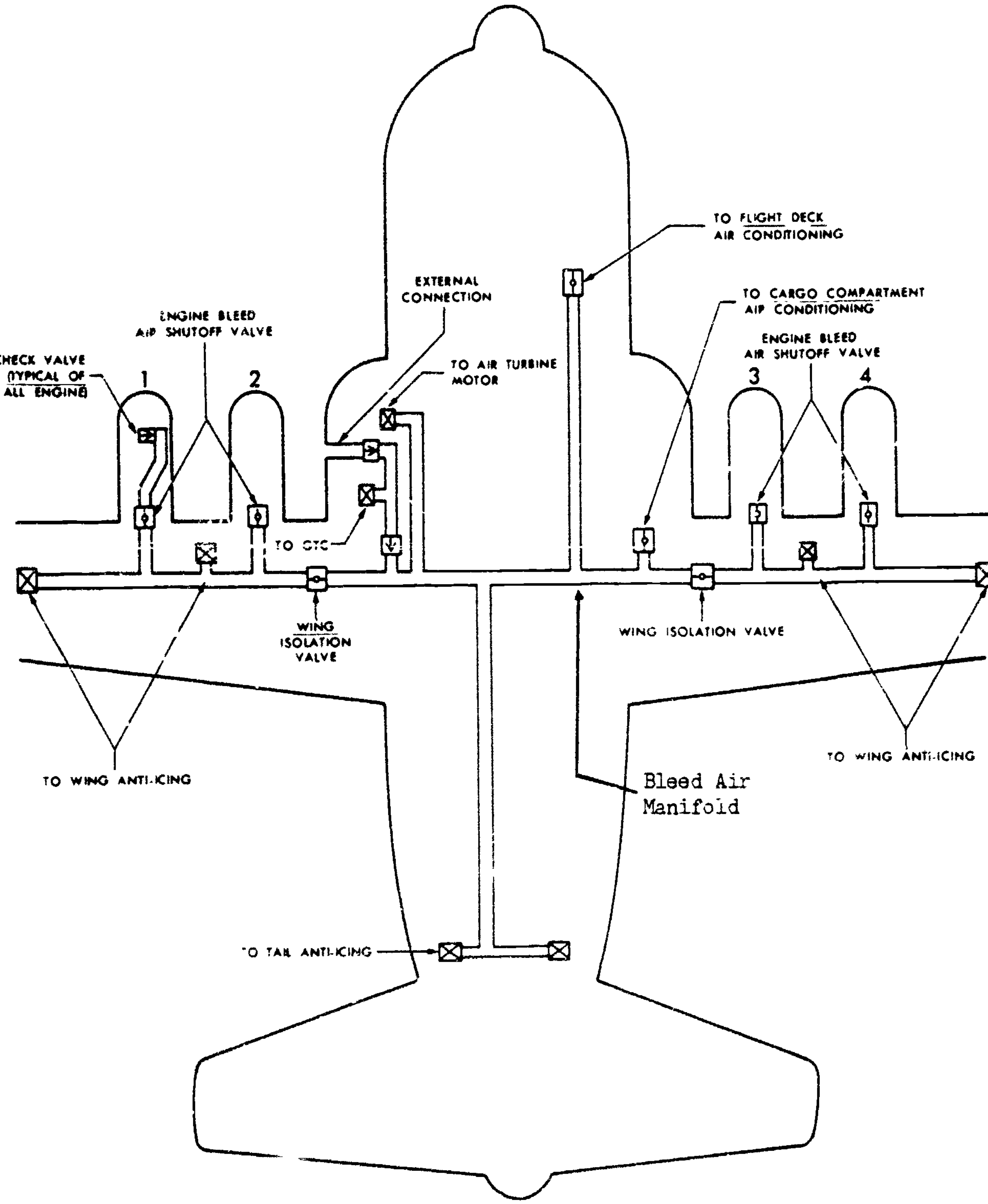

TO FLIGHT DECK
AIR CONDITIONING
EXTERNAL
CONNECTION
TO CARGO COMPARTMENT
AIR CONDITIONING
ENGINE BLEED
AIR SHUTOFF VALVE
ENGINE BLEED
AIR SHUTOFF VALVE
CHECK VALVE
(TYPICAL OF
ALL ENGINE)
TO AIR TURBINE
MOTOR
1
2
3
4
TO GTC
WING
ISOLATION
VALVE
WING ISOLATION VALVE
TO WING ANTI-ICING
TO WING ANTI-ICING
Bleed Air
Manifold
TO TAIL ANTI-ICING

Figure 4.

1696
Frame 7

The engine bleed air shutoff valves are 28-volt DC motor actuated, butterfly type valves. Figure 5 shows a typical engine bleed air shutoff valve.

Individual Switches are provided on the aircraft instrument panel for control of each valve. Figure 6 shows the portion of the instrument panel that contains the switches for controlling the engine bleed air shutoff valves and also the controls for the GTC.

During flight all four engine bleed air shutoff valves are normally open. However, the pilot can close anyone of the valves if necessary by placing the switch to the CLOSE position. Notice how the bleed air manifold is illustrated on the instrument panel.

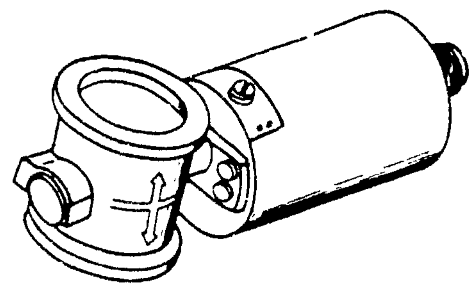


Figure 5.

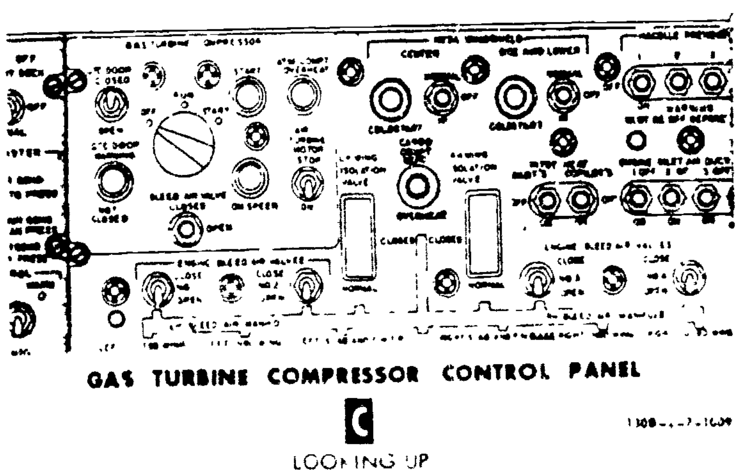


Figure 6.

Fill in the blanks to complete the following statements.

1. The engine bleed air shutoff valves are actuated by a __________ __________ __________.

2. Each engine bleed air shutoff valve is controlled by a separate __________________.

The wing isolation valves are solenoid controlled, spring actuated valves. The valve is held open by a solenoid and closed by a spring.

Energizing the solenoid releases the valve poppet, allowing the valve to be closed by the spring.

The valve can only be reopened by a mechanical linkage. This is done by a wing isolation valve control lever. The control lever is shown in figure 7.

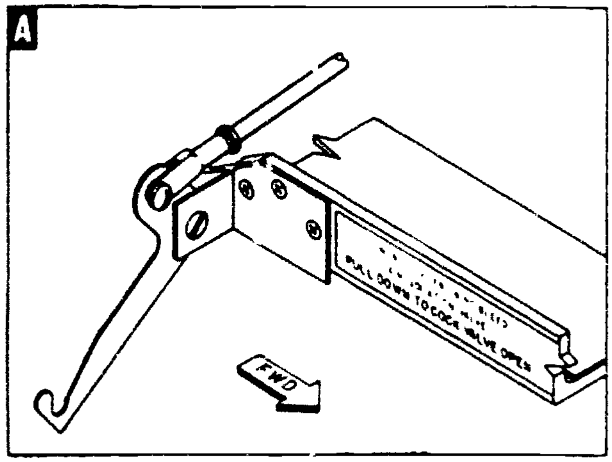
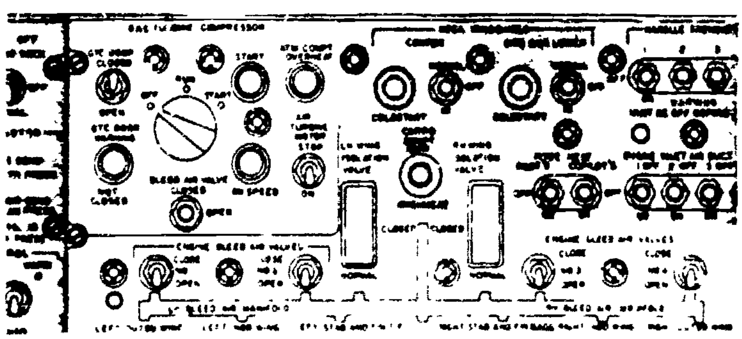


Figure 7.

Separate switches are provided on the instrument panel for closing the wing isolation valves. These switches are shown in figure 8. The switches are marked LH WING ISOLATION VALVE and RH WING ISOLATION VALVE.



GAS TURBINE COMPRESSOR CONTROL PANEL

C

LOOKING UP

Figure 8.

1698

Questions for Frame 8.

Fill in the blanks to complete the following statements.

1. The wing isolation valves are closed by the ________________ ________________ ________________ switches.

2. The purpose of the wing isolation valve lever is to ____________ the wing isolation valve.

3. Placing the wing isolation valve switch to closed, will energize the ____________________.

475

For problems 1, 2, and 3 select the statements from column B that correctly completes the statement given in column A. Place the letter of the matching statement in the blank space provided. NOTE: There are more blanks than correct matching statements.

COLUMN A	COLUMN B
1. Bleed air is used on the cargo aircraft for _____ _____ _____ _____ _____.	A. Air Conditioning. B. Starting the Engines. C. Cooling the electronic equipment compartment. D. Leading edge anti-icing. E. Rain Removal. F. Driving an ATM. G. Engine air intake anti-icing.
2. The sources of bleed air on the cargo aircraft are _____ _____ _____.	A. All 4 engines B. Engines 2 and 3 only. C. Gas turbine compressor. D. Ground air conditioner. E. Ground air cart.
3. The bleed air system consists of _____ _____ _____ _____.	A. 28V DC motor operated engine bleed air valves. B. Solenoid controlled, air actuated bleed air valves. C. Aluminum Ducting. D. Stainless Steel Ducting. E. Wing isolation valves. F. Body crossover valves. G. Check valves.

Read each of the following statements, then mark them as either True (T) or False (F).

4. _____ The wing isolation valves are held open by a solenoid.

5. _____ The wing isolation valves are closed by spring tension.

6. _____ After the wing isolation valve is closed, it can only be reopened mechanically.

7. _____ During flight, engine bleed air is normally taken only from engines 1 & 2.

8. _____ The bleed air from the GTC can be used to start the aircraft engines.

1706
Frame 10

The electrical circuits for controlling the bleed air system are shown in Foldout 1 (the last page of this text). Open this foldout.

Locate the four engine bleed air shutoff valves and the LH and RH isolation valves. The engine bleed air shutoff valves are each controlled by an engine bleed air control switch.

Locate these switches on the diagram. Placing the switch to OPEN position directs power to open the bleed air shutoff valve.

The diagram shows each of these switches in the OPEN position. Placing the switch to the CLOSED position directs power to close the valve.

Also notice that when the switch is placed to the OPEN position, current has to go through a second switch, which is actuated by the fire control handle.

In case of an engine fire, the pilot will pull the fire control handle; this will cause several things to happen, such as closing off the fuel supply and the bleed air shutoff valve to close.

Trace the circuit for control of Engine No. 1 bleed air shutoff valve. Starting at the Engine No.1 circuit breaker, follow the path of current flow to Engine No. 1 bleed air valve control switch.

With the switch in the OPEN position, current will flow through the switch to B2 of the fire control switch. Current will go through this switch to Pin A of the No. 1 engine bleed air shutoff valve.

This will cause the valve motor to run to the open position. Now follow the path of current flow for normal closing of the valve. With the control switch in the CLOSED position, current will flow through the switch to B1 of the No. 1 engine bleed air shutoff valve.

With the NO. 1 engine bleed air valve switch in the OPEN position, if the fire control handle is pulled, it will direct power to close the valve.

When the fire control handle is pulled, it moves the switch contact, connecting B2 to B1. This directs current to the closed side of the engine bleed air shutoff valve.

Notice that all four of the engine bleed air shutoff valve circuits are identical. Since we have followed the current for engine No. 1, you should be able to analyze the electrical control for the other three.

As stated earlier, the wing isolation valves are controlled by separate switches. With the switches in NORMAL there is no current flow and the valves remain open.

Placing either switch to CLOSED permits current flow from the circuit breaker to the valve solenoid. This energizes the solenoid ..n releases the valve allowing the spring rension to close the valve.

Fill in the blanks to complete the following statements.

1. The engine bleed air shutoff valves are actuated by ___________ volt DC ____________________.

2. Each engine bleed air shutoff valve is controlled by a separate engine bleed air valve ____________________.

3. With the No. 3 engine bleed air valve switch in the OPEN position, pulling the fire control handle will cause the engine bleed air shutoff valve to ________________.

4. The LH wing isolation valve solenoid is energized when the LH wing isolation valve switch is in the ____________________(normal/closed) position.

1702
Frame 11

A bleed manifold pressure gage is located in the cockpit. Figure 9 shows the gage and illustrates how it is connected to the bleed air manifold.

This gage indicates the bleed air pressure in the bleed air manifold. It serves to keep the pilot informed of the pressure in the manifold, and can also be used by maintenance personnel (you) when checking to determine if the system has excessive leakage.

When using the MA-1A ground air cart of the GTC, the gage will normally indicate approximately 40 psi. When the engines are supplying air to the manifold the gage will indicate approximately 70 psi. However this will depend on the engine throttle settings.

Fill in the blanks to complete the following statements.

1. The pressure in the bleed air manifold is indicated by a ______________ ______________.

2. The bleed air system can be checked for excessive leakage by using the bleed manifold ______________ ______________.

479

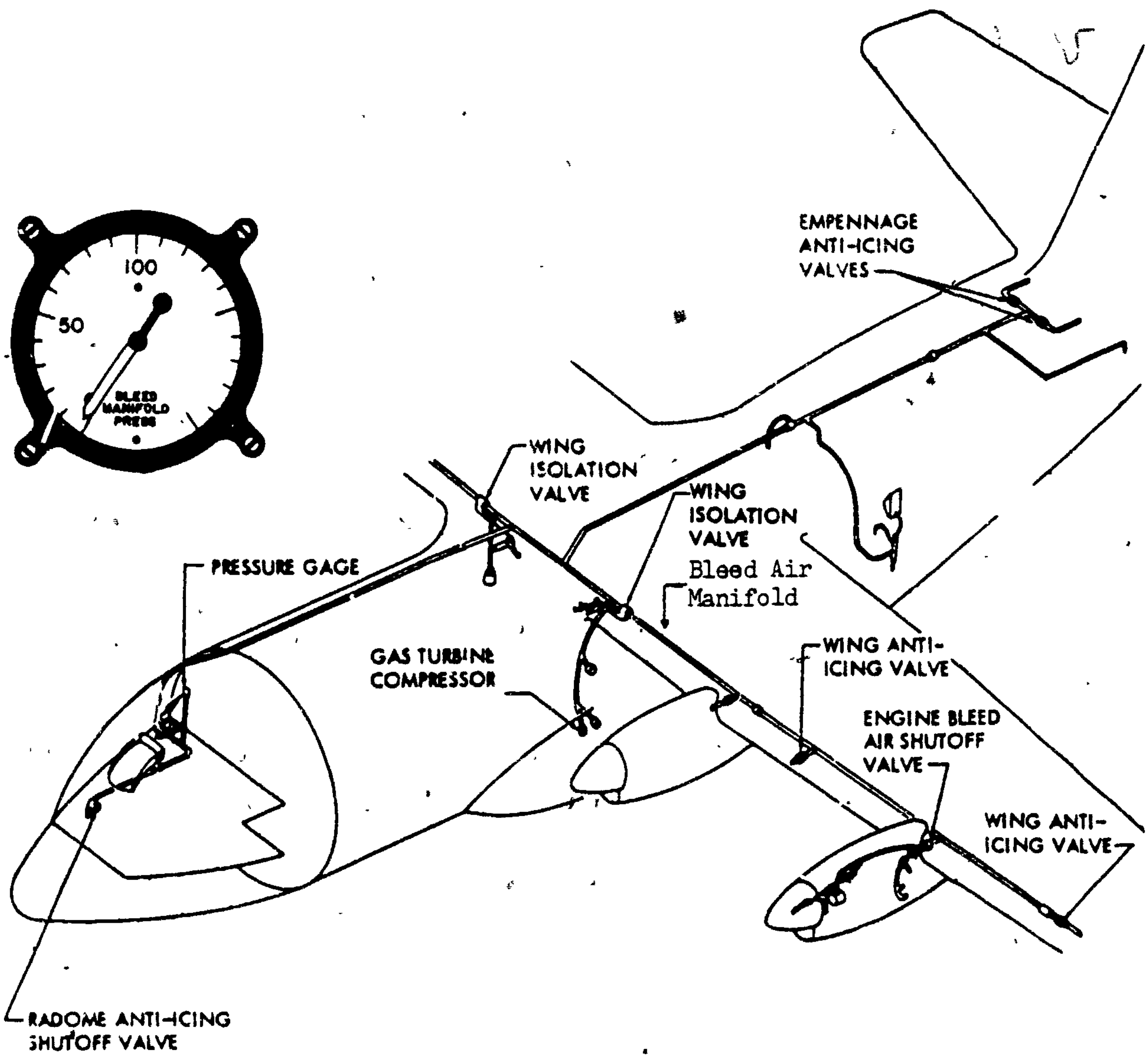

100
50
BLEED MANIFOLD PRESS
EMPENNAGE ANTI-ICING VALVES
WING ISOLATION VALVE
WING ISOLATION VALVE
Bleed Air Manifold
PRESSURE GAGE
GAS TURBINE COMPRESSOR
WING ANTI-ICING VALVE
ENGINE BLEED AIR SHUTOFF VALVE
WING ANTI-ICING VALVE
RADOME ANTI-ICING SHUTOFF VALVE

Figure 9.

1704

Frame 1?

Maintenance on bleed air systems is similar for all aircraft. However, you should always refer to the applicable aircraft technical order to obtain specific instructions. General inspection and maintenance consists of:

1. Checking bleed air ducting for corrosion, cracks and dents.

2. Checking duct couplings (clamps) for security.

3. Checking duct insulation for tears or saturation from oil or hydraulic fluid.

4. Removing and replacing sections of ducting, clamps, gaskets, and components, such as bleed air valves.

5. Checking system for leakage.

Checking the system for leakage is accomplished in various ways. The system can be checked to determine if excessive leakage exists by observing the pressure gage and timing the pressure drop when the system is turned off.

This method of testing will locate extreme leakage through ruptured ducts, missing V-band couplings and gaskets, or it will indicate a shutoff valve that has failed to close.

The pressure decay method of leak testing is accomplished by assuring all systems are turned off, then pressurizing the bleed air system using the GTC or by running the engines. An example of this procedure would be as follows:

1. With the GTC running, allow the bleed air manifold pressure to buildup to 35 psi. Then close off the air from the GTC, thus trapping the air in the bleed air manifold.

2. Using a stop watch, time the pressure drop as it drops from 30 psi to 15 psi. If the time for the pressure to drop from 30 psi to 15 psi is <u>less</u> than 8.5 seconds, the leakage at some point in the manifold is excessive.

If the time is <u>greater</u> than 8.5 seconds, the leakage is not excessive. The pressure will drop as there is an allowable leakage around some valves and through the urinal drain anti-icing tubes.

Locating leaks is done by the hand survey method. This is accomplished by pressurizing the manifold with the GTC, then cautiously feeling around each duct connection or area where leakage is suspected. Remember, this air and the ducts can still be very hot.

451

1705

Questions for Frame 12.

Fill in the blanks to complete the following statements.

1. To determine specific procedures for maintaining a bleed air system, you should refer to the applicable _______________ _______________.

2. To determine if the leakage from a bleed air manifold is within the allowable specifications, you should leak test the system using the _______________ _______________ method.

3. In the example given for leak checking a bleed air system, if the pressure drops from 30 psi to 15 psi in 6 seconds, this would indicate _______________ (a normal system/excessive leakage).

4. If excessive leakage is indicated when performing a leak test by the pressure decay method, the trouble could be caused by an engine bleed air shutoff valve failing to _______________.

1706

Frame 13

Place a T or F in the blank to indicate whether the statement is True or False.

_____1. Engine bleed air is used on the cargo aircraft for starting engines, air conditioning and pressurizing the cabin, anti-icing the wings, empennage and engine air intakes, and for driving an air turbine motor.

_____2. When performing a ground operational check, bleed air can be supplied by either the engines, GTC, or ground air supply cart.

_____3. During flight, engine bleed air is normally supplied by engines NO. 1 and NO. 2 only.

_____4. Closing of the wing isolation valves is accomplished by energizing a solenoid.

_____5. During flight, the wing isolation valves are normally closed.

_____6. The engine bleed air shutoff valves are actuated by a 28 volt DC motor.

_____7. The bleed manifold pressure gage is used when performing a leak test of the bleed air system by the pressure decay method.

_____8. When the bleed air system is checked for excessive leakage by the pressure decay method, the pressure drops from 30 psi to 15 psi in 20 sec.; this indicates excessive leakage.

_____9. When a fire control handle is pulled it will cause the engine bleed air shutoff valve to close for that particular engine.

Select the correct answer or answers to the following question.

10. The No. 2 engine bleed air shutoff valve fails to close. This could be caused by

a. a defective shutoff valve motor.
b. the fire control handle being pulled out.
c. the isolation valve switch being in normal.
d. an open in the electrical circuit between B1 of the fire control handle and B of the valve motor.

453

CORRECT RESPONSES TO ALL THE FRAMES.

Frame 1

1. bleed air
2. bleed air
3. engine bleed air
4. intake scoop and guide

Frame 2

1. engines, gas turbine, ground air
2. ground air, compressor
3. bleed, ground

Frame 3

1. stainless steel, shutoff valves, isolation
2. 4
3. 4

Frame 4

1. air cart
   gas turbine
   engines

Frame 5

1. ground air cart

Frame 6

1. engines, gas turbine, ground air
2. bleed air, shutoff
3. engine, connection, gas turbine compressor
4. wing isolation
5. all four

Frame 7

1. 28V DC motor
2. switch

Frame 8

1. wing isolation valve
2. open
3. solenoid

Frame 9

1. A B D F G
2. A C E
3. A D E G

Frame 9 (Continued)

4. T
5. T
6. T
7. F
8. T

Frame 10

1. 28 motors
2. switch
3. close
4. closed

Frame 11

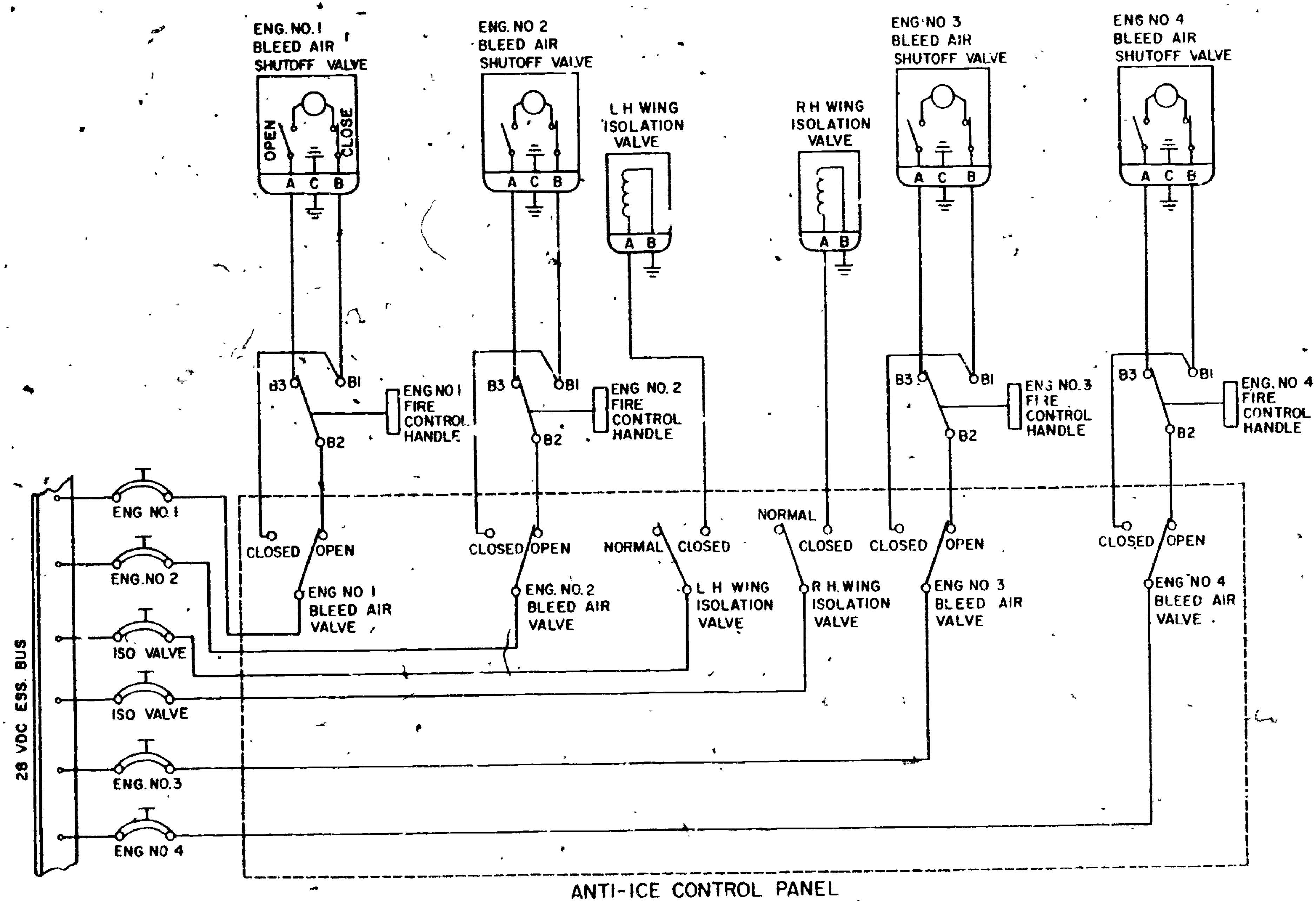
1. pressure gage
2. pressure gage

Frame 12

1. te [illegible]ical order
2. pressure decay
3. excessive leakage
4. close

Frame 13

1. T
2. T
3. F
4. T
5. F
6. T
7. T
8. F
9. T
10. a and d



ENG. NO. 1 BLEED AIR SHUTOFF VALVE
OPEN
CLOSE
A C B
ENG. NO 2 BLEED AIR SHUTOFF VALVE
A C B
L H WING ISOLATION VALVE
A B
R H WING ISOLATION VALVE
A B
ENG NO 3 BLEED AIR SHUTOFF VALVE
A C B
ENG NO 4 BLEED AIR SHUTOFF VALVE
A C B
B3
B1
B2
ENG NO 1 FIRE CONTROL HANDLE
ENG NO. 2 FIRE CONTROL HANDLE
ENG NO. 3 FIRE CONTROL HANDLE
ENG. NO 4 FIRE CONTROL HANDLE
ENG NO. 1
ENG. NO 2
ISO VALVE
ISO VALVE
ENG. NO. 3
ENG NO 4
28 VDC ESS. BUS
CLOSED
OPEN
ENG NO 1 BLEED AIR VALVE
ENG. NO. 2 BLEED AIR VALVE
NORMAL
CLOSED
L H WING ISOLATION VALVE
R H. WING ISOLATION VALVE
ENG NO 3 BLEED AIR VALVE
ENG NO 4 BLEED AIR VALVE
ANTI-ICE CONTROL PANEL

1709

PROGRAMMED TEXT
3ABR42331-PT-208A

Technical Training

Aircraft Environmental Systems Mechanic

WING AND EMPENNAGE ANTI-ICING SYSTEM

5 July 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE
DO NOT USE ON THE JOB

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FOREWORD

This programmed text was prepared for use in course 3ABR42331. The material contained herein has been validated using thirty 42010 students enrolled in the 3ABR42331 course. Ninety percent of the students taking this text achieved or surpassed the criterion called for in the approved lesson objective. The average student required 207 minutes to complete this workbook.

OBJECTIVES

Using a wiring diagram, identify four out of five given anti-icing system control circuit troubles.

In order for yoo to accomplish this objective the following areas will be covered by this programmed text.

1. The purpose of the wing and empennage anti-icing systems.

2. The function of the wing and empennage anti-icing system components.

3. The normal operation of the wing and empennage anti-icing systems.

4. The operation of the wing and empennage anti-icing control cirj uits and overheat warning circuits.

INSTRUCTIONS

This text presents material in small steps called "frames." After each frame you are asked to respond by completing statements, matching statements, or by selecting the true statements. Read the material carefully before making the response. The correct answers to the responses are given on the top of the next page of the text. If you select the correct answers, continue to the next frame. If you are incorrect, read the material again and correct your answers before continuing.

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In the past lesson you studied the cargo aircraft bleed air system. You should recall from that lesson that on the cargo aircraft, bleed air is used for several purposes, and that one of these purposes was to anti-ice the leading edge surfaces of the aircraft.

You should also recall that on the cargo aircraft, the bleed air can be supplied to the bleed air manifold by the engines, a GTC, or by a ground air supply cart.

In this lesson you will study the anti-icing system which stops ice from building up on the leading edge of the wings and empennage surfaces.

You will learn that hot engine bleed air is used to stop ice from forming on these surfaces and how this bleed air is controlled.

You should keep in mind that even though there are three sources of bleed air, the only source that can be used to operate the anti-icing system while the aircraft is in flight is the air from the engines.

As was said in the past text, this air is supplied from all four engines. For ground operation, the GTC or ground air supply cart can be used.

Fill in the blanks to complete the following statements.

1. One purpose of the engine bleed air is for ____________ the wing and empennage leading edges.

2. During flight, bleed air supplied to the bleed air manifold on the cargo aircraft by the ____________.

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Answers to Frame 1: 1. anti-icing 2. engines.

Frame 2

Anti-icing systems are required to prevent ice from forming which could force the aircraft to land or crash.

Some aircraft use anti-icing systems for the wings and empennage (tail section), and for anti-icing areas such as the radome. Others may use the anti-icing systems for the engine inlet air ducts only, while others may not have any anti-icing systems.

In addition to the anti-icing system, an automatic ice detection system is often used. The cargo aircraft that you will be studying has several anti-icing systems plus an ice detection system.

Figure 1 shows the main areas that are anti-iced on this aircraft. These areas include: (1) the leading edge of the wings, (2) the leading edge of the horizontal stabilizer, (3) the leading edge of the vertical stabilizer, (4) the engine inlet air duct and (5) the radome.

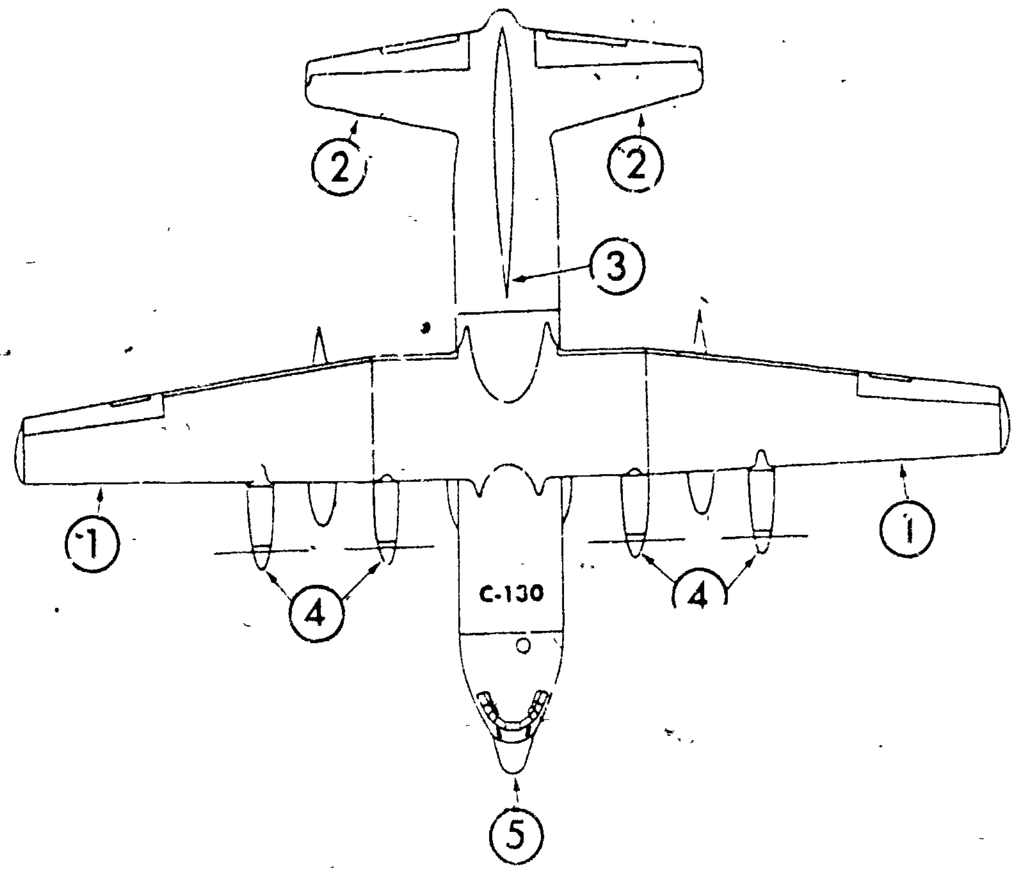

Figure 1.

Fill in the blanks to complete the following statements.

1. The purpose of an anti-icing system is to ____________ ice from accumulating.

2. The areas that are anti-iced on the cargo aircraft include the ____________ ____________ of the wings, the engine ____________ ____________ ____________, the leading edge of the ____________ ____________

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Answers to Frame 2: 1. prevent 2. leading edge, inlet air duct, vertical stabilizer.

Frame 3

In this lesson you will study only the wing and empennage anti-icing system. The engine air intake duct anti-icing system will be talked about in your next lesson.

The wing and empennage anti-icing system is made up of the ducting and valves necessary to direct the hot engine bleed air to the leading edge surfaces.

Figure 2 shows the ducting for the right wing. The left wing is the same as the right wing so it will not be taken up.

The wing leading edge anti-icing system is split up into the left and right wing systems. Then, in each wing the anti-icing system is further split up into an <u>inboard section</u> and an <u>outboard section</u>.

In the sketch shown, (A) is the inboard section, and (B) is the outboard section. The airflow from the bleed air manifold to each section is controlled by an anti-icing shutoff valve. The inboard section is controlled by the valve marked (C) and the outboard section is controlled by the valve marked (D).

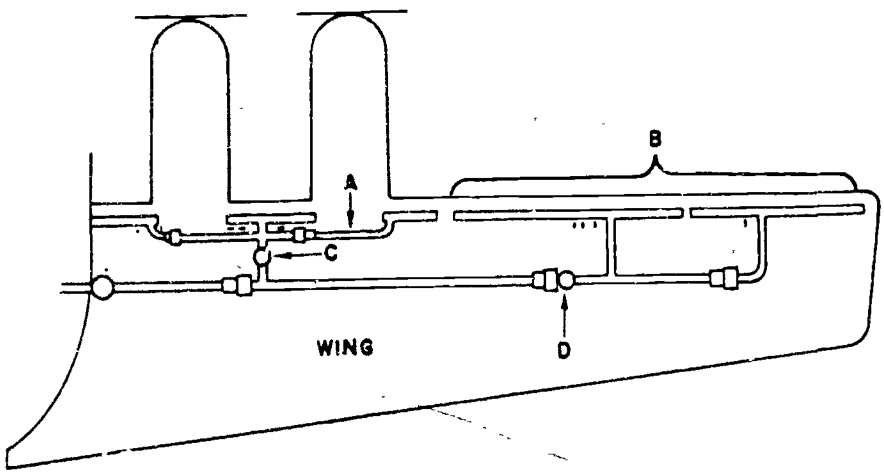

Figure 2.

Remember, this only shows the right wing. The left wing is identical. This means there are four valves that control bleed airflow for anti-icing the wing leading edge.

Fill in the blanks to complete the following statements.

1. The wing leading edge anti-icing system is divided into an ______________ and an ________________ section in each wing.
2. The bleed airflow for wing anti-icing is controlled by __________ shutoff valves.
3. The wing leading edge anti-icing is controlled by _______ (2/4) valves.

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Answers to Frame 3: 1. inboard-outboard 2. anti-icing 3. four

Frame 4

The empennage anti-icing system is also split up into two sections. Figure 3 shows this system.

Section (A) provides air for anti-icing the left horizontal stabilizer and the upper portion of the vertical stabilizer.

Section (B) provides air for anti-icing the right horizontal stabilizer and the lower portion of the vertical stabilizer.

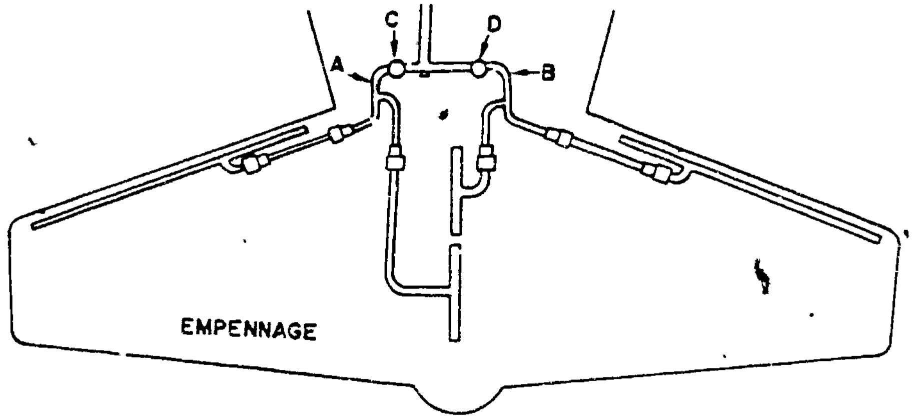

Figure 3.

Each section is controlled by a separate anti-icing system shutoff valve. The valve marked (C) controls bleed air for anti-icing the left horizontal stabilizer and the upper portion of the vertical stabilizer.

The valve marked (D) controls the bleed air for anti-icing the right horizontal stabilizer and the lower section of the vertical stabilizer.

This means there are a total of six anti-icing shutoff valves in the anti-icing system; two in the empennage and four in the wings.

Fill in the blanks to complete the following statements.

1. The empennage anti-icing system is divided into __________ sections.

2. The leading edge anti-icing system contains a total of __________ valves.

3. Anti-icing of the upper portion of the vertical stabilizer and the left horizontal stabilizer is controlled by ______________ (the same/different) valve(s).

Answers to Frame 4: 1. two 2. six 3. the same

Frame 5

The bleed air used for the leading edge anti-icing system is controlled by air actuated, solenoid controlled valves.

In the past frames, these valves were referred to as anti-icing system shutoff valves. For the remainder of the text these valves will simply be called anti-icing valves. All six valves are the same. The anti-icing valve is shown in figure 4.

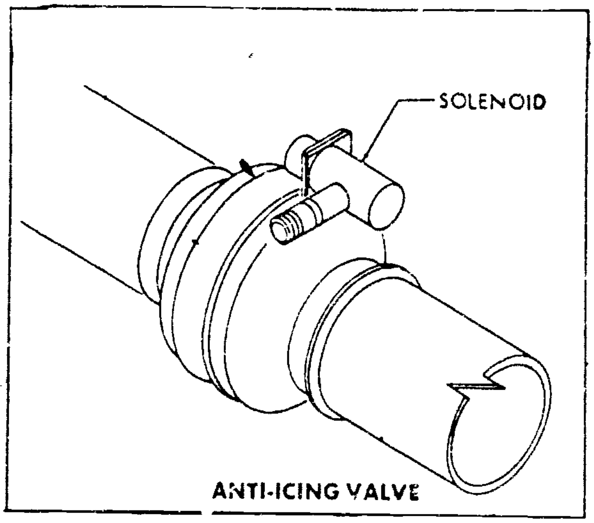

Figure 4.

Fill in the blanks to complete the following statements.

1. Anti-icing valves are actuated (opened/closed) by ______________ ______________.

2. The anti-icing valves are controlled by a ______________.

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Answers to Frame 5: 1. air pressure. 2. solenoid

Frame 6

Figure 5 shows an internal view of the anti-icing valve. The operation of this valve is somewhat different from those you have studied in the past.

This valve is made up of a solenoid, actuator, piston, return spring, orifice, and orifice seal. The opening that the air flows through is called an orifice, and the plate that opens and closes is called the orifice seal.

Find each of these parts on the sketch shown.

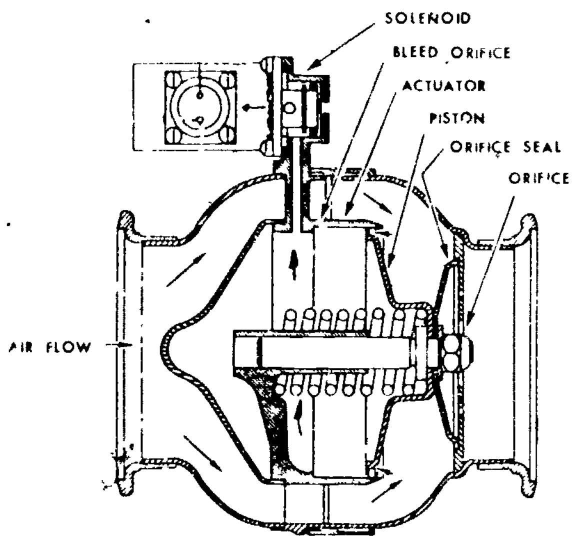

Figure 5.

The sketch shows the valve in the closed position. Let's see how the valve is held closed.

Engine bleed air from the bleed air manifold flows in and surrounds the actuator (shown by the arrows).

Now note the bleed orifice in the side of the actuator. The air that flows around the actuator will also flow into this orifice. This will equalize the pressure inside the actuator with the pressure surrounding the actuator and equalizes the pressure on each side of the piston.

Notice that the piston and orifice seal are connected. Since the pressure is the same on each side of the piston, it will not move, and the return spring will hold the orifice seal closed.

Fill in the blanks to complete the following statements.

1. The opening in the anti-icing valve that air flows through is called an ____________________.
2. When the pressure inside of the actuator is equal to the pressure surrounding the actuator, the valve will be ____________________.

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Answers to Frame 6: 1. orifice 2. closed.

Frame 7

We said earlier that the anti-icing valve is controlled by a solenoid. Let's see how this is done.

To open the valve, the solenoid must be energized. Remember, the valve was held closed by allowing the air pressure to bleed in through the bleed orifice. This keeps the air pressure the same on each side of the piston.

When the solenoid is energized, it opens a vent port. Note the vent port in the sketch shown.

With the vent port open, the air bleeds in through the bleed orifice and continues to flow out through the vent port. This will stop the pressure from building up inside the actuator and will result in a difference in pressure on the piston.

The pressure will be greater on side B than on side A (see figure 6). This pressure will overcome the spring tension and cause the actuator to move, which also moves the orifice seal. This will open the valve.

Figure 6 shows the valve in the open position.

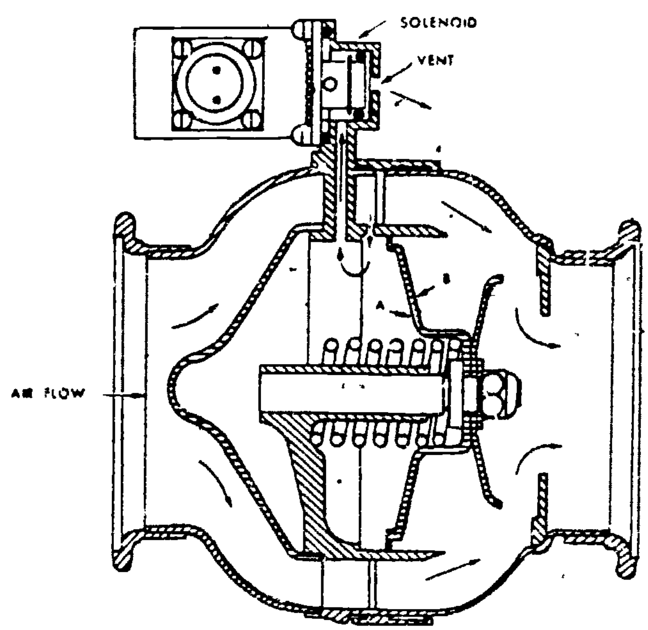

Figure 6.

Fill in the blanks to complete the following statements.

1. When the solenoid is energized, it opens a ____________ port.
2. The anti-icing valve is opened by a difference in ____________.
3. When the solenoid is energized, the pressure will be ________ surrounding the actuator than inside the actuator.

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Answers to Frame 7: 1. vent 2. pressure 3. greater

Frame 8

Now that you know the anti-icing valves are controlled by energizing and deenergizing a solenoid, let's see how the solenoid is controlled.

There are two switches on the instrument panel that control the leading edge anti-icing.

One switch controls the wing anti-icing and one controls the empennage anti-icing.

The switch for the wings, controls all four wing anti-icing valves, and the switch for the empennage controls both empennage anti-icing valves.

The sketch shows the circuit for controlling one valve. This same circuit controls the other valves also.

Detail A shows the switches that control the valves. When either of these switches is placed to the on position, it energizes the solenoids on the valves for that system.

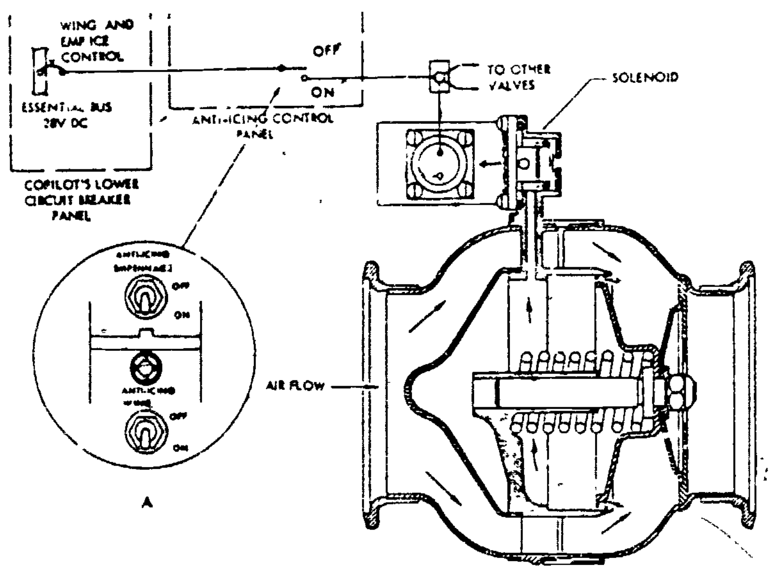


Figure 7.

Fill in blanks to complete the following statements.

1. The horizontal and vertical stabilizer anti-icing system is controlled by the ______________ ______________ switch.
2. The wing anti-icing switch controls _____ (1, 2, 3, or 4) valves.
3. The voltage required for energizing the anti-icing valve solenoids is ______________.
4. The empennage anti-icing switch controls ____ (1, 2, 3, or 4) valves.
5. To open the anti-icing valves, the solenoid must be ______________.

Answers to Frame 8: 1. anti-icing empennage 2. 4 3. 28V DC 4. 2
5. energized.

With the anti-icing valves open, the hot bleed air flows into the leading edge anti-icing ducts. Remember, the bleed air is extremely hot. If the bleed air was circulated through the wing itself, it could damage the wing surface.

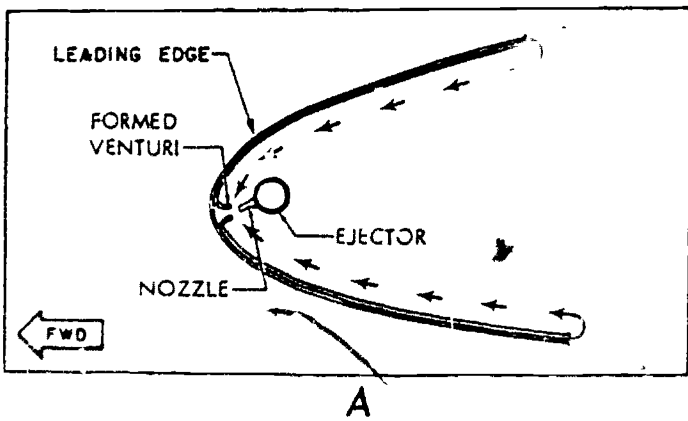
To reduce this temperature, the bleed air is mixed with the surrounding "ambient" air.

The bleed air is directed into a duct that contains several small ejector nozzles. The ejector nozzles direct the bleed air into a formed venturi as shown in figure 8, detail A. This causes a low pressure area between the ejectors and the formed venturi which pulls in ambient air.

The ambient air mixes with the bleed air. The ambient air is much cooler than the bleed air and reduces the temperature of the air circulating against the leading edge surface. This mixture of bleed air and ambient air then passes through small passages in the leading edge surface. This is shown in detail B of the sketch.

After the air flows through the passages it is pulled back into the venturi by the ejectors. This mixes with more bleed air and the air recirculates through the passages.

This recirculating process continues as long as the anti-icing system is on. As the air reaches the outboard tip of the leading edge surface, it is vented overboard through a vent.



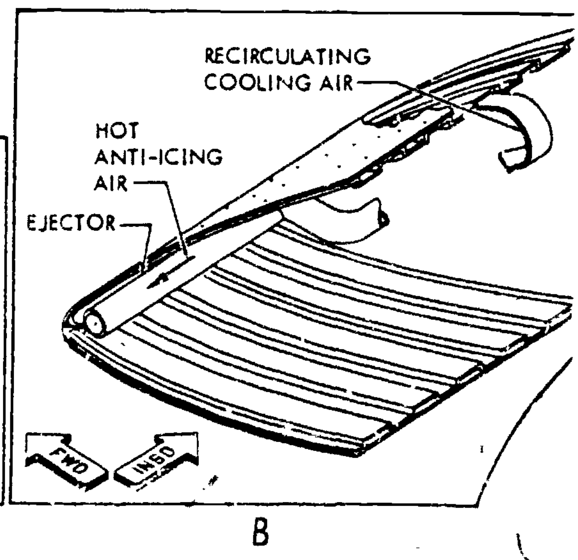


Figure 8.

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Frame 9 (Cont'd)

Fill in the blanks to complete the following statements.

1. The temperature of the air circulating against the skin of the leading edge is cooled by mixing __________ air and __________ air.

2. Ambient air is mixed with bleed air by action of the __________ __________ and formed __________.

3. After recirculating through the passages, the anti-icing air is __________ overboard.

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Answers to Frame 9: 1. bleed, ambient 2. ejector nozzles, venturi
3. vented

Frame 10

With the recirculating of air through the leading edge ducts, the temperature in the leading edge space could still go past a safe operating range.

When the system is on, an anti-ice control thermostat is used to cycle the anti-icing valve on or off.

But, before we go through the operation of the anti-ice control thermostat, we need to bring out two concepts that may be new to you. One is how a mercury thermostat operates and the second is the use of an electrical circuit called a "holding circuit."

Mercury thermostats are used in both the anti-icing systems and the cabin temperature control system. Holding circuits are used in the anti-icing control thermostat, in conjunction with the mercury thermostat, and in the ice detection system that you will learn later.

Mercury thermostats are used to control a relay which in turn will control a valve. You are probably familiar with the common mercury thermometer. A mercury thermostat is similar to the mercury thermometer.

The mercury is housed in a glass tube. When the temperature near the glass tube goes up, the mercury will expand. This will cause it to rise in the tube. When the temperature goes down, it will shrink, which will make it fall in the tube.

Since we know that mercury is temperature sensitive, it should be easy to see that it can be used in a temperature control device.

To show how a mercury thermostat can be used as a temperature sensitive control device, we'll start with a very simple control circuit.

Figure 9 shows a mercury thermostat that controls a light bulb. In this simple circuit, when the temperature is below some set value, the light will be off. Then as the temperature goes past the set value, the light will come on, because you now have provided a ground for the circuit.

The mercury thermostat acts as a switch for the light. The shaded area shows the mercury after the temperature goes up. Note that the mercury completes a circuit to turn on the light.

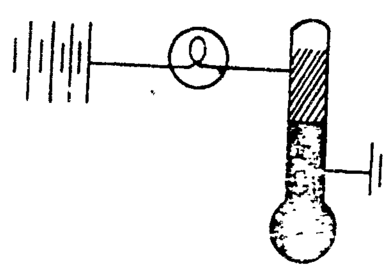

Figure 9.

-1722
Frame 10 (Cont'd)

Fill in the blanks to complete the following statements.

1. An increase in temperature will cause the mercury to __________ (expand/contract).

2. The mercury thermostat can be used as a temperature sensitive __________________.

3. In the basic circuit illustrated in figure 9, an increase in temperature will turn the light __________ (on/off).

Now let's put the mercury thermostat to work controlling a solenoid valve

Figure 10 shows a circuit that uses a mercury thermostat to control a relay which in turn controls the solenoid. In this circuit, the solenoid will be deenergized when the temperature goes past some set value (let's say 180°F).

As the air temperature on all sides of the thermostat gets to 180°F, the mercury will rise to the 180°F contact point (shown by the shaded space) which completes the ground circuit for the relay.

Let's see how this circuit works. When the switch is closed (moved to the on position), a path for 28V DC is completed through point A and point B on the solenoid coil, through the relay contacts, to ground. This will energize the solenoid.

When the temperature builds up to 180°F, the mercury will rise and complete a path through the mercury to ground for the relay coil. This will energize the relay, and pull the contacts down. Note that this will open the ground circuit for the solenoid.

As the temperature drops below 180°F, the mercury will drop in the tube and open the circuit to the relay. This will deenergize the relay, and complete the circuit to the solenoid ground. Now the solenoid will again be energized.

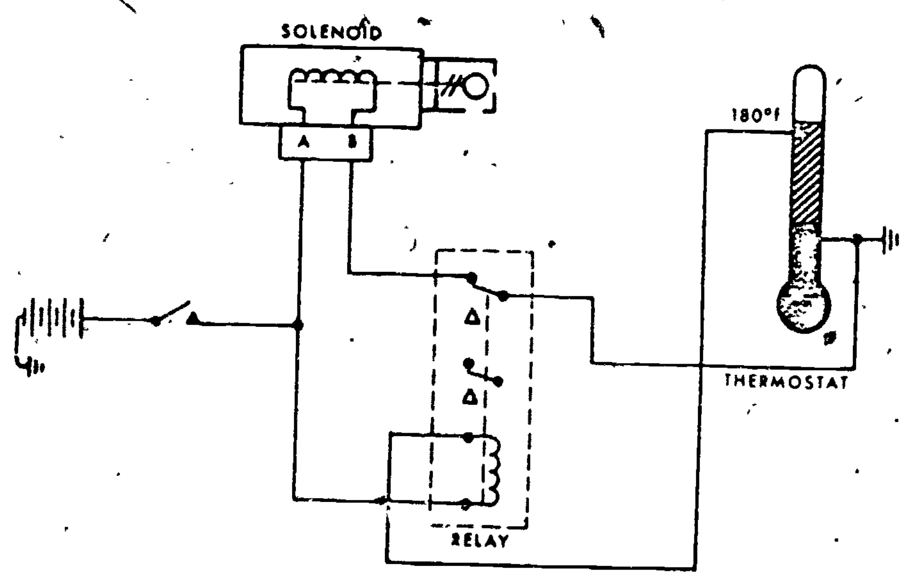

Figure 10.

Remember, the temperature of the air determines the height of the mercury. The height of the mercury determines which circuit is operating.

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Frame 11 (Cont'd)

Fill in the blanks to complete the following statements.

1. When the mercury in the thermostat reaches the 180°F point, the relay will be ____________________ (energized/deenergized).

2. When the relay is energized, the solenoid will be ________________ (energized/deenergized).

3. The thermostat assembly (relay and thermostat) controls the _______________ circuit of the solenoid.

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We've seen how a mercury thermostat can be used to deenergize a solenoid at 180°F. Now let us assume we want the solenoid to stay deenergized until the temperature drops several degrees below the 180°F setting (let's say to 158°F). This is where the "holding circuit" will be used.

Figure 11 shows the same mercury thermostat control circuit as before but now a holding circuit has been added and is shown by the dark, bold lines.

Frame 10 showed how a mercury thermostat could be used to control a valve (solenoid) at 180°F. In that circuit the relay was energized as the temperature reached 180°F, and deenergized as the temperature dropped below 180°F.

Now let's see how the thermostat control circuit can energize the relay when the temperature reaches 180°F and then keep it energized until the temperature drops below 158°F.

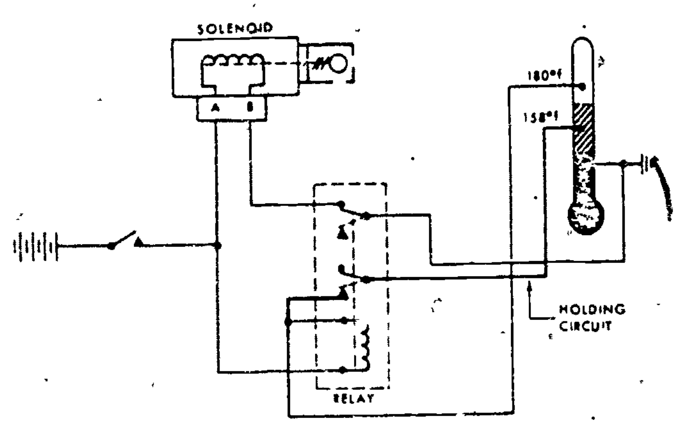

Figure 11.

Figure 11 shows the mercury on the rise due to a temperature increase. The mercury will first come in contact with the 158°F point. But, note that since the relay is still deenergized it will have no effect on our control circuit.

As the temperature goes up the mercury will rise in the tube to the 180°F point. This will complete the ground circuit to the relay coil and will energize the relay. With the relay energized, note that the relay coil now has a second path to ground through the lower relay contact and through the 158°F point on the thermostat.

Now as the temperature drops, the mercury also drops. But now the circuit through the 158°F point will keep the relay energized until the temperature drops below 158°F.

The circuit through the 158°F point serves to hold the relay energized while the temperature drops from 180°F to 158°F. This is why it is called a holding circuit.

What effect does the holding circuit have on the solenoid? When the relay is energized, the solenoid will be deenergized. From this we can see that the solenoid will be deenergized when the temperature rises to 180°F and will stay deenergized until the temperature drops below 158°F.

Fill in the blanks to complete the following statements.

1. After the temperature reaches 180°F, the solenoid will remain ______________ (energized/deenergized) until the temperature drops below 158°F due to the ______________ ______________.

2. The mercury thermostat provides the ground circuit for the ______________.

Answers to Frame 12: 1. deenergized, holding circuit 2. relay

The sketch below shows the anti-icing valve with the thermostat control circuit. From the information given in frames 10 through 12 you know how the thermostat assembly controls the anti-icing valve.

The thermostats are found in the leading edge, downstream of the valve outlet. There is one thermostat for each valve.

The thermostats are made to close the anti-icing valve when the temperature goes past 180°F and to re-open the valve when the temperature drops below 158°F The sketch shows the electrical circuit for one valve. The electrical circuit is the same for the rest of the valves.

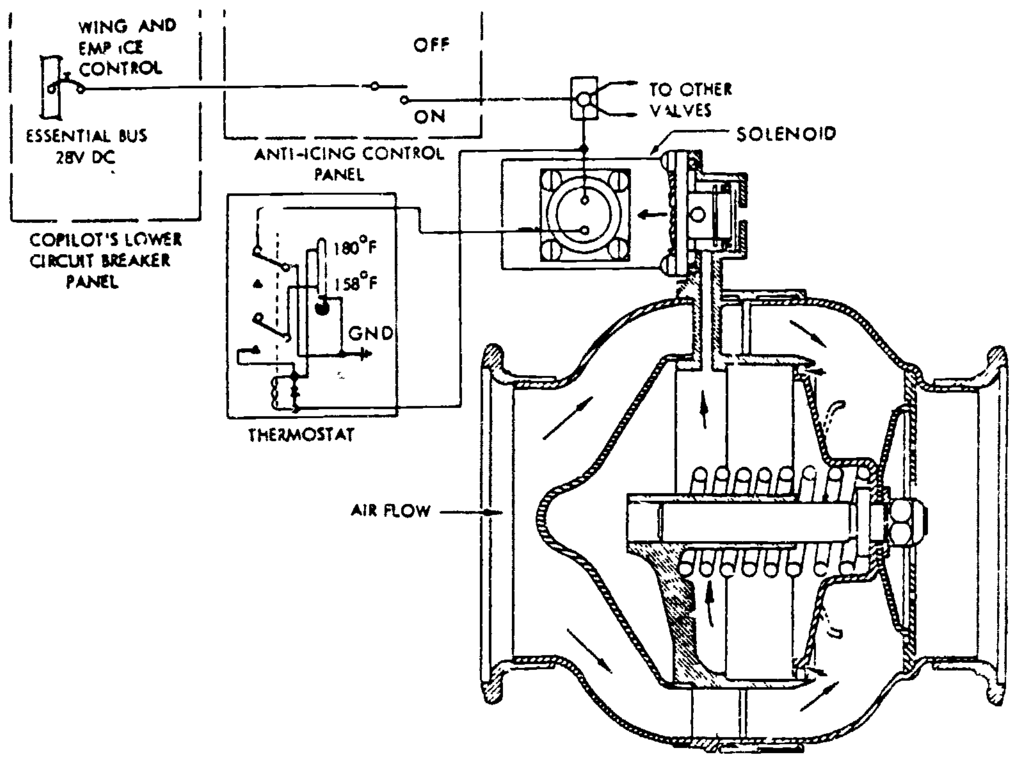

Figure 12.

Fill in the blanks to complete the following statements.

1. The leading edge anti-icing system contains ________ (2, 4, or 6) temperature control thermostats.

2. The temperature control thermostats controls the ______________ circuit of the anti-icing valve solenoid.

3. The thermostat controls the leading edge temperature by cycling the ____________ ____________ open and closed.

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Answers to Frame 13: 1. 6 2. ground 3. anti-icing valve

Frame 14

So far we've seen two ways to control the temperature of the bleed air used for anti-icing. These are the mixing of the air through the ejectors which tends to cut down the temperature, and then the thermostats that control the leading edge temperature between 158°F and 180°F.

However, there is always the possibility that a thermostat will fail or a valve will stay open which would cause an overheat condition.

Temperature indicators are used to show the leading edge temperature. The temperature indicators are shown in figure 13.

The indicators are marked "inoperative," "normal operating range," and "overheat". There are six indicators; one for each section of the leading edge anti-icing system.

During operation of the system, if the temperature is between 93°F to 180°F the temperature indicators will be in the "normal operating range."

If the temperature drops below 93°F, the indicators would show "inoperative". The temperature drop would be caused by a solenoid not energizing or a valve stuck in the closed position.

If the temperature goes above 180°F, the indicators would go to the "overheat" condition. This could be caused by a defective thermostat or a valve stuck in the open position.

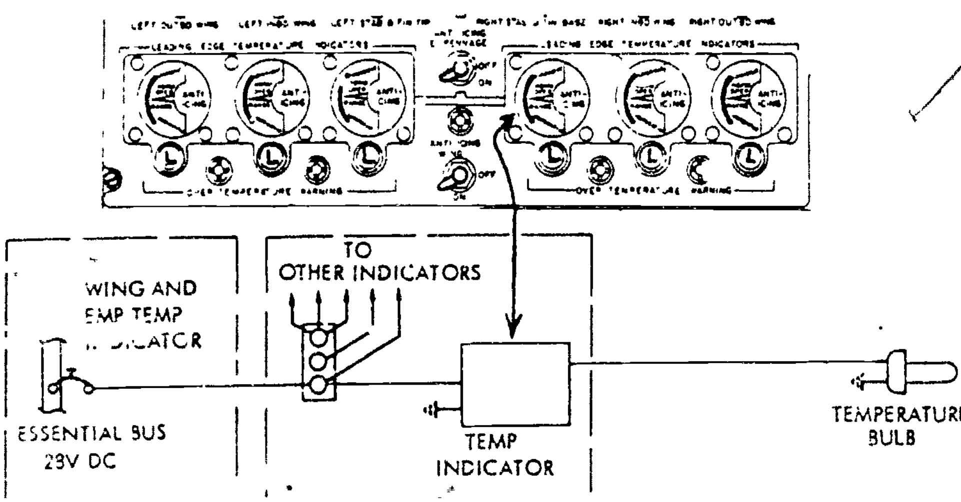

Figure 13.

In figure 13, the electrical circuit for one indicator is shown. The circuit for the other indicators are the same.

The circuit is made up of the indicator and a temperature sensing bulb. The temperature bulb is found in the leading edge.

The temper .cure bulb has a resistance that will change with temperature This will change the amount of current flow through the sensor (bulb) and through the indicator. This change in current flow will cause the indicators to show if each valve is inoperative, operating normally, or causing an overheat condition.

Fill in the blanks to complete the following statements.

1. When using the leading edge anti-icing system, the pilot can monitor the leading edge temperature by observing the temperature ________________.

2. The leading edge temperature indicators are marked ____________, ____________ ____________ ____________, and ________________.

3. The temperature in the leading edge is sensed by ________________ ________________.

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Answers to Frame 14: 1. indicator 2. inoperative, normal operating range, overheat 3. temperature bulbs.

Frame 15

In addition to the temperature indicators, six thermostatically controlled overtemperature warning lights are provided to monitor overheat conditions.

The overtemperature warning lights are found directly below the indicators on the anti-icing panel (see figure 14).

The warning lights are operated by separate warning thermostats found in the leading edge. There are two overheat warning thermostats hooked to each light.

Using two thermostats allows sensing of the temperature in two different areas within each section of the leading edge.

The warning light only tells the pilot of the overheat condition, he must take action to correct the problem. This could involve turning off the anti-icing system or closing the engine bleed air valves and the isolation valves.

The sketch in figure 14 shows the electrical circuit for one warning light. All six thermostats are wired the same.

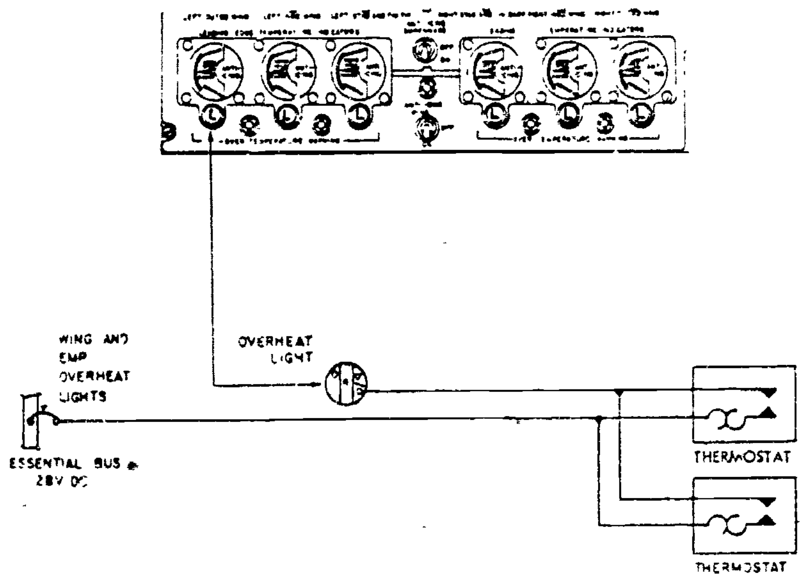

Figure 14.

Fill in the blanks to complete the following statements.

1. Should the temperature in the leading edge exceed a safe operating range, the pilot will be warned by the overtemperature __________ __________.

Frame 15 (Cont'd)

2. An overheat condition in the leading edge is sensed by overheat ________ ________.

3. With the anti-icing system operating, one section of the wing leading edge over heats. This could be caused by a malfunctioning temperature control ________.

4. During flight, to correct the problem stated in question 3 above, the pilot would have to turn off the ________ ________ system.

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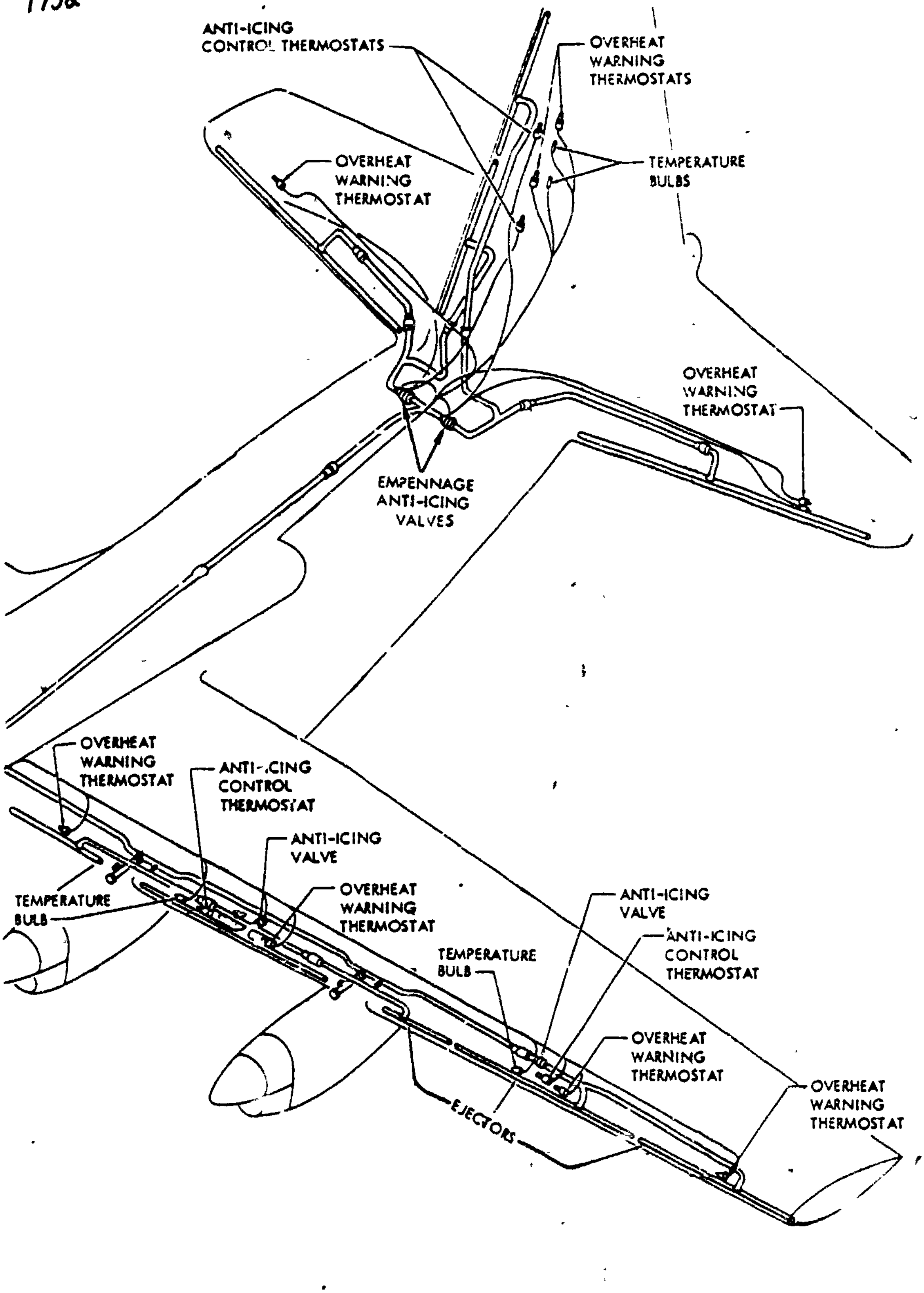


Figure 15.

Answers to Frame 15: 1. warning light 2. warning thermostat
3. thermostats 4. wing anti-icing

Frame 16

Figure 15 shows the complete anti-icing system for the left wing and empennage. The right wing is the same as the left wing. Study the sketch and find each of the parts that have been discussed in the past frames. Complete each of the following statements using the sketch as an aid.

1. The leading edge anti-icing system contains __________ anti-icing valves.

2. Each empennage anti-icing valve controls air for one side of the __________ stabilizer and half of the __________ stabilizer.

3. The leading edge overheat warning system contains __________ (3, 6, 8, or 12) thermostats.

4. The wing leading edge anti-icing system is divided into __________ __________ and contains __________ anti-icing valves.

5. The wing anti-icing switch controls ___ ______ (2/4) anti-icing valves.

6. During operation of the leading edge anti-icing system the air temperature can be monitored by the temperature __________.

7. The six tempterature indicators are operated by changes in resistance of the temperature sensing __________ located in the leading edge.

8. An overheat condition in the leading edge surface is indicated by the overtemperature __________ __________.

9. A warm air mixture is circulated through the leading edge passages by the action of the __________ __________.

10. When the wing leading edge anti-icing switch is placed to ON it energizes the __________ of the wing anti-icing valves.

11. The anti-icing valve is actuated open by ________ ________.

12. The leading edge anti-icing temperature is controlled between 158°F and 180°F by the anti-icing __________ __________.

13. The thermostat assembly consists of a __________ thermostat and a __________.

1734.

Answers to Frame 16: 1. six 2. horizontal-vertical 3. 12
4. four sections, 4 5. four 6. indicators
7. bulb 8. warning lights 9. ejector nozzles
10. solenoid 11. air pressure 12. control thermostat
13. mercury relay

Frame 17

In the past frames you learned that the air for anti-icing is held in check by air actuated, solenoid controlled valves and that the solenoids are controlled by mercury type control thermostats.

At the time of normal operation of the anti-icing system, the temperature of the anti-icing air in the leading edge is shown on temperature indicators found in the cockpit.

Should the temperature in the leading edges go past a safe operating range, an overtemperature warning light will be turned on by overheat warning thermostat.

The electrical circuitry for this system is shown in foldout 1. Foldout 1 is the last page of this text, please open to this foldout now.

This sketch shows the anti-icing valve solenoids, anti-icing control thermostats, overheat warning thermostats and temperature sensing bulbs for each of the six zones. Find each of these parts on the diagram. Now find the anti-icing wing and anti-icing empennage switches, the leading edge temperature indicators, and the overtemperature warning lights.

The electrical circuitry for control of each zone is the same. Let's trace the circuits for the left outboard wing zone.

Use your RED pencil and draw the anti-icing wing switch to the ON position. Trace from the wing and empennage ice control circuit breaker, through the anti-icing wing switch, and up to pin A of the left outboard wing anti-icing valve solenoid.

Then trace through the solenoid to pin B and then down to the top contact of the anti-icing control thermostat. Trace through the thermostat relay to ground.

This circuit will energize the solenoid, permitting the anti-icing valve to open if air pressure is available. Note that the circuit from the wing anti-icing switch powers each of the wing anti-icing solenoids in the same way.

With your red pencil keep on tracing the circuit to point X and down to the thermostat relay coil. Trace through the relay coil to the 180°F contact.

Since the mercury is down, this is an open circuit and we have only a voltage potential. As the temperature reaches 180°F, the mercury will complete the circuit, energizing the relay. This opens the ground circuit to the solenoid which closes the valve.

Frame 17 (Cont'd)

Using your BLUE pencil, trace the overheat warning light circuit for the left outboard wing.

Start by tracing from the wing and empennage overheat light circuit breaker to the left outboard wing overtemperature warning light. Then trace from the overtemperature warning light to pin A on each of the overheat warning thermostats.

If either thermostat contact closes, due to an overheat condition, it will complete the circuit to ground, which will turn on the warning light. Again note that the circuits for all six lights are the same and operate in the same way.

Using your GREEN pencil, trace the circuit for the left outboard wing temperature indicator.

Start by tracing from the wing and empennage temperature indicator circuit breaker to the left outboard wing temperature indicator.

Then trace from the indicator to pin A of the left outboard wing sensing bulb. Continue tracing through the sensing bulb to pin B and ground.

Remember from Frame 14 that the resistance of the sensing bulb will vary with the changes in temperature. This change in resistance will change the current flow through the indicators. The change in current flow through the indicators will inform the pilot if the system is operating normally, is inoperative, or is in an overheat condition. Notice that all six indicator circuits are the same.

Fill in the blanks to complete the following statements.

1. The overtemperature warning lights are turned on by ____________ ____________ ____________.

2. The anti-icing control thermostat controls the anti-icing valve ____________ by opening and closing the ____________ circuit to the solenoid.

3. The anti-icing control thermostat consists of a ____________ and a ____________ type thermostat.

1736

Answers to Frame 17: 1. overheat warning thermostat
2. solenoid, ground
3. relay, mercury

Frame 18

On foldout 1 there are 15 circled numbers. These numbers indicate troubles, either in a circuit or a part. The numbers that point to a part mean that the part could have a short or an open circuit on the inside.

The statements below give the condition for a trouble in the system. Read the statement then analyze the sketch to determine the possible cause. Place the number of the trouble that would cause this condition in the blank provided.

_____1. The right inboard wing overtemperature warning light comes on with the anti-icing system OFF.

_____2. With the anti-icing switches ON, the right stabilizer and fin base temperature indicator shows inoperative.

_____3. With both anti-icing switches ON, the wing system operates normally, but the empennage system fails to operate.

_____4. During operation of the anti-icing system, the left stabilizer and fin tip temperature indicator goes to overheat and the warning light comes on.

_____5. With the anti-icing system turned ON, the left stabilizer and fin tip anti-icing valve fails to open.

_____6. During operation of the anti-icing system, the right inboard wing temperature indicator shows OVERHEAT, and the overtemperature warning light comes on.

_____7. During operation of the anti-icing system, the right outboard wing temperature indicator shows OVERHEAT but the warning light does not come on.

_____8. The right inboard wing temperature indicator shows inoperative with the wing anti-icing switch ON.

_____9. With both anti-icing switches ON, the empennage temperature indicators show normal operation, but the wing temperature indicators show inoperative.

_____10. The right outboard wing anti-icing valve fails to open with the wing anti-icing switch ON and air pressure available.

Answers to Frame 18: 1. 5 2. 12 3. 1 4. 15 5. 10 6. 8 7. 14 and 11 8. 7 9. 2 10. 13

Frame 19

At this point you should know how a leading edge anti-icing system works. But your tasks as a maintenance mechanic demands that you keep this system working right. So the next points, we need to look at are the inspection and maintenance procedures:

Inspection of the system takes in a visual inspection for cracks in the ducting, corrosion, loose connections, or any signs of leaks.

The insulation should be checked for being secure and to make sure there are no tears. The system should be checked to make sure the parts are working right.

The system can be checked for operation while the aircraft is on the ground by looking at the temperature indicators for a temperature rise. Most technical manuals will caution you not to operate an anti-icing system for more than 30 seconds while the aircraft is on the ground.

Since there is no airflow over the leading edge surfaces, such as there is in flight, leaving the anti-icing system on for more than 30 seconds could damage the leading edge by warping the skin.

The general procedures for performing an operational check are as follows:

1. Make sure all systems using bleed air are OFF.

2. Apply bleed air to the system using either the GTC or ground air cart.

3. Place the wing and empennage anti-icing switches to ON. Look at the bleed air pressure gage as the switches are turned on. The bleed air pressure should drop indicating that the valves are opening.

4. Look at the anti-icing temperature indicators. The temperature indicators should show a temperature rise of approximately the same amount on all indicators. If one indicator does not show a temperature rise, then it will be necessary to check the valve in that specific location.

The operational check procedures are used to find out if the valves will open. It does not check thermostat operation. Keep in mind that the procedures given are general concepts only.

NOTE: Before doing any maintenance on an aircraft, you must always refer to the applicable technical manual for the correct procedure and to determine specifically what must be done.

1738

Frame 19 (Cont'd)

The repair procedures depend on the cause for the specific problem. If a valve fails to operate properly, you will have to find out the cause through troubleshooting. In most cases the problem will be due to a defective valve or thermostat. This would require replacement of the defective part. Again, it's a must that you refer to the technical manual for the correct removal and replacement procedures.

Fill in the blanks to complete the following statements

1. When performing a ground operational check, anti-icing valve operation is indicated by a temperature rise on the ________ ________ ________________.

2. The maximum time for operating the anti-icing system while the aircraft is on the ground is ________________.

3. To determine procedures for operational checking or repairing the anti-icing system, you should refer to the aircraft ____________ ____________.

Answers to Frame 19: 1. temperature indicators 2. 30 seconds
3. technical manual

Frame 20

Place a T or F in the blank to identify the statements that are either true or false.

_____1. Each section of the wing leading edge anti-icing system has an anti-icing shutoff valve.

_____2. The wing anti-icing switch controls four valves.

_____3. During flight, air can be supplied for anti-icing by the GTC.

_____4. When the leading edge anti-icing valve solenoids are energized the valve will be open.

_____5. The wing leading edge anti-icing valves are solenoid controlled and pneumatically actuated.

_____6. During anti-icing operation, the temperature of the leading edge is controlled by a mercury thermostat.

_____7. An overheat condition of the leading edge is indicated by the temperature indicator and by warning lights.

_____8. The anti-icing systems should never be operated for more than 30 seconds when the aircraft is on the ground.

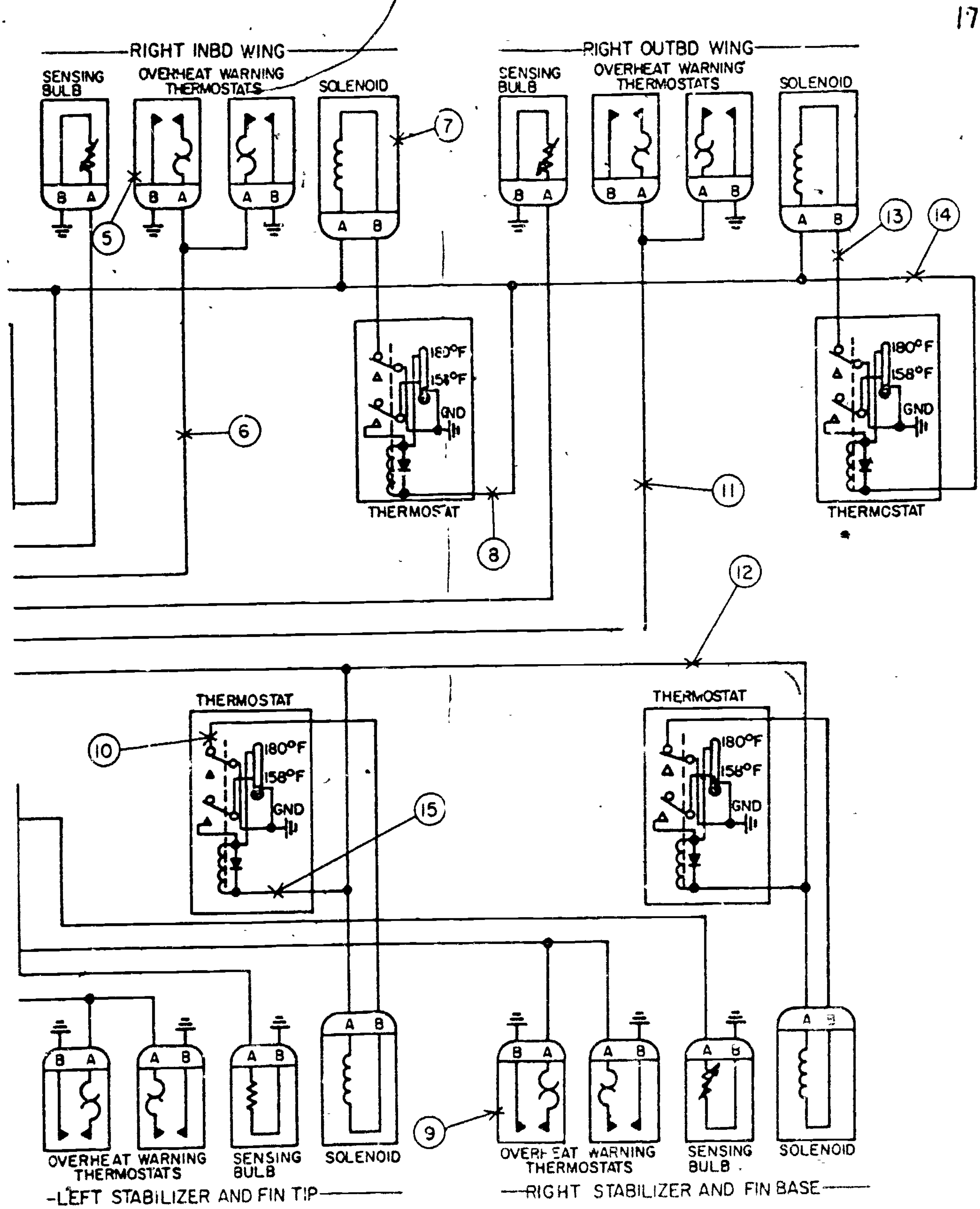
_____9. To perform an operational check of the anti-icing systems, you should follow the steps given in the technical manual.

_____10. During operation of the anti-icing system, the thermostat controls thy position of the valve by opening and closing the solenoid ground circuit.

Answers to Frame 20:

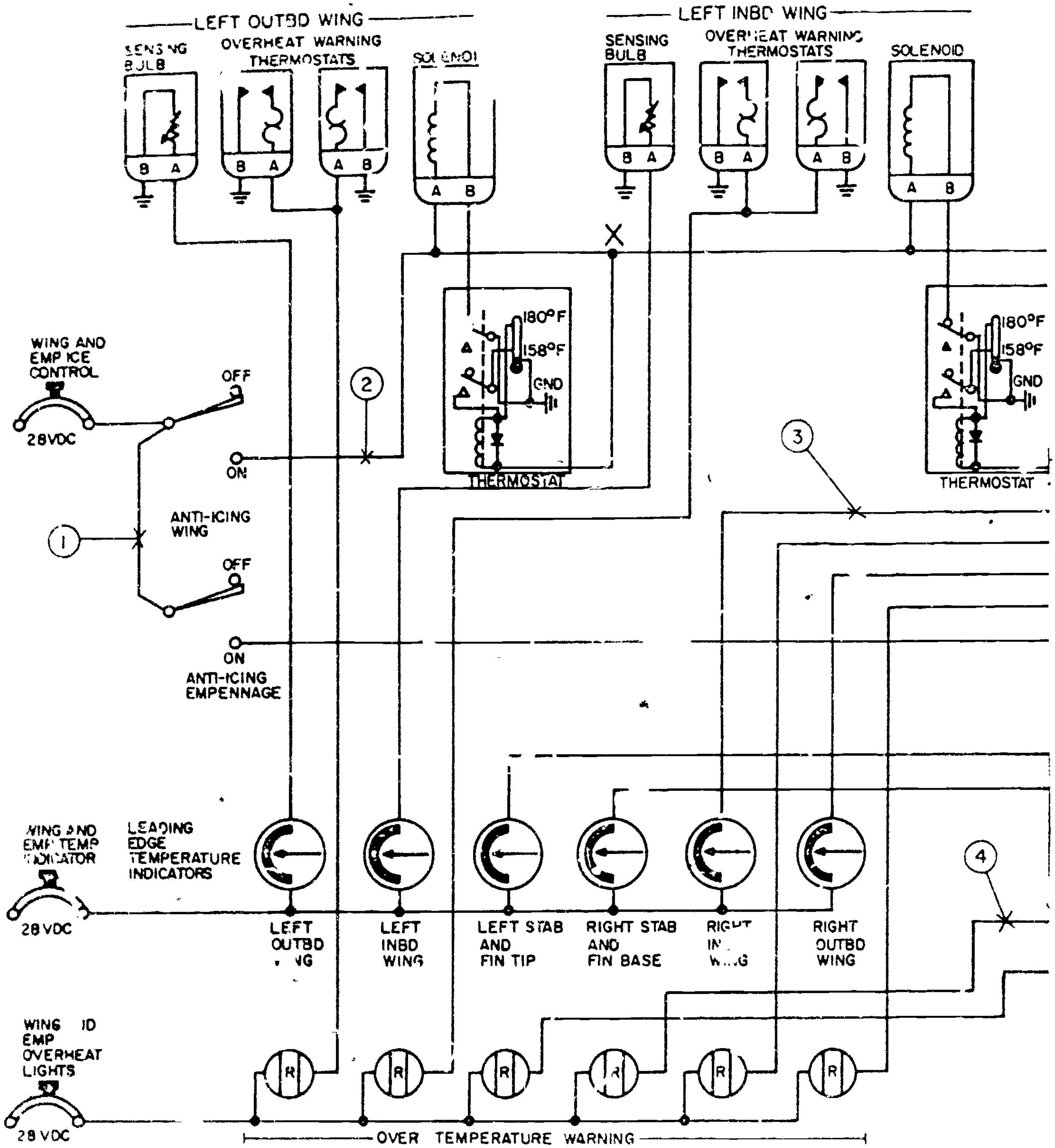
1. T
2. T
3. F
4. T
5. T
6. T
7. T
8. T
9. T
10. T

1740



Foldout 1. Section 2.

1741



Foldout 1. Section 1.

1742

PROGRAMMED TEXT

3ABR42331-PT-208B

Technical Training

Aircraft Environment 1 Systems Mechanic

ENGINE AIR INTAKE DUCT ANTI-ICING SYSTEM

20 June 1977

3350 TECHNICAL TRAINING WING
3370th Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

DO NOT USE ON THE JOB

1743

OBJECTIVE

Using a wiring diagram, identify four (4) out of five (5) given air intake duct anti-icing control circuit troubles.

INSTRUCTIONS

This text presents material in steps called frames. After each frame you are asked to respond to questions in some manner. Read the material carefully and accomplish what each frame directs you to do. The correct answers are given at the end of the next frame. If you have answered each response correctly continue on to the next frame. If you are incorrect, read the material again and correct your answer before continuing.

This programmed text will cover the function and operation of the air intake duct anti-icing system, the system components, and the ice detection system. In addition, the location of the switches on the control panel will be gone over, and you will be required to trace through the electrical circuit to learn normal operation. Finally, you will be required to analyze the wiring diagram and determine the cause for system troubles that you will be given.

Proceed on to Frame 1.

[illegible]-PT-2073, 24 January 1973.
[illegible]

The previous text told how hot engine bleed air is used to prevent ice from building up on the wing and empennage leading edges. In the previous text we also pointed out the various areas that were anti-iced on a typical cargo aircraft.

The sketch that was used in the previous text is shown again in figure 1 below. Note that item 4 points to the engines. If the aircraft flies into an area where icing conditions are taking place, the ice will build up on the engine air intake ducts. In fact, ice will build up in the engine inlet area sooner than on the leading edges. This is due to the increase in air velocity at the engine air intake which causes a lower temperature.

Any buildup of ice in the engine air intake system could be harmful to engine operation. In this text we'll discuss how ice is detected in the air inlet and how any buildup of ice is prevented.

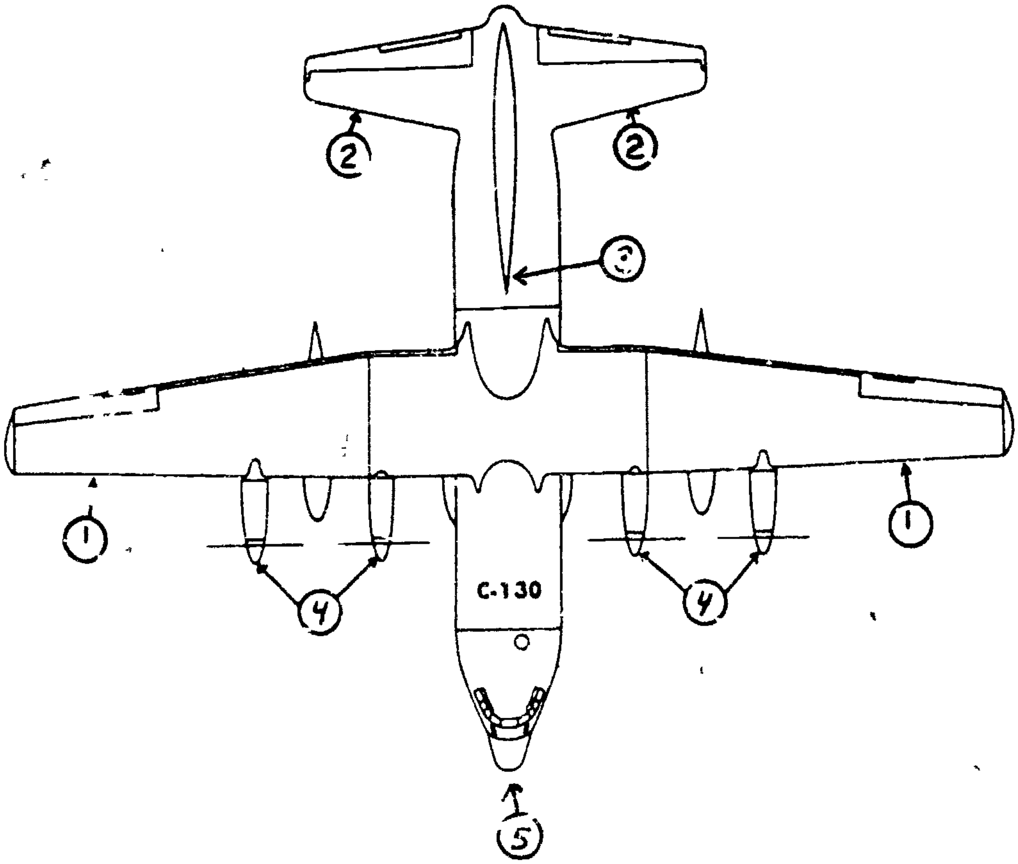


Figure 1.

NO RESPONSE REQUIRED

1745
Frame 2

Figure 2 below depicts the engine nacelle and shows how the bleed air flows from the engine to the oil cooler scoop and air intake scoop. The bleed air is taken from the last stage of engine compression. This is normally called the "engine inlet scoop" anti-icing system.

Note the arrows that show the flow of air from the bleed air tap-offs to the air intake scoop area. Also note the small arrows showing the flow of air through the passages around the air intake scoop.

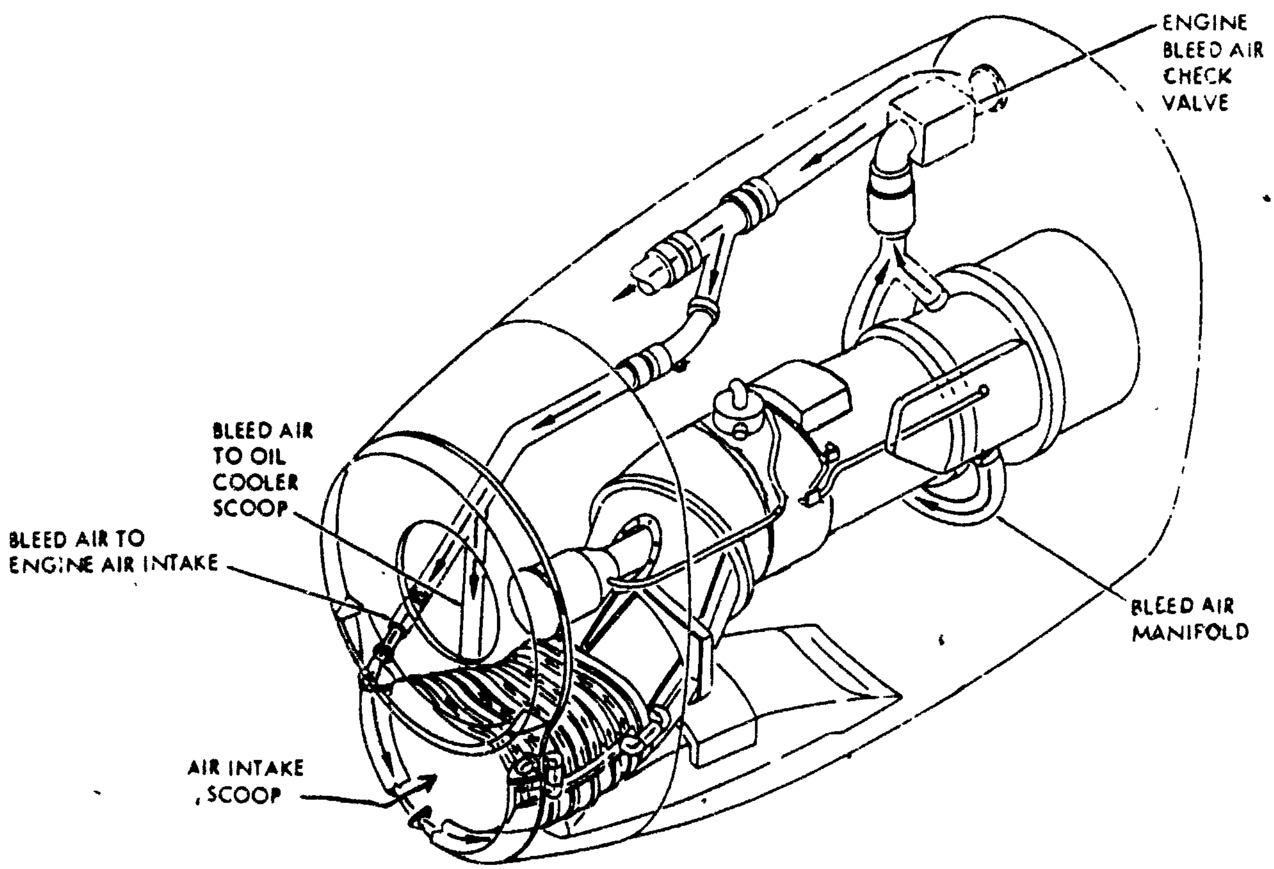


Figure 2.

Fill in the blanks to complete the following statements.

1. The air for the anti-icing system (inlet air scoop) is taken from the ________________ stage of engine compression.

2. The air for anti-icing the air intake scoop is circulated through ____________________.

A <u>solenoid controlled</u>, <u>air actuated valve</u> is used to control air flow to the air intake and oil cooler scoops. Figure 3 shows the engine air intake and oil cooler scoop anti-icing valve. Reference point A in the illustration shows the location of this valve in the system. This valve is normally called the "engine inlet scoop anti-icing valve."

There is one feature about the engine inlet scoop anti-icing valve that is different from other valves that you've studied On this valve the solenoid is energized to close the valve, and deenergized to open the valve. This is called a fail-safe valve. That is, if there is an electrical power failure the valve will open. This feature insures anti-icing of the scoops even with an electrical power failure.

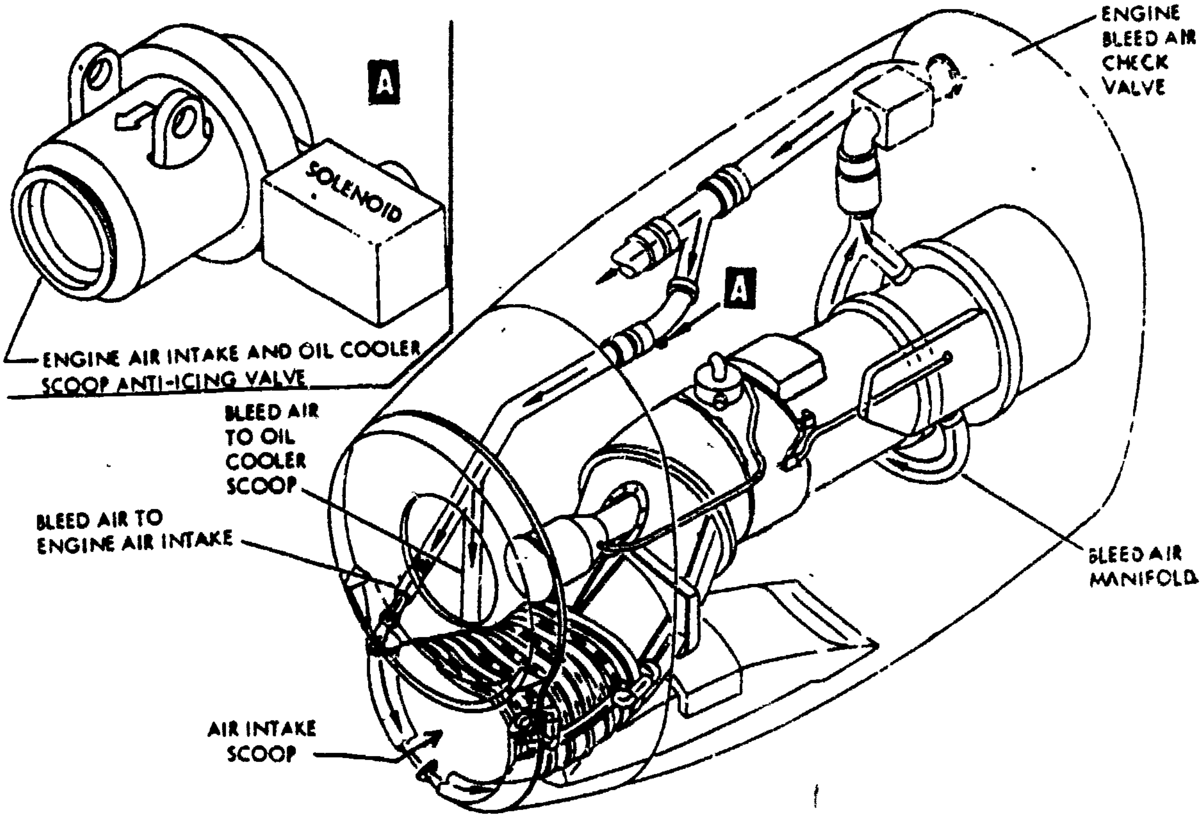


Figure 3.

1747

Frame 3 (Cont'd)

Fill in the blanks to complete the following statements.

1. Air for anti-icing the engine air intake is controlled by the engine ____________ ____________ ____________ valve.

2. Opening and closing of the engine inlet scoop anti-icing valve is controlled by a ________________.

3. When the engine inlet scoop anti-icing valve is closed, the solenoid is ____________________ (energized/deenergized).

Answers to Frame 2: 1. last 2. passages

Another area in the air intake duct where ice can build up is the guide vanes. Figure 4 shows the guide vane anti-icing system. Detail B shows the inlet vane anti-icing valve, and detail C shows the inlet vane anti-icing solenoid valve. Note the reference points showing the location of these units on the engine.

There are two inlet vane anti-icing valves for each engine. One valve is located on each side of the engine as shown in detail D. The same solenoid controls both valves.

Detail D shows the guide vane and flow of air through the vanes. The guide vanes direct the flow of ram air to the engine compressor. Any buildup of ice on the vanes could cause engine failure.

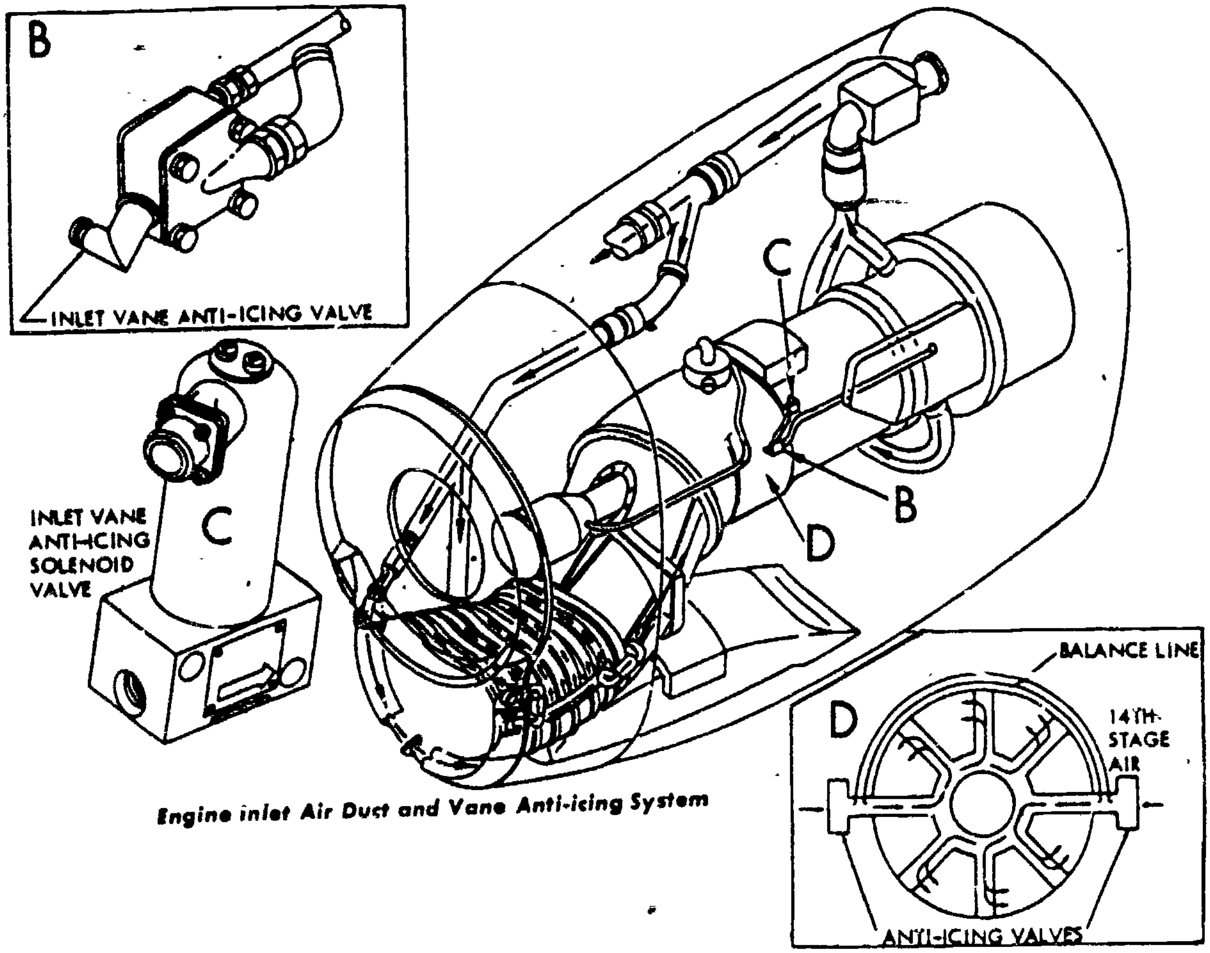


Figure 4.

1749

Frame 4 (Cont'd)

Fill in the blanks to complete the following statements.

1. Ice is prevented from accumulating on the engine guide vanes by circulating hot ________________ ________________ through the vanes.

2. The units that control air for guide vana anti-icing are the inlet vane anti-icing _____________ valve and the inlet vane _____________.

Answers to Frame 3:
1. inlet scoop anti-icing
2. solenoid
3. energized

The inlet vane anti-icing solenoid valve controls the on and off action of the guide vane anti-icing system. The bleed air from the 14th (last) stage is directed to the anti-icing air valve as shown in the illustration below.

When the solenoid is energized, as shown, the anti-icing valve is held closed by the pressure of the bleed air. When the solenoid is deenergized it opens a vent port that vents the pressure from the poppet in the anti-icing air valve, thus allowing the valve to open. The 14th stage bleed air can now flow to the guide vanes.

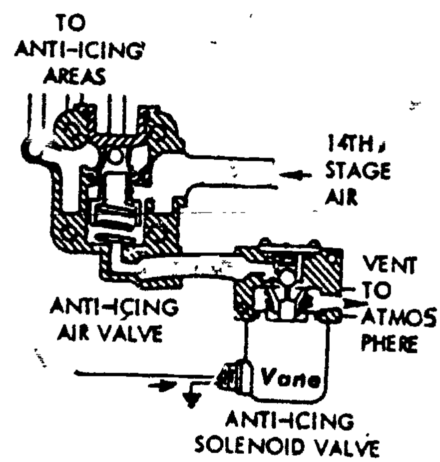


Figure 5.

Fill in the blanks to complete the following statements.

1. The guide vane anti-icing air valve is controlled by the anti-icing ________________ ________________.

2. Deenergizing the anti-icing solenoid valve opens a ____________ port.

3. When the anti-icing solenoid valve is energized, the anti-icing air valve will be ________________(open/closed).

Answers to Frame 4: 1. bleed air 2. solenoid anti-icing valve

The engine inlet air duct and vane anti-icing system can be controlled either automatically or manually. The control switches for the engine inlet duct and vane anti-icing are shown in the illustration below.

The PROP and ENGINE ANTI-ICING MASTER SWITCH controls the manual or automatic selection. The ENGINE INLET AIR DUCT ANTI-ICING SWITCHES control the on and off selection of the anti-icing valves.

Placing the MASTER SWITCH in AUTO and the ANTI-ICING SWITCHES ON, the anti-icing valves will be opened by the ice detection system, and will only open when an icing condition occurs.

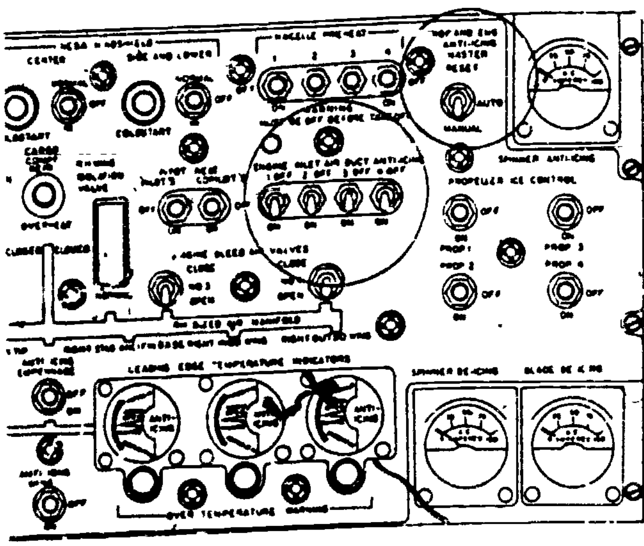


Figure 6.

Fill in the blanks to complete the following statements.

1. The auto or manual selection of the engine inlet duct and vane anti-icing system is controlled by the ______________ and ______________ anti-icing ______________ ______________.

2. The on and off selection of the inlet scoop anti-icing system is controlled by the ______________ ______________ ______________ ______________ anti-icing switches.

3. When the prop and engine anti-icing master switch is in AUTO, the inlet scoop anti-icing valves will open only when an ______________ ______________ occurs.

Answers to Frame 5: 1. solenoid valve 2. vent 3. closed

 1752

Figure 7 shows the electrical schematic of the engine inlet air duct and vane anti-icing system. Remember, when the system is off, the solenoids are energized, and when ON the solenoids are deenergized. Let's follow the circuits for anti-icing control for number 1 engine to see how this system is controlled manually. The arrows show the path of current flow.

When the engine inlet air duct anti-icing switches are off, the circuit is complete from the circuit breaker to the inlet scoop anti-icing valve solenoid and to the guide vane anti-icing solenoid valve. This energizes both solenoids. If the anti-icing switch is placed to ON it opens the circuit, deenergizing the solenoids which open the valves.

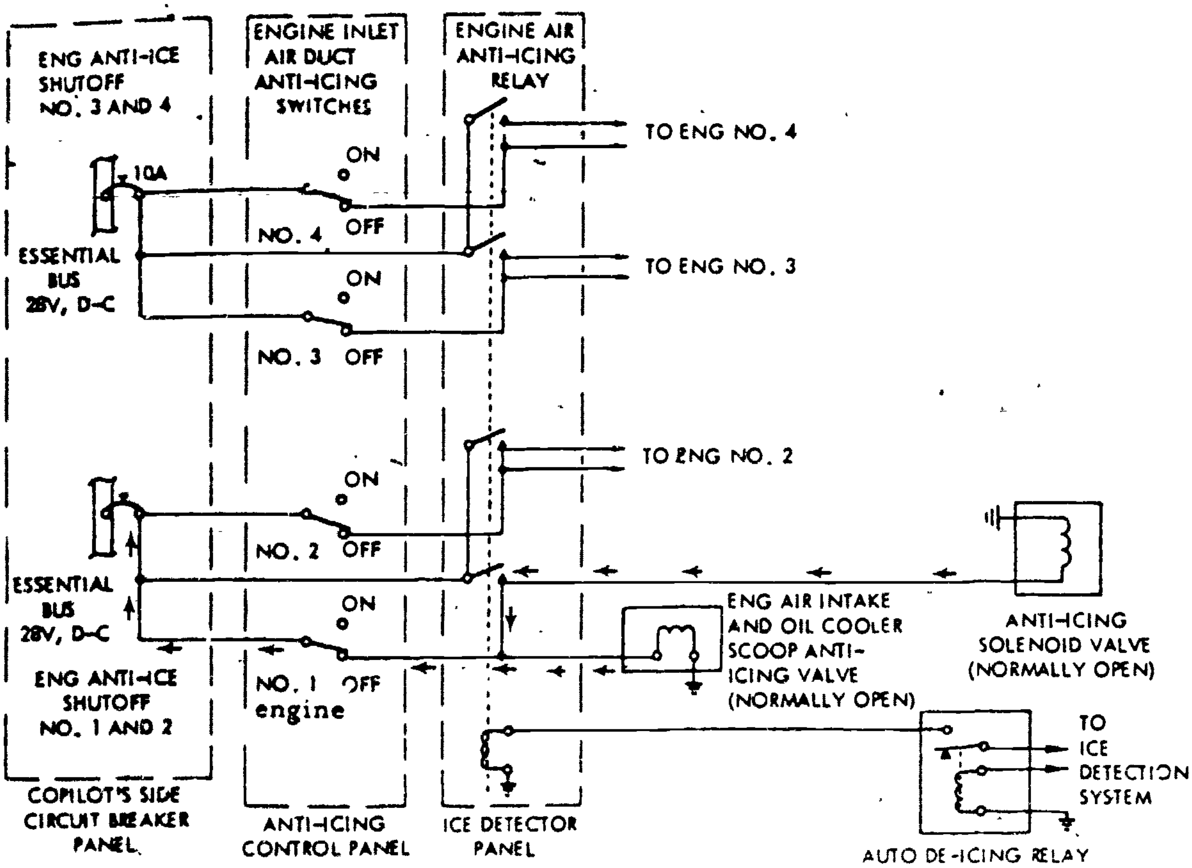


Figure 7.

530

1753

Frame 7 (Cont'd)

Fill in the blanks to complete the following statements.

1. When the engine inlet air duct anti-icing switches are OFF, the engine air intake scoop anti-icing solenoid valve will be ______________.

2. The engine inlet air duct and vane anti-icing valves will be open when the solenoids are ________________.

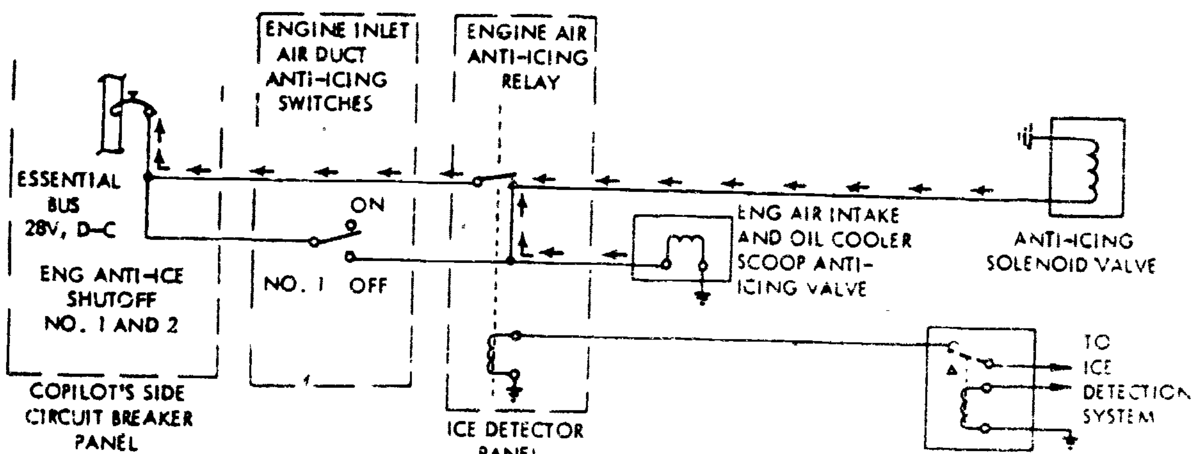
.wers to Frame 6: 1. prop engine master switch
2. engine inlet air duct
3. icing condition

Placing the prop and engine anti-icing master switch to AUTO will turn on the ice detection system. With the ice detection system operating, the engine inlet air duct anti-icing switches can be placed to ON, but the valves will onlv open when an icing condition occurs.

Find the engine air anti-icing relay and the auto deicing relay on the sketch shown. When the ice detection system is operating, with no ice, the auto deicing relay is deenergized and directs current flow to keep the engine air anti-icing relay energized. The sketch shows the circuit with a no ice condition.

The arrows show current flow for the valves on number 1 engine. Keep in mind that anti-icing control of all four engines is the same. Note that in the no ice condition, electrical power is lead to the solenoids regardless of the position of the engine inlet air duct anti-icing switches.

When an icing condition takes place, the ice detection system will cause the auto deicing relay to energize. This opens the circuit to the engine air anti-icing relay causing it to deenergize. This will deenergize the solenoids opening the valves.



Engine Inlet Air Duct and Vane Anti-icing System

Figure 8.

1755

Frame 8 (cont'd)

Fill in the blanks to complete the following statements.

1. With the prop and engine anti-icing master switch in AUTO, and a no ice condition, the engine air anti-icing relay will be ____________.

2. When the engine air anti-icing relay is energized, the inlet scoop and vane anti-icing valves will be __________ (opened/closed).

3. The engine air anti-icing relay is controlled by the __________ ____________ system.

Answers to Frame 7: 1. energized 2. deenergized

Select the component name from column B that matches the statement given in column A. Place the letter of the matching component in the blank space provided.

Column A	Column B
1. _____ Controls the inlet vane anti-icing valves.	A. Engine air intake and oil cooler scoop anti-icing valve.
2. _____ Controls the automatic and manual selection of the inlet scoop and guide vane anti-icing system.	B. Inlet vane anti-icing valve.
	C. Inlet vane anti-icing solenoid valve.
3. _____ Directs 14th stage air to passages in the guide vanes.	D. Prop and engine anti-icing master switch.
4. _____ Directs 14th stage air to passages in the air intake scoop.	E. Engine inlet air duct anti-icing switch.

Place a T (true) or an F (false) in the blank to identify the statement(s) that are either true or false.

5. _____ The fail-safe feature of the engine inlet scoop and guide vane anti-icing valves means that in case of an electrical power failure, the valves will open.

6. _____ The engine inlet scoop and guide vane anti-icing system contains one inlet vane anti-icing valve and one inlet vane anti-icing solenoid valve.

Answers to Frame 8: . energized 2. closed 3. ice detection

The ice detection system is used as an automatic control for the engine inlet air anti-icing system. That is, it will automatically open the engine inlet scoop and guide vane anti-icing valves when an icing condition takes place. Keep in mind that this system does not control the wing or tail leading edge anti-icing system.

The ice detection system is made up of TWO sets of detection units, an auto deicing relay, a reset relay, a warning-icing condition light, and a no-ice light.

Each set of detection units has a detector and an interpreter. These units are shown below. The detector and interpreter are the two chief parts of this system.

The interpreters are found on the ice detection panel. The detectors are found in the engine nacelles. One detector is found in the number 2 engine nacelle and one is found in the number 3 engine nacelle. The probe of the detector unit goes through the nacelle and into the inlet air duct just in front of the engine.

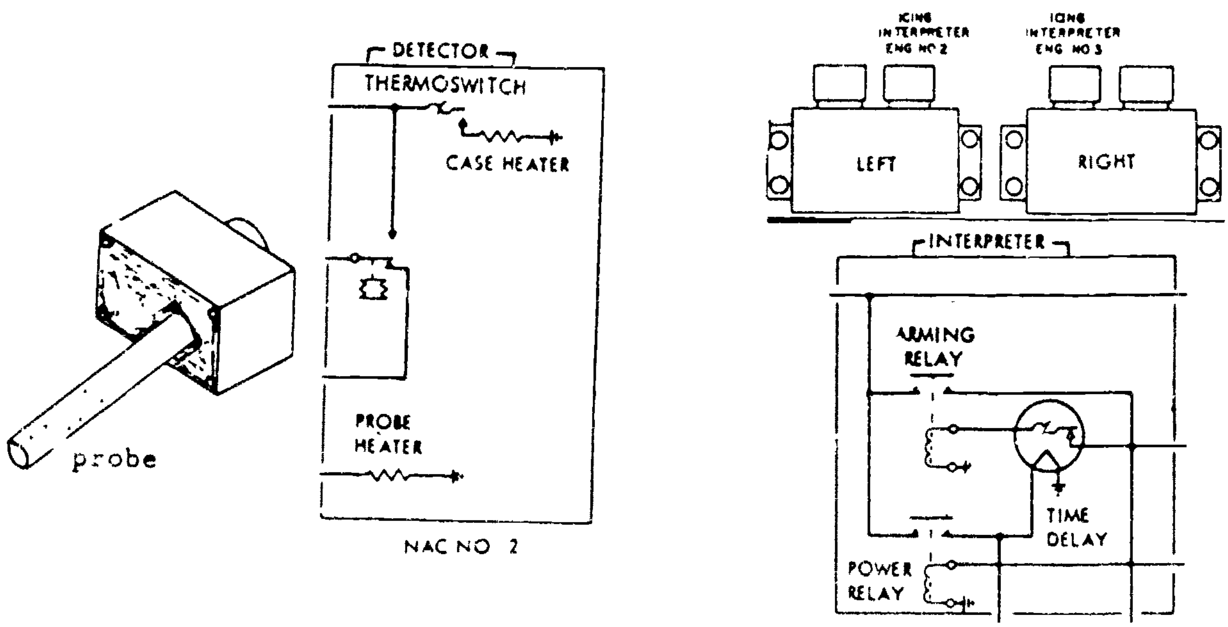


Figure 9.

Fill in the blanks to complete the following statements.

1. The ice detection system controls the opening of the ____________ ____________ ____________ and ____________ ____________ anti-icing valves.

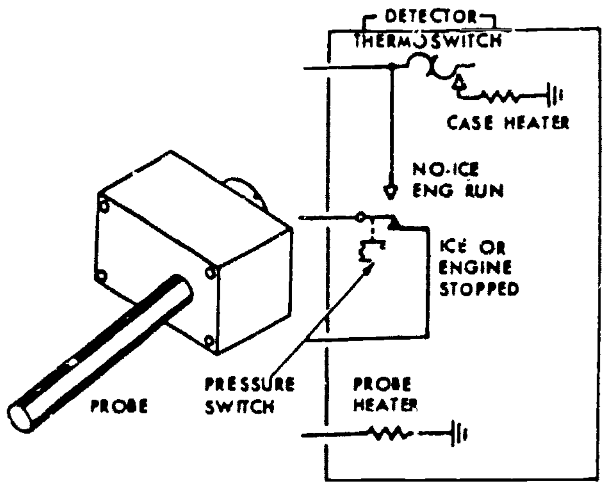
2. The two major components of the ice detection system are the ____________ and ____________.

3. The ice detectors are located in the inlet scoop of engines number ____________ and ____________.

Answers to Frame 9: 1. C 2. D 3. B 4. A 5. T 6. F

1759
Frame 11

The detector, shown in figure 10, is made up of the probe, a pressure sensitive switch, a case heater, and a thermoswitch. The probe, extending into the inlet air scoop, senses the pressure of the incoming ram air. If there is no ice, the opening to the probe is open and the pressure of the incoming ram air is passed on to the pressure switch. This pressure will keep the pressure switch contacts in the no-ice position. An airspeed of 40 knots or above (or by operating the engines) will provide enough of an air pressure to actuate the switch.



NAC NO. 2.

Figure 10.

When the aircraft meets an icing condition, the ice will form over the opening in the probe. This will stop the pressure that goes to the pressure switch. The switch contacts will move to the ice or engine stopped position. This will set the detector system in operation causing the engine air intake anti-icing valves to open.

The probe heater will also start operating to melt the ice from the probe, which allows the system to return to the no-ice condition after the aircraft flies out of the area where icing is occurring. The case heater and thermostat maintains between 55°F and 75°F in the detector unit to prevent moisture from accumulating.

Fill in the blanks to complete the following statements.

1. The detector consists of a ____________, pressure ____________, probe ____________, and ______________ heater.

2. The detector detects ice by sensing air ______________.

Answers to Frame 10:
1. engine inlet scoop guide vane
2. detector interpreter
3. 2 and 3

1761

Frame 12

At this point you know the engine air intake duct anti-icing system can either be operated manually or automatically. Your next step is tracing the circuits to learn how the system is controlled in manual and how the ice detection system controls the system in automatic. The next to the las page of this text contains a foldout diagram (foldout 1) of this system. Fold out this page now.

On the foldout, locate the PROP AND ENGINE ANTI-ICING MASTER SWITCH, the reset relay, scoop anti-icing solenoid valves, vane anti-icing solenoid valves, and the engine inlet air duct anti-icing switches.

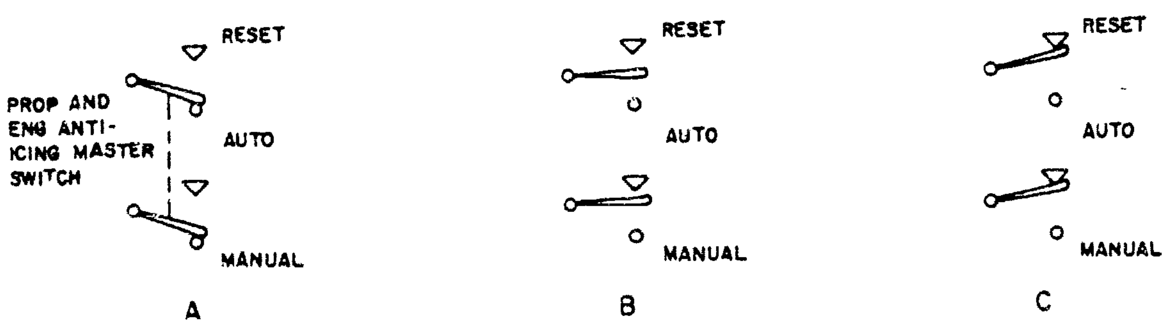
We'll start our analysis of how the system operates by first tracing the manual operation, then by tracing the automatic operation. However, before we start tracing circuit operation, let's look at the switch that selects manual or automatic operation. This switch is the PROP AND ENGINE ANTI-ICING MASTER SWITCH.

Notice the prop and engine anti-icing Master Switch in foldout 1. This same switch is also shown in illustrations A, B, and C below. This is a three position switch. The positions are MANUAL, AUTO, and RESET.

Illustration A shows the switch in manual Position. Notice that the switch levers are down. By looking at foldout 1 you will see that this directs power to the reset relay coil.

Illustration B shows the switch in the AUTO position. Notice that both contacts are open. In this position the switch simply opens the circuit to the reset relay coil. This permits the reset relay to remain deenergized. In this position the relay will direct power for automatic operation.

The third position on the switch is RESET. This is shown in illustration C. Notice the contacts for the reset position are triangular shaped. This means the switch is spring loaded from this position, or that it must be held in this position.



Fill in the blanks to complete the following statements.

1. Manual or Auto operation of the engine air intake duct anti-icing system is selected by using the __________ __________ __________ __________ __________ __________.

2. When the prop and engine anti-icing master switch contacts are in the center position, the engine air intake duct anti-icing valves will be controlled ________________ (automatically/manually).

Answers to Frame 11: 1. probe switch heater case
2. pressure

1763
Frame 13

We'll start circuit tracing by analyzing manual operation first. On foldout 1, using an orange pencil, draw the master switch contacts to the MANUAL position. Trace from the prop deicing timer circuit breaker to the master switch.

Trace through the top contact and to the reset relay coil. When the master switch is in MANUAL, the reset relay is energized. Without tracing follow the circuit from the PROP DE-ICING TIMER circuit breaker to the top contact of the reset relay. Notice that when the relay is deenergized there is a completed circuit that goes to the engine air anti-icing relay coil.

From this we can see that when the master switch is in MANUAL, the engine air anti-icing relay is deenergized, and when the master switch is in AUTO the engine air anti-icing relay will be energized.

Keep in mind that when the engine inlet air duct anti-icing switches are off, the solenoids will be energized. We'll trace the circuit for the valves in No. 1 engine. You can then notice that the circuits for the other three engines are identical.

With an orange pencil, trace from the ANTI-ICE No. 1 and 2 circuit breaker to the No. 1 engine inlet air duct anti-icing switch.

With the switch in OFF, trace through the switch to the No. 1 engine scoop anti-icing solenoid valve and to the vane anti-icing solenoid valve.

This energizes the solenoids, keeping the valves closed. If we place the switch to ON, we'll open the circuit, deenergizing the solenoids, thus permitting the valves to open.

Fill in the blanks to complete the following statements.

1. The prop and engine anti-icing ____________ ______________ is used to select AUTO or MANUAL operation.

2. When the master switch is in manual the reset relay is ______________ (energized/deenergized).

3. The engine air anti-icing relay is deenergized when the reset relay is ________________ (energized/deenergized).

4. For manual operation the engine air anti-icing relay is ____________ (energized/deenergized).

Answers to Frame 12: 1. prop and engine anti-icing master switch
2. automatically

Before we trace the circuits for automatic operation, locate the following items on the foldout diagram.

1. Detector
    a. Case heater
    b. Pressure switch
    c. Probe heater
2. Interpreter
    a. Arming relay
    b. Power relay
3. No-ice pulsing relay
4. No-ice light
5. Warning icing condition light
6. Auto deicing relay

The ice detection system works in a set sequence. It starts with the "engine stopped" condition, goes to an "engine run" condition, then to the "ice" condition (when a real icing is met), and last to the "no-ice" condition. When electrical power is first put on the aircraft, the engines are not operating so the pressure switch will be in the ice or engine stopped position. We'll start by tracing the power potential that will exist when electrical power is first put on the aircraft.

We'll trace the circuits with the master switch in AUTO and the engine/inlet air duct anti-icing switches ON.

With a RED pencil, draw the master switch to AUTO, and the anti-icing switches to ON. Note that with the master switch in AUTO, the reset relay will be deenergized.

Start to trace, in RED, the circuit wire from the prop deicing timer circuit breaker, through the top contact of the reset relay, and through the bottom contact of the auto deicing relay. Then trace to the engine air anti-icing relay coil. This will energize this relay.

Starting at the ENG ANTI-ICING No. 1 and 2 circuit breaker, trace to Point A, then from point A, trace the circuit to the bottom contact of the engine air anti-icing relay.

1765

Frame 14 (Cont'd)

From this relay contact, trace the circuits to the scoop anti-icing solenoid valve and to the vane anti-icing solenoid valve.

This will keep the solenoids energized. Notice that to deenergize the solenoids (open the valves) it will be necessary to deenergize the engine air anti-icing relay.

Also notice that for the system to operate in AUTO, the engine inlet air duct anti-icing switches must be placed to ON.

With the red pencil, trace from the LH ICE DETECTOR circuit breaker to the first junction.

Then trace down to the arming relay and power relay contacts.

Next trace from the junction to the detector thermoswitch down to the pressure switch contact.

Since the engines are not running, this switch will be in the ICE OR ENGINE STOPPED position. These circuits provide the voltage potential to arm the system once the engines are started.

Fill in the blanks to complete the following statements.

1. For the system to operate in AUTO, the engine inlet air ducting anti-icing switches must be placed to __________ (on/off).

2. During automatic operation, the reset relay will be ______________ (energized/deenergized).

3. With the master switch in AUTO, when electrical power is first applied to the aircraft, the anti-icing valve solenoids will be ____________.

4. When electrical power is first applied to the aircraft, if the temperature in the detector is below 55°F the case heater ___________ (will/will not) operate.

5. When the solenoids are energized, the valves are ___________ (closed/open).

Answers to Frame 13:
1. master switch
2. energized
3. energized
4. deenergized

The next step in our sequence is engine run condition. When either of the inboard engines (No. 2 or 3) are started, the air pressure in the engine air intake will be sufficient to move the pressure switch contacts to the NO-ICE ENGINE RUN position.

Using a BLUE pencil, draw the switch to this position.

With the blue pencil, trace from the pressure switch contact to junction No. 1.

From junction No. 1, trace through the time delay thermoswitch contact to the arming relay coil. This will energize the arming relay.

Draw the arming relay contacts down.

Trace from the arming relay contact back to junction No. 1.

From junction No. 1 trace back through the arming relay coil. This forms a holding circuit which will keep the arming relay energized regardless of the position of the pressure switch contacts.

With the blue pencil, trace from junction 1 to contact 2 of the auto de-icing relay.

This provides a voltage potential at this point that will be used when ice is detected.

Fill in the blanks to complete the following statements.

1. When the pressure switch moves from the engine stopped position to the engine run position, the ice detection system will be _____________.

2. After the arming relay closes, it will be held in this position by the _______________ _______________.

Answers to Frame 14:
1. on
2. deenergized
3. energized
4. will
5. closed

1767

Frame 16

If an actual icing condition is encountered (during flight), ice will form over the probe. This will cause the pressure switch to move to the ICE or ENGINE STOPPED position.

Using a GREEN pencil, draw the pressure switch to the ICE or ENGINE STOPPED position.

With the green pencil, trace a dashed line from the pressure switch contact to the power relay coil. This will energize the power relay.

Draw the power relay contacts closed. Then trace a dashed line to junction 2.

From junction 2, trace a dashed line to junction 5, then to junction 6.

Then trace down and across the bottom contact of the reset relay and to the auto deicing relay coil. Then to the warning icing condition light.

This circuit turns on the warning light to inform the pilot of the icing condition, and also energizes the auto deicing relay.

NOTICE that when the auto deicing relay is energized it opens the circuit going to the engine air anti-icing relay. Remember, when this relay is deenergized during automatic operation, it permits the anti-icing valves to open.

Go back to junction 3 and trace a dashed green line to the probe heater. Also trace from junction 4 to the no-ice pulsing relay coil. These circuits provide power to the heater and to the no-ice pulsing relay whenever the power relay is energized.

You're probably wondering why the dashed green line. Part of this circuit is a pulsating circuit. The probe heater is wound around the probe. When electrical current flows through the heater, it will melt the ice from the probe.

This means that when ice forms over the probe, the pressure switch moves to the ice position which energizes the power relay. This in turn allows current flow to the probe heater which melts the ice from the probe. When this happens, the pressure switch moves to the NO-ice position which deenergizes the power relay. This stops current going to the probe heater which permits ice to again form over the probe.

The power relay will stay energized for less than 15 seconds. Also notice that the current going to the no-ice pulsing relay will also pulsate causing this relay to pulsate. However, the anti-icing valves will not pulsate. They will stay open. We'll see how this is possible in the next frame.

Questions for this frame will be found on the next page.

Fill in the blanks to complete the following statements.

1. The power relay receives electrical power whenever ice forms on the ________________.

2. When the power relay is energized, current will flow to the ____________ heater, ____________ pulsing relay, ____________ ____________ light, and to the auto deicing relay. ____________

3. The engine air anti-icing relay is controlled by the ____________ ________________ ____________.

Answers to Frame 15: 1. armed
2. holding circuit

1769

Frame 17

We've noted that part of the circuit gets a pulsating current flow. Still, we want the anti-icing valves to stay open, and the warning light to stay on as long as the aircraft is in an icing condition. This it will do. But let's see how.

We previously traced power to contact 2 (blue line) of the auto deicing relay. When the icing state was detected it energized the auto deicing relay

With the green pencil draw the contacts of the auto deicing relay down.

Now trace the circuits from contact 2, using a solid green line to junction 5.

Keep on tracing from junction 5 to junction 6, then down and across the bottom contact of the reset relay.

From the bottom contact of the reset relay, go on to the auto deicing relay coil and to the warning icing condition light.

The circuit from contact 2 around to the auto deicing relay coil has formed a holding circuit that will keep the auto deicing relay energized, even though the power from the power relay is pulsating.

The auto deicing relay will stay energized continuously, because of the steady power received from contact 2. Also the light will remain on continuously.

Power from junction 6 will also go to the no-ice pulsing relay contact, and to the thermal switch in the no-ice time delay.

With a green pencil trace these circuits.

These circuits tell the pilot when he out of the icing condition. We'll analyze the no-ice condition in the next frame.

Fill in the blanks to complete the following statements.

1. When an icing condition is encountered, the pressure switch and power relay will ________________.

2. When the auto deicing relay energizes, contact 2 will complete a ________________ circuit to keep the relay energized.

Answers to Frame 16:
1. probe
2. probe no-ice warning icing condition
3. auto deicing relay.

Up to this point we have traced the circuits that will cause the anti-icing valves to open by deenergizing the solenoids, and turning on the warning icing condition light.

The next step in our sequence is the no-ice condition. When the aircraft flies out of the icing condition, the pilot has to be told so that he can turn the system off. An important point to note is that the system will not turn off automatically.

When the aircraft goes to a no-ice condition, the ice will stop forming over the probe. The pressure switch will then stay in the no-ice engine run position. This means the power relay will stay deenergized. When this takes place there will no longer be current flow to the no-ice pulsing relay, and the relay will stay deenergized.

Earlier we had traced a voltage potential to the no-ice pulsing relay contact, and to the thermal switch in the no-ice time delay. Since the no-ice pulsing relay is now remaining in the deenergized position, current will flow through the contact to the heating element in the no-ice time delay. When current flows through this heater for 90 seconds, it will cause sufficient heat to close the contacts of the thermal switch. When the thermal switch closes current can flow to the no-ice light.

Using a BROWN pencil, trace from the no-ice time delay thermal switch to the no-ice light.

The result of current flow through the no-ice time delay heating element, and then through the thermal switch, turns on the no ice light. This tells the pilot that he no longer needs the engine inlet air duct anti-icing system on. Remember, we stated earlier that the system will not shut off automatically, the pilot must turn it off.

Also remember, that the no-ice light will not come on until 90 seconds after the aircraft flies out of an icing condition.

Fill in the blanks to complete the following statements.

1. When an icing condition no longer exists, the NO-ICE light will be turned on by the __________ __________ __________.

2. The no-ice time delay thermoswitch is closed by a __________ element.

Answers to Frame 17: 1. pulsate
2. holding

Frame 19

To stop the anti-icing system from operating the pilot will momentarily place the master switch to reset. The switch is spring loaded from this position. When this switch is held momentarily to RESET, it will direct current flow to the reset relay. This will energize the relay.

Now notice that when the relay is energized, it opens the holding circuit (bottom contact) to the auto deicing relay. This deenergizes the auto deicing relay. When the master switch is released it goes back to AUTO, which again deenergizes the reset relay.

Now notice that when the reset relay and the auto deicing relays are deenergized there is a complete circuit to the engine air anti-icing relay coil. This energizes the engine air anti-icing relay which completes the circuit to energize the scoop and vane anti-icing solenoids. This closes all valves.

Fill in the blanks to complete the following statements.

1. After an icing condition, to close the engine inlet scoop and guide vane anti-icing valves the pilot must place the master switch to ______________________.

2. The no-ice light is turned off after the master switch is placed to ______________________.

Answers to Frame 18: 1. no-ice time delay
2. heating

In the course of normal operation, the power relay should at no time stay energized for more than 15 seconds. If it should stay energized for more than 15 seconds, the time delay unit in the interpreter will dearm the system.

Let's see how this will take place. Note that when the power relay is energized, current flows to junction 2 and from junction 2 it can go up to the heater in the time delay unit.

If current flows through the heater for more than 15 seconds it will cause enough heat which will open the time delay thermal switch. This will open the switch contacts, which will open the holding circuit that is keeping the arming relay energized.

This will open the circuit through the arming relay which turns the system off. The system will stay off until the pressure switch moves back to the NO-ICE ENGINE RUN position which will rearm the system. This would be an abnormal operation which could be caused by a trouble such as an <u>inoperative probe heater</u>.

Fill in the blanks to complete the following statements.

1. If the pressure switch remains in the ICE OR ENGINE STOPPED position, the system will be shut off by the ______________ ______________ unit.

2. During inflight operation, with the master switch in AUTO, the warning icing condition light comes on, but after a few seconds the light goes out. This trouble could be caused by a defective ______________ ______________ ______________.

Answers to Frame 19: 1. reset
2. reset

1773
Frame 21

Open foldout 2. This foldout contains the electrical diagram of the system with several troubles indicated by circled numbers. The following statements identify probable troubles in the system. Read the statements, then select the circled number from the diagram that would cause the trouble. When complete, have thy instructor check your answers.

1. _____ During flight, with the master switch in Auto, the warning icing condition light does not come on, but the valves opened.

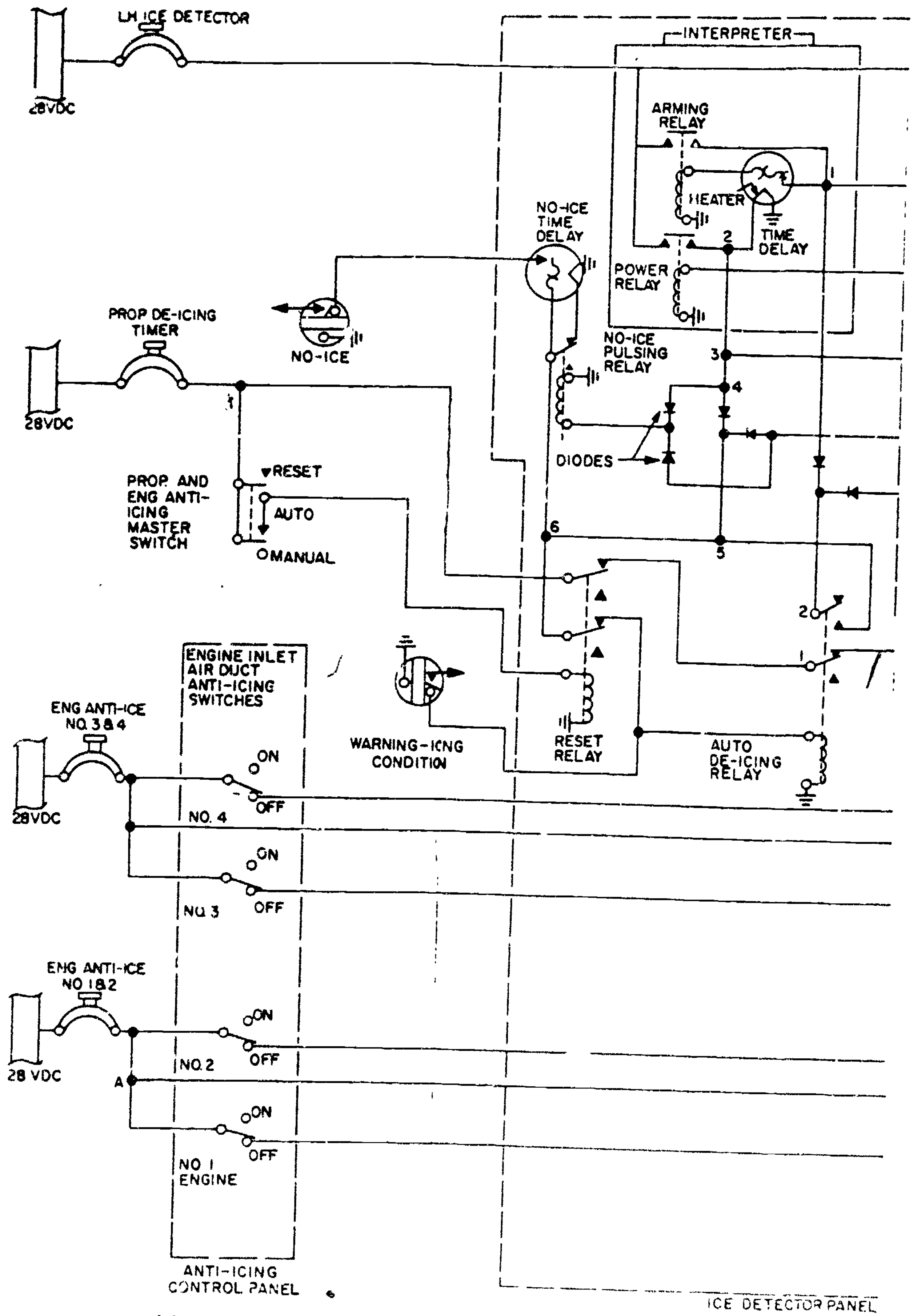
2. _____ During flight, the warning icing condition light comes on; remains on for approximately 15 seconds, then goes out. To maintain engine anti-icing, the system must be operated in manual.

3. _____ During flight, the master switch in AUTO, the warning icing condition light shows a pulsating operation, and the engine anti-ice valves do not open.

4. _____ During operation of the ice detection system, the warning icing condition light comes on, but the no-ice light does not come on.

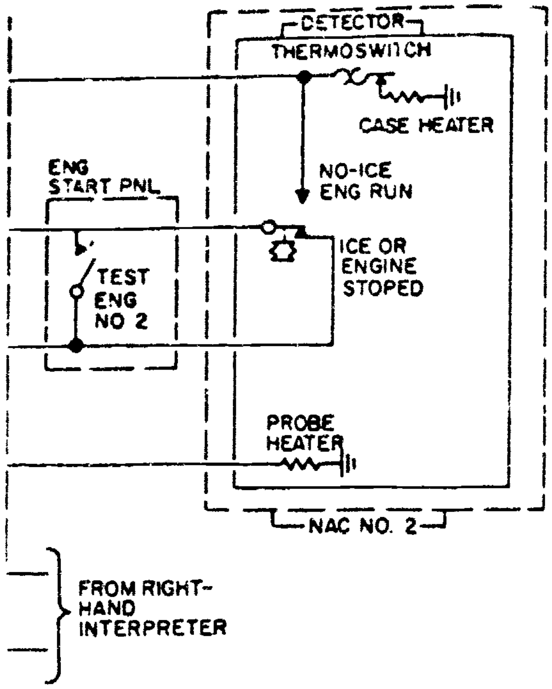
5. _____ With the master switch in MANUAL, the No. 1 engine anti-icing valves remain open with the switch in OFF. The valves close when the master switch is placed to AUTO.

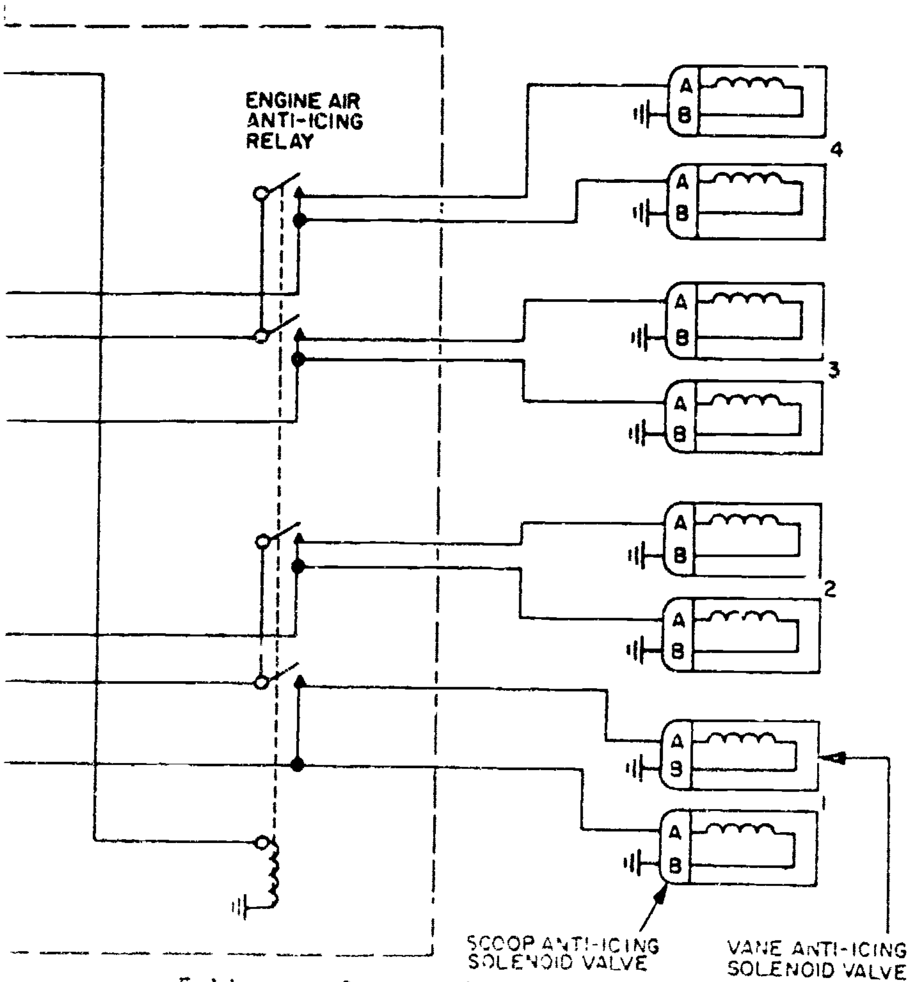
Answers to Frame 20: 1. time delay
2. probe heater



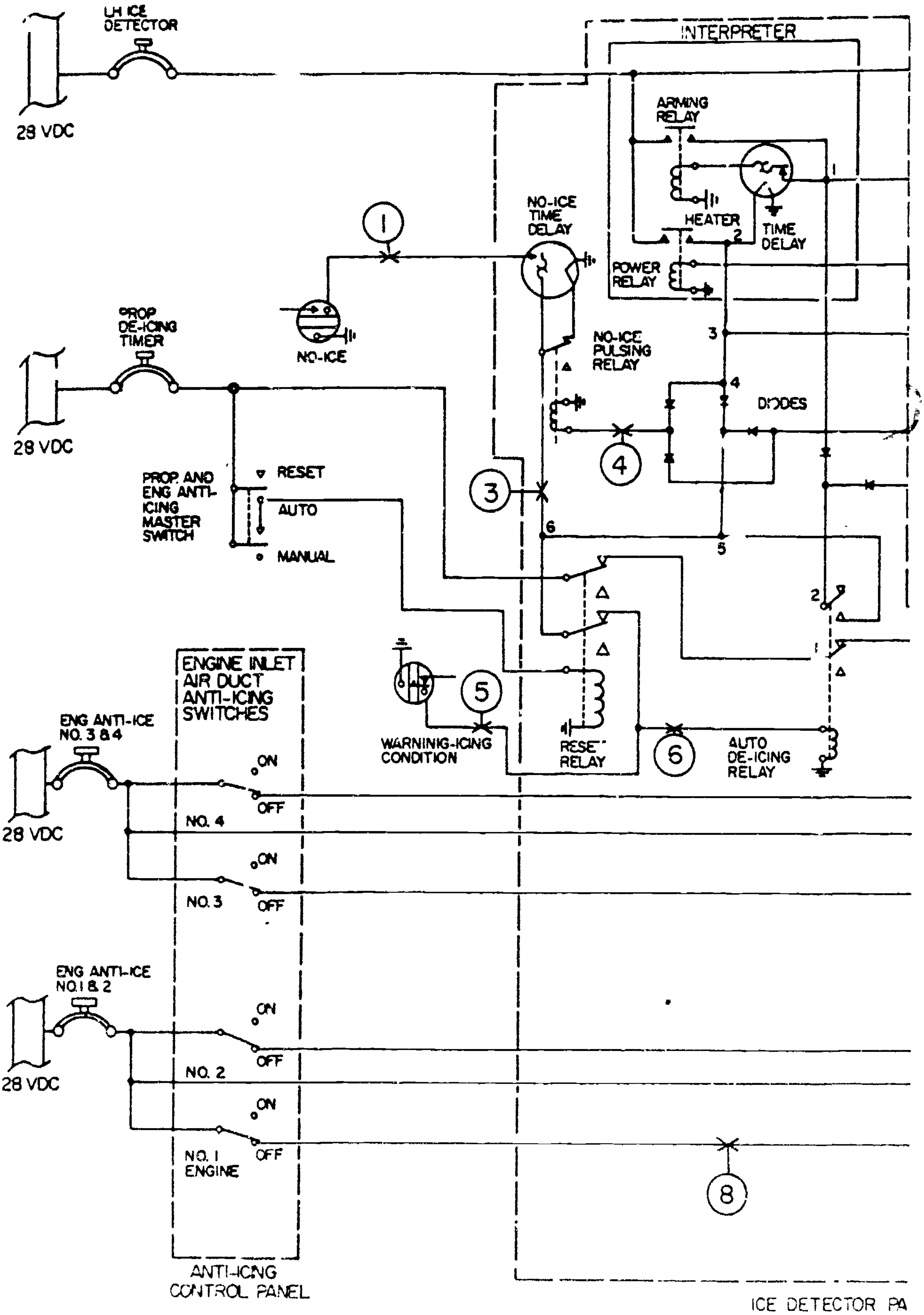
Foldout 1. Section 1.

1775



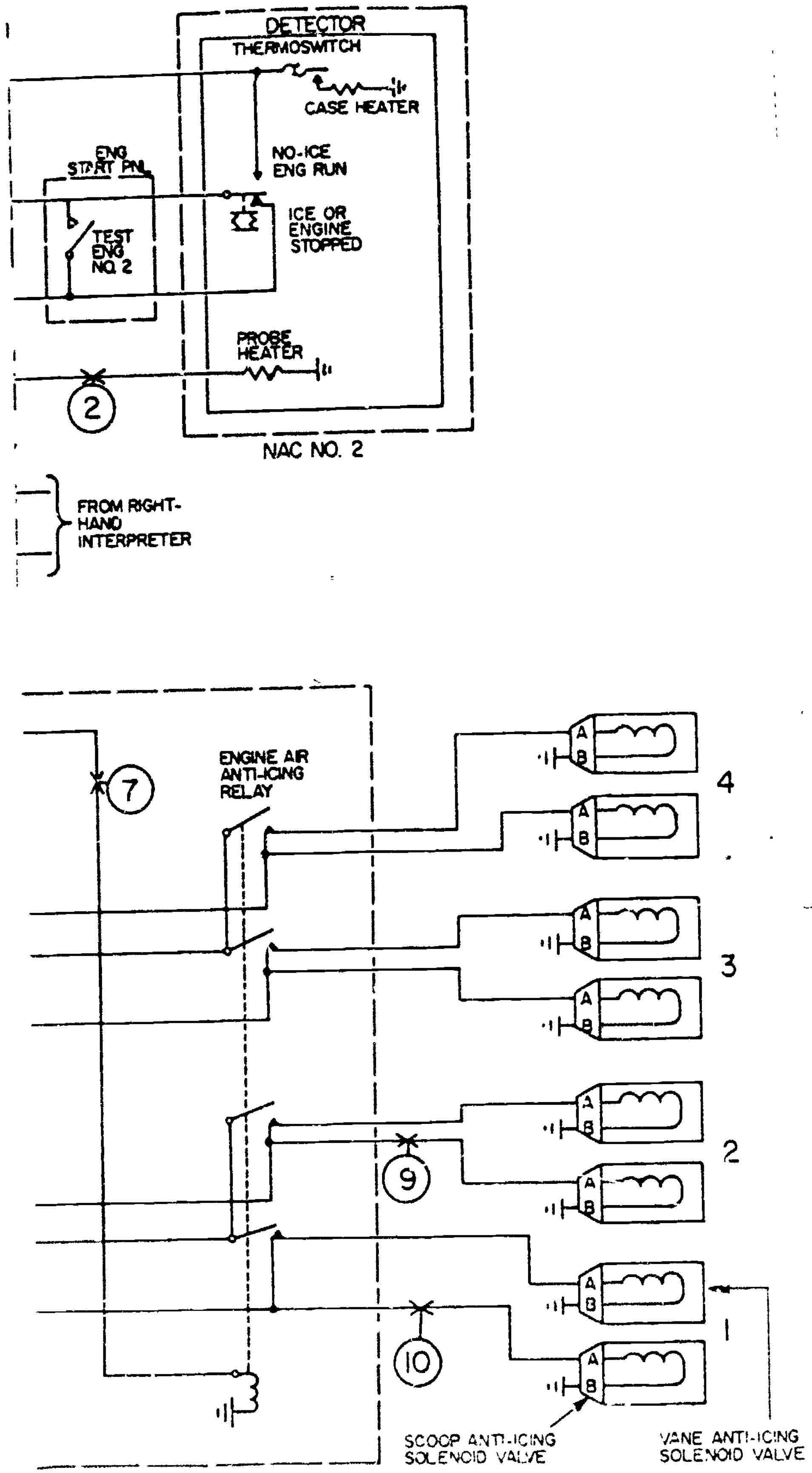


Foldout 1. Section 2.



Foldout 2. Section 1.

1727



Foldout 2. Section 2.

555

70-04592

1778

PROGRAMMED TEXT
3ABR42331-PT-209

Technical Training

Aircraft Environmental Systems Mechanic

CARGO AIR CONDITIONING SYSTEM

21 July 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

DO NOT USE ON THE JOB

1779

Environmental Pneudraulics Branch
Chanute AFB, Illinois

3ABR42331-PT-209

CARGO AIR CONDITIONING SYSTEM

OBJECTIVE

Associate the name of each cargo air conditioning system component to its operation with 80% accuracy.

INSTRUCTIONS

This programmed text presents information in small steps called "frames". After each step you are asked to select a statement, match items, or answer true or false questions. Read each frame carefully before responding. The correct answers to the questions are located at the back of the text. If you select the correct answers, continue to the next frame. If you are incorrect, read the material again and correct your answers before continuing.

Supersedes Programmed Text 3ABR42231-PT-217, 31 August 1970.
OPR: 3370TTGTC
DISTRIBUTION: X
3370TTGTC - 300; TTVSR - 1

557

Two separate air conditioning systems supply conditioned air to the interior of the cargo aircraft. The two systems are similar except for flow capacity. The higher-capacity system is used for the cargo compartment and the lower capacity system is used for the flight deck station.

NO RESPONSE REQUIRED

Frame 2

Each air conditioning system cools bleed air fed to it from the bleed air supply system, removes water from the cooled air, and conducts a mixture of hot air and cold air through ducts to outlets in the aircraft compartments. Temperature of the air supplied to the interior compartments is regulated by controlling the ratio of hot air to cold air in the mixture.

Read each statement below, then mark each one either T (true) or F (false).

____ 1. The air conditioning system regrigerates bleed air, removes water from the cooler air, and conducts a mixture of hot air and cooled air through ducts to outlets in the aircraft compartments.

____ 2. The air conditioning system cools ram air, removes water from the ram air, and conducts a mixture of ram air and atmospheric air through ducts to outlets in the aircraft compartments.

____ 3. The temperature of the air supplied to the compartments is regulated by controlling the ratio of hot air to cold air in the mixture.

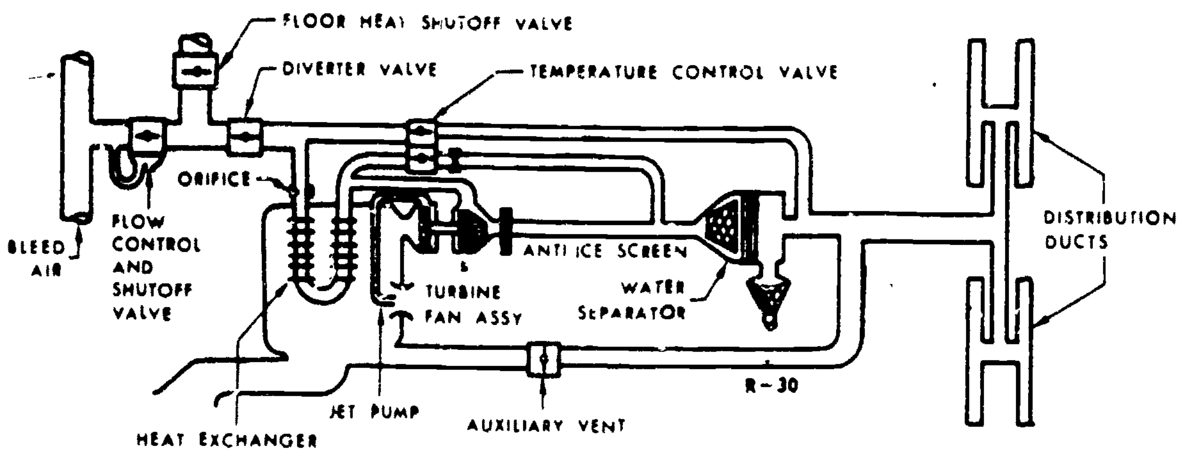
____ 4. The temperature of the air supplied to the compartments is regulated by controlling the ratio of ram air to hot air in the mixture.

1781 Frame 3

In this package we shall cover the high-capacity (cargo compartment) air conditioning system shown in the schematic below.

Each air conditioning system consists of a venturi-type flow control and shutoff valve, a refrigeration unit (made up of a heat exchanger, turbine and fan assembly, and jet pump), water separator, anti-ice screen, auxiliary vent valve, and distribution ducts.

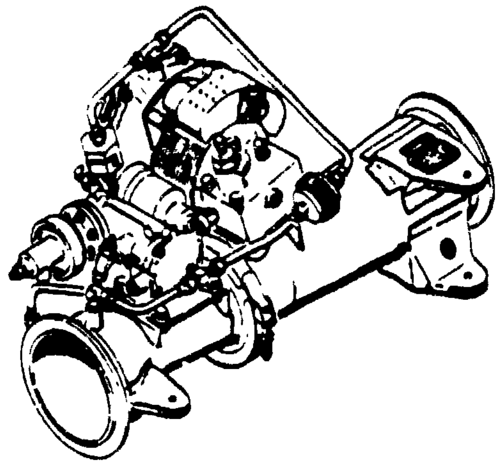
The cargo compartment system includes the cargo under floor heating system made up of a floor heat shutoff valve and diverter valve for heating the cargo floor.



NO RESPONSE REQUIRED

559

A venturi-type flow control and shutoff valve, shown below, is the first unit mounted in the air conditioning system.



This unit is set, by the position of the air conditioning master switch, for three operating conditions:

1. Operation during flight,

2. operation on the ground with the gas turbine compressor (GTC) supplying bleed air,

3. and the shutoff condition when air conditioning or pressurization is not wanted.

During flight operation, or ground operation with the engines operating, the cargo compartment flow control valve maintains nearly a constant flow of 70 pounds per minute of air into the cargo compartment.

The GTC supplies only a limited amount of air for ground air conditioning. The cargo compartment flow control is set to throttle flow according to pressure only, regardless of the amount of flow allowed.

The cargo compartment flow control valve is preset to maintain a pressure of 55 inches of mercury in the bleed air system to insure an adequate supply of air to the flight station when the aircraft air conditioning master switch is in the AIR COND GTC position.

With the air conditioning master switch in the OFF position, the cargo compartment flow control and shutoff valve closes and stops the flow of bleed air into the air conditioning system.

1783 Frame 4 (Cont'd)

Read each statement below, then mark each one, either T (true) or F (false).

____ 1. The flow control and shutoff valve is set for three operating conditions by the position of the air conditioning master switch.

____ 2. During flight operation or ground operation with the engines running the flow of 70 pounds per minute is maintained by the flow control and shutoff valve.

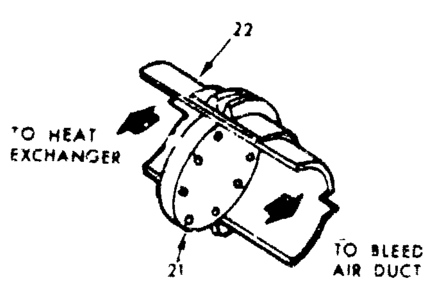
____ 3. When the air conditioning master switch is in the AIR COND GTC position the cargo compartment flow control and shutoff valve insures a pressure of 55 inches of mercury to the flight station.

____ 4. With the air conditioning master switch in the OFF position, the flow control and shutoff valve is closed.

Frame 5

An eight hole orifice (21) is installed in the bleed air duct (22) leading to the heat exchanger.

The orifice is used to drop the air pressure entering the heat exchanger and prevent overspeeding of the turbine.

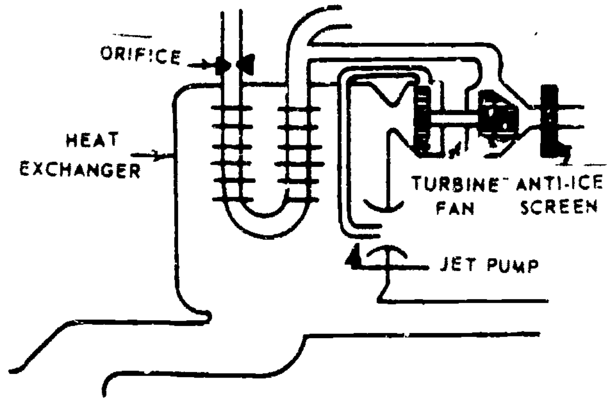


Circle the number of the statement that best describes thy purpose of the orifice.

1. The orifice drops the air pressure entering the heat exchanger and prevents overspeeding of the turbine.

2. The orifice restricts the flow of air leaving the heat exchanger.

3. The orifice stops the flow of air entering the heat exchanger.



The cargo air conditioning unit (above) is made up of an air-to air heat exchanger, a turbine and fan assembly, and a jet pump.

Hot bleed air is conducted through dimpled tubes of the heat exchanger. Because outside (ram) air is drawn over the tubes, part of the heat of the bleed air is lost to the ram air which is exhausted overboard from the heat exchanger.

Circle the number of the statement that best describes thy purpose of the heat exchanger.

1. The heat exchanger reduces the temperature of the bleed air by transferring heat to ram air.

2. The heat exchanger reduces the temperature of the ram air by transferring heat to bleed air.

3. The heat exchanger increases the temperature of the bleed air by transferring heat from the ram air.

Ram air is drawn over the tubes of the heat exchanger by the fan of the turbine and fan assembly and a jet pump. Only a small part of the cooling air passes through the fan. This part of the air is forced out at high speed through the jet pump.

The jet pump creates a low pressure area in te heat exchanger exhaust which draws a large volume of cooling air through the heat exchanger.

The fan, by drawing ram air across the heat exchanger, puts a load on the turbine to keep it from overspeeding. Bleed air, partially cooled by flowing through the heat exchanger, is fed through a duct to the turbine. The high pressure air strikes the turbine blades to drive the wheel at high speed. The warm, high pressure air thus loses its heat energy by converting heat energy to mechanical energy and by rapid expansion of the air. Not all the air is cooled.

Air can flow through the turbine bypass or the refrigeration unit bypass. The amount of air flowing through the heat exchanger and turbine depends on cooling requirements established by the temperature control system.

NO RESPONSE REQUIRED

564

Read each statement below, then mark each one either T (true) or F (false).

____ 1. The jet pump creates a low pressure area in the heat exchanger exhaust which draws a large volume of ram air through the heat exchanger.

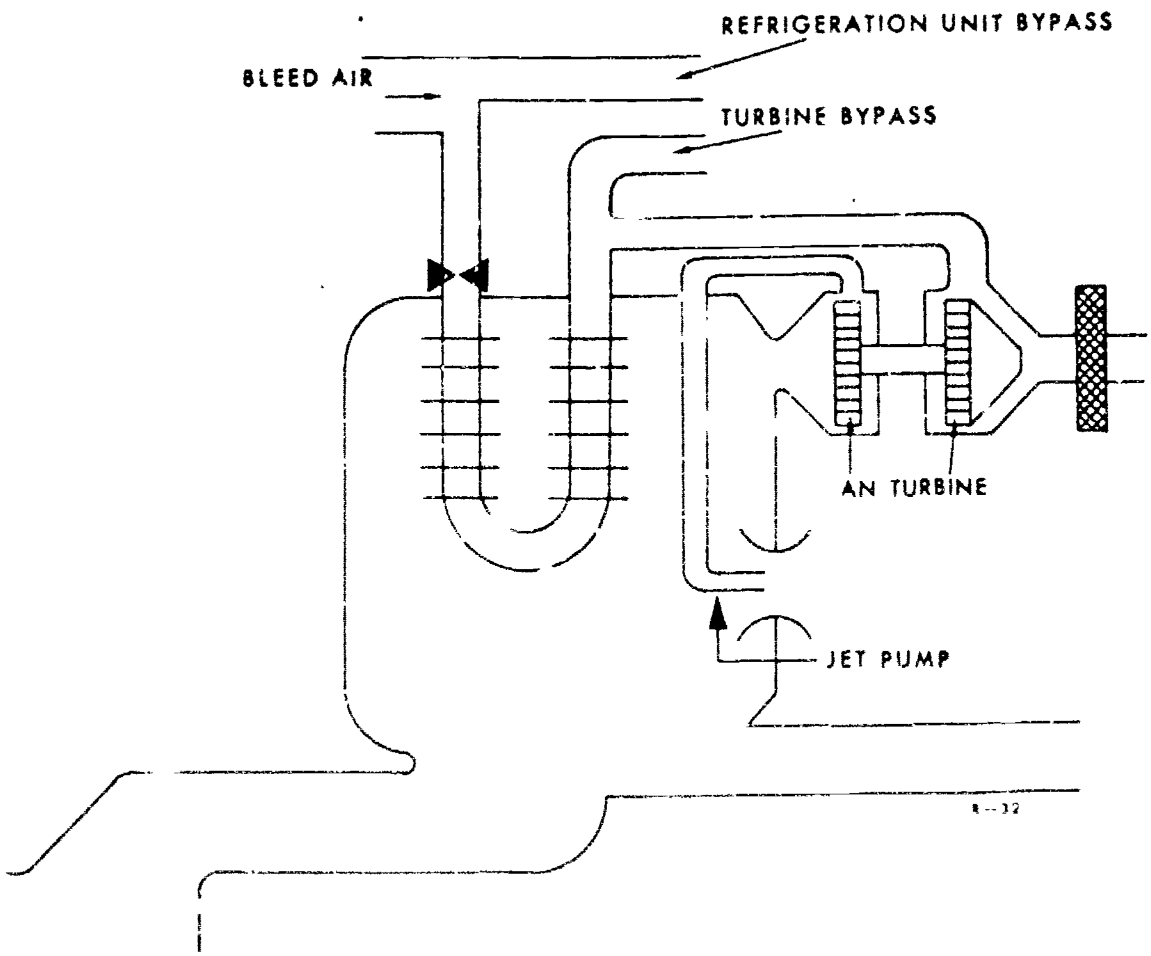
____ 2. The fan by drawing ram air across the heat exchanger, puts a load on the turbine to keep it from overspeeding.

____ 3. The turbine cools ram air by converting heat energy to mechanical energy and by rapid expansion.

____ 4. All the bleed air is cooled.

____ 5. The temperature control system establishes the cooling requirements.

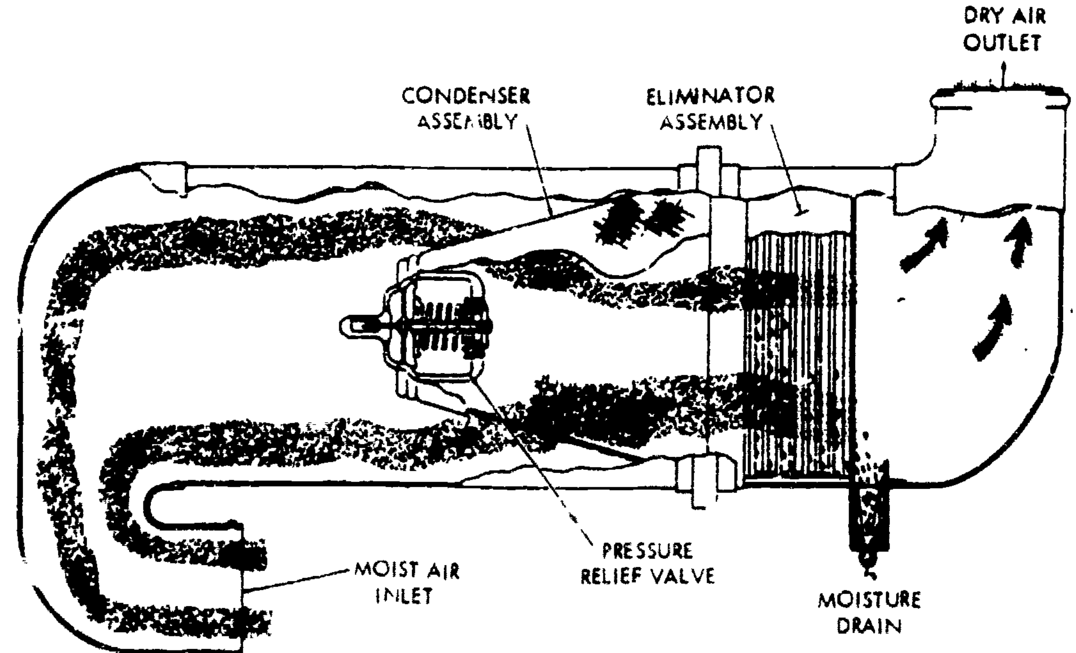
____ 6. The amount of air blown through the heat exchanger and turbine depends upon the cooling requirements established by the temperature control system.



The condenser-eliminator type of water separator shown below is used to remove 70 to 85 percent of the water from the cooled air.

A conical fiberglas bag (condenser assembly) is used to consense the fog in the cooled air to water droplets. These water droplets are carried with the air to the eliminator section. Here they collect into larger drops, run to the bottom of the unit, and out through the moisture drain.

A bypass valve (pressure relief valve) is installed in the nose of the condenser to provide an alternate path for the air if ice or any other substance clogs the fiberglas condenser bag.



CARGO COMPARTMENT WATER SEPARATOR

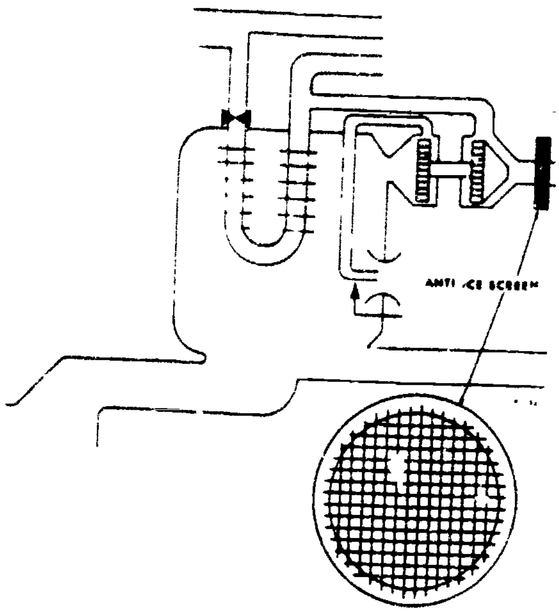
Read each statement below, then mark each one either T (true) or F (false).

____ 1. The water separator removes 70 to 85 percent of the water from the cooled air.

____ 2. A conical wire screen is used to condense the fog in the cooled air to water droplets.

____ 3. The water droplets collect into larger drops inside the eliminator assembly, run to the bottom of the separator, and drain out through the moisture drain.

____ 4. The pressure relief valve provides an alternate path for the air if ice or any other substance clogs the fiberglas condenser bag.



Anti-Ice Screen.

Icing of the water separator is prevented by an anti-ice control screen shown above. The screen is mounted in the turbine discharge duct. If the temperature of the turbine discharge air is at the frezing point and the air contains enough water, ice forms on the screen.

The ice partly blocks the screen area to cause a pressure drop across the screen, reducing airflow through the turbine. When the airflow through the turbine reduces, the speed of the turbine is also reduced. With the speed of the turbine reduced, less cooled air is produced, allowing the temperature of the turbine discharge air to rise.

When the temperature reaches the melting point for the ice on the screen, the turbine speed increases again. In this way the turbine discharge temperature is maintained at the exact freezing point for the water in the air.

Read each statement below, then mark each one either T (true) or F (false).

____ 1. The anti-ice screen prevents icing of the water separator.

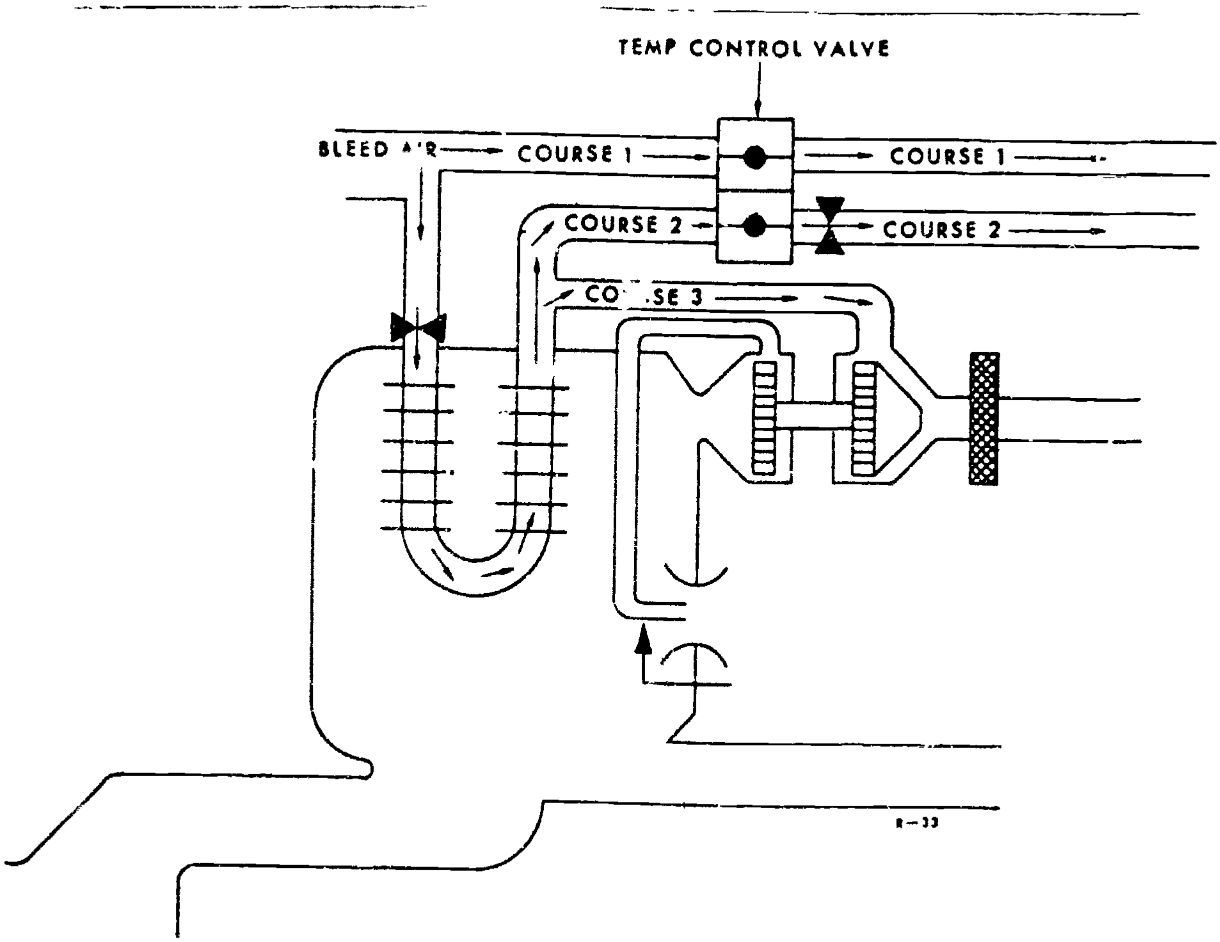
____ 2. The speed of the turbine will decrease when the anti-ice screen ices up.

____ 3. Reducing the speed of the turbine will reduce the temperature of the turbine discharge air

____ 4. The airflow through the turbine is reduced when ice partly blocks the anti-ice screen area.

1789 Frame 11

When bleed air flows through the cargo compartment air conditioning system, it follows three courses as shown in the schematic below.



COURSE 1: The bleed air flows directly to the overhead outlets without being cooled.

COURSE 2: The bleed air is directed through the heat exchanger, but not the turbine.

COURSE 3: The air is directed through the turbine of the turbine and fan assembly.

The air flowing from all these courses is mixed, and the mixture flows through the overhead outlets to the cabin. The temperature control valve is operated to distribute the bleed airflow to these paths, thus it controls the temperature of the mixture distributed through overhead outlets to the cabin.

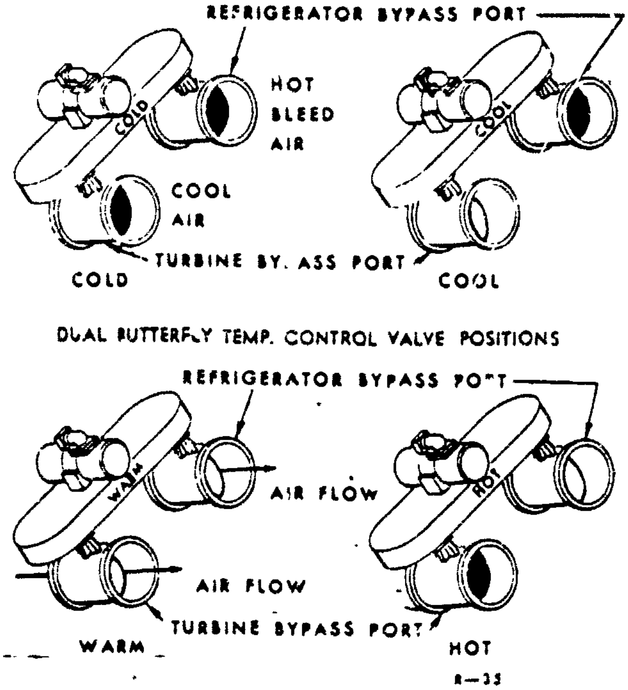
Read each statement below, then mark each one either T (true) or F (false).

____ 1. There are three paths for bleed air to flow through in the air conditioning system.

____ 2. The temperature control valve controls the mixture of air distributed through the overhead ducts by controlling the airflow through three (3) paths.

____ 3. To get hot air, the bleed air must go through the turbine of the turbine and fan assembly and then be distributed through the overhead outlets to the cabin.

1791 Frame 12



The temperature control valve, shown above, is a dual unit with one butterfly in the refrigerator bypass and another in the turbine bypass.

The two butterflies, driven by an electric actuator are positioned as follows:

	COLD	COOL	WARM	HOT
Turbine Bypass	CLOSED	OPEN	OPEN	CLOSED
Refrigerator Bypass	CLOSED	CLOSED	OPEN	OPEN

This valve is controlled by the temperature control system.

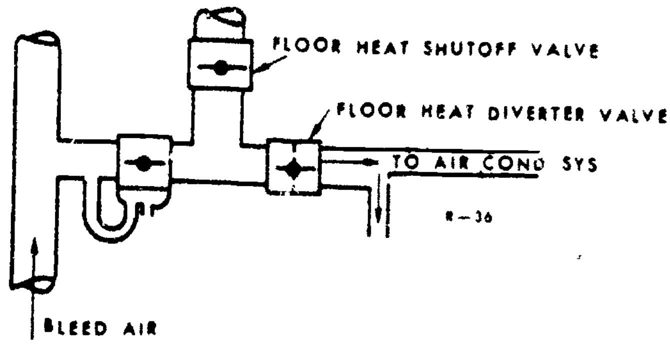
Read each statement below, then mark each one either T (true) or F (false).

____ 1. To get cold air, both the turbine bypass port and the refrigerator bypass port are closed.

____ 2. To get hot air, the refrigerator bypass port is open and the turbine bypass port is closed.

____ 3. To get warm air, the refrigerator bypass port is closed and the turbine bypass port is open.

____ 4. To get cool air, the refrigerator bypass port is open and the turbine bypass port is open.



The floor heat diverter valve is part of the under-floor heat system.

The diverter valve controls the diversion of bleed air flow from the cargo compartment air conditioning system to the floor heating system.

The diverter valve is used to maintain a comfortable temperature during operation of the aircraft at low outside ambient temperature.

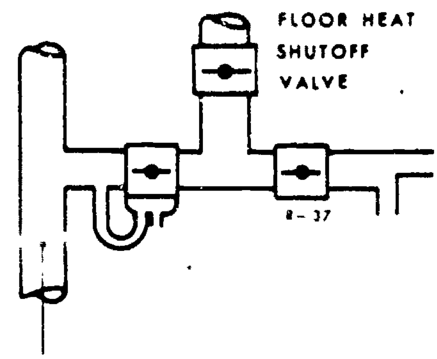
This valve is controlled by the under-floor heat temperature control system.

Cir. . the number of the statement that best describes the purpose of the ..oor heat diverter valve.

1. The floor heat diverter valve, diverts the flow of bleed a'r from the cargo compartment air conditioning system to the under-floor heating system.

2. The floor heat diverter valve turns the cargo compartment air conditioning system on and off.

3. The floor heat diverter valve stops the flow of air entering the cargo compartment air conditioning system.

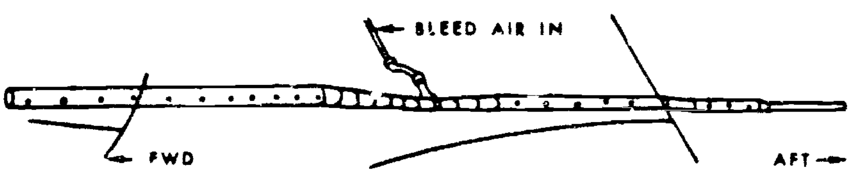


The floor heat shutoff valve is moved to the OPEN position when the under-floor heating switch is placed in the ON position.

Opening the floor heat shutoff valve allows bleed air to flow to an ejector (see the schematic below), installed under the cargo floor.

The bleed air is routed forward and aft through nozzles in the ejector (see the schematic below), into mixing chambers where bleed air is mixed with ambient temperature air from the floor cavity.

The air is than routed through distribution manifolds extending the length of the cargo compartment floor.



EJECTOR NOZZLE

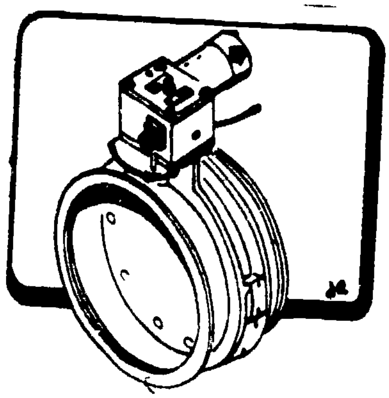
Read each statement below, then mark each one either T (true) or F (false).

____ 1. Opening the floor heat shutoff valve will allow bleed air to flow to an ejector under the cargo compartment floor.

____ 2. Bleed air is routed forward and aft through nozzles in the ejector into mixing chambers where it is mixed with ambient temperature air from the floor cavity.

____ 3. Opening the floor heat shutoff valve will position the cargo compartment temperature control valve.

____ 4. Opening the floor heat shutoff valve will remove moisture from the refrigerated air.



The auxiliary vent valve is a 28 volt DC motor operated valve located at the ram air inlet.

This valve is controlled by the air conditioning system master switch, a differential pressure switch, and a relay.

The master switch is positioned in "AUX VENT" to close a circuit that energizes the relay. The relay applies DC voltage to the valve motor to open the valve.

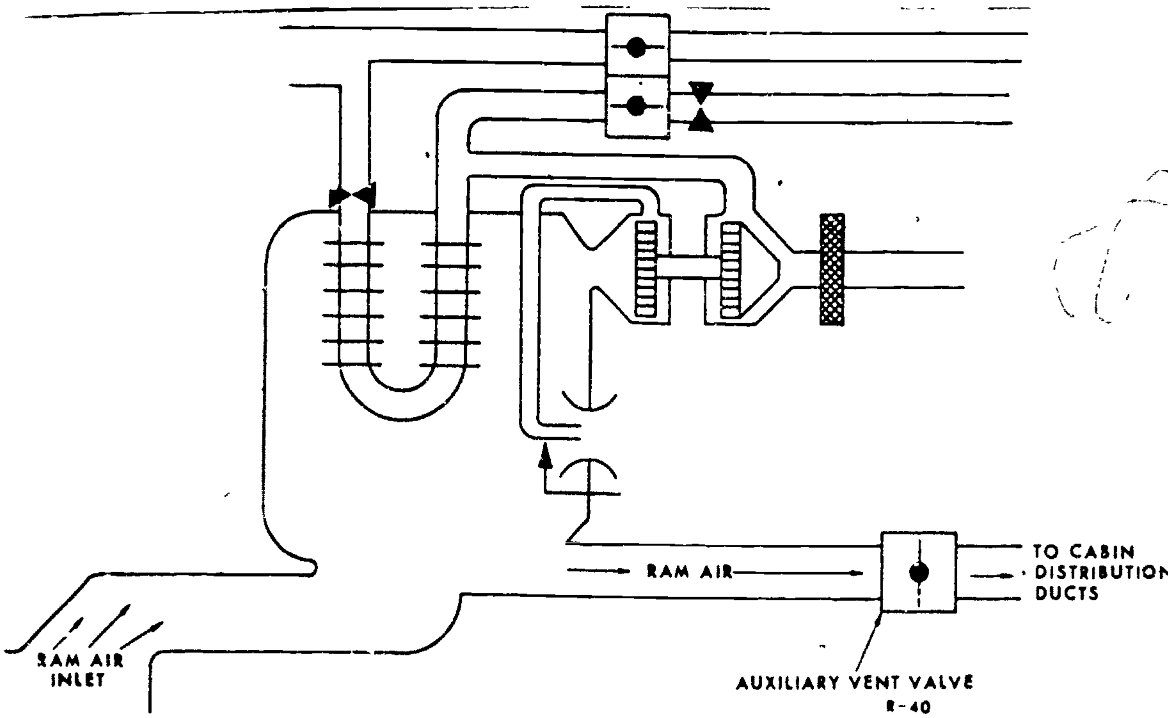
Circle the number of the statement that best describes the method of controlling the auxiliary vent valve.

1. The auxiliary vent valve is controlled by the cargo compartment shutoff switch, a relay, and an emergency depressurization switch.
2. The auxiliary vent valve is controlled by an air conditioning master switch, a differential pressure switch, and a relay.
3. The auxiliary vent valve is controlled by the "Ram-Dump" position of the cabin pressure switch.

1795 Frame 16

The auxiliary vent valve is used to ventilate the aircraft in flight at low altitudes. It is also used to supply conditioned air to the cabin from external air conditioners when the aircraft is on the ground.

In flight, the ram air entering the heat exchanger ram air inlet is used to ventilate the aircraft in case the cabin air conditioning unit breaks down.

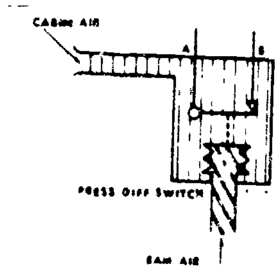


Circle the number of the statement that best describes the purpose of the auxiliary vent valve.

1. The auxiliary vent valve is used to ventilate the fuselage

2. The auxiliary vent valve is used to ventilate the aircraft in flight at low altitudes and to supply conditioned air to the cabin from external air conditioners when the aircraft is on the ground.

3. The auxiliary vent valve is used to ventilate the electronic compartment at low altitudes and to supply conditioned air to the electronic compartment from external air conditioners.



The pressure switch, shown a'ove, is in the auxiliary vent valve electrical circuit.

It opens its contacts when cabin pressure exceeds ram air pressure in the heat exchanger ram air inlet by more than 0.28 psi.

While the switch contacts are open, the auxiliary vent valve relay cannot be energized, so the valve cannot be opened.

The purpose of the switch is to prevent collapse of the air conditioning distribution ducts resulting from differential pressure across the duct walls. This differential pressure would occur if the auxiliary vent valve was opened while the aircraft was pressurized.

Read each statement below, then mark each one either T (true) or F (false).

____ 1. The pressure switch opens its contacts when ram air pressure exceeds cabin pressure.

____ 2. While the pressure switch contacts are open, the auxiliary vent valve relay cannot be energized and the valve cannot be opened.

____ 3. The pressure switch prevents a collapse of the air conditioning distribution ducts resulting from differential pressure across the ct walls.

____ 4. The pressure switch operates on a differential pressure of more than 0.28 psi.

1797

Correct Responses to all Frames.

Frame 2

1. T
2. F
3. T
4. F

Frame 4

1. T
2. T
3. T
4. T

Frame 5

1

Frame 6

1

Frame 8

1. T
2. T
3. F
4. F
5. T
6. T

Frame 9

1. T
2. F
3. T
4. T

Frame 10

1. T
2. T
3. F
4. T

Frame 11

1. T
2. T
3. F

Frame 12

1. T
2. T
3. F
4. F

Frame 13

1

Frame 14

1. T
2. T
3. F
4. F

Frame 15

2

Frame 16

2

Frame 17

1. F
2. T
3. T
4. T

575

1798

PROGRAMMED TEXT

3ABR42331-PT-209A

Technical Training

Aircraft Environmental Systems Mechanic

MERCURY THERMOSTAT TEMPERATURE CONTROL SYSTEM

12 September 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

DO NOT USE ON THE JCB

ATC FORM 214 (JAN 76) OBSOLETES ATC FORMS 214, MAY 69, 522, NOV 63 AND 523, MAY 71 STANDARD COVERSHEET

1799

FOREWORD

This programmed text was prepared for use in the 3ABR42331 Aircraft Environmental Systems Mechanic Course. The materials contained herein were validated with students from the subject course. At least 90% of the students taking this text achieved or surpassed the criteria established in the lesson objective. The average time for completion of this text was 3 hours and 30 minutes.

OBJECTIVES

Associate the name of the mercury thermostat temperature control system component with its operation with 80% accuracy.

INSTRUCTIONS

This text presents material in small steps called "frames". Read the material presented in each frame and answer the questions at the end of the frame. Also answer the questions in the review exercises throughout the text and then check your responses with the correct answers found at the top of the next frame or as specified. If you are wrong or in doubt, restudy the material and correct your answers before continuing.

Frames 9 thru 15 require that you use an overlay transparency. You can get this transparency from your instructor when you reach frame 9.

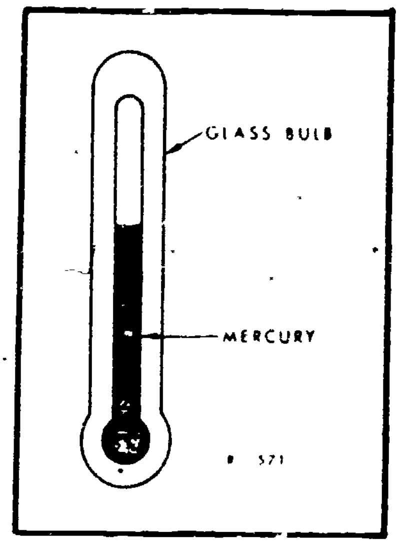
Supersedes 3ABR42231-PT-208A, 26 July 1974.
OPR: 3370TTG
DISTRIBUTION: X
3370TTCTC - 400; TTVSR - 1

577

Frame

In this lesson you will learn how mercury thermostats can be used to control the temperature of conditioned air in the aircraft.

A mercury thermostat can be compared with an ordinary thermometer which you would use at home to take your temperature or to find the temperature on any day. It works on the principle that mercury expands (rises) when heated and contracts (falls) when cooled.



No Response Required

Frame 2

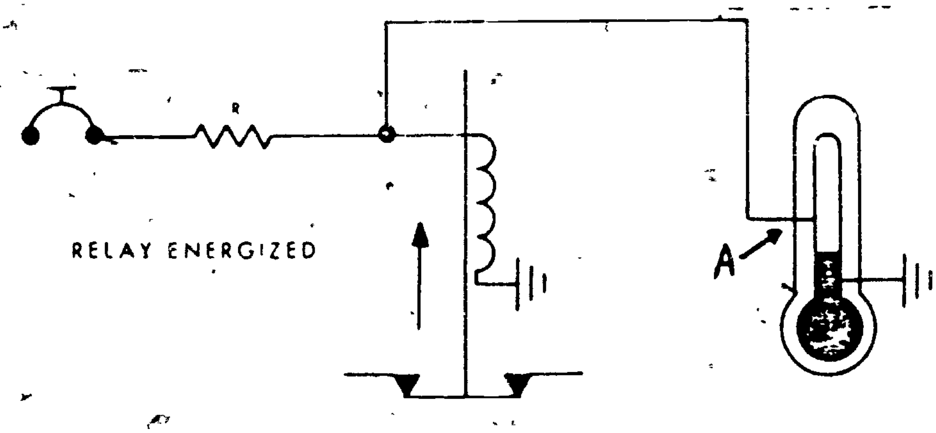
Now we will take a thermostat, add some wire and show you a simple thermostat control circuit.

REMEMBER: Mercury inside a thermostat rises when heated.

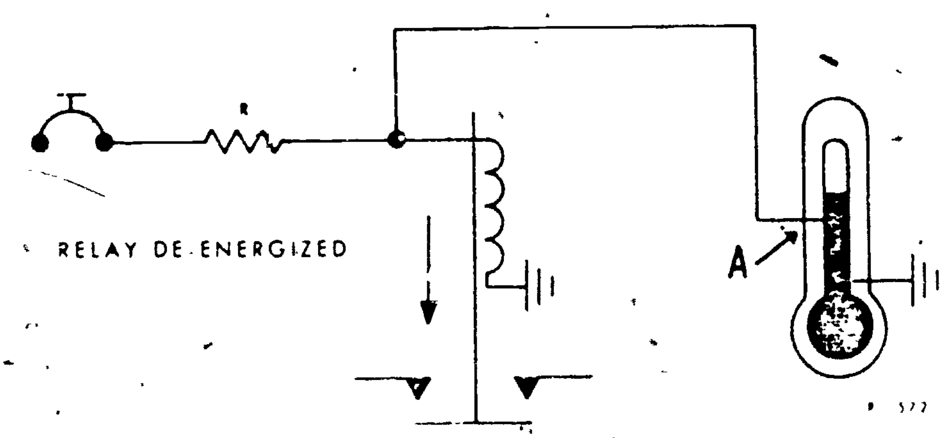
Mercury is a good electrical conductor.

Current will follow the path of least resistance.

Frame 2 Con't



If the mercury is below the contact wire (Point A), the relay will be energized. This is because the circuit between Point A and the thermostat ground is open.



If mercury rises to the contact wire (Point A) then the relay will be deenergized. This is because the thermostat has provided an easier path (less resistance) to ground than the relay.

The temperature of the air in the aircraft causes the mercury to rise or fall within the thermostat. Hot air causes mercury to rise and cold air causes mercury to fall.

Frame 2 Con't

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

1. _____ Mercury is a good electrical conductor.

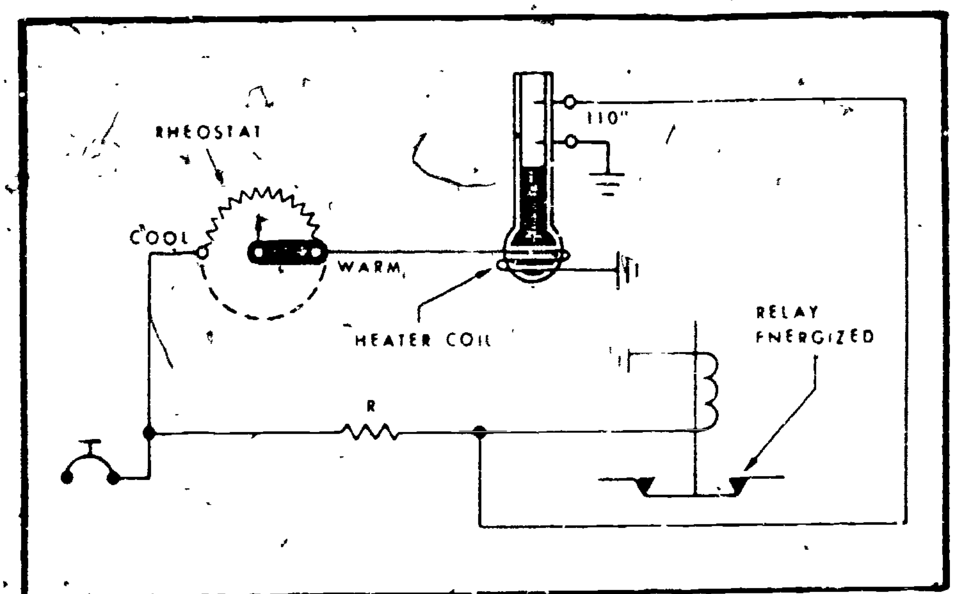
2. _____ Current takes the path of least resistance.

3. _____ If the mercury reaches the contact wire then the relay will deenergize because it has <u>less</u> resistance.

Answers to Frame 2: 1. T 2. T 3. F

Frame 3

Now let's say that we want to complete a circuit through a thermostat but the air is not warm enough to raise the mercury to the contact wire. To raise the mercury we add a "heater" to the thermostat.



The heater is made of a small wire wrapped around the base of the thermostat. The heat that is generated by allowing current to flow through the heater coil will cause the mercury to rise. A variable resistor or rheostat is used to control the amount of current being applied to the heater.

If the rheostat is moved toward cool, the resistance in the heater circuit decreases and the current applied to the heater increases. Thus, more heat will be given off by the heater and the mercury rises faster.

If the rheostat is moved toward warm, the resistance in the heater circuit increases and the current applied to the heater decreases. Thus, less heat will be given off by the heater and the mercury will rise slower.

By using the rheostat and heater we can control the movement of mercury inside the thermostat and in turn control the temperature of the air.

Fill in the blanks to complete the following statements.

1. A __________ __________ can be used to control the mercury in the thermostat.

2. By using the __________ and __________ we can control the temperature of the air in the aircraft.

Answers to Frame 3: 1. thermostat heater 2. rheostat and heater

REVIEW EXERCISE #1

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

1. _____ A mercury thermostat can control such devices as relays.
2. _____ A mercury thermostat can be used to control a complete temperature control system.
3. _____ The mercury will rise when heat is applied to the thermostat.
4. _____ A mercury thermostat can be compared to an ordinary thermometer.
5. _____ The more resistance in the rheostat the faster the heater will warm up the rheostat.

Fill in the blanks to complete the following statements.

6. If two (2) wires are connected by the ______________, current will flow through the thermostat.
7. A heater is used to heat the thermostat so the mercury will __________ faster than normal.
8. A ______________ controls the amount of current going to the heater.
9. The rheostat and heater ______________ the movement of mercury inside the thermostat.
10. A rheostat is a ______________ resistor.
11. __________ __________ to the thermostat heater coil can be changed by using the ______________.
12. Mercury is a __________ electrical conductor.
13. Current takes the path of __________ ______________.

Check your responses at the top of frame 4.

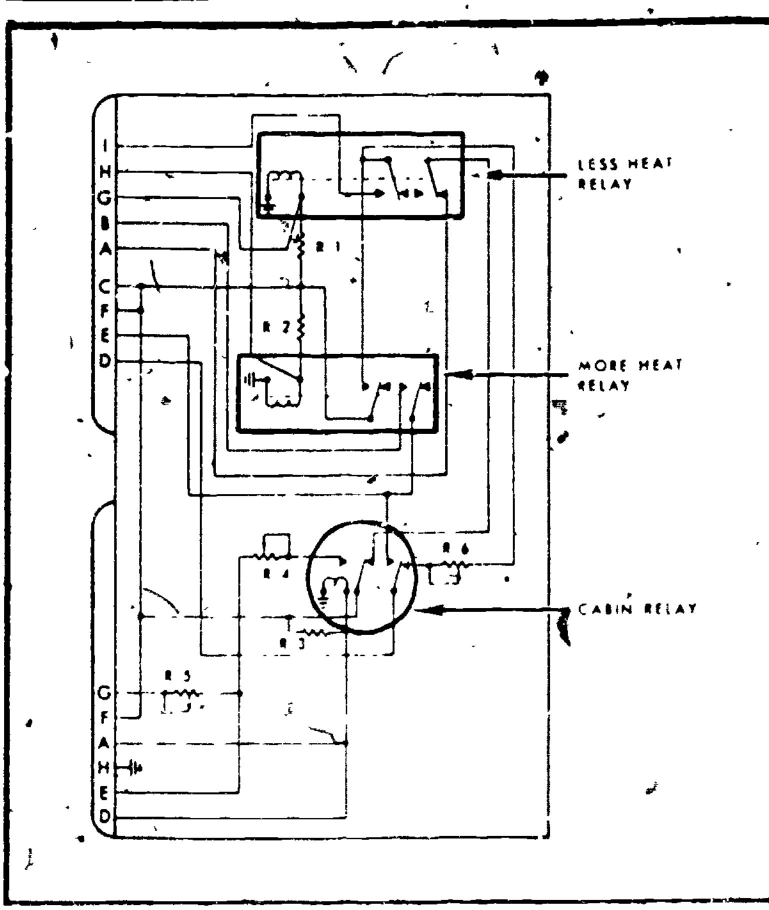
1805

Answers to Review Exercise 1: 1. T 2. T 3. T 4. T 5. F 6. Mercury
7. Rise 8. Rheostat 9. Control 10. Variable
11. Current Flow, Rheostat 12. Good
13. Least resistance.

Frame 4

The temperature control box for this system contains three (3) relays (shown below) and six resistors.

The relays are energized and deenergized by the mercury thermostats. These thermostats will control the relays and the relays will determine if the temperature control system calls for hot or cold air.



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

1. _____ The thermostats are controlled by the relays.

2. _____ The thermostats will determine if the temperature control system calls for hot or cold air.

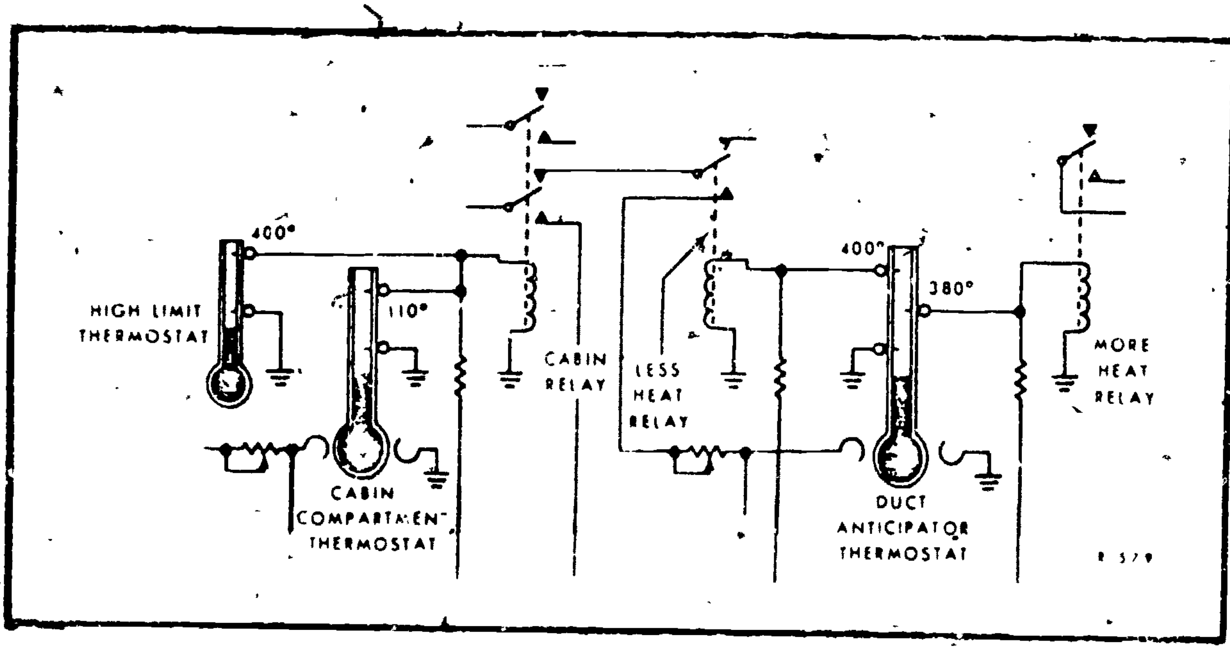
558

Answers to Frame 4: 1. F 2. F

Frame 5

Shown below are the High Limit thermostat, Cabin Compartment thermostat, and Duct Anticipator thermostat.

Each thermostat has a different operating temperature and a different purpose to help maintain the desired cabin temperature.

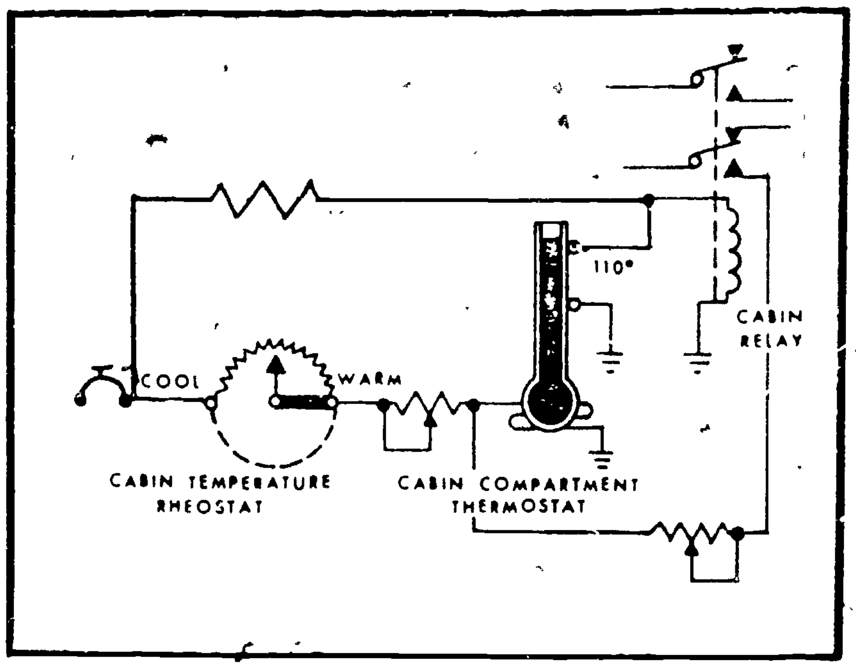


No Response Required

1807

Frame 6

The Cabin thermostat, shown below, controls the operation of the Cabin relay. When mercury comes in contact with the 110° contact wire the Cabin relay will deenergize. Remember, current follows the path of least resistance.



The heater of the Cabin thermostat has two (2) current supplies:

(1) From the bottom contact of the cabin relay.

(2) From the cabin temperature rheostat.

By positioning the rheostat, the amount of current being applied to the heater can be increased or decreased. This in turn controls how fast the mercury in the thermostat rises or falls.

By controlling the movement of the mercury you can control the operation of the cabin relay. In turn, by controlling the cabin relay you can control the temperature of the air entering the cabin.

Fill in the blanks to complete the following statements.

1. The Cabin thermostat heater has ________ current supplies.

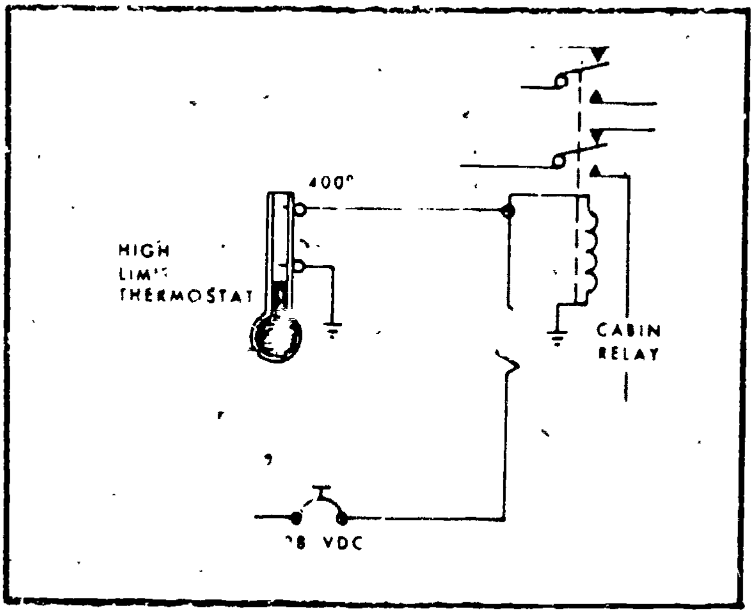
2. The Cabin relay will ______________ at ________.

585

Answers to Frame 6: 1. 2 (two) 2. deenergize, 110°

Frame 7

The high Limit thermostat also controls the cabin relay and in turn, controls the maximum temperature that can be received from the system. This thermostat acts as a safety factor in case the other thermostats fail.



There is no heater for this thermostat. It is located in the air conditioning duct and works from the duct temperat . If the mercury reaches the 400° contact wire the relay deenerg...

Fill in the blanks to complete the following statements.

1. The ______________ temperature that can be received from the system is controlled by the high limit thermostat.

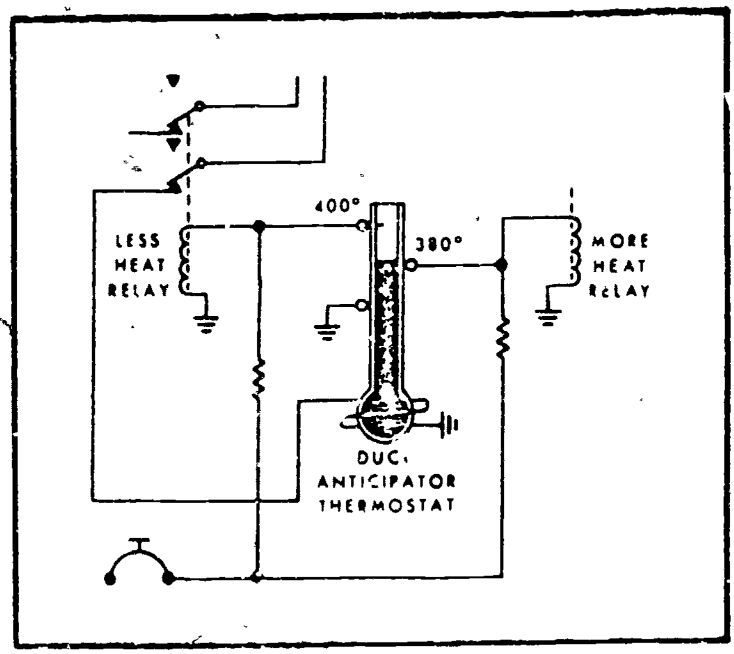
2. The cabin relay will be ________________ when the mercury in the high limit thermostat is below 400°.

1809

Answers to Frame 7: 1. Maximum 2. Energized

Frame 8

The Duct Anticipator thermostat controls both the More Heat and the Less Heat relays. This thermostat is in the air conditioning duct next to the High Limit thermostat and works off the air temperature in the duct and a heater. The heater receives power from the bottom contact of the Less Heat relay.



When the mercury is below the 380° contact wire, the More Heat and Less Heat relays will be energized.

If the mercury reaches the 380° contact wire, the More Heat relay will deenergize. Remember, current will follow the path of least resistance. With the More Heat relay deenergized, the circuit going to the Hot side of the temperature control valve is opened. The valve will not be able to run any further towards Hot. (This will be shown completely in a later frame.)

If the temperature in the duct continues to rise, the mercury will rise with it. When the mercury reaches the 400° contact wire the Less Heat relay will deenergize. When the Less Heat relay deenergizes it removes current from the thermostat heater and sends current to the Cool side of the temperature control valve. (This will be shown completely in a later frame.)

587

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

1. _____ The more and less heat relays control the Duct Anticipator thermostat.

2. _____ When the less heat relay is deenergized, current will be removed from the cool side of the temperature control valve and sent to the heater coil on the Duct Anticipator thermostat.

Answers to Frame 8: 1. F 2. F

REVIEW EXERCISE #2

Mark each of the following statements either T (true) or F (false).

1. _____ The relays control mercury thermostat operation.

2. _____ All of the thermostats have the same operating temperature.

3. _____ The thermostats help maintain a desired cabin temperature.

4. _____ The heater on the thermostat causes the mercury to fall.

5. _____ The Duct Anticipator thermostat controls the cabin relay.

6. _____ When energized, the more heat relay will allow current to flow to the hot side of the temperature control valve.

7. _____ The cabin thermostat controls the cabin relay.

8. _____ Current for the Cabin thermostat heater is supplied by the cabin relay and the rheostat.

9. _____ The less heat relay will deenergize when the High Limit thermostat reaches 400°.

10. _____ The rheostat varies the current flow to the Duct Anticipator thermostat heater.

11. _____ By controlling the cabin relay you can control the cabin temperature.

12. _____ The air in the ducting causes the mercury in the High Limit thermostat to rise or fall.

13. _____ The High Limit thermostat acts as a safety factor.

14. _____ The High Limit thermostat is located in the cabin.

Fill in the blanks to complete the following statements.

15. The relays that make up the control box are the __________, __________ __________ and _______ _________ relays.

16. The thermostats that are used to control the temperature control system are the ________, _______ __________ and _________ ________________ thermostats.

17. When the _______ _________ relay deenergizes current goes to the cool side of the temperature control valve.

18. When the mercury in the Duct Anticipator thermostat reaches the 400° contact wire the more and less heat relays will be ________________.

Answers to Review Exercise 2

1. F
2. F
3. T
4. F
5. F
6. T
7. T
8. T
9. F
10. F
11. T
12. T
13. T
14. F
15. Cabin, more heat, less heat
16. Cabin, high limit, duct anticipator
17. Less heat
18. Deenergized

1813

Now we are going to put all of these individual components together and operate a mercury thermostat automatic temperature control system. Ask the instructor for an overlay transparency. Fold all of the sheets back until only Sheet 1 is showing.

Frame 9

As you can see, Sheet 1 shows the components of the system with a voltage potential at the circuit breaker and at Pin "D" of the upper connector on the control box.

FOLD OVER SHEET 2

Current flows from the circuit breaker through Pin "C" on the upper connector and down to a contact point on the cabin relay.

Current also flows through R-3 and then can go in 1 of 2 directions:

(1) Up to energize the cabin relay

or

(2) Down through Pin "A" to the High Limit thermostat or through Pin "D" to the Cabin thermostat.

Since the mercury in these thermostats have not yet reached the contact wires these circuits are incomplete and the cabin relay is energized as shown.

No Response Required

591

Frame 10

FOLD OVER SHEET 3

Current from the rheostat flows through Pin "G" and resistor R-5 to point A in the control box. From here it flows down and out Pin "E" to the cabin thermostat heater.

Since the cabin relay is energized, current from its left contact lever flows through R-4 and down to combine with the current from the rheostat and flows to the cabin thermostat heater.

The voltage potential at Pin "D" flows across the right contact lever of the cabin relay and up to another contact point which will be shown in the next frame.

No Response Required

1815

Frame 11

FOLD OVER SHEET 4

This sheet shows the More Heat relay circuit.

Current from the circuit breaker goes from point B in the control box through R-2 and then can go in 1 of 2 directions:

(1) Down to energize the More Heat relay.

or

(2) Up through Pin "H" to the 380° contact point on the Duct Anticipator thermostat.

Since the mercury is below 380° the circuit to the thermostat is open and the More Heat relay is energized as shown.

Current can also flow from point B to the More Heat relay left contact lever. Since this relay is energized current flows across the contact lever and up to another contact point which will be shown in the next frame.

Since the Cabin relay was energized back in Frame 9, we also have current flowing across the right contact lever to the More Heat relay. This current flows out Pin "B" on the upper connector and out to Pin B on the temperature control valve. As you can see, with both the Cabin and More Heat relays energized this valve will run toward HOT.

No Response Required

593

FOLD OVER SHEET 5.

This sheet shows the Less Heat relay circuit.

As you can see, the Less Heat relay receives power from the same source that is used for the More Heat relay. Current flows up through R-1 and can than go in 1 of 2 directions:

(1) Up to energize the Less Heat relay.

or

(2) Down through Pin "G" to the 400° contact wire on the Duct Anticipator thermostat.

Since the mercury is still below 380° this circuit is incomplete and the Less Heat relay is energized as shown.

Current has been supplied from the More Heat relay to the left contact lever of the Less Heat relay. This current flows across the contact and out Pin "I" to the duct anticipator heater. The heater and the air temperature in the ducting, begins to raise the mercury inside the thermostat.

At this point there is no current to the Less Heat relay right contact lever. As the circuit is set up so far, we are now calling for and receiving a warmer air temperature.

No Response Required

1817

Frame 13

FOLD OVER SHEET 6

At this point we are receiving warm air in the cabin. To make sure that the cabin does not get too hot the pilot or flight engineer has moved the temperture control rheostat toward cool. By doing this the resistance in the circuit has decreased. Therefore more current flows through the rheostat and Pin "G" to point A and down and out Pin "E" to the cabin thermostat heater.

This increased current applied to the heater will generate more heat around the thermostat. When the mercury reached the 110° wire, all of the current at point C in the control box will follow the path of least resistance and flow down and out Pin "D" through the cabin thermostat to ground. The cabin relay now deenergizes.

With the cabin relay deenergized current going to the more heat relay contact has stopped. In turn, you have stopped current from going to the HOT side of the temperature control valve. Therefore the valve will stop and the temperature will not increase.

Current from the cabin relay will now flow across both contact levers up to the contact levers on the less heat relay.

No Response Required

595

FOLD OVER SHEET 7

As the mercury in the duct anticipator thermostat rises it will make contact with the 380° wire. At this time the more heat relay deenergizes because current to the relay follows the path of least resistance through the thermostat to ground.

With the more heat relay deenergized current will be taken away from the less heat relay contact which was used for the duct anticipator heater.

FOLD OVER SHEET 8

Current is still being applied to the duct anticipator heater. It is supplied through the less heat relay contact from the deenergized cabin relay.

The mercury in the thermostat continues to rise until it reaches the 400° wire. Now the less heat relay deenergizes because current to the relay follows the path of least resistance through the thermostat to ground.

With this relay deenergized current will be taken away from the thermostat heater. From the right contact lever it will flow out Pin "A" to Pin A on the temperature control valve. The valve now runs COLD delivering cooler air to the cabin.

No Response Required

1819-

Frame 15

Notice that the mercury in the high limit thermostat has also made contact with its 400° wire. This is the safety factor that was mentioned earlier in the text.

A circuit has been completed through the mercury to ground. This is a positive way to restrict the maximum temperature from the system. By deenergizing the cabin relay if the cabin thermostat should fail, taking power away from the HOT side of the temperature control valve.

No Response Required

597

REVIEW EXERCISE #3

Mark the following either T (true) or F (false).

1. _____ The same current that energizes the cabin relay can also flow to the cabin thermostat.

2. _____ The current for the control box comes from 2 different sources.

3. _____ If the mercury in the high limit thermostat reaches 400° the cabin relay will deenergize.

4. _____ The cabin thermostat heater receives current from the temperature control rheostat only.

5. _____ The more heat relay must be deenergized before the less heat relay will deenergize.

6. _____ The temperature control valve will not run towards <u>hot</u> if either the cabin relay <u>or</u> the more heat relay were deenergized.

7. _____ The same current that energized the cabin relay <u>will not</u> energize the more heat relay.

8. _____ Current that flows across the cabin relay and R-4 combines with the current that flows from the rheostat and goes to the cabin thermostat heater.

9. _____ The cabin relay will not energize unless it receives a <u>full</u> 28V DC.

10. _____ If the mercury in the duct anticipator thermostat reaches 380° the temperature control valve will run toward hot.

11. _____ The more heat and less heat relays receive current from the same power source.

12. _____ The more heat relay will deenergize when the duct anticipator thermostat reaches 380°.

13. _____ The cabin relay must be deenergized before the control valve will run toward hot.

14. _____ The high limit thermostat will deenergize the cabin relay when the mercury reaches 110°.

Check your responses on the answer sheet at the back of the text.

1821

MERCURY THERMOSTAT TEMPERATURE CONTROL SYSTEM REVIEW

Match the description in Column B with the item it describes in Column A.

Column A	Column B
1. More Heat relay	A. Controls both the more heat and less heat relays.
2. Cabin thermostat	B. Controls amount of power going to the cabin thermostat heater.
3. Rheostat	C. Raises and lowers the mercury in the high limit thermostat.
4. Cabin relay	D. When energized, this relay directly supplies current to the hot side of the temperature control valve.
5. Thermostat heater	E. Helps to raise the mercury inside the thermostat faster than normal.
6. High Limit thermostat	F. A safety factor that will de-energize the cabin relay at 400°.
7. Duct Anticipator thermostat	G. Controls operation of the Cabin relay.
8. Less Heat relay	H. When energized, this relay supplies current to a contact lever on the more heat relay.
	I. When deenergized, this relay supplies current to the cold side of the temperature control valve.

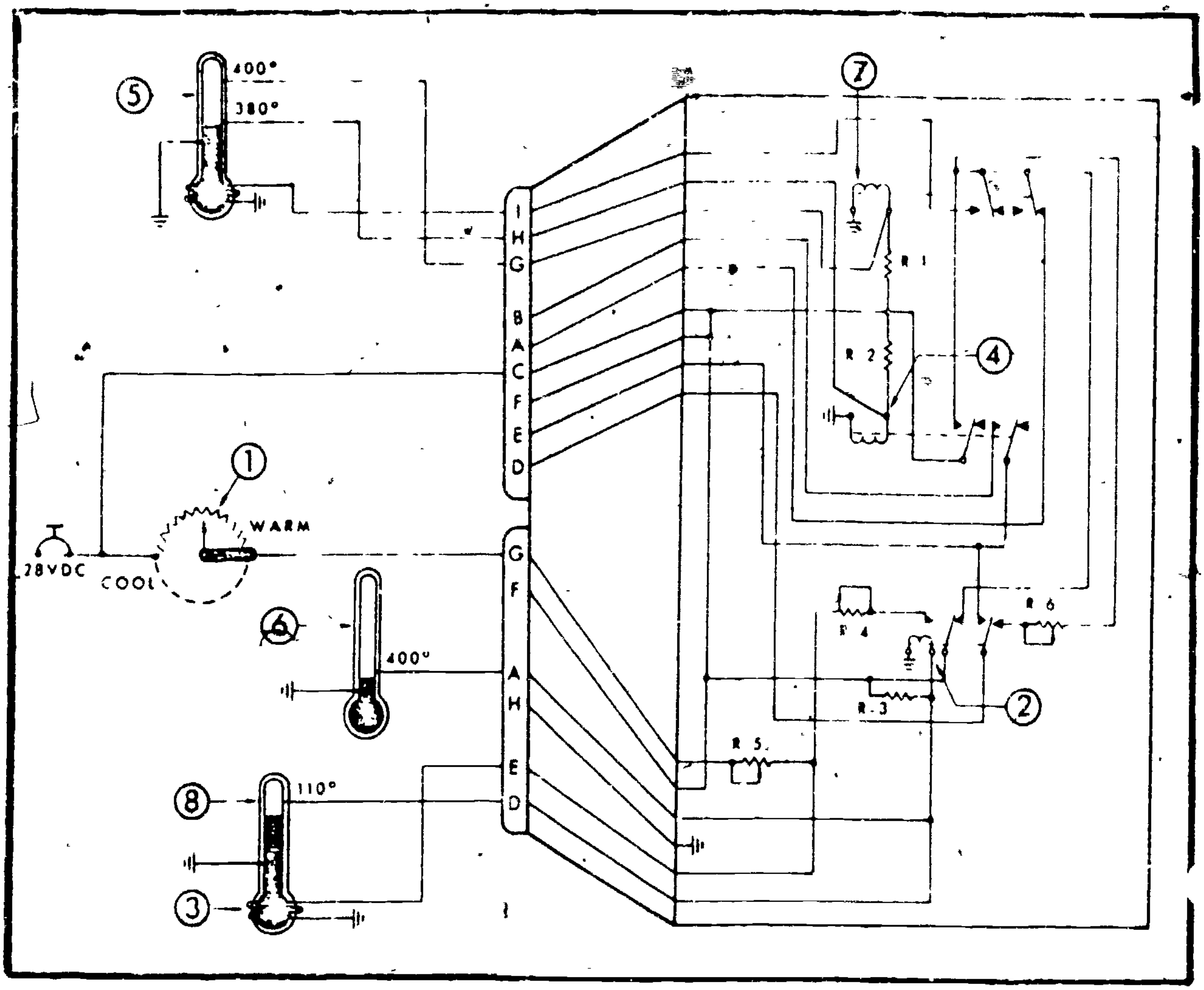
Refer to the overlay transparency to answer the following statements as either true or false.

9. If the temperature in the cabin reaches 110°, the cabin relay will deenergize.

10. As temperature around the duct anticipator thermostat rises, the less heat relay will deenergize before the more heat relay.

11. The less heat relay controls current to the cool side of the temperature control valve.

599



Match the circled number in the above schematic with the item listed below.

_____Rheostat

_____Cabin relay

_____Duct Anticipator thermostat

_____More Heat relay

_____Cabin thermostat

_____Heater coil

_____Less Heat relay

_____High Limit thermostat

Check your responses on the answer sheet at the back of the text.

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CORRECT RESPONSES

<u>Review Exercise #3</u>

1.	T	8.	T
2.	T	9.	F
3.	T	10.	F
4.	F	11.	T
5.	T	12.	T
6.	T	13.	F
7.	F	14.	F

<u>Mercury Thermostat Temperature Control System Review</u>

1.	D	7.	A
2.	G	8.	I
3.	B	9.	T
4.	H	10.	F
5.	E	11.	T
6.	F		

__1__ Rheostat

__2__ Cabin relay

__5__ Duct Anticipator Thermostat

__4__ More heat relay

__8__ Cabin thermostat

__3__ Heater coil

__5__ Less heat relay

__6__ High limit thermostat

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WORKBOOK
3ABR42331-WB-209

Technical Training

Aircraft Environmental Systems Mechanic

CARGO AIR CONDITIONING SYSTEM WIRING DIAGRAM

26 April 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

1825

Environmental/Pneudraulics Branch
Chanute AFB, Illinois

3ABR42331-WB-209

CARGO AIR CONDITIONING SYSTEM WIRING DIAGRAM

OBJECTIVE

Using the cargo aircraft air conditioning system wiring diagram, identify eight causes for the ten electrical system troubles.

EQUIPMENT

	Basis of Issue
Colored Pencil Set	1 set/student
3ABR42331-WB-209	1/student

PROCEDURE

Figures 1 and 2 are in the back of this booklet. The circuits you will be tracing in this text are listed in the lower left corner of figure 1. The color code you are to use for each circuit is shown in the block before each circuit. Follow directions carefully and do all the steps. Do not trace ahead of what you have read. The diagram used in this project is the same diagram you will use on the cargo air conditioning system trainer, when you troubleshoot that trainer. If you do not understand the circuit after tracing, check with your instructor.

Note: In this diagram we are tracing current from the circuit breakers to the components ground. This is not the way current flows, but it is the easiest because of so many ground points in the diagram. Remember this note when using any wiring diagram.

POWER CIRCUIT

1. Use your RED pencil to trace this circuit. Current flows from the 28V DC temperature control circuit breaker over wire 2H200A20 to pin N of bulkhead connector #2. It continues on wire 2H200B20 to the pole of the master air conditioning switch.

2. This is the system power circuit. All power for automatic and manual temperature control comes from this wire.

Note: You will trace circuits for the following functions of the air conditioning system. Manual Warm with GTC, Manual Cool in Air Conditioner and Pressure Position, Automatic Warm, and Automatic Cool. Even though current is distributed over numerous other circuits, only those circuits required for a particular function will be traced.

Supersedes 3ABR42231-WB-208, 5 June 1974.
OPR: 3370 TTG
DISTRIBUTION: X
3370 TTGTC - 600; TTVSR - 1

MANUAL WARM WITH GTC

1. Use your BLUE pencil to trace this circuit. First, draw the master air conditioning switch contact lever to the air conditioning GTC position.

2. Current flows over wire 2H201D20 to pin M on bulkhead connector #2. Current flows out pin M on wire 2H201E20 and over to terminal #1 on terminal strip #2.

3. It leaves terminal #1 on two wires. Current flows over wire 2H201G20 to pin A on the cabin thermostat blower. Then current flows out pin B on wire 2H207A20N to ground. The blower now operates.

4. Go back to terminal #1. Current also flows over wire 2H201F20 to pin C on the control box electrical connector #1.

5. It flows from pin C to point A inside the temperature control box. Here current flows in two directions.

6. First, it flows to point B where it flows in many directions again. Current continues to pole X1 on the more heat relay. The relay is not energized yet, so current flow stops at this point.

7. Going back to point B, current flows through both R1 and R2 to energize both the more heat and less heat relays.

8. Because we are concerned with the more heat relay, draw the contact levers on X1 and X2 to the energized position (contacts 1 and 3). This is as far as we will go for now.

9. Going back to point A, current flows to point C and out to pin F of the control box electrical connector #1.

10. It leaves pin F on wire 2H202A20 and flows to terminal #2 on terminal strip #2. From here it flows over wire 2H202B20 to pin H on bulkhead connector #2.

11. Current flows to the temperature control switch on wire 2H202C20. Draw the temperature control switch to the manual warm position.

12. Now current flows over wire 2H203C20 to pin G on bulkhead connector #2. It leaves pin G on wire 2H203B20 and flows to terminal #5 on terminal strip #2. Current flows from terminal #5 on wire 2H203A20 to pin E on the control box electrical connector #1.

13. Current flows inside the control box to X2 of the more heat relay. We are tracing only necessary circuits so we will not tap off current from this wire. The more heat relay is energized so current flows from X2, over contact 3, and out pin B on the control box electrical connector #1.

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14. It leaves pin B on wire 2H212A20 and flows to pin B on the temperature control valve. Current flows through the valve motor and out pin C on wire 2H214A20N to ground. The temperature control valve now runs to warm, which was your selection.

MANUAL COOL IN AIR CONDITIONER AND PRESSURE POSITION

1. Again we are going to trace only the necessary circuits. Use your GREEN pencil to trace this circuit.

2. First, draw the master switch to the air conditioner and press position. All the air condition positions of the master switch go to the same wire so this is the last time you will change positions on the master switch.

3. Current flows from the master switch on wire 2H201D20 to pin M on bulkhead connector #2. From here it flows over wire 2H201E20 to terminal #1 on terminal strip #2.

4. Again current flows over wire 2H201G20 to run the cabin thermostat blower. It also flows over wire 2H201F20 to pin C on the #1 electrical connector.

5. Current continues to point A inside the control box and then to point C. From point C it flows to pin F on the #1 electrical connector and out on wire 2H202A20 to terminal #2 of terminal strip #2.

6. Current leaves terminal #2 on wire 2H202B20 and flows to pin H on bulkhead connector #2.

7. It leaves on wire 2H202C20 and flows to the temperature control switch pole. You want manual cool, so current flows to the cool contact, and over wire 2H213C20 to pin C on bulkhead connector #2.

8. Here, it leaves on wire 2H213B20 and flows to terminal #6 on terminal strip #2. Current leaves terminal #6 on two wires, but the one we are concerned with is wire 2H213D20.

9. Current flows over wire 2H213D20 to pin A on the temperature control valve. It continues through the valve motor and out pin C on wire 2H214A20N to ground. The temperature control valve now runs toward cool which is what you selected.

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AUTOMATIC WARM

Note: The temperature selector does not directly control the temperature control valve's operation. Instead, it controls the amount of current going to the mercury thermostat heater. This thermostat, in turn, controls the cabin relay which controls the temperature control valve's operation. As you go through this circuit, you will see how this is done.

1. Use your BLACK pencil to trace this circuit. The master switch is still in the air conditioner and pressure position, so current flows over wire 2H201D20 to pin M on bulkhead connector #2.

2. Current leaves pin M on wire 2H201E20 and flows to terminal #1 on terminal strip #2. Again current flows to the blower which causes it to operate.

3. Current also leaves terminal #1 on wire 2H201F20 and flows to pin C on the temperature control Box #1 electrical connector.

4. From here it flows to point A inside the control box where it will flow in two directions.

5. First, trace the current up to point B. At this point you want current to flow through R1 and R2 to energize the more heat and less heat relays. Current also flows over both tap-off wires and out pins H and G on the #1 electrical connector to the anticipator thermostat. Here current flow stops.

6. Now, let's go back to point A. Current flows from here through point C, down to point D. Here again current flows in two directions.

7. For now current flows from point D to point E, through R3 to point F. Remember, we are tracing only necessary circuits.

8. At point F, current flows in two directions. It flows up to energize the cabin relay and down to point G. From point G current goes in two directions.

9. First, it flows down and out pin D on #2 electrical connector and over to pin C on the control thermostat. Current flow stops at this point for now.

10. Going back to point G, current also flows out pin A on #2 electrical connector to pin E on the high limit thermostat. Here current flow stops again for the time being. You now have all three relays energized, so draw the contact levers to the energized position.

11. Going back to point C, current flows from point C to point F on electrical connector #1. From here it flows over wire 2H202A20 to terminal #2 on terminal strip #2.

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12. From here it flows on wire 2H202B20 to pin H on the bulkhead connector #2. Current leaves pin h on wire 2H202C20 and flows to the temperature control switch, which is in the automatic position.

13. Current now flows over wire 2H204C20 to pin F on bulkhead connector #2. From pin F it flows over wire 2H204B20 to terminal #7 on terminal strip #2. Current leaves terminal #7 on wire 2H204A20 and flows to pin D on electrical connector #2.

14. From here it flows inside the control box and comes to X2 on the cabin relay. Since the relay is energized, current continues to contact 10 and up to point J.

15. From point J, current flows to X2 on the more heat relay. This relay is also energized, so current flows over contact 3 and out to pin B on electrical connector #1.

16. It leaves pin B on wire 2H212A20 and flows to pin B on the temperature control valve. Current continues through the valve motor and out to ground. This causes the valve to run toward hot. To determine how far the valve runs toward hot, go back to point D inside the temperature control box.

17. Current continues down from point D and out to pin F on electrical connector #2. It leaves pin F on wire 2H206A20 and flows to terminal #3 on terminal strip #2.

18. It leaves terminal #3 on wire 2H206B20 and flows to pin K on bulkhead connector #2. From here current flows over wire 2H206C20 to the temperature selector.

19. The temperature selector is toward the warm position so this puts more resistance into the circuit. This resistance causes a voltage drop as current flows through the selector. This current, at the reduced voltage, comes out wire 2H205C20 to pin J on bulkhead connector #2.

20. It leaves pin J on wire 2H205B20 and flows to terminal #4 on terminal strip #2. Current leaves terminal #4 on wire 2H205A20 and flows to pin G on the control box electrical connector #2.

21. From pin G current flows inside the control box, over R5, and to point H. From point H, it flows out pin E on electrical connector #2.

22. Current flows from pin E on wire 2H219A20 to pin B on the control thermostat. This current flows through the thermostat heater and out to ground. This heats the mercury inside the thermostat and causes it to rise. As the mercury rises, it makes contact with the 110° wire from pin C on the thermostat.

23. The potential on this wire is then grounded to the thermostat heater ground. The voltage that energized the cabin relay now has a path of less resistance to follow so the cabin relay deenergizes.

24. With this relay deenergized, you lose power at contact 10 and also to the hot side of the temperature control valve. Now the valve stops operating.

25. You have controlled the movement of the temperature control valve by controlling the amount of voltage going to the thermostat heater. If more voltage had been applied to the heater, the running time of the valve toward hot would have been much shorter.

In the next and last circuit, we will continue from where you are now and see how this system will call for a cool temperature.

AUTOMATIC COOL

Note: Use your PURPLE pencil to trace this circuit. If the temperature selector were set to cool, this would increase the amount of voltage going to the control thermostat heater, and, in turn, would deenergize the cabin relay much faster. With this in mind, we will continue with Auto-Cool

1. Start with current flow at point B inside the control box. Current flows from point B to X1 on the more heat relay. This relay is still energized, so current flows from X1 to contact #1 and over to the less heat relay.

2. It then flows from X1 on the less heat relay and since the relay is still energized, over to contact #5.

3. From here current flows to pin I on electrical connector #1. It then continues from pin I on wire 2E208A20 to pin B on the anticipator thermostat. Current continues through the thermostat heater and out to ground making a complete circuit.

4. This heater, along with duct temperature, starts the mercury rising inside the thermostat. While the mercury is rising, current is flowing from point E, inside the control box, to X1 of the cabin relay. This relay is deenergized, so current flows from X1 to contact #11 and over to X2 on the less heat relay. At this time the current cannot continue because the less heat relay is energized.

5. By now the mercury in the anticipator thermostat has risen enough to make contact with the potential at the 380° wire. This now completes a circuit through the mercury and heater ground wire. This deenergizes the more heat relay. Now power is removed from the hot side of the temperature control valve.

6. The heater on the anticipator thermostat is still in operation, so the mercury rises until it comes in contact with the 400° wire. Now the less heat relay will deenergize. The current at X2 on the less heat relay will flow over contact #8 and out to pin A of electrical connector #1. From here it flows over wire 2H213A20 to terminal #6 on terminal strip #2, and then over wire 2H213D20 to pin A of the temperature control valve. Current continues through the valve motor and out to ground. The circuit is now completed and the valve will run toward the cool position.

7. You have now completed the tracing of mercury thermostat temperature control system. If there is some area you feel you do not understand, ask your instructor for assistance.

Use figure #2 to answer the following questions. Figure #2 has numbers placed on it representing a system trouble. You are to select the number that would cause the trouble described in the discrepancy and draw a circle around your answer.

1. The temperature control valve is inoperative in auto <u>and</u> manual.

a. 1
b. 2
c. 4
d. 3

2. The temperature control valve is inoperative in automatic and manual warm. Automatic and manual cold operate normally.

a. 3
b. 6
c. 7
d. 8

3. The temperature control valve is inoperative in manual cool selection.

a. 2
b. 5
c. 8
d. 1

4. The temperature control valve will not operate to the cold position when automatic cool is selected.

a. 1
b. 4
c. 2
d. 3

5. No automatic control of the temperature control valve. Manual selections operate normally.

a. 2
b. 3
c. 7
d. 10

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6. The temperature control valve will not operate in manual warm.

a. 4
b. 5
c. 8
d. 9

7. The temperature control valve goes full cold in automatic.

a. 1
b. 4
c. 5
d. 6

8. Automatic cool is inoperative, automatic warm operates normally.

a. 2
b. 3
c. 7
d. 4

9. The temperature control valve goes full hot in automatic.

a. 1
b. 4
c. 5
d. 6

10. The temperature control valve is inoperative in auto and manual.

a. 3
b. 6
c. 9
d. 11

You have not been provided with the correct responses for these questions. Take your text to the instructor and he will check your answers for correctness. Rework those problems you have not solved correctly.

1833

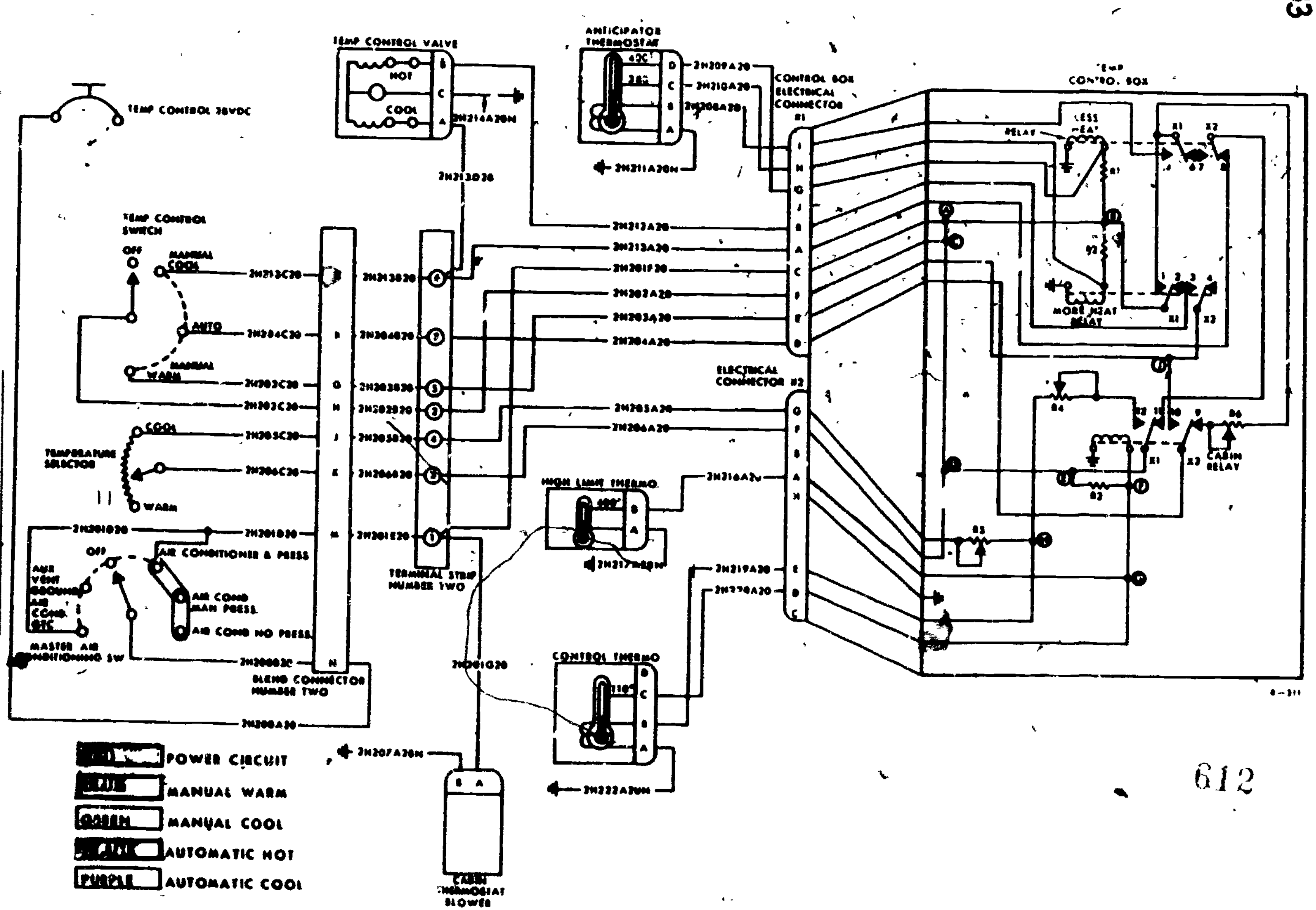
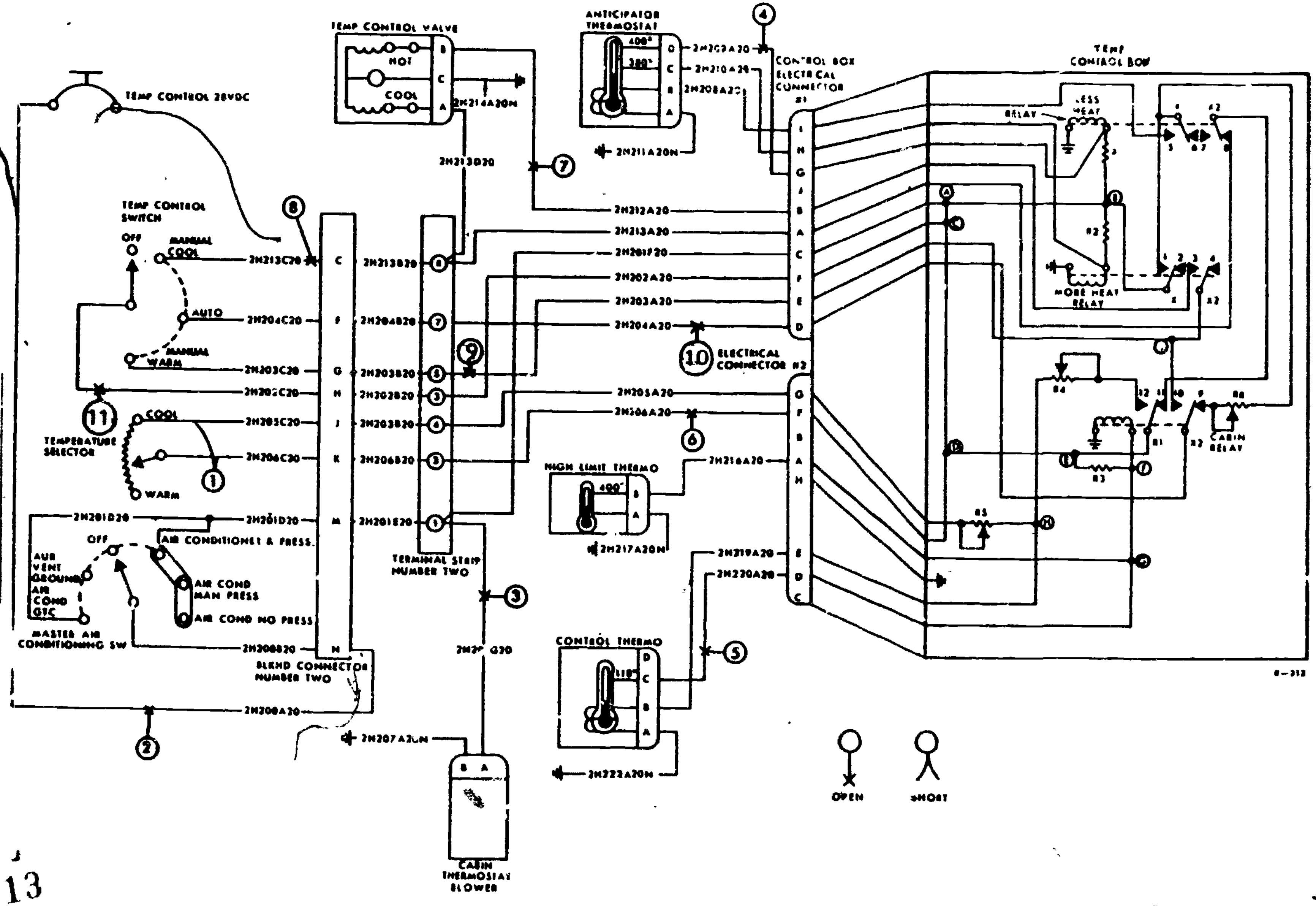


Figure 1.

11

Figure 2.
12



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WORKBOOK

3ABR42331-WB-209A

Technical Training

Aircraft Environmental Systems Mechanic

CARGO AIR CONDITIONING SYSTEM TROUBLESHOOTING

15 September 1977

3350 TECHNICAL TRAINING WING
3370 Technical Training Group
Chanute Air Force Base, Illinois

DESIGNED FOR ATC COURSE USE

DO NOT USE ON THE JOB

1836

Environmental Pneudraulics Branch 3ABR42331-WB-209A

Chanute AFB, Illinois

OBJECTIVES

1. Perform an operational check on the flight deck or cargo compartment a' conditioning system.

2. Troubleshoot the flight deck or cargo compartment air conditioning system using the AN/PSM-37 multime r and wiring diagram, correctly locating 5 out of 7 troubles.

EQUIPMENT

	Basis of Issue
Trainer 3021 Cargo Air Conditioning System	1/student
Multimeter AN/PSM-37	1/student

PROCEDURE

Remove all of your jewelry. Report to the lab instructor and inform him of the lesson on which vo are working. The lab instructor will assign you to a trainer and provide the necessary materials.

This workbook is presented in two sections. Section 1A and 1B are to familiarize you with the components of the flight deck or cargo compartment air conditioning systems and to prepare you for performing the operational check and troubleshooting. Section 2 contains the steps for operational checking these systems and the malfunctions that you are to troubleshoot. Perform each step as directed on the following pages.

NOTE: You will be assigned to perform this lesson either on the flight deck system or on the cargo compartment system. Check the name of the trainer you are assigned to. If you are assigned to a flight deck system, start with section 1A. If you are assigned to a cargo compartment system, start with section 1B.

Supersedes 3ABR42331-WB-208A, 2 January 1973.
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DISTRIBUTION: X
3370 TTGTC - 600; TTVSR - 1

SECTION 1A. FLIGHT DECK AIR CONDITIONING SYSTEM COMPONENTS

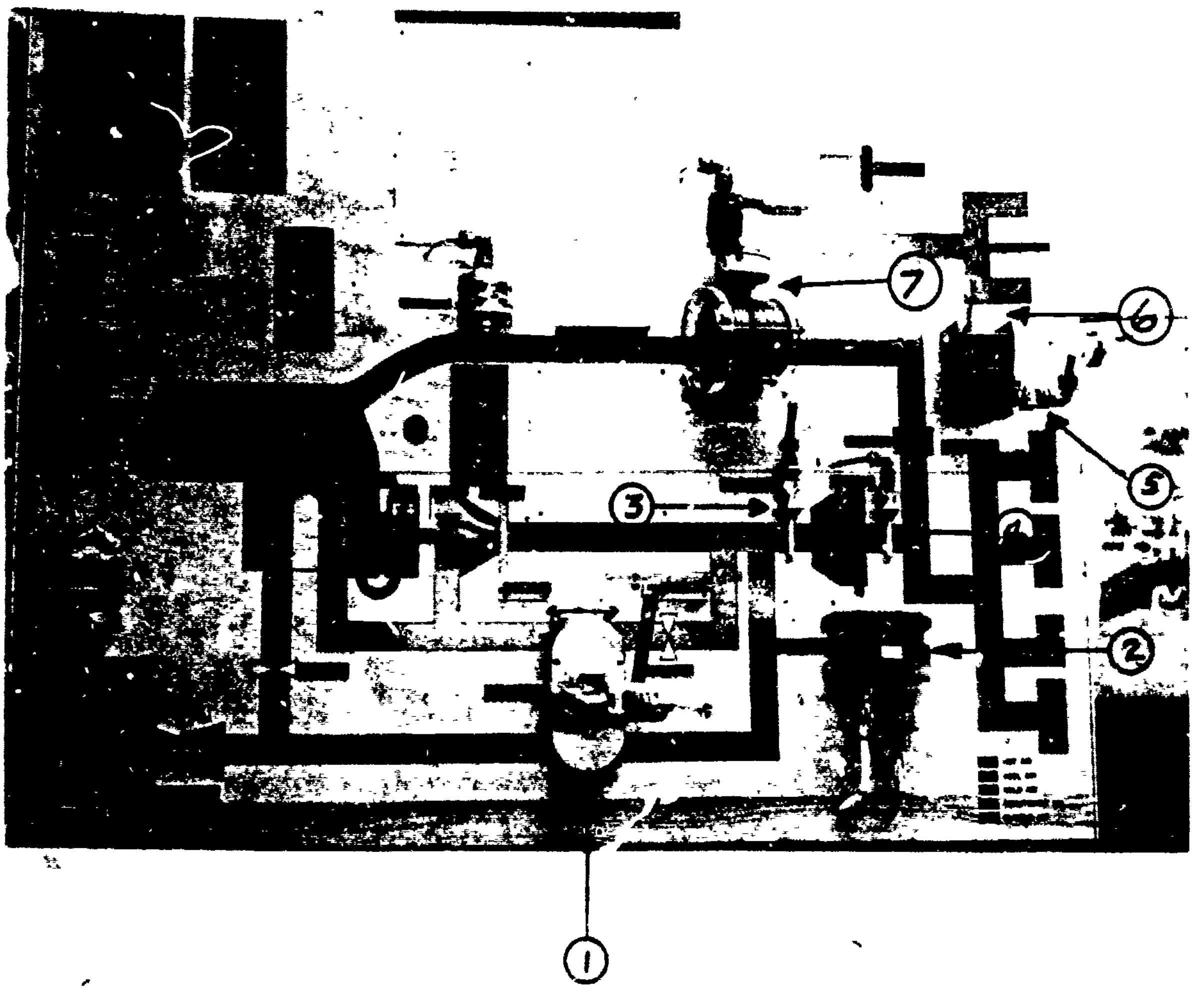

Figure 1.

1. Location and identification of system components.

a. Using the trainer and the illustrations in figure 1, locate each of the numbered items. Write the name of each of these numbered items in the blank spaces below.

(1) ______________________

(2) ______________________

(3) ______________________

(4) ______________________

(5) ______________________

(6) ______________________

(7) ______________________

COMPARE YOUR ANSWERS TO THOSE ON PAGE 5.

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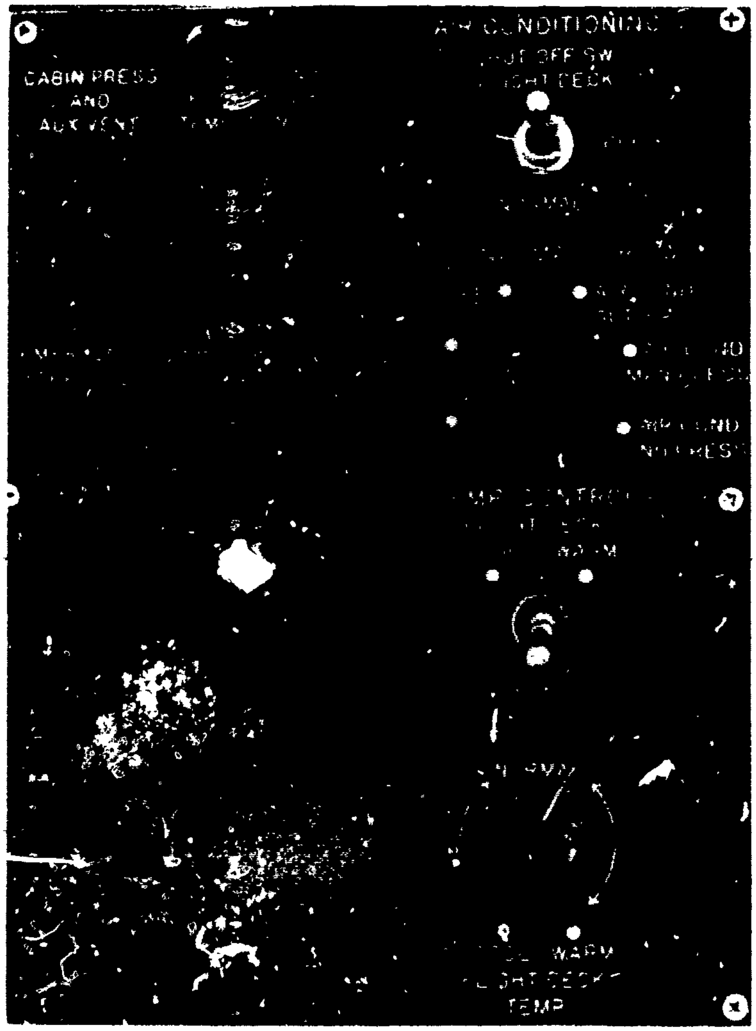

Figure 2.

b. Using the trainer and the illustration in figure 2, locate each of the numbered items. Write the name of each of these numbered items in the blank spaces below

(1) ____________________________________

(2) ____________________________________

(3) ____________________________________

COMPARE YOUR ANSWERS TO THOSE ON PAGE 5.

Answers to location and identification Section 1A, para 1a.

(1) Temperature Control Valve.

(2) Temperature Control Box.

(3) Duct Anticipator Thermostat.

(4) Hi-Limit Thermostat.

(5) Cabin Thermostat.

(6) Cabin Thermostat Blower.

(7) Aux Vent Valve.

Answers to locations and identification Section 1A, para 1b.

(1) Air Conditioning Master Switch.

(2) Temperature Control Switch.

(3) Temperature Selector.

After comparing your answers, turn to page 8, para 2.

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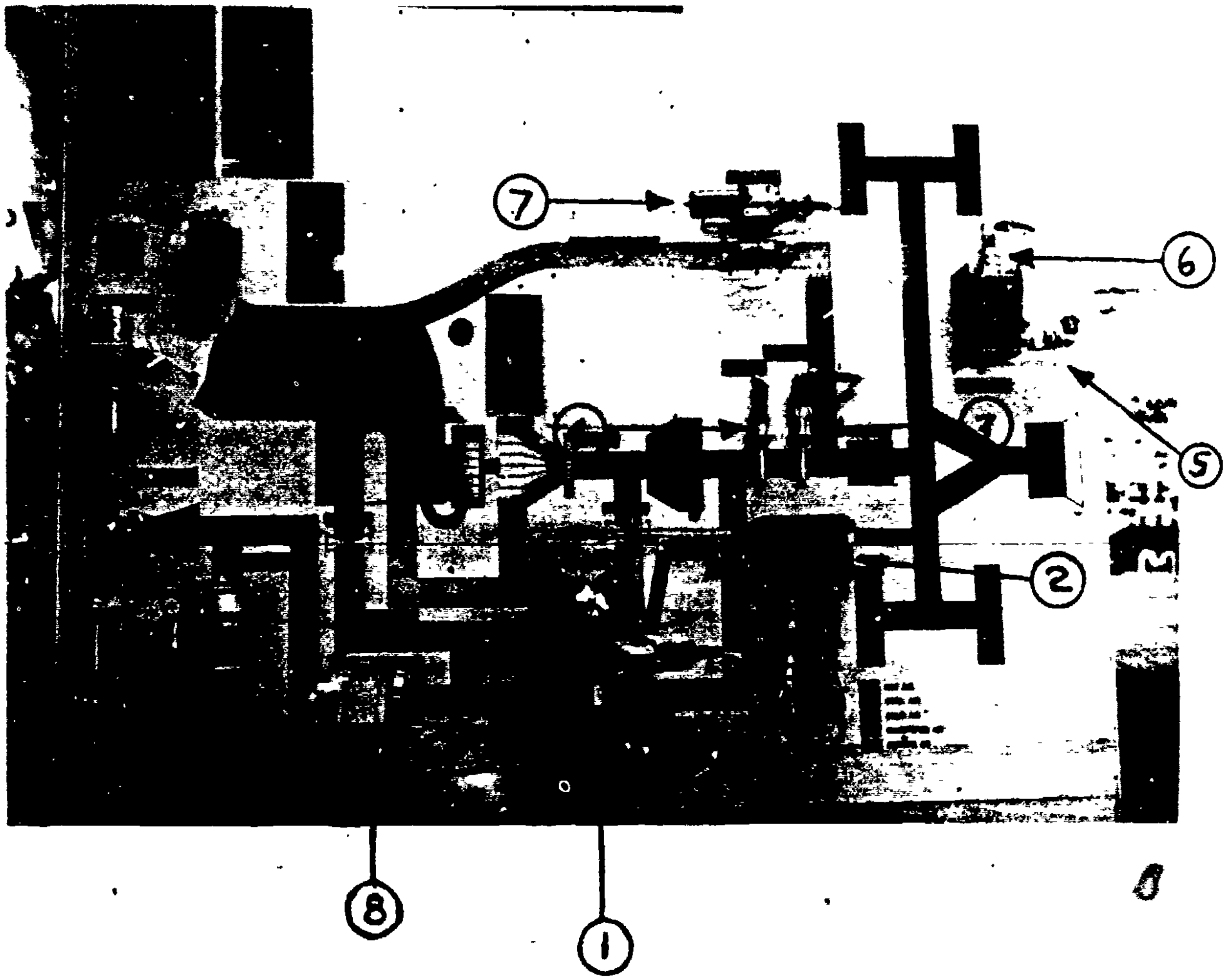

Figure 3.

SECTION 1B. CARGO COMPARTMENT AIR CONDITIONING SYSTEM COMPONENTS

1. Location and identification of system components.

a. Using the trainer and the illustrations in figure 3, locate each of the numbered items. Write the name of each of these numbered items in the blank spaces below.

(1) ____________	(5) ____________
(2) ____________	(6) ____________
(3) ____________	(7) ____________
(4) ____________	(8) ____________

COMPARE YOUR ANSWERS TO THOSE ON PAGE 10.

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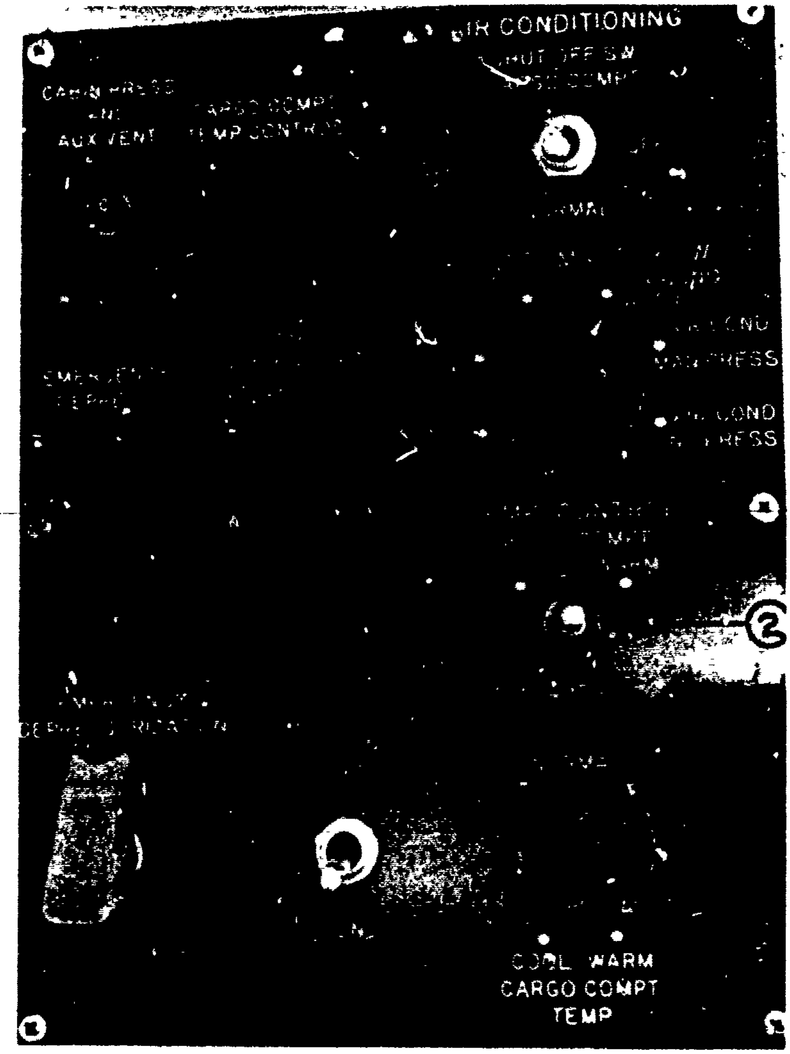

Figure 4.

b. Using the trainer and the illustration in figure 4, locate each of the numbered items. Write the name of each of these numbered items in the blank spaces below.

(1) ______________________________

(2) ______________________________

(3) ______________________________

COMPARE YOUR ANSWERS TO THOSE ON PAGE 10.

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2. Trainer preparation for the operational check and troubleshooting of the flight deck and cargo compartment air conditioning system.

a. Place all trouble switches to the OUT position. These switches are located at the left side of the trainer.

b. Make sure all circuit breakers are pushed in.

c. Place the following switches to the NORMAL positions as listed below.

(1) Air Conditioning Master Switch. . . . . .OFF

(2) Temperature Selector. . . . . .COOL

(3) Temperature Control Switch. . . . . .OFF

d. Place the trainer power switch to the ON position. This switch is located on the upper left side of the trainer.

3. Trainer operation for the flight deck and cargo compartment air conditioning system.

a. During the following steps you will operate each component on either the flight deck or cargo compartment air conditioning trainer. When a switch is actuated be sure to notice which valves operate and the valve position. Actuate each switch as directed. From your observation of the trainer operation complete each statement by circling the correct word.

Step 1. Air Conditioning System Operation.

(1) Place the air conditioning master switch in the air cond - GTC position.

(a) Cabin thermostat blower runs (yes / no).

(b) Aux vent valve (open / close).

(2) If the components failed to operate, it indicates a defective component or an open electrical circuit.

Step 2. Temperature control system: Manual Operation

(1) Place the temperature control switch to Manual Cool. The temperature control valve moves toward (hot / cold).

(2) Place the temperature control switch to Manual Warm. The temperature control valve pulses toward (hot / cold).

Step 3. Temperature control system: Automatic Operation.

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(1) Place the temperature control switch to the AUTOMATIC position, then rotate the temperature selector toward WARM. The temperature control valve pulses toward (hot / cold).

(2) Rotate the temperature selector toward COOL. The temperature control valve pulses toward (hot / cold).

Step 4. Aux Vent System Operation:

(1) Place the master air cond switch to aux vent position.

(a) Aux vent valve (opens / closes).

(b) Cabin thermostat blower runs (yes / no).

(c) Will the Auto and Manual temperature control operate (yes / no).

Step 5. Return all switches to the NORMAL position as indicated in paragraph 2c page 7 and place trainer power to OFF.

COMPARE YOUR ANSWERS TO THOSE ON PAGE 10.

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Answers to location and identification Section 1B, para 1a.

(1) Temperature Control valve.

(2) Temperature Control Box.

(3) Duct Anticipator Thermostat.

(4) Hi-Limit Thermostat.

(5) Cabin Thermostat.

(6) Cabin Thermostat Blower.

(7) Aux Vent Valve.

(8) Floor Heat Diverter Valve.

Answers to locations and identification Sect 1B, para 1b.

(1) Air Conditioning Master Switch.

(2) Temperature Control Switch.

(3) Temperature Selector.

Answers to the trainer operation statements in Sect 1B, para 3a.

Step 1.	(1)	(a) YES		Step 3.	(1)	HOT	
		(b) CLOSED			(2)	COLD	
Step 2.	(1)	COLD		Step 4.	(1)	(a)	OPENS
	(2)	HOT				(b)	NO
						(c)	NO

If all of your answers agree with the answers above, you are ready to begin troubleshooting. If they do not agree, tell the lab instructor you need assistance.

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SECTION 2. FLIGHT DECK AND CARGO COMPARTMENT AIR CONDITIONING SYSTEM OPERATIONAL CHECK AND TROUBLESHOOTING

OPERATIONAL CHECK:

1. The steps that you performed in paragraph 3a, of section 1B involved operating each component in the flight deck or cargo compartment air conditioning system. These steps are used to determine if each component is operating properly and they are called operational checks.

2. The chart below lists step by step procedures for performing operational checks of the system. To insure that you are familiar with this procedure, turn the trainer power ON and perform each of the steps. After you are sure you understand the operational check procedure, then continue to the troubleshooting part of this lesson. You will be required to perform a complete operational check for each trouble.

Note: This chart is provided only as a guide for learning the operational check procedure.

POSITIONING THE CONTROL DEVICES	OPERATING COMPONENT	COMPONENT OPERATION
Place the air cond master switch to the air cond-GTC position	Cabin thermostat Blower	Operates
Place the Temp Control switch to MANUAL COOL.	Temp Control Valve	Runs Toward Cool
Place the Temp Control switch to MANUAL WARM.	Temp Control Valve	Pulses toward HOT
Place the Temp Control switch to AUTO Rotate the Temp Selector to COOL.	Temp Control Valve	Pulses toward COOL
Rotate the Temp Selector to HOT.	Temp Control Valve	Pulses toward HOT
Place the Air Cond Master switch to AUX Vent.	Cabin Thermostat Blower Aux Vent Valve	No Operation Opens
Place the Temp Control switch to any position.	Temp Control Valve	No Operation
Place the Air Cond Master Switch to Air Cond - GTC position.	Cabin Thermostat Blower Aux Vent Valve	Operates Closes
Place the Temp Control Switch to any position.	Temp Control Valve	Will Operate

Operational Check Procedure Chart

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TROUBLESHOOTING

1. For each trouble, perform an operational check to determine the malfunctioning component. After you determine the malfunction, then place a statement in the "discrepancy" block of the attached troubleshooting answer sheet that describes the malfunction.

2. Using a waxed pencil, trace the electrical circuits that operate or controls the malfunctioning component.

3. Use the multimeter to locate the cause of the trouble.

Note: When measuring voltage, be sure the meter is set to the correct voltage range. Make sure that you have the negative (Black) lead to ground. Ground on the trainer is located on the center left of the trainer. When checking the manual temperature control system, be sure to hold the temperature control switch to either HOT or COLD. When measuring resistance, be sure the trainer power is OFF and the meter is set in OHMS. Use the OHM portion of the multimeter only to check the system when it is isolated from the rest of the circuit.

4. Record the cause of the trouble in the cause block on the troubleshooting answer sheet.

5. The trouble switch that you are to use for each problem is listed on the top line of the discrepancy block. There are 10 problems for you to troubleshoot. We will go through the first one with you to show you how to arrive at the correct answer.

a. If you are assigned to the Flight Deck Air Conditioning System, place trouble switch number 10 to the IN position.

b. If you are assigned to the Cargo Compartment Air Conditioning System, place trouble switch number 1 to the IN position.

c. Perform an operational check (use the operational check procedures chart.)

d. As you went through the operational check you found that the Temperature Control valve will not move to the HOT position in Auto and Manual position. Make the following statement in the discrepancy block of the troubleshooting answer sheet.

"No control of the Temp Control Valve in Auto and Manual Hot."

AUTOMATIC HOT

1. Since the temperature control valve will not operate in Auto and Manual Hot, the trouble must be in a wire or component that is common to both the automatic and manual operation. What part of the circuit would affect the Auto and Manual operation?....To determine this let's trace the circuits.

2. Trace the automatic hot operation; using a grease pencil, start tracing the electrical circuit at the 28V DC circuit breaker. Follow

the circuit to the bulkhead connector number 2 at point "N" to the Master Air Conditioning Switch.

3. Now draw the master switch in "Ground Air Cond GTC" position. Trace through the switch to bulkhead connector #2 at point "M." Now proceed to terminal strip #2 at pin #"1." You will notice that there are two electrical wires at this point; trace the one going to the control box electrical connector #1 at pin "C". Then trace to point "B" inside the temp control box and through resistor R-2 to the more heat relay coil. Energizing the more heat relay moving the contacts X-1 and X-2 to the left.

4. Return to point "A" inside the temp control box. Now trace from point "A" through point "C" to point "D". From point "D" trace to point "E" through resistor R-3 and up to the cabin relay coil. Energizing it will move the contacts X-1 and X-2 to the left.

5. Return to point "C" inside the temp control box. Trace this wire to pin "F" of connector #1 and follow it to terminal strip #2 pin #2. Then trace to pin "H" on the bulkhead connector #2 and to the temperature control switch.

6. Draw the temperature control switch in the Auto position. From the Auto position to bulkhead connector #2, point "F", then to terminal strip #2, point "7", and to pin "D" on the temp control box electrical connector #1. Trace this wire to X-2 of the cabin relay and to X-2 of the more heat relay, across the contacts and then to pin "B" of connector #1 and to pin "B" of the temperature control valve.

7. You have now traced the automatic hot temperature control circuit. Now you will trace the manual hot circuit. Notice that this circuit will bypass the cabin relay.

MANUAL HOT

1. Start at the 28 V DC circuit breaker. Follow the circuit to the bulkhead connector #2 at pin "N". With the master switch in "Ground Air Cond G.T.C." trace through the switch to bulkhead connector #2 to pin "M". Now move to terminal strip #2 to pin "1". Notice that there are two electrical wires at this point.

2. Trace the one that goes to the control box electrical connector #1 at p[illegible] "C" and to the more heat relay coil. Energizing the more heat relay [illegible] the contacts X-1 and X-2 to the left.

3. Return to point "A" inside the temp control box. Trace to point "C" inside the control box and then pin "F" of electrical connector #1. From pin "F" you trace to terminal strip #2, pin #2 and then pin "H" of the bulkhead connector; from pin "H" to the temperature control switch.

4. Now draw the temperature control switch to the manual warm position. Trace the wire to pin "G" of the bulkhead connector and then pin "5" of terminal strip #2. Now trace from pin #5 on the terminal strip to pin "E" of electrical connector #1. Follow this wire from pin "E" to X-2 of the more heat relay, through the contact to pin "B" of electrical connector #1 and to pin "B" on the temperature control valve.

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a. From the circuit that you have traced, what part of the circuit is common to both automatic and manual hot?

b. Any troubles in the circuit from the 28V DC circuit breaker to the maste switch and to pin "C" of the temperature control box would affect hot and cold both. So we can eliminate these circuits as possibilities for our trouble.

c. Any troubles in the circuit from auto position of the temperature control switch to X-2 of the cabin relay would affect the system in automatic operation only. Any troubles in the circuit from manual warm to pin "E" at the temperature control box would affect manual warm only. So, again, we can eliminate these circuits as possibilities.

d. However current has to travel from X-2 of the more heat relay, through pin "B" of the electrical connector #2, and to pin "B" of the temperature control valve for both auto and manual hot. Now troubleshoot to determine exactly where our problem is.

e. Set the PSM-37 to 28V DC. Place the master switch to the "Ground Air Cond G.T.C." position and the temperature control switch to automatic. Rotate the temperature selector to warm. Disconnect the electrical connector at the temperature control valve.

f. Place the black lead on the PSM-37 to ground and the red lead to pin "B" of the electrical connector. You should read 28V DC. However, you will notice that there is not voltage at this point.

g. Leaving the electrical connector disconnected, remove connector #1 from the control box. Looking at your wiring diagram, notice that when the connector is removed, the voltage is lost. This is because it goes in pin "C" of the control box and comes out at pin "B" on the control box. Due to the loss of voltage it means we will have to set the PSM-37 on OHMS.

h. After you set the meter on OHMS, place one lead in pin "B" of the temperature control valve connector and the other lead in pin "B" of the electrical connector #1. You should read continuity, but you will notice that the meter reads infinity. This reading indicates an open between these two points. Looking at your wiring diagram you will see that auto and manual must come through this wire to make the temperature control valve operate. Place this statement in the cause block.

Open Wire H212A20

Note: If you are on the flight deck air conditioning system, place trouble switch #10 out and move on to trouble #1.

If you are on the cargo compartment air conditioning system, place trouble switch #1 out and move on to trouble #2.

Note: When troubleshooting the temperature control system and either a connector #1 or #2 is removed, this disconnects the power going to the temperature control box. To continue troubleshooting the system the multimeter must be placed to the OHMS position.

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Troubleshooting Response Sheet

TROUBLE SWITCH NUMBER	Discrepancy	Cause
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

WHEN COMPLETED, REPORT TO THE INSTRUCTOR

Instructors signature showing satisfacory completion of this objective.

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