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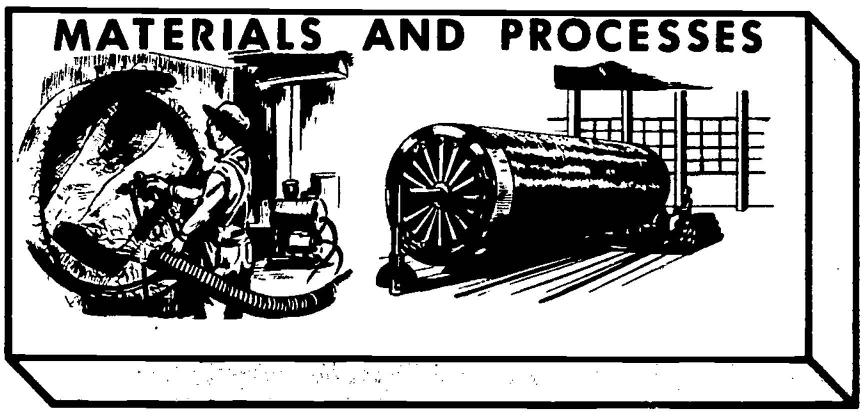
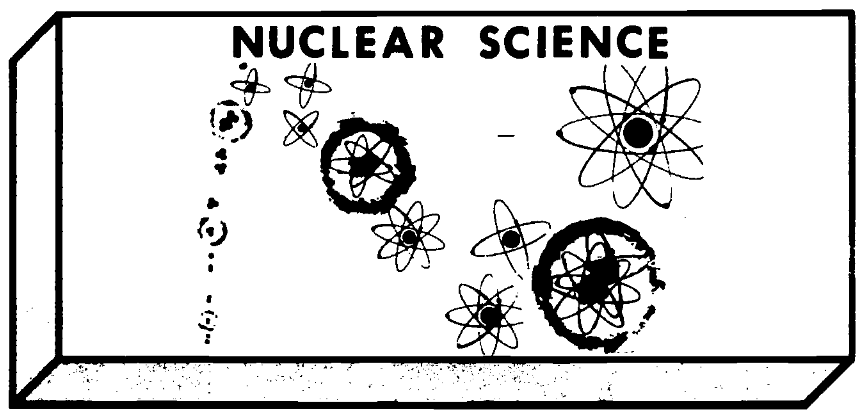
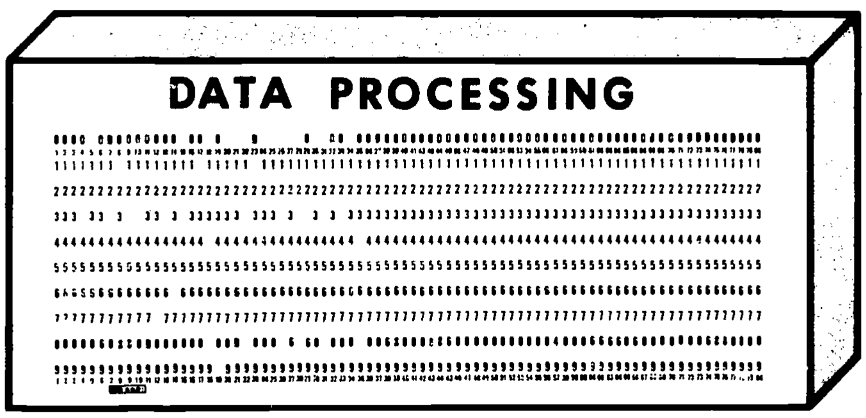
Descriptors-Bibliographies, Curriculum Development, *Industrial Arts, *Industrial Arts Teachers, *Inservice Teacher Education, *Laboratory Experiments, Resource Materials, Science Experiments, Secondary Grades, Teaching Guides

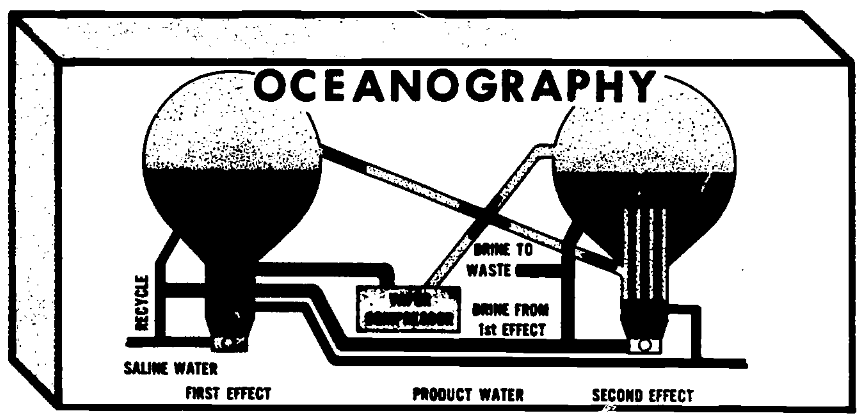
These units developed for teacher use consist primarily of a collection of typical experiments or research activities developed by staff and participants of a National Defense Education Act Institute. The institute was designed to broaden the viewpoint of 25 industrial arts teachers with regard to some of the newer scientific and/or engineering disciplines. Each experiment or activity follows a general outline of: title, objectives, introduction, references, definitions, equipment and materials needed, procedures, and questions. Textual material is presented for the topics of: (1) adhesives, (2) drawing, (3) electricity-electronics, (4) finishes, (5) forest products, (6) fuels and lubricants, (7) metals, and (8) other suggested experimental activities. (GR)

SCIENTIFIC AND ENGINEERING INFLUENCES ON INDUSTRIAL ARTS









NDEA SUMMER INSTITUTE

TEXAS A&M UNIVERSITY

1967

SCIENTIFIC AND ENGINEERING INFLUENCES

ON

INDUSTRIAL ARTS

A Summary of Institute Activities

N.D.E.A. Summer Institute
Department of Industrial Education
Texas A&M University
College Station, Texas

1967

ACKNOWLEDGEMENT

The Director wishes to express sincere appreciation to the Institute Staff for their assistance and to the Participants for their cooperation during the institute. The result has been a very rewarding experience for all involved with the institute. It is hoped that any spark of interest kindled during the institute will grow into a significant contribution to the field of industrial arts.

Clint A. Bertrand

INSTITUTE STAFF

DEPARTMENT OF INDUSTRIAL EDUCATION:

Director	Dr. Clint A. Bertrand, Associate Professor
Assistant Director	Dr. James Boone, Associate Professor
Coordinating Instructor	Dr. Leslie Hawkins, Professor
Assistants	Mr. Gary Grannis, Graduate Assistant
	Mr. Darrell Smith, Graduate Assistant
Secretaries	Mrs. May Heatherly Mrs. Rita Merchant Miss Marilyn Melcher

DEPARTMENT OF INDUSTRIAL ENGINEERING:

Instructors (Part-time)	Dr. Dan Drew, Associate Director, Data Processing Center
	Mr. Robert Anderson, Instructor, Industrial Engineering
	Mr. Hugh Herrington, Instructor, Industrial Engineering
Assistant	Mr. Rao S. Suryadevara, Graduate Assistant

Institute staff, cont'd.

DEPARTMENT OF NUCLEAR SCIENCE

Instructors (Part-time)	Dr. John Randall, Director, Nuclear Center
	Mr. Donald Anderson, Assistant Research Engineer, Nuclear Science Center
	Mr. Donald Feltz, Assistant Director, Nuclear Science Center
	Mr. David Mueller, Research Assistant, Nuclear Science Center
	Mr. Philip Sandel, Health Physicist, Nuclear Science Center

DEPARTMENT OF OCEANOGRAPHY

Instructor (Part-time)	Mr. Charles Knowles, Graduate Fellow, Oceanography

N.D.E.A. PARTICIPANTS
TEXAS A&M UNIVERSITY
1967

NAME	HOME ADDRESS	SCHOOL ADDRESS	TEACHING AREAS
BACH, MORRIS	658 Bauer Court Elmont, New York 11003	Springfield Gardens High School Queens, New York 11413	Woodworking, Drawing, Part-Time Supervisor
BURNS, MARION C.	111 Heiner Heights Lawrenceburg, Indiana 47025	Lawrenceburg High School Lawrenceburg, Indiana 47025	General Shop
CLOUSE, HARLAN J.	1905 Sherwood Pueblo, Colorado 81004	South High School Pueblo, Colorado 81004	Metals
COONEY, ROSSMOND E.	1513-12th Street Green Bay, Wisconsin 54301	Southwest High School Green Bay, Wisconsin 54301	Woodworking
DUFOUR, JOHN D.	20 Victor Avenue Nashua, New Hampshire 03060	Lexington High School Lexington, Massachusetts 02173	Electronics
DUGGAN, JOHN C.	1102 St. Paul Street Rochester, New York 14621	Greece Arcadia High School Rochester, New York 14612	Metals, Transportation & Machine Shop
FRICKE, RICHARD L.	508-2nd Avenue Ottawa, Illinois 61350	Ottawa Township High School Ottawa, Illinois 61350	Metals
GOODWIN, BRYCE E.	255 North 900 East Brigham City, Utah 84302	Intermountain School Brigham City, Utah	Drawing
HATTON, BILL C.	Box 285 Sharon Springs, Kansas 67758	Unified School Dist. #241 Sharon Springs, Kansas 67758	Woodworking, Drawing, Metals, & General Shop
HENLEY, MARION L.	709 West Street Picayune, Mississippi 39466	G. W. Carver High School Picayune, Mississippi 39466	General Shop
HORN, WALLY E.	6102 First Avenue, N.W. Cedar Rapids, Iowa 52405	Roosevelt Jr. High School Cedar Rapids, Iowa 52405	Metals, Electronics Drawing, Electricity

NAME	HOME ADDRESS	SCHOOL ADDRESS	TEACHING AREAS
ISAAC, COYDELL E.	6320 Vel Drive Fort Worth, Texas 76112	Morningside Jr. High School Fort Worth, Texas	Metals, Drawing
KERN, GEORGE J. JR.	254 Beverly Place Pacifica, California 94044	Parkside School San Bruno, California	Drawing, General Shop
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McALLISTER, RAYMOND S.	1325 Belvoir Avenue Kettering, Ohio 45409	Kettering City School Dist. Kettering, Ohio 45429	Supervisor of I.A.
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SCHMIDT, RAYMOND R.	2800 Skyline Drive Sioux Falls, S. D. 57107	Washington High School Sioux Falls, S. D.	Woodworking, Furniture Making, Asst. Principal
SHEFFIELD, WESLEY G.	3116-19th Avenue, South St. Petersburg, Florida 33712	16th Street Jr. High School St. Petersburg, Florida	General Shop
SPINKS, JAMES H.	1198 S. E. Rosewood Grasham, Oregon 97030	Gresham Union High School Gresham, Oregon	Drawing, Part-Time Supervisor
VAUGHN, RONALD J.	8865 Oak Park Drive Oak Creek, Wisconsin 53154	Cudahy Jr. High School Cudahy, Wisconsin	Drawing, Metals

NAME	HOME ADDRESS	SCHOOL ADDRESS	TEACHING AREAS
WALLACE, WAYNE E.	2324-9th Place Wasco, California	Wasco Union High School Wasco, California 93280	Auto Mechanics, General Shop, Electricity
WILSON, HARRY K.	802 Gwen Springdale, Arkansas 72764	Springdale High School Springdale, Arkansas	Woodworking, Drawing, Metals

PREFACE

This institute was designed to broaden the viewpoint of a selected group of industrial arts teachers with regard to some of the newer scientific and/or engineering disciplines. Included was instruction in data processing, laser technology, materials and processes of industry, nuclear science, numerical control, and oceanography. Methods of instruction included lecture-discussion, demonstration, laboratory research and experimentation, field trips, seminars, and educational films.

One area of study, materials and processes of industry, was oriented around the development of experiments or activities involving the various materials or processes used in industry. This book consists primarily of a collection of typical experiments or research activities developed by either the institute staff or the institute participants. It is hoped that these experiments and research activities will serve as examples of how industrial arts programs can be enriched and related more closely to scientific and engineering principles.

As is the case with any activity of this type, constant revision and improvement in procedure is a necessity. It is suggested that the interested industrial arts teachers adapt and modify these activities so that when used they will be of maximum benefit to the students. It is also hoped that this collection of researches will stimulate the development of others of a similar nature. This book also includes additional suggested research activities. Interested individuals are invited to write the Institute Director for information about other experiments and activities or related information.

TABLE OF CONTENTS

Section One

OBJECTIVES

OF THE INSTITUTE

OBJECTIVES

1. To provide an opportunity for the experienced industrial arts teachers to obtain instruction in advanced technology not previously available to them.

2. To stimulate industrial arts teachers to upgrade their industrial arts programs by relating them more closely to the technological factors influencing curriculum development.

3. To encourage the industrial arts teachers to strive for better articulation of industrial arts and science instruction in their schools.

4. To provide advanced scientifically-oriented instruction, not necessarily as information to be passed on to students, but as background information needed by a teacher to help students better understand industry.

5. To provide instruction relative to the development of new industrial materials used by industry.

6. To familiarize the industrial arts teacher with manufacturing processes of recent origin.

7. To provide a set of experiences within which the industrial arts teacher can be made more aware of various sociological features of our industrial environment.

8. To utilize instructional materials, teaching media, and instructional techniques of the type suitable for use by the institute participants in their own teaching situation.

Section Two

MATERIALS & PROCESSES

OF

INDUSTRY

Section 2-A

ADHESIVES

ADHERENCE OF ADHESIVES BETWEEN WOOD AND METAL

Carl Burns

N.D.E.A. Institute in Industrial Arts

Texas A & M University

College Station, Texas

N.D.E.A. Institute in
Industrial Arts

Texas A & M University
College Station, Texas

TITLE: ADHERANCE OF ADHESIVES BETWEEN WOOD AND METAL

OBJECTIVES:

(1) To become familiar with the varying types of commercially available adhesives.

(2) To test the tenacity of numerable adhesives which are available for general consumer use.

(3) To explore the limitations involved in the bonding of dissimiliar materials.

INTRODUCTION:

Within the past two decades the scope and manner of performing certain operations has changed so drastically that they are hardly recognizable. One of the major developmental changes has come in the field of adhesives which has produced glues with many wide and varying uses. One of the most interesting and challenging facets of this developing field is in the area of attaching materials of dissimiliar type and kind. The tests conducted in this experiment are not to qualify the product but rather to govern the application.

REFERENCES:

(1) American Society for Testing and Materials. ASTM Standards on Adhesives. Philadelphia, Pennsylvania, 1957, pp. 115-119.

(2) Braude, Felix, Adhesives. Brooklyn, New York: Chemical Publishing Company, 1943, pp. 154

(3) Delmonte, John, The Technology of Adhesives. New York: Reinhold Publishing Corporation, 1947, 615 p.

(4) Lindberg, Roy A., Processes and Materials of Manufacture. Boston: Allyn and Bacon, Inc., 1964, pp. 384.

DEFINITIONS:

Adhesive
A material that may be applied between adjacent surfaces of members to hold them together.

Adhesion
The state in which two surfaces are held together by interfacial forces which may consist of valence forces or interlocking action, or both.

Casein Glue
A glue made from powdered mild curd and certain chemicals. It is considered highly water resistant.

Contact Cement
A liquid, ready-to-use neoprene based adhesive used where no stress is required.

Epoxy Cement

A synthetic type of cement which is mixed with a hardening agent. It is considered to be very strong.

Synthetic Resin

A synthetic adhesive of more recent origin which forms the basis for a number of plastics. Some of the resin-glues are urea, phenol, resorcinal, and polyvinyl.

EQUIPMENT AND MATERIALS NEEDED:

(1) Specimens of sheet metal cut to 1" by 6".

(2) Specimens of wood precut to 1" by 3" by ½".

(3) Wire brush

(4) Carbon tetrachloride or alcohol

(5) Universal tensil testing machine

(6) Sets of grips of hold metal and wood

(7) Four different glues or any number desired as the method would be the same for any type.

(a) Casein

(b) Contact

(c) Epoxy

(d) Synthetic resin

PROCEDURE:

(1) Cut strips of sheet metal one inch wide by six inches long. Cut four strips for each type of adhesive to be tested.

(2) Remove all scale from metal test samples with a wire brush or some other feasable means.

(3) Remove all oil from metal samples by using carbon tetrachloride or alcohol.

(4) Secure same number of strips of wood as metal pieces. Their size should be 3 inches by 1 inch by ½ inch.

(5) Cut pieces as shown in figure A.

Figure A

NOTE: A slight undercut will facilitate matters when attaching metal to the wood by sliding the metal into the saw kerf.

(6) Set up the universal testing machine with jaws that will grip both the metal and wood securely when testing.

(7) Attach the metal to wood within the clamps of the testing machine.

(8) Test each specimen by groups of the same type of adhesive.

(9) Record your information on the appropriate chart.

CASEIN GLUE

	Aluminum	Galvanized	Stainless	Black Iron
Ash	175	165	180	175
Maple	200	190	200	200
Walnut	150	160	140	150
Sycamore	300	300	290	300

CONTACT CEMENT

	Aluminum	Galvanized	Stainless	Black Iron
Ash	10	10	10	10
Maple	25	30	20	30
Walnut	20	20	25	20
Sycamore	10	10	15	10

EPOXY RESIN

	Aluminum	Galvanized	Stainless	Black Iron
Ash	160	155	150	160
Maple	175	185	175	190
Walnut	345	350	345	340
Sycamore	300	310	300	330

SYNTHETIC RESIN

	Aluminum	Galvanized	Stainless	Black Iron
Ash	25	25	30	15
Maple	15	20	15	20
Walnut	20	25	20	20
Sycamore	20	15	30	25

QUESTIONS:

(1) Which glue seemed to be the strongest? EPOXY

(2) Give two situations that might call for such a bond as has just been tested.

(a) ORNAMENTAL WORK

(b) AIR CRAFT MANUFACTURE

(3) Did you notice anything different in the tests made on the samples glued with contact cement?

YES, IT DOES NOT BREAK SUDDENLY BUT STRETCHES.

PROPERTIES OF ADHESIVES

Bill C. Hatton

N.D.E.A. Institute in Industrial Arts

Texas A and M University

College Station, Texas

July, 1967

N.D.E.A. Institute in
Industrial Arts

Texas A & M University
College Station, Texas

TITLE: PROPERTIES OF ADHESIVES

OBJECTIVES:

(1) To examine various tensile strengths of commercially available adhesives.

(2) To determine the affect of moisture in wood on the adherence adhesives.

(3) To determine the relationship of the adherence of adhesives to hardwood and softwoods.

(4) To become acquainted with the various commercially available adhesives.

(5) To develop an understanding of advantages and limitations of various adhesives.

INTRODUCTION:

Until recently, animal glue was used almost exclusively by industry for joining wood. More recently, a large number of synthetic resin glues have been developed which offer a variety of particular properties such as moisture or heat resistance, high strength, fast setting, and indefinite working life. Joints which are well made, coated correctly with properly prepared glue, and clamped securely should be as strong as, or stronger than wood itself.

REFERENCES:

(1) American Society for Testing Materials. ASTM Standards on Adhesives. Philadelphia, Pennsylvania, 1957, pp. 57-60, 80-87.

(2) American Society for Testing Materials, ASTM Standards 1961, Part 6. Philadelphia, Pennsylvania, pp. 496-499.

(3) Feirer, John L. Advanced Woodworking and Furniture Making. Peoria, Illinois: Chas. A. Bennett Co., Inc., 1960, pp. 78-79.

(4) Groneman, Chris, and Glazener, Everett. Technical Woodworking. St. Louis: Webster Division of McGraw-Hill Book Co., 1966, pp. 297-299.

(5) Other references in the resource center.

DEFINITIONS:

Adhesive

A material that may be applied between adjacent surfaces of members to hold them together.

Adhesion

The state in which two surfaces are held together by interfacial forces which may consist of valence forces (combining capacity of an element) or interlocking action, or both.

Wood Failure

The rupturing of wood fibers in strength tests on bonded specimens, usually expressed as the percentage or total area involved which shows such failure.

Animal Glue

One of the oldest glues and is made principally from hides and hooves of cattle. It is strong, tough, non-staining, and free flowing.

Casein Glue

A glue made from powdered milk curd and certain chemicals. It is considered highly water resistant.

Contact Cement

A liquid, ready-to-use neoprene gased adhesive used where no stress is required.

Blood Albumin Glue

A glue which is made from the soluble albumin of beef blood. It is considered highly water resistant.

Synthetic Resin

A synthetic adhesive of more recent origin which forms the bases for a number of plastics. Some of the resin-glues are urea, phenol, resorcinal and polyvinyl.

EQUIPMENT AND MATERIALS NEEDED:

(1) Wood from which glue joints can be made.
(10 pieces each of red gum and white ash, each 3/8" x 2-1/2" x 3")

(2) Wood from which glue joints can be made.
(10 pieces of green oak, 3/8" x 2-1/2" x 3")

(3) Five (5) different glues.
   (a) Resorcinal glue
   (b) Contact cement
   (c) Urea-resin glue
   (d) Polyvinyl-resin glue
   (e) Epoxy-resin cement

(4) Gluing clamps.

(5) Dillon universal testing machine.

(6) Rule.

PROCEDURE A — Preparation of Test Samples

(1) Select five white ash samples utilizing a different glue as follows:
   (a) One resorcinal glue joint.
   (b) One contact cement joint.
   (c) One urea-resin glue joint.
   (d) One polyvinyl-resin glue joint.
   (e) One epoxy-resin cement joint.

(2) Install 1" jaws on the Dillon universal testing machine.

(3) Next place the specimens, one at a time, between the jaws of the tester and gradually apply stress with a smooth and continuous motion.

(4) Observe the behavior of each specimen as stress is applied to failure; record the maximum and minimum stress reached in the tables provided for each wood.

(5) Calculate the stress needed to cause failure.

(6) After each sample is broken, remove it from the machine and examine it to determine whether failure occured at the glue line or in the wood fibers. Estimate in per cent the amount of wood and the amount of glue failure. Record the percentages in the charts provided.

(7) Repeat the steps in (1) through (6) with samples of green oak and red gum.

COMPARATIVE ANALYSIS OF ADHESIVES

WHITE ASH
Hardwood
% Moisture Less than 7

	% Glue Failure	% Wood Failure	Minimum Load Stress (lbs.)	Maximum Load Stress (lbs.)	Tensile Strength (lbs. per sq. in.) Area/lbs. = lbs. per sq. in.
RESORCINAL GLUE	100	0	0	580	1547
CONTACT CEMENT	100	0	0	50	133
UREA-RESIN	100	0	0	600	1600
POLYVINYL-RESIN	-	-	-	-	-
EPOXY-RESIN	100	0	0	230	613

COMPARATIVE ANALYSIS OF ADHESIVES

WHITE OAK
Hardwood
% Moisture

	% Glue Failure	% Wood Failure	Minimum Load Stress (lbs.)	Maximum Load Stress (lbs.)	Tensile Strength (lbs. per sq. in.) Area/lbs. = lbs. per sq. in.
RESORCINAL GLUE	100	0	0	200	533
CONTACT CEMENT	100	0	0	2	5
UREA-RESIN	100	0	0	100	267
POLYVINYL-RESIN	100	0	0	250	667
EPOXY-RESIN	100	0	0	210	534

COMPARATIVE ANALYSIS OF ADHESIVES

RED GUM
Softwood
% Moisture Less than 7

	% Glue Failure	% Wood Failure	Minimum Load Stress (lbs.)	Maximum Load Stress (lbs.)	Tensile Strength (lbs. per sq. in.) Area/lbs. = lbs. per sq. in.
RESORCINAL GLUE	100	0	0	580	1547
CONTACT CEMENT	100	0	0	2	5
UREA-RESIN	100	0	0	868	2314
POLYVINYL-RESIN	100	0	0	580	1547
EPOXY-RESIN	100	0	0	565	1507

QUESTIONS:

(1) Which adhesive possessed the highest tensile strength on white ash?
Ans. Urea-resin.
Tensile strength was 1600 (psi).

(2) Which adhesive possessed the lowest tensile strength on white ash?
Ans. Contact cement.
Tensile strength was 133 (psi).

(3) Which adhesive possessed the highest tensile strength on red gum?
Ans. Urea-resin.
Tensile strength was 2314 (psi).

(4) Which adhesive possessed the lowest tensile strength on red gum?
Ans. Contact cement.
Tensile strength was 5 (psi).

(5) Which wood possessed the highest tensile strengths? (Circle one)

a. Hardwood
b. Softwood
c. Same

(6) Which adhesive possessed the highest tensile strength on white oak?
Ans. Polyvinyl-resin.
Tensile strength was 667 (psi).

(7) Which adhesive possessed the lowest tensile strength on white oak?
Ans. Contact cement.
Tensile strength was 5 (psi).

(8) How does the moisture content of the wood affect the tensile strength of the adhesive?
Ans. Moisture decreases the tensile strength of all the adhesives tested.

(9) Which adhesive would be the best to use on damp wood?
Ans. Polyvinyl-resin.

(10) Which adhesive would be the best to use on hardwoods?
Ans. Urea-resin.

(11) Which adhesive would be the best to use on softwoods?
Ans. Urea-resin.

(12) Suppose you were building some furniture which was to be utilized both indoors and outdoors. What type of adhesive would you suggest?
Ans. Urea-resin.
This answer was obtained by averaging the results of the charts.

PROPERTIES OF ADHESIVES

Raymond R. Schmidt

Harry K. Wilson

N.D.E.A. Institute in Industrial Arts

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College Station, Texas

Ausust, 1967

N.D.E.A. Institute in
Industrial Arts

Texas A & M University
College Station, Texas

TITLE: PROPERTIES OF ADHESIVES

OBJECTIVES:

(1) To become aquainted with the important types of adhesives.
(2) To develope an understanding of advantages and limitations of various adhesives.
(3) To compare the various shear strength qualities of different adhesives.
(4) To become aquainted with the process of dielectric heating as applied to the curing of glues.

INTRODUCTION:

Until recently, animal glue was used almost exclusively by industry for joining wood. More recently, a large number of synthetic resin glues have been developed which offer a variety of particular properties such as moisture or heat resistance, high strength, fast setting, and indefinite working life. Joints which are well made, coated correctly with properly prepared glue, and clamped securely should be as strong as, or stronger than wood itself.

REFERENCES:

(1) American Society for Testing Materials. <u>ASTM Standards on Adhesives</u>. Philadelphia, Pennsylvania, 1957, pp. 73-76, 80-87.

(2) American Society for Testing Materials, <u>ASTM Standards 1961, Part 6</u>. Philadelphia, Pennsylvania, pp. 496-499.

(3) Feirer, John L. <u>Advanced Woodworking and Furniture Making</u>. Peoria, Illinois: Chas. A. Bennett Co., Inc., 1960, pp. 78-79.

(4) Groneman, Chris, and Glazener, Everett. <u>Technical Woodworking</u>. St. Louis: Webster Division of McGraw-Hill Book Co., 1966, pp. 297-299.

(5) Westinghouse Electric Corporation. <u>Induction and Dielectric Heating; Applications and Equipment</u>. Baltimore: Industrial Electronics Division. pp. 8-9.

(6) Other references in the resource center.

DEFINITIONS:

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A material that may be applied between adjacent surfaces of members to hold them together.

<u>Adhesion</u>

The state in which two surfaces are held together by interfacial forces which may consist of valence forces (combining capacity of an element) or interlocking action, or both.

Wood Failure

The rupturing of wood fibers in strength tests on bonded specimens, usually expressed as the percentage of total area involved which shows such failure.

Animal Glue

One of the oldest glues made principally from hides and hooves of cattle and are strong, tough, non-staining, and free flowing.

Casein Glue

A glue made from powdered milk curd and certain chemicals. It is considered highly water resistant.

Contact Cement

A liquid, ready-to-use neoprene based adhesive used where no stress is required.

Blood Albumin Glue

A glue which is made from the soluble albumin of beef bloods. It is considered highly water resistant.

Synthetic Resin

A synthetic adhesive of more recent origin which forms the basis for a number of plastics. Some of the resin-glues are urea, phenol, resorcinal, and polyvinyl.

EQUIPMENT AND MATERIALS NEEDED:

(1) Wood from which glue joints will be made. (20 pieces of yellow pine, each 3/4" x 2" x 16") and (20 pieces of oak the same size)
(2) Five (5) different glues.
 (a) Animal glue
 (b) Contact cement
 (c) Urea-resin glue
 (d) Polyvinyl-resin glue
 (e) Epoxy-resin cement
(3) Electronic glue machine.
(4) Gluing clamps.
(5) Universal tensile testing machine.
(6) Rule.

PROCEDURE A Preparation of Test Samples

(1) Acquire wood stock from the instructor. (20 pieces of yellow pine 3/4" x 2" x 16")
(2) Join the surfaces of two pieces as follows:
 (a) Join two pieces using animal glue.
 (b) Join two pieces using contact cement.
 (c) Join two pieces using urea-resin glue.
 (d) Join two pieces using polyvinyl-resin glue.
 (e) Join two surfaces using epoxy-resin cement.

 Note: In items (a) through (e) be sure to apply glue to both surfaces to be glued together.

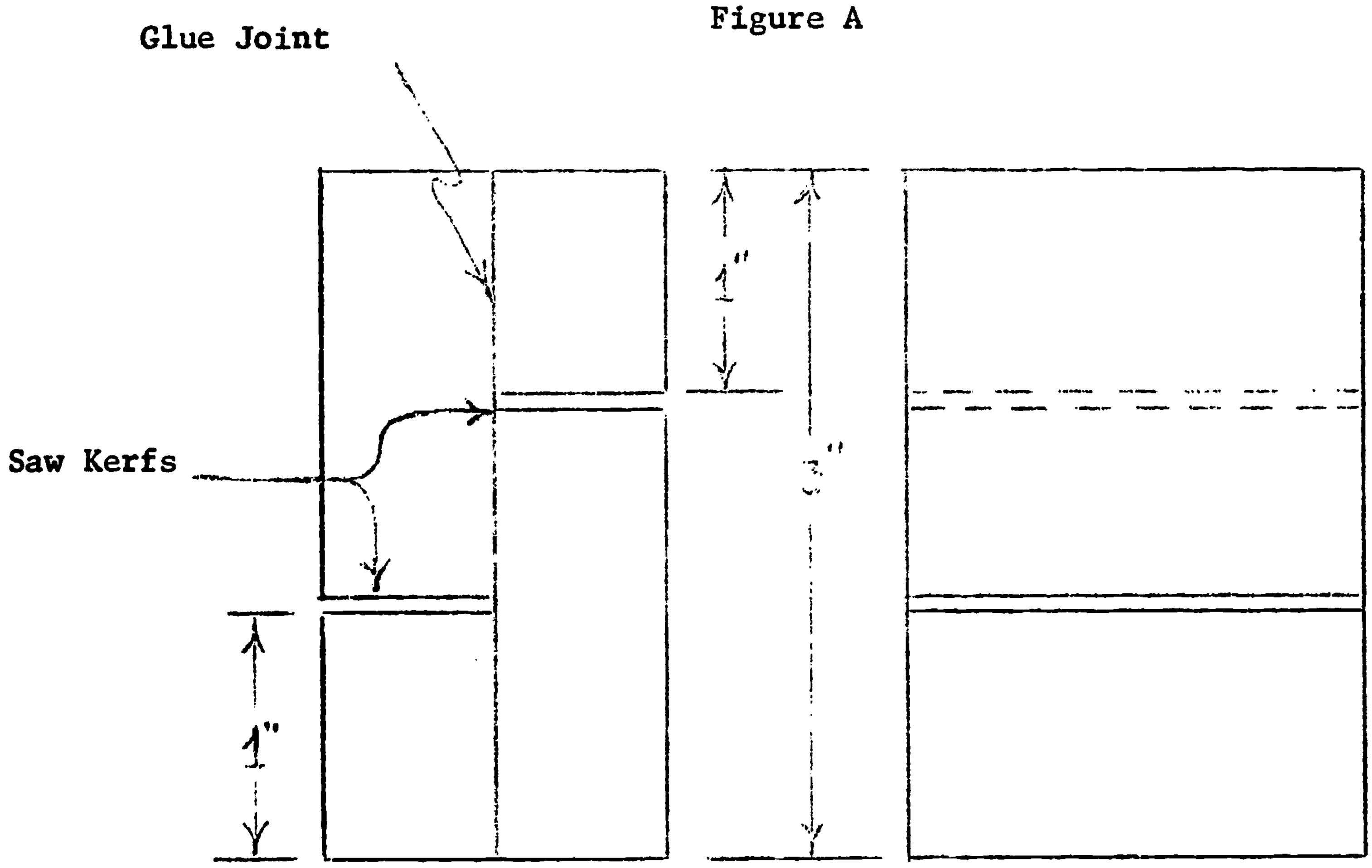
(3) Next prepare and join the surfaces as follows:
   (a) Join two pieces with only one of the joined surfaces coated with glue. Clamp and let dry.
   (b) Join two pieces with only one of the joined surfaces coated with glue and then cure the glue with the <u>electronic glue machine</u>. (See instructor and manual for proper operation techniques.)
   (c) Join two pieces using normal urea-resin glue consistency and both surfaces coated.
   (d) Join two pieces, using a watery consistency of urea-resin and coat both surfaces.
   (e) Join two surfaces, using a thick consistency of urea-resin and coat both surfaces.

   <u>Note</u>: Be sure to mark all test samples according to type of glue and how it was applied.

(4) Clamp all samples and allow them to dry for at least 18 hours.

(5) After allowing the joined boards to dry, cut each board into five 3" pieces on the circular saw. Then cut a saw kerf <u>one inch from each end</u> of the test block, across the grain and on opposite sides. (See Figure A)

Figure A



TEST SPECIMEN

PROCEDURE B Testing Shear Stress

(1) Select five test samples utilizing a different glue as follows:
   (a) 1 animal glue joint.
   (b) 1 contact cement joint.
   (c) 1 urea-resin glue joint.
   (d) 1 polyvinyl-resin glue joint.
   (e) 1 epoxy-resin glue joint.

(2) Measure the actual joint area available to resist loading for each sample and record the area (inches^2) for each sample in the tables provided.

(3) Install the compression test discs in the universal testing machine. (See Figure B)

(4) Next place the specimens, one at a time, between the compression discs (properly centered) in the universal tester and gradually apply load with a smooth and continuous motion. (See Figure B for setup)

(5) Observe the behavior of each specimen as load is applied to failure; record the maximum and minimum load reached in the tables provided for each glue.

(6) After each sample is broken, remove it from the machine and examine it to determine whether failure occurred at the glue line or in the wood fibers. Estimate in per cent the amount of wood failure and record the percentage in the charts provided.

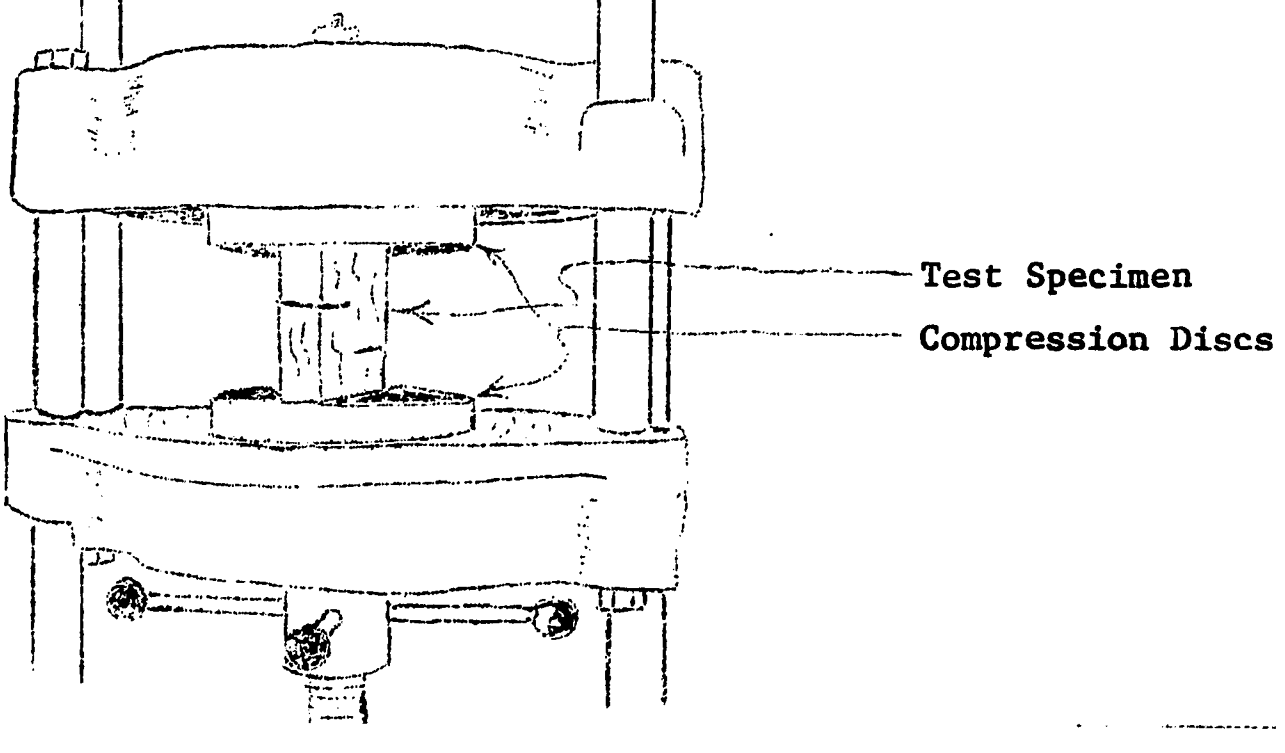
(7) Calculate the shear strength of each sample by dividing

$$\frac{\text{Maximum Load (psi)}}{\text{Area (inches}^2)}$$

(8) You are to acquire the remaining sample data necessary for each table by recording what others have found with each of their samples.

(9) Next average the data in each of the tables provided for each type of adhesive.

Figure B



	ANIMAL GLUE Sample No.					One Surface
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	880	720	700	900	400	720
Min. Load	0	0	0	0	0	0
Shear Stress	5.7	423	411	529	235	423
Est. % of Wood Failure	0	0	0	0	0	0

	CONTACT CEMENT Sample No.					One Surface
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	370	150	50	200	200	190
Min. Load	0	0	0	0	0	0
Shear Stress	217	88	29	117	117	113.6
Est. % of Wood Failure	C	0	0	0	0	0

	EPOXY-RESIN Sample No.					One Surface
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	2450	2800	2400	2000	2150	2360
Min. Load	2400	2000	900	0	1400	1340
Shear Stress	1441	1647	1411	1176	1264	1387.8
Est. % of Wood Failure	10	0	20	0	10	8

	POLYVINYL Sample No.					One Surface
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	2100	2400	1500	1900	2350	2050
Min. Load	1800	1000	400	1600	2000	1360
Shear Stress	1235	1411	882	1117	1382	1205.4
Est. % of Wood Failure	0	30	0	0	10	8

	UREA-RESIN Sample No.					
	1	2	3	4	5	Avg.
Glued Surface Area						
Max. Load						
Min. Load						
Shear Stress						
Est. % of Wood Failure						

Note:

(a) Surface area is recorded in square inches.

(b) Maximum and minimun loads are recorded in pounds per square inch.

	UREA-RESIN 2 Surface Oak					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	2900	3400	3100	3000	3100	3100
Min. Load	0	22	0	0	0	4.40
Shear Stress	1705	2000	1823	1764	1823	1823
Per Cent of Wood Failure	95	100	95	100	100	98

	UREA-RESIN 1 Surface Oak					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	3100	3300	3400	2200	3000	3000
Min. Load	0	0	0	0	0	0
Shear Stress	1823	1941	2000	1294	1764	1411.
Per Cent of Wood Failure	25	10	100	5	10	30

	EPOXY-RESIN 2 Surface Oak					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	2200	2400	2300	2500	2400	2360
Min. Load	0	0	0	0	0	0
Shear Stress	1294	1411	1352	1470	1411	1387.6
Per Cent of Wood Failure	10	100	100	90	100	80

	POLYVINYL 2 Surface Oak					
	1	2	3	4	5	Avg
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	2500	2800	2700	2900	2400	2660
Min. Load	0	0	0	0	0	0
Shear Stress	1470	1647	1588	1705	1470	1576
Per Cent of Wood Failure	0	0	0	0	0	0

	POLYVINYL 1 Surface Oak					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	850	1500	1800	1300	900	1270
Min. Load	0	0	0	0	0	0
Shear Stress	500	882	1058	764	529	746.6
Per Cent of Wood Failure	100	100	100	100	100	100

	ANIMAL GLUE Sample No.						CONTACT CEMENT Sample No.					
	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	3700	1500	50.	200	200	190.	500	500	500	430	400	460.
Min. Load	0	0	0	0	0	0	0	0	0	0	0	0
Shear Stress	217	88	29	117	117	113.6	294	294	294	252	235	273.8
Est. % of Wood Failure	0	0	0	0	0	0	0	0	0	0	0	0

	EPOXY-RESIN Sample No.						POLYVINYL Sample No.					
	1	2	3	4	5	Avg.	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	2700	2600	3000	2550	2450	26.60	2220	2900	2800	2400	1800	2424.
Min. Load	1800	1000	1[illegible]00	0	400	960.	1600	2600	900	1200	900	1440.
Shear Stress	1588	1529	1764	1500	1441	1564.4	1305	1705	1647	1411	1058	1425.
Est. % of Wood Failure	100	100	100	100	100	10	0	0	100	100	100	60

QUESTIONS: (Procedure B)

(1) Which adhesive possessed the highest shear stress?
UREA-RESIN
Shear stress was 1823

(2) Which adhesive possessed the lowest shear stress?
UREA-RESIN (watery)
Shear stress was 53.6

(3) The conditions under which the bonding process is carried out can affect the quality of adhesion, even with regard to your samples. List five (5) variables that should be considered. (ASTM)

1. Weakness of wood fibers
2. Composition of adhesives
3. Moisture content of wood
4. Human error
5. Unequal pressure

PROCEDURE C Resin Consistency and Dielectric Heating

(1) Select one (1) sample of each description as listed below:
(a) 1 sample with water urea-resin consistency.
(b) 1 sample with thick urea-resin consistency
(c) 1 sample with urea-resin coated on one surface.
(d) 1 sample with urea-resin coated on two surfaces.
(e) 1 sample with urea-resin coated on one surface and glued electronically.

(2) Test each sample in the same manner as previously and record the results in the tables provided.

	UREA-RESIN WATERY RESIN CONSISTENCY Sample No.					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	50	20	100	70	220	92
Min. Load	0	0	0	0	0	0
Shear Stress	29	11	58	41	129	53.6
Per Cent of Wood Failure	0	0	0	0	0	0

	UREA-RESIN THICK RESIN CONSISTENCY Sample No.					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	100	250	100	1350	200	400
Min. Load	0	150	0	200	50	40
Shear Stress	58	147	58	794	117	234.8
Per Cent of Wood Failure	0	0	0	0	0	0

	UREA-RESIN COATED ON ONE SURFACE Sample No.					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	1550	2500	2900	2700	2770	2480
Min. Load	500	1800	2400	1300	2300	1660
Shear Stress	911	1470	1705	1588	1629	1460.6
Per Cent of Wood Failure	30	70	50	100	60	62

	UREA-RESIN COATED ON TWO SURFACES Sample No.					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	3450	3300	3500	2200	3050	3100
Min. Load	1400	2220	800	600	800	1160
Shear Stress	2029	1941	2058	1294	1794	1823
Per Cent of Wood Failure	100	400	100	100	90	86

	UREA-RESIN 1 SURFACE-ELECTRONIC CURING Sample No.					
	1	2	3	4	5	Avg.
Glued Surface Area	1.7	1.7	1.7	1.7	1.7	1.7
Max. Load	1600	1400	1600	1300	2350	1645
Min. Load	.200	0	0	1000	1400	720
Shear Stress	941	823	941	764	1382	970.2
Per Cent of Wood Failure	10	20	60	50	100	48

QUESTIONS: (Procedure C)

(1) What happened to the sample which had only one surface coated with resin as compared to the sample with both surfaces coated?

Shear stress was not as great on the one-coated surface (pine 1460, 1823) (oak 1387.6 - 1576)

(2) Did the consistency of the glue effect the shear stress quality? If so, in what way?

Watery resin and thick resin, both didn't have the shear stress as that of the proper consistency.

(3) Compare the results obtained using the dielectric curing process with one surface coated and the air dried process with one surface coated. Is there any difference? How would you account for the difference?

GENERAL QUESTIONS:

(1) Briefly explain the principles of dielectric heating.

(2) Synthetic resins are classified into two types. Name them and give a <u>brief</u> description of each.

1.

2.

(3) Which type of resin can be used to bond dissimilar materials?

(4) Can two perfectly smooth and flat materials be successfully joined with adhesives?

(5) List five (5) synthetic resin adhesives, each being different, and write a <u>brief</u> description of each.

1.

2.

3.

4.

5.

(6) Suppose you were building some furniture which was to be utilized both indoors and outdoors. What type of adhesive would you suggest and what factors should be considered in selecting the proper adhesive?

(7) How would you as a teacher utilize the information presented in this experimental unit? (on the basis of knowledge gained and testing procedures)

ANSWERS TO QUESTIONS: (Procedure C)

(1) Shear stress was not as great on the one-coated surface (pine 1460, 1823) (oak 1387.6 - 1576).

(2) Watery resin and thick resin, both didn't have the shear stress as that of the proper consistency.

(3) Dielectric curing had less shear stress. This may be to the fact that the wood fibers were dried by the dielectric process therefore a true picture could not be obtained.

ANSWERS TO GENERAL QUESTIONS:

(1) It is a form of electronic heating which generates heat within the wood by a molecular disturbance due to high voltage stresses produced by the use of alternating currents at high frequencies.

(2) Thermoplastic - They include the polyvinyls, they require special handling.

Thermosetting - Used very successfully for gluing wood.

(3) Expoxy Resin

(4) No

(5) (a) Expoxy Resin - A two part adhesive consisting of a resin and a hardener.
(b) Polyvinyl - White liquid glue, not water proof, dries rapidly.
(c) Urea-Resin - must be mixed with water; is water.
(d) Resorcinal - Good strong waterproof glue.
(e) Aliphatic - Not waterproof, stronger than polyvinyl.

(6) Urea Resin should be used, because it is water resistant, it has strength, it is durable.

(7) Stress to the students the importance of proper selection of glues and proper preparation of materials. Give them new techniques in gluing and industrial uses of glue.

Section 2-B

DRAWING

N.D.E.A. Institute in
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Texas A & M University
College Station, Texas

TITLE: EXPLORATION OF COMMERCIALLY AVAILABLE RENDERING MATERIALS

OBJECTIVES:

(1) Develop an awareness of new materials used in industrial drafting.

(2) Provide instruction in the use of these materials in an attempt to up-date present programs to better correlate with industrial practice.

(3) Develop a method and technique incorporate these materials into instructional programs at all levels

INTRODUCTION:

Many time-saving drafting materials have been developed by industry for industry. In exposing students to basic drafting methods and techniques, an attempt should be made to introduce new things that have developed. Industrial processes have undergone rapid change in the last decade. With these changes comes a need for instructional innovations in both content and technique. A drafting program can no longer be satisfied with covering basic problems using antiquated materials and techniques. It is therefore necessary to integrate modern industrial materials and methods with the present basic course content.

REFERENCES:

(1) French, Thomas E. and Vierck, Charles J. A Manual of Engineering Drawing for Students and Draftsmen. McGraw-Hill Book Company, New York: 1966.

(2) Giachino, J. W. and Beukema, Henry J. Engineering-Technical Drafting and Graphics. American Technical Society, Chicago, Illinois: 1961.

(3) Giachino, J. W. and Beukema, Henry J. Drafting Technology. American Technical Society, Chicago, Illinois: 1964.

(4) Gibby, Joseph C. Technical Illustration. American Technical Society, Chicago, Illinois: 1965.

(5) Maurello, S. Ralph. Commercial Art Techniques. Tudor Publishing Company, New York: 1952.

DEFINITIONS:

Shading Sheets

A transparent sheet with an imprinted pattern. There are four major types of shading sheets.

(1) Transograph shading material A shading sheet with the pattern printed on top and a transparent adhesive on the back allowing the sheet to be pressed down.

(2) Zip-A-Tone The pattern is printed on the back of a clear acetate sheet. An adhesive on the back consists of wax.

(3) Craftint A pattern is printed on a clear acetate sheet. It has no adhesive.

(4) Craftint-V-Film A thin transparent sheet with a self-adhesive backing. The tone or pattern is developed with special chemicals.

Paste-up type
Ready-to-use alphabets printed on clear acetate with a protective backing sheet. The acetate has a self-adhesive backing. Artype and Presto-Type are two popular brands.

Press on letters
Ready-to-use alphabets printed on waxed sheets. By rubbing the letters with medium pressure, they can be transferred to the drawing or copy.

Prestape
Tape of different width, color, and symbols used to form lines on a drawing. Used extensively in chart and map making. Ink or pencil need not be used.

Doubletone board
A type of board having two invisible patterns printed on one surface. A special chemical is used to develop each pattern.

MATERIALS:

Samples of the many new and unique materials as mentioned in the definitions. Pencils, ink and the minimum drafting equipment needed to utilize and demonstrate the basic use and application of these materials.

PROCEDURE A

Following the method and technique presented in the demonstration, utilize the sample materials in order to become familiar with them.

PROCEDURE B

Develop a problem or project applicable to your present position utilizing one of the materials presented in this unit.

THE RELATIVE FLOWABILITY OF INKS IN AIR BRUSH WORK

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July, 1967

N.D.E.A. Institute in
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TITLE: THE RELATIVE FLOWABILITY OF INKS IN AIR BRUSH WORK

OBJECTIVES:

(1) To become familiar with the operation of the air brush.

(2) To use various inks.
   a. To compare and evaluate their ease of use.
   b. To compare and evaluate results using different papers such as oak tag, drawing paper, bristol board, vellum, newsprint and bond paper.

(3) To experiment with ink and acetate sheets for the making of overhead projector transparencies.

INTRODUCTION:

The use of the air brush, as a school activity, is relatively new. This activity can be introduced in the mechanical drafting area to enrich the course of instruction. It should achieve a greater level of interest and student activity because of the high impact values that are inherent in air brush renderings. It is a process of industry that has many applications to school and shop activities, at relatively little cost.

REFERENCES:

(1) S. Ralph Maurello, The Complete Air Brush Book. William Penn Publishing Co. New York City 1955.

(2) Field Enterprises Educational Corp. The World Book. Chicago, Illinois 60654 page 187 Book A1.

(3) S. Ralph Maurello, Commercial Art Techniques. Tudor Pub. Co. New York City 1952.

(4) Gibbey, Joseph C. Technical Illustration, American Technical Society, Chicago, Illinois 1965

(5) Giachino, J. W. and Beukema, H. J. Engineering-Technical Drafting and Graphics. American Technical Society, Chicago, Illinois 1964.

DEFINITIONS:

Air Brush

An air brush is a tool used by photographers and commercial artists to apply color or shading to drawings, prints, and photographs. Photographers find it useful to bring out high lights and to supply backgrounds. The air brush looks something like a pencil. It has a length of tubing at one end and a fine needle at the other. An electric pump or tank with a pressure gauge supplies a current of compressed air. The air enters the brush through the tubing and sends a stream of fine particles of liquid coloring matter through the needle. The operator controls the current of air by means of a valve.

MATERIALS:

(1) Samples of various inks that may be used in air brush work.

(2) Samples of the following kinds of paper:
- a. Oak tag
- b. Drawing paper
- c. Bristol board
- d. Vellum
- e. Newsprint
- f. Bond paper

(3) Masking tape.

(4) A design mask.

EQUIPMENT:

(1) Air brush.

(2) Compressed air supply.

(3) Regulator valve.

(4) Depressed ink holder.

(5) Eye dropper.

(6) Glass clean water container.

PROCEDURE A

(1) Place mask over sample papers to be tested.

(2) Load air brush with sample ink to be tested.

(3) Apply design through mask on each of the sample papers. Use the same type of ink through each series of papers to avoid constant emptying and refilling of the air brush.

(4) Repeat this procedure using other types of inks with the same mask design.

PROCEDURE B

(1) Obtain a sheet of acetate for transparency use with overhead projector.

(2) Place the masked design over the acetate.

(3) Apply specimen inks on same sheet of acetate to facilitate viewing on overhead projector.

(4) Evaluate results on overhead projector for opacity.

TABULATED RESULTS FOR PROCEDURE A

INKS	BOND PAPER					NEWS PRINT					VELLUM					BRISTOL BOARD					DRAWING PAPER					OAK TAG				
	E	F	G	B	U	E	F	G	B	U	E	F	G	B	U	E	F	G	B	U	E	F	G	B	U	E	F	G	B	U
Gamma		X				X					X					X					X					X				
Koh-I-Noor	X					X						X				X					X					X				
Waterman Perm		X							X						X					X					X					X
Skrip Wash				X						X				X						X			X						X	

Key:
E = Excellent
F = Fair
G = Good
B = Bad
U = Unacceptable

TABULATED RESULTS FOR PROCEDURE B
(Opacity test on Overhead Projector)

GAMMA					KOH-I-NOOR					WATERMAN					SKRIP				
E	F	B	G	U	E	F	G	B	U	E	F	G	B	U	E	F	G	B	U
			X			X								X					X

QUESTIONS:

(1) Which combination of ink and paper produces the most acceptable results?

Koh-I-Noor Ink and All Papers

(2) Which ink or inks are smearproof?

They are all smearproof after drying.

(3) Can acceptable transparencies be made with the air brush?

Yes.

(4) If so, which ink produces the best contrast on the screen?

Koh-I-Noor.

EXPLORING MECHANICAL MEANS OF CHECKING DRAFTING SOLUTIONS TO VECTOR PROBLEMS

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TITLE: EXPLORING MECHANICAL MEANS OF CHECKING DRAFTING SOLUTIONS TO VECTOR PROBLEMS

OBJECTIVES:

(1) To develop an experimental apparatus that can be utilized in the drafting classroom.

(2) To mechanically illustrate the basic principles of vector forces as they apply in physics, mathematics and geometry.

(3) To develop an understanding of the advantages and limitations of various graphical solutions to force problems.

INTRODUCTION:

Science, engineering and architecture are basically concerned with the effects of force in or on natural bodies and on man-made structures. In order to analyze efficiently the various types of force systems that occur in nature and that act upon man-made structures, various methods must be devised. Much force analysis is done through graphical and mathematical methods. In many cases, graphical methods can be used most efficiently since they are more direct. Both are important.

The emphasis in this experiment is put on the graphical method: first, on the principles which are applied; and second, on the means of expressing them in the language of graphics (descriptive geometry.)

REFERENCES:

(1) French, Thomas E. and Vierck, Charles J. A Manual of Engineering Drawing for Students and Draftsmen. McGraw-Hill Book Company, New York: 1966.

(2) Giachino, J. W. and Beukema, Henry J. Engineering-Technical Drafting and Graphics. American Technical Society, Chicago, Illinois: 1961.

(3) Harris, Charles O. Elementary Structural Design. American Technical Society, Chicago, Illinois: 1963.

(4) Parker, Harry. Simplified Mechanics and Strength of Materials. John Wiley and Sons, New York: 1951.

(5) Slaby, Steve M. Fundamentals of Three-Dimensional Descriptive Geometry. Harcourt, Brace & World, Inc., New York: 1966.

DEFINITIONS:

Force System

A group of forces which act on an object. The general types of systems are coplaner, non-coplaner, concurrent and non-concurrent.

Force

That which produces a change in the state of rest or motion of a body.

Vector

A line with an arrowhead drawn to scale which represents a force of specific direction and position.

Space Diagram

A drawing which represents the lines of action of forces acting on a structure.

Vector Diagram

A drawing which shows the forces in the space diagram to scale and parallel to the forces.

Resultant

A single force representing the total effect of a force system that can be drawn as a vector.

Equilibrant

A force equal and opposite to the resultant and which counter-balances the effect of the resultant.

EQUIPMENT AND MATERIALS NEEDED:

(1) Pegboard or chalkboard, approximately 4' x 8'.

(2) Three household spring scales (1# to 25#) such as can be purchased at a hardware store.

(3) Four hooks (pegboard or screw type.)

(4) One 5/8" hardwood dowel approximately 24-30" long with wire loops at ends.

(5) Five or ten pound weight with a loop attached for lifting.

(6) Fifteen feet of 1/8" cotton cord.

(7) Blackboard drafting equipment such as protractor, scale and long straight edge.

PROCEDURE A Demonstration

The following steps are suggested in preparing for demonstrations using the mechanical model:

(1) Place hooks on board according to figure A in the sample problems.

(2) Place spring scales on hooks and attach cord to scales.

(3) Position weight on cord as indicated in problems.

PROCEDURE B Problem Solutions

After using the mechanical model with spring scales to demonstrate the tension forces for each problem, the following steps are used to solve the problems graphically:

(1) Draw Space Diagram showing relative position of forces F_1 and F_2 etc.

(2) Draw Vector Diagram to scale. Let W = known weight and F_1 and F_2 plotted in same relative direction as in figure B.

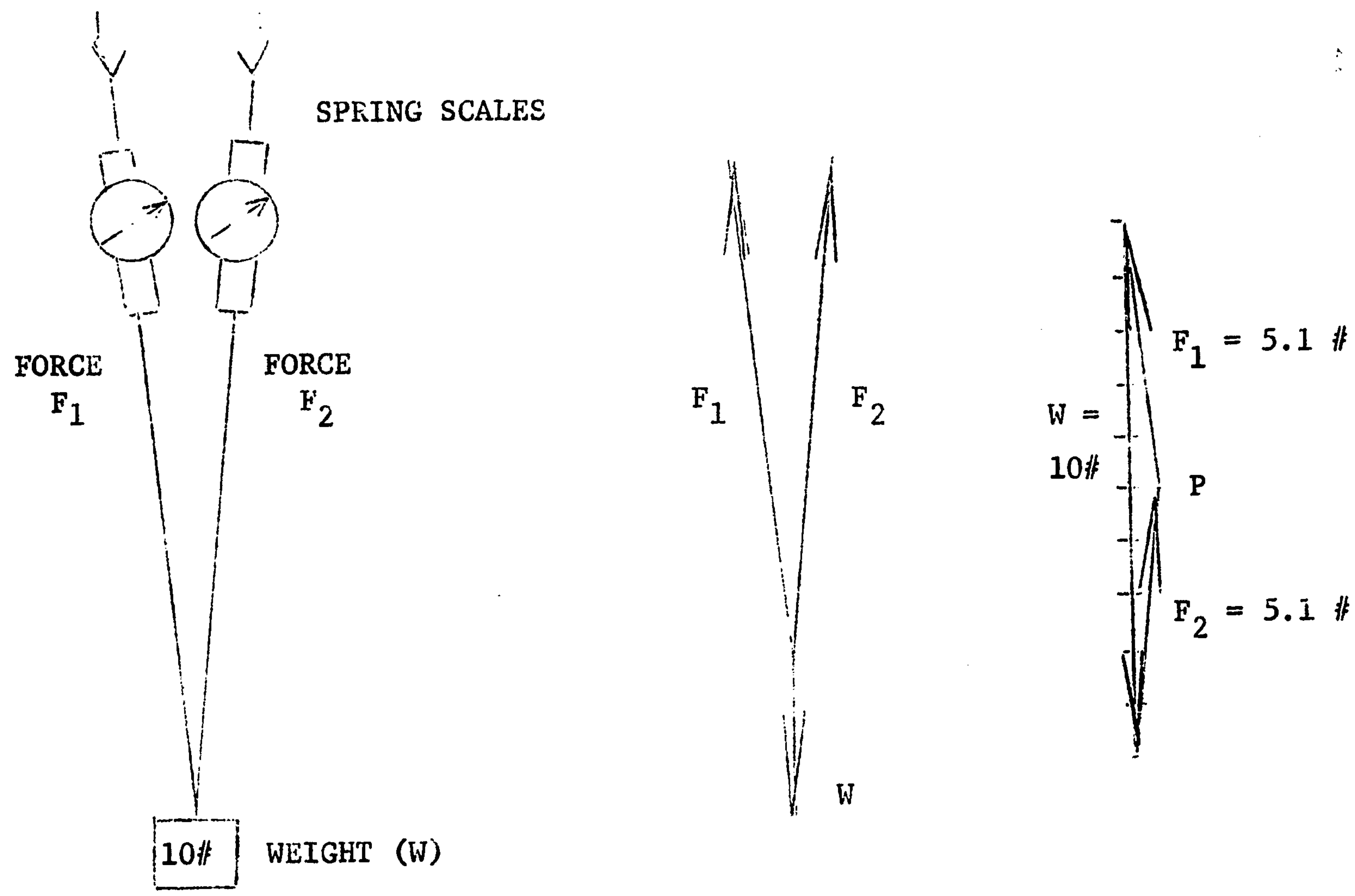
(3) Indicate conclusions regarding:

(a) summation of verticle forces in tension

(b) summation of horizontal forces in tension

(c) mechanical vs graphical accuracy of forces.

SAMPLE PROBLEM 1



(a) MECHANICAL MODEL (b) SPACE DIAGRAM (c) VECTOR DIAGRAM

TO SHOW:

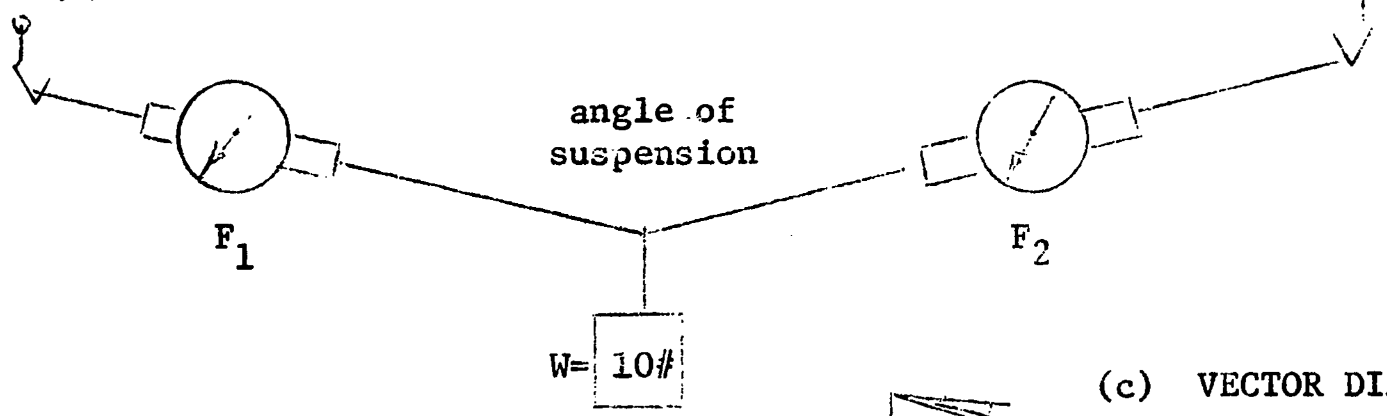
(a) How one 10# downward force W will logically be divided between two near verticle suspension lines of 5# each.

(b) The Space Diagram shows the forces F_1 and F_2 and their directions relative to each other.

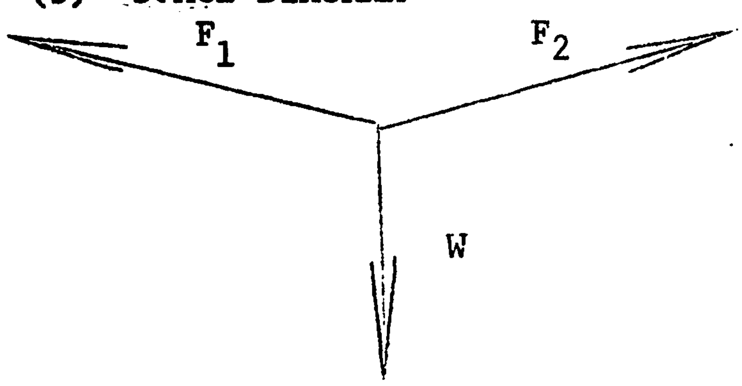
(c) The Vector Diagram shows the known 10# weight W to scale - ¼" = 1#. The forces F_1 and F_2 are then plotted from the ends of the weight W in their same relative directions as in the space diagram. As F_1 and F_2 close the triangle they automatically intersect each other at point P thereby indicating their tension force to be 5.1 lbs. each.

SAMPLE PROBLEM 2

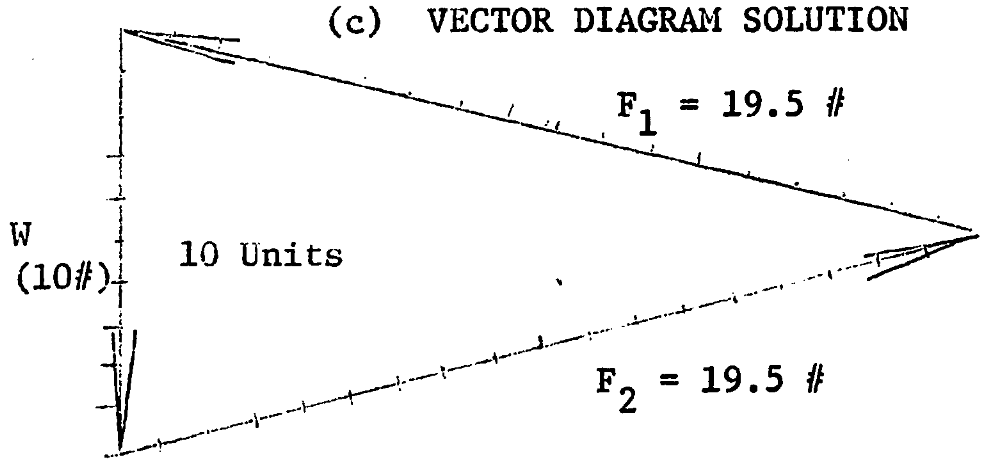
(a) MECHANICAL MODEL



(b) SPACE DIAGRAM



(c) VECTOR DIAGRAM SOLUTION



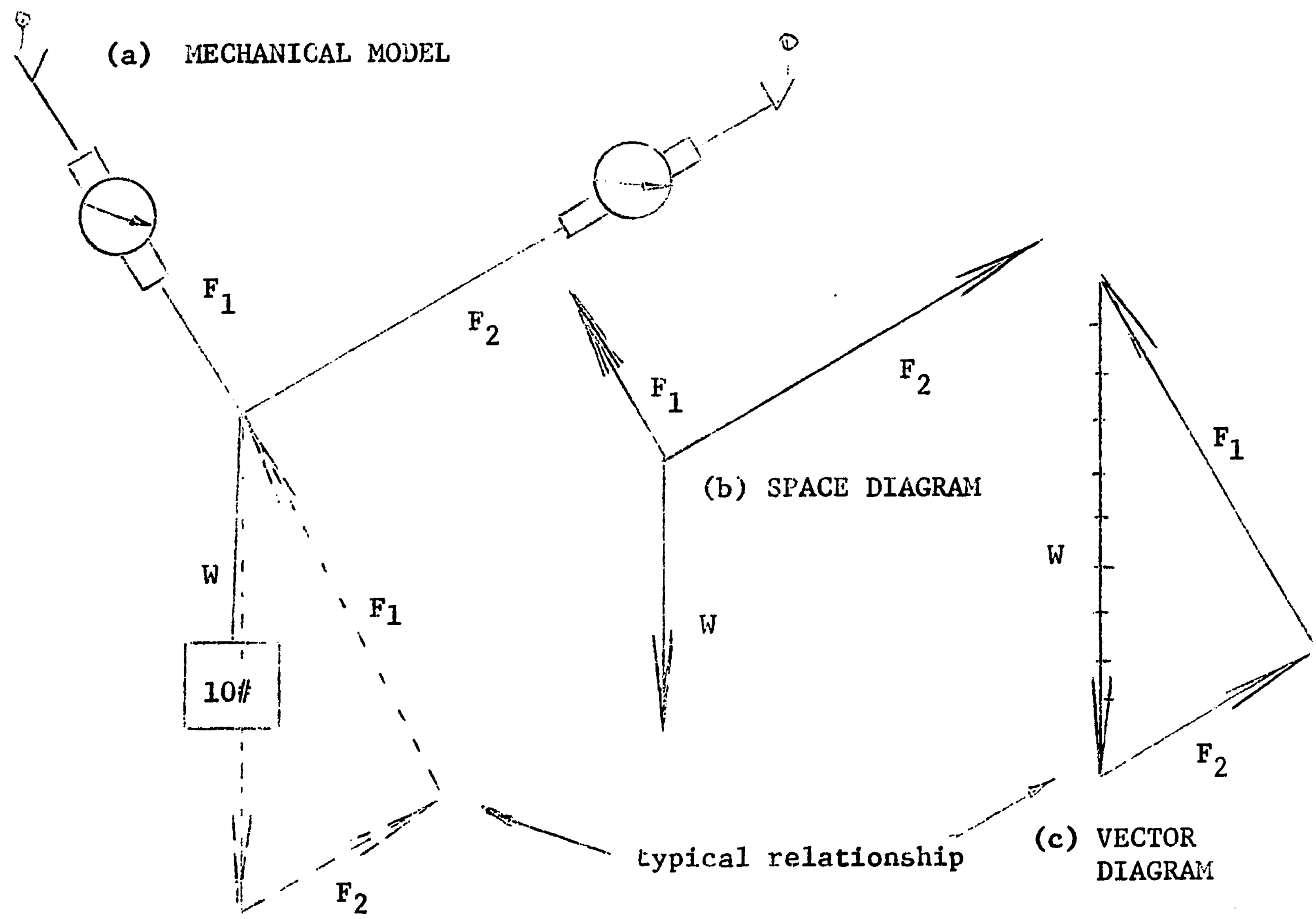
TO SHOW:

(a) The tension in F_1 and F_2 will increase rapidly as the angle of suspension is increased.

(b) The Space Diagram models the relationship of the forces illustrated in the physical model.

(c) The Vector Diagram illustrates the true force distribution throughout the force system.

SAMPLE PROBLEM 3



TO SHOW:

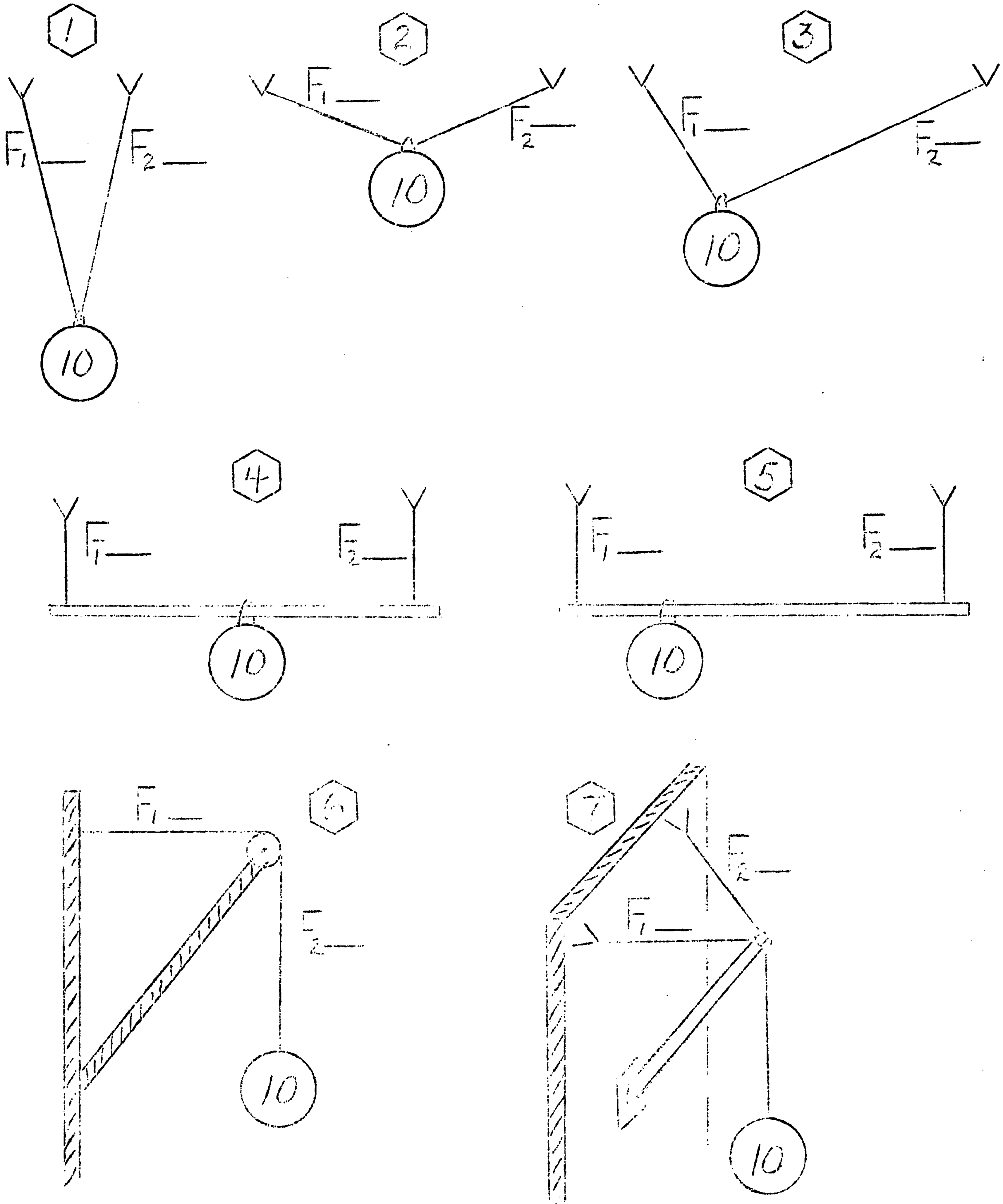
(a) When an unequal distribution of weight occurs in the force system the tension force will be greatest in the near verticle component (s).

(b) Forces in the Space Diagram and Vector Diagram are plotted in the same relative direction as in the mechanical illustration.

SELF TESTING PROBLEMS

(1) Estimate and Record the F1 and F2 forces in Pounds which would occur in the lines of tension shown below. Assume a weight of 10# in suspension for each problem.

(2) Check your answers by mechanical and graphical means.



The following questions will help to stimulate discussion around each of the vector problems after they have been solved graphically.

PROBLEM #1

Why is F1 and F2 slightly larger than the total weight (W)?

PROBLEM #2

Theoretically what forces would be required to hold the weight (W) in horizontal suspension?

PROBLEM #3

The two forces F1 and F2 will carry unequal amounts of the load. As a rule of thumb which force will always the greater load--the more verticle or the more horizontal force?

PROBLEM #4

Omitting the weight of the beam, does the length of the beam affect the forces F1 and F2?

PROBLEM #5

Can a rule of thumb similar to Problem 3 regarding which force will always carry the greater load be stated for an unequal beam load?

PROBLEM #6

Assuming F1 and F2 remained perpendicular to each other, would the length of the supporting arm affect the forces in tension?

PROBLEM #7

Would forces F1 and F2 become larger or smaller if spread farther apart?

* * * * * *

ANSWERS AND CONCLUSIONS:

1. The two forces F1 and F2 oppose each other to a slight degree thereby adding to the total weight (W).
2. Infinite horizontal forces required.
3. The more verticle suspension force.
4. Length of the beam does not affect F1 and F2.
5. The tension force nearest the load carries the greater part of load.
6. Supporting arm length does not affect the forces.
7. Forces would increase due to pull against each other.

APPLICATIONS FOR TEACHING

(1) Vector forces can be logically related to structural and mechanical objects with which the student is familiar. Some of these are:

(a) bridge structures

(b) roof loads on homes

(c) truss structures for the support of building roofs

(d) power shovel lifting devices

(e) crane operations

(f) electronic circuitry

(g) air and sea navigation

SUMMARY

The demonstrations and problems presented in this report deal only with introductory concurrent, coplaner forces. (Forces originating from the same point and in the same plane.) Students who desire to continue their study of more complex forces in tension and compression will find suitable references listed herein.

R E P R O D U C T I O N Q U A L I T Y O F
T R A N S L U C E N T D R A W I N G M A T E R I A L

Luty LeNorman

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TITLE: REPRODUCTION QUALITY OF TRANSLUCENT DRAWING MATERIAL

OBJECTIVES:

(1) Develop experimental material and apparatus that can be utilized in a drafting classroom.

(2) Illustrate basic needs for good quality material.

(3) Demonstrate the translucent quality of different drawing media, such as paper, cloth, and film.

(4) Illustrate reproduction qualities of translucent paper, cloth, and film.

INTRODUCTION:

Ideas conceived in the minds of men are usually transmitted to paper so that industry can begin to produce a product in some shape or form. Many times a number of copies are required before a product can go into production. The tracing operation previously done by individuals is outmoded and has been replaced by several methods known as the iron process and the diazo process. The diazo process requires that the drawing be drawn on some translucent material so that light can pass through to expose the drawing on the reproduction paper. The selection of a satisfactory translucent material becomes an important requirement for successful reproduction.

REFERENCES:

(1) French, Thomas E. and Svensen, Carl L. Mechanical Drawing. McGraw-Hill Book Company, New York: 1966; pp. 100.

(2) French, Thomas E. and Vierch, Charles J. A Manual of Engineering Drawing for Students and Draftsmen.

(3) Giachino, J. W. and Beukema, Henry J. Engineering-Technical Drafting and Graphics. American Technical Society, Chicago, Illinois: 1961. pp. 735.

(4) Giachino, J. W. and Beudema, Henry J. Drafting Technology. American Technical Society, Chicago, Illinois: 1964; pp. 253.

(5) Gibby, Joseph C. Technical Illustration. American Technical Society, Chicago, Illinois: 1965; Chap. 4 and 8.

(6) Earl, Arthur W. Experiments with Materials and Products of Industry. McKnight & McKnight Publishing Co., Bloomington, Illinois; 1960; pp. 170.

DEFINITIONS:

Iron Process

The blueprint or ferro-prussiate process discovered in England in 1840. A negative process producing prints with a white image on a blue background.

Diazo Process

A process involving the exposure of sensitized material to ultraviolet light through a translucent material or drawing whose image prevents exposure in specified areas.

Translucent

Transmitting light diffusely.

Tooth

Roughness of the paper surface.

Paper

A translucent paper used for original drawings.

Film

A translucent film prepared to accept pencil or ink and is used for original drawings.

Cloth

Linen cloth sized with some substance to make it accept pencil and ink.

MATERIALS:

(1) Samples of as many different types and brands of translucent drawing material as possible.

(2) Pencils - HB - 2H - 6H

(3) Pencil weight 143 grams

(4) Eraser

(5) Eraser weight 150 grams

(6) Diazo paper

EQUIPMENT:

(1) Apparatus to hold the lamp and test samples.

(2) Light meter to make comparative measurements.

(3) Kodak Carousel 800.

(4) Diazo machine and developing equipment.

PROCEDURE A Development of Testing Apparatus

(1) Develop testing apparatus.

(2) Follow suggested materials list or substitute similar component parts.

(3) Provide for adequate ventilation.

(4) Exercise your imagination as much as possible.

PROCEDURE B Measuring the Translucent Quality of Drawing Material

(1) Cut enough test samples to run a minimum of three tests on each type of paper.

(2) Mark each test sample for easy identification as to type and brand.

(3) Select one of the samples and mount it in the holder.

(4) Light source. (Kodak Carousel 800).

(5) Take a light meter reading.

(6) Run a minimum of three such tests with each type of paper. Record the average in Table.

PROCEDURE C Line Quality on Different Materials

(1) Draw lines on each sample using the three grades of pencils weighted by 143 grams as suggested in the materials list.

(2) Identify each line drawn with the pencil grade.

(3) Select one of the samples and mount it in the holder.

(4) Using the fingers, attempt to smear the lines drawn with each grade of pencil on each sample.

(5) Observe the pencil lines for smear resistance. Record the results according to the classification in the table.

(6) Using 150 gram weighted eraser, attempt to erase part of the lines drawn on each sample, three strokes on each sample.

(7) Observe the surface area of the paper where the eraser was used. Record the results according to the classification in Table.

PROCEDURE D   Diazo Quality of Different Materials

(1) Draw lines on each sample using the three grades of pencils as suggested in the materials list.

(2) Using the fingers, attempt to smear the lines drawn with each grade of pencil on each sample.

(3) Using the eraser, attempt to erase part of the lines drawn on each sample.

(4) Attach like sample materials to film and reproduce all samples at same speed.

(5) Observe the pencil lines for smear resistance.

(6) Observe the surface area of the paper where the eraser was used.

KEY: (E - Excellent; G - Good; P - Poor)

Pencil line sharpness

Excellent - line is sharp
Good - line contains fuzziness
Poor - line is dull and hazy

Smear resistance

Excellent - no evidence of smear
Good - some evidence of smear
Poor - great evidence of smear

Erasability

Excellent - no surface injury
Good - some surface injury
Poor - great surface injury

Diazo Process

Excellent - sharp reproduction quality
Good - legible reproduction quality
Poor - little or no reproduction quality

TABLE I

TRANSLUCENT VELLUM

Post Co. No.	173,	174,	175,	175H,	175EH,	177,	177H,	179,	179H
Transparency meter reading	15.3	14.7	14.6	14.5	14.5	14.9	14.6	14.4	14.5
Pencil line sharpness	E	E	E	E	E	E	E	E	E
Smear resistance	P	P	P	P	P	P	P	P	P
Erasability	G	P	G	G	E	G	G	E	E
Diazo Process	G	E	P	P	G	G	P	P	P

TABLE II

TRANSLUCENT VELLUM

Ridgway Co. No.	1015	1020	1025	1000	1000H	141	472S	472R	473	474L	474M
Transparency meter reading	14.5	14.2	14.2	14.5	14.5	15.0	14.1	14.2	14.3	14.5	14.2
Pencil line sharpness	E	E	E	E	E	E	E	E	E	E	E
Smear resistance	G	G	P	P	G	G	E	G	G	G	P
Erasability	G	G	G	G	G	E	G	P	G	G	E
Diazo process	G	P	G	G	P	G	G	P	P	P	P

TABLE III

TRANSLUCENT SKETCH PAPER

Post Co. No.	161	166	167	167D	169
Transparency meter reading	14.8	14.9	14.8	14.6	14.8
Pencil line sharpness	G	G	G	G	E
Smear resistance	E	P	G	P	E
Erasability	E	G	G	G	G
Diazo process	P	P	P	P	G

TABLE IV

TRANSLUCENT SKETCH PAPER

Ridgway Co. No.	452	460T	460ET	462L	462M	464L	464M	466	468S	468R
Transparency meter reading	15.4	15.2	14.7	14.8	14.9	14.8	14.8	14.9	14.5	14.6
Pencil line sharpness	G	G	G	G	G	G	G	G	G	G
Smear resistance	G	G	E	G	P	G	P	G	E	G
Erasability	P	E	G	E	E	G	G	G	E	G
Diazo process	G	P	P	P	P	P	P	P	P	G

TABLE V

TRANSLUCENT FILM

Post Co. No.	126-3	Ridgway Co. No.	422-5	404	413TB	413TW	423-3
Transparency meter reading	15.0		15.4	14.9	15.2	15.2	15.4
Pencil line sharpness	E		✓	E	E	G	P
Smear resistance	P		✓	P	G	P	G
Erasability	E		✓	G	E	G	G
Diazo process	E		✓	E	E	G	P

TABLE VI

TRANSLUCENT CLOTH

Post Co. No.	120	121	122	123	124	125	125A	125B	128	128A	130W
Transparency meter reading	14.7	15.0	14.6	14.6	14.5	15.1	14.9	15.1	14.4	14.6	14.5
Pencil line sharpness	E	P	G	E	E	P	G	G	P	P	P
Smear resistance	P	E	P	P	P	E	E	G	E	E	E
Erasability	G	E	P	P	G	E	E	G	E	E	E
Diazo process	E	P	G	E	E	P	P	G	P	P	P

TABLE VII

TRANSLUCENT CLOTH

Ridgway Co.	430	432	439B	439W	446B	446W	448B
Transparency meter reading	14.8	14.6	14.8	15.0	15.2	14.3	14.6
Pencil line sharpness	P	G	G	G	P	P	E
Smear resistance	E	E	P	G	G	G	P
Erasability	E	G	G	P	G	E	P
Diazo process	P	G	G	E	P	P	E

QUESTIONS:

(1) What material shows evidence of being most transparent?
Ans. Translucent film.

(2) What material produces the sharpest pencil line?
Ans. Translucent vellum.

(3) What material has the most smear resistance?
Ans. Translucent cloth.

(4) What material has the best reproductive quality?
Ans. Translucent film.

(5) What material has the best erasability quality?
Ans. Translucent cloth.

R E P R O D U C T I O N   Q U A L I T I E S   O F
" B A L L   P O I N T "   I N K S

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TITLE: REPRODUCTION QUALITIES OF "BALL POINT" INKS

OBJECTIVES:

(1) To determine the feasibility of using ball point pens for lettering and line work in Mechanical Drawing.

(2) To demonstrate the opacity and metallic content of different inks found in ball point pens.

(3) To develop an experimental technique that will be instructive to a drafting student.

INTRODUCTION:

India ink has long been considered the only ink to be used for mechanical drawing. With the development of the diazo and thermofax process of reproduction, inked drawings are not generally used because inking is tedious and time consuming. When an original tracing more permanent than penciling is required, inking is demanded.

Recently the ball point pen has become generally accepted as a writing instrument but its use for drawing is not mentioned in drafting text books. The testing of the reproduction qualities of "Ball Point" inks is necessary to gain knowledge of their properties and to determine the practicability of their use in drafting.

REFERENCES:

(1) French, Thomas E. and Svensen, Carl L. Mechanical Drawing. McGraw-Hill Book Company, New York: 1966; pp. 95-101.

(2) Giachino, J. W. and Beudema, Henry J. Engineering-Technical Drafting and Graphics. American Technical Society, Chicago, Illinois: 1961; pp. 735.

(3) Giachino, J. W. and Beukema, Henry J. Drafting Technology. American Technical Society, Chicago, Illinois: 1964; pp. 25 & 253.

(4) Gieseche, Fredrick E., Mitchell, Alva, Spencer, Henry Cecil, and Hill, Ivan Leroy. Technical Drawing. The Macmillion Co., New York: 1966; pp. 496.

DEFINITIONS:

"Ball Point" Inks

A general reference made to the various kinds and qualities of ink found in a variety of trade name ball point pens.

Diazo Process

A process of reproduction involving the exposure of a sensitized material to ultraviolet light through a translucent material on which an image has been drawn that will prevent exposure in specified areas.

Thermofax Process

A process of reproduction involving the exposure of a paper coated with a material sensitive to heat instead of light. The original drawing need not be on transparent paper as the heat is reflected from the metallic material in the image.

Opacity

The quality or state of a body that makes it impervious to the rays of light.

Metallic Content

The presence of carbon or other materials used to make ink opaque.

MATERIALS:

(1) Samples of as many colors, grades, point size, and brands of ball point pens and refills as possible.

(2) Tracing paper or vellum.

(3) Diazo type reproduction paper.

(4) Thermo-Fax copy paper.

EQUIPMENT:

(1) Satellite diazo developer or similar equipment.

(2) Diazo type developing tube.

(3) Thermo-Fax Copying Machine.

PROCEDURE A — Opaque Qualities of Inks

(1) Using samples of inks, construct lines or do lettering on a translucent medium. Identify each sample by trade name, grade name, point size, number, or any other identifying characteristic.

(2) Reproduce by diazo process. Inks with the best opaque qualities will give the darkest lines.

PROCEDURE B

Metallic Content of Inks

(1) Follow step (1) of Procedure A. (Opaque drawing paper may be used rather than a translucent medium.)

(2) Produce a copy by thermofax process. Darkest developed lines will indicate greatest metallic content.

A COMPARISON OF "Ball Point" INKS WHEN REPRODUCED

1. KOH-I-NOOR Special Repro 3024 Fine (Black)

2. LINDY Legal Copy Fine Pt. 474F G6 (Black)

3. LINDY Auditor's Shorty 450F C6 (Black)

4. LINDY Utility Shorty 450M D5 (Blue)

5. BIC F-25 Fine Pt. (Black)

6. BIC No. 5130 (Black)

7. BIC (Blue)

8. SHEAFFER Dokumental "303" 'Skrip' Fine (Blue)

9. SHEAFFER 'Skrip' Stainless Steel Refill Fine (Black)

10. UNION PEN & PENCIL CO. #91 Fine-Riter refill (Blue)

11. FEND dokumentenecht DIN 16554 F (Black)

12. FEND dokumentenecht DIN 16554 F (Blue)

13. FEND dokumentenecht DIN 16554 F (Green)

14. FEND dokumentenecht DIN 16554 F (Red)

15. INDIA DRAWING INK

A COMPARISON OF "Ball Point" INKS WHEN REPRODUCED

1. KOH-I-NOOR Special Repro 3024 Fine (Black)

2. LINDY Legal Copy Fine Pt. 474F G6 (Black)

3. LINDY Auditor's Shorty 450F C6 (Black)

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12. FEND dokumentenecht DIN 16554 F (Blue)

13. FEND dokumentenecht DIN 16554 F (Green)

14. FEND dokumentenecht DIN 16554 F (Red)

15. INDIA DRAWING INK

Section 2-C

ELECTRICITY-ELECTRONICS

TRANSISTOR CHARACTERISTICS

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TITLE: TRANSISTOR CHARACTERISTICS

OBJECTIVES:

(1) To become familiar with input and output characteristics of transistors.

(2) To become familiar with basic principles of transistor circuitry.

(3) To become familiar with laboratory techniques to determine transistor characteristics.

INTRODUCTION:

To determine the characteristics of various transistors, input and output characteristic curves should be consulted, these curves represent the effects of changing operating potentials and currents on the transistor. This permits the selection of a particular transistor for a definite purpose and also indicates how it will perform in a particular circuit.

REFERENCES:

(1) Philco Corp. AN-451 Laboratory Manual for Transistor Electronics. Fort Washington, Pennsylvania, 1964.

(2) Hickey and Villines, Elements of Electronics. McGraw-Hill Book Co., Inc. 1961, pp. 490-506.

(3) William Bevitt, Transistor Handbook. Prentice-Hall, Inc. 1959, pp. 7-124.

(4) Allied Radio, Understanding Transistors. Chicago, Illinois, 1964, pp. 7-40.

DEFINITIONS:

Static Input Characteristics
Characteristics of the emitter-base circuit under various voltage and current conditions (common base configuration).

Static Output Characteristics
Characteristics of the collector-base circuit under various voltage and current conditions (common-base configuration).

Ie Emitter current

Ic Collector current

Ve Emitter voltage

Vc Collector voltage

Alpha

Current gain (ratio of change in collector current to change in emitter current with emitter voltage constant.

Forward bias

Voltage polarity is such that external electron flow results.

Reverse bias

Voltage polarity is such that a high resistance to current results.

EQUIPMENT AND MATERIALS NEEDED:

(1) Philco transistor laboratory circuit analysis unit

(2) Dry cell type D (4 required)

(3) Multimeter

(4) Vacuum tube voltmeter

PROCEDURE A Static Input Characteristics

(1) Using the Philco laboratory unit, connect the equipment as shown in Figure 1.

(2) Adjust Ie to .25 MA

(3) Measure Ve with the VTVM and enter the value in the Ve column in Table I

(4) Increase the emitter current in increments of .25 MA to 3 MA. For each reading measure the Ve and record in Table I.

(5) Complete the collector current to .5MA.
Note: The collector current is measured indirectly by measuring the IR drop across the 1000 ohm resistor.

(6) Measure Ve and record in Table I under the proper column.

(7) Increase Ie in increments of .25 MA to 3 MA. For each reading measure Ve and record in Table I under the proper column.

(8) Repeat steps 5, 6, 7 for Ic of 1 MA.

(9) Repeat steps 5, 6, 7 for Ic of 1.5 MA.

(10) Repeat steps 5, 6, 7 for Ic of 2 MA.

PROCEDURE B Static Output Characteristics

(1) Connect the equipment as shown in Figure 2.

(2) Set the collector bias potentiometer for maximum reverse bias.

(3) Set the emitter current to 0.5 MA by measuring the IR drop across the 100 ohm resistor.

(4) Read Ic and enter in the proper column in Table 2. Marked "Max. Neg."

(5) Adjust Vc to zero and enter Ic in Table 2.

(6) Reverse the polarity of the VTVM, and increase Vc in increments of .05 volts until no furthur increase in Vc can be obtained. For each increment, measure Ic and record in Table 2.

(7) Repeat steps 3 through 6 for Ie values of 1 MA, 1.5 MA, and 2 MA and enter Ic readings in the appropriate column in Table 2.

PROCEDURE C

(1) Plot the input characteristics of the 2N344 transistor on Graph 1 using the data in Table 1.

(2) Plot the output characteristics of the 2N344 transistor on Graph 2 using the data in Table 2.

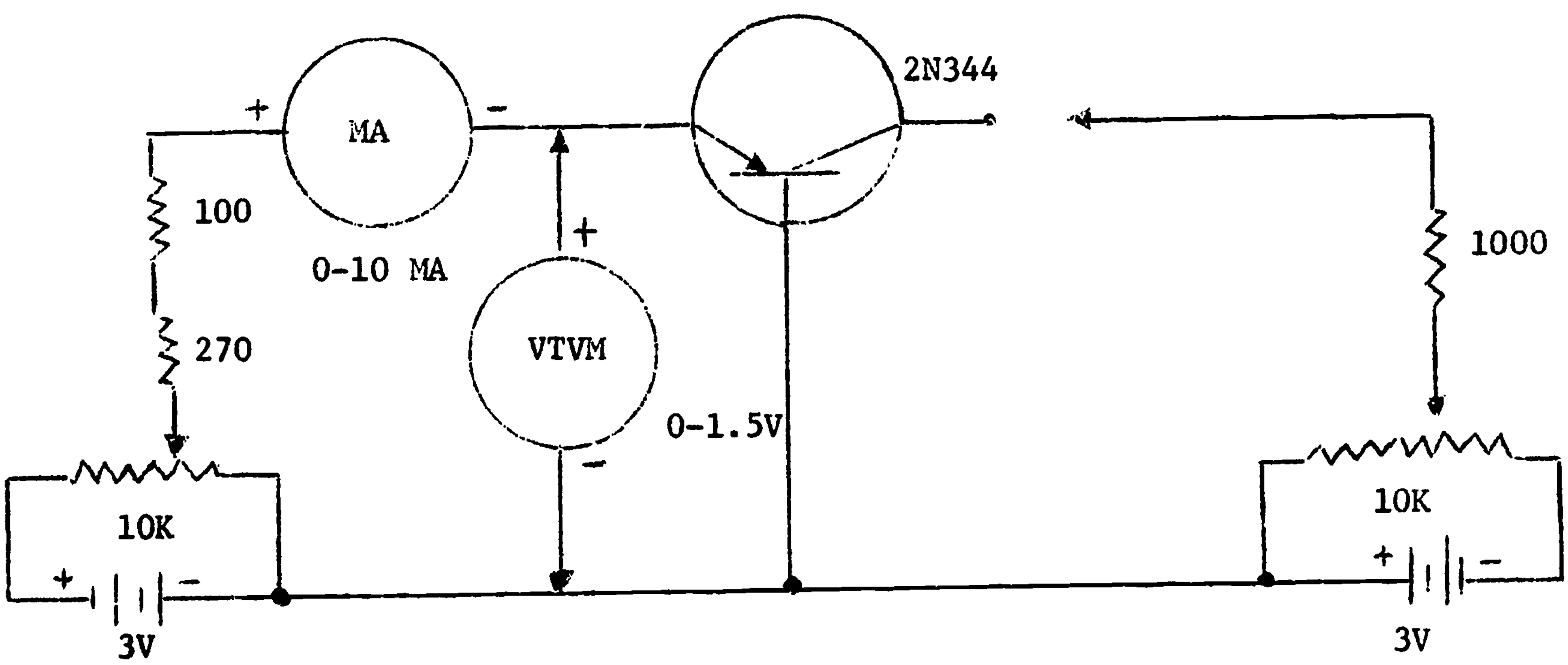
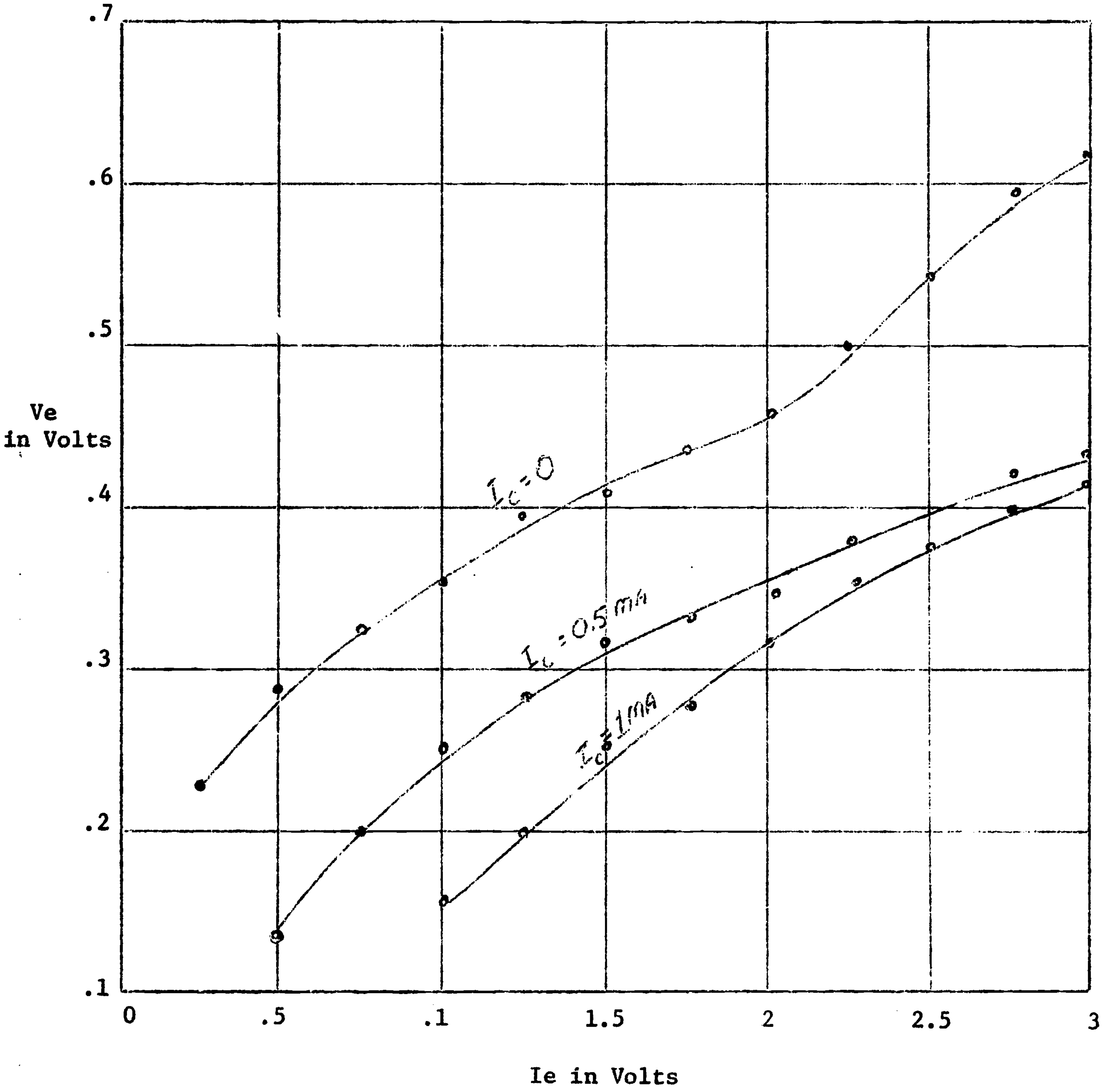


Figure I

	Ic = 0	Ic = 0.5	Ic = 1.0	Ic = 1.5	Ic = 2.0
Ie in MA	Ve in volts	Ve in volts	Ve in volts	Ve in volts	Ve in volts
0.25	.225	X	X	X	X
0.50	.29	.13	X	X	X
0.75	.325	.20	X	X	X
1.00	.35	.25	.15	X	X
1.25	.39	.28	.20	X	X
1.50	.41	.32	.25	.19	X
1.75	.43	.33	.28	.23	X
2.00	.45	.34	.32	.27	.2
2.25	.5	.38	.36	.34	.23
2.50	.54	.40	.38	.36	.27
2.75	.59	.42	.40	.37	.29
3.00	.62	.43	.41	.38	.31

Table 1



Graph 1

Transistor Input Characteristic Curves

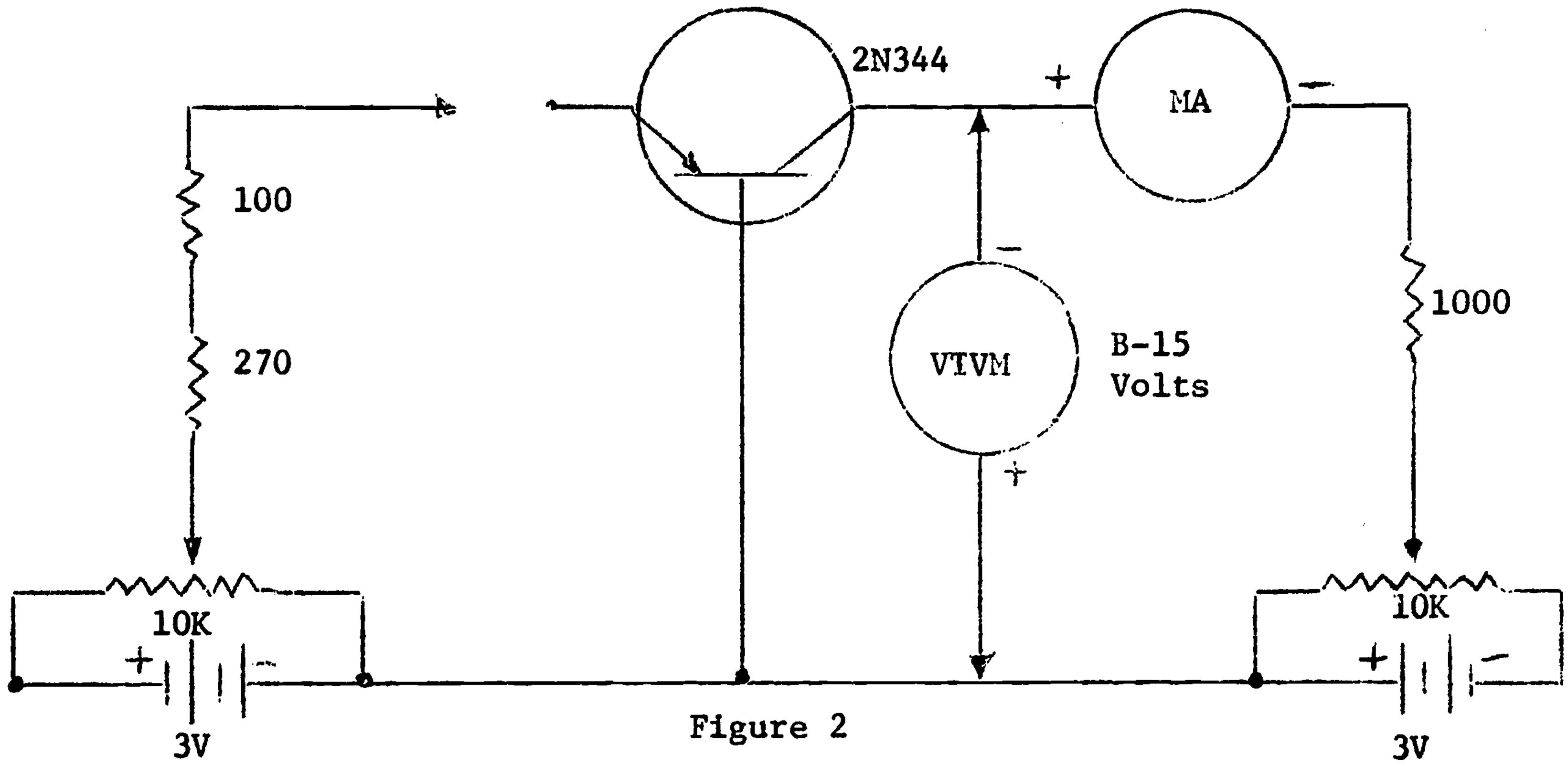
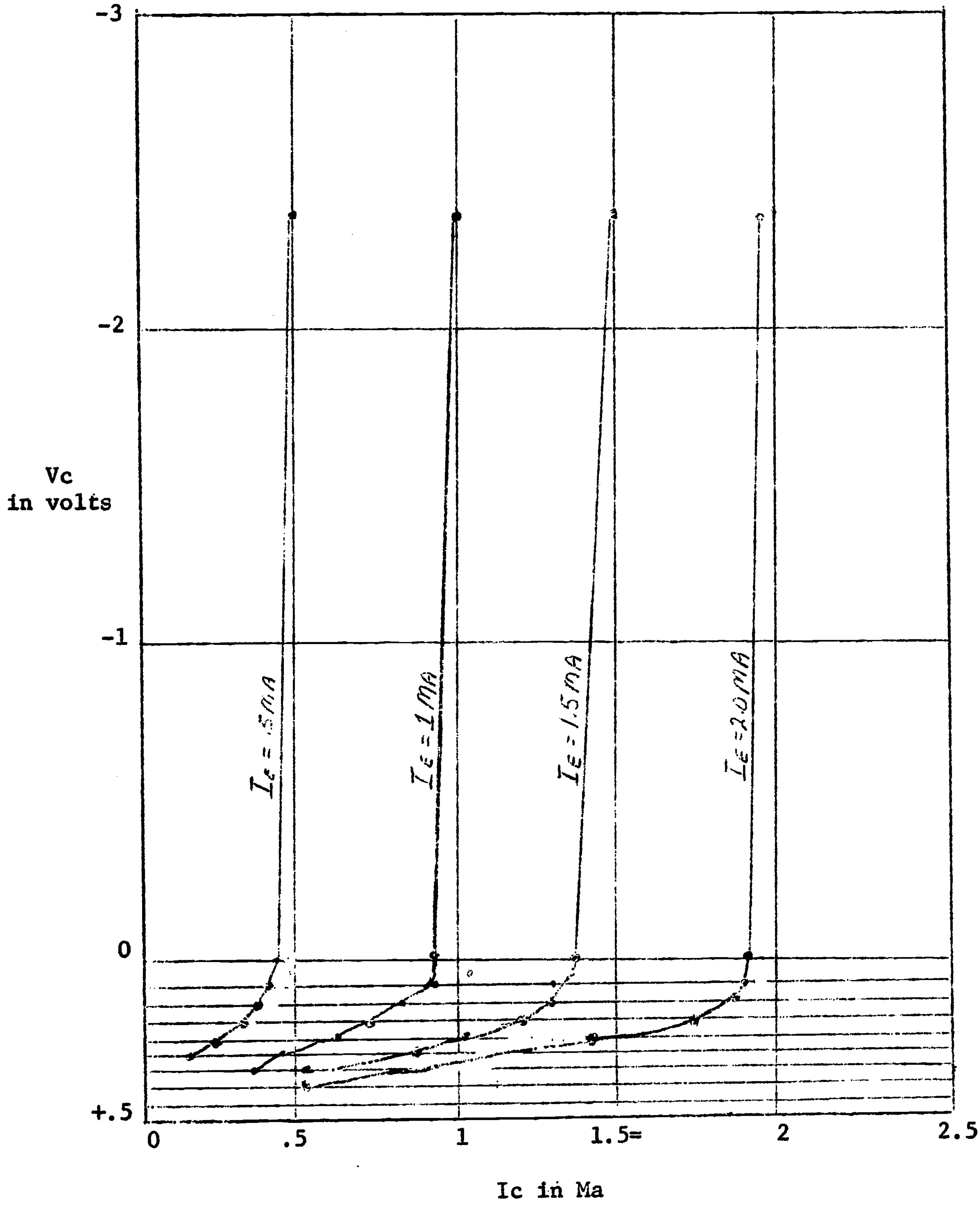


Figure 2

	Ie = .5	Ie = 1.0	Ie = 1.5	Ie = 2.0
Vc in Volts	Ic Ma	Ic Ma	Ic Ma	Ic Ma
Max Neg.	.5	1.0	1.5	1.9
0	.45	.9	1.4	1.9
+.05	.45	.9	1.4	1.9
+.10	.45	.9	1.3	1.9
+.15	.4	.8	1.3	1.9
+.20	.4	.7	1.2	1.9
+.25	.3	.6	1.0	1.8
+.30	.2	.4	.8	1.7
+.35		.3	.5	1.4
+.40				.5
+.45				
+.50				

Table 2

Transistor Characteristics



Graph 2

Transistor Output Characteristic Curves

QUESTIONS:

(1) Why is the input impedance of the transistor low?
Ans. The emitter-base circuit is biased in a forward direction and the opposition, or resistance, to current flow is low.

(2) Why is the output impedance high?
Ans. The collector-base circuit is reverse biased and exercises great opposition to the flow of current.

(3) Using the characteristic curves, what is the current gain (Alpha)?
Ans. Alpha = $\frac{\Delta \; Ie}{\Delta \; Ic}$ (with Vc constant) = .95.

(4) What is the reason for current gain of less than 1 in the common base configuration?
Ans. Output current (Ic) also flows in the input circuit (Ic).

(5) If the Alpha is less than one, how does a transistor in the common base configuration amplify?
Ans. Ie is emitted through a low input impedance and collected through a high output impedance thus achieving a high voltage amplification.

S T R E N G T H O F E L E C T R O M A G N E T S

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TITLE: STRENGTH OF ELECTROMAGNETS

OBJECTIVES:

To determine how the strength of the electromagnet may be increased by the materials used, the increase of turns and current flow through the turns used.

INTRODUCTION:

The practical application of magnetic force and electromagnetic effects form the basis of our present entire electrical industry. The discovery that magnetism could be produced by the simple process of sending an electric current through a coil led to the development of the powerful electromagnets needed to produce strong magnetic fields, which make possible the generation of electrical energy.

By the application of magnetic force, huge generators produce current to operate the many motors, magnetic controls, telephones, radios, lifting magnets, and a host of other appliances which also depend on this magnetic force so simply produced. Of the three effects produced by the flow of electric current---namely the "heating effect", the "electrochemical effect", and the "electromagnetic effect"---the electromagnetic effect which depends on the relationship between electric current flow and magnetism has been of the greatest value to mankind. It is the purpose of this experiment to determine the strength of electromagnets.

REFERENCES:

(1) Chute, George M. Electronics in Industry. New York: McGraw-Hill Book Company, Inc., 1964.

(2) Eby, George S. Understanding Radio. New York: McGraw-Hill Book Company, Inc., 1951.

(3) Gerrish, Howard H. Electricity and Electronics. Chicago: The Good-Heart-Willcox Company, Inc., 1964.

(4) Mercus, Abraham. Basic Electricity. Englewood Cliffs: Prentice-Hall, Inc., 1963.

(5) Slurzberg, Morris, and William Osterheld. Essentials of Radio-Electronics. New York: McGraw-Hill Book Company, Inc., 1964.

DEFINITIONS:

Current

Transfer of electrical energy in conductor by means of electrons moving constantly and changing positions in vibrating manner.

Electrodynamic

Speaker . . . Dynamic speaker that uses electromagnetic fixed field.

Electromagnet

Coil wound on soft iron core. When current runs through the coil, the core becomes magnetized.

Electrostatic

Space around charged body in which its influences is felt.

Field magnets

Electromagnets which make field or motor or generator.

Flux density

(Symbol B) Number of lines of flux per cross sectional area of magnetic circuit.

Frequency

Number of complete cycles per second measured in cycles per second.

Induced EMF

Voltage induced in conductor as it moves through magnetic field.

Left-hand rule

A method, using your left hand, to determine polarity of an electromagnetic field or direction of electron flow.

Lines of force

Graphic representation of electrostatic and magnetic fields showing direction and intensity.

MATERIALS NEEDED:

(1) Electromagnet

(2) Dry cell

(3) Iron nails

(4) Copper wire

(5) Piece of cardboard

PROCEDURE:

(1) Connect the wires from the coil to the dry cell.

(2) Reverse the direction of current flow.

(3) Lower the end of the coil onto a pile of small nails.

(4) Observe the number of nails the coil will pick up with only air for a core.

(5) Disconnect one wire from the dry cell.

(6) Remove all nails from the coil.

(7) Insert the iron core in the coil.

(8) Connect the wire to the dry cell again.

(9) Lower the end of the coil onto the pile of small nails.

(10) Observe the number of nails the coil will pick up with the iron for a core.

DIAGRAMS:

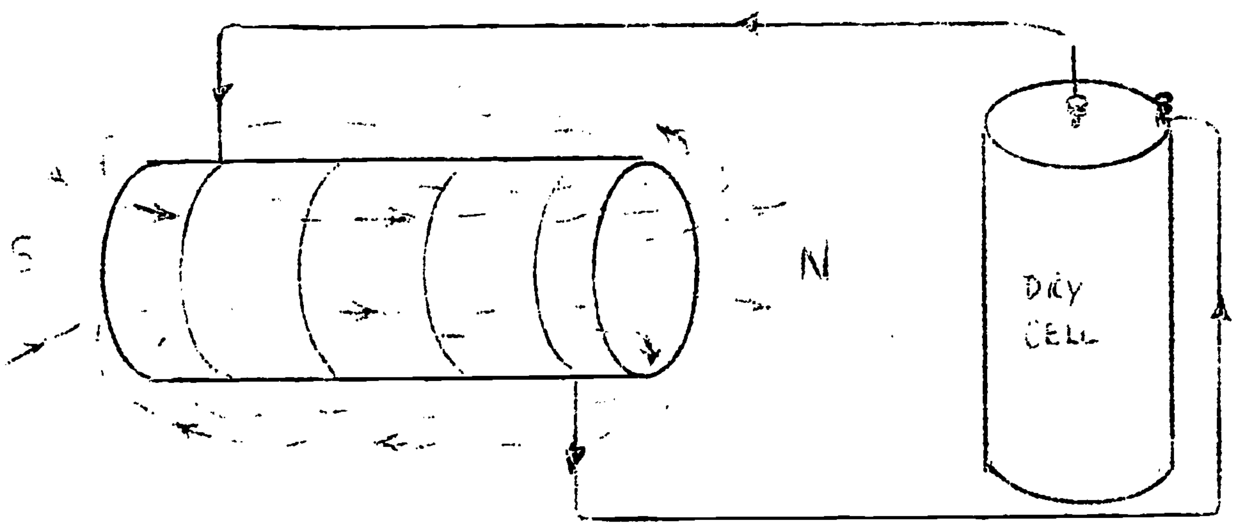
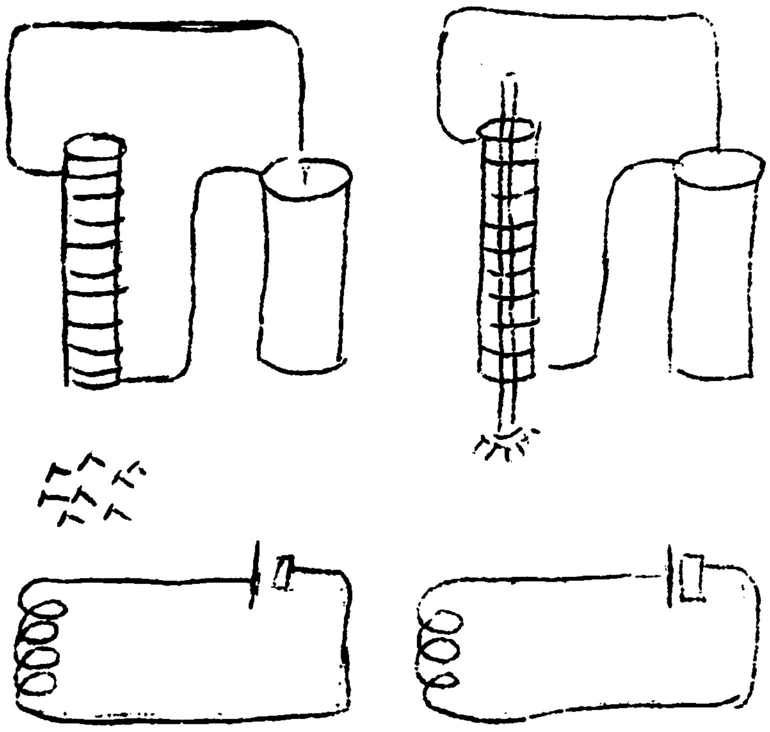


Figure 1
Concentrated Magnetic Field



The upper pictures show current flowing through a conductor, lines of force produced around it. At the left is shown the coil with an air core. Although able to exert considerable magnetic force, such a coil will probably lift few if any of the nails. At the right is shown what happens when an iron core is provided for the magnetic flux. With one cell and the same coil, all the tacks can now be lifted. The lower diagrams show the symbol for a coil in electrical circuits. Notice how the iron core is indicated in the diagram at the right.

FINDINGS:

It was concluded when current flows through a conductor, lines of force are produced around it. The greater the current flow, the greater the number of lines produced. Since these lines of force are distributed equally along the conductors length, the strength of the magnetic field at any one point is very weak, compared to that of the total field produced by the full length of the conductor.

If the conductor is wound into a coil, the lines of force of the adjacent turns combine or interlink, forming a concentrated magnetic field, having a north magnetic pole at one end of the coil and a south magnetic pole at the other. A reversal of the direction of current flows through the coil will cause a reversal of the magnetic poles of the coil. It was apparent that the magnetism of a coil can therefore be controlled by increasing or decreasing the current flow or by changing the number of turns in the coil.

The strength of the magnetic field may also be increased by the use of an iron core, since iron has far less reluctance than air and allows easy passage of the magnetic lines. The "ampere-turns" required to set up a given magnetic field strength are, therefore, less when a core material having lower magnetic reluctance than air is used.

QUESTIONS:

(1) Give one reason why electromagnets are used instead of permanent magnets.
Ans. Electromagnets were used instead of permanent magnets because, in order to afford complete control of an electromagnet, the core material must lose its magnetism at the same rate that the magnamotive force is decreased. For this reason steel or other magnetic substances which have permanent magnetic tendencies are unsuitable as cores for electromagnets.

(2) Why is steel unsuitable for the core of an electromagnet?
Ans. The reason why steel is unsuitable for the core of an electromagnet is because steel has permanent magnetic tendencies and the core material must lose its magnetism at the same rate that the magnamotive force is decreased.

(3) State three or more reasons why soft iron is used as a core for an electromagnet?
Ans. Reasons why soft iron is used as a core for an electromagnet are because:
A. Iron has far less relectance than air.
B. Iron allows easy passage of the magnetic lines.
C. By use of the iron core the magnetic field strength will be increased.

(4) Discuss briefly "core shapes of electromagnets."
Ans. It is essential that the core material be of sufficient size (cross section) to accommodate the total flux produced by the magnetic motive force (M. M. F.). The core shape depends on the use of the electromagnet and is a function of design.

INDUCING CURRENT IN A CONDUCTOR

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TITLE: INDUCING CURRENT IN A CONDUCTOR

OBJECTIVE:

To inform the learner how magnetism may be used to produce an electric current flow as the result of the E.M.F. of induction.

INTRODUCTION:

An electromotive force is produced in a conductor whenever there is a change in the magnetic field around the conductor. The strength of the E.M.F. depends on the number of lines of force cut in a certain time. It is the purpose of this assignment to show how magnetism may be used to produce an electric current flow as the result of the E.M.F. of induction.

REFERENCES:

(1) Gerrish, Howard H. Electricity and Electronics, Homewood, Illinois. The Goodheart-Willcox Co., 1964.

(2) Watson, Herbert M. Understanding Radio, New York; McGraw Hill Book Co., 1951.

(3) Welch, Herbert E. Basic Electricity. Bloomington, Ill., McKnight and McKnight Publishing Co., 1952.

DEFINITIONS:

Current
Transfer of electrical energy in conductor by means of electrons moving constantly and changing positions in vibrating manner.

E.M.F.
Electromotive force that causes free electrons to move in conductor. Unit of measurement is the volt.

Induced E.M.F.
Voltage induced in conductor as it moves through magnetic field.

Inductance
Inherent property of electric circuit that opposes a change in current. Property of circuit whereby energy may be stored in magnetic field.

EQUIPMENT AND MATERIALS NEEDED:

(1) Coil of 300 or 400 turns of No. 30 cotton covered or enamel coated copper wire.

(2) U-shaped permanent magnet

(3) Sensitive galvanometer

(4) Bar magnet

PROCEDURE A

(1) Connect the wires of the coil to the galvanometer.

(2) Set the U-shaped magnet so that it's poles point upward.

(3) Move the coil edgewise down between the poles of the magnet.

(4) Watch the galvanometer needle.

(5) Stop the coil.

(6) Look at the needle again.

(7) Move the coil up between the poles.

(8) Observe the needle.

(9) Move the coil down and up as before, stopping it before changing direction.

(10) Observe the needle.

(11) Move the coil faster or slower and notice what happens.

PROCEDURE B

(1) Repeat part A. First using a coil of more turns.

(2) Use one of fewer turns.

(3) Notice the results.

(4) Move the magnet instead of the coil.

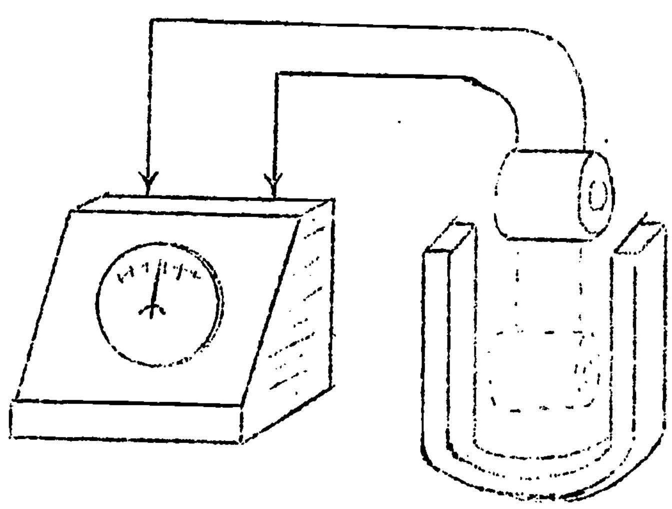
(5) Observe what happens.

(6) Use a bar magnet in place of the U-shaped magnet.

(7) Insert the bar magnet in the coil and withdraw it.

(8) Turn the bar magnet end for end and repeat with the other pole.

DIAGRAM



The picture shows how an E.M.F. can be induced in a coil of wire. Moving the coil, which consist of 300 to 400 turns of fine copper wire, to the position shown by dotted line causes the needle of the galvanometer to swing to one side of the center zero mark. Moving the coil back causes the needle to swing to the other side of the zero mark. When coil and magnet are stationary, no lines of force are cut, and the needle of the meter remains at zero.

FINDINGS:

It was concluded when a conductor is moved through a magnetic field of force, an induced current will flow in the conductor, provided that it is a part of a closed circuit. The amount of current that flows is dependent on the amount of voltage induced in the conductor and resistance of the closed circuit of which the conductor is a part.

The induced voltage will depend on the rate at which magnetic lines of force cut through the conductor. An E.M.F. of one volt is produced when a conductor cuts 100,000,000 lines of force per second. This voltage may be induced by moving the conductor through the field of force, or by moving the field through the conductor.

Reversing the motion of the conductor or the field results in a reversed current flow in the conductor. Similarly a reversal of polarity of the magnetic field produces a reversal of induced current flow.

When an electromagnet is used to produce a magnetic field, the amount of induced voltage may be regulated by increasing or decreasing the flow of current through the electromagnet to effect a change in the number of magnetic lines of force in the field.

QUESTIONS:

(1) Define:

(a) Induced E.M.F.
Ans. Voltage induced in conductor as it moves through magnetic field.

(b) induced current.
Ans. Current that flows as result of an induced electromotive force.

(2) Describe the action of a galvanometer when a coil connected to it is raised and lowered in the magnetic field of a U-shaped permanent magnet.
Ans. The action of a galvanometer when a coil connected to it raised and lowered in the magnetic field of a U-shaped permanent magnet causes the needle of the galvanometer to swing to one side of the center zero mark. Moving the coil back causes the needle to swing to the other side of the zero mark. When coil and magnet are stationary, no lines of force are cut, and the needle of the meter remains at zero.

Section 2-D

FINISHES

AUTOMOTIVE PAINT TESTING

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TITLE: AUTOMOTIVE PAINT TESTING

OBJECTIVES:

(1) To become familiar with the technique of testing automotive enamel paints.

(2) To become familiar with the instruments used in testing metal painted surfaces.

(3) To compare three different brands of paint having the same viscosity under controlled temperatures.

INTRODUCTION:

Automotive paints in the container are similar to one another in so far as they all contain three basic components. One component part is pigment. This gives it color, durability, and hiding power. The second component part of paint is binder, sometimes called fixed vehicle. The binder firmly attaches itself to the surface being painted.

The third component part of wet paint is the clear, thin liquid known as thinner or solvent which makes the binder-pigment workable and fluid.

The purpose of this experiment is to test automotive enamel paint for the following:

(a) leveling or flow-out.
(b) drying time.
(c) paint film thickness.
(d) hardness or scratch.

REFERENCES:

(1) American Society for Testing and Materials, ASTM Standards, 1961, part 8. Philadelphia, Pennsylvania. pp. 736-738.

(2) Refinisher's Guide #AD130. Rinshed-Mason Company, Detroit, Michigan. pp. 21-22.

(3) Ditzler Product Data Sheet #6790. Pittsburgh Plate Glass Company, Detroit, Michigan. pp. 2-3.

(4) Dupont News #160. E. I. duPont de Nemourst & Co., Inc., Wilmimgton, Deleware. pp. 1-2.

(5) Toboldt, Bill. Auto Body Repairing and Repainting. The Goodhart-Willox Co., Inc., 1965. pp. 186-194.

DEFINITIONS:

Viscosity
The internal fluid resistance of a substance, caused by molecular attraction.

Orange Peel
When high pressure forces too much solvent out before the mix reaches the surface. This prevents flow out, causing excessive orange peel.

Adhesion
A sticking (to something) or being stuck together. The force that holds together the unlike molecules of substances.

Slow-drying
The appearance of wet spots on the finished surface. This is caused by painting over the surface contaminated with wax, silicone, grease, oil, finger marks, or gasoline residue.

Hold-out
A statement referring to the insufficient amount of color coat. This occurs with insufficient stirring of undercoat as well as the finish coat.

EQUIPMENT AND MATERIALS NEEDED:

(1) Ford Viscosimeter #3 Orifice.

(2) Hoffman scratch-hardness tester.

(3) Koehler paint film gauge.

(4) Temperature gauge.

(5) Graduated measurement gauge.

(6) Air-compressor.

(7) Air hose.

(8) Air regulator.

(9) Syphon spray gun.

(10) Paint strainers.

(11) Paint paddles.

(12) Enamel paint . . . 3 qts.

(13) Enamel thinner.

(14) Tac rag.

(15) 3 pieces of 11" x 8½" no. 20 gauge metal.

PROCEDURE A

(1) Select three (3) one quart samples of enamel.
   (a) Brand name A color white
   (b) Brand name B color blue
   (c) Brand name C color red

(2) Select materials and equipment adequate to conduct the experiment.

(3) Thoroughly mix the paint to be tested. Pour an equal amount of the paint to be tested into three (3) 5-3/4 fluid ounce containers.

(4) Pour twenty-eight (28) centimeters of enamel reducer into each 5-3/4 fluid containers. Stir vigourously.

(5) Level viscosimeter. Check the temperature to see if it is at 77° F.

(6) Pour paint (A) into the viscosimeter until it overflows. Take a straight edge and level paint into the viscosimeter cup. Remove finger from orifice and time flow. Clean the cup and repeat the same procedure for paint (B) and (C).

(7) Viscosity . . . 4.3 seconds at 77° F.

PROCEDURE B

(1) Spray two (2) uniform coats of paint on a primed piece of metal (11" x 8½"). Repeat the same operations for paint sample B and C.

(2) Press the paint film gauge firmly down on the painted surface so as to bring the lens into contact with the surface underlying the paint film.

(3) Release the pressure and remove the gauge. A circular spot will be left on the gauge as well as on the painted surface.

(4) Measure the diameter of this spot (preferably the one on the lens) to an accuracy of 1/10 of a millimeter by means of a steel scale.

(5) In order to obtain a fair average, carry out the test on 10 regions well distributed over the painted surface, taking care to remove paint from the lens after each impression.

(6) Take the average diameter thus obtained and refer to the table accompanying the instrument. From this it is possible to evaluate at once the thickness of the paint film.

(7)

Average Diameter	Thickness
#A . . . . . . 26 mm	.00900
#B . . . . . . 15 mm	.05625
#C . . . . . . 23 mm	.13225

PROCEDURE C — Scratch Hardness Test

(1) All four wheels of the instrument are placed on the finish panel or surface and drawn in a straight line across the film.

(2) The scratching tool must follow, never precede, the carriage.

(3) Tests are repeated, increasing the weight on the scratching tool until a just perceptible mark is made.

(4) Compose the size and character of the mark in various finishes with the same load.

(5) The weight on the scale from 1 to 9 showed #A to be harder than #B. #B was harder than #C.

GENERAL QUESTIONS:

(1) Name the three component parts of paint.
Ans. The three component parts of paint are pigment, binder, thinner, or solvent.

(2) Explain why a solvent has a different effect on the work ability and performance of paint.
Ans. Solvents are chemically different. The solvent should be selected for the use with the temperature and humidity considerations that prevail at spraying time.

(3) What is considered to be the major cause of paint failures ?
Ans. The operator did not use the material according to the manufacturer's direction.

(4) What are the two stages at which enamel paint dries?
Ans. Stage one: The solvent (thinners) evaporate from the paint film. Stage two: The remaining paint film hardens either by application of heat, absorption of oxygen from the air, or both.

(5) What are the differences between acrylics, lacquers and enamels?
Ans.
(a) Enamel dries slower than acrylic or lacquer.
(b) Enamel dries to a full gloss and needs no polishing.
(c) Because of its slower drying speed, dust in the work area is more of a problem with enamel than acrilic or lacquer.
(d) Acrilics and lacquers usually require a rubbing or polishing operation to attain full gloss.

PAINT ROOM SAFETY:

The Painter's Seven Rules for Safety:

(1) Provide a good ventilation system to remove fumes.

(2) Display "No Smoking" and caution signs in and around the spray area.

(3) Place fire extinguishers and equipment in handy spots.

(4) Never drive a car in or out of the spray booth...push it by hand.

(5) Comply with safety codes on electrical equipment and never use "temporary" electrical setups.

(6) Check regularly all electrically driven equipment. Be sure ground wires are intact to avoid static electricity.

(7) Keep the area, including the floors, clean. Avoid fires from spontaneous combustion by disposing of dirty rags and papers, at least daily, preferably just before quitting time.

Section 2-E

FOREST PRODUCTS

TESTING THE SHEAR AND BENDING STRENGTH
OF A CERTAIN TYPE OF WOOD

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TITLE: TESTING THE SHEAR AND BENDING STRENGTH OF A CERTAIN TYPE OF WOOD

OBJECTIVES:

(1) To develop an experiment which could be understood and performed by a high school student.

(2) To incorporate some practical application of the math which is used in the Industrial Arts area.

(3) To incorporate a problem solving approach, rather than a mere "do it" experiment.

(4) To stimulate some interest in the student which may lead him to perform the same experiment with some of the other woods.

(5) To help the student gain some knowledge about the properties of a certain wood under limited conditions.

INTRODUCTION:

Wood shear and bending strength is of particular importance to industry in the manufacture of furniture, boats, tool handles, and sporting goods equipment. Its value as a commercial operation is because of the economical use of materials, the production of curved pieces with great strength, and the inexpensiveness of bending methods.

These properties vary greatly according to the species, and also when cut from the same tree. The principal factors that cause strength-reducing defects are decay, cross grain, knots, shake, pith, surface checks, and brash wood.

A very thin strip of seasoned wood can be easily bent with the hands to a sharp curve. However, in bending thick, solid pieces of wood many problems arise. A piece of bent wood is stretched along the outer (convex) side. The stretching places the outer surface under extreme tension. The inner (concave) side is squeezed-in. The squeezing-in places the inner surface under high compression. The lengthened outside surface and the shortened inside surface, with their opposing pressures, set up external and internal stresses. When accompanied by the afore-mentioned wood defects, these stresses make the successful bending of wood difficult.

REFERENCES:

(1) Forbes, Reginald D. Forestry Handbook, New York; The Ronald Press Co., 1956.

(2) American Society for Testing and Materials. ASTM Standards 1961, Part 3. Philadelphia, Pennsylvania.

(3) Experiments with Materials and Products of Industry, McKnight & McKnight, 1960.

(4) Other references obtained from the resource center.

DEFINITIONS:

Compression Strength
The ability of a material to resist opposing forces tending to crush or shorten it.

Shear Strength
Stress caused by forces which act parallel to a given area and in opposite direction, tending to produce a sliding of one portion past another.

Elasticity
That property of a material which allows it to bend under a load and return to its original shape when the load is removed.

Breaking Strength
The unit stress developed in a material at the moment of failure. For some materials this also is the ultimate strength, but for others it may also be a lower value.

EQUIPMENT AND MATERIALS NEEDED:

(1) Universal testing machine

(2) Micrometer caliper (1")

(3) Pocket rule

(4) Goggles

(5) Materials (in this test maple was used.)

PROCEDURE:

(1) Select enough samples of straight grain stock to run a minimum of three tests in each size group.

(2) The wood should be machined down to the following square sizes: 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4".

(3) Cut twelve pieces eight inches long of each of the following sizes mentioned.

(4) Mark the pieces of wood, for identification purposes. Six plain and six quarter sawed should be marked in each size group.

(5) Center a piece of wood in the apparatus. There should be six inches of material not supported, and they should be one inch high off the surface of the apparatus.

(6) Operate the apparatus. Observe closely the pounds of pressure required to bend the wood 1/8".

(7) With another piece of wood operate apparatus and observe the pounds of pressure required to break the wood.

(8) With graph paper, plot x & y and show the curve. The y axis represents size, while x axis should represent pounds of pressure.

PRECAUTIONS:

(1) Select a good grade of straight grain wood that is free of knots, and checks.

(2) Surface smoothly all of the pieces of wood to the same thickness and width. Variations in the surfacing and size will cause discrepancies in the findings.

(3) Follow proper safety precautions when working with the machines and apparatus.

(4) Observe the scale closely and be accurate in the bending limit, and pounds of pressure readings. Carelessness with this factor will result in inaccurate readings of the ruler or scale.

QUESTIONS:

(1) Name the principle factors that cause strength-reducing defects in wood.

A. ____________________ B. ____________________

C. ____________________ D. ____________________

E. ____________________ F. ____________________

G. ____________________

(2) Estimate the following results using the curve constructed on the graph.

A. 13/16" ------ ________________ lb. of pressure

B. 7/8" ------ ________________ lb. of pressure

C. 1-3/16" ------ ________________ lb. of pressure

D. 1-3/4" ------ ________________ lb. of pressure

(3) What size board would you use if you knew the amount of pressure?

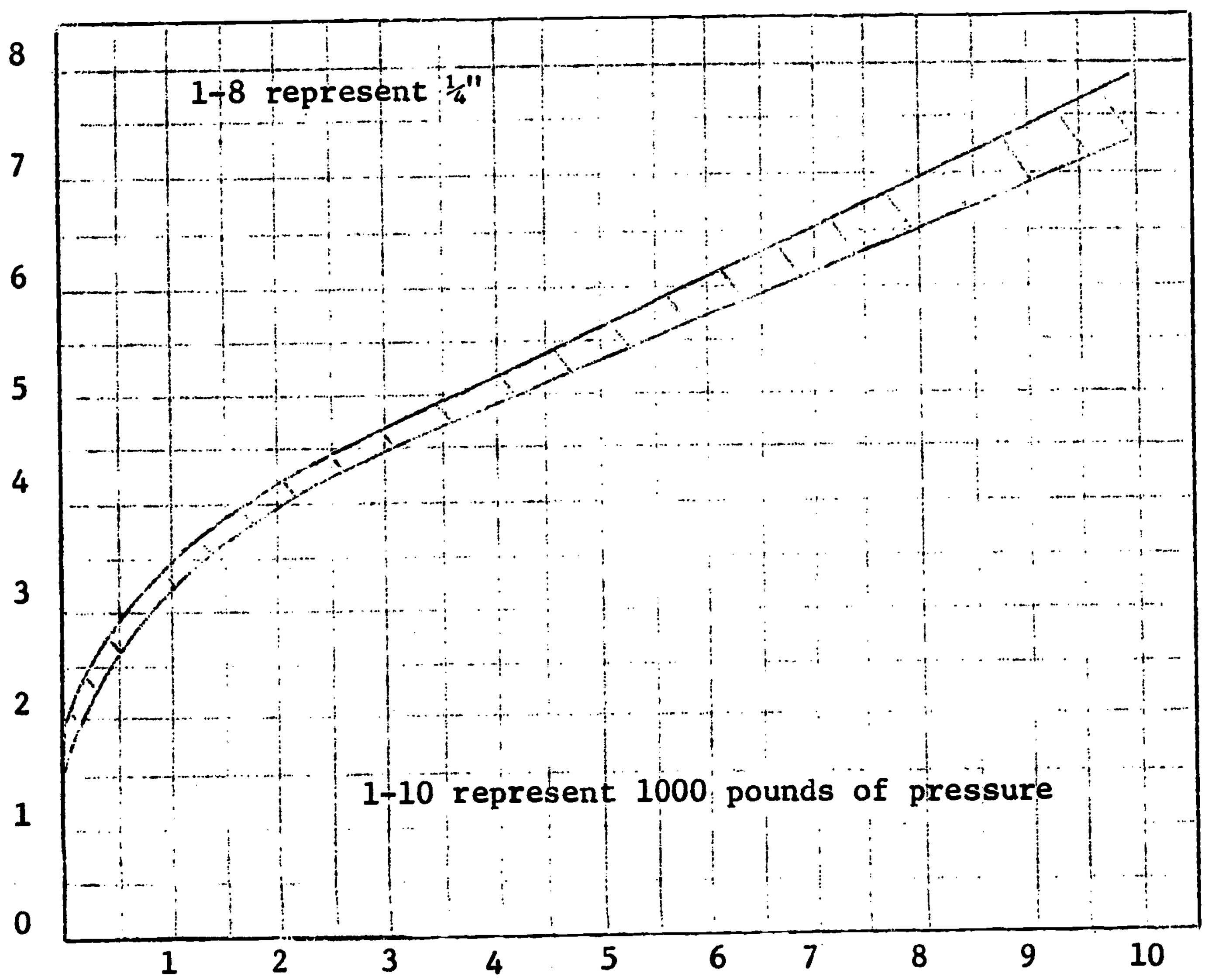
A. 5,500 lb. of pressure ------ ________________

B. 1,800 lb. of pressure ------ ________________

(4) Write the formula which would express the curve drawn.

____

STRENGTH OF MAPLE AS THE SIZE IS SQUARED



	BREAKING		1/8" BEND	
Size	Against	With	Against	With
1-3/4"	8900	8400	8000	7800
1-1/2"	7000	6400	6100	5800
1-1/4"	4400	4100	4000	3800
1"	2000	1900	1800	1700
3/4"	800	700	600	500
1/2"	100	50	---	---
1/4"	---	---	---	---

Experimental Check

(1) A piece of wood 5/8" square should be within 200-400 pounds, and was found to be around 325 pounds.

(2) Another was 15/16" square and should have been within 1200-1500 pounds, and was found to be around 1400 pounds.

(3) Another was 1-1/16" square and should have been within 1800-2300 pounds, and was found to be around 2000 pounds.

(4) Another was 1-5/8" square and should have been within 6600-7500 pounds, and was found to be around 7000 pounds.

EFFECT OF TORSION TESTING OF DIFFERENT SELECTED WOODS

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TITLE: EFFECT OF TORSION TESTING OF DIFFERENT SELECTED WOODS

OBJECTIVES:

(1) To become acquainted with torsion testing in determining the elasticity of different types of woods.

(2) To test selected types of woods and compare their ability to withstand torsion.

(3) To become acquainted with properties of wood for correct wood selection.

(4) To determine the effects of moisture and steam on wood during torsion testing.

INTRODUCTION:

The mechanical or strength properties of wood measures its fitness and ability to resist applied forces. It is largely the mechanical properties that determine the fitness of wood for structural purposes, boat building, furniture, vehicles, implements, tool handles, athletic equipment and other various wood products. This knowledge is important not only in the construction of these desired items, but in knowing the expected performances of these items in general use. It is important to determine which woods will break gradually and will give warning of failure.

Knowledge of the mechanical properties of wood is obtained through experimentation, either by means of service tests or by laboratory experiments. Laboratory tests can be more efficient if they are properly conducted. They are more economical of time and material and provide control of most variables which may seriously affect the results.

REFERENCES:

(1) Betts, Harold S. Timber Its Strength, Seasoning, and Grading. Mc Graw-Hill Book Company, New York: 1919, pp. 10-42.

(2) Garratt, George A. The Mechanical Properties of Wood. John Wiley and Sons, Incorporated, New York: 1931, pp. 41-49.

(3) Hammond, James J., Donnelly, Edward T., Harrod, Walter F. and Rayner, Norman A. Woodworking Technology. McKnight Publishing Company, Bloomington, Illinois: 1961, pp. 329-333.

(4) Stamm, Alfred J. Wood and Cellulose Science. The Ronald Press Company, New York: 1964, pp. 274-275.

DEFINITIONS:

Elasticity

It may be defined as the limit beyond which it is impossible to carry the distortion of a body without producing a permanent alteration in shape.

Flexibility

It may be defined as meaning wood that will not rupture until it has deformed considerably under strains at or near its maximum strength.

Permanent Set

It may be defined as once the limit of elasticity has been exceeded, the size and shape of the specimen after removal of the load will not be the same as before, and the difference or amount of change is known as the permanent set.

Torsion Testing

It may be defined as meaning that the ends of a beam are turned in opposite directions, or one end is turned and the other end is fixed and all the fibers except those at the axis tend to assume the form of helices.

Toughness

It may be defined as meaning wood that will not rupture until it has deformed considerably under loads at or near its maximum strength, or one which still hangs together after it has been ruptured and may be bent back and forth without breaking apart.

Wood Failure

It may be defined as meaning the rupturing of wood fibers in torsion testing.

EQUIPMENT AND MATERIALS NEEDED:

(1) Wood on which the torsion testing will be made. (18 pieces of 1/2"x1/2"x8 3/4" of 3 each of ash, cedar, mahogany, maple, oak and walnut)

(2) Torque wrench

(3) Torque wrench adaptor

(4) Protractor

(5) Vise

(6) Rule

(7) Steam generator

(8) Bunsen burner

(9) Tri-square

PROCEDURE A Testing Untreated Seasoned Wood

(1) Acquire wood stock from instructor. (6 pieces of 1/2"x 1/2"x 8 3/4" of 1 each of ash, cedar, mahogany, maple, oak, and walnut.)

(2) Insert bottom 1" of wood stock into vise and secure.

(3) Apply torque wrench with adaptor on upper end of wood stock.

(4) Apply 45 degree turn with torque wrench and record foot/ pounds reading in Table A.

(5) Release force on torque wrench and note if wood returns to original starting position. Take reading from protractor and record in Table B.

(6) Follow procedures (4) and (5) at the following degree readings: 60, 90, 135, 180, 225, 270, 315, and 360.

(7) After wood rupture, continue force until wood stock separates and record from the protractor the degree reading in Table A.

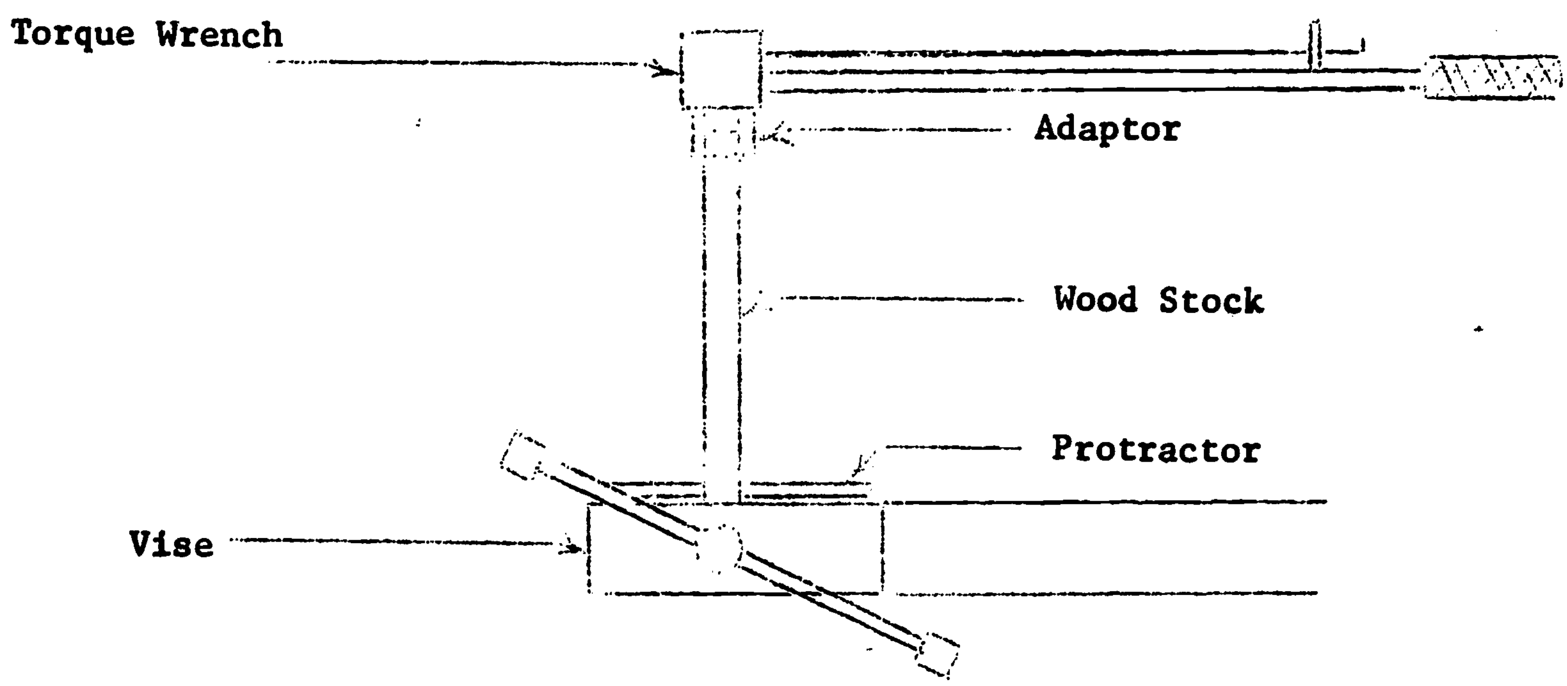
(8) Complete the test for the remaining samples.

(9) Rank wood samples in Table C in terms of elasticity.

(10) Rank wood samples in Table D in terms of torsion strength.

(11) Rank wood samples in Table E in terms of toughness.

Figure A



	45	60	90	135	180	225	270	315	360	#	0
Ash	4									4	57
Cedar	-									8	40
Mahogany	5	3*								1	260
Maple	10									12	59
Oak	4	5	5	3*	2*	2*				1	360
Walnut	2	1*								.2	290

(Degrees) (Failure)

Pounds
o Degree
* Rupture

TABLE A Foot/Pound Readings

	45	60	90	135	180	225	270	315	360		
Ash	30										
Cedar	-										
Mahogany	3	43*									
Maple	0										
Oak	20	22	30	50*	70*	90*					
Walnut	10	55*									

(Degrees)

* Rupture

TABLE B Degree of Elasticity

1.	Maple
2.	Mahogany
3.	Walnut
4.	Oak
5.	Ash
6.	Cedar

TABLE C

(Elasticity)

Oak
Maple
Mahogany
Ash
Walnut
Cedar

TABLE D

(Torsion Strength)

Oak
Walnut
Mahogany
Maple
Ash
Cedar

TABLE E

(Toughness)

PROCEDURE B Testing Boiled Seasoned Wood

(1) Acquire wood stock from instructor. (6 pieces of 1/2" x 1/2" x 8 3/4" of each of ash, cedar, mahogany, maple, oak, and walnut.)

(2) Cover wood stock with clear water and boil for 30 minutes.

(3) Remove wood stock for water and insert bottom 1" of wood into a vise and secure.

(4) Apply 45 degree turn with torque wrench and record foot/pounds reading in Table F.

(5) Release force on torque wrench and note if wood returns to original starting position. Take reading from protractor and record in Table G.

(6) Follow procedures (4) and (5) at the following degree readings: 60, 90, 135, 180, 225, 315, and 360.

(7) After wood rupture, continue force until wood stock separates and record from the protractor the degree reading in Table F.

(8) Complete the test for the remaining samples.

(9) Rank wood samples in Table H in terms of elasticity.

(10) Rank wood samples in Table I in terms of torsion strength.

(11) Rank wood samples in Table J in terms of toughness.

Ash	1	1	1	1	1*					.5	720
Cedar	4	4	3*							.5	450
Mahogany	2	2	2	2	1*	1*				.5	630
Maple	2	2	2							3	95
Oak	2	3	3	3	3	3	3	3	2*	2	540
Walnut	2	2	3	3	3	3	3	3*		1	900
	45	60	90	135	180	225	270	315	360	#	o

(Degrees) (Failure)

Pounds
o Degree
* Rupture

TABLE F Foot/Pound Readings

Ash	5	10	20	45	100*				
Cedar	5	15	30*						
Mahogany	10	20	40	85	105*	175*			
Maple	5	10	15						
Oak	5	10	20	60	135	140	150	155	190*
Walnut	5	15	20	50	90	140	170	185*	
	45	60	90	135	180	225	270	315	360

* Rupture

(Degrees)

TABLE G Degree Of Elasticity

1.	Maple
2.	Ash
3.	Walnut
4.	Oak
5.	Mahogany
6.	Cedar

Table H

(Elasticity)

Oak
Walnut
Ash
Mahogany
Maple
Cedar

Table I

(Torsion Strength)

Walnut
Ash
Mahogany
Oak
Cedar
Maple

Table J

(Toughness)

PROCEDURE C **Testing Steamed Seasoned Wood**

(1) Acquire wood stock from instructor. (6 pieces of 1/2" x 1/2" x 8 3/4" of each of ash, cedar, mahogany, maple, oak, and walnut.)

(2) Place wood in steam chamber and steam wood stock for 30 minutes.

(3) Remove wood stock from steam and insert bottom 1" of wood into a vise and secure.

(4) Apply 45 degree turn with torque wrench and record foot/pounds reading in Table K.

(5) Release force on torque wrench and note if wood returns to original starting position. Take reading from protractor and record in Table L.

(6) Follow procedures (4) and (5) at the following degree readings: 60, 90, 135, 180, 225, 315, and 360.

(7) After wood rupture, continue force until wood stock separates and record from the protractor the degree reading in Table K.

(8) Complete the test for the remaining samples.

(9) Rank wood samples in Table M in terms of elasticity.

(10) Rank wood samples in Table N in terms of torsion strength.

(11) Rank wood samples in Table O in terms of toughness.

Ash	1	1	1	1	2	2*				.5	630
Cedar	2	2	1*							1	298
Mahogany	3	3	2*	2*						1	450
Maple	3	4	7	5*						4*	140
Oak	2	2	2	2	2	2	3	3	2*	2	540
Walnut	2	3	2*							1	360
	45	60	90	135	180	225	270	315	360	#	o

#Pounds
o Degree
* Rupture

(Failure)

(Degrees)

Table K Foot/Pound Readings

Ash	15	20	30	60	100	130*			
Cedar	10	25	40*						
Mahogany	4	20	35*	60*					
Maple	0	10	30	60*					
Oak	20	25	45	75	125	160	180	220	235*
Walnut	10	10	40*						
	45	60	90	135	180	225	270	315	360

(Degrees)

* Rupture

Table L Degree Of Elasticity

1.	Maple
2.	Ash
3.	Walnut
4.	Oak
5.	Mahogany
6.	Cedar

Table M
(Elasticity)

Oak
Walnut
Ash
Mahogany
Maple
Cedar

Table N
(Torsion Strength)

Ash
Oak
Mahogany
Walnut
Cedar
Maple

Table O
(Toughness)

QUESTIONS:

(1) Which procedure appears to be the best for forming wood? Ans. Procedure C, Steaming, appears to have a slight edge from this test.

(2) Can you name one disadvantage of boiling the wood? Ans. Discoloration of the wood appears.

(3) List factors that should be considered in forming wood. Ans. (a) thickness, (b) grain structure, (c) wood defects, (d) moisture content and (e) type of wood.

(4) From this test which wood would you select for toughness? Ans. Oak.

(5) From this test, which wood would you avoid if you needed a warning before failure? Ans. Maple.

(6) From this test, which wood would you use if you needed a warning before failure? Ans. Oak.

(7) From this test, which wood appears to be least adaptable to forming? Ans. Cedar.

(8) What other types of experiments are suggested that students might perform from this experiment?

Ans.

(a) Repeat experiment using different sizes of wood.
(b) Repeat experiment using other types of woods.
(c) Repeat experiment by using dry heat of various temperatures.
(d) Repeat experiment by using different solutions and vapors.

THE PRODUCTION OF CHARCOAL WITH RECOVERY OF BY-PRODUCTS

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TITLE: THE PRODUCTION OF CHARCOAL WITH RECOVERY OF BY-PRODUCTS

OBJECTIVES:

(1) To show principle of producing charcoal.

(2) To become familiar with products of wood distillation.

(3) To become familiar with method of distillation.

INTRODUCTION:

Charcoal is a black, solid, non-lustrous residue, or amorphous carbon produced from vegetable or animal substances such as cellulose, wood, peat and bitiminous or lower rank coal. It is made by charring the parent substance in a kiln at 500-600 degrees centigrade without air. When it is a hardwood distillation product, it contains 84 percent fixed carbon, 14 percent volatile matter, two percent ash, and a small amount of sulphur.

Charcoal is used for fuel for industrial furnaces and because of its quick, hot fire it is used for broiling and roasting in cafes, restaurants, trains, homes and outdoor grills. It is a very efficient fuel. As a chemical, it is employed in the manufacturing of carbon bisulphide, carbon tetrachloride, sodium cyanide, and similar substances. It is used in mixed feeds for poultry and livestock and is an absorbent for vapor and a clarifying, deordorizing and decolorizing agent.

Activated charcoal is becoming increasingly important in treating municipal water supplies and for control of offensive odors from sewage sludge beds. In European countries it is used as a fuel to produce motor gas for automobiles, buses and trucks.

An estimated 350,000 ton of charcoal are produced annually in the United States.

REFERENCES:

(1) McGraw-Hill Encyclopedia of Science and Technology, vol. 3, p. 10

(2) Encyclopedia Americana, vol. 6, p. 303

(3) U. S. Department of Agriculture, Forest Service, Forest Products Laboratory. Charcoal Production, Marketing and Use. Report No. 2213, 1961.

(4) A. J. Panshin, E. S. Harrar, J. S. Bethel and W. J. Baker, Forest Products, pp. 404-424.

DEFINITIONS:

Charcoal Burner
A person whose work is making charcoal.

Charcoal Burning
The making of charcoal.

Acetic Acid
A compound which in the pure state is a colorless, pungent, biting liquid congealing in cool weather.

Methanol
A light, volatile, inflammable liquid used as a solvent, as a fuel, but chiefly in the manufacturing of formaldehyde.

Residue
That which remains after a part is taken.

Amorphous
Shapeless.

Activated Charcoal
It is charcoal that has been steam treated ranging from 1500-1800°F making it highly absorbent to liquids.

EQUIPMENT AND MATERIALS NEEDED:

(1) Chips of wood (½ test tube) may be yellow pine, oak or cedar.

(2) Bunsen burner

(3) Two test tubes about 3/4 inch diameter and six inches long.

(4) One stopper with a center hole diameter ¼ inch, one stopper with two ¼ inch holes that will fit test tubes.

(5) ¼ inch glass tube, 4 inches long; one piece 8 inches long, and one piece 5 inches long that has been bent to an angle of 60° and tapered on one end to 1/16 inch.

(6) 1 piece of ¼ inch hose, 16 inches long

(7) Stand and clamps to hold test tube

(8) Test tube rack

(9) Tongs

(10) Safety Goggles

(11) 3/4 test tube of water

PROCEDURE

(1) Obtain the necessary equipment and materials needed from your instructor.

(2) Go over safety factors with your instructor.

NOTE: See attached sketch when completing the following steps or assembly.

(3) Fill one test tube with chips about ¼ full.

(4) Put the stopper with one hole in this test tube.

(5) Scatter chips of wood evenly along in the test tube.

(6) Put the 4 inch glass tube in the stopper with one hole.

(7) Fasten the test tube with the chips on the stand and adjust it approximately 2½ inches above the bunsen burner.

(8) Fill the second test tube with water about 3/4 full.

(9) Put stopper with two holes in this test tube.

(10) Put bent glass tube in the hole nearest the edge.

(11) Put the eight inch long glass tube into the center hole and adjust it so that the part on the inside of the test tube will be half way down in the water.

(12) Connect the test tubes with the chips and the test tube to the water with the rubber hose. DO NOT fasten the hose to the bent piece of glass tubing.

(13) Lower the water filled tube to a level below the tube containing the chips and mounted on the stand.

(14) Strike match and hold over bunsen burner and then turn on a small amount of gas. Adjust gas and air valves on the bunsen burner to get the desired flame.

(15) After distillation starts check the gas coming from the glass jet to see if it will support combustion. This can be done by holding a lighted match at the end of the jet.

(16) Watch the test tube with water and make sure that gases continue to come off the chips. When the bubbles stop coming into the water your distillation is finished.

(17) Pull stopper out of the test tube containing the chips before turning off the heat.

(18) Allow ample cooling time before disassembling and examining the products.

(19) Examine the products visually, by smell, or other available methods and try to identify each product.

(20) Answer the following questions.

QUESTIONS:

(1) How much heat is applied in the production of charcoal?
Ans. 500-600° C.

(2) Name some types of kilns used in charcoal production.
Ans. Pit, masonary, beehive, and steel drum kiln.

(3) Which type of kiln is primarily used today?
Ans. Masonary.

(4) Name some uses of charcoal.
Ans. Fuel, absorbent, deodorizing and decolorizing agent.

(5) How is charcoal activated?
Ans. Treated with steam and carbon dioxide at temperatures ranging from 1500-1800° F.

(6) Where is activated charcoal used?
Ans. Absorbing gases, liquids and finely divided solids.

(7) What are some of the products given off during the distillation process?
Ans. Acetic acid, menthanol, tar oil and pitch.

(8) How do you run an acid test?
Ans. Use blue litmus paper. It will turn red.

(9) What test is used to see if gases are given off during distillation?
Ans. Check and see if it will support combustion.

(10) Which regions in the United States produce the most charcoal?
Ans. East of Mississippi and the southern region.

SAFETY FACTORS:

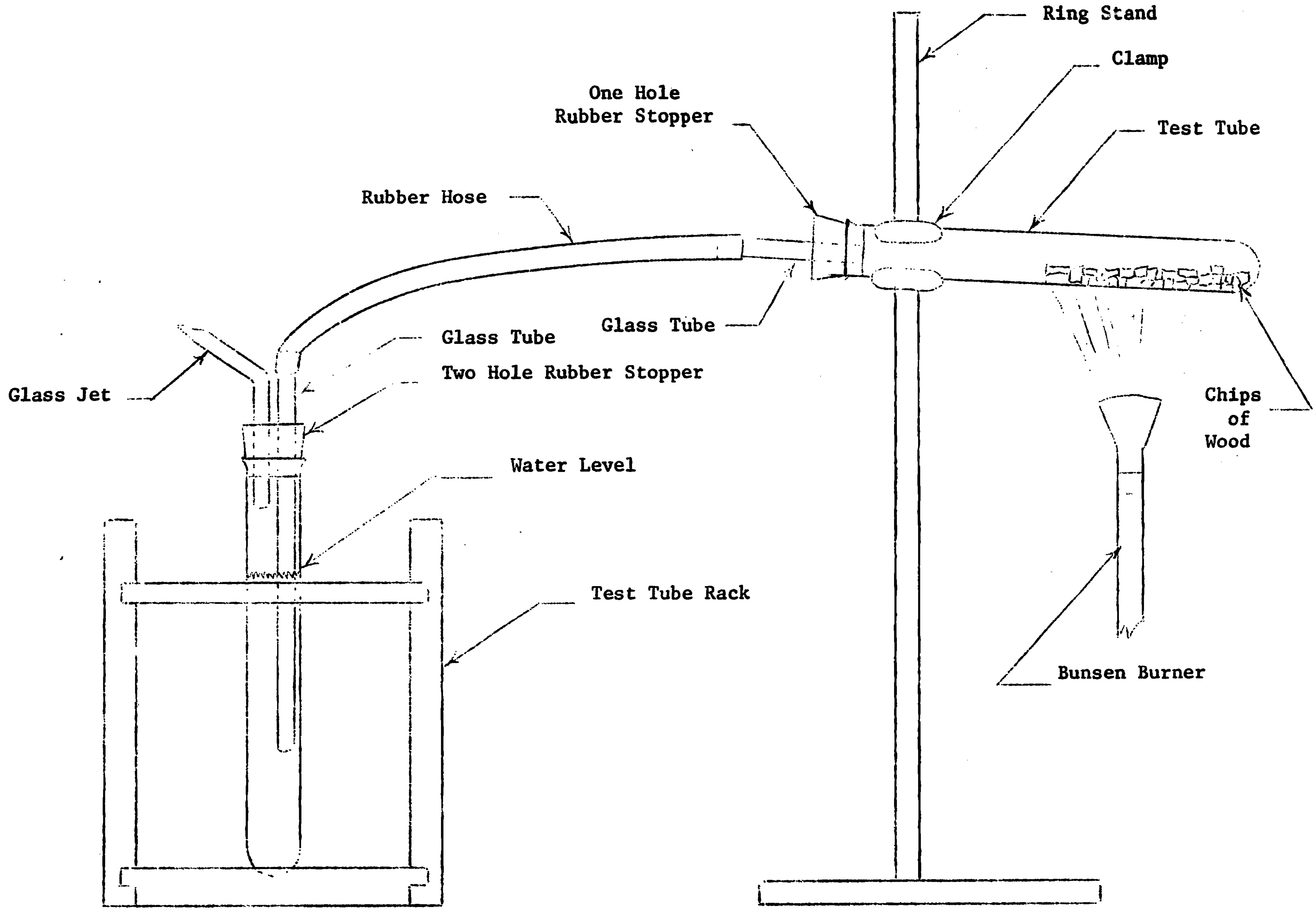
(1) Wear goggles during distillation.

(2) Make sure the gas is properly turned on and properly lit.

(3) Don't let water back into the tube where the chips are being heated. Either heat the chips more vigorously or pinch the rubber hose shut and disconnect from either test tube to balance pressure.

(4) Unplug stopper in the tube containing the chips before turning off the heat.

DIAGRAM OF DISTILLATION UNIT



HOLDING POWER OF NAILS

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TITLE: HOLDING POWER OF NAILS

OBJECTIVES:

(1) To become acquainted with various types of nails.

(2) To become acquainted with various types of woods.

(3) To compare the holding power of different nails.

(4) To develop an understanding of advantages and limitations of different nails.

INTRODUCTION:

Nails are the most common type of fastener used today. They receive the most use in the construction field because of the ease and speed with which they can be driven into a piece of wood.

Nails are the least expensive of all the holding devices on the market.

The hardness, texture, and grain of a piece of wood will determine the amount of pressure exerted against the nail body. The implication is that different types of wood will create varying amounts of holding power for a nail.

REFERENCES:

(1) Cramlet, Ross C., Woodwork Visualized, Milwaukee, Wisconsin; Bruce Publishing Company, 1950, pp. 158.

(2) Durham, Walter E., Fundamentals of Carpentry; Chicago, Illinois: American Technical Society, Vol. 1, pp. 336

(3) Earl, Arthur W., Experiments with Materials and Products of Industry. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1960. pp. 117-121.

(4) Groneman, Chris H., Glazener, Everett R., Technical Woodworking. St. Louis, Mo. and New York, N. Y. McGraw-Hill Book Co. pp. 293.

(5) Lindberg, Roy A., Processes and Materials of Manufacture. Boston, Mass., Allyn and Bacon, Inc., 1964, pp. 405.

(6) National Lumber Manufacturers Association National Design Specifications for Stress-Grade Lumber and Its Fastenings. Washington, D. C. 1956, pp. 44-46.

(7) Soled, Julius, Fasteners Handbook. New York, N. Y. Reinhold Publishing Corporation. 1957, pp. 232-33.

DEFINITIONS:

Seasoned Lumber

Removal of moisture from the wood until a specified dryness is obtained.

Penny

Denotes nail sizes. Example, a thousand nails weighing six pounds are known as six-penny nails.

Common Nails

Have relatively thick heads and are larger in diameter than most nails.

Torque Wrench

Wrench that measures the twisting effect in inches or foot lbs.

Quarter Sawed Wood

A log that is cut quartered and then cut radially from the back to the center.

Flat Sawed

A log that is slabbed on either two or four sides to form a cant from which other plainsawed lumber is cut.

Box Nails

Have thin, flat heads, that are similar to common nail heads and smaller diameter than common nails.

Ring Nails

Nails that have a number of rings perpendicular to the shaft.

Foot pounds

Amount of energy required to raise one pound to a height of one foot.

MATERIALS:

Samples of as many different kinds of nails as possible.

Samples of different kinds of wood.

EQUIPMENT:

(1) Table saw

(2) Band saw

(3) Slotted-nail-pulling claw

(4) Torque Wrench

(5) 1/32" twist drill

(6) Holding power of nail apparatus

(a) Made of 3/4" stock

(b) Flexible chain provides an easy attachment and pulling arrangement.

(c) Nail-pulling claw bent to an angle that will permit a vertical pull.

(d) Bore a hole in the base large enough to allow the nail head to pass through.

3

PROCEDURE:

(1) Cut a minimum of three pieces of wood for each kind of nail to be tested. All samples must be of the same thickness and cut to the same size.

(2) Locate, with diagonals, the center of each piece of wood.

(3) Drill a vertical pilot hole, using the 1/32" drill.

(4) Secure one of the wood samples firmly to the top of a metal plate.

(5) Drive a nail into the pilot hole. Stop when it hits the metal plate.

(6) Drive nails, following this procedure, into the wood blocks.

(7) Place one of the blocks in the holding power of nail apparatus.

(8) Operate the apparatus until the nails pull loose from the wood.

(9) Observe the scale reading of the torque wrench at the moment the nails begin to pull from the wood.

(10) Run a minimum of three tests on each kind of nail with each of the different woods, and record the average findings.

PRECAUTIONS:

(1) Select wood with as uniform a texture as possible. Cut all samples of one kind from the same board. All boards must be of the same uniform thickness.

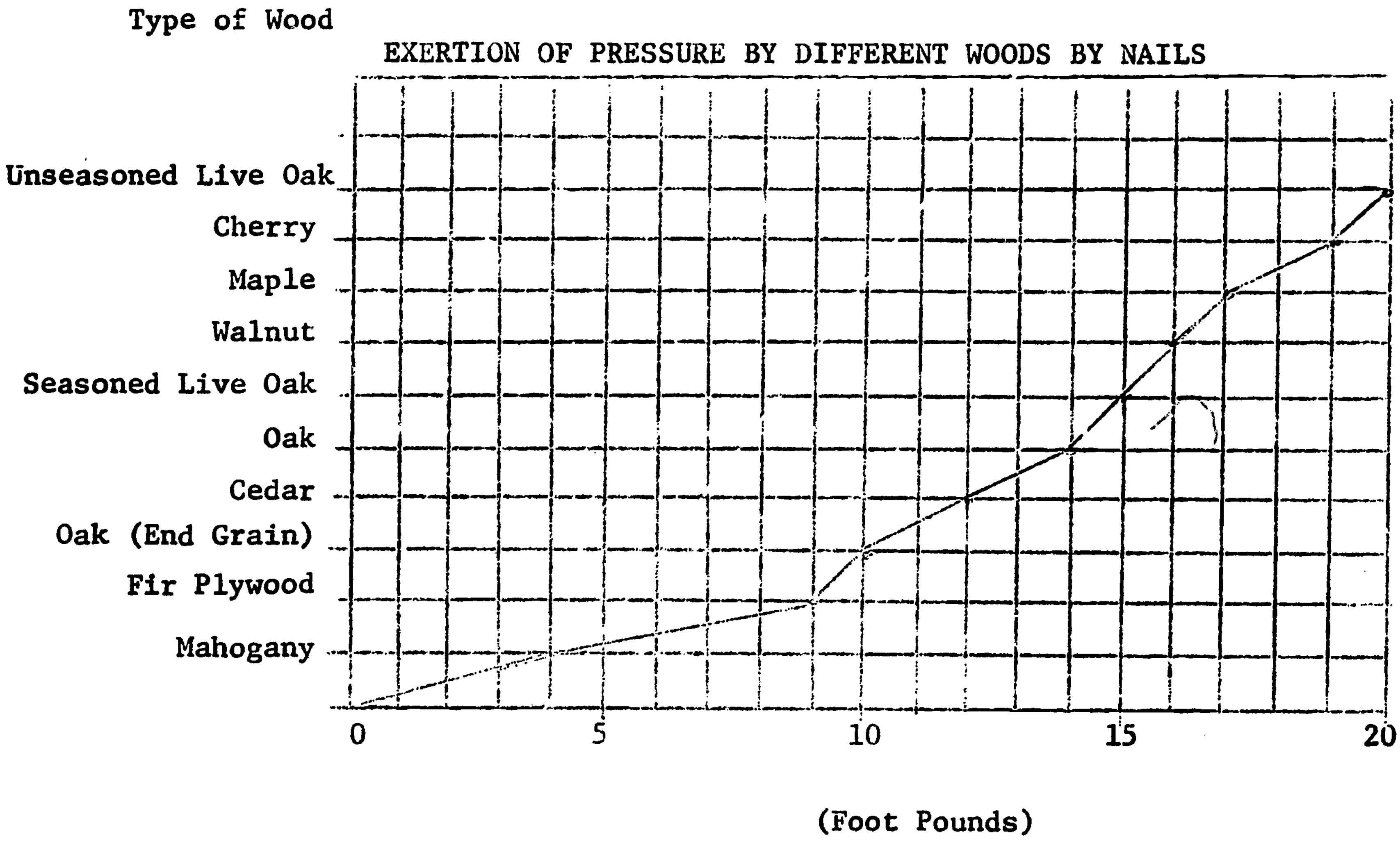
(2) Drill all pilot holes in the center of, and at right angles to, the wood surface. This will insure the nails being driven vertically into the wood. A slanted or bent nail will give an inaccurate indication of the nail's holding power.

(3) All nails must be driven the same depth into the wood. This will insure, for comparison purposes, an accurate reading of the nail's holding power.

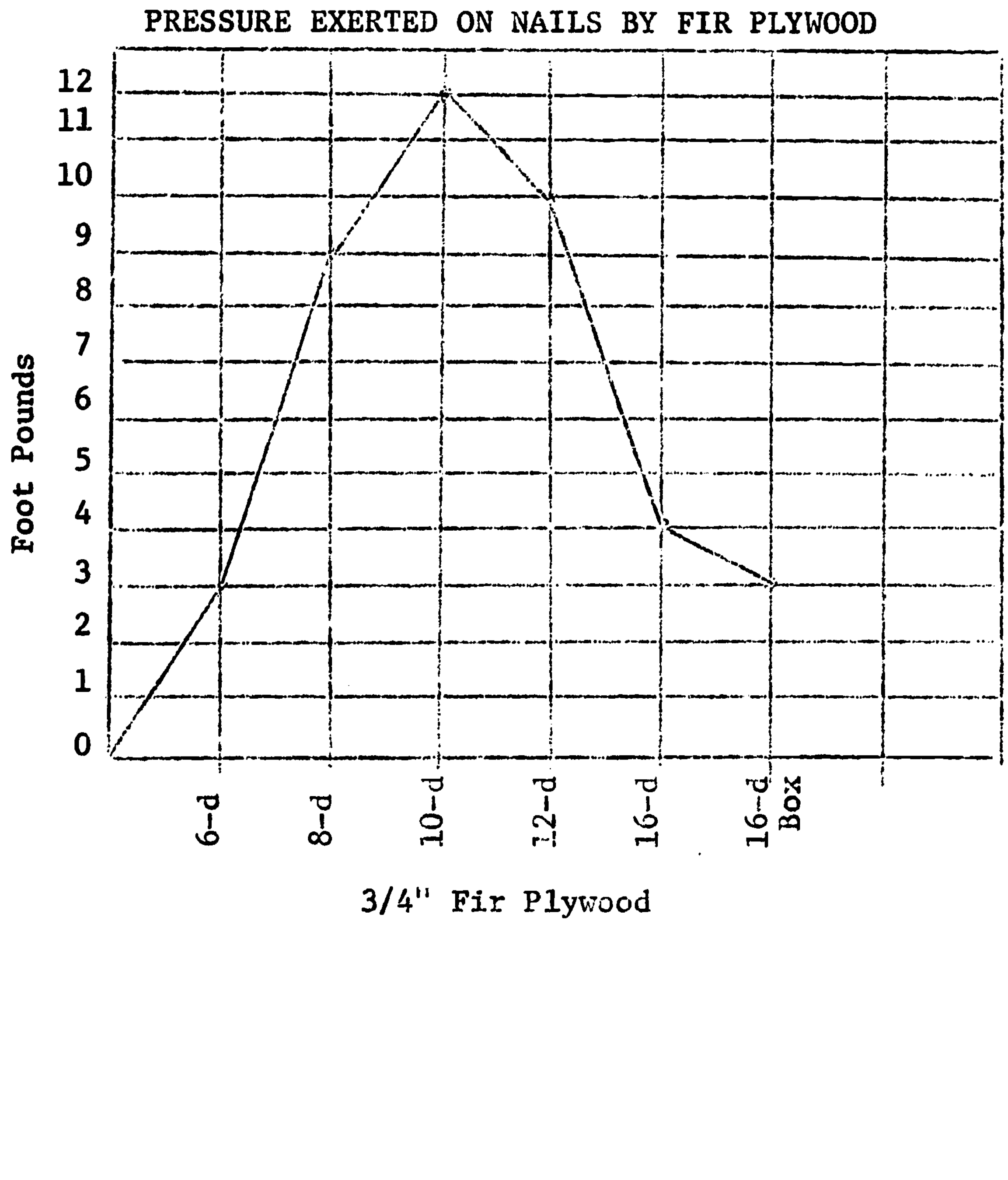
(4) The hole bored in the base of the Power of Nails Apparatus must be positioned so that a vertical pulling force is applied on the nail.

(5) Apply slow, even pressure to the torque wrench while conducting each test. This allows cable slack to be removed and avoids any sudden, jerky motion that will tend to cause erratic scale indications.

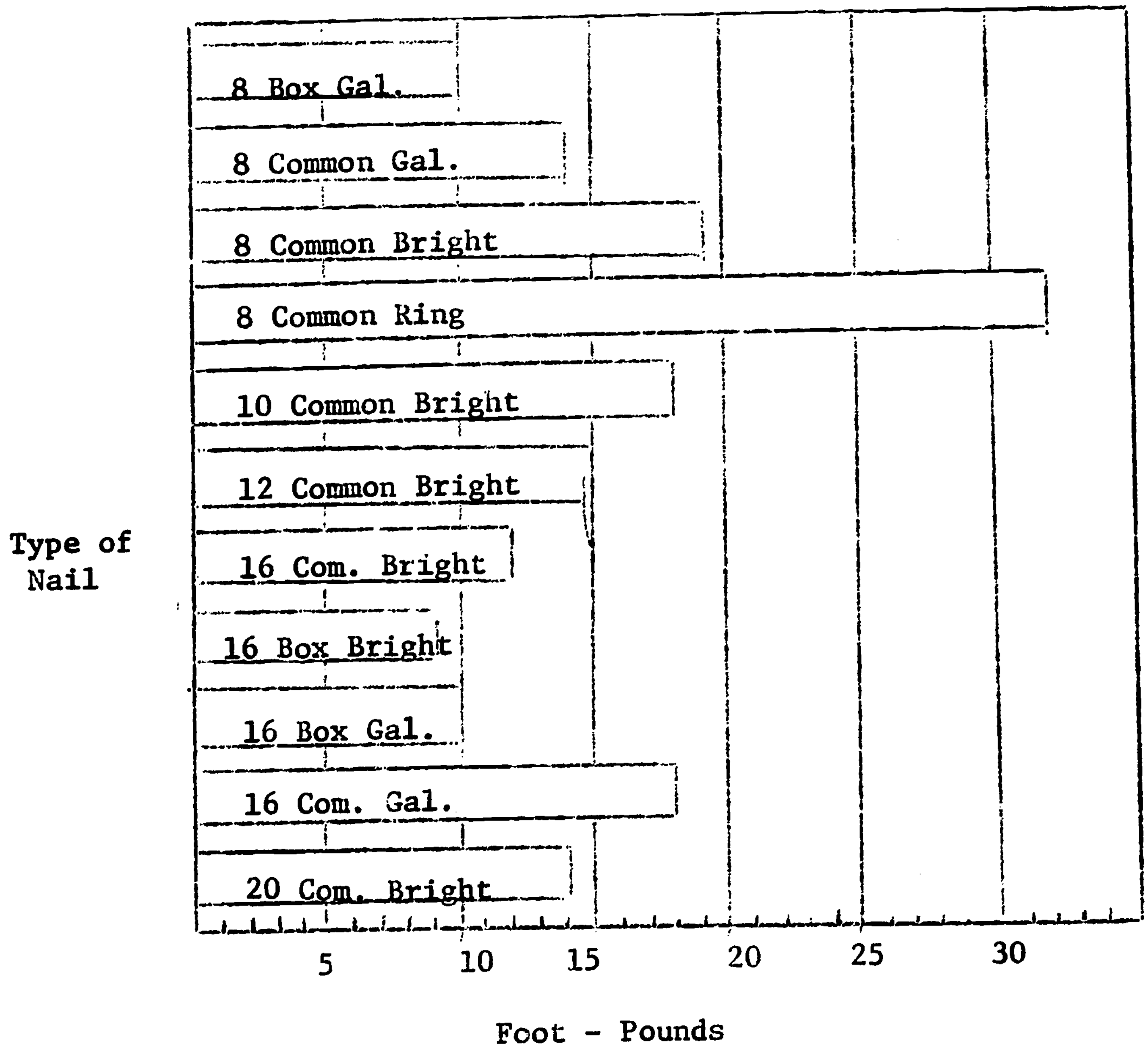
(6) Observe the torque wrench scale closely and be accurate in reading the pressure point when the nail begins to pull away from the wood. Carelessness with this factor will cause variations in the results.



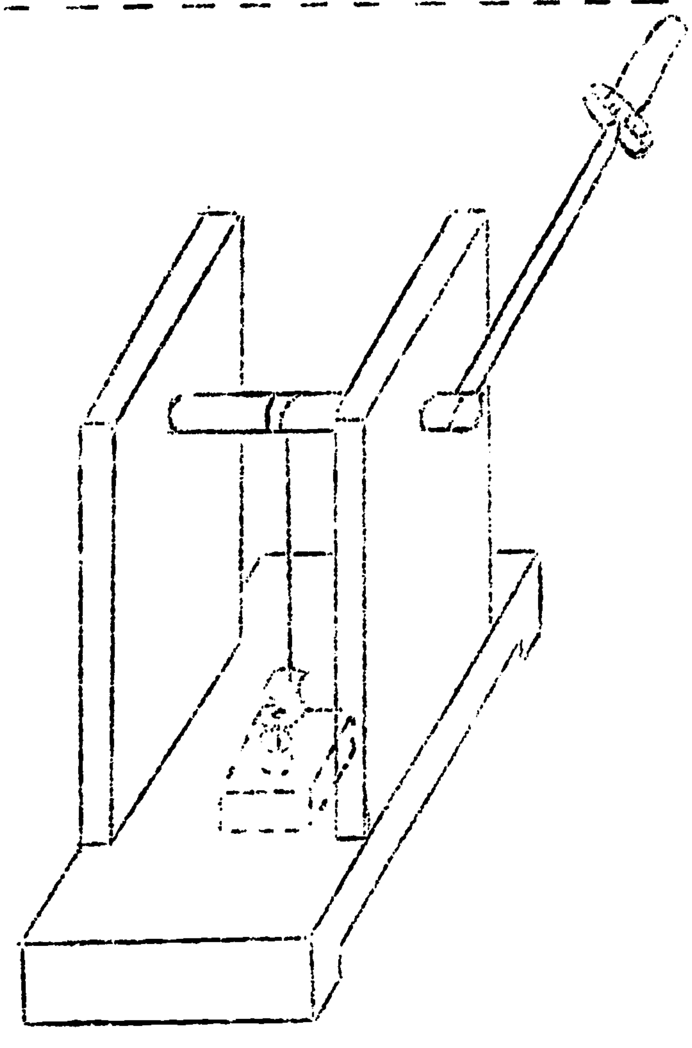
8-d Commom Nail 3/4" Depth



3/4" Fir Plywood



1½" D = pth in Fir Plywood



Holding Power of Nail Apparatus

QUESTIONS:

(1) What happens to the holding power as the nail size increases?
Ans. As the size of the nail increases the holding power decreases.

(2) Does seasoned wood have more holding power than unseasoned woods?
Ans. Testing unseasoned live Oak, it was found that it had more holding power than seasoned live Oak.

(3) When using the same size nail, which kind of wood has more holding power?
Ans. Cherry, (excluding unseasoned live Oak).

(4) Compare the holding power of 8d common nail with that of a 8d ring nail. Is there any difference? How would you account for the difference?
Ans. Yes, the holding power is greater with the ring nail, because the rings have the same effect as wood screws.

S E A S O N I N G   O F   W O O D

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TITLE: SEASONING OF WOOD

OBJECTIVES:

(1) To become familiar with the methods utilized in seasoning wood.

(2) To learn the effects of seasoning on lumber.

(3) To become familiar with the methods utilized to determine the moisture content of wood.

INTRODUCTION:

The seasoning of freshly sawed lumber is one of the most important and difficult processes associated with the manufacture of lumber. The specific use of lumber is directly dependent upon the skill and care given to the drying process.

The purpose of seasoning is to remove the moisture from the innumerable cells of which wood is composed. The degree to which moisture is removed depends upon the type of wood and its intended use.

REFERENCES:

(1) Forbes, Reginald D. Forestry Handbook, New York: The Ronald Press Co., 1956, 14-36-45.

(2) Groneman, Chris, and Glazener, Everett. Technical Woodworking. Dallas: Webster Division of McGraw-Hill Book Co., 1966 , pp. 32-37

(3) Hammond, James J., and Others. Woodworking Technology. Bloomfield, Illinois: McKnight and McKnight Publishing Co., 1961, pp. 22-27.

(4) Panshin, A. J., De Zeeuw, Carl, and H. P. Brown. Textbook of Wood Technology. Vol. I. New York: McGraw-Hill Book Co. 1964, pp. 283-303.

(5) U. S. Department of Agriculture. Wood Handbook No. 72. Washington, D. C.: U. S. Government Printing Office, 1955, pp. 31[illegible]-336.

DEFINITIONS:

Air Seasoning
A seasoning method which consists of piling freshly cut boards or planks carefully in the open air.

Kiln Seasoning
An artificial means of drying green wood by rapid moisture evaporation under controlled atmospheric conditions.

Free Water
The amount of water each little vessel or cell cavity contains.

Imbibed Water

The water absorbed in the porous walls of the cell. It is the evaporation of this water which causes the wood to change dimensions during the drying process.

EQUIPMENT AND MATERIALS NEEDED:

(1) Balance

(2) Green log samples

(3) Rule

(4) Tack hammer

(5) Electronic moisture meter

(6) Kiln

(7) Thermometer, F^{O}

(8) Brads or tacks

(9) String

(10) Self-calculating moisture meter (not a necessity)

(11) Bandsaw

(12) Goggles

PROCEDURE A Specimen Preparation

(1) Obtain from the instructor two (2) samples of flat sawed wood and two (2) samples of quarter sawed wood.

(2) Cut each sample to the following dimensions: 5" x 5" x ½".

(3) Number and label each sample according to the type of cut.

(4) Measure each sample as accurately as possible. It may be necessary to measure the thickness in at least three different places and take an average. Record the data on the wood sample and also in Table A.

(5) Make a notation of any unusual shape and weigh each sample on the balance. Record the weight (grams) on each sample and in Table B.

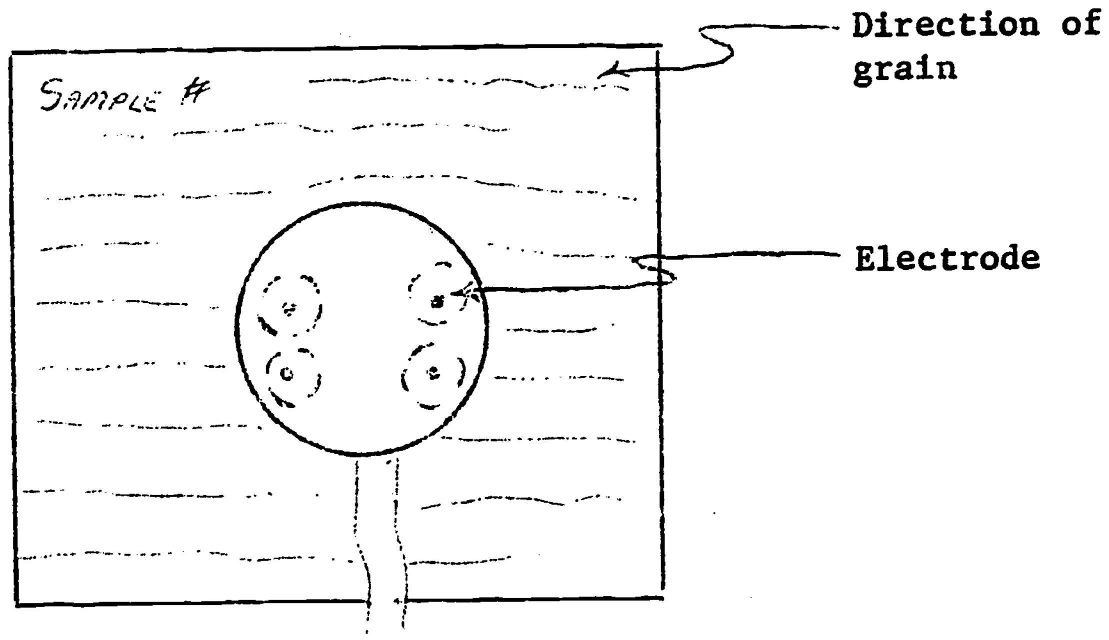
(6) Take a moisture reading of each sample utilizing the electronic moisture meter. Instructions are provided on the inside of the cover.

Caution :

(a) Sink the pairs of electrodes into the wood perpendicular to the direction of the grain. (See Figure A).

(b) When removing the electrodes, hold firmly down on the sample and pull straight up on the weighted handle. If you do not, the electrodes will break off.

Figure A



(7) Record the moisture readings on the sample and in Table C.

(8) With a tack hammer, drive a brad into each of the samples. Attach each sample in succession on a piece of string, making sure they do not touch each other.

(9) Hang the string of samples on a coat hook in the materials laboratory and allow them to air dry for at least 1½ weeks.

(10) Make certain that you place your name on the string of samples to avoid confusion later.

Table A

CHANGE IN DIMENSIONS

Sample No.	Thickness (inches)			Length (inches)			Width (inches)		
	Green	Seasoned	Percent Change	Green	Seasoned	Percent Change	Green	Seasoned	Percent Change
Flat Sawed#1	15/32	14/32	6%	3 15/16	3 15/16	0	4	3 3/4	6 %
Flat Sawed#2	15/32	15/32	0	3 15/16	3 7/8	1.5%	4	3 3/4	6 %
Quarter Sawed#1	17/32	1/2	5%	3 3/4	3 22/32	1.6%	3 15/16	3 13/16	3 %
Quarter Sawed #2	17/32	1/2	5%	3 15/16	3 29/32	.1%	3 15/16	3 7/8	1.5 %

Table B

MOISTURE CONTENT (Weight Method)

	Weight (grams)			1" Sample		
	Green	Seasoned	Percent Change	Seasoned Weight	Dry Weight	Moisture Content
Flat Sawed#1	133.7	94.5	29.3%	2	1.7	17.5 %
Flat Sawed#2	102	72.5	28.9%	1.1	.9	22. %
Quarter Sawed#1	152	113.2	25.5%	2	1.6	25 %
Quarter Sawed#2	193.6	151.5	21.7%	3.1	2.6	19 %

Table C

MOISTURE CONTENT (Electronic Method)

	Percent Green	Percent Seasoned
Flat Sawed#1	43 %	10 %
Flat Sawed#2	43 %	10 %
Quarter Sawed#1	43 %	12 %
Quarter Sawed#2	75 %	13 %

PROCEDURE B

Effects of Seasoning

(1) After allowing the samples to dry the specified time ($1\frac{1}{2}$ weeks), remeasure each sample in thickness, length, and width. Record the data in Table A, page 4, and calculate the percent change for each dimension.

(a) To calculate per cent change divide:

$$\frac{\text{Green Measurement - Seasoned Measurement}}{\text{Seasoned Measurement}}$$

(2) Reweigh each sample and record the new weight in Table B, page 4. Utilize this data to calculate the per cent change in moisture content.

Note: To avoid error, use the same balance previously used during Procedure A of this experiment.

(3) Next take each sample and remeasure the moisture content with the electronic moisture meter. Place the data in Table C, page 4.

(4) To determine the actual moisture content by the weight method you must now do the following:

(a) Cut a thin sliver of wood measuring $\frac{1}{4}$" x 1" (across the grain) from one sample. Weigh the sliver on a balance and record the data in Table B, page 4.

(b) Regulate the kiln at approximately 215°F and place the sliver of wood in it. Wait approximately 20 minutes and remove and reweigh the sample. Place the sample back in the kiln for 10 minutes and remove and reweigh it once again. When there is no change in weight, you have the dry weight of the wood. Record this information in the appropriate column and calculate the moisture content.

(c) The formula utilized to calculate the moisture content is:

$$\frac{\text{Weight Seasoned - Oven Dry Weight}}{\text{Oven Dry Weight}}$$

Note: You may also use the Moore Self-Calculating Moisture Content Scale if you desire. See the instructor for additional instruction.

QUESTIONS: (Procedure B)

(1) Account for the changes in the quarter sawed samples and the flat sawed samples from the standpoint of size, shape and weight?

(2) Which method provides the most accurate measure of moisture content? Why?

GENERAL QUESTIONS:

(1) When is it desirable to air dry lumber instead of kiln drying it?

(2) Does the drying time of different species of wood vary? If so, give some examples.

(3) Wood looses moisture fastest from which surface? How can this hopefully be prevented?

(4) When are the readings on an electronic moisture meter inaccurate?

(5) Give some advantages and disadvantages of kiln drying and air drying of lumber.

Air Dried	Kiln Dried

(6) What are some common wood defects which are the result of improper seasoning? Name five (5) and give a brief description of each.

1.

2.

3.

4.

5.

(7) Suppose you are building some furniture to be used in your home. What should be the moisture content range of the wood you select? Why?

(8) Name the two types of kilns used in seasoning lumber. When would it be advantageous to use one type of kiln rather than the other?

(1)

(2)

(9) As an instructor, how could you utilize all or some part of this experimental unit in teaching your students the importance of proper seasoning and selection of lumber for various purposes?

ANSWERS TO QUESTIONS: (Procedure B)

(1) The quarter sawed lumber warps less, loses less weight, and shrinks less. This is due, in part, to the direction of the grain, and may be due, in part, to the fact that some of the quarter sawed wood was heart wood.

(2) The weighing method was most accurate because the moisture meter is affected by the amount of moisture in the air.

ANSWERS TO GENERAL QUESTIONS:

(1) When you need lumber with a higher moisture content and do not have a storage problem and are not in a hurry.

(2) Yes, Hardwoods take longer because they are denser.

(3) Wood loses moisture fastest from the end grain. This can probably be prevented by sealing the end grain before drying so that the wood will not dry too fast near the end and crack.

(4) Readings on an electronic moisture meter are most inaccurate when there is a lot of humidity in the air. Below 7% and greater than 60%.

(5) Air Dried: Air drying is a slow process, costs less, not as accurate, natural resources not required, and takes more space.
Kiln Dried: Wood can be dried faster, it can be dried more accurately, it kills insects in the wood, it kills fungi in the wood, there are fewer imperfections, costs more, and takes less space.

(6) Warping - a variation from a true or plane surface.

Winding - slight twisting of a board.

Splitting - grain structure pulls apart.

Cupping - carpage on one side more than on the other.

Checks - a crack in the wood structure.

(7) 6 to 12 percent. Glue joints need less moisture to hold good. The wood will swell and shrink some, therefore, the moisture content should about average the swelling and shrinkage so that drawers and doors will fit properly.

(8) (a) Compartment kilns
(b) Progressive kilns

The compartment method should be used when speed is important.

(9) (a) Proper construction calls for properly seasoned lumber.

(b) Different methods of seasoning.

(c) Effects of proper seasoning.

(d) Problems in seasoning.

Section 2-F

FUELS & LUBRICANTS

F I L M   S T R E N G T H   O F   O I L S

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TITLE: FILM STRENGTH OF OILS

OBJECTIVES:

(1) To become familiar with various additives and lubricating qualities of oils.

(2) To test selected brands of oil and compare their ability to lubricate and provide film strength.

(3) To become familiar with special oil "improver" additives and their effect on oils.

INTRODUCTION:

Lubrication may be defined as the reduction of friction between two relatively moving surfaces by the interposition of some other substance such as a solid lubricant or a fluid lubricant.

The load carrying capacity of a lubricant is considered to be the maximum load which can be imposed upon a given system containing the lubricant and operating under specific conditions without permitting seizure, welding, galling, scoring, or excessive wear of surfaces. This property of oil is often referred to as "film strength."

REFERENCES:

(1) Bouman, C. A., Properties of Lubricating Oil and Engine Deposits. London: Macmillian and Co., 1950.

(2) Brewer, A. F., Basic Lubrication Practice. New York: Reinhold Publishing Corp., 1955.

(3) Crouse, William H., Automotive Mechanics. 5th ed. Dallas: McGraw-Hill Book Co., Inc., 1965.

(4) Doolittle, J. S., Mechanical Engineering Laboratory. New York: McGraw-Hill Book Co., Inc. 1957.

(5) Evans, E. A., Lubricating and Allied Oils, 3rd ed. London: Chapman and Hall L.T.D., 1948.

(6) Freeman, Peter, Lubrication and Friction. New York: Pitman Publishing Corp., 1962.

(7) Forbes, W. M., and Others. Lubrication of Industrial and Marine Machinery. 2nd ed., New York: John Wiley and Sons, 1954.

(8) Hobson, Paul D. Industrial Lubrication Practice. New York: The Industrial Press, 1955.

DEFINITIONS:

Oil Additives
Substances added to fluid lubricants to obtain or enhance properties desired in the final product.

Extreme Pressure Additive
An additive which prevents seizure under conditions of extreme load when failure occurs in the liquid film.

Oiliness Additives
These substances, also known as tacky or adhesive additives, cause the oil to adhere more firmly to metallic surfaces.

MS Oil (formerly heavy-duty grade)
MS oil is a well refined oil, which may be made from any type base, containing detergent and anti-oxide additives. Anti-corrosion and mild extreme-pressure additives are usually included, and the oil may be treated to reduce foaming and emulsibility.

MM Oil (formerly premium grade)
MM oil is a very well refined oil with few or no additives.

ML Oil (formerly regular grade)
ML oil is intended for use under light or favorable conditions and usually contains no additives.

Oil Improvers
Oil "improvers" are additives of various kinds to be put into the oil by the user.

Viscosity
The viscosity of an oil usually is specified as the time in seconds that it takes for a given amount of oil to flow by gravity through a standard-sized orifice or hole at a given temperature.

EQUIPMENT AND MATERIALS NEEDED:

(1) Film strength testing machine.

(2) Samples of lubricants to be tested.

(3) Brand name oil "improver" additives.

(4) Metal test pellets.

(5) Electric timer.

(6) Bunsen burner and ring stand or hot plate.

(7) Containers for test samples.

(8) Thermometer.

(9) Allen key.

(10) Vernier caliper.

(11) Gloves.

(12) Goggles.

(13) 250 ml beaker.

PROCEDURE A

(1) Select samples of lubricants to be tested.

(2) Secure the proper equipment and materials necessary to perform the experiment.

(3) Fill a container with an oil sample and place it under the hardened steel bearing race. Adjust the height of the container with the wooden blocks until the oil is touching the bottom side of the race. (See figure A for proper setup.)

(4) Mark steel pellets for identification and place one soft steel pellet in the jug and tighten the allen screw. (See figure A.)

(5) Position the arm which houses the steel pellet down on the bearing race and attach the five (5) pound weight to the end of the arm.

(6) Setup the electric timer for five (5) minutes with the testing machine plugged into the timer. Turn on the timer and at the end of five minutes the testing machine will shut off automatically.

(7) Remove the test pellet from the testing machine and measure the degree of wear lengthwise with a vernier caliper. Record the degree of wear in Table A opposite the brand of oil.

(8) Clean steel race with solvent and fine emery cloth. Clean all abrasive from steel race before making the next test.

(9) Repeat steps 3, 4, 5, 6, 7, and 8 for the remaining oil samples and record the data in Table A below. All the samples tested for Table A should be at room temperature.

(10) Next you are to heat each sample previously tested to 175-180 degrees F and perform the same steps once again (steps 3-9). The only change will be to place the test results in Table B above. The sample oils should be heated in a test container.

QUESTIONS: (procedure A)

(1) Which oil appeared to provide the greatest film strength or ability to carry a load at:

(a) room temperature Shell 30 ms

(b) 180 degrees Havolin 10 w 30 ms

(2) Which oil appeared to provide the lowest film strength or ability to carry a load at:

(a) room temperature Mobile 30 ms

(b) 180 degrees Hudson 30 ml

(3) Did the change in temperature of the lubricants affect the lubricating quality? yes

(a) If yes, in what way? higher temperature reduced the lubricating quality.

(4) In comparing the same brand of oil, which SAE viscosity provided the greatest film strength?

(a) at room temperature (SAE 10 w 30) (brand Havoline).

(b) at 180 degrees (SAE 10 w 30) (brand Havoline).

(5) Under what operating conditions might ml oils prove to be economical? + light duty

Give reason for your answer.

Oil proves to have as good lubricating qualities at room remperature as ms but is lower in cost.

PROCEDURE B Testing Oil "Improver" Additives

(1) Select additives to be tested and test each additive, undiluted, at room temperature as in Procedure A (steps 3 to 8).

(2) Record the test data in Table C.

(3) Heat the additives to 180 degrees F and test as in Procedure A (steps 3 to 8).

QUESTIONS (Procedure B)

(1) Do undiluted additives wear as well as ms oils?
No

(2) Which additive appeared to provide the greatest film strength at 72 degrees? Bardahl

At 180 degrees? STP

(3) How do additives compare in price with oils?

More expensive than oils X

Less expensive than oils ________

(4) Would it be practical to use an undiluted additive in the crankcase in place of an ms oil?

Yes ________ No X

Give reason for your answer.

Additives are more expensive and do not have as great a film strength as some ms oils.

PROCEDURE C Testing Oil "Improver" Additives

(1) Select the brand oil which had the lowest film strength at room temperature in Procedure A of this experiment. Add to this oil sample the proper proportion of "improver" additive. (See directions on additive can)

(2) Next test the mixture for five (5) minutes on the testing machine utilizing the same procedure as outlined in Procedure A (steps 3-8) page 3. Record the test data in Table C.

(3) Now you are to heat this same mixture to 180 degrees F and again test it. Record the results in Table D.

(4) Now take another clean sample of the same brand oil and add to it the proper proportion of the second "improver" additive and proceed to test this sample .

(5) Next take this same mixture and this time heat it to 180 degrees F as you did with the last "improver" additive. After testing for five minutes, place the test data in Table D.

(6) Follow steps 1 to 3 for remaining samples.

QUESTIONS: (Procedure C)

(1) Which additive provided the best film strength?

(a) at room temperature? Adams

(b) at 180 degrees Bardahl

(2) Did the increased temperature (180 degrees F) affect the lubricating quality of the special additives?

Yes, it causes more wear.

GENERAL QUESTIONS:

(1) Oils are liquids, characterized by long complex hydrocarbon molecules of varying chemical composition. They are divided into two categories of oils. (Hobson 3-3)

(a) Organic

(b) Mineral

(2) Mineral oils are subdivided into two types of oils. List them and discuss the characteristics of each.

(a) Paraffinic

(b) Naphthenic

(3) List five (5) classifications of internal combustion engine crankcase oils as adopted by the Society of Automotive Engineers and briefly describe each. (Hobson 14-18)

(a) ms

(b) ms

(c) ml

(d) dl

(e) ds

(4) Interpret the following numbers and letters which are printed on a can of oil.

SAE Society of Automotive Engineers

30 Viscosity

MS Severe service

DG Diesel engine use, light duty

(5) Does the addition of additives to oil during the blending process increase or decrease the lubricating quality of oil?

(a) increase

(6) Additives are specially blended to oils in the refinery to obtain or enhance certain lubrication qualities. Name these additives and briefly describe their purpose.

(a) Oxidation inhibitor - prevents oxidation due to oil mixing with air causing corrosion and harmful varnish like coating.

(b) Extreme pressure additive - prevents seizure under conditions of extreme load.

(c) Oiliness additive - causes oil to adhere more firmly to metal surface.

(d) Anti-rust additive - form corrosion-resistant film and also neutralize acids.

(e) Detergent additive - metallic soaps that remove gum and sludge and keep them in suspension.

(f) Pour point depressives - napthalene wax compounds form coating over wax particles keeping them in suspension.

(g) Viscosity index improvers - reduce the change of viscosity with temperature change.

(h) Anti-foaming additive - addition of silicones reduce surface tension but does not effect the film strength.

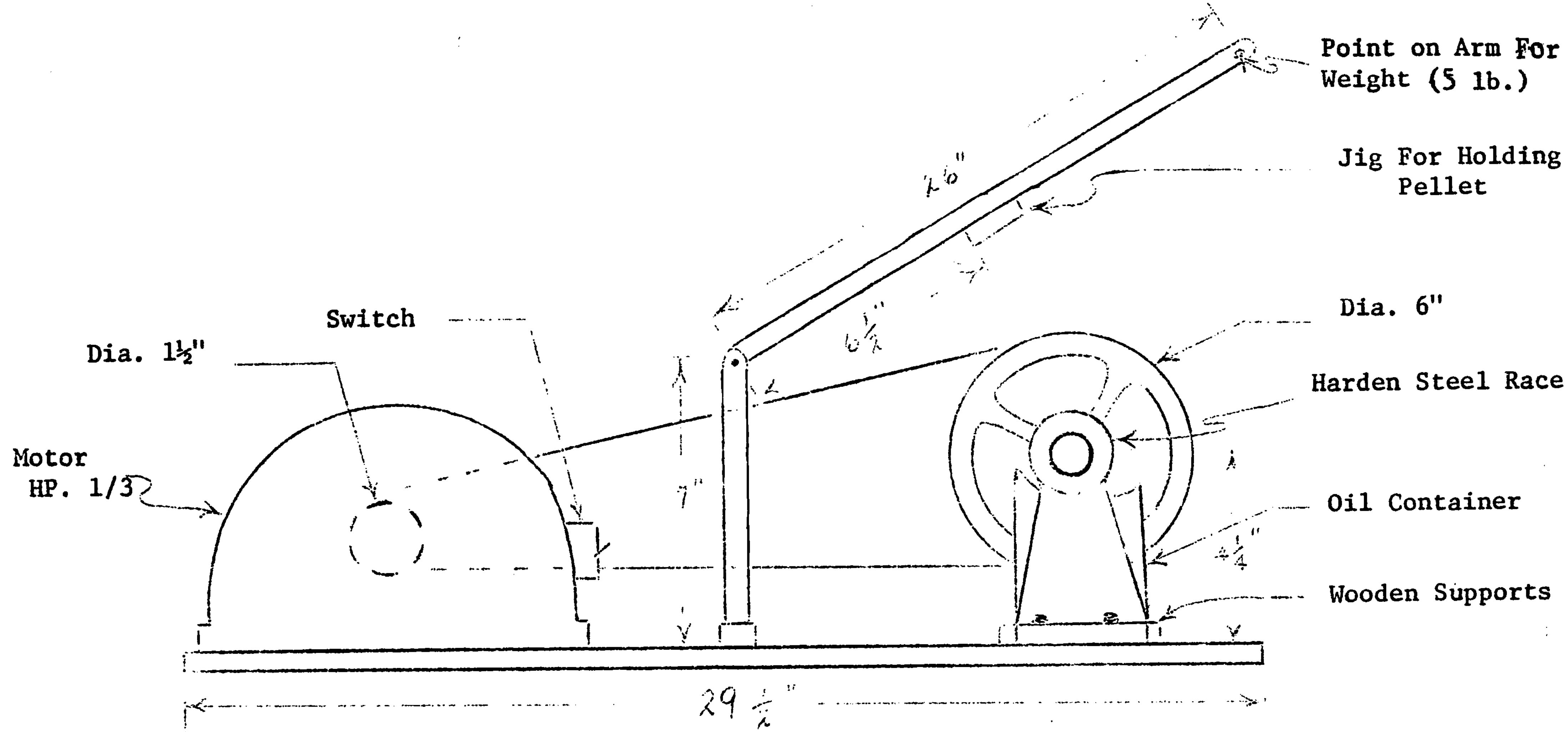
(7) Should an internal combustion engine in good condition use oil? Justify your statement.

Yes

A small amount will pass by the rings while lubricating the cylinder walls.

Brand	SAE No.	Service Classification	TABLE A 72^{o}F-77^{o}F Pellet Number	Wear	TABLE B 180^{o}F Pellet Number	Wear
Havoline	20-20 w	ms	B 10	.072	B 1	.129
Mobile	20-20 w	ms	B 9	.088	B 2	.122
Havoline	30	ms	B 12	.093	B 17	.115
Shell	30	ms	B 11	.065	C 2	.108
Mobile	30	ms	B 13	.092	C 3	.124
Havoline	10w 30	ms	B 4	.069	B 7	.106
Penzip Z7	10x 30	ms	B 3	.075	B 6	.113
Mobile Special	10w 30	ms	B5	.076	B 8	.122
Hudson LLL	30	ml	C 15	.084	C 6	.226
Alemite	30	ml	C 14	.091	C10	.204
			TABLE C		TABLE D	
STP		Additive	B 14	.124	C 4	.116
Adams		Additive	B 16	.355	----	----
Bardahl		Additive	B 15	.115	C 5	.221
STP in Hudson		Additive	C 16	.091	C 8	.161
Adams in Hudson		Additive	C 17	.069	C 12	.275
Bardoil in Hudson		Additive	C 1	.124	C 7	.132

Figure A


Point on Arm For Weight (5 lb.)
Jig For Holding Pellet
Dia. 6"
Harden Steel Race
Oil Container
Wooden Supports
Switch
Dia. 1½"
Motor HP. 1/3
29 ½"
7"
6½"
2⁶"
4¼"

Section 2-G

METALS

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TITLE: TESTING TENSILE, COMPRESSION, AND SHEAR STRENGTH OF FERROUS AND NONFERROUS METALS

OBJECTIVES:

(1) To become familiar with the technique and significance of measuring the tensile strength of metals.

(2) To become familiar with the technique and significance of measuring the compression strength of metals.

(3) To become familiar with the technique and significance of measuring the shear strength of metals.

(4) To test and compare the results of such tests on different metals.

INTRODUCTION:

The testing of materials is necessary to gain practical knowledge of how materials react under various conditions. Over the years a number of tests have been developed and standardized for checking the properties of different materials. In this experimental unit three basic types of stress (tensile, compression, and shear) will be experimented with and discussed. Of these three, tensile strength is perhaps the single most important property of engineering materials. The proper selection and application of materials are determined by understanding the material characteristics.

REFERENCES:

(1) American Society for Testing and Materials. ASTM Standards 1961, Part 3. Philadelphia, Pennsylvania, pp. 11, 112, 165.

(2) Kohn, Max, and Starfield, Martin. Materials and Processes. New York: The Macmillian Co., 1959. pp. 244-296.

(3) Moore, Harry D., and Kibbey, Donald R. Manufacturing Materials and Processes. Homewood, Illinois: Richard D. Irwin, Inc., 1965, Chapter 2, 5, 6.

(4) Research Staff. Practical Metallurgy for Engineers. Philadelphia, Pennsylvania: E. F. Houghton and Co., 1952, Chapter 14.

(5) Other references in the resource center.

DEFINITIONS:

Tensile Strength
That property of a material which gives it maximum resistance to being separated by two forces acting in opposite directions.

Compression Strength
The ability of a material to resist opposing forces tending to crush or shorten it.

Shear Strength
Stress caused by forces which act parallel to a given area and in opposite directions, tending to produce a sliding of one portion past another.

Elasticity
That property of a material which allows it to deform under load and return to its original shape when the load is removed.

Yield Strength
A practical way of defining a stress that represents the elastic limit of a material.

Yield Point
The stress at which there occurs a marked increase in strain without an increase of stress.

Breaking Strength
The unit stress developed in a material at the moment of failure. For some materials this is also the ultimate strength, but for others it may also be a lower value.

EQUIPMENT AND MATERIALS NEEDED:

(1) Universal testing machine.
(2) Vernier micrometer caliper (1")
(3) Divider
(4) Gage length machine
(5) Tensile specimens as specified in Procedure A.
(6) Universal grips with V-jaws
(7) Hardened compression test discs and raising block
(8) Compression cage (if Dillon)
(9) Compression test specimens as specified in Procedure B
(10) Double-shear test fixture
(11) Shear test specimens as specified in Procedure C
(12) Pocket rule
(13) Goggles

PROCEDURE A Tensile Testing

Note: There should be three members to a group

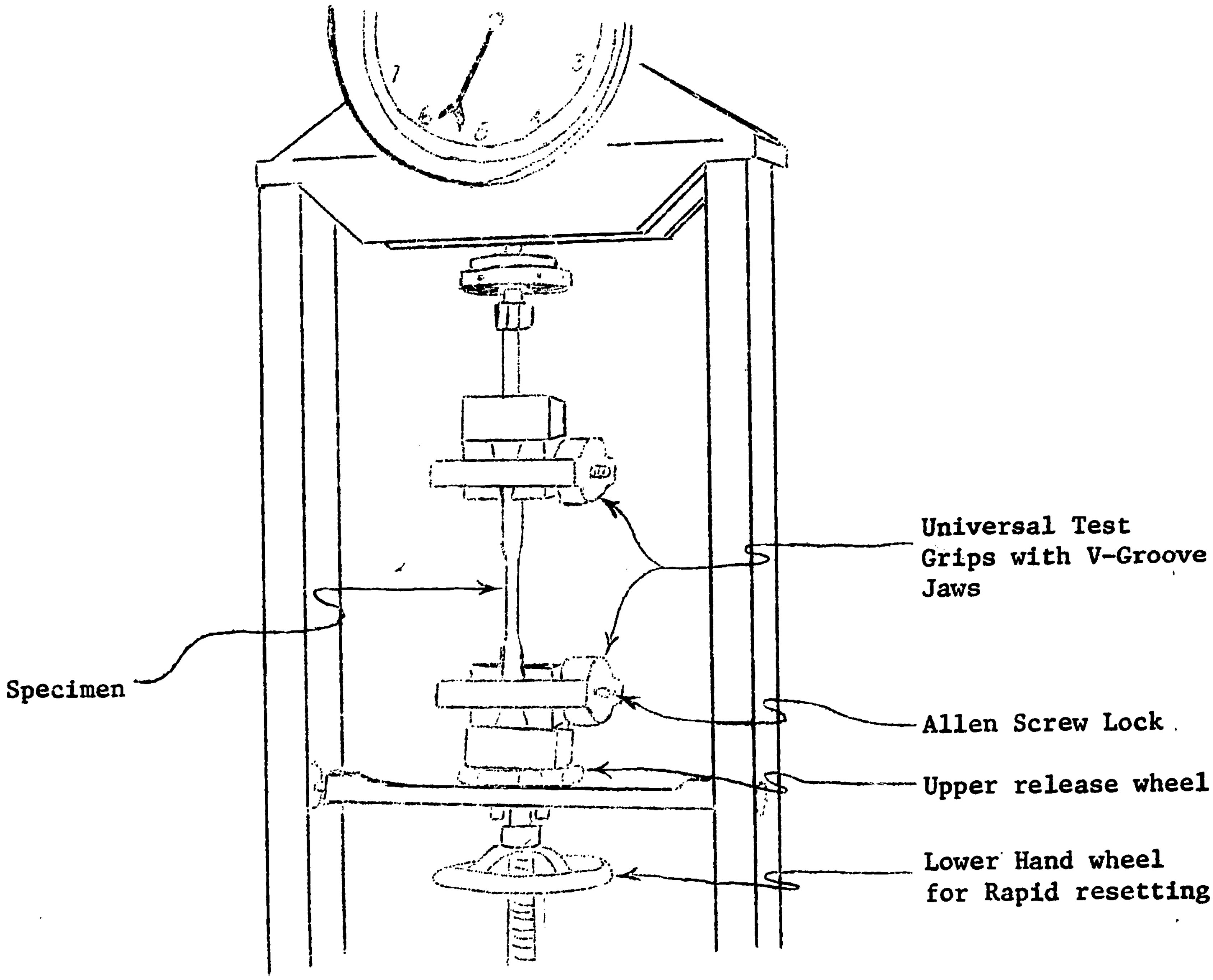
(1) Select three (3) test specimens as follows:

(a) 1 cast iron test specimen (round stock)
(b) 1 aluminum test specimen (round stock)
(c) 1 steel test specimen (round stock)

(2) Setup the universal testing machine with the universal jaws utilizing the V-grooved grips for round specimens (See Figure A)

(3) Utilizing the micrometer, measure and record the diameter of each specimen in the chart provided.

Figure A



Dillon Universal Tester

(4) Determine the area of each specimen by utilizing the formula $A = (3.14)r^2$.

(5) Mark each sample with two-inch gage marks.

(6) Install the specimen in the V-groove jaws, making certain that the specimen is properly inserted, aligned, and locked with the allen screw. (See Figure A)

(7) Put on goggles and begin to apply load. Observe the load gage carefully, for specimens have limited elongation and will provide little or no sign before failure. Record the maximum load and breaking load in the chart provided.

(8) Continue to test the remaining specimens and record the data.

(9) Determine the ultimate strength of each specimen by dividing

$$\frac{\text{Maximum Load (psi)}}{\text{Specimen Area (inches}^2\text{)}}$$

(10) Determine the percentage elongation of each specimen by dividing

$$\frac{\text{Final length} - \text{Original length}}{\text{Original length}} \times 100$$

(11) Determine the per cent area reduction by dividing

$$\frac{\text{Original area} - \text{Final area}}{\text{Original area}} \times 100$$

(12) Obtain the additional data necessary to fill the charts from other groups that have tested the metal specimens.

	Cast Iron Specimens				Aluminum Specimens				Steel Specimens			
	1	2	3	Avg. C.I	1	2	3	Avg. Al.	1	2	3	Avg St/
Original Diameter												
Original Area												
Maximum Load												
Breaking Load												
Ultimate Strength												
Percentage Elongation												
Percent Area Reduction												

QUESTIONS (Procedure A)

(1) Which material appeared to be more ductile? Least Ductile?

(2) Account for the differences in ultimate strength of the materials tested.

(3) What determines whether aluminum is brittle or ductile?

(4) Why is cast iron brittle?

(5) What is the significance of the tensile test?

PRODEDURE B Compression Test

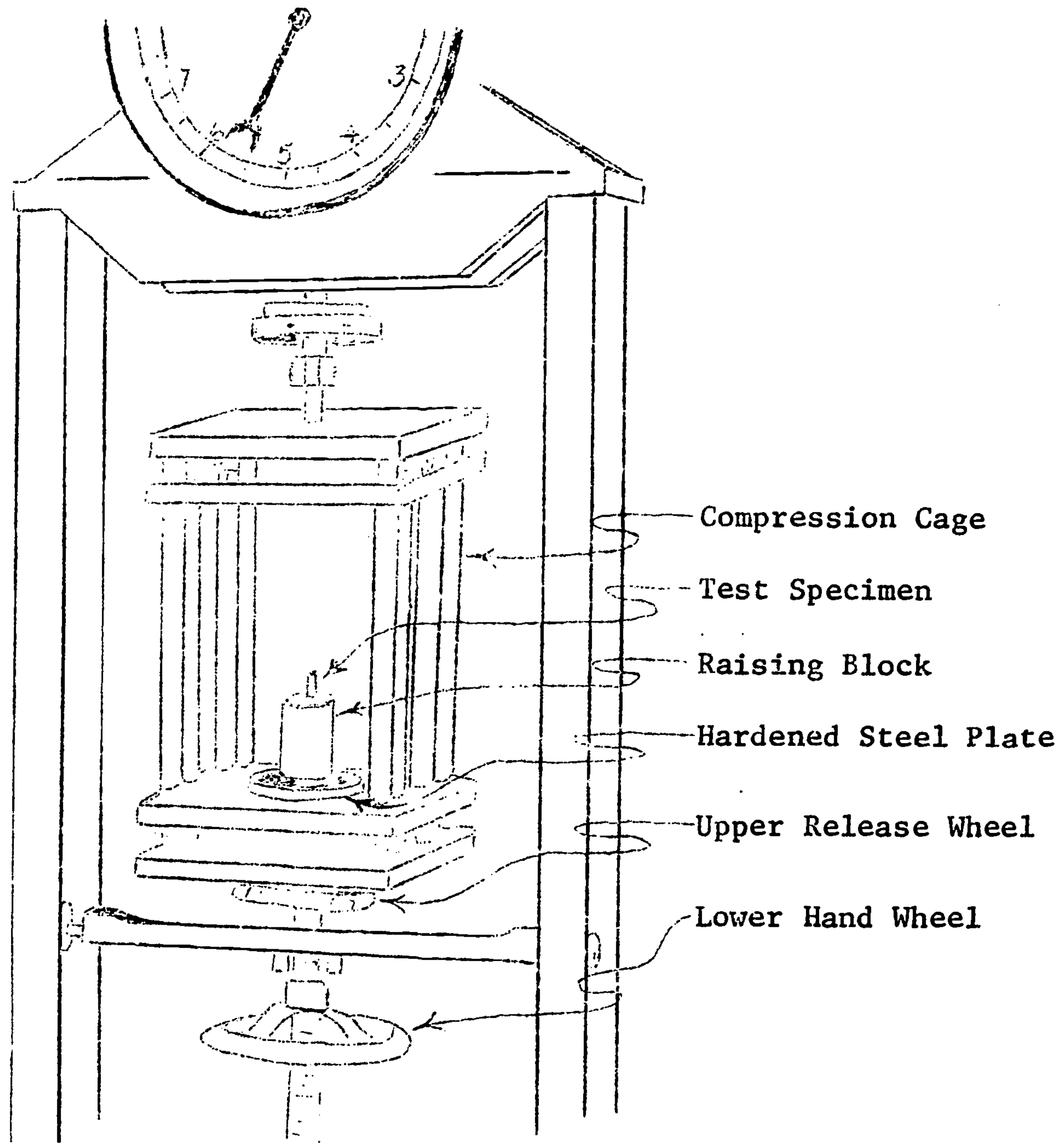
(1) Select three (3) compression test specimens as follows:
- (a) 1 cast iron test specimen, 3/8" Dia. x 3/4"
- (b) 1 aluminum test specimen " " " "
- (c) 1 steel test specimen " " " "

(2) Setup the universal testing machine with the appropriate compression cage. (See Figure B)
- (a) Place a hardened steel plate on the lower platen of the compression cage and place the raising block (centered) on it. (See Figure B)

(3) Utilizing the micrometer, measure and record the diameter of each specimen in the chart provided. Use this information to find the <u>area</u> (inches^2) as performed in Procedure B.

(4) Place the specimen on the raising block, making sure the specimen and block are properly centered in the machine.

Figure B



Dillon Universal Tester

(5) Gradually load the specimen until the diameter has increased measurably. This can be determined with a pre-set outside caliper or micrometer. Record the yield load.

(6) Remove the specimen and remeasure the diameter. If the specimen returns to its original diameter, reload to a higher load. Record the results in the appropriate column in the chart.

(7) Test the remaining test specimens in the same manner.

(8) Calculate the percentage deformation by dividing

$$\frac{\text{Original Diameter}}{\text{Final Diameter}} \times 100 - 100.0$$

(9) Calculate the yield strength (compressive strength) by dividing $\frac{\text{Yield Load (psi)}}{\text{Original Area (inches}^2\text{)}}$

(10) Obtain the additional data necessary to fill the charts from other groups that have tested the metal specimens.

	Cast Iron Specimen				Aluminum Specimen				Steel Specimen			
	1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
Original Diameter												
Area												
Final Diameter												
Yield Load(psi)												
Yield Strength(psi)												

QUESTIONS (Procedure B)

(1) Which material had the greatest yield strength? Lowest yield strength?

(2) Compare the compressive strengths with tensile strengths determined earlier.

(3) List five structures or machines which are subject to compression loading.

1.

2.

3.

4.

5.

PROCEDURE C Shear Strength

(1) Select three (3) shear test specimens of rod 3/8" Dia. x 4" as follows:

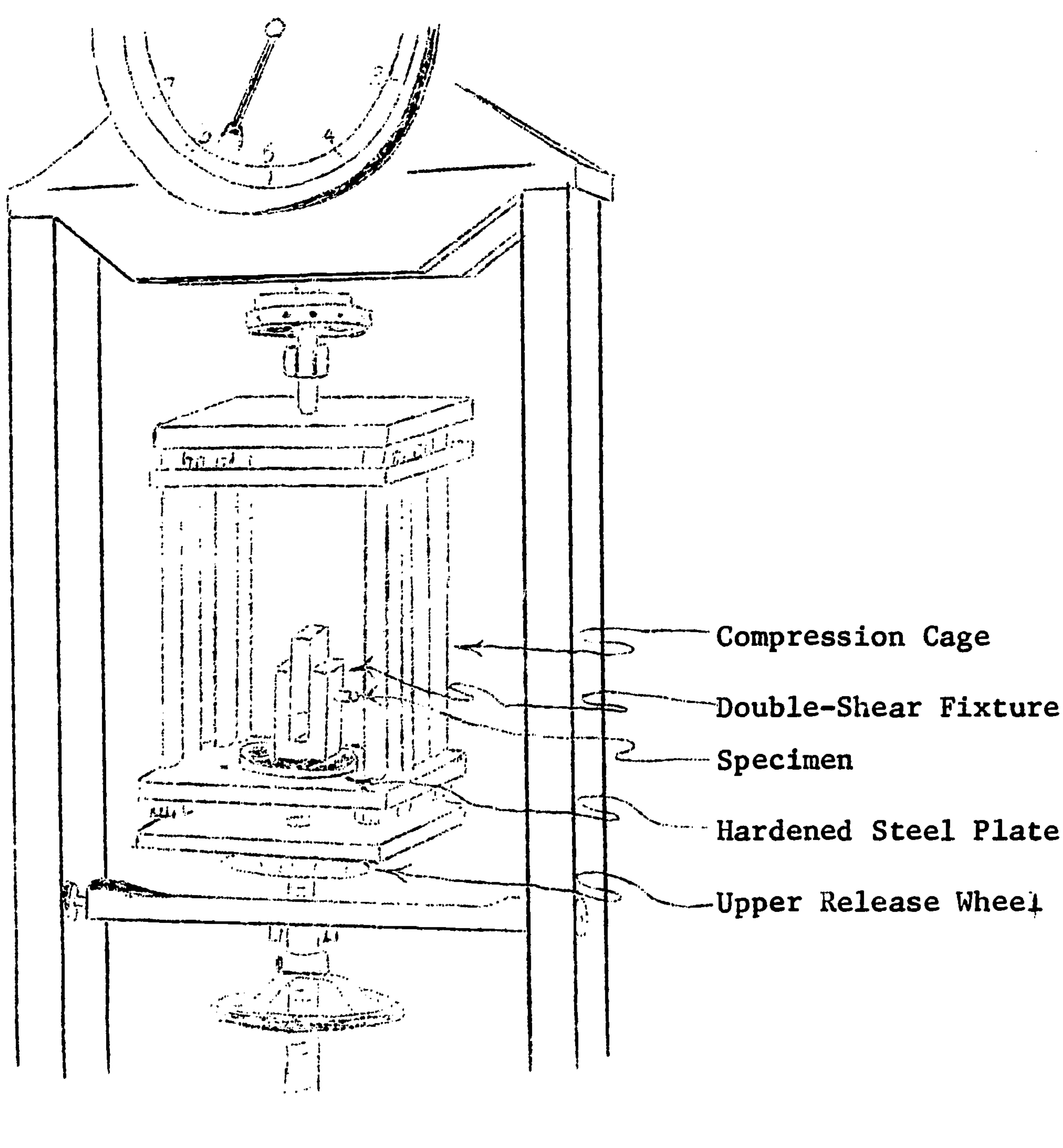
   (a) 1 aluminum specimen
   (b) 1 steel specimen
   (c) 1 brass specimen

(2) Leave the hardened steel plate in position on the compression cage but remove the raising block used in Procedure B.

(3) Obtain the double-shear type test fixture and place a specimen through the corresponding sized hole in the shear fixture.

(4) Place the fixture in the compression cage properly centered. (See Figure C)

Figure C



(5) Load the specimen to failure and observe the maximum load. Record this data in the chart below.

(6) After failure continue to close the compression platens until the upper blade passes into the relieved area in the lower part of the fixture. Remove the fixture from the machine and remove the upper blade by sliding it to the side. Eject the sheared plug.

(7) Make several tests on the remaining length of rod to allow averaging.

(8) Determine shear strength by dividing

$$\frac{\text{Maximum Load}}{\text{Original Area}} - 2 \text{ (because of double fixture)}$$

	Maximum Load				Spec.	Shear
	1	2	3	Avg.	Dia.	Strength
Aluminum						
Brass						
Steel						

QUESTIONS: (Procedure C)

(1) Which material had the lowest shear strength? Which had the highest strength?

(2) Give five examples of fasteners or machine parts which are under shear stress.

1.

2.

3.

4.

5.

(3) How does shear stress compare with tensile and compressive strengths derived in the previous tests?

(4) What is the significance of the shear test?

GENERAL QUESTIONS:

(1) How would you as a teacher utilize all or some part of this experimental unit in a teaching situation?

VISUAL OBSERVATIONS OF VARIOUS STEELS

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TITLE: VISUAL OBSERVATIONS OF VARIOUS STEELS

OBJECTIVES:

(1) To develop a method of teaching in the area of heat treating.

(2) To learn the effects of heat upon various metals.

(3) To make visual observations of the structure of carbon before and after heat treating.

INTRODUCTION:

The natural properties of metals can be greatly modified by simply heating and cooling under proper conditions. The success of many jobs is determined almost entirely by how well this part of the work is done.

REFERENCES:

(1) Donald S. Clark, and Wilbur R. Varney. Physical Metallurgy for Engineers, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1962, pp. 132-133, 284-285.

(2) T. B. Jefferson. The Welding Encyclopedia, Chicago, Illinois, 1947, pp. 324-325.

(3) Oswald A. Ludwig. Metal Work Technology and Practice, McKnight and McKnight Publishing Company, 1962, pp. 349-352.

(4) Erik Oberg and F. D. Jones. Machinery's Handbook, The Industrial Press, New York 13, New York, 1959, pp. 1749-1794.

(5) S. E. Rusinoff. Manufacturing Processes Materials and Production, American Technical Society, Chicago, Illinois, 1962, Chapter eleven.

DEFINITIONS:

Annealing
A process involving heating and cooling applied usually to induce softening. The term is also used to cover treatments intended to remove stresses; alter mechanical or physical properties; produce a definite microstructure; remove gases.

Austenite
The non-magnetic form of iron and has the power to dissolve carbon and alloying elements.

Carbon steel

Carbon steels may be produced with chemical compositions (carbon, manganese, phosphorus, sulfur, and silicon) within the specified limits of a given grade and still have characteristics that are dissimilar. Each grade and quality variation thereof has a proper and useful place, depending upon the end products to be made and the methods of fabrication. In all phases of steel production, various practices are employed which determine the quality and types of the finished material.

Cementite

Or iron carbide is a compound of iron and carbon.

Critical point

The critical point is the temperature at which a piece of carbon steel may be correctly hardened. When steel is heated to the critical temperature, the grain becomes very fine (the crystals become very fine). If suddenly cooled, this fine grain is trapped in the steel and is very hard. It may be tested with a magnet.

Ferrite

Practically pure iron. It is magnetic and has very slight solid solubility for carbon.

Hardening

When steel is heated to a red heat and suddenly cooled in water or oil - it becomes very hard and brittle.

High carbon steel

High carbon steel, known as tool steel, contains .60 to 1.50% carbon. The more carbon the steel contains and the more quickly it is cooled, the harder it becomes. Used for drills, files, chisels, and hammers.

Low carbon steel

Low carbon is also known as mild steel. It contains about .04 to .75 carbon. It is used for forge work, rivets, chains, and machine parts which do not need great strength.

Molecule

One or more atoms constituting the smallest part of an element or compound that can exist separately without losing its chemical properties.

Properties

Any of the qualities or characteristics that together make up the nature or basic structure of a thing.

Quenching

To cool - as heated iron or steel, by thrusting into water or other liquid.

Tempering

A process of reheating hardened steel to a temperature below the transformation temperature range, followed by any desired rate of cooling.

<u>Wrought iron</u>

Wrought iron is purified pig iron. It contains almost no carbon (only about 0.04%). Wrought iron is purist form of iron and often is just called iron.

EQUIPMENT AND MATERIALS NEEDED:

(1) Cut samples of: hot round steel, cold rolled round steel, steel drill rod, and octagon tool steel.

(2) Steel rule

(3) File - mill single cut

(4) Gas air furnace

(5) Bolt tongs

(6) Tub of water

(7) Abrasive cloth 600 wet or dry

(8) Metallurgical microscope

(9) Face shield

(10) Buffing machine, or powdered aluminum oxide and leather buffing board.

(11) Vise

PROCEDURE A

(1) Polish all samples.

(2) Observe under metallurgical microscope and note grain structure.

(3) Anneal all samples and follow step (2).

(4) Continue the hardening and tempering process in the same manner with a follow-up observation of each step.

(5) Polish and etch half of each sample with a solution of 2% nitric acid. Make a drawing of each half in the space

provided at the bottom of the page.

NOTE: VISUAL MICROSCOPIC DIFFERENCES

	Stock samples	Stock obtained	Annealed	Hardened	Tempered
	MILD STEEL	FERRITE PEARLITE	FERRITE PEARLITE	AUSTENITE	AUSTENITE
LOW CARBON	COLD ROLLED	"	"	"	"
	DRILL ROD	PEARLITE CEMENTITE	PEARLITE CEMENTITE	AUSTENITE CEMENTITE	AUSTENITE CEMENTITE
HIGH CARBON	TOOL STEEL	"	"	"	"

Note: Variations observed from Procedure A (1) through (4).

QUESTIONS: (Procedure A)

(1) Which of the material made major changes that are noted in your observations?
Ans. All of the materials will undergo internal atomic changes which affect the properties of the materials.

(2) Which of the material made minor or no changes in your observations?
Ans. Some changes will be noted in all of the materials at the hardened stage.

(3) What can you attribute these changes to?
Ans. In heating the elements of ferrite and pearlite begin to dissolve into each other to form austenite.

(4) Will the carbon content affect these changes? If so, in what way?
Ans. The change will be unnoticed. The carbon is added to give the steel other desired characteristics.

(5) The temperature at which a piece of carbon steel may be hardened is known as the critical point. What happens if the material at this point is cooled suddenly?
Ans. If suddenly cooled, the fine grain is trapped in the steel and the steel is very hard.

(6) What will happen if the critical point or temperature is exceeded greatly?
Ans. Cracks are caused by overheating.

GENERAL QUESTIONS:

(1) Give applications for use of the four types of materials considered.
Ans. (1) Mild Steel: welding, furniture, structures
(2) Cold Roll: shafts, bolts, rods
(3) Dill Rod: tools
(4) Tool Steel: tools, springs, gears

(2) What practical value is a metallurgical microscope in industry?
Ans. The practical value of a metallurgical microscope is to extend man's vision in the study of metals for research and production control.

(3) Can the color of a piece of steel give any indication of temperature?
Ans. Very definite indications. ex: Black range or no visual sight of color will range to 1000°F. Shades of red will indicate heat from 1400°F. to +1700°F.

ROCKWELL HARDNESS TESTING

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TITLE: ROCKWELL HARDNESS TESTING

OBJECTIVES:

(1) To understand the operation of the Rockwell hardness testing machine.

(2) To determine the hardness of various materials.

(3) To use the results of the Rockwell hardness test to draw conclusions on the relative hardness of various materials.

INTRODUCTION:

Hardness of materials means many things. To the mineralologist, hardness means the resistance to scratching. The shop man may consider hardness on the basis of resistance to filing. In engineering, hardness is usually defined as resistance to penetration. Resistance to wear is also an indication of hardness. Studies show that hardness is not a simple physical property, and that the various manifestations of hardness are the results of a complex combination of properties. The purpose of hardness testing is to draw results from conclusions based on the relative hardness of various specimens.

REFERENCES:

(1) Umowski, Joseph S. Ferrous Metallurgy. Chicago: American Technical Society, 1960, pp. 1-4.

(2) Clark, Donald,S. Engineering Materials and Processes. 3rd Ed. Pennsylvania: International Textbook Co., 1959, pp. 45-52.

(3) Keyser, Carl A. Basic Engineering Metallurgy. New York: Prentice-Hall, Inc., 1952, pp. 29, 87.

DEFINITIONS:

The Hardness Value
The value depends upon the depth of impression that is made on the surface of the specimen and the force of penetration under certain combinations of penetrator and load.

Rockwell "B" Hardness Scale
The red scale of the dial, used in combination with the 1/16 inch and ¼ inch ball penetrator, for testing unhardened steel, steel of soft temper, cast irons, non-ferrous metals and soft non-metallic materials.

Brale
A diamond cone penetrator.

Minor Load
A load which is first applied, which seats the penetrator firmly on the surface of the specimen.

Major Load

The load which is allowed to act on the penetrator until the pointer of the depth gage comes to rest at which time it is removed.

Rockwell Reading

The reading is a function of the depth of plastic deformation produced by the major load.

EQUIPMENT AND MATERIALS NEEDED:

(1) Rockwell hardness testing machine

(2) Various specimens of unhardened steel, cast iron, brass, copper, plastics, etc.

(3) Graph paper

(4) Rockwell hardness test data sheet

(5) Rockwell "C" test block

(6) Flat and cylindron Rockwell hardness tester anvils

(7) 1/16 inch ball penetrator

(8) $\frac{1}{4}$ inch ball penetrator

(9) French curve

PROCEDURE A Rockwell Hardness Testing

(1) Select test specimens (select specimens from materials found in the laboratory. For good results specimens should consist of various unhardened steels, cast iron, copper, brass and plastics.)

(2) Remove burrs from test specimens on belt sander.

(3) Take three hardness readings on one side of each specimen according to the following directions:

(a) Check crank handle and return to upward position before starting test.

(b) Select penetrator and anvil to suit specimen.

(c) Select scale and major load.

(d) Place specimen securely on anvil.

(e) Elevate specimen until it comes in contact with the penetrator, and continue elevating until the small pointer on the dial is nearly vertical and large pointer is vertical.

(f) Turn zero adjuster until the SET arrow on the dial is exactly in line with the large pointer.

(g) Press down depressor bar to apply major load.

(h) Watch pointer until it stops.

(i) Pull crank handle upward slowly lifting major load, but leaving minor load still applied.

(j) Read Rockwell hardness on proper scale of dial.

(4) Record the three hardness readings of each specimen on your data sheet.

(5) Compute the average of the three hardness readings and place the figure in the average column.

(6) Construct a graph to show the comparison of hardness of the various selected material specimens.

SAMPLE DATA SHEET:

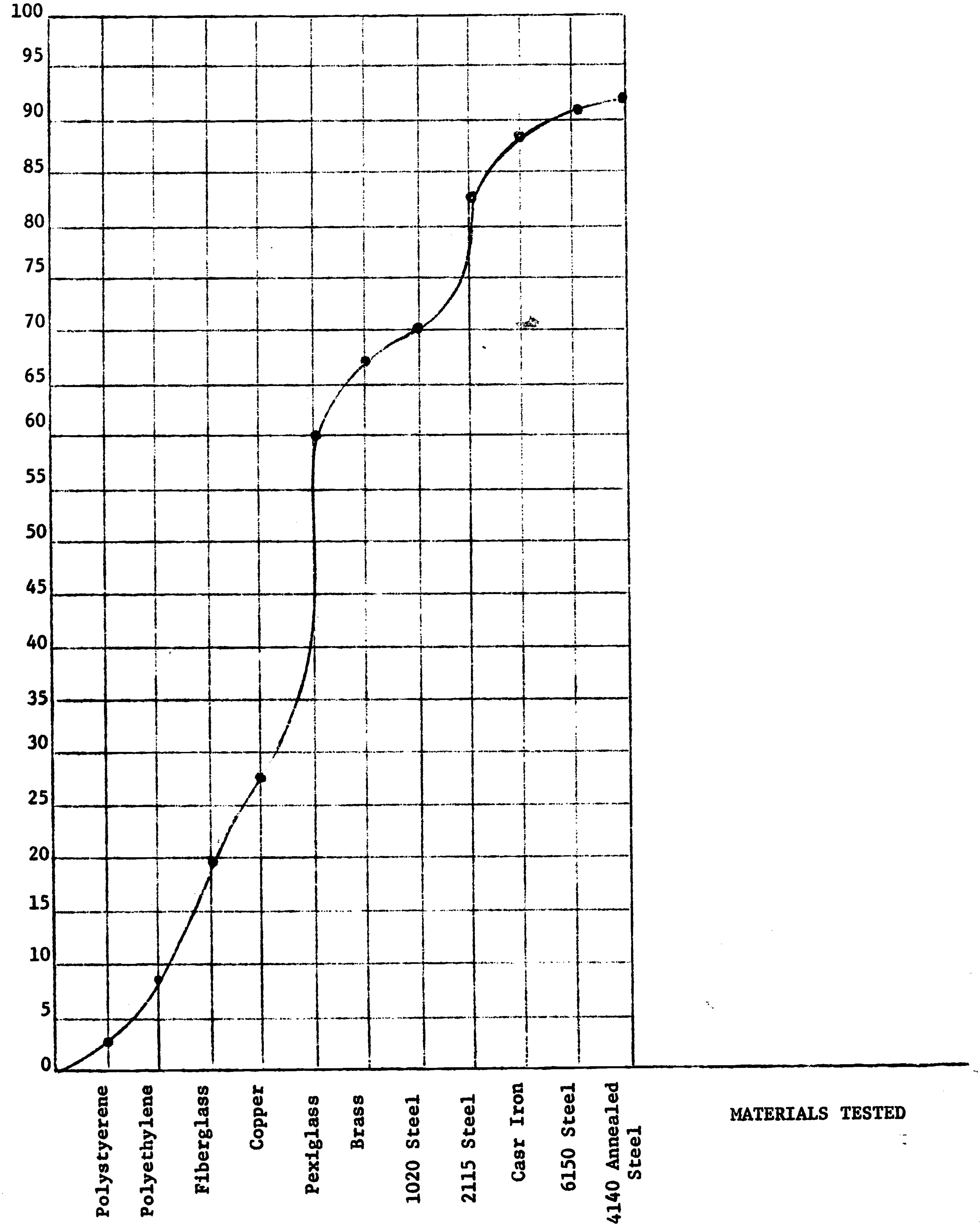
Rockwell Hardness Test Data Sheet

No.	Type of Material	Condition	Rockwell Hardness				
			Scale	Readings 1	2	3	Average
1	4140 Annealed Steel	Smooth Surface	Rockwell "B"	92	93	92	92
2	1020 Steel	" "	"	72	72	70	71
3	2115 Steel	" "	"	82	82	86	83
4	6150 Steel	" "	"	90	92	92	91
5	Cast Iron	" "	"	86	91	87	88
6	Brass	" "	"	68	69	67	68
7	Copper	" "	"	29	29	26	28
8	Polystyerene	" "	"	03	04	01	03
9	Polyethylene	" "	"	11	10	06	09
10	Plexiglass	" "	"	64	61	60	62
11	Fiberglass	Rough Surface	"	29	23	25	26

Calculation of Readings:

Rockwell hardness readings will in most instances vary from 1 - 5 units on the same specimen. Readings that vary more than five units between the highest and lowest values are inaccurate, and should not be recorded. The average hardness reading is a mathematical average of three or more readings within the variation of 5 units.

SAMPLE GRAPH SHEET



PROCEDURE B:

(1) From your results draw conclusions on the relative hardness of various specimens.

(2) Select specimens of the same basic metal and explain why they differ in hardness.

(3) List five instances when you would utilize the Rockwell hardness tester to find the relative hardness of a piece of material.

QUESTIONS: (Procedure C)

(1) What is the significance of the Rockwell hardness test?

(2) List five instances when the Rockwell tester could be utilized in the laboratory.
1.
2.
3.
4.
5.

(3) How does the Rockwell hardness tester differ from the Brinell hardness tester?

(4) List three reasons why you would want to know the hardness of a piece of steel.
1.
2.
3.

F E R R O U S M E T A L L U R G Y

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TITLE: FERROUS METALLURGY

OBJECTIVES:

(1) To become familiar with the technique of preparing ferrous metal specimens for microscopic evaluation.

(2) To become familiar with ferrous metallurgy interpretation and better understand the crystalline transformation.

(3) To appreciate the effect of heat treatment on ferrous metal.

INTRODUCTION:

Ferrous metals look alike to the naked eye. An experienced metals worker could identify some of the general process metal classifications such as: cast, hot rolled, cold rolled, annealed, hardened, etc. However, it is difficult to understand the crystalline transformation without the aid of special equipment.

The metallurgical microscope is such an instrument; it can be used to study the transformation of metal crystal as the metal is exposed to various degrees of heating and cooling.

It is intended to show that the element carbon in ferrous metal greatly affects the crystal structure and transformation.

REFERENCES:

(1) Giachino, J. W., Weeks, William, and Brune, Elmer. Welding Skills and Practices. Chicago, Illinois: American Technical Society, 1965. pp. 9-25.

(2) Begeman, Myron L., Manufacturing Processes. New York, New York: John Wiley & Sons, Inc., 1958. pp. 65-68 and 123-143.

(3) Clark, Donald S., Engineering Materials and Processes. Scranton, Pennsylvania: International Textbook Company, 1959. Chapter 1 and 5.

(4) American Society for Testing Materials. ASTM Standards 1961 Part 3. Philadelphia, Pennsylvania. pp. 808-848.

DEFINITIONS:

Cementite

The compound of iron and carbon or iron carbide at normal room temperature.

Pearlite

All carbon combined with iron to form iron carbide in steel with .83 per cent carbon.

Austenite

Iron carbide separated into carbon and iron, with the solid carbon distributing itself evenly in the gamma iron.

Martensite

Super-saturated solid solution of carbon in alpha iron.

Face Centered Cube

Fourteen atom cube with atom in center of each surface face and is very ductile.

Body Centered Cube

Nine atom cube with atom on each corner and one in the center and has high strength.

EQUIPMENT AND MATERIALS NEEDED:

(1) Six pieces of specimen:
6130
4140
2115
1020
High speed steel
Cast iron

(2) Belt sander

(3) Metallurgical abrasive block

(4) Rotating cloth lap polisher machine

(5) Alcohol

(6) Nital (acid)

(7) Microscope (metallurgical)

(8) Dryer

PROCEDURE A Specimen Preparation

(1) Obtain the specimens:
1/4"-3/8" long
diameter 1/2"-1"

(2) Grind one end of each specimen on the belt sander.

(3) Hand grind each specimen on abrasive paper. Grit range 240, 320, 480, 600. Specimen should be rotated 90° with respect to the previous direction of grinding.

(4) Final polishing to be performed on the rotating cloth lap polishing machine.

(5) Wash each specimen with distilled water.

(6) Rinse each specimen with alcohol and dry with hot air dryer.

(7) Etch each specimen with "Nital" 5 seconds. (5% Nitric acid and Ethyl Alcohol).

(8) Rinse each specimen and dry.

PROCEDURE B Interpretation of Specimen

(1) Mount an etched specimen under the microscope and focus lense.

(2) Compare the etched specimen with a specimen photograph or drawing in the reference books.

(3) Heat treat specimen and compare with specimens in question #2.

QUESTIONS: (Procedures A & B)

(1) Why are metal specimens polished for microscopic examination?
Ans. Produce level surface perpendicular to microscope lense.

(2) Are metal crystals visible to the eye?
Ans. No.

(3) How is a metallurgical microscope different from biological microscope?
Ans. It is a reflection process with addition of light.

(4) Why are space-lattice formations important in steels?
Ans. Determines characteristics of steel.

(5) Ductile metals have what kind of lattice structure?
Ans. Face center lattice.

(6) Describe alpha iron.
Ans. Carbon steel, at room temperature in a body centered lattice.

(7) Describe gamma iron.
Ans. Steel heated to above 1333^{o} F. pearlite grains change from body-centered lattice to face-centered structure.

(8) Try to identify the various crystal structures of steel as compared with photograph in reference books.
Ans. Heat treat specimens and study the crystalline change.

FORMED RIVET HEAD TESTING

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TITLE: FORMED RIVET HEAD TESTING

OBJECTIVES:

(1) To become acquainted with the various types of stresses imposed on rivets.

(2) To become acquainted with the procedure of forming rivet heads.

(3) To test and compare the results of various stresses imposed on formed rivet heads.

INTRODUCTION:

Various formed rivet heads have been developed to serve basic functions. Some of these functions are: strength, decoration, and aero-dynamically smooth.

In this experimental test, two basic stress types (tensile and shear) will be applied to the flat and countersunk formed rivet head, including the newer "pop rivet" variety.

The test will be performed with 1/8 inch diameter rivets of different composition. They are 2S aluminum, copper, iron, and monel.

REFERENCES:

(1) American Society for testing materials. ASTM Standards, 1961 Part 1 & 2. Philadelphia, Pennsylvania, pp. 1436-1439, and 874-80.

(2) Feirer, John L. General Metals. New York, New York: McGraw-Hill Book Company 1961, pp. 117-118.

(3) Lindbeck, John R., Feirer, John L. I. A. Metalwork. Peoria, Illinois: Chas. A. Bennett Co., Inc.; 1965; pp. 116-19.

(4) Earl, Arthur W. Materials and Products of Industry. Bloomington, Illinois: McKnight and McKnight Publishing Co., 1960; pp. 122-26.

DEFINITIONS:

Tensile Strength
That property of a material which gives it maximum resistance to being separated by two forces acting with a pulling force in opposite directions.

Shear Strength
Stress caused by forces which act parallel to a given area and in opposite directions tending to produce a sliding of one portion past another.

Pop Rivet
Mechanical rivet which has its shank formed rivet head formed from outside by using a special tool provided for pop riveting.

Formed Rivet Head
Rivet head formed with a hammer using steady even blows.

Machine Rivet Head
Rivet head pre-formed on rivet shank.

EQUIPMENT AND MATERIALS NEEDED:

(1) Universal testing machine

(2) Ball pein hammer

(3) Rivet block

(4) File

(5) Rivet cutter (diagonal pliers)

(6) Drill Press

(7) Pocket Rule

(8) Safety glasses

(9) Tensile test specimen holder (See Figure A)

(10) Shear test specimen holder

(11) 250 Rivets (1/8") - 50 each of aluminum, copper, steel,aluminum pop rivets and monel pop rivets.

(12) 1/8" pin punch

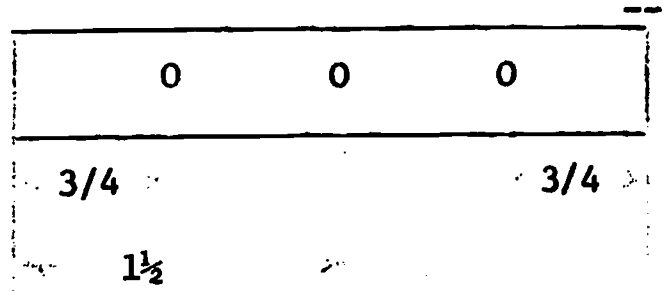
(13) 12 test specimens
1/4 - 3/4-3 " crs

(14) 12 test specimens
12 ga. 3/4" - 3" crs

PROCEDURE A Specimen Preparation

(1) Obtain from stock twelve pieces 1/4" - 3/4" - 3"

(2) Drill three 1/8 inch holes in each piece as shown here.



(3) Construct a specimen holder; two identical pieces required; for applying tensile stress to a rivet head

Figure A

Use ½" Sq. CRS

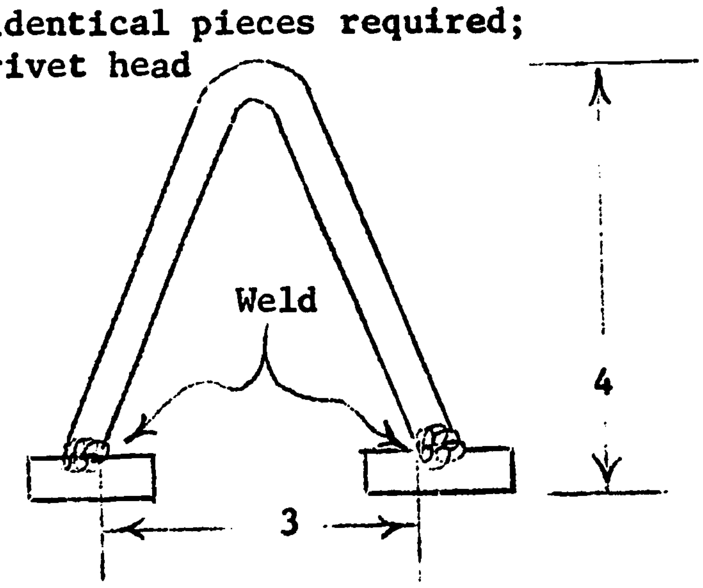
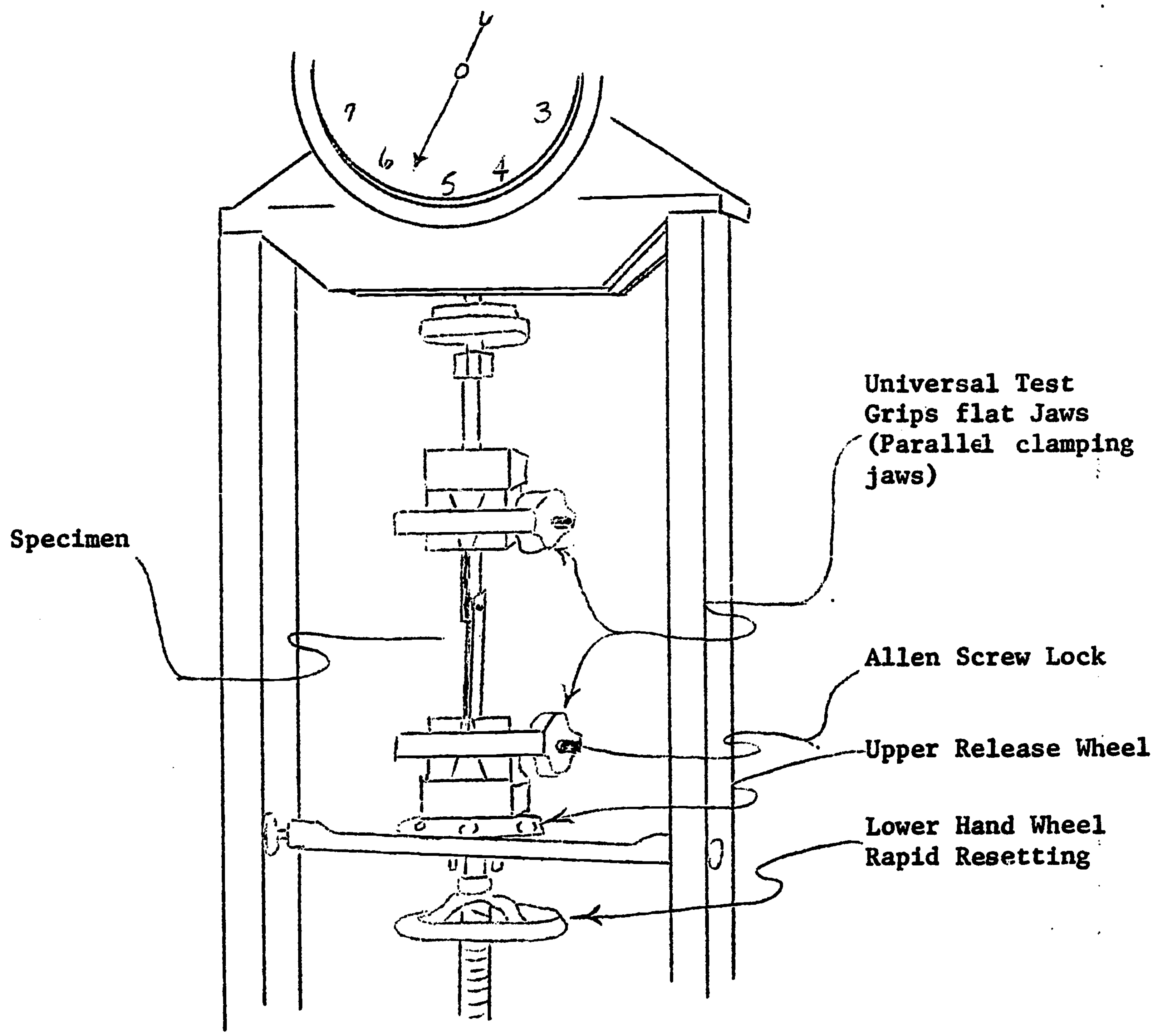


Figure B



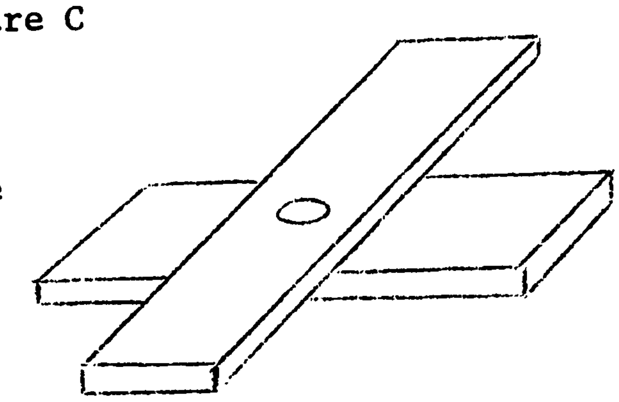
Dillon Universal Tested

(4) Set up the universal testing machine with the parallel clamping jaws and clamp the above specimen holders in the jaws. (See figure B)

(5) Rivet three sets of test specimen (1/4 x 3/4 - 3") as shown in figure C.

Figure C

formed rivet head made with material ½ dia.



(6) Mount in universal test and apply tensile stress. Record in table. Use 0-2000 lb. or smaller synammeter.

(7) Drill out rivets. 1/8" drill.

(8) Repeat steps 5, 6, 7 formed rivet head 1 dia.

(9) Repeat steps 5, 6, 7 formed rivet head 1½ dia.

(10) Repeat steps 5, 6, 7, 8, 9 using the two other rivet compositions.

(11) Repeat step 5 using aluminum and monel pop rivets sllowing about 1 dia. for formed rivet head.

(12) Countersink one side of three specimens and perform test using the three solid rivet compositions. Allow 3/4 dia. to form the countersunk head.

(13) Determine the area of each rivet specimen by utilizing the formula

$$A = R^2$$
$$A = (3.1415)\ R^2$$
$$A = 3.1415\ (1.16)^2$$
$$A = (3.1415)(1/256)$$
$$A = .01223$$

Rivet diameters 1/8 inch.

(14) Determine the ultimate strength of each specimen by dividing:

$$\frac{\text{Maximum Load (lbs)}}{\text{Rivet specimen area Sq. in.}} = \_\_\ \text{psi}$$

Rivet Head Tensile Test

2 S Aluminum Rivet

Rivet Head Metal Allowance	Head Type	1st	2nd	3rd	avg.	PSI	Shank Elongated	Formed Head Sheared	Machine Rivet Head Sheared
1/2 Dia	Flat	210	195	200	202	16,516		X(3)	
1 Dia	Flat	290	260	265	272	22,240	X(2)	X(1)	
1 1/2 Dia.	Flat	300	305	307	304	24,857	X(3)		
2 Dia.	Flat	310	305	305	307	25,102	X(3)		
3/4 Dia.	CSK	290	280	280	283	23,139		X(3)	

Copper

1/2 Dia.	Flat	340	390	300	343	28,046		X(3)	
1 Dia.	Flat	430	460	470	453	37,040	X(3)		
3/4 Dia.	CSK	470	470	490	477	39,002	X(3)		

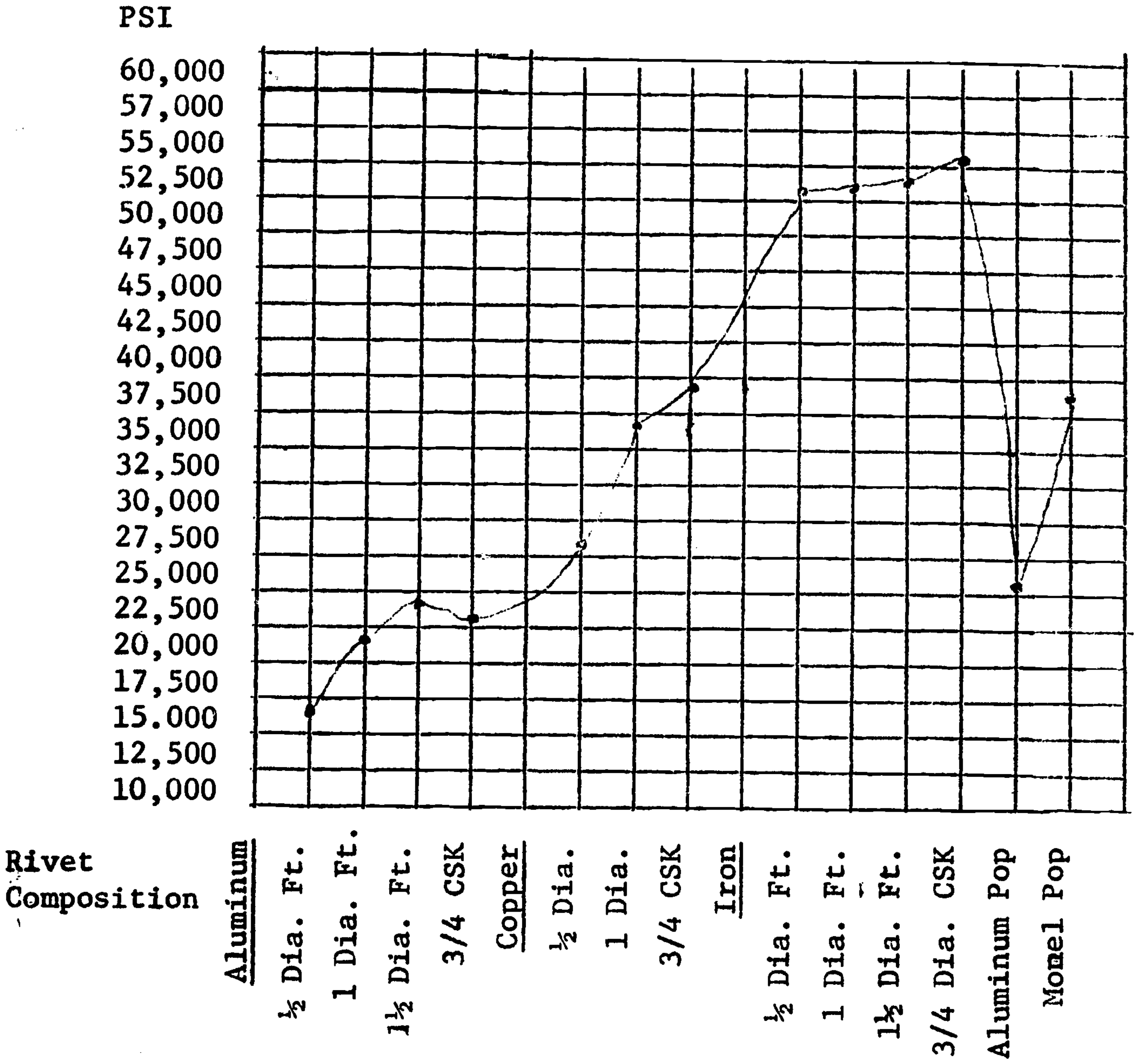
Iron

1/2 Dia.	Flat	650	650	650	650	53,148		X(3)	
1 Dia.	Flat	670	660	660	663	54,211	X(3)		
1 1/2 Dia	Flat	670	665	665	667	54,584	X(3)		
3/4 Dia.	CSK	710	660	690	680	55,601	X(3)		

Aluminum Pop Rivet

1 Dia.	Flat	310	310	330	317	25,919		X(1)	X(2)
Monel Pop Rivet									
1 Dia.	Flat	460	500	430	463	37,857			X(3)

Rivet Head Tensile Test



QUESTIONS: (Procedure A)

(1) What are two stresses emposed on rivets?
Ans. Shear, tensile

(2) Did the tensile stress rupture any of the flat head rivets? If so, which ones?
Ans. Yes.

Aluminum	1/2 Dia. Ft.
	1 Dia. Ft.
	3/4 Dia. CSK
Copper	1/2 Dia. Ft.
Iron	1/2 Dia. Ft.
Aluminum pop rivet	

(3) Did the tensile stress elongate rupture any of the rivet shanks? If so, which ones?
Ans. Yes. All other test on solid rivets.

(4) Did the countersunk formed rivet head of any of the solid rivets hold more than the shank elongation rupture? Is so, which ones?
Ans. Yes. Copper and iron.

(5) How does the countersunk rivet heads compare with each of the three flat heads?
Ans. Aluminum comparable to 1" dia. Copper and iron strongest.

(6) How do pop rivet machine formed rivet heads compare with the pop rivet formed rivet heads?
Ans. The machine formed heads are weaker than the formed heads.

(7) What solid rivet head metal allowance did all rivet shank elongate rupture?
Ans. 1 dia. allowance.

(8) The monel pop rivet has the approximate same tensile stress resistance as what solid rivet?
Ans. Material copper Metal Allowance 1 dia. allowance

(9) Why do you think all the 3/4 dia. countersunk rivet heads have more tensile stress resistance than the 1" dia. flat head rivets?
Ans. Additional hammer blows to form head increase work harden effects.

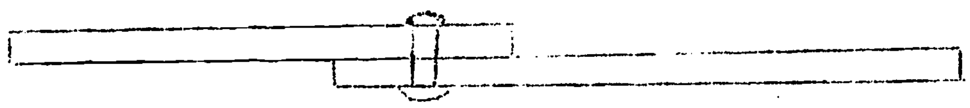
(10) Do the pop rivet have adequate resistance to tensile stress?
Ans. Yes.

(11) What are two considerations in using pop rivets over the solid rivets.
Ans. Time to perform riveting operation per rivet; cost per rivet.

PROCEDURE B Shear Stress and Head Effect

(1) Use the 12 gauge specimen.

(2) Rivet the test specimens as shown for shear test.



(3) Form the formed rivet heads as described in Procedure A. Steps 5, 8, 9, 11.

(4) Repeat for all three rivet compositions and both pop rivet compositions.

QUESTIONS: (Procedure B)

(1) Did any of the formed rivet heads rupture on the shear stress?
Ans. No. Not visible to eye.

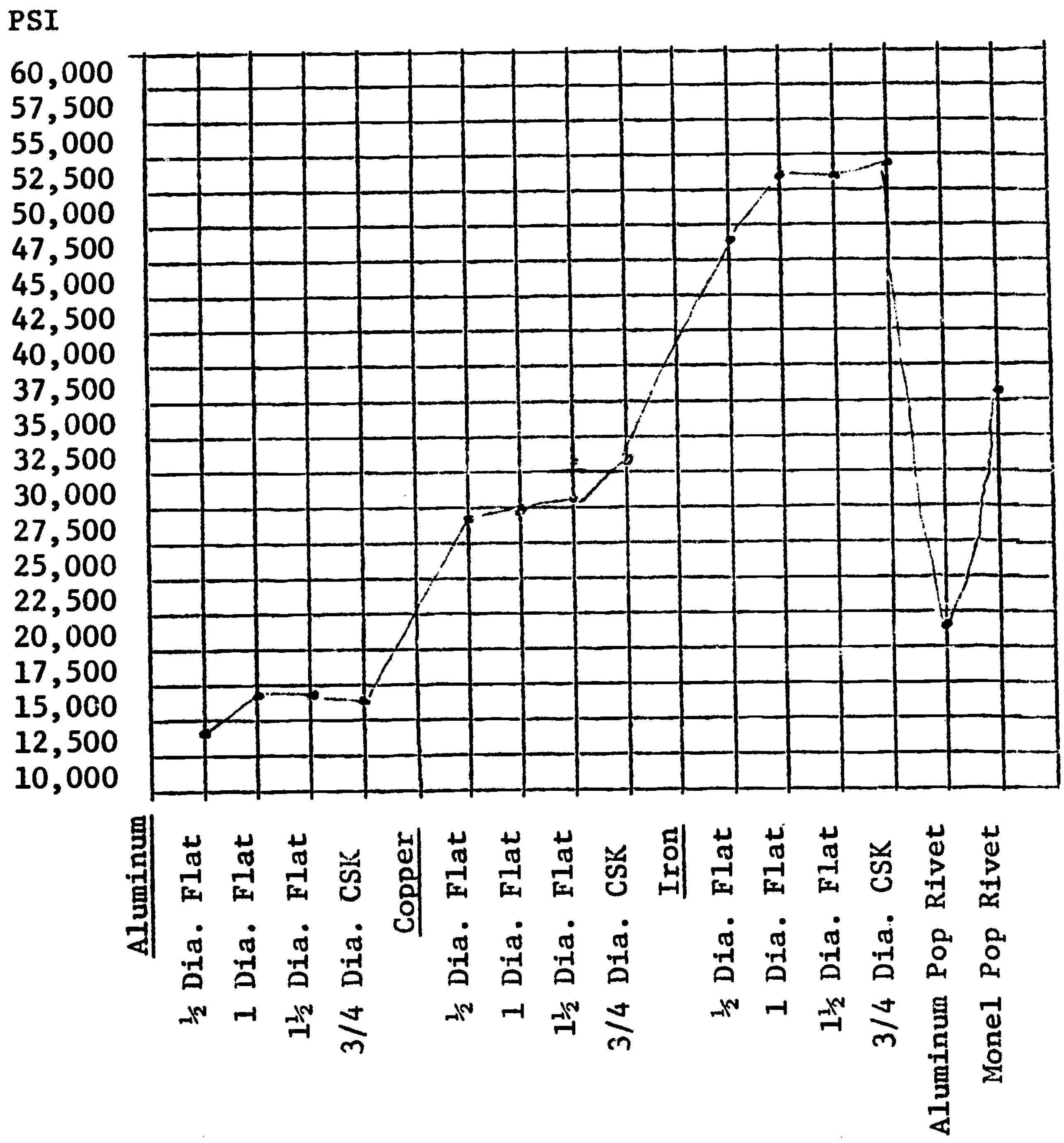
(2) How does the countersunk head compare with the flat heads?
Ans. Very little differency in total capacity.

(3) Which of the formed rivet heads do not add any appreciatable resistance to shearing?
Ans. Metal allowance 1 1/2 dia.

(4) Does the aluminum pop rivet have a higher or lower resistance to shear stress than the 2S aluminum solid rivet?
Ans. Higher resistance 19051 psi to approximate 14,500 psi.

(5) What stress causes most rivet head failures in riveted sections? Tensile or shear.
Ans. Tensile.

Shank Shear Stress and Head Effect



Shank Shear Stress and Head Effect

Rivet Head Metal Allowance	Head Type	1st	2nd	3rd	Avg.	Psi	Shank Sheared	Formed Head Sheared	Machine Rivet Head Sheared
2S Aluminum									
½ Dia.	Flat	170	175	165	170	13,900	X(3)		
1 Dia.	Flat	195	175	175	181	14,800	X(3)		
1½ Dia.	Flat	175	185	184	182	14,881	X(3)		
3/4 Dia	CSK	195	198	192	175	14,309	X(3)		
Copper									
½ Dia.	Flat	330	360	390	360	29,436	X(3)		
1 Dia.	Flat	370	370	365	368	30,090	X(3)		
1½ Dia	Flat	375	360	405	380	31,070	X(3)		
3/4 Dia.	CSK	493	402	411	402	32,870	X(3)		
Iron									
½ Dia	Flat	590	585	600	592	48,405	X(3)		
1 Dia.	Flat	625	640	690	650	53,148	X(3)		
1½ Dia.	Flat	690	620	630	648	52,984	X(3)		
3/4 Dia	CSK	670	675	665	670	54,783	X(3)		
Aluminum Pop Rivet									
1 Dia.	Flat	240	220	240	233	19,051	X(3)		
Monel Pop Rivet									
1 Dia.	Flat	440	500	440	460	37,612	X(3)		

WELDED JOINT TESTING --- A COMPARATIVE STUDY USING A GENERAL PURPOSE STEEL FILLER ROD AND A BRONZE FILLER ROD

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TITLE: WELDED JOINT TESTING --- A COMPARITIVE STUDY USING A GENERAL PURPOSE STEEL FILLER ROD AND A BRONZE FILLER ROD

OBJECTIVES:

(1) To become familiar with the various methods to test the strength of welds.

(2) To use the tensile test to evaluate a steel welded joint as compared to bronzed welded joint.

(3) To evaluate student ability to weld a successful joint.

INTRODUCTION:

The quality of a welded joint cannot be determined by a simple visual examination. In critical applications, non-destructive tests of actual welds may be required. For this purpose, X-ray examinations or ultrasonic tests are often used as well as a number of other methods.

This study will be limited to the point of failure and actual strength of welded and bronzed joints.

REFERENCES:

(1) American Society for Testing Materials. ASTM Standards 1961 Part 3. Philadelphia, Pennsylvania, pp. 5-8.

(2) Giachino, J. W. , Oxy-Acetylene For Beginners. Peoria, Illinois. The Manual Art Press, 1942, pp. 21-22.

(3) Harcourt, R. H. . Oxy-Acetylene Welding and Cutting. Standford University Press, California, 1937, pp. 71-80.

(4) Other references available.

DEFINITIONS:

Oxy-Acetylene Welding

A fusion process whereby the bond between metals is created by reducing the surfaces to be joined to a liquid state and then allowing the liquid to solidify.

Bronze Welding (Brazing)

A process of flowing molten bronze over the heated surfaces of the metal to be joined, furnishing a solid bond between the two seams.

Tensile Test

A destructive test utilized to show the mode of failure and the actual tensile strength (psi) of the welded joint.

MATERIALS AND EQUIPMENT NEEDED:

(1) Pre-cut pieces of mild steel,
Four (4) pieces each measuring 1/8" x 1" x 6".
Forty-eight (48) pieces each measuring 1/8" x 1" x 3".

(2) Gas welding setup with Oxygen and Acetylene gases.

(3) Filler rods, general purpose steel and bronze.

(4) Shop apron.

(5) Goggles, (clear and tinted).

(6) Universal Tensile testing machine.

(7) Universal tensile grips.

PROCEDURE A — Specimen Preparation

(1) Test the four (4) pieces (1/8" x 1" x 6") to determine the failure points, record and find the average failure point of the four.

(2) Prepare eight (8) pieces (1/8" x 1" x 3") by cutting the ends square.

(a) Weld four specimens utilizing the square butt weld, using the steel filler rod.
(b) Weld four specimens utilizing the single V butt weld, using the bronze filler rod.
(c) Weld four specimens utilizing the double V butt weld, using the bronze filler rod.

CAUTION: DO NOT submerge any of the hot welds in water to cool. This will cause the weld to crystalize.

PROCEDURE B

Tensile Test

(1) Select the appropriate test specimens as follows:

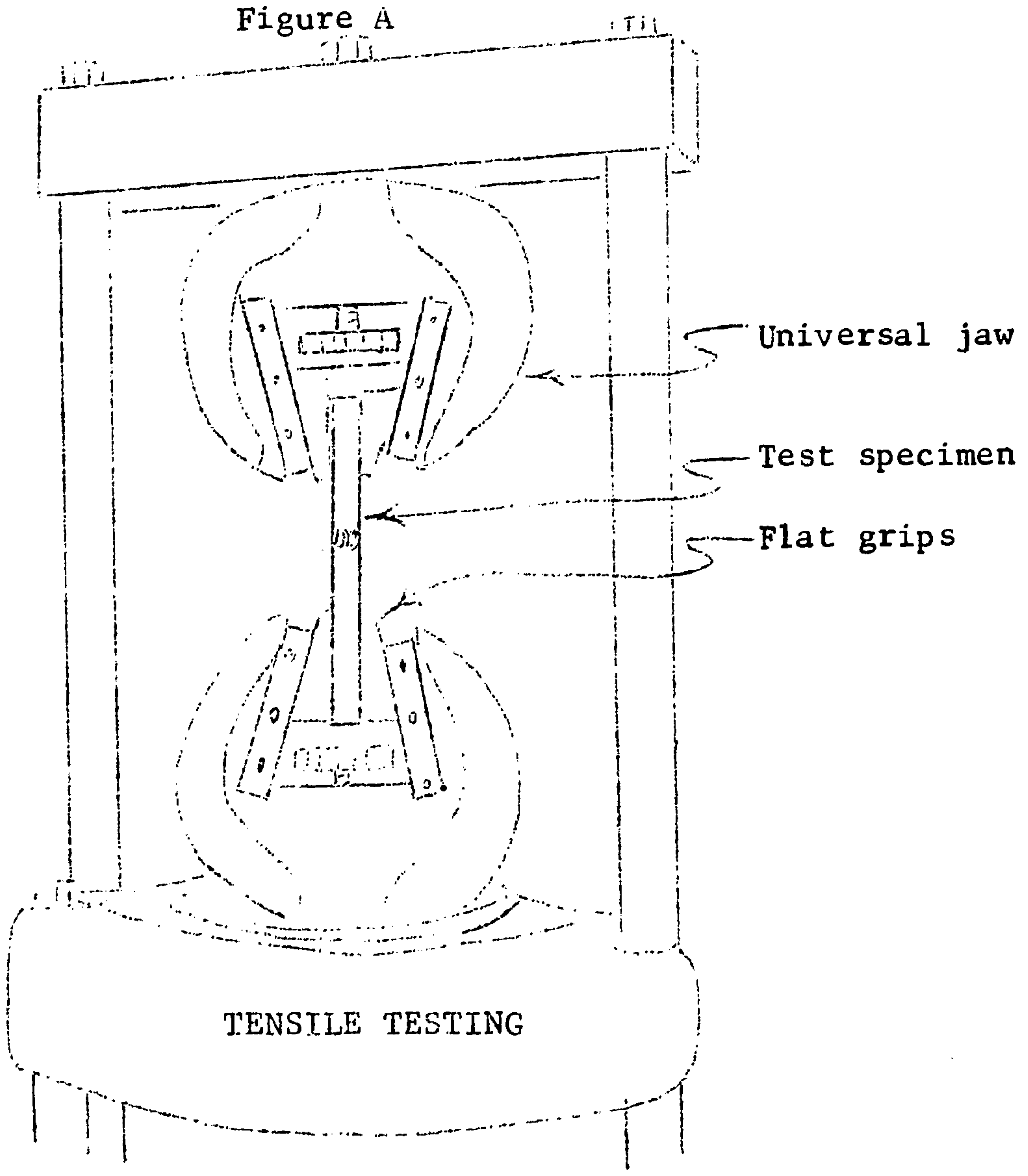
(a) Four pieces 6" long with no weld
(b) Four weld specimens utilizing the square butt weld, steel rod filler
(c) Four weld specimens utilizing the single V butt weld, steel rod filler.
(d) Four weld specimens utilizing the double V butt weld, steel rod filler.
(e) Repeat (a), (b) and (c) utilizing bronze filler rod.

(2) Set up the universal testing machine as follows:

(a) Install the universal tensile jaws between the cross-bar and the middle platen.
(b) Use the flat face grips and filler plates for holding the specimens.

(3) Insert the test specimen and gradually load each sample to failure, while carefully observing the behavior of the specimen and the maximum load reached.

Figure A



(4) Record results of each test.

(5) Calculate the percentage of full strength of each joint based on the reference specimen as 100 per cent.

Reference specimen (no weld) Maximum load _____psi.

Note: To determine per cent of full strength divide:

$$\frac{\text{Maximum Load (welded sample)}}{\text{Maximum Load (reference specimen)}}$$

Test Results

	Tensile Strength (psi)				
	I	II	III	IV	Average
Samples (1/8" x 1" x 6")	7700	7800	7650	7800	7750
Steel Filler					
Square Butt Joint	5900	6200	5800	5750	5910
Single V Joint	2800	2200	3000	2200	2470
Double V Joint	6050	6200	6200	6150	6180
Bronze Filler					
Square Butt Joint	6700	6800	7000	6400	6370
Single V Joint	6020	000	6100	5980	6030
Double V Joint	6200	8000	5000	6450	6490

Square Butt Weld

	Steel Rod		Bronze Rod	
Maximum Load	5910	psi	6730	psi
% of Full Strength	76		86	

Single V Joint

	Steel Rod		Bronze Rod	
Maximum Load	2470	psi	6030	psi
% of Full Strength	32		77	

	Double V Joint Steel Rod	Bronze Rod
Maximum Load	6180 psi	6490 psi
% of Full Strength	78	83

QUESTIONS: (Procedure C)

(1) Which type of weld provided the highest tensile strength?
Ans. It was found that the bronze weld averaged the highest tensile strength.

(2) Which type of weld appeared to be the most difficult to perfect? Why?
Ans. The weld utilizing the steel rod was the most difficult to perfect. Because more heat was needed which caused the metal to become crystalized.

(3) Should all of the welds have provided equal strength?
Ans. No, because there were different kinds of joints used.

GENERAL QUESTIONS:

(1) Does the failure of a weld always indicate a poor welding job? What other factors are involved, if any?
Ans. No, it is possible to obtain a poor mixture of metal.

(2) What two basic types of testing methods are used to determine the quality of a metal?
Ans. The Guided Bend Test and The Tensile Strength Test.

(3) Name five (5) types of defects which may be present in a welded joint.

1. Flame adjusted improperly, too much oxygen of acetylene.
2. Flame not held properly, either too close or too far from material.
3. The wrong type of filler rod being used.
4. The flame moved too fast or too slow along work.
5. Improper spacing of pieces to be welded, either too close not obtaining maximum penetration, or too far apart obtaining a joint too weak.

PROPERTIES OF VARIOUS FILLER RODS USED IN OXY-ACETYLENE WELDING

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TITLE: PROPERTIES OF VARIOUS FILLER RODS USED IN OXY-ACETYLENE WELDING

OBJECTIVES:

(1) To develop an understanding of advantages and limitations of various filler rods.

(2) To compare different Oxy-Acetylene welds using basic tests of tensile strength, and bend.

(3) To test and compare the results of such tests on different metal combinations.

(4) To evaluate student ability to weld a successful joint.

INTRODUCTION:

The purpose of this experiment is to gain an understanding of the advantages and limitations of the various filler rods on the market today. Students studying metals should become familiar with equipment, methods and materials used in oxy-acetylene welding.

REFERENCES:

(1) Ginchino, J. W., Weeks, William, and Brune, Elmer. Welding Skills and Practices. 2nd ed., Chicago, Illinois: American Technical Society, Chapters 19, 27.

(2) Jennings, Royalston, F. Gas and A. C. Arc Welding & Cutting. Bloomining, Illinois: McKnight & McKnight, 1956. Units 10, 13, 30, 31, 32.

(3) Feirer, John, F. General Metals. 3rd ed., New York, New York: McGraw-Hill, 1967, Chapters 42, 52.

(4) Feirer, John, F. Lindbeck, John, R. I. A. Metalwork. Peoria, Illinois: Chas. A. Bennett Co., Inc. 1965 pp. 130-131.

(5) American Society for Testing Materials. ASTM Standards 1961 Part 3. Philadelphia, Pennsylvania: pp. 5 - 8.

DEFINITIONS:

Tensile Strength

That property of a material which gives it maximum resistance to being separated by two forces acting in opposite directions.

Brazing

Fastening two pieces of metal together by melting on a non-ferrous metal or alloy of lower melting point in such a way as to form a bond.

Guided Bend Test

A destructive test utilized to determine the physical condition of the weld.

Face of Weld

The exposed surface of the weld.

EQUIPMENT AND MATERIALS NEEDED:

(1) Mild steel, hot rolled, 16 pieces 1/8" x 1-1/2" x 3"
1 piece 1/8" x 1" x 6"

(2) Copper, 8 pieces 12 ga. x 1-1/2" x 3"
1 piece 12 ga. x 1" x 6"

(3) Filler Rod 1/8" in diam. Low-fuming Bronze

(4) Filler Rod 1/8" in diam. Mild Steel.

(5) Brazing flux

(6) Oxy-acetylene welding outfit

(7) Welding goggles

(8) Shop coat

(9) Universal tensile testing machine

(10) Guided Bend accessory

(11) Universal tensile grips

(12) Bench shears

(13) Belt sander

(14) Pedestal grinder

PROCEDURE A Specimen Preparation

(1) For all welds:
 (A) Obtain necessary materials from instructor.
 (B) All welds are of the square butt type.
 (C) Grind the weld flush with the surface of each test specimen and label each type of weld for later reference.
 (D) All welds should be smoothed to a final finish on the sander.

(2) Brazing
 (A) Using mild steel make 4 weld specimens.
 (B) Make 4 weld specimens from copper.

(3) Mild steel filler rod
 (A) Make 4 weld specimens using mild steel.

Note: Each of the above specimens will require two pieces of stock. The piece of stock which is already 6 inches long will be used as a reference specimen for maximum strength of the metal without a weld.

PROCEDURE B Guided Bend Testing

(1) Select appropriate test specimens:
 (A) 2 mild steel, brazed weld specimens measuring 1/8" x 1" x 6"
 (B) 2 mild steel, welded with mild steel filler rod, specimens measuring 1/8" x 1" x 6"
 (C) 2 copper, brazed, specimens 12 ga. x 1" x 6"

(2) Set up the universal testing machine as follows: Place the roller-equipped die beneath the plunger and center it. One roller is mounted on an eccentric which has a positioning handle attached. Rotate the handle until it rests on the lower platen with its roller as close as possible.

(3) Lay the test specimen on the top of the rollers, with the weld centered under the plunger.

(4) Apply a steady load and form the specimen down between the rollers and bottom it out against the semi-circular cavity below the rollers. Form the sample completely but do not exceed 20,000 psi.

(5) After forming the specimen, release the load and turn the handle on the eccentric shaft to open the roller which will free the sample.

(6) Inspect each specimen for cracks.

(7) Record the results from each specimen in the appropriate chart provided.

Guided Bend Testing Chart		
Sample		Pass or fail
	Mild steel, Brazed	
1		Pass
2		Pass
	Mild steel, Mild steel filler rod	
1		Fail
2		Fail
	Copper, Brazed	
1		Pass
2		Pass

QUESTIONS: (Procedure B)

(1) Which type of filler rod seemed to produce the strongest type of weld on the mild steel? Why?
Ans. Brazing produced the strongest weld. The reason being 100% penetration with brazing rod produces a stronger weld than 1/3 penetration using mild steel filler rod.

(2) Can you give a reason why we didn't try to weld copper using a mild steel filler rod?
Ans. The melting point of mild steel is much higher than copper. The two metals won't mix in the liquid state. Therefore copper can not be welded using a mild steel filler rod.

(3) How would you rate yourself as a welder? Based on your test results compared with your fellow students.
Ans. Poor using the mild steel filler rod and very good with the brazing rod. The main reason was the greater heat needed for welding with mild steel. The result was less than desirable penetration.

(4) Which filler rod is easier to weld with? Why?
Ans. Brazing is a much easier method of welding, because it requires less heat and time. The student should remember not to get the metal too hot or the zinc will vaporize.

PROCEDURE C

Tensile Testing

(1) Select the proper test specimens:
- (A) one piece of mild steel 1/8" x 1" x 6"
- (B) 2 pieces of mild steel 1/8" x 1" x 6", brazed
- (C) 2 pieces of mild steel 1/8" x 1" x 6", mild steel filler rod
- (D) one piece of copper 12 ga. x 1" x 6"
- (E) 2 pieces of copper 12 ga. x 1" x 6", brazed

(2) Set up the universal testing machine as follows:
- (A) Install the universal tensile jaws between the crossbar and the middle platen.
- (B) use the flat face grips and filler plates for holding the specimens.

(3) Insert the test specimen and gradually load each sample to failure, while carefully observing the behavior of the specimen and the maximum load reached.

(4) Test reference specimen first and record maximum reading in space provided.

(5) After each test, examine the specimen to determine the cause of failure.

(6) Record the results of each test in the charts provided.

(7) Calculate the percentage of full strength of each joint based on the reference specimen as 100 percent.

Note: To determine percent of full strength divide

$$\frac{\text{Maximum Load (welded sample)}}{\text{Maximum Load (reference specimen)}}$$

Tensile Testing

Reference specimen	(No weld)
Mild steel	Maximum force 7,000 lbs.
Copper	Maximum force 580 lbs.

	Mild steel, brazed			Mild steel, filler rod mild steel SPECIMENS			Copper, brazed		
	1	2	Average	1	2	Average	1	2	Average
Max. load	4600 lb.	5600 lb.	5,100 lb.	600 lb.	2400 lb.	1,500 lb.	400 lb.	425 lb.	412 lb.
% of full strength	65.5 %	80 %	72.7%	8.57%	34.2%	21.35%	68.9%	73.3%	71.1%

QUESTIONS: (Procedure C)

(1) If you are welding like metals and using the same filler rod should all your weld be of equal strength?
Ans. Theoretically your weld should be the same along its entire length although such things as gas bubbles and depth of penetration will make some parts of a weld weaker.

(2) What does a tensile test tell us?
Ans. A tensile test tells us the amount of force, in pounds, necessary to pull a weld apart.

(3) Which metal and filler rod combination had the highest percent of full strength? What conclusion can you make concerning this.
Ans. Mild steel welded with brazing rod gave the highest percent of full strength. This is because of the adhesion between porent metal and brazing compound plus a high degree of penetration.

GENERAL QUESTIONS

(1) List 5 reasons that will make a weld fail.
Ans. The following could be reasons for a weld failing.
(a) insufficient heat
(b) gas holes forming inside a weld
(c) to small or large a welding tip
(d) a highly oxidizing flame
(e) not enough or wrong type of flux

(2) When is it impractical to use the guided bend or tensile strength test for testing welding joint?
Ans. The guided bend and tensile are both destructive tests. If your welded samples are something you do not want broken, then other methods are needed.

(3) Considering your welding ability, which type of filler rod will give you the stronger joint?
Ans. From this experiment and experience I would recommend brazing.

(4) Why do you need a flux for brazing?
Ans. The purpose of a flux in the brazing operation is:
(a) reduce surface tension
(b) remove oxides from the metal
(c) prevent new oxides from forming

(5) Why does industry use mild steel filler rod instead of brazing whenever possible?
Ans. Industry uses mild steel rod in preference to brazing rod because of the high cost difference.

Section 2-H

OTHER SUGGESTED EXPERIMENTAL ACTIVITIES

SUGGESTED EXPERIMENTAL ACTIVITIES

During the institute the participants were asked to work on one or more experimental activities in the general area of materials and processes of industry. It was hoped that such an assignment would familiarize them with the over-all procedure for making experimental studies and would suggest comparable activities for future experimentation by their students. The following possible activities were suggested by the participants. It is hoped that enough interest was generated during the institute to encourage the participants or others to follow through with these and other possible experimental activities in their industrial arts classes.

Abrasives

1. Title: Cutting Ability of Abrasive Papers

Objectives:

(1) Develop experimental material and apparatus that can be utilized in a shop.
(2) To demonstrate the different effects of several abrasives.
(3) To demonstrate the different effects on several kinds of wood.
(4) To demonstrate the different effects of the several kinds of backing materials.
(5) To demonstrate the different effects of the several kinds of bonding materials used.
(6) To demonstrate the different effects of the sizes of grit materials.
(7) To obtain a better understanding of abrasive paper and its uses in the finishing area.

Rossmond E. Cooney

2. Title: The Effect of Age on Sander Belts

Objectives:

(1) To determine the shelf life of a sander belt.
(2) To compare brands to determine if shelf life varies with different brands.

Raymond S. McAllister

Drawing

1. Title: To Compare Relative Quality of Different Manufacturer's Offset Press Inks, As to Their Drying Characteristics, Color Tone, Costs, Ease of Use, and Set Off.

   Objectives:
   (1) To become familiar with the inking process on the offset press.
   (2) To learn comparison techniques by the use of the light table and other comparing instruments.

   Morris Bach

2. Title: Erasing Quality of the Ruby Eraser on Drafting Media

   Objectives:
   (1) To develop experimental material and apparatus that can be used for evaluation in the classroom.
   (2) To demonstrate the erasing ability of the eraser on various drawing media such as bellum, film and tracing cloths.

   Bryce E. Goodwin

3. Title: A Product Presentation Typical of Industry

   Objectives:
   (1) To let the student prepare a presentation typical of an industrial product from the idea through the manufacture, including sales.
   (2) To acquaint the student with techniques of another graphical media in industrial communications.

   Bryce E. Goodwin

4. Title: Models as an Aid to Research

   Objectives:
   (1) To develop models of research (such as atom structure of iron metals and its alloys) to support and communicate ideas found in research.
   (2) To teach students the value of model making in the communication of ideas.

   Bryce E. Goodwin

5. Title: Use of Erasers

Objectives:

(1) To become acquainted with the abilities of different erasers by using different numbered pencils.
(2) To compare motor-driven eraser with the conventional eraser.

Wally E. Horn

6. Title: Use of Drafting Machine

Objectives:

(1) To compare the time element of the drafting machine in relation to the conventional.
(2) To evaluate student ability to use a T-square and triangle before he is permitted to operate a drafting machine.

Wally E. Horn

7. Title: Reproductions Used in Drafting

Objectives:

(1) To become familiar with different reproduction methods used in drafting.
(2) To test and compare results of different reproductions.

Wally E. Horn

8. Title: Exploration of Reproduction Methods

Objectives:

(1) To develop an awareness of the new methods used in reproduction drawings.
(2) To identify new methods and provide instruction in their use and
(3) To evaluate their importance in drafting.

Luby LeNorman

9. Title: Exploration of Ozalid Chemical Coated Materials

Objectives:

(1) To become familiar with the material available.
(2) To test selected materials and compare their reproductive abilities.
(3) To become familiar with the developing speeds.
(4) To test their reliability.

Luby LeNorman

10. Title: Pencil Line Density Reproduced by Diazo

Objectives:

(1) To illustrate the need of dense black lines for reproduction qualities.
(2) To illustrate that line width may vary but density must remain good.

Dean Sawin

11. Title: Exploring an Introductory Unit on Numerical Control for the Advanced Drafting Student.

Objectives:

(1) To help span the gap between advanced manufacturing methods and the ineritable teaching lag.
(2) To acquaint the industrial education student with the concept of numerical control in industry.

James Spinks

12. Title: An Exploration of Programmed Instruction in Drafting Fundamentals

Objectives:

(1) To demonstrate the advantages of programmed instruction as a valid teaching device in drafting instruction.
(2) To determine something about the limitations of programmed learning as applied to the teaching of drafting fundamentals.

James Spinks

Electricity

1. Title: Fuse Load Capacity

Objectives:

(1) Develop experimental material and apparatus that can be utilized in a shop.
(2) To demonstrate the different effect of amperes on a fuse.
(3) To demonstrate the different effect of series and parallel circuit and a fuse.
(4) To obtain a better understanding of the functions of a fuse in an electricial circuit.

Rossmond E. Cooney

2. Title: Transistor Equivalent Circuits

Objectives:

(1) To become familiar with the method of determining y-parameters for a point-contact transistor.
(2) To become familiar with the method of determining hybrid (h-) parameters for a junction-type transistor.
(3) To evaluate the three circuit configurations by the use of their parameters.

John Dufour

3. Title: Transistor Bias and Stabilization

Objectives:

(1) To become familiar with the various methods of providing bias to reduce the number of potential sources.
(2) To become familiar with the various methods used to stabilize the action in a given stage.
(3) To evaluate component selection in maintaining proper bias, good regulation, and prevention of distortion.

John Dufour

4. Title: Transistor Amplifier Circuits

Objectives:

(1) To evaluate the operating characteristics of transistor amplifiers connected in common emitter, common base, and common collector configurations.
(2) To become familiar with typical component valves of transistor amplifiers.
(3) To become familiar with the method of determining voltage gain in transistor amplifiers.

John Dufour

5. Title: Electric Arc Electrode Test

Ojectives:

(1) To use the guided bend and tensile tests to evaluate the strength of different types of electrodes after they have formed a weld.

<u>Note</u> This would be used in conjunction with welded joint testing.

Bill C. Hatton

6. Title: Electrical Conductivity of Wire

Objectives:

(1) To become familiar with the methods of utilizing wire.
(2) To develop experimental materials and apparatus that can be utilized in electrical conductivity.
(3) To demonstrate the resistance produced by different gauges of wire.

M. L. Henley

7. Title: Capacitance in Electrical Circuits

Objectives;

(1) To understand what is a capacitor.
(2) To develop an awareness of how capacitors behave in a circuit.
(3) To become aquainted with some of the common applications of capacitors in electronic equipment.
(4) To develop an awareness of how capacitance affect an AC circuit.
(5) To understand the results of combining capacitance and resistance in a circuit.

M. L. Henley

8. Title: Making an Electric Generator

Objectives:

(1) To make a simple D.C. generator which generates a small amount of electric current.

Clarence L. Robinson

9. Title: Current-Carrying Conductor in a Magnetic Field

Objectives:

(1) To acquaint the learner with the action of a current carrying conductor in a magnetic field.
(2) To show how action of a current carrying conductor may be explained by the use of the left hand rule for motors.

Clarence L. Robinson

Finishes

1. Title: Chemical Analyzation of Paints

Objectives:

(1) To gain a basic knowledge of the chemical configuration of paint.
(2) To develop techniques in the area of chemical analysis.

Marion C. Burns

2. Title: Black Iron Sheet Metal Paint Finish Testing

Objectives:
(1) Evaluate various surface preparation techniques.
(2) Evaluate various undercoating techniques.
(3) Identify the various destructive media and their effect on the finishes.
(Example: chip resistant, acid resistant, oil can effect resistant)

Richard L. Fricke

3. Title: Effects of Thinner on Lacquer

Objectives:
(1) To determine the amount of thinner added for best spraying effect.
(2) To determine the quality of finish produced by various amounts of thinner.

Dean Sawin

4. Title: Stain Ability of Woods

Objectives:
(1) To determine which woods will take stains best.
(2) To determine which types of stains are best for various woods.

Dean Sawin

5. Title: Properties of Finishes

Objectives:
(1) To learn more about the different types of finishes.
(2) To determine the best types of finish for outdoor furniture.
(3) To determine the strongest types of finish.
(4) To determine which types of finish resist stain penetration best.
(5) To determine which types of finish resists spills best.

Harry K. Wilson

Insulation

1. Title: Thermoconductivity of Insulation Material's

Objectives:
(1) To compare plastics with other materials for insulation.
(2) To compare the various thicknesses of different materials relative to insulating value.

Raymond R. Schmidt

Metal

1. Title: To compare Cutting Characteristics of Different Kinds of Tool Bits

   Objectives:
   (1) To learn how to grind and hone tool bits to perform particular operations on the lathe.
   (2) To compare speeds and feeds that are inherent for efficient use of each kind of tool bit.

   Morris Bach

2. Title: Spectrogrophic Analyization of Metals

   Objectives:
   (1) To become familiar with various types of metals.
   (2) To develop an insight into the basic configuration of metals.
   (3) To acquaint the individual with various elements in the field of chemistry.

   Marion Burns

3. Title: Strength of Materials

   Objectives:
   (1) To determine temperature effects, hot and cold.
   (2) To determine the effect of shot peening on various materials.

   Harlan Clouse

4. Title: Unrestricted Torsion

   Objectives:
   (1) To become familiar with external twist deformation.
   (2) To see the effects of microstruture of fractures.

   Harlan Clouse

5. Title: Bimetallic Property of Metal

   Objectives:
   (1) Develop experimental material and apparatus that can be utilized in a shop.
   (2) To demonstrate the different effects of several metals that can be used to build a thermostat.
   (3) To obtain a better understanding of the functions of a thermostat.

   Ross Cooney

6. Title: Design and Build a Small Explosive Forming Mold

Objectives:

(1) To demonstrate a new and different method of forming metals. Uses: beer barrels, rocket nose cones.
(2) To demonstrate drawability of different metals.
(3) To demonstrate terrific hardness induced during forming process.

John C. Duggan

7. Title: Select Several Pieces of Steel With Varying Carbon Content. Identify Temperatures Required for Quench and Harden the Selected Pieces.

Objectives:

(1) To use metals handbook for obtaining temperatures.
(2) To learn how to harden steel.
(3) To observe difference in hardness.due to carbon content.
(4) To use Rockwell Hardness Tester.

John C. Duggan

8. Title: Quench Pieces of Steel in Water, Oil, Cooled Brine. Make Polished and Etched Samples of Various Pieces of Quenched Steel.

Objectives:

(1) To observe the grain structure to see which quench was faster.
(2) To polish samples.
(3) To use microscope.

John C. Duggan

9. Title: Soft Solder Alloy Testing

Objectives:

(1) Evaluate holding power of various soft soldering alloys.
(2) Identify melting temperature characteristics of soft solder alloys.

Richard Fricke

10. Title: Stress Resistance To Structural Shapes

Objectives:

(1) To become acquainted with fabricated metal structural shapes.
(2) To become acquainted with two types of structural loads. (Deflection and cantilever)
(3) To identify shapes with greatest resistance to deflection.

Richard Fricke

11. Title: Holding Power of Tapped Threads

Objectives:

(1) To become familiar with the various methods utilized to test the strength of tapped threads.
(2) To use the torque wrench to test the holding power of tapped threads.
(3) To use the fensile test to evaluate the holding power of tapped threads.
(4) To evaluate the student's ability to construct a matched set of internal and external threads.

Coydell E. Isaac

12. Title: Strength of Sheet Metal Joints

Objectives:

(1) To become familiar with the various methods of joining sheet metal.
(2) To use a screw jack and scale set-up to determine which joint affords the greatest holding power.
(3) To determine which joint provides the greatest shock power.

Coydell E. Isaac

13. Title: Tensile Strength of Wire

Objectives:

(1) To become familiar with the various methods utilized to test the strength of commonly used wires.
(2) To study the strength of wires with respect to size.
(3) To use the tensile test to evaluate the strength of wires.

Coydell E. Isaac

14. Title: Testing the Strength of Metals Exposed to Corrosion

Objectives:

(1) To determine the strength of metals under the combined action of corrosion and of static stresses. (Corrosion cracking)
(2) To determine the resistance of metals to fatique in the presence of corrosion. (Corrosion fatique)
(3) To determine the resistance to damage by cavitation. (Cavitation resistance)

George J. Kern, Jr.

15. Title: Hardness Measurements by Spherical Indenters on Different Selected Metals

Objectives:

(1) To become familiar with the Brinell hardness test.
(2) To become familiar with the Meyer hardness test.

George J. Kern

16. Title: To Secure the Best Surface Finish on a Piece Turned Between Centers on a Lathe

Objectives:

(1) To prove the value of the speed and feed formula in turning stock on a lathe.

Raymond S. McAllister

17. Title: Testing Soldering Fluxes

Objectives:

(1) To help students better understand the purpose of flux.
(2) To determine some differences in various fluxes.

Ronald J. Vaughn

Power

1. Title: Testing the Effect of Different Areas, Thickness and Materials of Storage Batteries

Objectives:

(1) To test and compare the results of different plates in a storage battery.
(2) To become familiar with the principle of a storage battery.

George J. Kern

2. Title: Test the Volatility of Various Brands of Gasoline

Objectives:

(1) To determine why vapor lock may occur with one gasoline and not with another.

Raymond S. McAllister

3. Title: Energy, Force and Work

Objectives:

(1) To acquaint the student with the different kinds of energy.
(2) To show that energy cannot be created or destroyed.
(3) To explain the meaning of force.
(4) To show that no force can be exerted without a source of energy.
(5) To inform the learner that work is done when force accomplishes something.
(6) To show how work may be measured by the unit called the foot pound.

Clarence L. Robinson

4. Title: Reaction of Anti-Freeze Under Varying Conditions

Objectives:

(1) To become acquainted with the composition of different coolants.
(2) To demonstrate the different temperatures coolants will freeze and boil.
(3) To become acquainted with how coolants react under pressure and without pressure.

Wesley Sheffield

5. Title: Lubricants

Objectives:

(1) To become familiar with the different types of lubricants.
(2) To determine what happens to lubricants under various conditions.
(3) To evaluate the advantages and disadvantages of solid and liquid lubricants.

Wesley Sheffield

6. Title: Using a Dynometer

Objectives:

(1) To familiarize oneself with the possible operations.
(2) Potential uses for making the automobile more reliable and safe.

Wayne E. Wallace

7. Title: Engine Analizers

Objectives:

(1) To become familiar with its varied uses and operations in the automotive field.
(2) Why they are needed for servicing and checking the modern day automobile.

Wayne E. Wallace

8. Title: Engine Analizers---Kit - vs - Factory Produced Items

Objectives:
(1) Can "Do-it-yourself" kits perform the same functions as the factory produced type?
(2) Should a <u>small</u> school purchase one? If so, which one?

Wayne E. Wallace

Safety

1. Title: Flash Point and Five Test

Objectives:
(1) To consider the distinction between the flash point and the fire test.
(2) To determine safe limits of various oils or finishes used.

Harlan Clouse

2. Title: Solvents

Objectives:
(1) To investigate the threat to safety.
(2) To gather data concerning solvents in the form of explosion, asphyxiation and toxicity of solvents.
(3) To determine the safe limits of air contamination.

Harlan Clouse

3. Title: Strain and Cold Work

Objectives:
(1) To become familiar with external twist deformation.
(2) To see the effects of microstructure of fractures.

Harlan Clouse

Synthetics

1. Title: Exploring the Wearing Quality of Various Brands of Tire Rubber

Objectives:
(1) To become aware of the lasting quality of various brands of automobile tires.
(2) To become a better oriented consumer.

Carl Burns

2. Title: Bending Deformation

Objectives:

(1) Forms of plastic bending deformation.
(2) To see the effects of, and change of, hardness as a result of plastic deformation.
(3) To become familiar with plastic.

Harlan Clouse

3. Title: Twisting Characteristics of Plastics

Objectives:

(1) To demonstrate the twisting ability of plastics.
(2) To become familiar with the methods of utilizing plastics.
(3) To develop an understanding of how a twisting plastic apparatus works.

Marion L. Henley

4. Title: Characteristics, Advantages, Disadvantages and Comparison of Plastic with Other Materials

Objectives:

(1) To develop conditions that will cause plastic to react in different ways.
(2) To compare plastic durability and cost with other materials.
(3) To explore the different uses in comparison with other materials.

Wesley Sheffield

5. Title: Strength of Different Plastics, Including Laminations

Objectives:

(1) To become familiar with various types of plastics.
(2) To compare strength of different plastics.

Raymond R. Schmidt

Wood

1. Title: To Compare Relative Strengths of Various Edge to Edge Fastening Methods. Butt Joint, Tongue and Groove Joint, Dowel Joint, Corrugated Fastener Joint.

Objectives:

(1) To become familiar with the varied types of edge to edge joints.
(2) To become proficient in the joining of stock in these various methods.
(3) To test their relative strengths under like conditions.

Morris Bach

2. Title: Water Absorbtion of Wood

Objectives:

(1) To determine ability of hardwood and softwood to absorb water.
(2) To determine the difference of absorbtion of hot and cold water.

Bill C. Hatton

3. Title: Testing Tensile, Compression and Shear Strength of Wood During Exposure to Different Types of Vapors

Objectives:

(1) To become aware of the effect of vapors on different woods.
(2) To become acquainted with the technique and significance of measuring the strength of different woods.

George J. Kern

4. Title: The Testing of Wood Density

Objectives:

(1) To determine the relation of bending strength to dry weight.
(2) To compute the modulus of rupture, modulus of elasticity, and longitudinal shear.

George J. Kern

5. Title: The Effects of Moisture Content on Glues

Objectives:

(1) To find which glues will hold best on wood that has been stick stacked as compared to kiln dried wood.
(2) To find the maximum moisture content that wood can have and still have reasonable holding power from the glue.

Linville G. Reed

6. Title: Why Do Wood Joints Have Different Holding Powers?

Objectives:

(1) To find joints with more holding surface.
(2) To find out how much holding power is added by tenons and dowels.

Linville G. Reed

7. Title: Strength of Wood Joints

Objectives:

(1) To compare different joints to their ability of strength.
(2) To develop an understanding of advantages and limitations of different joints.

Raymond R. Schmidt

8. Title: Holding Power of Wood Screws

Objectives:

(1) To learn about the properties of wood screws.
(2) Holding power of wood screws in different woods.
(3) Holding power of different sizes of wood screws.

Harry K. Wilson

9. Title: Properties of Wood

Objectives:

(1) To learn more about the properties of wood.
(2) To determine the strength of different woods.
(3) To determine the machineability of different woods.
(4) Hardness of different woods.

Harry K. Wilson

Section Three

RELATED DISCIPLINES

Data Processing

Nuclear Science

Oceanography

Related Disciplines

Three disciplines related to science and engineering were included in the Institute because of their influence on industrial arts.

Data Processing

The principles of data processing are directly related to industrial arts in several ways. These include applications to numerical machine tool and drafting operations, handling personnel records, business data processing, research, and controlling automated processes. Data processing is one of the more significant new activities being used in industry and as such should be reflected in industrial arts curricula.

Nuclear Science

Nuclear science has industrial application through power production and for applications based on radio-active characteristics of nuclear substances. Among these applications are product tagging for future identification purposes, activation analysis for content determinations of substances, and tracers used for research purposes. The major significance to industrial arts is through the total impact on industry and the need for industrial arts to present as complete a picture of industry as is possible.

Oceanography

Oceanography is a "new frontier" with much possible impact on industrial arts. It is significant primarily as a source of industrial raw materials, as a means of transportation, and as a water source through de-salination processes. It has many of the same implications for industrial arts that conventional mining has had for years.

Section Four

FIELD TRIPS

FIELD TRIPS

Field trips to the following industries or installations were conducted during the institute:

Dow Chemical Company, Freeport, Texas
- Chemical Research & Production
- Magnesium Production
- Desalination of Sea Water

ALCOA, Rockdale, Texas
- Aluminum Ingot Production
- Lignite Coal Mining
- Power Generation

General Dynamics, Ft. Worth, Texas
- Data Processing
- Numerical Controlled Milling
- Numerical Controlled Drafting
- Aircraft Assembly

NASA, Houston, Texas
- Flight Control
- Flight Simulation
- Centrifuge

Nuclear Reactor, Texas A&M
- Reactor Operation
- Research Techniques
- Safety Procedures

Cyclotron, Texas A&M
- Equipment Operation
- Research Techniques

Section Five

SEMINARS

SEMINARS

A variety of topics were covered in seminars conducted by guest speakers.

Society and Modern Industry	- - -	Dr. Robert L. Skrabanek, Professor of Sociology, Texas A&M
Oceanic Exploration	- - -	Lt. Commander Don Walsh, Department of Oceanography, Texas A&M
The Geology of Industrial Raw Materials	- - -	Dr. Horace Blank, Professor Emeritus of Geology, Texas A&M
Industrial Arts of the Future	- -	N.D.E.A. Staff and Participants
Metallurgy	- - -	Mr. Charles Lewis, Metallurgist, Cook Heat Treating Co., Houston, Texas
Fluid Power & Fluidics	- - -	Mr. Charles Hedges, Engineer, Womack Machine Supply Co., Dallas, Texas
Integrated Circuits	- - -	Mr. Earl Ritenour, Product Specialist, Texas Instruments Supply Co., Dallas, Texas

Section Six

RECREATION

RECREATION

Recreational opportunities included both formal group and informal activities.

Orientation Fellowship for Participants	- - -	Memorial Student Center
4th of July Barbecue & Picnic	-	Director's Backyard
Tea for Wives	- - -	Memorial Student Center
Weekly Fellowship for Wives and Children	- -	City Park
Free Weekends for Family Travel	- - -	Various Points of Interest