THE 1952 REVISION OF A COURSE OF STUDY IN BEGINNING ELECTRICAL WORK

By

ARLAND PRICE

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1952

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Acknowledgement is due my wife, Ruth Price, for making this study possible by her help and encouragement in every way.

Special recognition is extended to all book companies participating in this study for their promptness in submitting examination copies of various electrical books.

A. P.

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A FOREWORD TO THE 1952 REVISION OF A COURSE OF STUDY IN BEGINNING ELECTRICAL WORK

Due to the usual difficulty experienced by students in the selection of a subject that will lend itself to research, a suggestion was made by Dr. DeWitt Hunt, Head, Department of Industrial Arts Education and Engineering Shopwork, Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, that this advisee revise the state course of study in electrical work. This recommendation was made because of the advisee's experience in electrical wiring.

The Old Course of Study

The original course of study was prepared by a study committee, members of which were individuals active in the field of industrial arts on both the high school and college levels. Under the direction of Dr. DeWitt Hunt, members of this committee endeavored to work up the course of study so that it would fit the needs of both large and small schools.

The first edition was published in 1942 as Bulletin No. 42-C-1 from the Curriculum Division of the Oklahoma State Department of Education. The volume contained 66 pages and 1,000 copies were printed.

The Revision

This new course of study has been assembled and prepared by the writer under the guidance of Dr. DeWitt Hunt, who directed the preparation and publication of the first edition. The revision was developed in a similar manner as the first course of study; however, a selected group of modern electrical books was used to obtain new ideas and methods that seemed more appropriate at this time. Three of the books used were revised editions of books used in the first course of study. These copies, along with two completely new publications, were chosen as the five recommended textbooks.

Omissions

In view of the fact that the old course of study was published in the year 1942, it is a natural consequence that a considerable amount of the material is now out of date and has little or no value for current or future use. Much of the material listed in the old course of study is either no longer available or is now considered to be obsolete.

How This Course of Study was Revised

Because of the necessary omission and addition of various materials, the introduction was completely revised. The objectives were altered to allow more emphasis on student needs and requirements without violating any essential of the teaching process. More recent electrical books were selected for both the primary textbooks and the reference book listings. In order to clarify each problem, an introductory page was made for each problem board. Another addition was an annotated bibliography which provides a brief summary of each of the five primary textbooks and the four project books.

A COURSE OF STUDY FOR BEGINNING ELECTRICAL WORK

Revised by Arland Price, Summer, 1952

This electrical course is designed similarly to any other introductory or general course in the field of industrial arts. It is limited to the comparatively brief period of two semesters of study. Such a course is designed to serve in an exploratory and general educational capacity, so that the student may either discover his tastes and talents, thereby enabling him to make a better choice of a life career or to learn fundamental information for use in everyday life. In any general course, which is not planned for specialized vocational training, the field is so vast that only a small portion of the available material can be presented in the allotted time.

A Definition of and Objectives for Industrial Arts

The broad scope of introductory or general industrial arts is expressed and a good definition is provided by Gorden O. Wilbur in his book, Industrial Arts in General Education. According to Wilbur, industrial arts embraces:

> ... those phases of general education which deal with industry - its organization, materials, occupations, processes, and products - and with the problems resulting from the industrial and technological nature of society.

Even with regard to the widespread area to be covered in a basic electrical course, certain general and many somewhat specific purposes must be kept in mind at all times. The writer believes that Louis V. Newkirk in the book, Organizing and Teaching the General Shop, has adequately summarized such purposes. Although these are presented in consideration of the entire field of industrial arts, they are also applicable to any introductory course, and consequently, to the beginning electrical course. They are as follows:

1. Self-expression through planning and building useful projects with tools and materials typical of modern industry.

2. Exploring aptitudes and interests in industrial work.

3. An understanding of industry, its workers, and processes.

4. Reading and making working drawings for personal use.

5. Choosing wisely the industrial products that are needed for modern living.

6. Adjusting and making minor repairs on the industrial products used around the home and community.

7. Providing craft experiences suitable for hobby interests.

8. Giving social experiences that will develop understanding and ability to work effectively with others.

Since industrial arts is almost universally included in the curriculum of Oklahoma high schools and junior high schools, consideration has been given to the selection of courses of study to be included in the offerings of each department of industrial arts. The subjects which are now recommended for industrial arts education in Oklahoma include (1) automobile mechanics; (2) ceramics; (3) crafts and handicrafts; (4) electrical work; (5) general metal work; (6) industrial drawing; (7) machine shop practice; (8) printing; (9) woodworking; and (10) plastics.

Electrical Work in the General Shop

Electrical work for the beginner is generally considered to be a good division of instruction for the general shop. It may be offered as an exploratory course in the general shop in the junior high school and then followed with the unit course to meet the needs of those interested in the further study of electricity. The value of electrical work in the general shop was stressed in the book, Organizing and Teaching the General Shop, when the author, Louis V. Newkirk, made this statement:

> Electricity plays an important part in the lives of all of us. Boys and girls should learn about the divisions of the electrical trade and the opportunities that are afforded for employment. Students should learn how to use simple electrical tools and how to use electricity safely. They should have an opportunity to study the elementary and fundamental principles of electrical equipment.

Electrical Work in the Unit Shop

The unit shop can provide the student with a much wider concept of electrical work. It may serve to explore more completely the tastes and talents of each individual student in regard to the electronics field, and in the more technical work of the unit shop the student may find new stimulation through additional phases of electrical work that could not be covered in the general shop classes. This course of study would be inadequate for use in the unit electrical shop.

Objectives of this Course of Study

The objectives of this electrical course are more than vague and remote educational ideals. They should be thought of as definite changes which are to take place in the student's development. The instructor should provide experiences which will make a reasonable contribution to the desired goals. If these experiences are such that they will stimulate the individual student through his knowledge and skills, attitudes and accomplishments, they will naturally aid in making him a happier, more useful and successful citizen.

The general purpose of this two-semester electrical course of study then is the development of an individual who will be more valuable as a producer, more appreciative and happier as a consumer, and more useful as a citizen. A summary of the objectives for which the instructor should strive is listed as follows: (Quoted from original bulletin, <u>A Course of Study in Electrical Work 1a and 1b</u>)

1. Provides opportunity for the student to become familiar with the appliances, materials, tools, terms, and symbols used by the electrician in and around the home.

2. Develops consumers' knowledges and the ability to judge more accurately electrical products and services and their values.

3. Instills self-confidence and initiative through having successfully used and repaired electrical appliances.

4. Aids safety education through the practice of safety methods when installing and using electrical equipment.

5. Development of handy-man abilities through repairing, assembling and caring for the appliances used in the home and in the school.

6. Discovers interests and aptitudes that may lead to a specific vocational choice of an occupation in the field of electrical work.

7. Teaches basic principles and laws governing the application of electrical energy for home and industrial uses through actual laboratory experiments.

8. Develops avocational interests which may be used outside of school in later life.

9. Develops a favorable attitude toward industrial pursuits, and the men that work in electrical industries.

10. Gives the pupil the knowledge of and experiences in good workmanship and skill.

11. Much basic knowledge about electricity is taught in this course. It does not duplicate general science or physics.

12. The electrical course should provide opportunity for the boy to experiment and invent and should provide opportunities for creative activities.

13. Experiences in reading working drawings, especially wiring diagrams, are provided.

Grade Placement

This course of study is designed primarily for use in the junior high schools, and is adaptable for use in the general shop. Since the field is so broad, this introductory course must necessarily be general, and it deals primarily with fundamental principles and their applications. It may be used at the start of electrical study at any level.

Teaching Methods

Class participation is of utmost importance in this teaching procedure. The instructor can capitalize on the enthusiasm and interest of the students for a new field of study by letting them take part in the experiments at the earliest possible time. The students are anxious to get to work and should be allowed to handle tools and work on the electrical problems as soon as necessary explanations and safety precautions are properly presented.

Recommended Textbooks

Five primary textbooks have been selected in accordance with the Oklahoma Multiple Adoption Plan. This procedure enables teachers to participate in determining the textbook or textbooks to be used in their schools.

After critical study and deliberation, the five recommended textbooks were chosen after giving due consideration to (1) the subject matter; (2) the qualifications of the author in the field of industrial arts; and (3) the author's ability to present the material clearly for the required grade level. Other less important but necessary factors which were studied included (1) the size of the print; (2) the general attractiveness of the book; (3) the quality and clarity of the illustrations; (4) the binding; (5) the cost; and (6) the probable durability of the book.

The five primary textbooks which most adequately met these requirements are as follows:

1. Jones, E. W., General Electricity, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1950, 89 pages.

2. Feirer, John L. and Williams, Ralph O., Basic Electricity, Charles A. Bennett Co., Inc., Publishers, Peoria, Illinois, 1943, 222 pages.

3. Johnson, William H., and Newkirk, Louis V., The Electrical Crafts, The Macmillan Co., New York, 1943, 146 pages.

4. Wright, Forest B., Electricity in the Home and on the Farm, John Wiley and Sons, Inc., New York, 1950, 380 pages.

5. Jones, E. W., Fundamentals of Applied Electricity, The Bruce Publishing Co., Milwaukee, Wisconsin, 1943, 341 pages.

THE 1952 REVISION OF THE COURSE OUTLINE
FOR ELECTRICAL WORK
(One Year of Junior High School Work)

Unit Assignments for the Course in Electrical Work

In the following outline, "A" indicates the manipulative work to be performed by the students in each unit of instruction, and "B" indicates the informational material which is to be taught and learned as a part of this unit.

The columns are arranged to match the recommended textbooks and all assignments and topics of information are documented in as many of the recommended textbooks as contain information about them. Problem boards to use for each problem or assignment so far as formal boards are used are referred to as P.B.-1, P.B.-2, etc.

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 1a - Bells and Buzzers Operated With Dry Cells P.B.-1	5			236, 237	322, 324
A. Using one dry cell, one bell and one push button, wire up a circuit so that the bell will ring when button is pushed.	5		4, 24	236	324
B. Voltage of any size dry cell. (2) Amperes of a 6" dry cell.	16, 17 17	56 56			
(3) Amperage of flash light dry cells.	17				
(4) Determine positive and negative poles of dry cells.	17	56	4	230	

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(5) Several uses for dry cells.	17	57	25		
(6) Purpose of the magnets in bell.	5			237	
(7) Difference between a dry cell and a battery.	16,17	56		65	
Unit 1b. - <u>Bells and Buzzers Operated with Dry Cells P.B-1</u>					
A. Using two dry cells, one bell and one push button, wire circuit so dry cells will be in series and so that bell will ring.	5		21	236	
B. Test Voltage of the circuit.	17,18	56,57	94	22	
(2) Test amperes of the circuit.	17,18	56,93	94	39	
(3) Material in the two electrodes of the dry cell.	16,17	56	4	87	51
(4) What materials are used inside of the dry cell?			4		
(5) Size of bell wire.	25	81			
(6) How bell wire is attached to building.	6				
(7) Advantage of dry cells in series, disadvantage.	16	57,92			55
(8) What maximum voltage can be attained?	18	57,92			55
Unit 1c - <u>Bells and Buzzers Operated with Dry Cells P.B.-1</u>	5,6		24		324
A. Using two dry cells, one bell and one push button, wire up circuit so dry cells are in parallel and so buzzer will ring.				24, 236	324

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
B. Which will ring the louder, dry cells in series or in parallel?	16-18	57,92		22-24	55
(2) In which one will the dry cell last the	16	57,92			55
longer? (3) Will the bell ring louder if one dry cell is added?	18	57,92			55
(4) Voltage of the cir-	18	57,92			
cuit. (5) Advantage of		57,92			55
dry cells in parallel.	16	57,92			55
Unit 1d - Bells and Buzzers Operated with Dry Cells P.B-1	5,6		24-27	235	324
A. Using two dry cells, one bell, one buzzer and two push buttons wire up circuit so bell will ring from front door and buzzer will ring from back door.					324
B. Would you wire the dry cell in parallel or in series? Why?	16-18	57,92	21	22-24	55
(2) Where would you place the dry cells?		57		24	
(3) Location of bell and buzzer?	6				
Unit 2a - Bells and Buzzers Operated from Bell Ringing Transformer P.B-2			24		312
A. Using one transformer, one bell, one push button, and insulated bell wire, connect them together so that bell rings by means of electricity passing through the transformer.	6				

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
B. Recognize bells and buzzers, transformers and size of wire to	5,6				312
use. (2) Alternating as compared to direct	9	159-162	10	20	18
current. (3) Safety rules. Voltage of primary circuit.	44,45		23	32	
Voltage of current leaving transformer.		191		100	258
(4) Install a simple bell circuit.	6			92,93	
(5) How does the transformer work?	6		118	92	
(6) Advantage of bell ringing transformer over a dry cell battery.	60	190,191	118	92,93	312
Unit 2b - <u>Bells and Buzzers Operated from Bell Ringing Transformer P.B-2</u>					
A. Using one transformer, two bells and one push button connect bells together in series so that both bells ring when the button is pressed.	5,6				
B. How a number of bells in series will operate with one button. (2) How to adjust bells and buzzers when not working properly.	6		25,27		324
(3) Know how to equalize energy. (4) Effect of connecting bells in series. (5) How many could be connected in series?		57,92	25,27	22-23	

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 2c - Bells and Buzzers Operated from Bell Ringing Transformer P.B-2					
A. Using two bells, one push button, and insulated wire, connect bells together in parallel so that both bells ring from electricity passing through first.	6				
B. Understand a parallel circuit.	16	57,92	21	25	105
(2) How many bells can be included in this circuit?					
(3) Is there a negative and a positive wire in this circuit? Why?	56	92			
(4) How many wires should run to each push button?			24		324
Unit 2d - Bells and Buzzers Operated from Bell Ringing Transformer P.B-2					
A. Using two bells, two push buttons, one transformer, connect bells together in a return-call system so that calls may be returned.	6		24		
B. Understand the uses of the return call system.					324
(2) Economize in the use of wire when installing a return call system.	6				

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(3) What is the purpose of a return-call system? (4) What is the advantage of using only three wires?	6				
Unit 3a - Fuses - Kinds and Uses P.B-3		126	86,91	253-268	
A. Using one strand of picture wire (iron). Add enough 75,100 or 150 watt bulbs to cause the wire to melt. Also use copper wire.					
B. What number of watts was required to burn out the iron wire? The copper wire? (2) What caused the wires to melt? (3) Which was the better conductor?	24			259	
(4) Of what metal are fuse links made?	30	126			93
(5) How are circuit breakers, temperature cutouts and overload relays used?			91,93	133	
Unit 3b - Fuses, Kinds and Uses P.B-3	31	126	86,91	253-268	93
A. Use a 2, 3, 4 or 5 amp. link in a renewable base and add enough lamps to burn out the fuse.					
B. What are renewable type fuses?	31	126		257	94
(2) What are one-time fuses?	31	126		256	94
(3) Compute the number of watts necessary to burn the 5 amp. fuse.					94

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(4) How does this check with the actual number required?					94
(5) How are watts of an appliance deter-	31		119		32
mined? (6) What type fuses are used on circuits of 30 amps or over?	31	128		256	94
Unit 3c - Fuses, Kinds and Uses P.B-3	31	126	86,91	253-268	93,94
A. Calculate the number of 75 watt bulbs allowed by Underwriters Code on #14 wire. Do same on #12 and #16 wire.					95
B. How is wire numbered? (2) What is Underwriters Code?	25	81	98	279	88
(3) What wattage will #14 wire carry?			76	143	
#12 and #16? (4) What size fuse will protect #14 wire, #12, #16?	25				95
(5) What is the meaning of single circuit and nultiple circuit?				21	
What are circuit breakers?			93	133	
Unit 3d - Fuses, Kinds and Uses P.B-3	30,31	126	86,91		93-95
A. By investigating books and catalogs determine the number of watts required to operate each of the following household appliances: radio, refrigerator, flat iron, percolator, toaster, fan, sewing machine,					

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
heating pad, clock, vacuum cleaner, hot plate, range, water heater, various motors.	28			42	31
B. Which uses the most current, a radio or a toaster? (2) How much does it cost to operate an electric iron for three hours if electricity costs 7¢ per KW and the iron is rated 650 watts? (3) How many watts are required to operate an electric clock for one hour? (4) What is the cost of operation of an electric clock for one month? (5) What is the cost of operation of a water heater for one month? (6) What is the consumption of wattage on a door bell transformer in one day? (7) If all the equipment in your home were used at the same time, what total number of watts would be required?	28 28 28		119	42	31 31
Unit 4a - <u>Circuit Wiring Using Several Kinds of Single Pole Switches P.B-4</u>					
A. Using a single pole snap switch wire up one lamp in a porcelain receptacle to be controlled from a single point.	35	99			

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
B. Determine hot wire.	78				
(2) To what part of circuit does it lead?	78,79				
(3) Tracing the circuit, voltage of lamp, switches used, differences noted.	78,79				
(4) Reason for entrance switches.	34				
(5) Difference in hour current and battery current?	50,51		10,66		
Unit 4b - <u>Circuit Wiring Using Several Kinds of Single Pole Switches P.B-4</u>	35			238, 239	191
A. Using two receptacles and a single pole wall type push switch, wire two lights in series.			94,95	23	105
B. Single or double pole switch?				239	191
(2) Trace current through switch.					
(3) Difference in series and parallel.					
(4) Effect on first bulb if second bulb is removed.					
(5) Effect if one bulb burns out.			95	24	
(6) Difference in brillancy in series and parallel wiring.			95		
(7) Account for any difference.			95		
(8) Effects when using bulbs of different wattage.					

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 4c - Circuit Wiring Using Several Kinds of Single Pole Switches P.B-4					191
A. Using three or more receptacles and a single pole toggle switch, wire up several lamps in parallel. Compute both wattage and amps in this circuit.	35			25	
B. Single or double pole switch? (2) What does "toggle" mean? (3) Does the adding of extra lamps affect brillancy of other lamps? (4) Effect of one lamp burning out? (5) How many lamps can be put on this circuit?					
Unit 4d - Circuit Wiring Using Several Kinds of Single Pole Switches P.B-4					191
A. Using several receptacles and another type of single pole switch, wire up several lights in parallel.	35	99		239	
B. Reason for using snap switches for high voltage. (2) How many circuits can be controlled by a single pole switch? (3) Is line drop greater in series or parallel wiring?				238 239 25	

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(4) Explain how the voltage is the same at any point in a parallel circuit. (5) What is the law of the parallel circuit?				25	
Unit 5 - Identification of Electrical Supplies and Equipment P.B-5					
A. Know and identify objects on equipment board.					
B. What is the purpose of wire gauge?					
(2) Materials used in	25		99	279	104
making wire. (3) Wire used for outside	24	44	27	278	84
wiring. (4) Wire used for interior wiring.	25				
(5) Materials used in					84
drop cords. (6) Name four types of sockets.	37				
(7) Three types of low amperage wall switches.			84,85	295, 296	
(8) How many wires on three-way switch? Insulation used on	35			240	191
conductors. (9) Five porcelain electrical	37				
devices. (10) Three types of plugs and plug bases.	37			294	
Unit 6 - Make a Drop Cord or an Extension Cord.	37		81,82		197
A. Use any of the following attachments: plug cap, swivel plug, or ceiling rosette and	37				

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
any type of extension cord conductor and socket, and make a drop cord or extension cord.					
B. Name materials and appliances used.				296	
(2) Why should there be several wires in each cord? (3) Is the red thread in both strands of cord?	37			291	
(4) Give two rules for attaching strand of extension cord to the binding post--(a) red thread, (b) direction of loop.				294	
(5) Where is the hot part of the socket? (6) Purpose of hard-rubber bushing in socket. (7) What is the importance of tinning cable ends?			82		
(8) Make Problem Board No. 6 containing several types of extension cords and appliance connector plugs.				291	
Unit 7a - <u>Two Point Control Circuit P.B-7</u>	35			240	191
A. Using two three-way snap switches (to be taken apart for identification of working parts) wire up a light controlled from two points.	35			24	191

Detailed outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
B. How many circuits are there that must be checked before current is turned on?					
(2) How can you determine a three-way switch?				240	
(3) For what purpose are the three-way switches used? (4) Do these switches have an "on" and "off" position? (5) Can one buy 3 wire cable with all wires a different color?				240	191
Unit 7b - <u>Two Point Control of Electrical Circuits P.B-7</u>	35			240	191
A. Using two three-way wall type toggle or push button switches, wire up a circuit of two lights to be controlled from two points.	35			240	191
B. Number of points in three-way switch. (2) Number of pigtails in a three-way switch.				240	191
(3) Where hot wire connects to switch.				240	191
(4) Where neutral wire connects.				240	191
(5) How many circuits must be checked before current is turned on? (6) Kinds of three-way switches.					191

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 8a - Three and Four Point Control of a Single Circuit P.B-8				240	191
A. Using two three-way toggle switches and one four-way toggle switch, wire up one lamp to be controlled from any one of three points.					191
B. How many posts does a three-way switch have? (2) Where does hot wire lead to?				240	
(3) How many circuits must be checked?				240	191
(4) Interpretation of wiring diagram.				240	191
(5) How many pig-tails on a four-way switch?					
Unit 8b - Three and Four Point Control of Single Circuit P.B-8				240	191
A. Using two three-way toggle switches and one four-way toggle switch and one double-pole double-throw knife switch, wire a lamp to be controlled from four points.				240	191
B. In what directions does a four-way toggle switch pass circuits?				240	191
(2) How many pig-tails are there? (3) Where would a three-point control circuit be used?				240	191

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 9 - <u>Heating Elements in Household Appliances P.B-9</u>					336
A. Determine the number of watts per hour consumed by at least three household heating elements. Use the watt-hour meter and determine the amount of current consumed - in terms of killowatt hours. Improvise necessary equipment and circuits.	28		119	41	
B. Definition of watt, killowatt, killowatt-hour.	27	142,143	119	41	31
(2) Use of watt-hour meter.	27	143	119	41	32
(3) Definition of amperage.	27		94	35	20
(4) Use of ammeter.		112		36	21
(5) Cause of heat in electric circuit.	40		20		
(6) Kinds of wire used in heating elements.	40	136,140		57	336
(7) Computing resistance.		133,136			22
(8) Watt's Law.	27			40	30
(9) Three ways of determining wattage consumption of an appliance.			119		32
(10) Materials used in insulating heating elements.	28				13
(11) Practibility of repairing heating elements.					327
(12) Comparison of heating cords with ordinary extension cords.				391, 302	

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 10 - Make a Chemical Electric Cell.	49				52
A. Use a pint or quart fruit jar as a container and use electrodes of zinc and copper. Use dilute sulphuric acid for the liquid. Use the home built galvanometer (Unit 11) to test the electric cell for current.	49				
B. What gas is given off in the bubbles? (2) What causes the current? (3) How long will current be given off?	55 55				
Unit 11 - Make a Small Galvanometer.	96				
A. Use either a small bought compass or make a small permanent magnet mounted on a needle and wind a coil of #18 bell wire. Assemble these similar to the problem in Chapter 4 in Lehmann's *Shop Projects in Electricity*, (page 25). Test the home built chemical cell already made. (Unit No. 10)	98				
B. Answer all of the questions about the galvanometer in the Lehmann book (pages 27-28).					

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 12 - <u>Make Three Standard Splices</u>.			87		
A. Using No. 14 rubber covered wire make the following standard	24				
splices: <u>Western Union</u> or <u>End Splice</u>, and <u>Rat-Tail Splice</u>. Solder all joints and tape one joint.	24		87		
B. Why should the knife be slanted in cutting the insulation from the wire?					
(2) Why should the wire be cleaned thoroughly?	24		87		
(3) Where is the Western Union splice	81-82				
used? (4) Do the rat-tail joints carry much				282	
strain? (5) How many turns should be used on a Western Union			87	289	
splice? (6) Why should the end wire on the rat-tails be turned			87	282	
back? (7) Why should one use splicing com-			87	289	
pound? (8) What two kinds of tape must be used in insulating a spliced joint?	82			289	
(9) How should a lamp cord be spliced and			87	289	
taped? (10) How is this joint soldered, soldering iron or	24				
torch? (11) What flux should be used?	81,82				
(12) What kind of solder should be used? Wire or bar?	81,82				

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(13) Use of porcelain connectors, solderless connections and lugs.	81,82				
Unit 13 - <u>Conductors, Types and Sizes of Single Wire and Stranded Cables</u>.	23	44	98	278, 279	83
A. Make a collection of as many kinds of conductors as can be found in the shop and about the shop.	23				
B. Wire sizes, circular and mil. Rubber covered and weatherproof. Stranded cable. Leaded cable. New types of wire, synthetic insulated, flame-proof, etc.		81	99		86
Unit 14 - <u>Meter Reading</u>.					
A. Using the A. & M. College meter reading blank, work the eight problems found on this sheet. Have instructor grade the results.	27,28			304	
B. Why is it convenient to know how to read meters?	28			305	33
(2) Which dial is read first?	28		121	306	33
(3) Calculate the monthly consumption of electricity in your home.	28		121	307	34
Read the meter at 30 day intervals.	28		121	307	34

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 15 - <u>Using "Romex" or Non-Metallic Sheathed Cable in House Wiring</u>.					
A. Add one complete circuit to the circuits in the practice wiring house frame. The following operations will be involved: (1) Make sketch of work to be done.					
(2) Locate and cut hole for outlet boxes and switches.				351	
(3) Install wall switch box.				351	
(4) Bore holes in studding, plates, joints, etc., for cable.				350, 355	
(5) Pull Romex through holes. (6) Connect the two wires to the switch and lock cable to box. (7) Make proper joints, solder and tape in junction box.					
(8) Make proper connections to appliance and seal terminal boxes. (Be sure that all cables are fastened to boxes).				134	
(9) Close main switch and check all outlets.					
B. Why is Romex better than knob and tube wiring? (1) Why should holes be bored in the studding? (2) What depth of box is recommended for side wall outlets?					

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(3) Must the loom enter the box?					
(4) How is Romex fastened to boxes?				134	
(5) What must be done to all wire that runs into a junction box?					
(6) How should Romex be supported when not in bored studding?					
Unit 16 - <u>Use of B-X (Metal Sheathed or Armored Cable)</u>.					
A. Add one complete circuit to the circuit in the practice wiring house frame. The following operations will be involved:					
(1) Locating and cutting hole for outlet box. (2) Cutting B-X cable. (3) Removing insulation.				352	
(4) Attach cable to box with cable clamp.				134	
(5) Attach wires to receptacle and assemble complete with cover plate. (6) Run free end of cable to junction box supporting with straps. Open main switch. (7) Remove armor, attach cable connector, and attach cable to box.					
(8) Remove insulation from old splices and new cable. (9) Splice and solder connection, then wrap with splicing tape. (10) Replace box cover and close main switch.			87		

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
B. What are the code rules on installing outlets? (2) What tools are needed in cutting holes for outlet box? (3) Why is B-X outlawed in some states and localities? (4) How much cable should be removed when making a connection? (5) How often should the cable be supported by straps? (6) What protective and insulating coverings are found on B-X? (7) Why should a fiber collar or bushing be used in the end of the cable?				352	
Unit 17 - <u>Using Rigid Conduit with Threaded Connections</u>.					
A. Install one complete circuit on the rigid conduit practice wiring panel or on one wall of the practice wiring house. The operations involved will include the following: (1) Planning the installation. (2) Selecting materials needed. (3) Cutting conduit. (4) Threading and reaming conduit. (5) Installing junction and outlet boxes. (6) Attaching conduit to junction and outlet boxes with bushing and lock nuts.					

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(7) Pull wires through conduit using red wire for the hot wire and a white wire for the neutral. (8) Attach wires to fixtures. (9) Splice soldered, taped joints in junction box. (10) Install junction box cover and test circuit.					
B. Where is the rigid type conduit used? (2) What are the advantages of rigid conduit wiring? (3) What is the smallest size of conduit that may be used? (4) Why is galvanized iron used? (5) How is conduit bent? (6) Why must the ends of the conduit be reamed after cutting with a pipe cutter? (7) Is it desirable to use resin core wire solder?	81				
Unit 18 - <u>Use of Thin Wall Conduit in House Wiring</u>.					
A. Add one branch circuit to the wiring found on the wall of practice wiring houses.					
B. How is thin wall conduit cut? (2) What type of connectors are used? (3) What is advantage of this over rigid conduit?					

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(4) How is this conduit supported? (5) How is the wire pulled into the conduit? (6) How many bends are allowed in a run? (7) What is the difference in the use of black or colored wire and white wire? (8) Costs compared with Romex and B-X. (9) How is tube grounded? (10) Costs compared with conduit? (11) Use of National Electric Code.				143	
Unit 19 - <u>Studying the Storage Battery</u>.		59-75			
A. Test a car battery with hydrometer, voltmeter and ammeter. Check each cell separately and record results.	50,51	69		65	52
Operate a small motor, a car horn with a car battery.		70			
B. Parts of a storage battery cell.	50	63-66		65	52
(2) Uses of storage batteries.	51	70			
(3) How should you test and care for a car battery?	50,51	68,69			
(4) What kind of energy is stored in a storage battery?	50,51	62		65	53
(5) How should the charging rate of the generator be for short trips? For long trips?	65				

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
(6) How many plates does a good storage battery have in it?	50	64,65			53
(7) Voltage of storage battery.		59			
Unit 20 - <u>Projects Required in Electricity 1a</u>					
A. Each student shall make at least two projects in this course. One shall be a heating device and the other shall be an operative or moving device.					
B. <u>Heating Devices</u> - (1) Soldering coppers, (2) Electric pencils.	40, 41 81				
C. <u>Operative Devices</u> -					
(1) Transformers,	60,88	189	118, 119	92,93	168
(2) DC Motor,					
(3) AC Motor,	88	169- 175			
(4) Buzzer, (5) Chimes,			121		
(6) Circuit Breaker.	101	91			
<u>Demonstration Units</u> - To be demonstrated to the class by teacher or by pupils.					
Unit 21 - Demonstrate magnetic fields and magnetic lines of force surrounding a wire with a current in it.	1-3	20-24	6,8	48	71

Detailed Outline of Instructional Units	(1) Jones General	(2) Feirer and Williams	(3) Johnson and Newkirk	(4) Wright	(5) Jones (Fund.)
Unit 22 - The simple electric motor. Show several types beginning with the simple two-part commutator and including the squirrel case A-C type.	54-56		124, 125	176 176-195	
Unit 23 - The use of transformers and induction coils.	59-61	189-193		192-101	168, 173
Unit 24 - Electrical circuits in the automobile.	64,67	70			
Unit 25 - Telegraph and telephone sets.	70-72	103, 192			319, 174
Unit 26 - Radio receiving sets.	74,75				220
Unit 27 - Electric lighting. Cost, kinds of lamps, the light meter, fluorescent, neon, sodium vapor, mercury vapor and black light.	46-48 47				202
Unit 28 - Condensers.		39			163, 178
Unit 29 - Electroplating.					57,63
Unit 30 - Care of Motors.				203	

THE PROBLEM BOARDS

When the original course of study was prepared, the committee members actually went into the shop and designed, made up and experimented with the problem boards illustrated in the following eight drawings. The first part of the course is built on the use of these problem boards. The problems are mounted on 5/8" or 3/4" five-ply fir panels and are completely portable. Each drawing contained illustrations of the electrical device required in addition to detailed listing of required equipment and the assignment of problems to be worked on each board.

These problems may be worked in two ways. Either short sections of stranded (insulated) wire with battery clips soldered on each end may be used for working out the wiring diagrams, or similar sections of stranded wire may be screwed solidly to the electrical devices as in permanent wiring installation.

The problem boards are designed for use with regular 110 volt A.C. current, and each board has an entrance switch, fused with 5 ampere renewable plug fuses and about three feet of extension cord attached to the entrance switch. First, the student should be required to work out the problem and write out the answers to all questions contained in the assignment, and then the board may be plugged in on the 110 volt circuit in the shop for final testing under direct supervision of the teacher.

There might be some objection to the use of 110 volt current by junior high school students. It could be argued that students of this age and grade are constantly using devices powered by 110 volt current in their homes. However, if the electrical shop is in a room with a wooden floor and proper safety precautions are emphasized there is very little if any danger involved in work with the 110 volt current. It is essential that the electrical shop always be installed in rooms with wooden flooring and that the students are impressed with the proper respect for electrical equipment. For those who prefer working with a lower voltage, thus avoiding any possible risk with the 110 volt current, the following plan is suggested.

For the utmost safety, the practice wiring house and wall panels may be provided with 24 or 32 volt current by using a standard transformer in the service line. It is recommended that all equipment such as sockets, switches, receptacles, etc., be full-sized so that the student may become accustomed to using standard electrical supplies, devices and equipment. Thirty-two volt lamps may be used in this circuit. For the protection of those lamps and to avoid burning them out in 110 volt circuits, it is recommended that socket reducers be used in all sockets and receptacles and the 32 volt lamps with candelabra base can be used. These lamps cannot be used in regular equipment so should not be subject to burning out on account of the heavier voltage.

In the practice boards recommended for use in this course of study each drawing represents a board 20" x 30" in size. The back should be made of 3/4" plywood. On the board the various pieces of electrical equipment, such as bells, switches, etc., may be mounted. The problems may then be worked out by the student through using short cables made of a single strand of flexible cotton covered drop cord. If the drop cord is used, battery clips may be attached to each end of the cable so that the cables may be clipped to the binding posts.

It is possible that 10 ampere circuit breakers be used in place of the two pole knife switch and fuse plate on the problem boards. The problem boards may be built up with 2" sides and all items mortised to make them "dead front" and then wired from the back. If large classes are involved, two or more of each problem board should be constructed.

In the following illustrations, each drawing is preceded by an explanatory page including (1) description of the problem, (2) equipment, (3) special electrical principles involved; and (4) application of the problem.

PROBLEM BOARD NO. 1

Bells and Buzzers Operated with Dry Cells

A course in beginning electricity should probably start with problems and experiences with bells, buzzers, push buttons and dry cell batteries. Panel Board No. 1 is designed to provide a number of problems in both series and parallel wiring of both bells and dry cells.

Equipment. In describing the materials briefly, the push button can be referred to as the controlling part. It is a mechanism to complete the circuit as long as the button is pressed. This may be compared with the gate valve used in water systems. Most push buttons operate on the same principle with very little difference in their materials. The bells and buzzers are the make and break type, composed of an electromagnet, armature, bell, breaker points, hammer or striker and the base on which the parts are mounted.

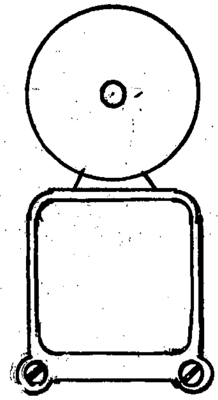
Special Electrical Principles Involved. There is a distinct difference between a dry cell and a battery. A dry cell has reference to a single unit. A battery is a group of two or more cells wired either in series or parallel. The poles of the dry cells are the zinc or negative and positive and positive or carbon pole. The positive and negative presence in every electrical circuit should be pointed out in this problem.

The voltage of a number of dry cells in series wiring is the product of the number of cells. The voltage of an individual dry cell is approximately one and one half volts. The voltage of a number of dry cells in parallel is one and one half volts. The voltage may be increased only by wiring the dry cells in series. The use of dry cells as a power unit is a good example of chemical energy that has been changed to mechanical energy. The term dry cell simply means that the battery does not contain a liquid. It cannot be recharged.

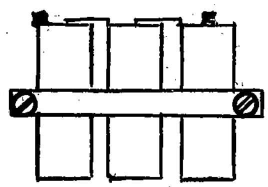
Application of the Problem. Bells and buzzers are sometimes operated with dry cells. If strong sound is desired the dry cells can be wired in series. Two dry cells in series will produce approximately three volts. If louder ringing is desired, wire three dry cells in series to produce about four and one half volts. Parallel wiring is used mostly because the dry cells used have a longer life. If one dry cell is used for actuating a bell, the ringing will be weak since the voltage is only one and one half and the life of the dry cell will be short.

Problem Board No. 1

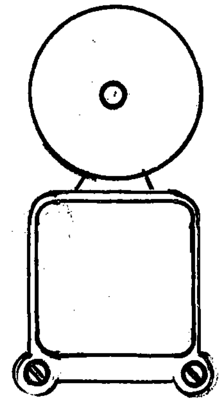
Bells and Buzzers
Operated With Dry Cells



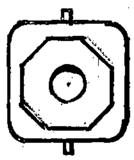
Door Bell



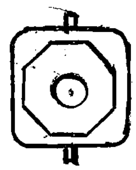
4½ V Radio Battery



Door Bell



Push Button



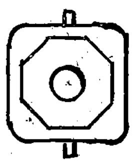
Push Button

1a. Using one dry cell, one bell and one push button, wire up a circuit so that the bell will ring when button is pushed.

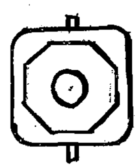
1b. Using two dry cells, one bell and one push button, wire circuit so dry cells will be in series and so that bell will ring.

1c. Using two dry cells, one bell and one push button, wire up circuit so dry cells are in parallel and so buzzer will ring.

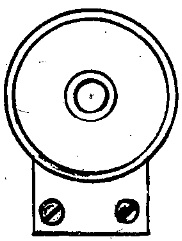
1d. Using two dry cells, one bell, one buzzer and two push buttons, wire up circuit so bell will ring from front door and buzzer wil ring from back door



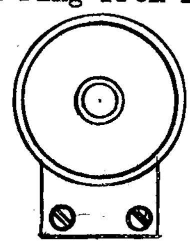
Push Button



Push Button



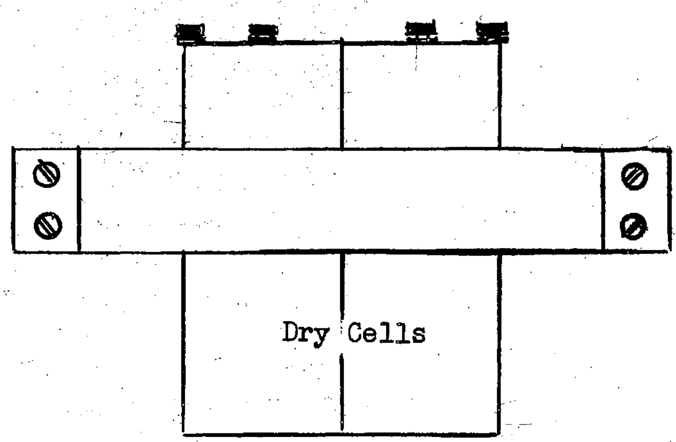
Buzzer



Buzzer

Equipment Required for Unit 1

2 Electric Door Bells
2 Double Coil Buzzers
4 Square Base Push Buttons
2 1½V 2½ Diam. Dry Cells
1 4½V Radio Battery



PROBLEM BOARD NO. 2

Bells and Buzzers Operated from Bell Ringing Transformer

The use of the transformer may be considered another step above the dry cell as a source of power. This is an example where the house current is stepped down to low voltage in order to operate bells and buzzers.

Equipment. To describe the equipment on this board briefly, the double pole fused entrance switch or power supply control is shown. Fused as it is, the wiring of the complete circuit is protected. The transformer is used to step one hundred and ten volts down to a low voltage of about six to ten volts. The push button is used to control the bells and buzzers.

Special Electrical Principles Involved. The bell and the buzzer work on the same principle. The bell has a striker that strikes the gong to produce a loud sound. The buzzer only produces a vibration in most types by striking the side wall of the cover. The bells and buzzers used in this illustration are the same as those used with dry cells as source of power.

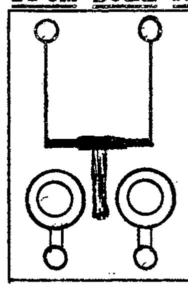
Application of the problem. The transformer is used as the source of power in much of the bell systems in residence. The transformer does not require a special location as dry cells. It does not have to be replaced as dry cells. The transformer operates by a primary coil in proximity with a secondary cell. The voltage is governed by the number of turns in the coil windings. This system may be wired in series as well as parallel. It is not essential that the positive and negative principle be observed.

Problem Board No. 2

Bells and Buzzers Operated from Bell Ringing Transformer

2a. Using one transformer, one bell, one push button, and insulated bell wire, connect them together so that bell rings by means of electricity passing through the transformer.

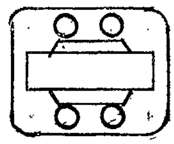
2b. Using one transformer, two bells and one push button, connect bells together in series so that both bells ring when the button is pressed.



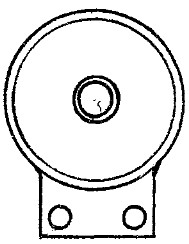
Entrance Switch

2c. Using two bells, one push button, and insulated wire, connect bells together in parallel so that both bells ring from electricity passing through transformer.

2d. Using two bells, two push buttons and one transformer, connect bells together in return-call system so that calls may be returned.



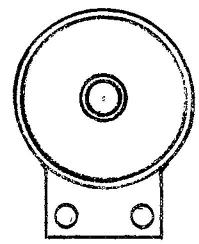
110V Transformer



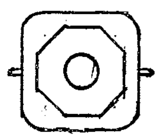
Buzzer

Equipment Required for Unit 2

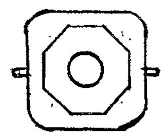
4 Square Base Push Buttons
4 Bells or Buzzers
1 110V Transformer
1 D-P Fused Entrance Switch



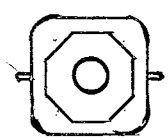
Buzzer



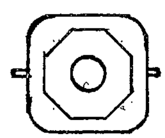
Push Button



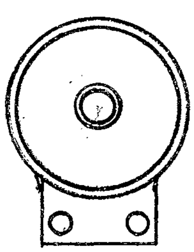
Push Button



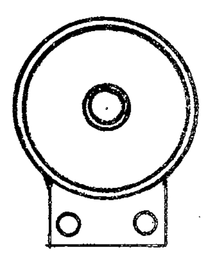
Push Button



Push Button



Buzzer



Buzzer

PROBLEM BOARD NO. 3

Fuses, Kinds, Sizes and Uses

Without the aid of the fuse, the use of electricity would be extremely hazardous. This is just as true in automobile wiring as in residential electrical systems.

The size of a fuse is equally as important as the necessity for having a fuse present. Many individuals are misinformed and believe that a large fuse will produce better results than the small ampere rated fuse. This is certainly not true and serious result may occur if such a practice is carried out.

Equipment. There are various kinds of fuses including the cartidge fuse that is inserted and the plug fuse that is screwed in. Both the cartidge fuse and the plug fuse are made in renewable and non-renewable types.

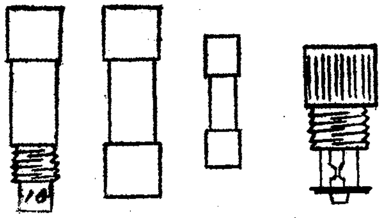
Each fuse has a number indicating the amperage load. If a circuit becomes shorted, the fuse element melts to disconnect the source of power. Most household appliances are stamped according to the wattage that they consume.

Special Electrical Principles Involved. Sometimes, in the event of an emergency, it may be permissable to use a small wattage light bulb in the place of a fuse. The practice of using coins in back of a blown fuse makes a direct circuit, and for obvious reasons of safety, should never be used.

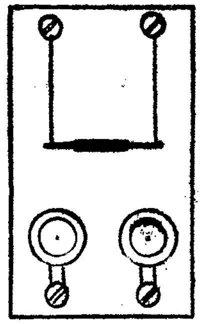
Application of the Problem. When it is necessary to estimate the size of the fuse needed, it can be done easily and with safety by adding up the total wattage on the line and dividing this total by 110, the voltage of the line. Suppose 10-100 watt lights and a 650 watt iron are in one line, 1650 watts divided by 110 volts equals 15 amps, the size of the fuse needed.

Problem Board No. 3

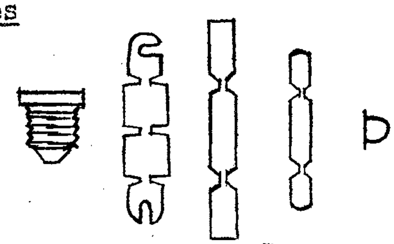
Fuses - Kinds, Sizes and Uses



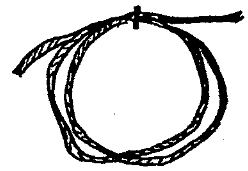
Renewable and Non-renewable
Cartidge Fuses and a
Renewable Plug Fuse



Entrance Switch

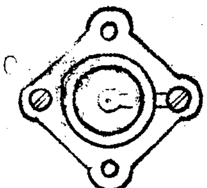


Non-renewable Plug Fuses
and Various Fuse Links



Picture Cord Wire

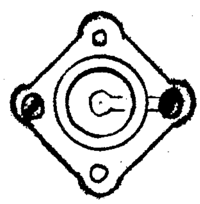
3a. Using one strand of picture cord wire (iron). Add enough 75, 100, or 150 watt bulbs to cause the wire to melt. Also use copper wire.



Receptacle

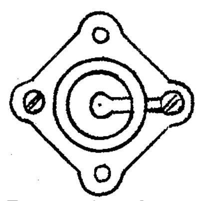
3b. Use a 2,3,4 or 5 amp. link in a renewable fuse and add enough lamps to burn out the fuse.

3c. Calculate the number of 75 watt bulbs allowed by Underwriters Code on #14 wire; do same for #12 and #16 wire.

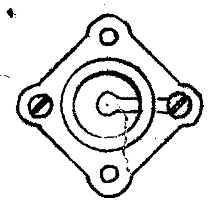


Receptacle

3d. By investigating books and catalogs, determine the number of watts required to operate each of the following household appliances: bulb, radio, refrigerator, flat iron, percolator, toaster, fan, sewing machine, heating pad, clock, vacuum cleaner, hot plate, range, water heater and various motors.



Receptacle



Receptacle

Equipment Required for Unit 3

1 Plug Fuse, Renewable
1 Plug Fuse, Non-renewable, 10 amp.
1 Cartidge Fuse, 30 amp., Renewable
1 Cartidge Fuse, 30 amp, Non-renewable
1 each, Fuse Links for 5 amp. Renewable Plug Fuse, 30 amp. Cartidge Fuse, 200 amp. Cartidge Fuse and Thermal Type Fuse Link
1 D-P Fused Entrance Switch
12" Picture Cord Wire

PROBLEM BOARD NO. 4

Circuit Wiring Using Several Kinds of Single Pole Switches

Switches used in electrical wiring serve to complete and break the circuit. There are various kinds of electrical switches, but Problem Board No. 4 is an illustration of the single pole switch. The term single pole refers to the contact pole that is forced back and forth by the switch lever which disconnects only one wire in a two-wire circuit.

Equipment. The equipment displayed includes the flush type push switch, the snap switch, the flush type toggle switch, a double pole fused entrance switch, and cleat type receptacles. This sort of equipment is found in many old residences, but the toggle switch is used in most modern wiring.

Special Electrical Principles Involved. The fuse type knife is now being replaced with the modern circuit breakers. These breakers have proved to be as effective as the fuse and have an additional advantage in that they can be reset without the necessity of replacing a fuse.

Application of the Problem. This problem consists of wiring several lights in both series and parallel using regular house voltage. If the receptacles are wired in series the whole circuit must be complete in order for each part to function. If more than one bulb is wired in series, then one bulb cannot be turned out unless the complete lighting system is turned out. The series wiring is used on older Christmas tree lighting circuits and on street lights.

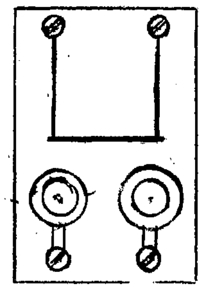
The parallel wiring, which is the system of most resident wiring at the present time, uses more than one bulb in the circuit and may not be changed by the addition or removal of one of the lights. Line drop is greater in the parallel wiring than series wiring since more wire must be used.

Problem Board No. 4

Circuit Wiring Using Several Kinds of Single Pole Switches

quipment Required for Unit 4

Porcelain Cleat Receptacle
Single Pole Snap Switch
Single Pole Flush Toggle Switch
Single Pole Flush Push Switch
D-P Entrance Switch, Fused

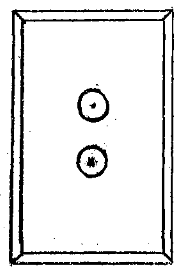


Entrance Switch

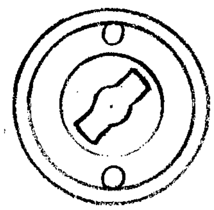
4a. Using a single pole snap switch wire up one lamp in a porcelain receptacl to be controlled from a single point.

4b. Using two receptacles ar a single pole wall type push switch, wire two lights in series.

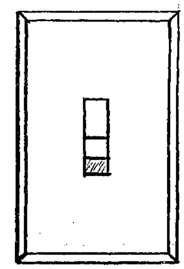
4c. Using three or more rece cles and a single pole t switch, wire up several lamps in parallel. Comp both wattage and amps. i this circuit.



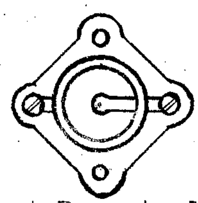
Flush Push Switch



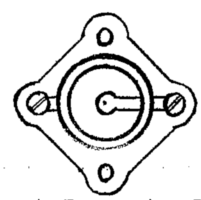
Snap Switch



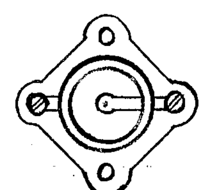
Flush Toggle Switch



Cleat Receptacle

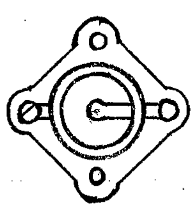


Cleat Receptacle

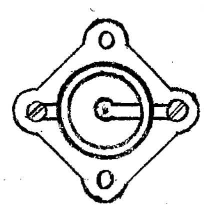


Cleat Receptacle

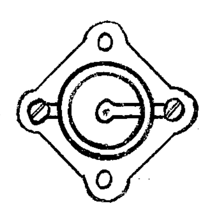
4d. Determine which is the h wire and which is the neutral wire in each circuit.



Cleat Receptacle



Cleat Receptacle



Cleat Receptacle

PROBLEM BOARD NO. 5

Identification of Electrical Supplies and Equipment

It is highly important that the electrician have a common language pertaining to the materials used in his work. This use of specialized terms enables electricians to work faster and more efficiently. The primary purpose of this illustration board is to point out a few of these electrical terms and devices used in all work with electricity. Although some of the materials found on this board may be considered obsolete, it cannot be denied that they function successfully in demonstrations.

Equipment. The equipment illustrated in this panel includes conductors, switches, sockets, porcelain tube, knob, cleat, ceiling rosette, cleat receptacle, swivel plug, plug, and base. The materials are of the type which is customarily used in simple circuits and inside wiring.

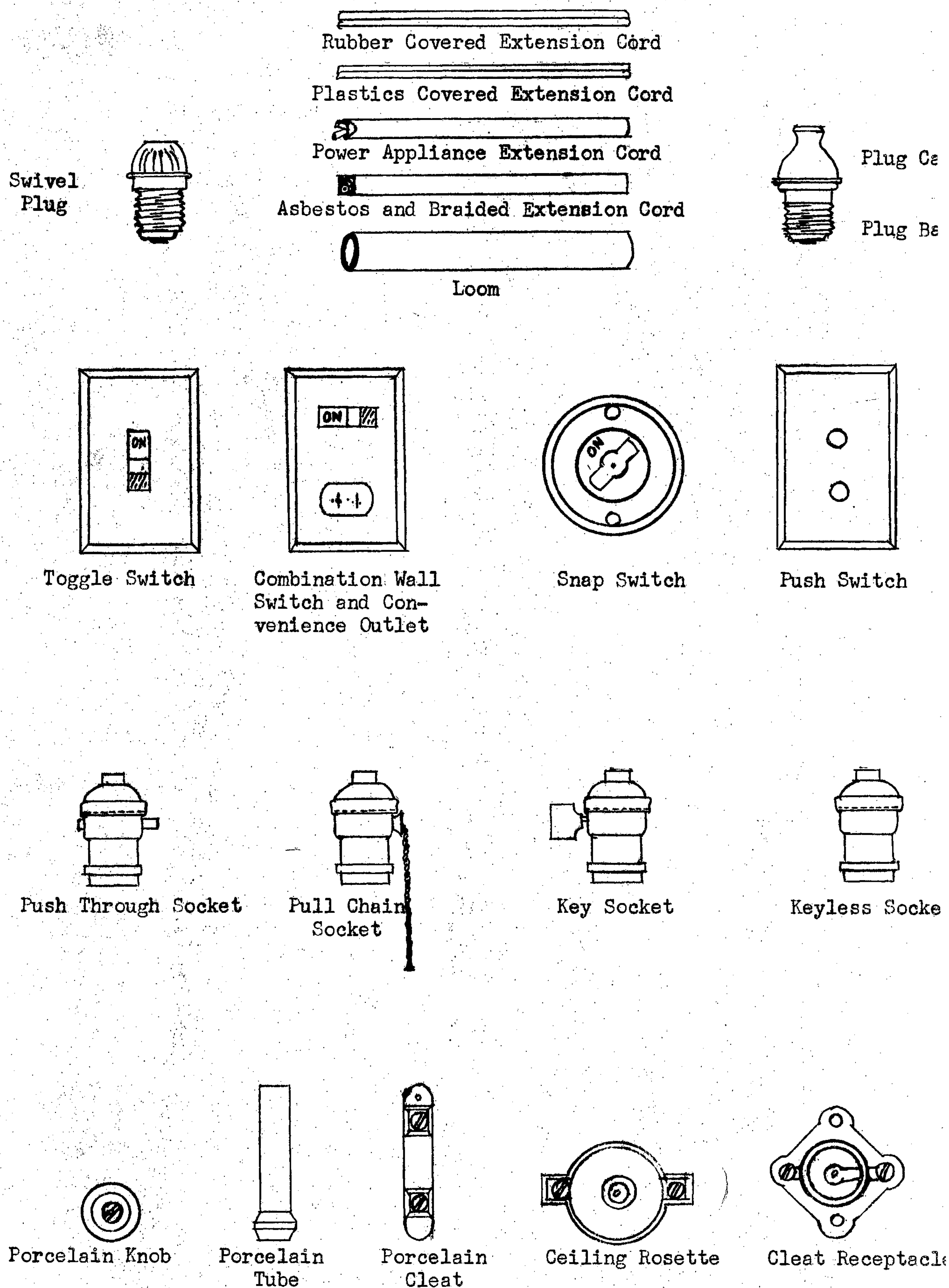
Special Electrical Principles Involved. The conductors illustrated may be identified by the type of insulation covering they have. Where extreme heated conditions are involved, the asbestos covering is used. The rubber covered conductor is used where more precaution against shock is required.

The switches are of the single pole type used primarily for breaking and completing a single phase circuit. Sockets described are used in the various types of incandescent lighting. The porcelain materials, which are shown at the bottom of the panel, were used in the old type of knob and tube wiring which is obsolete today.

Application of the Problem. Conductors are manufactured and available in different sizes according to the wire gauge. These conductors are made of copper wire, an expensive process, and compare favorably with the best type of conductors. The switches are all of the positive action type, and they are employed where single phase wiring is used. The sockets are those used in various lighting fixtures, and they are designed specifically for convenience and appearance.

Problem Board No. 5

Identification of Electrical Supplies and Equipment



PROBLEM BOARD NO. 7

Two Point Control Circuits

Two point control circuits are considered highly convenient because of the fact that light can be controlled from two different locations. Two different types of dual point control units are illustrated in Panel Board No. 7.

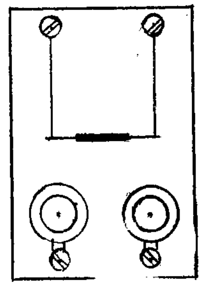
Equipment. A brief listing of the materials which are shown on this board consists of a fused double pole entrance switch--or what is commonly known as the safety control--, two each, three way toggle and snap, or rotary, switches, and the receptacles or bulb holders.

Special Electrical Principles Involved. The primary difference in the toggle and snap switch can be found in the contacts. The toggle switch makes contact in both upward and downward positions by a cross bar that is on a pivot in the center; whereas the snap switch operates by the turning of a knob that has a cross bar inside to contact each of its points. There is no marked on and off position on the three way switch. It has three pig-tails or contact points with four binding posts. One pair of binding posts are wired together in the switch.

Application of the Problem. In the case where a three point control system is preferable, it may be completed by the addition of a four way switch in the circuit with two three way switches.

Problem Board No. 7

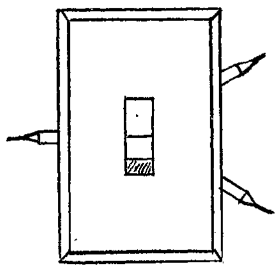
Two Point Control Circuits



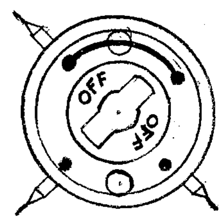
Entrance Switch

7a. Using two three snap switches (to be taken apart for identification of working parts) wire up a light controlled from two points.

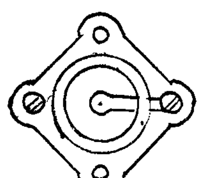
7b. Using two three-way wall type toggle or push button switches, wire up a circuit of two lights to be controlled from two points.



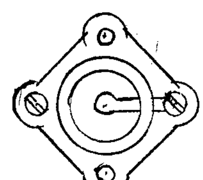
Three-way Toggle Switch



Three-way Snap Switch



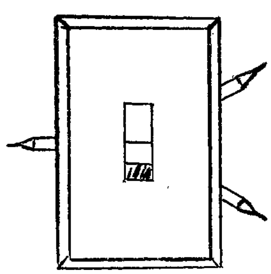
Receptacle



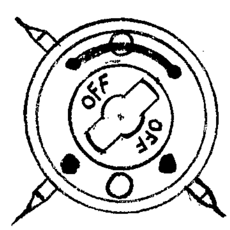
Receptacle

Equipment Required for Unit 7

2 Three-way Switches
2 Porcelain, Cleat Type Receptacles
2 Three-way Flush Toggle Switch
1 D-P Entrance Switch, Fused



Three-way Toggle Switch



Three-way Snap Switch

PROBLEM BOARD NO. 8

Three and Four Point Control of Single Circuit

The beginner should have a well rounded program in circuit wiring and this problem board will be a great help. Three and four way switches are used today in city wiring as well as on the farm. They are used when it is desirable that a single circuit be controlled from two or three different places. Some times the two point system is used in wiring hall lights with a switch upstairs and another at the foot of the stairs. A yard light with a three point control could be turned on from the back porch, the barn, or the gate to the yard.

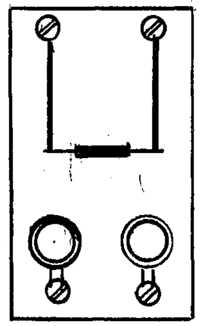
Equipment. In describing the material on this board briefly, the double pole fused knife switch serves as a safety unit for the complete circuit. The three way toggle switch, which is used in pairs, control a circuit from two points. This switch does not have an off and on marking. The four way toggle switch is used when three points may be controlled by using two three way and one four way switch. Also included on this board are the four way double pole knife switch and the cleat type receptacle or bulb holder.

Special Electrical Principles Involved. The three way switch has three points for wire connections. One of the three points is connected to a bar which completes the circuit in one or the other of the two connections. This is why the switch does not have an on or off marking. The four way switch as indicated has four contact points which completes four circuits. The term toggle refers to a double lever type switch.

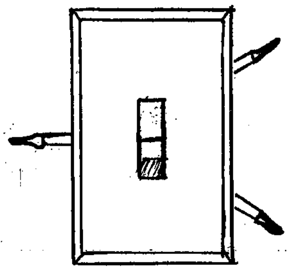
Application of the Problem. If four place control of a circuit is desirable it can be accomplished by using two three way switches on the outside and two four way switches on the inside or middle of the circuit. The four way double pole knife switch will aid in understanding the function of a four way switch. The three way switch should be disassembled to understand completely just what happens when the switch is moved up and down.

Problem Board No. 8

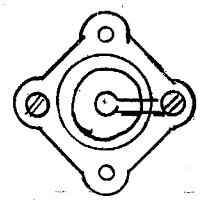
Three and Four Point Control of a Single Circuit



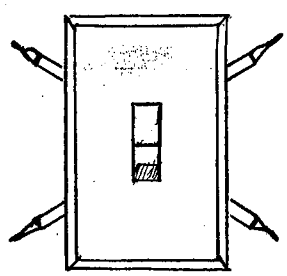
Entrance Switch



Three-way Toggle Switch



Receptacle



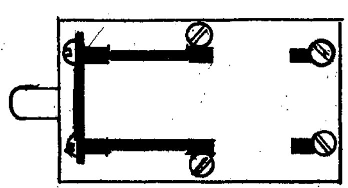
Four-way Toggle Switch

8a. Using two three-way toggle switches and one four-way toggle switch, wire up one lamp to be controlled from any one of three points.

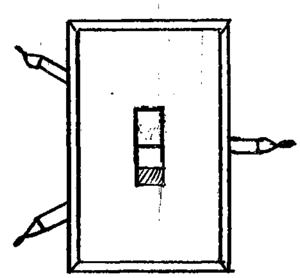
8b. Using two three-way toggle switches and one four-way toggle switch and one double-pole double-throw knife switch, wire a lamp to be controlled from four points.

Equipment Required for Unit 8

2 Three-way Flush Type Toggle Switches
1 Four-way Flush Type Toggle Switch
1 Four-way D-P Knife Switch



Four-way D-P Knife Switch



Three-way Toggle Switch

PROBLEM BOARD NO. 9

Heating Elements in Household Appliances

Since the heating element has been accepted as the most convenient method of conveying electrical heat where and when needed, it is found today in a majority of rural and city areas. The smoothing iron, one of the most common heating elements present in homes, is illustrated in Panel Board No. 9.

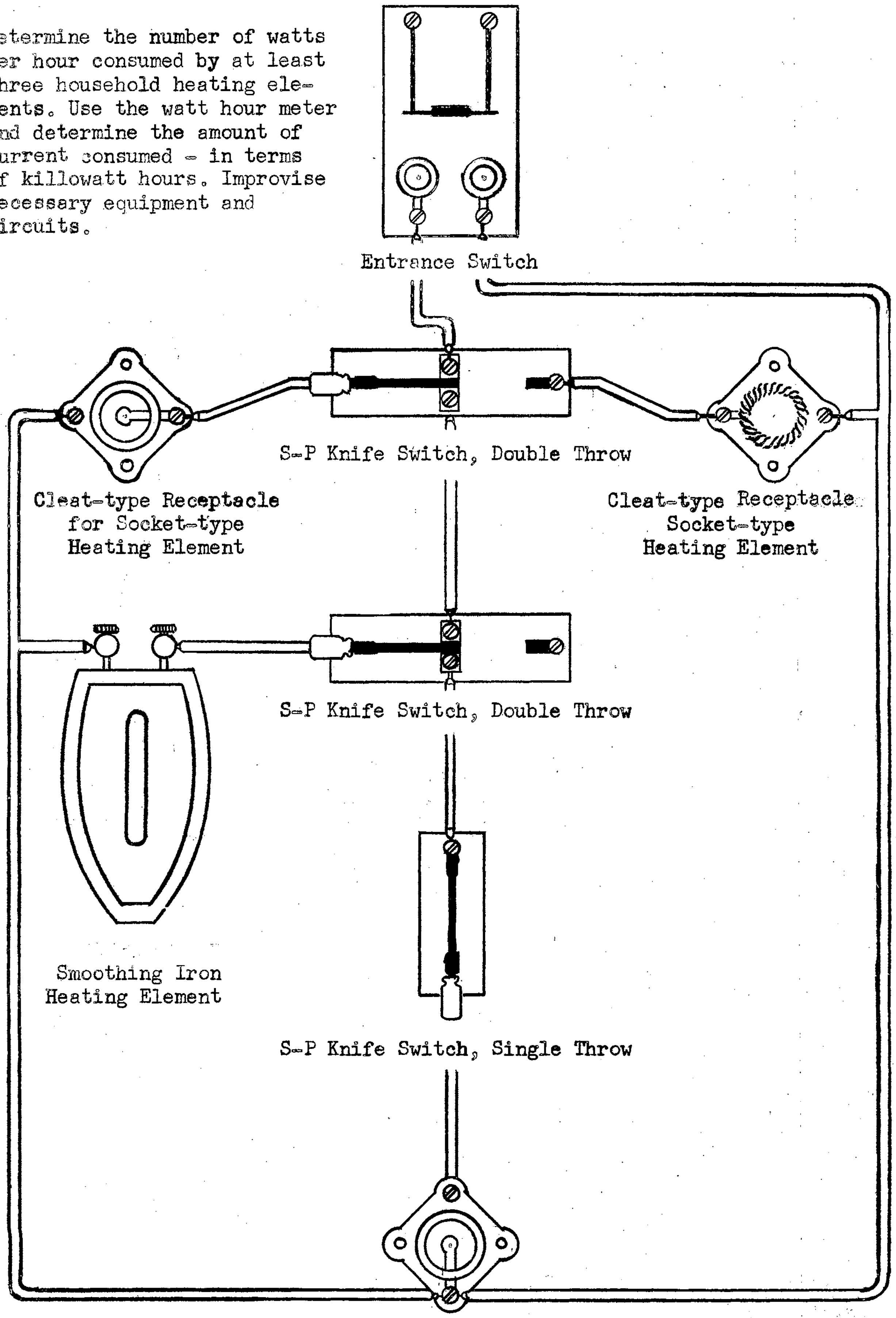
Equipment. In explaining the materials used in this problem board, it is to be understood that it is arranged in a complete circuit using the items listed as follows: the entrance switch, which serves as the circuit controlling device, and a safety factor; the conductor wire necessary to complete the circuit, both single and double type knife switches, cleat receptacles for socket type heating elements and a smoothing iron heating element.

Special Electrical Principles Involved. The heating element heats by resistance produced in the nickel and chromium wire or tape and the amount of heat is determined by the length of the nicrome element. This element is constructed to withstand enormous amounts of heat. The heating elements used in such devices as the toaster, percolator, and smoothing iron can easily be replaced if one burns out. The socket type of heating element is made so that it cannot be used for other purposes, as the left hand threads prevent other usage.

Application of the Problem. Heating elements made of nickel and chromium are used in the form of tape and wire. This enables its use in different devices and by different methods of manufacturing. The amount of heat is determined by the size and length of the wire. An example of a heating element that produces light by resistance is the incandescent light bulb.

Problem Board No. 9
Heating Elements in Household Appliances

Determine the number of watts per hour consumed by at least three household heating elements. Use the watt hour meter and determine the amount of current consumed - in terms of killowatt hours. Improvise necessary equipment and circuits.



A SUMMARY SHEET OR GRADE RECORD FORM FOR THE REVISED ELECTRICAL WORK COURSE OF STUDY

This summary sheet lists the units of work recommended for the course. A space is available for the date on which the student completed the assignment and the grade made by him. This summary sheet should be duplicated by the teacher in charge and may be used as an individual grade record for each pupil. It may also be used as a record of lectures and demonstrations given to the members of the group.

	Grade	Date
Unit 1 - <u>Bells and Buzzers Operated with Dry Cells</u>		
1a. Simple bell circuit with one dry cell. .	____	____
1b. Two dry cells in series operating one bell.	____	____
1c. Two dry cells, parallel, operating one bell.	____	____
1d. Front and back door circuit.	____	____
Unit 2 - <u>Bells and Buzzers Operated by Bell Ringing Transformers</u>		
2a. Circuit involving transformer, push button and one bell	____	____
2b. Two bells in series operated from a transformer	____	____
2c. Two bells in parallel operated from a transformer	____	____
2d. Return call system	____	____
Unit 3 - <u>Fuses, Kinds and Uses</u>		
3a. Experiment with one strand of picture cord wire	____	____
3b. Experiment with 5 amp. fuse link	____	____
3c. Calculations of wattage allowances	____	____
3d. Number of watts used by household appliances.	____	____
Unit 4 - <u>Circuit Wiring with Several Kinds of Single Pole Switches</u>		
4a. Simple circuit with snap switch.	____	____
4b. Two lights in series with push switch. .	____	____

		Grade	Date
4c.	Two lights in parallel with toggle switch.	______	______
4d.	Parallel wiring using several receptacles.	______	______
Unit 5 -	<u>Identification of Electrical Equipment</u>.	______	______
Unit 6 -	<u>Making a Drop Cord</u>.	______	______
Unit 7 -	<u>Two Point Control of Electrical Circuits</u>		
7a.	Using two three-way snap switches . . .	______	______
7b.	Using two three-way toggle switches . .	______	______
Unit 8 -	<u>Multiple Point Control of Electrical Circuits</u>		
8a.	A three-point control circuit	______	______
8b.	A four-point control circuit.	______	______
Unit 9 -	<u>Heating Elements in Household Appliances</u>	______	______
Unit 10 -	<u>Make a Chemical Electric Cell</u>	______	______
Unit 11 -	<u>Make a Small Galvanometer</u>	______	______
Unit 12 -	<u>Make Three Standard Splices</u>	______	______
Unit 13 -	<u>Conductors, Types and Sizes of Single Wire and Stranded Cables</u>. . .	______	______
Unit 14 -	<u>Meter Reading</u>	______	______
Unit 15 -	<u>Using "Romex" or Non-metallic Sheathed Cable in House Wiring</u> . . .	______	______
Unit 16 -	<u>Use of B-X (Metal Sheathed or Armored Cable)</u>	______	______
Unit 17 -	<u>Using Rigid Conduit with Threaded Connections</u>.	______	______
Unit 18 -	<u>Use of Thin Wall Conduit in House Wiring</u>	______	______
Unit 19 -	<u>Studying the Storage Battery</u>.	______	______

	Grade	Date
Unit 20 - Projects Required in Electricity 1a and 1b		
20a. A heating device		
20b. A moving electrical device		
Unit 21 - Demonstration of Magnetic Fields and Lines of Force.		
Unit 22 - A Study of the Electric Motor.		
Unit 23 - The Use of Transformers and Induction Coils		
Unit 24 - Electrical Circuits in the Automobile.		
Unit 25 - Telegraph and Telephone Sets		
Unit 26 - Radio Receiving Sets		
Unit 27 - Electric Lighting. Cost, Kinds of Lamps, the Light Meter, etc.		
Unit 28 - Condensers		
Unit 29 - Electroplating		
Unit 30 - Care of Motors		

APPENDIX A, Part A

The writer made a careful study of books from various companies to make up the recommended textbooks, project books and reference list. One of the five textbooks should be adopted as the course textbook and either each student should buy a copy for his own use or as many copies as there are members of any one class should be purchased and kept available. These books could be checked out as needed by students in the course as could the reference books on hand. One copy of each of the five recommended texts should be available.

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Lush, Clifford K. and Engle, Glenn E., Industrial Arts Electricity*, Charles A. Bennett Co., Inc., Publishers, Peoria, Illinois, 1946, 144 pages.

McDougal, Wynee L., Ranson, Richard R., Dunlap, Carl H., Fundamentals of Electricity*, American Technical Society, Chicago, Illinois, 1948, 418 pages.

Nowak, John F., Electrical Work*, D. Van Nostrand Co., Inc., New York, 1949, 147 pages.

Perry, Edgar C., and Schafebook, Harry V., Fundamental Jobs in Electricity*, McGraw-Hill Book Co., Inc., New York, 1943, 306 pages.

Petersen, Charles F., Fundamentals of Electricity*, The Bruce Publishing Co., Milwaukee, Wisconsin, 1936, 112 pages.

Richter, Herbert P., Practical Electricity and House Wiring, Frederick J. Drake and Co., Chicago, Illinois, 1944, 180 pages.

Suffern, Maurice Grayle, Basic Electrical Principles*, McGraw-Hill Book Co., New York, 1949, 430 pages.

Uhl, Albert, Dunlap, Carl H., Flynn, Frank W., Interior Electric Wiring and Estimating*, American Technical Society, Chicago, Illinois, 1951, 312 pages.

Wright, Forrest B., Electricity in the Home and on the Farm**, John Wiley and Sons, Inc., New York, 1935, 380 pages.

Yates, Raymond F., A Boy and a Motor*, Harper and Brothers, Publishers, New York, 1944, 111 pages.

* Books marked with one asterisk were received from companies sending them for examination.

** Five books marked with two asterisks have been suggested as textbooks.

APPENDIX A, Part B

<u>An Annotated Bibliography of the Recommended Textbooks</u>

Feirer, John L. and Williams, Ralph O., <u>Basic Electricity</u>, Charles A. Bennett Co., Inc., Publishers, Peoria, Illinois, 1943, 222 pages.

This book is designed to provide instruction for individuals who will be producers or consumers of electrical equipment and services. It is a comprehensive first course in electricity that will be suitable for a well-organized one-semester course. The instructor can vary instruction methods and provide for student participation.

Johnson, William H., and Newkirk, Louis V., <u>The Electrical Crafts</u>, The Macmillan Co., New York, 1943, 146 pages.

This textbook contains experiments, projects, and problems suited to a wide range of pupil abilities. It is designed for junior high school grades and even for senior high school where previous electrical courses have not been given. It is supplemented with informative drawings and photographs.

Jones, E. W., <u>Fundamentals of Applied Electricity</u>, The Bruce Publishing Co., Milwaukee, Wisconsin, 1943, 341 pages.

This is both a classroom textbook and a shop manual. It is divided into two parts. Simple fundamental working principles of electricity and magnetism are presented in the first part. In part two, directions are given for the construction and use of experimental apparatus, shop equipment, and class projects. This material has been written with the idea that the teaching of elementary electricity should be based on practical application that gives a working knowledge of every-day electricity.

Jones, E. W., <u>General Electricity</u>, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1950, 89 pages.

This textbook offers a variety of things to do from which the teacher may choose according to his facilities, aims and length of course. It should furnish insight into electrical occupations and a better appreciation of the services rendered by workers in the field. It will familiarize the student with the ways of electricity and show him how to use and enjoy this power without waste or danger. The writer suggests the group demonstration method as being the best method for accomplishing his aims effectively and economically, where large classes and a small amount of equipment is found.

Wright, Forest B., <u>Electricity in the Home and on the Farm</u>, John Wiley and Sons, Inc., New York, 1950, 380 pages.

This book is written for those who want a practical knowledge of electricity in the home and on the farm. It is divided into two parts. The first part deals with the fundamentals of electricity and the applications in the home and on the farm. Practical jobs arranged in the order of their difficulty make up the second part.

APPENDIX A, Part C

Books Containing Projects Usable in the Electrical Course

Cook, Sherman R., Electrical Things Boys Like to Make, The Bruce Publishing Co., Milwaukee, Wisconsin, 1942, 205 pages.

Thirty-three projects were selected from two hundred to be used in this book. They contain excellent teaching material and much interest for boys. Any project may be made in a shop which has the usual hand metal working and a few woodworking tools. The projects are simple in order to hold the short interest span of the average school boy.

Collings, Merle D., Projects in Electricity, McKnight and McKnight, Bloomington, Illinois, 1941, 80 pages.

This book contains twenty-one projects that can be built from a variety of inexpensive materials and a minimum of tools and equipment. The needs of the beginner are met with the fundamentals of electricity included. The material will also act as a refresher for the experienced worker or teacher.

Ford, Walter B., Electrical Projects for the School and Home Workshop, The Bruce Publishing Co., Milwaukee, Wisconsin, 1951, 168 pages.

The projects presented in this book are made of inexpensive materials and are within the ability range of the average teen-age boy. This book brings a group of up-to-the-minute projects that will catch and hold the interest of junior and senior high school youth. They will illustrate electrical principles, stimulate inventive activity, develop manipulative skills and provide leisure activity for the home workshop.

Yates, Raymond F., *A Boy and A Motor*, Harper and Brothers, Publishers, New York, 1944, 111 pages.

This book has a simple direct style that will appeal to all boys. There is a brief history of development of motors and how to make them. The directions are clear and detailed. There are thirty-one diagrams and photographs included.

APPENDIX B

A List of Companies From Which Books Were Received

The writer sent out twenty-six letters to various book companies requesting a total of thirty-five books. Ten book companies responded and a total of eighteen books were received. Some of the book companies sent more than the books specified.

The following is a list of companies to which the letter was sent and from which books were received.

The Bruce Publishing Co., 400 North Broadway, Milwaukee, Wisconsin.

McKnight and McKnight, Market and Center Streets, Bloomington, Illinois.

Charles A. Bennett Co., Inc., 237 North Monroe Street, Peoria, 3, Illinois.

D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, New York.

The Macmillan Co., 60 Fifth Ave., New York, New York.

McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, New York.

American Technical Society, 848 East Fifty-eight Street, Chicago, Illinois.

John Wiley and Sons, Inc., 440 Fourth Ave., New York, New York.

Harper and Brothers, Publishers, 49 East 33rd Street, New York, New York.

Rinehart and Co., Inc., 232 Madison Ave., New York, New York.

Board of Education, 110 Livingston Street, Brooklyn, 2, New York.

OKLAHOMA INSTITUTE OF TECHNOLOGY
OF THE
OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE
SCHOOL OF INDUSTRIAL ARTS EDUCATION
AND ENGINEERING SHOPWORK
STILLWATER

May 22, 1952

As the required report for my Master's Degree, I am to revise the Oklahoma state bulletin on industrial arts, "The Course of Study in Electrical Work". This book is one of a series of courses of study issued by the State Department of Education for the use of industrial arts teachers in Oklahoma.

The first objective in the revision of this book is to select five optional textbooks. The course of study is to be documented with these textbooks. Also, a limited number of books shall be listed in a recommended supplementary book list.

Please send to me an examination copy of the elementary textbook listed below. This copy will be considered for use as one of the books to be recommended for multiple adoption.

When the study is completed, the examination copy will be returned to the sender or I will dispose of it as directed by the sender.

In addition to this, I would appreciate your sending to me your most recent catalog. We will select from the catalogs received the titles to be included in the recommended supplementary reference list.

Yours very truly,

Arland Price, Graduate Student
Oklahoma A. and M. College
9 B Grande, Veterans Village

DeWitt Hunt Adviser and Head
School of Industrial Arts Education
and Engineering Shopwork

REPORT TITLE: THE 1952 REVISION OF A COURSE OF STUDY IN BEGINNING ELECTRICAL WORK

AUTHOR: ARLAND PRICE

REPORT ADVISER: DR. DEWITT HUNT

The content and form have been checked and approved by the author and report adviser. Changes or corrections in the report are not made by the Graduate School office or by any committee. The copies are sent to the bindery just as they are approved by the author and faculty adviser.

TYPIST: Elizabeth J. Kerby
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