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ABSTRACT

This manual has been developed to aid the industrial arts teacher of electricity or electronics in implementing his course. It has been designed for beginning teachers and experienced instructors as a source for planning the term's work. Although programmed at the seventh or eighth grade level, course work is brought out in detail and could serve as a useful reference for other levels. Contained in this manual are suggested lesson plans and projects and also related material that is not required and should be adapted to the particular situation if chosen. Whenever possible woodworking and metalworking shop courses should be completed by students prior to the scheduling of this course. Objectives for the program are listed under the headings of Organizational Planning, Project Information, Guidance, Evaluation, and Safety, followed by the basic course broken down into: Organization, Electric Circuits, Sources of Electricity, Magnetism (and its applications), Testing and Measuring (electricity), Electricity in the Home, Electronics, and Industrial Education. (DS)

INDUSTRIAL ARTS

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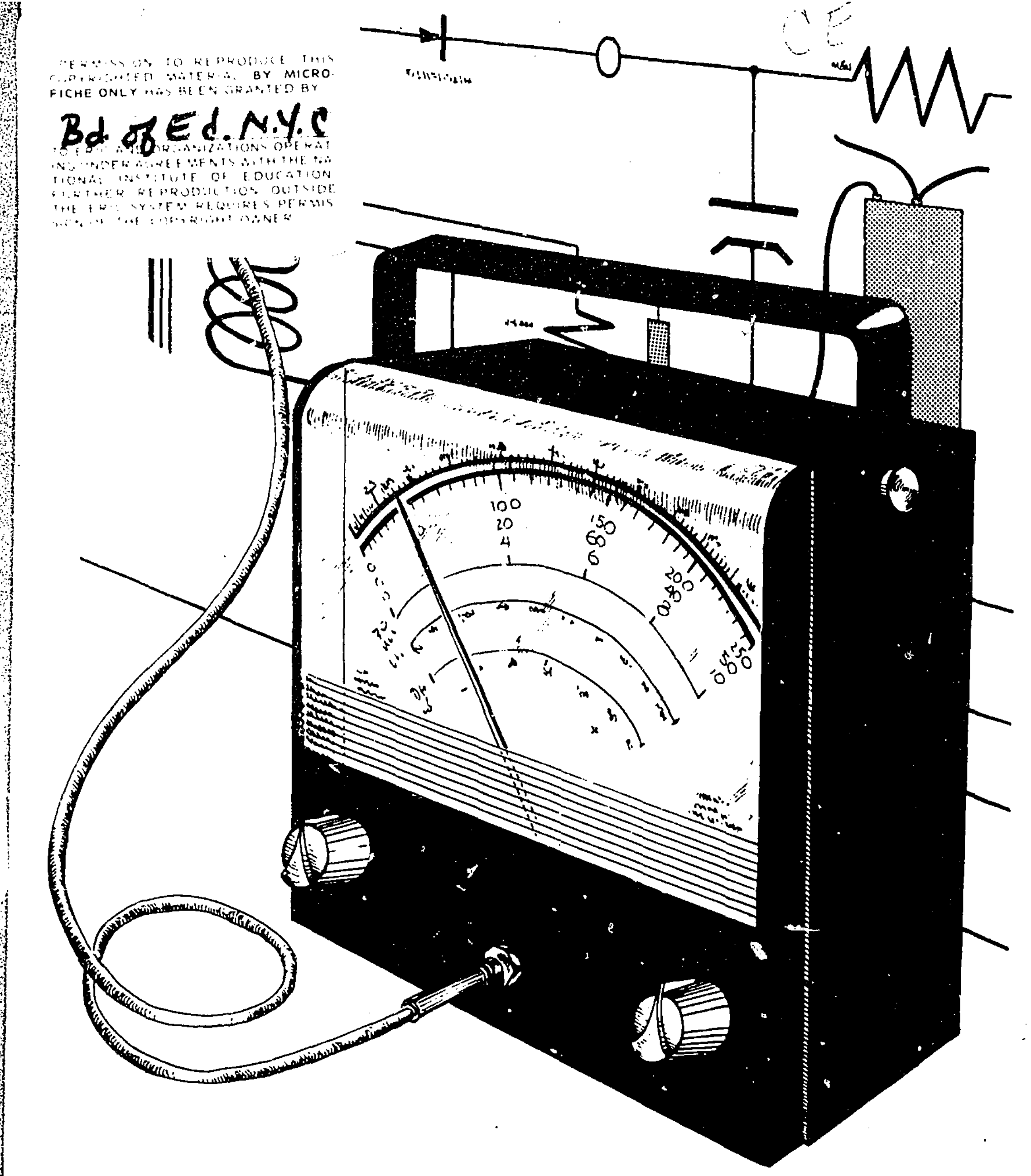

ELECTRICITY ELECTRONICS

FOR INTERMEDIATE AND JUNIOR HIGH SCHOOLS

BUREAU OF CURRICULUM DEVELOPMENT
BOARD OF EDUCATION • CITY OF NEW YORK

09-5530-30

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BOARD OF EDUCATION • CITY OF NEW YORK

BOARD OF EDUCATION

FOREWORD

This publication is designed to assist the industrial arts teacher in implementing an enriched electricity-electronics course at the intermediate and junior high school levels. Included are practical suggestions that can be adapted to meet the particular requirements of individual students, schools, and communities.

As man's dependence on the products and services of the electricity and electronics industries continues to expand, it is essential that students understand basic concepts and appreciate the contributions and opportunities being offered in this vital technological field.

This industrial arts electricity-electronics course serves as a vehicle to develop skills and knowledge and to establish positive social attitudes. In addition, the opportunities afforded enable students to discover interests and aptitudes which will help them to make decisions concerning their future education and careers.

SEELIG LESTER
Deputy Superintendent of Schools

ACKNOWLEDGMENTS

This curriculum bulletin, *Industrial Arts: Electricity-Electronics for Intermediate and Junior High Schools*, was developed as part of the Curriculum Workshop Program of the Bureau of Curriculum Development, David A. Abramson, Acting Director, in cooperation with the Bureau of Industrial Arts, Herbert Siegel, Director. Seelig Lester, Deputy Superintendent for Instructional Services, gave overall supervision to the program.

The committee which prepared the initial materials for this manual includes: William Block, Richard Braithewaite, Lawrence Chaikin, Gilbert Fishman, Donald Genco, Herbert Goldstein, David Kest, Gerald Lipkin, Irving Minkin, Jack Sackstein, Howard Sasson and Herbert Schachter.

An experimental curriculum was tried out in selected intermediate schools. Suggestions for improvement and modification were submitted by teachers and supervisors, and additional project ideas were recommended by teachers of electricity-electronics. The manuscript was reviewed and endorsed by the Association of Chairmen of Industrial Arts, and the Standing Advisory Committees for Industrial Arts in the Junior High Schools and Senior High Schools.

Final revisions of the manuscript were prepared by a committee of teachers and supervisors from intermediate schools, and academic and vocational high schools. This committee included Howard Sasson, teacher of industrial arts; Gerald Lipkin, chairman of industrial arts; Adolph Suchy, chairman of related technical subjects; Arthur Lefgren, chairman of electronics, and Lawrence Chaikin, teacher of industrial arts. Arthur E. Golomb formulated the objectives of the program and participated in the final editing of the manuscript.

Daniel A. Salmon, Acting Assistant Director, Bureau of Curriculum Development, served as editor and coordinator of this project. Drawings were done by Donald Pitkoff who also designed the cover. Photographs were taken by John Kane, official photographer for the Board of Education, or were supplied by cooperating agencies. Edythe Kahn, Editor, supervised the production of this manual. Eleanor Shea edited the manuscript; Elena Lucchini and Ellwood White were responsible for the page design and layout.

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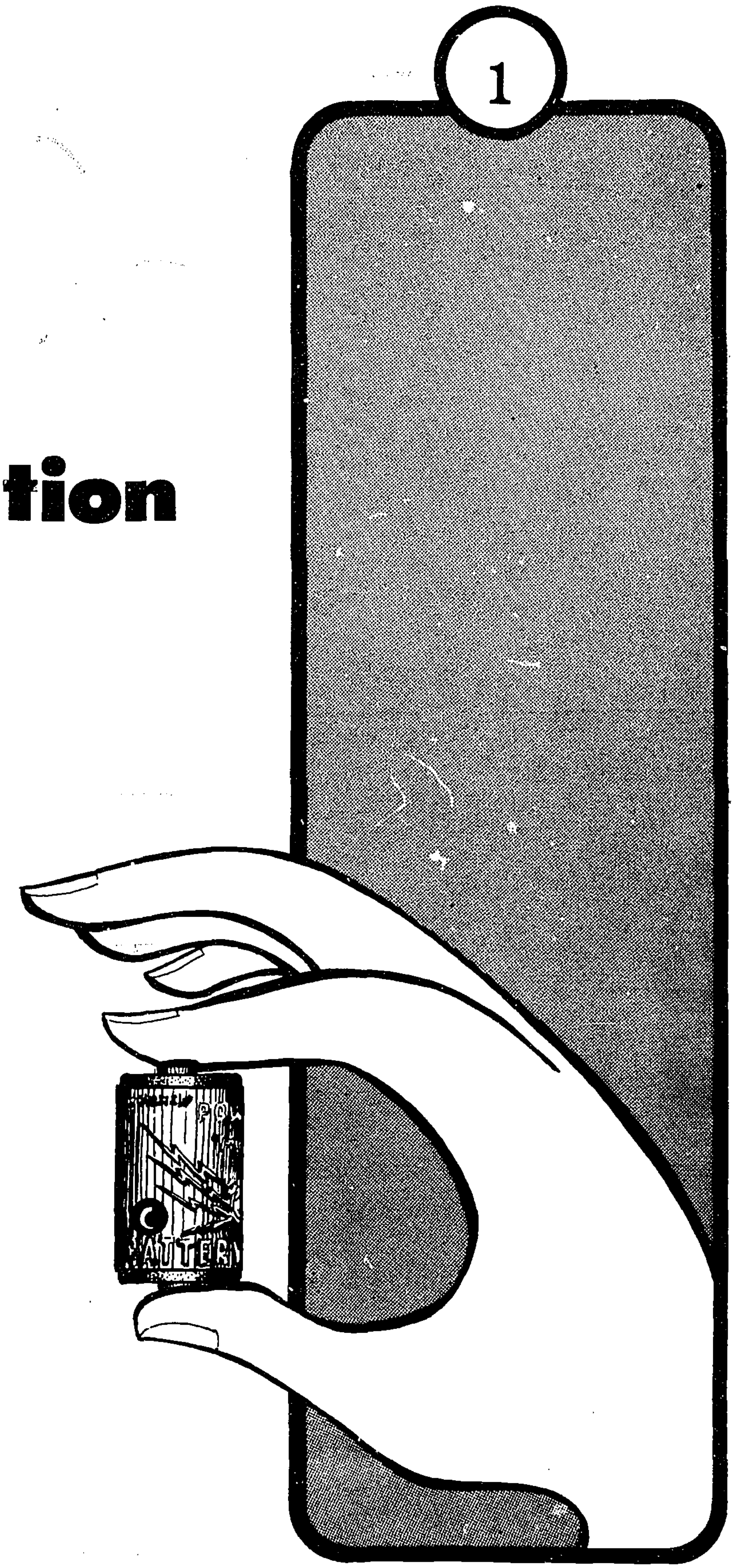
Introduction



GENERAL INFORMATION

This manual has been developed to aid the industrial arts teacher of electricity-electronics. The information found here has been designed as a reference for both the beginning teacher and the experienced instructor, and should be useful as a source for planning the term's work.

Industrial Arts Shop Management[1] and *School Shop Safety Manual*[2] are to be used in conjunction with this manual. These guides contain information necessary for the organization and administration of the industrial arts shop program.

FLEXIBILITY IN USING THIS BULLETIN

The units of work in this manual contain suggested lesson plans, suggested projects, and related material. The projects are not required problems, but examples of materials and information. Teachers may develop a variety of projects and materials based on the information in this bulletin. Because of different facilities and programs in the intermediate schools, it will be necessary for each teacher to adapt these materials to his own situation.

PROGRAMMING

This course has been designed for seventh and eighth grade industrial arts classes. Whenever possible, the students should have completed woodworking and metalworking shops prior to being scheduled for this course. The content of this course is designed primarily for a programming situation of four periods a week for five months, or two periods a week for ten months. This should be done with double period blocks. For other programming situations, the schedules can be modified.

COURSE EMPHASIS

This program emphasizes student experiences and activities which foster an understanding of basic concepts. Project work will still receive suitable emphasis, but not to the exclusion of the development of basic understandings and concepts.

TIME DIVISION

In order to accomplish this it is recommended that the ninety minute period be divided into:

Group Instruction	
Concepts and Content Lessons	15 minutes
Student Activities	
Experiments and Manipulative Work	65 minutes
Shop Management	
Attendance and Cleanup	10 minutes
Total Daily Time	90 minutes

It is of considerable importance that each class receive instruction in the development of concepts each time it meets. Instruction in the various operations and processes should be developed as required, supplementary to, but not as a substitute for instruction in the development of concepts.

1. Board of Education, City of New York. Curriculum Bulletin No. 9, 1964-1965 Series.
2. Board of Education, City of New York. Curriculum Bulletin No. 13, 1964-1965 Series.

OBJECTIVES OF THE PROGRAM

To provide a basic understanding of electricity-electronics through manipulative skills, projects, experiments, and related experiences.

To encourage an interest in the electricity-electronics industry through instruction in basic principles and concepts.

To determine talents and interests in electricity-electronics which may lead to a wise choice of vocation.

To inform the student of occupational opportunities in the electricity-electronics industry and possibilities for further experience and education.

To teach shop skills through the design, construction, and testing of electricity-electronics projects and equipment.

To demonstrate industrial procedures in the field of electricity-electronics including mass production, printed circuits, and automated processes.

To develop an appreciation of good design and workmanship in the construction of shop projects and commercially produced electricity-electronics equipment.

To emphasize safe practices in the handling and repair of electricity-electronics equipment.

To foster desirable social attitudes by encouraging students to work in groups or as part of a team.

To illustrate some of the basic skills and knowledge needed for employment in the electricity-electronics industry.

To develop communication skills by enlarging student vocabulary of technical terms.

To teach methods of graphic representation, working drawings, sketches, and schematics used in electricity-electronics.

To suggest worthwhile leisure-time activities in electricity-electronics.

To provide problem-solving activities which will challenge each student to the limit of his capacity.

To relate theoretical learnings of other subject areas to the application of practical shop problems and projects.

BASIC COURSE

SCOPE AND SEQUENCE

Unit	Number of Lessons
I. ORIENTATION	4
Introduction to the shop	
Electron theory	
Units of electricity	
Conductors and insulators	
II. ELECTRICAL CIRCUITS	4
Electrical and electronic symbols	
The circuit	
Connecting sources and loads in series	
Connecting sources and loads in parallel	

III.	SOURCES OF ELECTRICITY (other than the generator) Chemical sources of electricity Other electrical sources: photoelectricity, thermoelectricity Other electrical sources: piezoelectricity, bioelectricity	3
IV.	MAGNETISM AND ITS APPLICATIONS Magnetism The generator The transformer The motor	4
V.	TESTING AND MEASURING ELECTRICITY Simple tests Meters: voltmeter, ammeter, ohmmeter Other testing instruments (VOM, VTVM, oscilloscope, etc.)	3
VI.	ELECTRICITY IN THE HOME Electrical safety Protective devices Electrical codes in home wiring Home wiring systems	4
VII.	ELECTRONICS Vacuum tube Transistor Radio transmission Radio reception Amateur radio	5
VIII.	INDUSTRIAL EDUCATION Automation Educational-vocational guidance Consumer education	3
	Total	30 Lessons

RECOMMENDED OPERATIONS AND PROCESSES

1. Stripping a wire
2. Connecting wire to a terminal
3. Making a pigtail splice
4. Soldering a joint
5. Taping a joint
6. Wiring techniques
7. Determining sources and loads in series
8. Determining sources and loads in parallel
9. Making continuity checks
10. Testing for short circuit
11. Winding an electromagnet
12. Reading a kilowatt-hour meter
13. Using an ammeter
14. Using a voltmeter
15. Using an ohmmeter
16. Testing a tube
17. Using a multimeter
18. Tieing Underwriters' knot
19. Wiring a plug
20. Wiring a socket
21. Using a wire gage
22. Straightening wire
23. Using solder lugs
24. Using a metered power supply
25. Testing fuses
26. Replacing fuses
27. Using mechanical connectors
28. Making an etched circuit

29. Drawing schematic diagrams
30. Monitoring amateur radio
31. Using a ruler
32. Laying out a project base
33. Using a template for layout
34. Using jigs and fixtures
35. Using a center punch
36. Using a hand drill
37. Using a hand punch
38. Using a bench punch
39. Using a tinner's snips
40. Using a countersink
41. Using a reamer
42. Using a file
43. Using a standard screwdriver
44. Using a Phillips screwdriver
45. Using an Allen wrench
46. Bending metal
47. Forming a safety hem
48. Using a bar folder
49. Using a box and pan brake
50. Riveting metal
51. Using a chassis punch
52. Using a hacksaw
53. Using a sidecutting pliers
54. Using diagonal cutting pliers
55. Using combination pliers
56. Using round nose pliers
57. Using long nose pliers
58. Using wire strippers
59. Using a hammer
60. Using a drill press
61. Drilling glass
62. Using a soldering iron
63. Resetting a circuit breaker
64. Changing a wall switch
65. Changing a receptacle
66. Changing a socket
67. Making a simple bell circuit
68. Making a bell-buzzer call return system
69. Making an alarm circuit, using relay
70. Making a two-station telephone circuit

TOPICS FOR ENRICHMENT

These topics may be used as subjects for student investigation and reporting on an individual or committee basis, as material for enriching the lessons given to the class by the teacher, or as supplementary materials for classes or students who have had previous experience in this field.

Electric Power

- The generation of electricity
- The transmission of electricity to homes and industry
- The distribution of electricity in the home
- Modern wiring systems
- The kilowatt-hour meter

Lighting

- The incandescent lamp
- The fluorescent lamp
- The electroluminescent lamp
- Neon lighting
- Mercury vapor lighting
- Carbon arc lighting
- The laser

Heating

- Devices which produce heat
- Thermoelectric heating and cooling
- Electric welding
- Thermostatic control of heating devices

Control

- Factors which control resistance
- Factors which control current and voltage
- Ohm's law
- Power formula

Educational and Vocational Guidance

- High school courses in electricity and electronics
- Community college courses in electricity and electronics
- University courses in electricity and electronics
- Opportunities available for licensed electricians
- Opportunities available with public service companies such as the New York Telephone Company, Consolidated Edison, the Transit Authority, and Port of New York Authority
- Opportunities in the data processing field
- Opportunities in the communications industry

COMMUNICATIONS

- Development and operation of the telegraph
- Development and operation of the teletype
- Development and operation of the telephone
- Learning and using the Morse code
- Television transmission and reception
- Development and operation of microwave systems
- The printed circuit
- The integrated circuit

ALTERNATIVE COURSE

This course in electricity-electronics is for students with special abilities and/or those who have already completed the basic course. The guide for the alternative course is flexible and may be adapted to the individual class situation.

Class lesson topics may be developed within the framework of the Alternative Course Scope and Sequence. Thirty topics may be selected from among fifty or more suggested in this section. Other topics in the areas of electronics and communications may be introduced even though they may not be listed specifically. The latest developments in the rapidly expanding technological area should be introduced into the course by the instructor.

The operations and processes in this section are essentially the same as those in the basic course, with the exception that there should be stronger emphasis on those skills which are related to the areas of electronics and communications.

SCOPE AND SEQUENCE

Unit	Pupil Activities
I. INTRODUCTION TO ELECTRONICS	
Introduction to the shop Safety, pupil personnel, orientation Review of electron flow Units of electricity Review of basic circuits	Begin basic project, tube tester.
II. COMPONENTS USED IN ELECTRONICS	
Resistor Capacitor Inductor Transformer Rectifier Vacuum tube Transistor Other solid state devices	Construct a solid state battery charger.
III. ELECTRONIC CIRCUITRY	
Hand wired circuits Printed circuits Integrated circuits Modular circuit construction	Do individual projects and experiments.

IV. Electronics Industries

Television manufacturing
Appliance manufacturing
Electrical parts manufacturing
Test equipment manufacturing
Data processing
Communications

Arrange field trips. Invite guest speakers.

Do mass production project.

V. Amateur Radio

How to become a radio amateur
Short wave listening techniques
How to operate an amateur radio station
Learning the Morse code
Comparison with citizens band radio
Other radio services

Practice code. Study for licensing as a "ham."

VI. Testing and Measuring in Electronics

Meters
The VOM and VTVM
The oscilloscope
The signal generator
The signal tracer
The tube tester

Utilize all test equipment in tracing various circuits.

VII. Applications of Electronics

Communications
Industry
Home
Medicine
Aerospace

Construct individual projects and experiments.

VIII. Consumer Knowledge

Portable radios
Television sets
High fidelity phonographs
Electronic equipment
Kits

Use catalogs properly.

IX. Careers in Electronics

For engineering graduates
For community college graduates
For technical school graduates
For vocational course graduates

Prepare reports on various occupations.

X. New Developments in Electronics

As reported in current publications such as:
Scientific American
Popular Electronics
Electronics World

Use school library resources.

RELATIONSHIP OF ELECTRICITY-ELECTRONICS TO OTHER SUBJECTS

Electricity-electronics provides experiences that reinforce the content of other subject fields. Factors such as content, principles, academic skills, and attitudes underlie the relationship between various subject areas.

SCIENCE

Opportunities to do research and experimentation; development of problem-solving skills, incorporating the scientific method; development of mechanical skills for science equipment construction; practical application of scientific principles; designing of circuits taking into account the physical properties of each component; composition and properties of industrial materials.

MATHEMATICS

Use of measuring and layout devices; practical application of mathematical principles in designing and planning projects; development of computational skills; relationship of various electrical forces as expressed and developed through various formulae; problem solving; problems in costs and materials; making a bill of materials; estimation and mental computation.

SOCIAL STUDIES

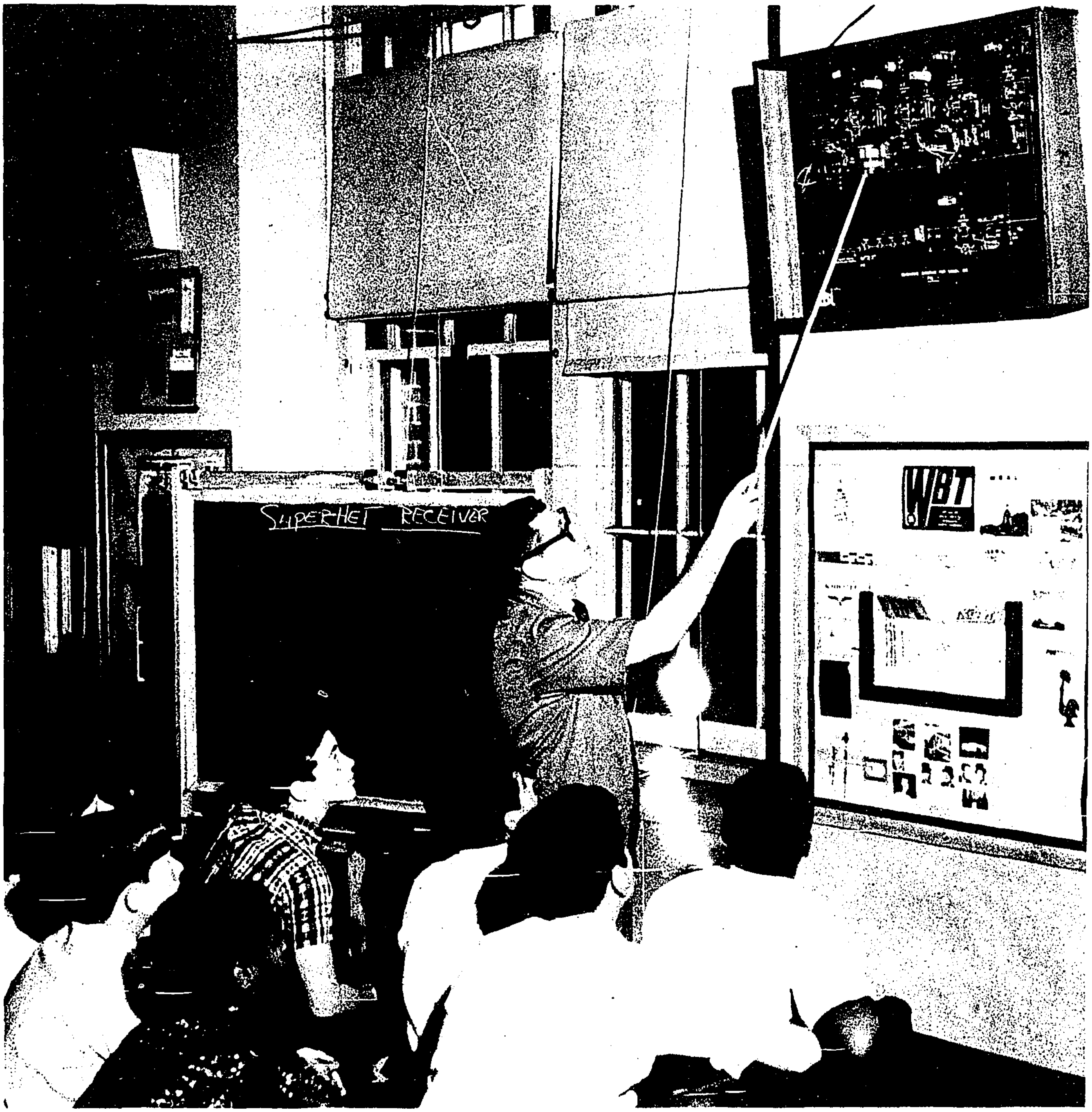
Investigation of industrial methods and materials, appreciation for conservation of natural resources; examination of industrial history and development; geography; economics; automation; building codes; use of international symbols and units; mass production; labor organizations; occupational information; sources of raw materials; changing of raw materials into useful products; industrial products used in home living; development of tools and machines; study of famous men in the field.

LANGUAGE ARTS

Utilization of oral and written communication in shop activities; enrichment of technical vocabulary; development of specialized language skills through the preparation of reports, materials, studies, lists, and procedural notes; writing of a bill of specifications before constructing a project; writing steps for procedure prior to the construction of a project; following written directions for project construction; following directions on labels; correct word usage.

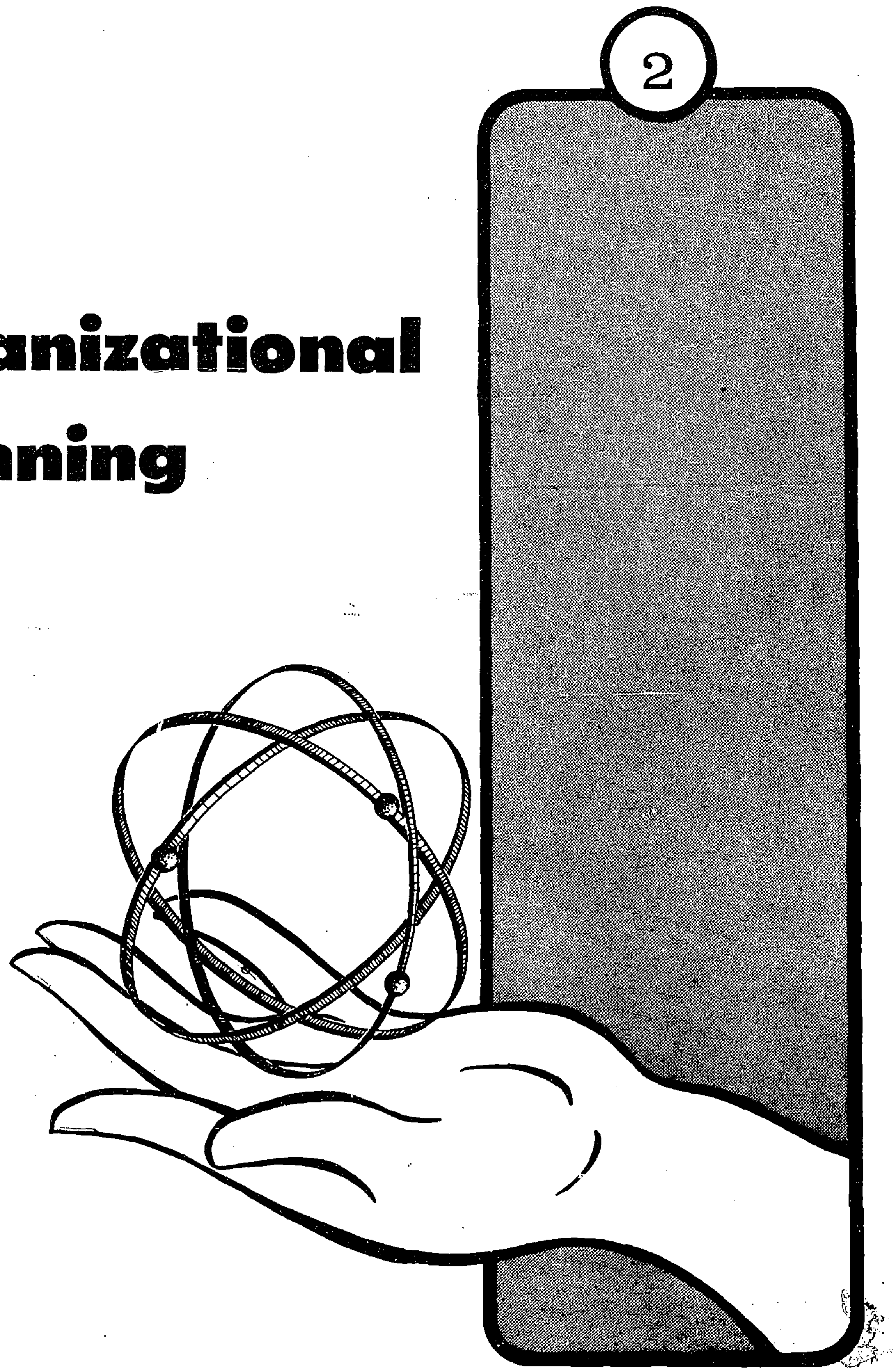
HEALTH, RECREATION, AND SAFETY

Development of safety habits and attitudes for home, school, and industry; personal hygiene; values of working with tools and materials for recreation; development of a hobby; construction of equipment to safeguard health and safety; development of physical self through manual activities; correct procedures in handling materials; use of safety devices; importance of correct lighting and ventilation; safe storage of tools and materials.



Teaching aids help pupils to learn the fundamentals of radio circuitry.

Organizational Planning



SUGGESTIONS FOR ORGANIZING TEACHING MATERIALS

Teachers should use a loose-leaf book, size 8½ x 11, as a binder for their plans. The contents of the book may be in this order:

Frontispiece with the name of the school, shop, teacher, room

A description of the shop and a short explanation of the objectives of the shop program as part of the total school program

A term plan listing the shop activities on a seventeen week basis with demonstrations, projects, and related lessons

A weekly plan, prepared one week in advance, to include a daily listing of the period, class, projects, demonstrations, and related lessons to be given that day

Lesson plans for demonstrations and related lessons. The detailed steps for these plans may be prescribed by the school principal. A suggested format is used in this manual; others are available in *Industrial Arts Shop Management* (Curriculum Bulletin No. 9, 1964-65 Series) and curriculum bulletins for other industrial arts courses. The file of plans should be numbered and referred to in the teacher's weekly plan described above.

Working drawings related to projects constructed in the shop

PROGRESS CHARTS

The Industrial Arts Progress Charts are used by teachers to maintain the individuality of the instructional program. Entries on the chart may include the pupils' names, official class, and a record of pupil test marks, operations and processes performed, projects completed, and any nonconfidential remarks about the needs and progress of the class. The back of the progress chart may be used for lesson checkoff and or class management. Many teachers prepare an overlay listing all of the standard projects and processes. This may be pasted over the appropriate spaces on the chart headings.

SHOP RECORD CARDS

An Industrial Arts Shop Record Card should be completed for every student. This card is to be used as a guide for programming students for the various shops at each grade level and for every term in the school. Such records make it possible to equalize shop registers and insure pupil experience in all shops.

Daily shop attendance records must be kept. The Number 11 attendance book or Delaney book is suggested.

CRITERIA FOR PLANNING

1. Time schedules should take into account: holidays, test periods, assemblies, open school days, term cleanup, etc.
2. Units should be completed during the allotted portion of the term.
3. Plans should be sufficiently detailed and practical.
4. Periodic testing and evaluation should be included in each unit to determine the degree of teaching effectiveness and student progress.
5. Plans should serve as practical and useful aids to the teacher and student, and they should not require an inordinate amount of teacher time for organization and development.
6. Adequate shop facilities, equipment, and supplies should be available.

7. Individual differences—manual and mental ability and students' past experience with tools and machines should be considered in lesson planning and project construction.
8. Programs should be designed for maximum utilization of all of the equipment in the shop.

OUTSIDE ASSIGNMENTS

1. Assignments of reasonable length should be given on a regular basis, about once a week. (The school may determine this policy.)
2. Assignments should be adjusted to the ability of the class and to the needs of groups of children within the class.
3. Student homework should be checked and recorded by the instructor on a regular basis.

TERM PLAN

Lessons	Pupil Activities	Homework Assignments
1. Introduction to the Shop	Explain shop routines. Distribute and discuss safety rules. Demonstrate some interesting devices that the pupils will learn about and make.	Have parents sign list of safety rules. Prepare several paragraphs on what effect an extended power failure would have on your family's life. Bring in notebook, pencil, cigar box, or envelope.
2. Electron Theory	Give safety test. Review homework. Show and explain basic project. Distribute project bases, and have students mark their name and class on them so that this information cannot be removed.	Organize shop notebook into sections.
3. Units of Electricity	Start continuity tester. Start Pupil Personnel Plan.	
4. Conductors and Insulators	Continue to work on continuity tester.	Prepare a suitable cover for shop notebook. Decorate cover.
5. Electrical and Electronic Symbols	Begin construction of wiring boards using practical exercise sheets. The most advanced students should start first. By midterm each student should have completed two wiring exercises.	

6. The Circuit	Continue to work on continuity tester. Several groups of students work on wiring boards.	Prepare a section in notebook showing five tools you have learned to use.
7. Connecting Sources and Loads in Series	Complete continuity tester.	
8. Connecting Sources and Loads in Parallel	Continue construction of wiring boards. Begin complex wiring project (quiz, baseball, computer, etc.). This project is suggested for mass production.	Assign pupil research reports. Each pupil should report on a notable contributor to the field.
REVIEW AND EXAMINATION		
9. Chemical Sources of Electricity	Continue on second project. Groups of students can make various kinds of cells: dry cell, wet cell, lemon cell, cheese cell, etc.	
10. Other Electrical Sources: Photoelectricity Thermoelectricity	Continue on second project. Experiment with photocells and thermocouples.	Read newspaper articles referring to advances in electricity-electronics. Clip several of these articles and paste into notebook. Write a brief paragraph explaining the importance of the new development.
11. Other Electrical Sources: Piezoelectricity Bioelectricity	Continue complex wiring project. Experiment with phonograph crystals.	
12. Magnetism	Complete complex wiring project.	Read classified advertisement section of local newspaper. Clip and paste into notebook several ads showing different kinds of jobs available in the electricity-electronics industry.
13. The Generator	Begin magnetism project (telegraph set, pick-up-stick, clicker-buzzer relay, etc.).	
14. The Transformer	Continue on magnetism project.	Begin a listing in your notebook of all the stores and factories in your area that deal mostly with electrical-electronic devices and services.
15. The Motor		
REVIEW AND EXAMINATION		
16. Simple Tests	Continue work on magnetism project. Check and repair home electrical appliances.	Read local newspaper advertisements for technical schools offering courses in electricity-electronics.

17. Meters: Voltmeter, Ammeter, Ohmmeter, Multimeter	Complete magnetism project. Use meters for current, voltage, and resistance measurements on project and practical exercise boards.	Clip these ads and paste them into your notebook.
18. Other Testing Instruments: Oscilloscope, Signal Generator, Signal Tracer, VTVM, etc.	Begin brief student oral reports to the class. Use tube tester to test tubes brought in from home.	
19. Electrical Safety	Begin light/heat project. Wire plug and socket. Tie Underwriters' knot.	Prepare your own list of five rules of electrical safety in the home.
20. Protective Devices	Begin use of wiring booth.	Draw diagrams of two types of fuses and identify each.
21. Electrical Codes in Home Wiring	Continue work on heat and light project.	Plan and describe one electrical improvement that you might make in your home.
22. Home Wiring Systems	Continue project and wiring booth. Complete light and heat project.	
REVIEW AND EXAMINATION		
23. Vacuum Tube	Begin electronics project.	
24. Transistor	Continue electronics project. Begin use of electronics kits.	Prepare a list of devices that use transistors.
25. Radio Transmission	Continue project construction. Begin amateur radio monitoring.	
26. Radio Reception	Continue project construction. Begin short periods of Morse code. Practice on code practice oscillator.	Prepare a short report in your notebook on Citizens Band Radio.
27. Amateur Radio	Continue project construction.	
28. Automation	Begin second mass production project.	Begin a review of term's work. Prepare questions for teacher to answer.
29. Educational-Vocational Guidance	Continue second mass production project.	
30. Consumer Education	Complete all projects.	Complete review of work.
REVIEW and FINAL EXAMINATION		

LESSON CHECKLIST

LESSON	CLASS							
1. Introduction to the Shop								
2. Electron Theory								
3. Units of Electricity								
4. Conductors and Insulators								
5. Electrical and Electronic Symbols								
6. The Circuit								
7. Connecting Sources and Loads in Series								
8. Connecting Sources and Loads in Parallel								
9. Chemical Sources of Electricity								
10. Photoelectricity; Thermoelectricity								
11. Piezoelectricity; Bioelectricity								
12. Magnetism								
13. Generator								
14. Transformer								
15. Motor								
16. Simple Tests								
17. Meters								
18. Other Testing Instruments								
19. Electrical Safety								
20. Protective Devices								
21. Electrical Codes in Home Wiring								
22. Home Wiring Systems								
23. Vacuum Tube								
24. Transistor								
25. Radio Transmission								
26. Radio Reception								
27. Amateur Radio								
28. Automation								
29. Educational-Vocational Guidance								
30. Consumer Education								

SHOP NOTEBOOK

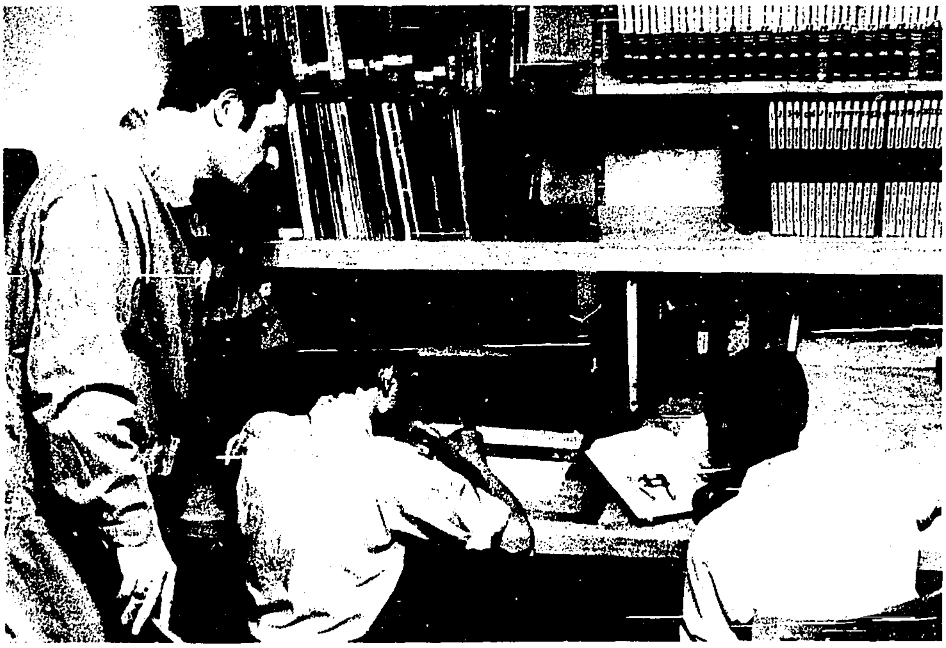
A shop notebook should be kept by every student. There are several reasons for keeping a shop notebook:

There is better retention of concepts when they are written as well as discussed.
The notebook is a source of information for problem-solving.
It is a means of reviewing materials covered in class.
The notebook is a source of information for problem-solving.
It provides parents with evidence of a good program.

Students should bring their notebooks to class at each session. Notebooks should be examined and graded periodically.

A shop notebook may contain these sections:

Shop Safety Rules
Tools and Machines Learned
Processes Learned
Vocabulary
Lesson Notes
Projects Planned and Constructed
Assignments
Newspaper Clippings
Suggested Readings
Occupational Information
Shop Personnel System
Shop Log
Demonstration Summary



Planning and research are important aspects of the industrial arts electronics program.

SHOP LOG

The daily shop log may be an integral part of the student shop notebook. In this log the student notes the date of the shop session and the activity he was engaged in. This record makes the student accountable for his time in the shop, shows the length of time he took on each project and the amount of work he completed. It is usually filled in at the end of each working period.

SAMPLE SHOP LOG

Name________________ **Course**________________ **Date Began**________________

Session Number	Date	Activity
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
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22		
23		
24		
25		
26		
27		
28		
29		
30		

WEEK OF 2-18- SAMPLE WEEKLY PLAN John Jones, INSTRUCTOR

PD.	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
1 & 2	Group A Lesson No. 3 UNITS OF ELECTRICITY	Group D Lesson No. 4 CONDUCTORS & INSULATORS	Group F Lesson No. 3 UNITS OF ELECTRICITY	Group __ Lesson No. __ ADMINISTRATIVE	Group E Lesson No. 4 CONDUCTORS & INSULATORS
3 & 4	Group B Lesson No. 3 UNITS OF ELECTRICITY	Group __ Lesson No. __ ADMINISTRATIVE	Group B Lesson No. 4 CONDUCTORS & INSULATORS	Group A Lesson No. 4 CONDUCTORS & INSULATORS	Group __ Lesson No. __ ADMINISTRATIVE
7 & 8	Group C Lesson No. 3 UNITS OF ELECTRICITY	Group E Lesson No. 3 UNITS OF ELECTRICITY	Group C Lesson No. 4 CONDUCTORS & INSULATORS	Group D Lesson No. 5 SYMBOLS	Group F Lesson No. 4 CONDUCTORS & INSULATORS

PUPIL PERSONNEL PLAN

Job	Duties
General Manager (Instructor)	1. Supervises the operation and insures the functioning of the entire program. 2. Assists pupil management and labor in the formation and operation of policy and standards.
Superintendent	1. Coordinates work of all personnel. 2. Checks attendance. Gives absentee list to teacher. 3. Calls conferences of management. 4. Assumes duties of shop foreman in case of his absence. 5. Takes charge of the class when the teacher is occupied with a visitor. 6. Rings signal bells for cleanup.
Safety and Production Engineer	1. Inspects the shop daily for safety hazards. 2. Regulates lighting and ventilation. 3. Takes charge of shop maintenance work. 4. Assists instructor in supervising proper work procedures. 5. Schedules use of special facilities to prevent tie-ups.
Publicity Coordinator	1. Greets visitors to the shop. 2. Takes charge of bulletin board and displays. 3. Assists in the preparation of a story for the school newspaper.
Shop Foreman	1. Directs cleanup process. 2. Assigns substitutes to duties as needed. 3. Receives completion reports from unit heads below him. 4. Reports to the superintendent when cleanup is properly completed. 5. Reports problems to the superintendent. 6. Assumes duties of superintendent when he is absent.
Supplies Foreman	1. Is responsible for checking and storing new supplies. 2. Distributes supplies to students. 3. Keeps records of what is distributed.
Equipment Engineer	1. Checks condition of all pieces of equipment at the end of the period. 2. Puts away portable equipment that must be stored. 3. Reports to the foreman when his job is completed.
Storage Foreman	1. Distributes and stores student materials. 2. Is responsible for security of student materials.
Tool Cabinet Inspector	1. Is responsible for the tools in the tool cabinet. 2. Checks tools before any are given out. 3. Distributes tools as needed.

4. Collects and stores tools at the end of the period.
5. Checks for missing and damaged tools at the end of the period.
6. Reports to foreman when his duties are completed.

APRON AND VISE INSPECTOR

1. Maintains aprons and checks them at the end of the period.
2. Cleans, adjusts, and inspects each vise at the end of the period.
3. Reports to the shop foreman when his job is finished.

SANITATION INSPECTOR

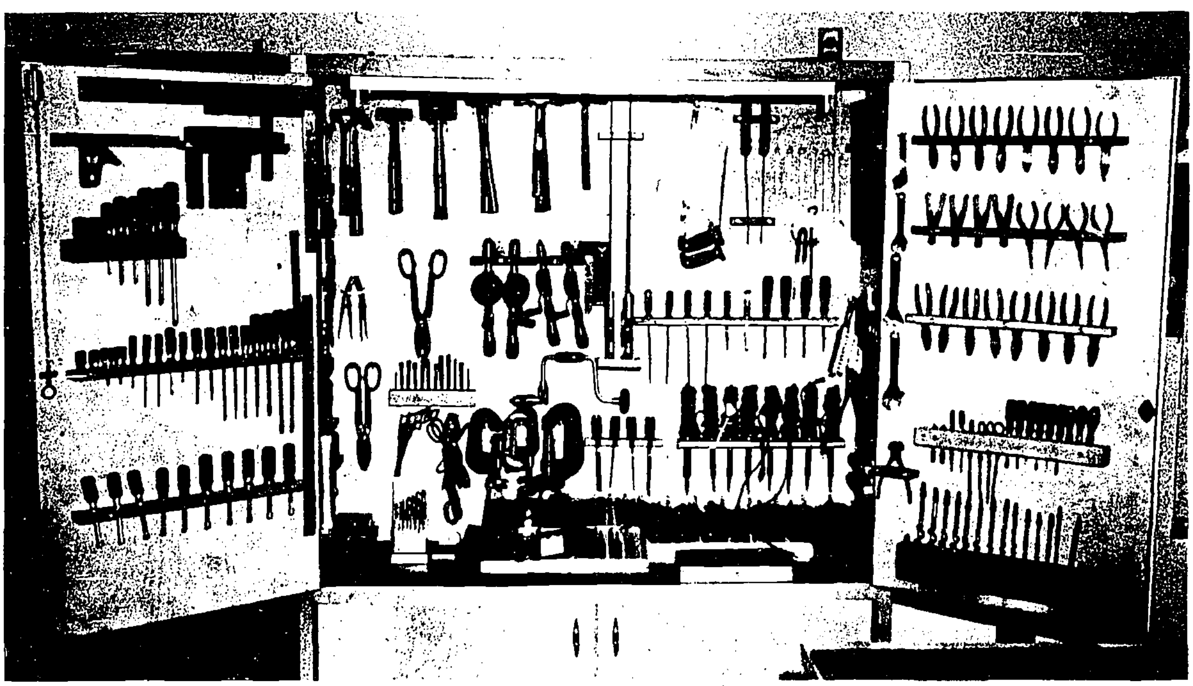
1. Refills soap and paper towel containers as needed.
2. Makes sure floor around sink is clear of paper towels.
3. Cleans sink.
4. Reports to foreman when his duties are finished.

FINISHING AREA INSPECTOR

1. Inspects the area to see that it is orderly and clean.
2. Makes sure that paint and oily rags are deposited in metal containers.
3. Supervises storage of finished projects.
4. Places a fresh layer of newspaper over the area for the next class, if it is required.
5. Reports to the foreman when his duties are completed.

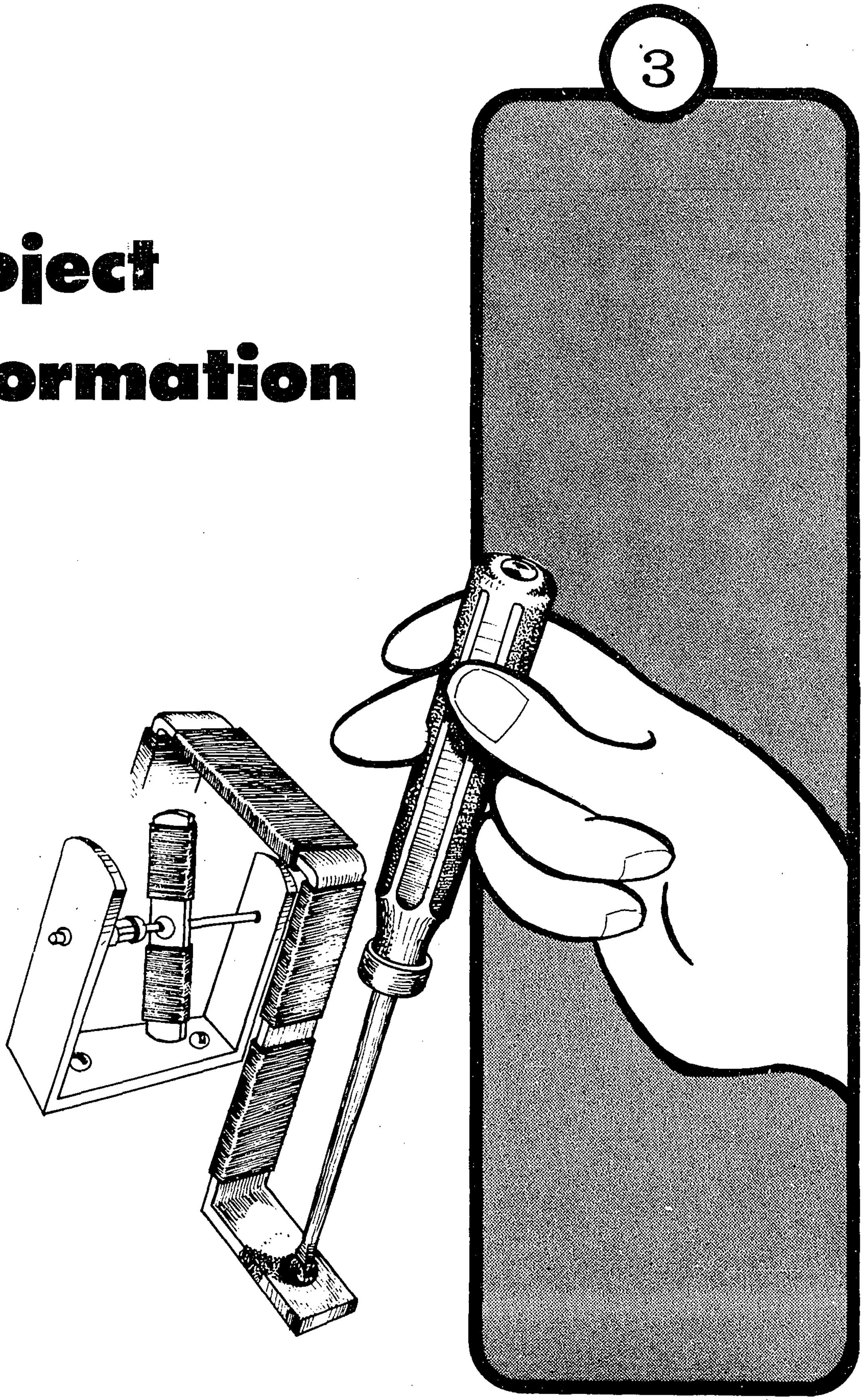
SWEEPERS

1. Assist in clearing and sweeping benches.
2. Sweep floor.
3. Return salvageable materials to the supply foreman.
4. Place trash in the basket.
5. Report to shop foreman when duties are completed.



A well-organized cabinet is used for general purpose handtools.

Project Information



PROJECT METHOD

The project method of instruction is a very important part of the industrial arts program. The planning, designing, and fabricating of the project requires the student's attention and involvement for the major portion of his time in the shop. As much as 75% of the total class time is allotted to the planning and execution of the project.

To the student, the project is a useful, attractive object that he will bring home to be admired by family or friends. To the teacher, the project is the means by which he will provide the manipulative experiences with tools and machines and develop wholesome work habits and attitudes.

CRITERIA FOR PROJECT SELECTION

Before an electricity-electronics project is selected, careful consideration of these criteria is necessary:

Projects should incorporate operations and processes that are listed in this manual.

Lessons should be taught to demonstrate pertinent skills and related information.

Safety hazards should be recognized, and safety precautions should be taken.

Projects should be within the ability of the student to complete within the time allotted.

Required tools and machines should be available.

Materials should be obtainable; cost should be within budget allotment.

Projects should be well designed and useable.

Projects should be modified to meet individual differences.

Space should be available for building and storing projects.

Projects should have student interest.

Projects should promote problem-solving activity.

CLASSIFICATION OF PROJECTS

Projects that are made in the electricity-electronics shop are classified in these categories: basic, individual, group, mass-produced, and combined.

Basic Project

The basic project is the initial activity that introduces fundamental skills, operations, and processes that are germane to a particular unit or work area of the shop. Because the industrial arts electricity-electronics shop may include work in many areas reflecting important segments of the industry, a basic project is made in each of these major work areas or in as many areas as time will permit. A basic project, however, may require operations outside the area it represents. For example, a basic electronics project may entail supplementary operations in the sheet metal section of the shop.

The basic project may be assigned to the entire class to make certain that all students cover a predetermined series of operations and processes. Basic projects should be small, of short duration, and within the range of ability of the average student to allow ample time for construction of other projects.

Individual Project

The individual project is one chosen by the student or suggested by the teacher after one or more basic projects have been completed.

Group Project

The group project involves the cooperative effort of two or more students who work together as a team. This type of project is valuable because it fosters leadership, cooperation, and the desire to give service for the betterment of the group.

Mass-Produced Project

The mass-produced project demonstrates the "division of labor" concept that is employed in industry to speed production and reduce costs. This type of project requires solving production problems that are inherent in any manufacturing plant. Prerequisites for efficient functioning of the production line are job analysis, setting up work stations, inspection and quality control. The role of planning and the use of labor-saving devices, such as power driven machinery, jigs, and fixtures are emphasized.

SELECTION OF PROJECTS

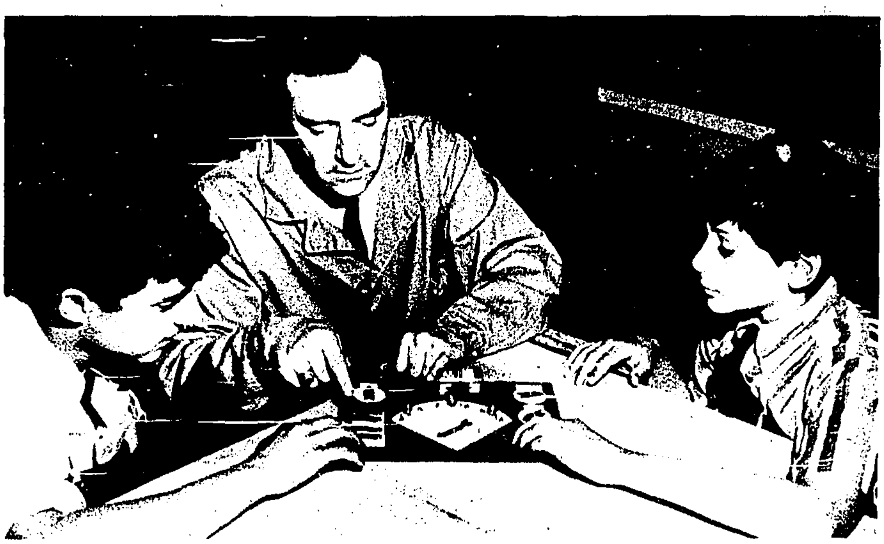
Projects can be selected from many sources including workbooks, textbooks, magazines, plan sheets, catalogs, advertisements, photographs, drawings, models, and many others. The problem is not the dearth of projects, but the selection of suitable ideas that can be completed in the shop within the inherent limitations of the program.

Over a period of time the teacher will develop a file of project ideas to which he can refer. These files should be kept up-to-date, and newer material should be noted with a date stamp. Projects that are found to be impractical should be discarded after evaluation is made. (See form, p. 26.)

Projects may be categorized according to the related area or industry. These areas include:

Continuity Testers	Magnetism	Heating
Complex Circuitry	Electronics	Lighting

Each teacher is expected to improve his collection of project ideas. The inexperienced teacher can secure much information by consulting with his chairman, his supervisor, other teachers, members of the staff of the Industrial Arts Department, and by attending meetings of several professional organizations which have been organized to promote industrial arts.



The teacher demonstrates how to use a project built by students in the shop.

INDUSTRIAL ARTS PROJECT EVALUATION

Shop____________________ **Class**__________ **Teacher**________________________ **Date**__________

Activity Area____________________________ **PROJECT**________________________

Materials Required____

Estimated Cost__________________________ **Time Required for Construction**________ Hours

Check the appropriate box in each of the following questions.

Rating Scale: Maximum Rating, (4) ; For the Most Part, (3) ; To Some Extent, (2) ; Not at All, (1).

		4	3	2	1
1.	Does the project incorporate basic operations and processes?	☐	☐	☐	☐
2.	Is the project of interest to the student?	☐	☐	☐	☐
3.	Does the project have practical value?	☐	☐	☐	☐
4.	Does the project introduce new industrial processes?	☐	☐	☐	☐
5.	Does the student have the ability to make the project?	☐	☐	☐	☐
6.	Can the project be completed within a reasonable time limit?	☐	☐	☐	☐
7.	Does the project appear to be well designed?	☐	☐	☐	☐
8.	Is the project reasonable in cost?	☐	☐	☐	☐
9.	Are the materials for the project available in the shop?	☐	☐	☐	☐
10.	Does the project provide opportunity for problem solving, planning, and individual design application?	☐	☐	☐	☐

Use the space below and the back of this sheet, if necessary, for additional remarks, suggestions, and criticism. Attach the working drawing or sketch of the project to this sheet.

ADMINISTRATIVE TECHNIQUES IN PROJECT CONSTRUCTION

To facilitate project planning and construction, the teacher should have all project information readily accessible for student use. This means that filing cabinets must be carefully organized and properly indexed. Project folders should contain drawings, sketches, photographs, job sheets, instruction sheets, and other prepared materials.

The shop library should contain books and periodicals that might suggest various types of electricity-electronics projects. Methods boards and completed models should be on display. With sources of information conveniently at hand, the student should be in a position to answer many of his own questions without relying on the teacher's assistance.

Of great importance is the problem of supplying the required materials to students needing them. To ease the teacher's burden of distributing materials and other problems inherent in project construction, a well-organized student personnel plan is vital. A smooth running shop results when the shop superintendent, the supply foreman, the safety foreman, and other designated personnel not only clearly understand their duties, but also carry them out effectively.

SOURCES OF PROJECT IDEAS

The shop teacher should be alert to possibilities for new project ideas. The introduction of a new project can strengthen the course by increasing student interest, by improving project design, and by reflecting the latest industrial technology.

The project construction phase of the electricity-electronics shop program can be upgraded by examining these sources for new project ideas:

Textbooks—books listed in Appendix
Professional magazines—*Industrial Arts and Vocational Education, School Shop*
General science magazines—*Popular Science, Popular Mechanics, Mechanix Illustrated*
Electronics magazines—*Popular Electricity-Electronics Illustrated, Modern Electronics*
Equipment catalogs—photos and drawings of industrial tools and equipment
Newspapers—advertisements illustrating electrical devices suitable for shop construction
Window displays—retail and department stores showing appliances and communications equipment
Museums and halls of science
Industrial arts exhibits—school fairs, citywide industrial arts exhibits
Professional organizations—meetings in schools and colleges where projects are on display
Hobbies—leisure time electrical work of pupils and parents
Commercial brochures—description of products (articles can be modified for shop use)

PROJECT PLANNING AND DEVELOPMENT

To reflect procedures used in the electricity-electronics industry, it is essential that the planning stage of project construction be emphasized. The student must be cognizant of the contributions made by the following employees who, while not operating production machines, share in the making of the manufactured article:

Product designer—decides the shape and the substance of the product
Draftsman-detailer—translates design ideas into a working drawing
Methods engineer—determines operations and their sequence
Time-study engineer—estimates average work/time rates
Safety engineer—investigates shop hazards; promotes adherence to safety regulations

To implement the planning phase within the electricity-electronics shop, the student should gather required information prior to construction. These preconstruction steps constitute the planning phase of project construction. If the lack of class time does not permit all preconstruction work to be completed during shop periods, the written work can be executed outside the shop and can be considered as outside preparation.

SAMPLE PROJECT PLAN/RATING CARD

LAST NAME	FIRST NAME			REG. CLASS	SHOP CLASS
PROJECT NAME			NO.		
	DATE STARTED	DATE COMPLETED	TOTAL DAYS		
PLANNING					
CONSTRUCTING					
EXPLANATION FOR OVERTIME:		TOTAL TIME→			
SAFETY APPROVAL		DATE			
SUPERINTENDENT'S APPROVAL		DATE			
1A	**PLAN/RATING CARD**				

PROJECT FACTORS		
DRAWING		
BILL OF MTL.		
EQUIPMENT		
SEQUENCE		
EVID. OF SAFETY		
TIME CONSUMED		
PROJECT		
FINAL RATING →		

FRONT

BILL OF MATERIAL							SEQ ↓	EQUIPMENT
PART	QTY.	MATERIAL	SIZE			COST		TOOLS:
			TH	W	L			
RIVETS								
SCREWS								
NUTS								MACHINES:
OTHER SUPPLIES								
					TOTAL COST→			

BACK

Project Plan/Rating Card

To assist the student in planning his project and to provide the teacher with a permanent record of the mark for the project, a project plan, rating card has been designed. The suggested form is printed on a 3" x 5" index card which can be easily filled out by the student and conveniently stored alphabetically by the teacher for future reference.

The card places the responsibility for planning on the student. The importance of time is stressed because the student must record the time needed to complete the project. Provision is made for the orderly arrangement of items to be included in the bill of materials with consideration of the cost of each item.

The electricity-electronics teacher can change the layout of the card according to his own personal preference and need. Cards of varying colors can denote different shop classes or designate beginning and advanced shop students. If all of the required information cannot fit on the card, the additional data can be recorded on a sheet of paper 8½" by 11" and then appended to the card.

Directions for Use

When the student is assigned a new project, he is immediately issued a blank project plan—rating card by the shop superintendent. The student makes the necessary entries on the card before starting his project.

Instructions to Student

Letter all information on the card in ink.

Fill in front of card by inserting name, official class, shop class, name of project, and project number. Record starting date under Planning.

Fill in back of card by listing items to be used in Bill of Materials after you have completed your drawing.

Indicate the cost of individual items and total cost of materials.

List tools and machines required.

Designate proper sequence of tool use by placing appropriate number in vertical column to the left of items listed under Equipment.

Obtain approval to work from safety foreman who will sign his name if your safety record is satisfactory.

When planning is finished, record date and compute time consumed in planning stage.

When work with tools and materials begins, record starting date of project construction. Indicate date when project is completed.

Compute time consumed.

Obtain preliminary approval of shop superintendent who will check off each item in Project Factors box so that teacher will have all necessary materials to evaluate project.

Submit completed project, drawing, and project/plan, rating card for teacher's evaluation.

Student Preparation

Before the actual construction has begun, the student must complete several prerequisites which will make the development of the project more meaningful:

- Working drawing of the project
- Bill of materials
- List of tools and machines required
- Description of operation sequence
- Record of time
- Evidence of safety

Working Drawing

Each student is expected to make, to the best of his ability and experience, a working drawing on regular drawing or graph paper. All pertinent information necessary to make the project will be included. An isometric drawing or other pictorial representation may be accepted with the teacher's approval. Photographs of the project may be attached if such material is available. The source of the project should be noted.

Bill of Materials

All metals, fasteners, and other materials are to be listed in a neat and orderly fashion on a standard form provided by the teacher. Suggested forms are illustrated in this manual. The number required of each item, its specifications and unit cost are to be designated. The total cost for materials is to be computed. Prices for various components can be obtained from catalogs, local hardware stores, department stores, and electrical supply houses. The G-1 book may be consulted for the school price.

Tools and Machines

A list of all equipment necessary for the construction of the project is to be prepared by the student. This list of tools and machines is to be complete and explicit. The teacher may include this form with the bill of materials, the project plan/rating card or place it on a separate sheet. Each machine that is to be used in the construction of the project must be listed and safety approved by the teacher. The teacher is to approve the student's project by placing his initials in a space provided.

Description of Operation Sequence

The student is to know, beforehand, the direction in which he is to proceed. He is to list, in sequential order, those operations that must be executed in project construction. Information relating to operational procedure can be obtained from observing the lesson that is devoted to how the project is made, from referring to textbook description concerning a particular project, or from examining the research material that is on file in the shop planning center.

Record of Time

The importance of the rate of work in terms of time expended is to be stressed. The student is to maintain a record of the time used for the completion of the project including the time spent for planning. The teacher can decide on the unit of time to be measured. These units can be expressed as "shop days," "shop periods," or "shop hours." By determining the average or standard time necessary to complete those basic and individual projects that are repeated in successive terms, the teacher has a yardstick with which to compare and measure student performance in relation to time consumed for making the project.

Evidence of Safety

The awareness of safe shop practice must prevail at all times not only while the student is occupied at the bench or at the machine but also while he is making preparations for handling tools and materials. Before actual physical work begins, the student should obtain the approval of the safety foreman who will check the student's safety record to determine if he has passed the latest safety test, does not have safety violations, and has a copy of his safety regulations on file in the shop. The safety foreman's signature on a printed form or project plan/rating card will acknowledge the satisfactory safety record of the student.

Evaluating the Project

When the project is submitted for evaluation, the mark that is given must reflect more than the quality of the project. The grade should include a consideration of job factors that relate to project planning.

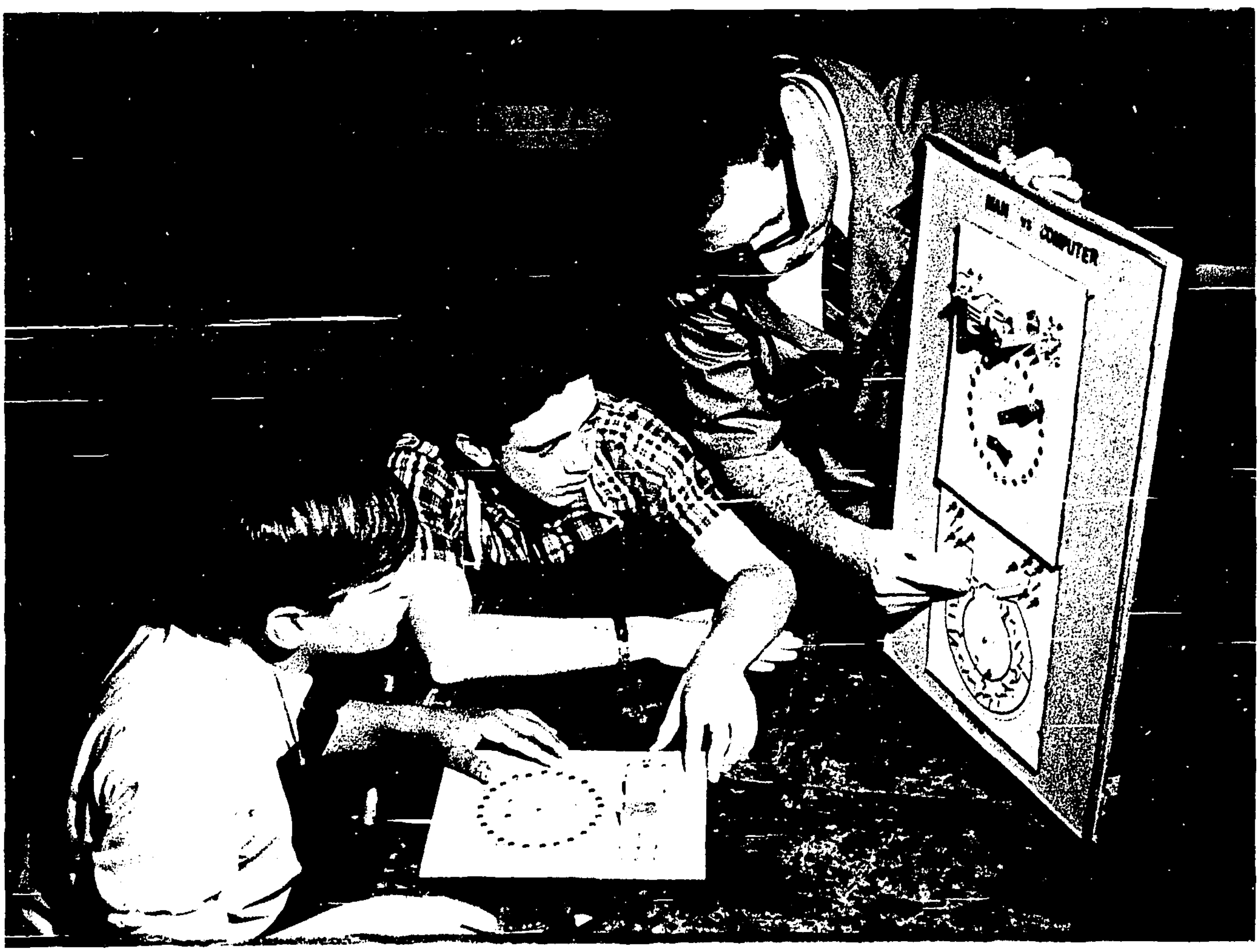
To expedite a more positive system of awarding grades in the electricity-electronics shop, the teacher must develop his own set of standards based on the needs, abilities, and past experiences of students. These standards should be applied to both the planning and construction phases of the project assignment.

Awarding a grade for the project as it relates to the quality of construction involves ascertaining:

The degree of accuracy—measuring the project against the specifications on the drawing
The quality of the finish—examining the surface for scratches, vise and tool marks.

Determining a grade for the project in terms of the quality of planning is accomplished by evaluating items listed in the Project Factors column on the project plan/rating card.

The final mark for the project is the composite score representing the quality of planning and the quality of construction.



A project display helps students to check their individual jobs.

THE INDIVIDUAL PROJECT

The individual project is made after one or more basic projects have been satisfactorily completed in the electricity-electronics shop. The individual project incorporates operations that were required for the basic project. The student transfers his newly acquired skills and exercises them on a project of his own choosing (with the teacher's approval) or one suggested by the teacher.

The individual project is more advanced than the basic project. It requires a greater degree of student creativity and planning. Because of the experience and knowledge gained as a result of having completed the basic project, the student is in a position to work on his own project with less supervision. This kind of project has a built-in advantage over the basic project because it allows for individual difference and preference to a greater degree.

Criteria

Before selecting a project for individual construction, the student should be aware of those criteria that are described in the section, Criteria for Project Selection. In addition, he should be particularly concerned with these questions as they relate to the individual project:

Is growth in knowledge and skills increased?
Does the individual project relate to the aims and objectives of the course?
Are the student's capabilities sufficient to enable him to construct the project?

Project Selection

When the student is ready to construct an individual project, his choice can be determined by several means:

1. Viewing models and samples provided by the teacher
2. Examining files of plans and designs kept in the school library
3. Studying plans and photographs in books and periodicals
4. Developing original designs

Limitations

The individual project does have limitations. To provide for efficient shop management, the teacher must use discretion concerning the choice of projects. The teacher must decide if he is willing to encourage the construction of a variety of projects in the same class. Activities of this nature require extensive individual instruction. The teacher may wish to limit the kinds of individual projects, providing only for variations in shape, decoration, and finish.

The variety of individual projects permitted is determined by such factors as class size, pupil ability and experience, physical conditions of the shop, availability of time, and the extent to which informational units have been covered in class.

Student Preparation

Before the student is allowed to proceed with his individual project, he must complete certain prerequisites. The teacher will provide a check sheet which indicates the necessary items. These items include the drawing, bill of materials, list of equipment, operational procedure, time reecord, and safety approval.

The student's material may be organized in a file folder. A photograph of the completed project along with the student's name and class should be attached to the cover. These folders may be filed for future use or displayed on a bulletin board in a corridor of the school. A library display of these folders will create interest in the individualized activities of the electricity-electronics working area of the industrial arts department.

Preparation Variables

The amount of preparation which can be expected from each student will depend upon many factors. Some of these factors are:

- Ability
- Interest
- Time available
- Motivation
- Habits and attitudes
- Desire for recognition
- Vocational interests
- Acceptance of a challenge
- Need to preplan and organize
- Competitive attitude in the class

The industrial arts teacher must determine the extent and degree of student planning that he can expect from each member of the class, and he should then adjust the planning requirements for the individual project accordingly.

All students will be given the necessary check sheets and planning blanks needed for preparation of the project-planning folder. Packages of these materials may be prepared in advance by a student service aide.

The bright student should select his own project basing it on individual research and planning. He often selects articles which have practical uses and displays mature judgment in his selection. He may express a desire to develop a project which is related to work that he is carrying on in other curriculum areas. The necessary drawings, material lists, procedure lists, and folder preparation can be developed by this pupil with a minimum of guidance on the part of the teacher.

The average student will be able to prepare the necessary materials for the individual project if he is given some direction and motivation by the teacher. He may be expected to consult the files in order to select a project, and he should be able to prepare the necessary related papers on the forms supplied by the instructor. His drawings may not be as well executed as those of the brighter student, but they should demonstrate a degree of comprehension and the ability to visualize. He should be able to prepare his own folder.

The less capable student may not be able to develop a complete folder without the assistance of the teacher. The selection of the project may be limited to a choice of two or three. The bill of materials must be simplified and prepared in advance on a duplicated form. The procedure sheets must be prepared in the simplest language. The use of machines may have to be restricted, depending on the proven ability of the individual student. All file folders should have the necessary format printed on the cover with a rubber stamp, thus guaranteeing uniformity of appearance.

Suggested Individual Projects

This manual contains ideas for the development of individual projects. These ideas are not meant to be copied; they serve as examples of some of the things which have been done in the schools. To list all of the articles that could be made would be impractical because of the great variety. In all the areas of the shop there are numerous possibilities for making individual projects that are challenging.

THE GROUP PROJECT

The industrial arts electricity-electronics shop is particularly well-suited to developing concepts which arise from project building by a group of students. This can be described as a method which represents a single project made by several students, and which may be constructed for use by the school or other community agency.

The group project may be developed at any period during the school term. Pupils may work on the project either during specific periods in the school year or during intervals between regularly scheduled projects. Extra-curricular activities and cooperative programs are suitable as related activities in which the pupils can participate.

Good soldering techniques are important in electrical work.

Organization

The organization of the group project is similar to that of a mass production problem, but it is more likely to be organized in a less rigid pattern. Pupils work on various parts and different operations, rather than on a specific production operation. The primary aim of the group project is to encourage cooperative enterprise on a project which does not necessarily become the personal property of each worker.

Motivation

Students' contributions to the project should be motivated by a desire to offer service to the department, school, or community. Pupil participation helps develop individual skills, encourages leadership, and explores abilities of the participants. The teacher should stress, however, that the project is being developed as a device for relating the work of the electricity-electronics area to the school or community. Pride and satisfaction in the students' part in the total effort is an important objective of this teaching method.

Source and Selection

The choice of a group project should recognize the requirements of the industrial arts course. Projects developed should serve the needs of the pupils in terms of learning and growth. At no time should the construction of the group project ignore the aims and objectives of the course.

Suggestions for group projects can come from the students, the teacher, the school administration, and the community. The final selection should rest with the teacher. Some factors in project selection are:

Value of the project to pupil growth and development
Source of necessary supplies and materials for construction
Space available for construction and storage
Integration of the work with regular shop schedule
Interests and aptitudes of the students
Need for the project
Methods of distribution of the completed project
Student recognition (newspaper photographs, awards, publicity)

Procedure

Several steps should be considered for development and selection of a group project:

Selection of the project
Tentative time schedule for construction
Drawings—assembly and detail
Procedures list
Bill of materials
Securing materials
Selection and scheduling of students
Construction, assembly and cleanup supervision
Distribution and delivery of project
Credits for participating students

The teacher must supervise all the phases of the group operation as carefully as any other shop activity. All information relating to the project should be filed for reference. Displays of the folder material, photographs, models, and publicity releases can be used to acquaint the student body and the school staff with these efforts.

Administrative Techniques

A unit or group project may be organized in several ways:

A section of the shop is set aside for the construction and storage of the group project. One or more units are constructed during the term by students who have time available in their work schedule.

Students are assigned to work on the group project at regular intervals during the term. Each student is given instruction by the project foreman or the teacher. Operations may be checked off on a work schedule as each student completes a part of the work.

A portion of the class is assigned to work on a group project. The work is developed as a unit of several weeks' duration. Each student contributes to the project by working on a part of the project either at his regular work station or in the area of the shop set aside for it.

A mass production problem may be developed as a group project for a small number of students. Participation is limited to a few periods until the project is completed and each student in the class has been involved in the total project.

Applications of the Group Project

The group project may be developed for several agencies, such as the Junior Red Cross, hospitals, charitable institutions. Some examples of group projects developed for agencies are: demonstration models, experiment boards, science apparatus, games for the Junior Red Cross, saleable items for school fairs.

THE INTEGRATED GROUP PROJECT

The industrial arts teacher can direct the efforts of all pupils in a group project which involves research and experimentation, correlation with other subject matter fields, and organized committee planning and development.

The selection of a project requiring background information available in a science, mathematics, or social studies class will enable the student in the industrial arts electricity-electronics shop to develop concepts of thinking and creative planning which will be enhanced by knowledge gained in other subjects. An example of the interdisciplinary approach is a study of the development of mass production techniques accompanied by group construction of a factory interior (model or diorama) showing the effects of early mechanization, contemporary standards of design and construction, and the effects of automation on the factory of the future.

PRINCIPLES OF PROJECT CONSTRUCTION IN ELECTRICITY-ELECTRONICS

The major justification for any project in industrial arts electricity-electronics is that it be used to demonstrate principles and reinforce learnings, preferably at the time the project is being constructed by the student.

To achieve the aims of the program, woodworking and metalworking processes are minimized in the electricity-electronics shop. To this end these suggestions are made:

As a general rule each student should first make a continuity tester, such as the handy-tester; second, a project involving more complex circuits, such as the quiz game, baseball game, football game, or computer; third, a project involving electromagnetism, such as the clicker-buzzer-relay, telegraph set, motor, or electric broom; fourth, a project in electronics; fifth, a bottle lamp, a remote TV switch, an electric stove, a high intensity lamp, etc. A student should not make more than one project involving the same electrical principle until he has constructed four or five other projects, each involving a different principle.

Wooden lamps should be made primarily in the woodworking shops. As substitutes, encourage the construction of safe bottle lamps, which can be completed in one week or less.

Use precut pressboard (masonite) bases wherever possible. Pressboard costs less than mahogany or pine and requires a minimum of work in preparing for project use.

If pressboard is impractical, use precut wooden bases. (Bases should be cut to exact size by teacher.) The students lay out holes, drill, sand lightly, wax, and assemble.

Redesign other projects so that they will involve as few woodworking operations as possible. Finishing in this shop should not involve more than a light sanding and a light coat of paste wax, or one coat of shellac. Another recommended finishing practice is the application of one coat of water-soluble latex paint.

Many teachers have found it convenient to standardize base sizes. The standard base sizes used are: 4" x 4", 4" x 8", 8" x 12" or 8½" x 11".

The use of ½" iron strapping, available by the roll, is suggested instead of tinplate or galvanized iron strips. This material is item 48-0380 on the G-1 List.

Many teachers have had a great deal of success in expediting project construction by mimeographing or rexographing the top of the project and then attaching the sheet to the pressboard with rubber cement. Incorrect measurements are avoided because the holes are laid out on top of the sheet correctly. This technique is also useful in the preparation of battery holders. In this case the sheet can be peeled off after the battery holder is completed.

GUIDE TO RECOMMENDED ELECTRICITY-ELECTRONICS PROJECTS

Area One: CONTINUITY TESTERS

Handy Tester (combination power supply and continuity tester)
Simple Continuity Tester (using one D cell in a horseshoe frame)
Pill Bottle Continuity Tester (using one C cell in a plastic bottle)
Nine Volter (a continuity tester using a 9-volt transistor radio battery in series with a 2.5-volt lamp)

Area Two: COMPLEX CIRCUITS

Electric Quiz Board
Baseball Game
Football Game
Computer

Area Three: MAGNETISM

Telegraph Set
Clicker-Buzzer Relay
Electromagnetic Broom
Motor
Transformer
Electric Arc Pencil
Galvanoscope

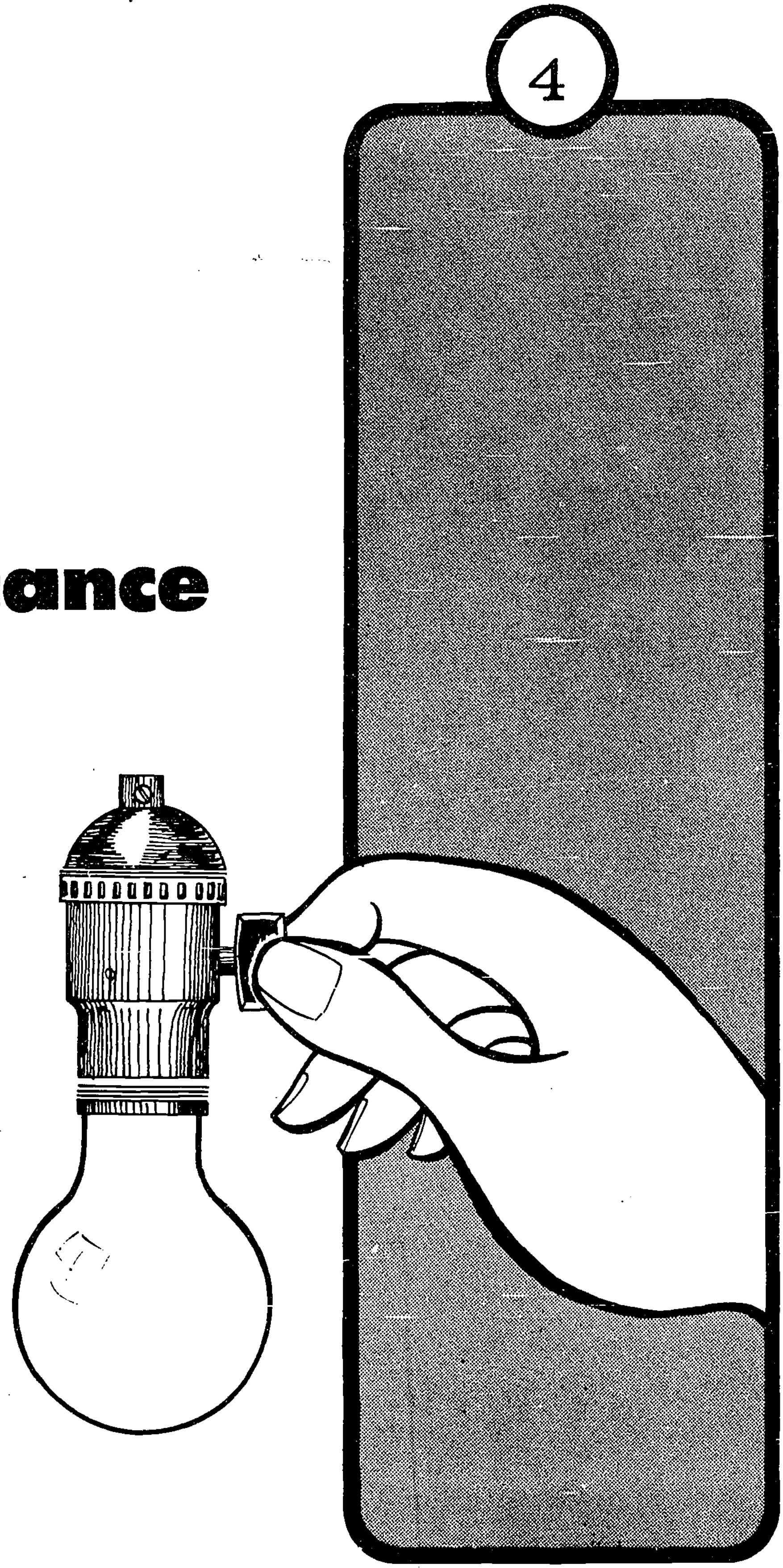
Area Four: ELECTRONICS

Tube and Continuity Tester
Crystal Radio
One-Transistor Radio
Two-Transistor Radio
Code Practice Oscillator
Amplifier
Photoelectric "Space Commander"
Extinction Voltmeter
Variable Power Supply
Electronic Ukelele
Electronic Organ
Wireless Microphone
Power Megaphone
Capacitor-Continuity Checker
Time Delay Relay
Twilight Lamp Switch
Short Wave Receiver

Area Five: GENERAL ELECTRICITY

Auto Trouble Light
Fire Alarm
Electric Stove
High Intensity Light
Variable Neon Flasher
Soldering Gun
Warming Plate
Binary Computer
Ammeter Movement
Woodburning Pencil
Fluorescent Lamp
Penlight
Simple Neon Tester
Remote TV On-Off Switch
Electrophorous
Bottle Lamp
Magnetic Compass
Electric Shaver Booster

Guidance



The industrial arts electricity-electronics shop provides an environment which promotes a much closer relationship between teacher and student than is usually found in the academic classroom. Through close personal contact and observation, the industrial arts teacher can ascertain the ambitions, interests, aptitudes, attitudes, and problems of the individual student. By noting the work habits, skills, and capacities of each pupil, the electricity-electronics teacher is in a unique position to assist the pupil in self-development, in revealing and appraising his own abilities and interests, and in acquainting him with educational and vocational possibilities that may exist in the future.

MOTIVATION

At the beginning of the term, inform the students that their purpose in the electricity-electronics shop is not only to learn how to use tools and machines, but also to discover information about themselves. Their likes and dislikes, abilities and weaknesses provide important clues which serve as a basis for making rational choices concerning their future activities at school and at work.

Throughout the term, advise students of the rewards awaiting those who prepare themselves at the present time so that they will be eligible for future educational and vocational opportunities. The importance of earning a high school diploma and obtaining as much education as possible beyond high school should be stressed. Increased automation signifies that the unskilled worker is going to find it more difficult to obtain employment; applicants for skilled occupations will be compelled to meet higher standards.

All the students must be informed of the significant changes that are taking place in the job market. A large number of students can be made aware of the teacher's recommendations for their continued education, a necessity in this changing, technological age.

GROUP GUIDANCE

Apprise all students in the electricity-electronics shop of the many educational and vocational opportunities that relate to the electricity-electronics industry. Related information lessons may include the following guidance topics:

- Types of jobs in the electricity-electronics industry
- Job possibilities in related fields
- Trade and industrial unions
- Automation and trends in employment in the electricity-electronics industry
- Teaching electricity-electronics and other industrial arts subjects

Other methods of providing guidance and acquainting students with the electricity-electronics field are:

- Visiting local manufacturing plant service shops
- Posting "Help Wanted" advertisements on shop bulletin board
- Attending talks by alumni who are presently employed in the electricity-electronics industry
- Studying the *Occupational Outlook Handbook*
- Attending a talk by a representative of electricity-electronics unions
- Showing motion pictures depicting employees at work
- Consulting with grade advisor, guidance counselor, and department chairman
- Acquiring electricity-electronics experience through after-school or summer employment
- Attending career conferences
- Organizing an occupational folder (outside preparation assignment) containing information about jobs in the electricity-electronics industry
- Inspecting exhibits at industrial shows depicting the products and operations of the electricity-electronics industry (Industrial shows are held periodically at the New York Coliseum under the sponsorship of professional engineering societies and manufacturing companies.)

INDIVIDUAL GUIDANCE

In order to advise a student showing interest in electricity-electronics, seek out information that will reveal the student's capabilities. The more comprehensive the teacher's knowledge of the student, the better equipped will he be to estimate student potential. To obtain important facts concerning the student, these approaches can be used:

Observe the student at work in the shop. Note his skills (or lack of them)—manual dexterity, numerical, spatial, creative, artistic, problem-solving abilities.

Discuss with the student your personal interest in his educational and vocational goals. Find out his ambitions and interests.

Consult with grade advisor, guidance counselor, department chairman, and other teachers to gain pertinent information about the student.

Confer with parents to determine whether or not the expectations they have for their child are realistic.

Examine the cumulative records to determine past performance in other school subjects and in previous schools. Note weak and strong subjects and examination scores.

EDUCATIONAL OPPORTUNITIES

Industrial arts students choosing their careers should think seriously about whether or not their abilities and inclinations should lead them to the field of electricity-electronics. If their interests lie in this direction, it is not too early to find out about the kind and amount of education they will need to enter the electricity-electronics industry, and succeed in it.

Acquaint the students with the various educational opportunities that are open to them. They should discuss these possibilities with their advisors in the school and with their parents at home. The electricity-electronics teacher should also be in close communication with guidance personnel, furnishing them with pertinent information concerning individual students who express a desire for further education to qualify for positions in the electricity-electronics industry. By the same token, it is the responsibility of the guidance counselors to cooperate with the electricity-electronics instructor by reporting to him the latest information concerning employment trends and educational programs that apply to the electricity-electronics field.

In-School Programming

The electricity-electronics teacher can point out the desirability of students' exploration of as many industrial art shops as are offered in the school. The skills and knowledge that are basic to each individual shop are, in some measure, related to the electricity-electronics industry.

If the student has already taken other industrial arts classes in the school and has demonstrated an interest in and an aptitude for electricity-electronics, he should be encouraged to continue in advanced work. In this way, he can develop continuing skills in electricity-electronics techniques and in increased knowledge about the electricity-electronics industry.

High School Courses

Basic and advanced industrial arts electricity-electronics courses are offered in many high schools. In addition, certain high schools offer trade and technical courses in electricity-electronics. It would be best to consult with the school guidance counselor for the latest listing.

Occupations in the Electricity-Electronics Industry

The electricity-electronics teacher can present a realistic appraisal of the employment situation that is likely to confront the industrial arts student. It is imperative that the student be cognizant of the spreading impact of technology resulting from automation and the accelerating growth of the labor force resulting from the increasing influx of young people into the labor market.

The necessity for career planning becomes obvious, and the teacher can enumerate those occupations that are presently in demand and are likely to be in demand in the near future.

Career-Oriented Student

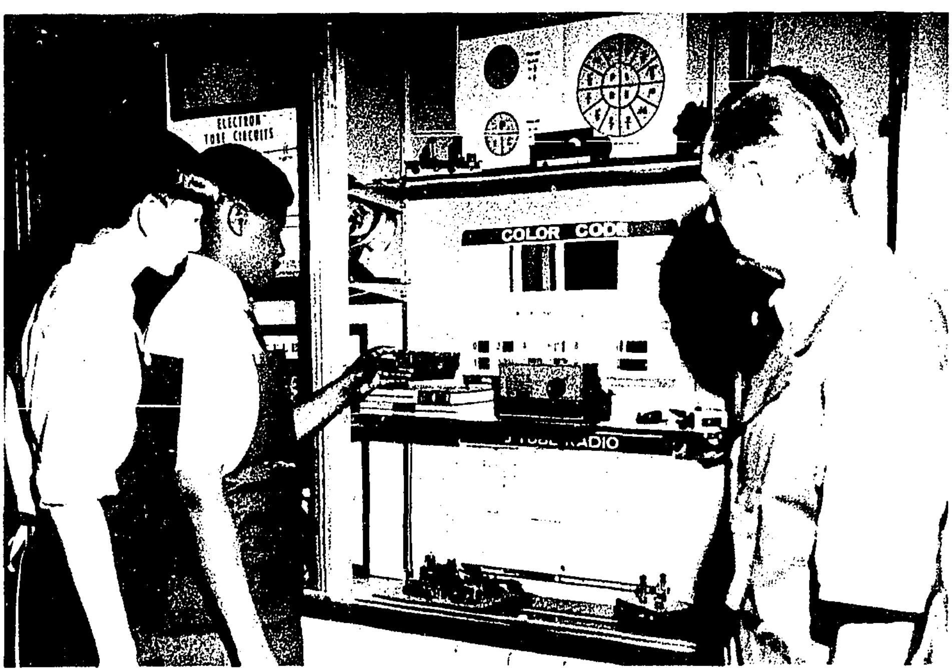
The career-oriented student in the electricity-electronics shop should know that job opportunities exist and will probably continue to exist in many occupational categories that relate directly or indirectly to the field of electricity-electronics:

- Assembler, electrical
- Automotive, ignition specialist
- Aviation electrician
- Draftsman, electrical
- General electrician (licensed)
- Inspector, electrical
- Instrument repairman
- Lineman
- Maintenance electrician
- Splicer
- Subway electrician
- Telephone installer

The job classifications listed above are skilled occupations which are obtainable only after a specific period of training has been completed. Many of these jobs are available not only in New York City, but also outside the metropolitan area.

It should be understood that the skills relating to the electricity-electronics area are utilized not only in the manufacture of machines and equipment, but also in the installation, maintenance, and repair of these devices. Furthermore, large numbers of personnel possessing requisite experience are employed in the aerospace, data processing, and other expanding industries.

Displays of electronic materials help to stimulate interest in the program.



On-the-Job Training

Many electrical-electronics companies offer on-the-job training in which the new employee is taught by an experienced worker to perform a specific operation. Once the operation has been mastered, the beginner can progress to a more difficult operation, depending on his ability and the requirements of the company.

Apprenticeship Training

The apprenticeship training program is jointly sponsored by the electrical contractor and the electrical union. Candidates possessing a high school diploma are selected for the program and work under the supervision of an experienced journeyman. In addition to obtaining practical skills and knowledge on the job. the apprentice is required to attend evening school. At the satisfactory completion of the five year program, the apprentice is eligible to qualify for the "journeyman" classification.

Armed Services Schools

The Army, Navy, and Air Force maintain technical training centers that are devoted to the teaching of electricity-electronics. These schools instruct trainees in the servicing and maintenance of equipment used by the armed forces.

Technical Institutes, Community and Junior Colleges

Technology programs provide pupils with technical and related general education for employment at the semi-professional level. Private trade schools also prepare high school graduates for various positions, such as:

- Electronics technician
- Electronic computer technician
- Electronic circuit technician
- Electronic instrument technician
- Electronic research technician
- Systems testing technician

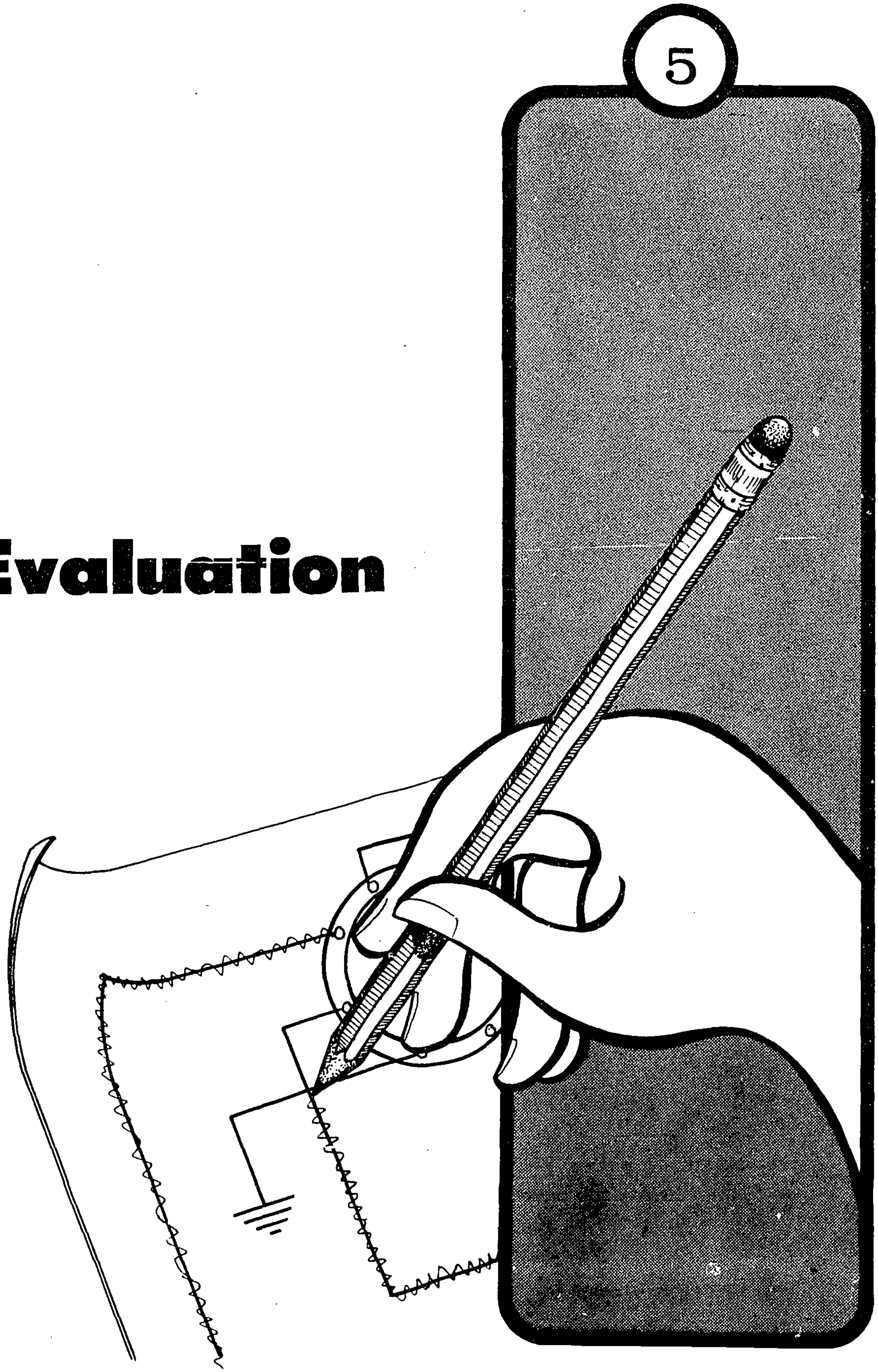
Senior Colleges and Universities

It is imperative that students realize that the schools of higher learning—that is, the senior colleges and the universities are degree-granting institutions that prepare students for professional engineering careers. If any student expects to study electrical or electronics engineering, he should be informed that it is usually necessary to enroll in the academic course in high school and to meet the admission standards of the college of his choice.

Testing should be an integral part of the electricity-electronics shop program because tests serve important functions, such as:

- Measuring individual and class achievement
- Revealing specific areas of strength and weakness
- Motivating students to further learning
- Establishing standards of skill and performance
- Indicating degree of teaching success
- Providing a basis for giving shop grades

Evaluation



CRITERIA OF A GOOD TEST

Virtually all the tests used in the industrial arts electricity-electronics shop are prepared, administered, scored, and interpreted by the teacher. It is essential that the teacher consider several factors basic to good test construction, when he prepares a test:

Validity—measures what it is intended to measure
Reliability—consistently provides the same results
Objectivity—eliminates personal judgment of scorer
Standards—matched to the level of student ability
Administration—can be easily given and quickly scored

CONSTRUCTING AND ADMINISTERING TESTS

The most important steps are:

Determining objectives (What should a test measure?)
Deciding on type of test (Should test be one of performance, answering objective questions, writing essays, or a combination of these forms?)
Formulating directions (Are instructions specific, clear, and concise?)
Selecting questions (Are there adequate scope and a sufficient number of items?)
Arranging layout and preparing copies (Will mimeographed or printed forms be used?)
Giving test and scoring (Are students following instructions?)
Analyzing results (What are weaknesses and strengths?)
Returning tests to students (How should results be reviewed?)

TESTS USED IN THE ELECTRICITY-ELECTRONICS SHOP

Safety Test

Written safety tests are mandatory at the beginning of the term and at periodic intervals throughout the term. These tests are designed to ascertain the student's knowledge* of the rules and regulations that apply to:

The general safety practices in the electricity-electronics shop, including such factors as good housekeeping, clothing, health, and cleanliness
Specific operations and processes involving tools, machines, and other shop equipment.

Instructions for preparing safety examinations and implementing the testing phase of the electricity-electronics shop are given in the *School Shop Safety Manual*, Curriculum Bulletin No. 13, 1964-65 Series, published by the Board of Education, City of New York. Part four of the manual contains suggested examinations for the electricity-electronics shop.

Informal Test

This type of test is a short, informal quiz covering a completed teaching unit to measure student achievement and ascertain quality of instruction. It is usually a written or oral test composed of objective questions.

* Tests in themselves will not measure understanding. It is only in the performance of a tool or machine operation that safety understanding will be evidenced.

Performance Test

The performance test evaluates the manipulative skills of the student performing operations using tools, machines, or other equipment in the shop.

Uniform Test

The uniform test is a formal midterm or final examination that is broad in scope and is designed to include objective or essay questions or a combination of both.

Vocabulary Test

This test is informal and determines the student's comprehension of technical vocabulary used in demonstrations and related lessons. Ability to spell these words correctly is also tested.

Shop Math Test

A shop math test is an examination to ascertain student's ability to make arithmetical computations and use mathematical formulas in practical electricity-electronics shop problems.

TEST CLASSIFICATIONS

PERFORMANCE TEST

This is a practical test which measures the degree of manipulative skill of the learner. The student is required to demonstrate his ability to perform operations with tools and/or machines. Properly administered, this kind of test aids diagnosis of student weaknesses.

Before proceeding with the assignment, the student should be provided with written instructions, a working drawing, adequate materials, and proper equipment. The teacher should prepare a check sheet with a rating scale so that a final rating can be obtained which will reflect the elements that make up the score of the performance test:

Quality of the work piece—accuracy and finish
Correct use of tools and equipment—observance of safe practices
Time used to complete assignment—comparison with predetermined rate
Ability to analyze the problem and plan the procedure

The performance test is the only kind of test which will give a true measure of the skill possessed by the learner. It should be used to determine student abilities relating to measuring and layout, sawing and filing, drilling and turning, and other important skills listed in the course of study.

The degree of complexity of the performance test may vary from a single skill to a combination of a number of skills. A single skill might include scribing a given line on metal. Making a layout on a similar piece of metal would be considered more complex because of the student's use of additional tools and operations.

OBJECTIVE TEST

The objective (short-answer) test is often used in the electricity-electronics shop to test a wide area of related information. Scoring is relatively rapid with the use of an answer key. Of all varieties of examinations used in the shop, this is the least subjective test in terms of marking.

The following examples illustrate the various kinds of objective tests.

Simple Recall Test

Usually a direct question requiring an answer in the form of a word, phrase, or number.

Directions: Answer each of the following questions by writing the correct answer in the blank space at the right.

1. What tool is used to cut a piece of wire? __________
2. What is the name of the operation which involves removing the insulation from a piece of wire? __________
3. What meter is used to measure electrical current? __________
4. What is the device used in an electrical circuit to protect against overloads and short circuits? __________

Multiple-Choice Test

One of the most valuable types of objective tests available. Multiple-choice items can be expressed either as questions or as incomplete statements followed by several possible answers.

Directions: Place on the line at the right of each statement or question the letter preceding the word or phrase which best completes the statement or answers the question.

1. All accidents in the shop must be reported to:
   a. teacher c. foreman
   b. safety engineer d. group leader 1. ______
2. The voltage of a single dry cell is:
   a. 3 volts c. 2 volts
   b. 1½ volts d. 1 volt 2. ______
3. A permanent magnet will attract
   a. aluminum c. nickel
   b. silver d. gold 3. ______
4. The electronic testing device used to measure current, voltage, and resistance is a (an):
   a. ammeter c. voltmeter
   b. Weston meter d. multimeter 4. ______
5. Which of the following scientists is credited with inventing FM radio?
   a. Edison c. Armstrong
   b. Gilbert d. Brattain 5. ______

Completion Test

This test has the advantage of requiring specific answers which can be marked quickly and accurately. Because the emphasis is on recall rather than recognition, guessing is at a minimum.

Directions: Complete the statement by inserting the answer in the space provided to the right of each sentence.

1. The man who invented the telephone is __________.
2. Solder is an alloy of __________ and __________.
3. A device which changes AC to DC is known as __________.
4. Electrical line voltage in our homes is __________.
5. The three parts of a transistor are the __________, the __________, and the __________.

True-False Test

This is a form of objective examination that is easy to construct and permits a wide sampling of content. Statements should be expressed so that they are completely true or false without qualifications or exceptions.

Directions: Listed below are several true and false statements. If the statement is true, encircle the "T" at the left of the statement. If the statement is false, encircle the "F."

T F 1. Soldering joins metals by melting them together.
T F 2. The higher the gauge number, the thicker the wire.
T F 3. A 35Z5 vacuum tube has a filament voltage of 35 volts.
T F 4. A parallel circuit has more than one path for the flow of electrons.
T F 5. The F.T.C. controls the licensing of radio communications.

Rearrangement Test

A rearrangement test is a method of discovering the student's knowledge of sequence of operations and processes in performing a job or manufacturing a product.

Directions: Rearrange the operations in the problem in their proper order by numbering the steps in the spaces provided at the left.

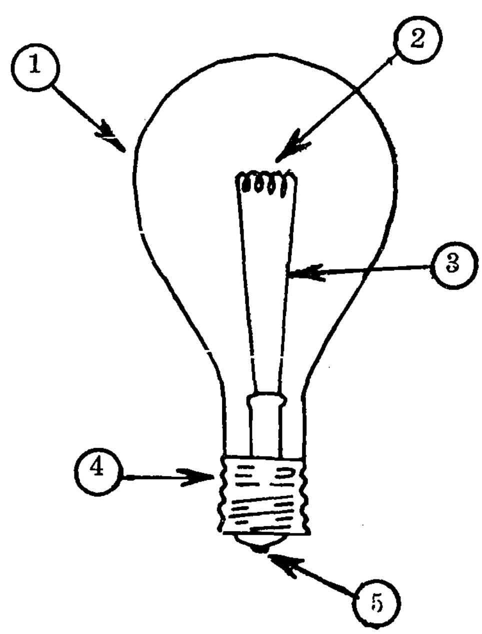
Problem: How to wire a plug

_______Make Underwriters' knot
_______Split wire
_______Bring wire around screws
_______Tighten screws
_______Loosen screws
_______Strip wire

Identification Test

This is a test of recall which measures the student's ability to recognize and indicate the names of tools, machines, and their parts.

Directions: Write the correct name of each part of the incandescent lamp in the corresponding numbered space at the right.



1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

Matching Test

The matching test is another form of objective test which is particularly well-suited to identification of technical terms, tools, machine parts, and materials. It is recommended that a matching test question have from five to twelve individual items. All items should be related, and extra responses should be provided to reduce guessing.

Directions: On the line at the left of each item in column A write the number of the answer in column B which best describes the part.

A	*B*
________Ohm	1. Electromotive force
________Volt	2. Rate of electron flow
________Hertz	3. Power
________Ampere	4. Opposition to the flow of electrons
________Watt	5. Cycles per second

ESSAY TEST

The essay question requires the student to develop an answer in his own words. He must use complete sentences. The essay question measures not only the student's ability to evaluate, analyze, compare, and solve problems, but also reveals his ability to organize his thoughts and express himself clearly.

The essay question can be classified in various categories, each of which is illustrated by the following examples:

Simple Recall Test

1. State five advantages of the transistor which the vacuum tube lacks.
2. List five tests that can be made with a multimeter.
3. Name three tools that can be used for stripping wire.

Description Test

1. Explain the meaning of 35Z5.
2. Give the main reason why copper is used for electrical conductors.
3. Describe the operation of a vacuum tube.

Comparison Test

1. Explain two advantages of each of the following methods:
   a. hand winding of coils   b. machine winding of coils
2. Compare two differences between vacuum tubes and transistors.
3. Give one advantage and one disadvantage of soldering versus the screw and nut method of connecting a wire to a terminal.

Procedure Test

1. List in correct order the four steps in soldering a joint.
2. Describe the procedure for making a continuity test on a table lamp.
3. What steps are necessary to test a burned-out fuse?

SUGGESTED FINAL EXAMINATION

SECTION I—Multiple Choice

> SAMPLE QUESTION
>
> A dry cell used in an ordinary flashlight has a pressure of
>
> a. 1 volt
> b. 3 volts
> c. 1.5 volts
> d. 4.5 volts
>
> SAMPLE ANSWER
>
> a b d
>
> (Correct answer is 1.5 volts; circle "c" on *answer sheet only.*)

1. An injury should be reported to the teacher
   a. at once
   b. when the student feels like reporting it
   c. after the student has completed what he is doing
   d. only if it is serious

2. The best conductor of electricity is
   a. copper
   b. mica
   c. aluminum
   d. silver

3. An insulator has __________ *resistance* to the flow of electricity
   a. low
   b. high
   c. medium
   d. no

4. A closed circuit is also called a (an) __________ circuit.
   a. open
   b. intermittent
   c. complete
   d. nonworking

5. The filament within an incandescent lamp is made of
   a. silver
   b. nichrome
   c. tungsten
   d. alnico

6. In an electric cell, electrons are released from certain metals by
   a. magnets
   b. light
   c. heat
   d. chemical action

7. The basic law of magnetism states
   a. like forces attract
   b. unlike forces repel
   c. like forces repel
   d. both b and c

8. A permanent magnet will attract
   a. aluminum
   b. iron
   c. copper
   d. brass

9. The revolving part of a motor is called the
   a. slip rings
   b. commutator
   c. field
   d. armature

10. A rheostat is a
   a. variable resistor
   b. transistor
   c. TV tube
   d. meter

11. Ohm's law is stated as
   a. E=IxR
   b. R=ExI
   c. I=ExR
   d. P=ExI

12. The term kilowatt is equal to
   a. 1,000 watts
   b. 10 watts
   c. 100 watts
   d. 10,000 watts

13. A meter should be connected to the circuit when the voltage is
   a. off
   b. 110
   c. on
   d. never

14. A device for measuring the consumption of electricity is
   a. a kilowatt-hour meter
   b. an anemometer
   c. a thermostat
   d. a galvanometer

15. The wire that gets red hot and gives off heat in a toaster is usually made of
   a. tungsten
   b. steel
   c. copper
   d. nichrome

16. Fire may result from
   a. an overloaded circuit
   b. 15 amperes
   c. rubber plug
   d. 110 volts

17. All electrical construction work done in New York City must be done or supervised by a
   a. licensed electrician
   b. maintenance man
   c. technician
   d. light power man

18. The best "ground" used by electricians is
   a. transmitter
   b. microphone
   c. receiver
   d. speaker

19. A simple three-element tube is called a
   a. pentode
   b. diode
   c. triode
   d. tetrode

20. A filament tester determines
   a. tube
   b. continuity
   c. transconductance
   d. potential

21. A transistor is better than a tube because it is
   a. smaller
   b. has a longer life
   c. requires no warm-up period
   d. all of the above

22. "Machines that control themselves" is a definition of
   a. industrialization
   b. amplification
   c. automation
   d. miniaturization

23. Wire secured under the head of a terminal screw should be wound
   a. counterclockwise
   b. either way
   c. clockwise
   d. several times

24. The best type of solder for radio work is
   a. solid core
   b. rosin core
   c. acid core
   d. apple core

25. The knot used when wiring a plug or socket is called a (an)
   a. square knot
   b. loop knot
   c. Underwriters' knot
   d. crown knot

26. If you see any dangerous condition in the shop, you should
   a. take care of it yourself
   b. report it to your teacher
   c. ignore it
   d. tell your friends

27. The rate of flow of electricity or the current is measured in
   a. ohms
   b. amperes
   c. watts
   d. volts

28. Electron flow in a circuit is from
   a. plus to minus
   b. minus to minus
   c. minus to plus
   d. plus to plus

29. When one light goes out in a series circuit, the others will
   a. go out
   b. stay on
   c. go dim
   d. get brighter

30. The voltage of three dry cells connected in parallel will be
   a. 1½ volts
   b. 3½ volts
   c. 3 volts
   d. 4½ volts

31. A thermocouple, used in an industrial pyrometer, is an example of electricity produced by
   a. light
   b. pressure
   c. organic material
   d. heat

32. A phonograph cartridge crystal generates electricity using the principle of
   a. piezoelectricity
   b. photoelectricity
   c. bioelectricity
   d. thermoelectricity

33. Electricity is produced in a generator
   a. by means of friction
   b. by a transformer
   c. when the magnetic lines of forces are cut
   d. by the turbine

34. A step-down transformer is used to
   a. increase voltage
   b. stop voltage
   c. decrease voltage
   d. filter voltage

35. Very low temperatures offer __________ resistance in an electrical circuit.
   a. less
   b. no change in
   c. more
   d. very high

36. An applied voltage of 50 volts causes a current of 2 amperes to flow. What is the circuit resistance?
   a. 100 ohms
   b. 1 ohm
   c. 25 ohms
   d. 500 ohms

37. An open circuit and a short circuit may be quickly located by a
   a. written test
   b. cycle test
   c. continuity test
   d. capacitor test

38. A multimeter is an electric measuring instrument that is used to measure
   a. volts, ohms, and amperes
   b. foot candles
   c. kilowatts
   d. negative, positive, and neutral charges

39. The electronic testing device which shows a wave-form picture on a small screen is the
   a. tube tester
   b. signal generator
   c. signal tracer
   d. oscilloscope

40. The electric lamp that used both a starter and a ballast transformer is the
   a. incandescent
   b. fluorescent
   c. neon
   d. argon

41. Electrical devices that have been inspected and certified carry the "approved" label of the
   a. N.Y.C. Dept. of Electricity
   b. Underwriters' Laboratories
   c. N.Y.S. Dept. of Safety
   d. the electrician who inspected it

42. The safety device in an electric circuit which works by means of electromagnetism is the
   a. single pole, single throw switch
   b. circuit breaker
   c. potentiometer
   d. rheostat

43. The starting license for a radio amateur is the
   a. general
   b. technician
   c. novice
   d. amateur extra

44. The part of a receiving set that separates the carrier wave from the audio wave is the
   a. tuner
   b. detector
   c. amplifier
   d. picture tube

45. A 5016 vacuum tube has a filament voltage of
   a. 5 volts
   b. 50 volts
   c. 16 volts
   d. 506 volts

46. Solid state circuitry is closely associated with
   a. vacuum tubes
   b. germanium crystals
   c. transistors
   d. P.M. speakers

47. A college trained person who designs and develops new items of equipment for electricity and electronics is usually a (an)

a. technician
b. electrician
c. engineer
d. contractor

48. When purchasing a small electric appliance, the least important aspect to consider is

a. safety of product
b. construction
c. ability to do a good job
d. amount of chrome on it

49. Covering a metal with a thin film of another metal, using electricity is known as

a. electrophorous
b. regulation
c. timing
d. electroplating

50. Which group of scientists is credited with inventing the transistor?

a. Franklin, Morse, Gilbert
b. Fleming, DeForest, Bohr
c. Hertz, Edison, Bell
d. Shockley, Brattain, Bardeen

SECTION II—Essay Questions

1. Name 5 tools used in electrical work. Describe how each of these tools is used.
2. Describe the soldering process, using a soldering iron to fasten a wire to a terminal lug.
3. Using a battery, a switch, a lamp, and a bell,
   a. draw a schematic diagram of all these devices in a series.
   b. draw a schematic diagram of the same circuit showing the lamp and bell in parallel to one another.
4. Prepare a schematic diagram of a crystal radio circuit. Label each part.
5. Name five occupations which require a knowledge of electricity or electronics. Describe each job and give the kind and amount of training needed.
6. State and explain six safety rules that should be followed when you are in the shop.

SECTION III—Practical

1. Wire a plug and socket properly, using the Underwriters' knot.
2. Demonstrate the proper technique in soldering several wires to terminal lugs.

6

Safety

The school shop safety program is the responsibility of the administration, the teacher, and the student. These responsibilities are outlined in the following publications of the Board of Education, City of New York:

The Administration of Safety in the New York City Schools, Curriculum Bulletin No. 13, 1958-59 Series.
School Shop Safety Manual, Curriculum Bulletin No. 13, 1964-65 Series.

The industrial arts teacher is required to carry on a program of safety instruction which is integrated with the activities in the shop. Shop accidents usually occur when the student ignores some part of the safety instruction or improvises an operation or procedure. It is the responsibility of the teacher to analyze the activities in his program periodically and to make certain that proper safety instruction is included in every phase of the work.

"Accidents in shops may be attributed to various causes, such as inability, poor attitude, and impaired health of the pupil. Sometimes, because of inexperience, a pupil may be unaware of dangerous situations while concerned with a particular job or project. Therefore, the teacher must be on the alert to guard against those hazards which go unnoticed by the pupil and give special attention to new pupils. Good judgment can be developed through well-planned instruction."[3]

SUGGESTIONS FOR A SAFETY PROGRAM

Safety instruction must be a part of every unit.

Safety tests are to be given in the beginning of each term. These tests are to be based on the general safety program in the shop. These tests are to be kept on file as long as the student is in the industrial arts program.

Safety rules are to be posted on bulletin boards, in conspicuous places, and at appropriate work stations in the shop. These rules should be printed or hand-lettered in large type in order that the material may be seen readily.

Because the general safety test is given at the beginning of the term, it is expected that the pupils will receive additional instruction in the use of hand and machine tools, the operation of gas, electrical, hydraulic, and mechanical equipment. As the term progresses, students must be instructed and tested on these additional devices.

The personnel program should involve a safety engineer or safety foreman whose duties include the supervision of safety during the working period, and reporting of unsafe conditions at any time the class is in session.

VISUAL AIDS

Safety charts, shop-made and commercial, will prove useful devices for bringing "Safety" to the attention of the student. Some commercial charts which can be obtained by the teacher are:

Safety Charts Series, Atlas Press Co., 4-116 N. Pitcher St., Kalamazoo, Mich. 49001
Stanley Safety Charts, Stanley Tools, Box 1800, New Britain, Conn. 06050

There are a number of educational safety films available to the teacher. They should be requested several months in advance of the play date, and they should be used as instructional devices—not

3. Board of Education, City of New York, *The Administration of Safety in the New York City Schools,* Curriculum Bulletin No. 13, 1958-59 Series (New York: The Board), p. 125.

as a means of entertainment. Some of these films are:

The ABC of Hand Tools, General Motors Corp., General Motors Film Library, General Motors Building, Detroit, Mich. 48202
Shop Safety, Universal Education and Visual Arts, 225 Park Ave., New York, N.Y. 10003
Accidents Don't Happen, International Film Bureau, 57 E. Jackson Blvd., Chicago, Ill. 60604

Safety charts or displays made in the shop are often the most effective means of calling students' attention to safety. Ideas for projects may be gotten from magazines and newspapers, and students can be given the responsibility for developing the projects and doing the research. Some suggestions for student-made safety projects are:

A display of pictures or articles relating to shop safety
An illuminated sign indicating safety rules
Drawings showing the safe use of machines or tools

SAFETY EXAMINATIONS

Periodic safety tests must be given in the industrial arts shop program. Sample tests can be found in the *School Shop Safety Manual*. A teacher-designed test may be used.

Test items should be objective. The purpose of the safety test should be to determine whether or not the individual student understands the prudent use of machines and tools.

Each machine used by students must have a related safety examination. Students should not be allowed to use any equipment until they have passed the safety test for the machine.

Students who have difficulty in reading may be given oral safety examinations, and the written results of these tests should be filed with those of the rest of the group.

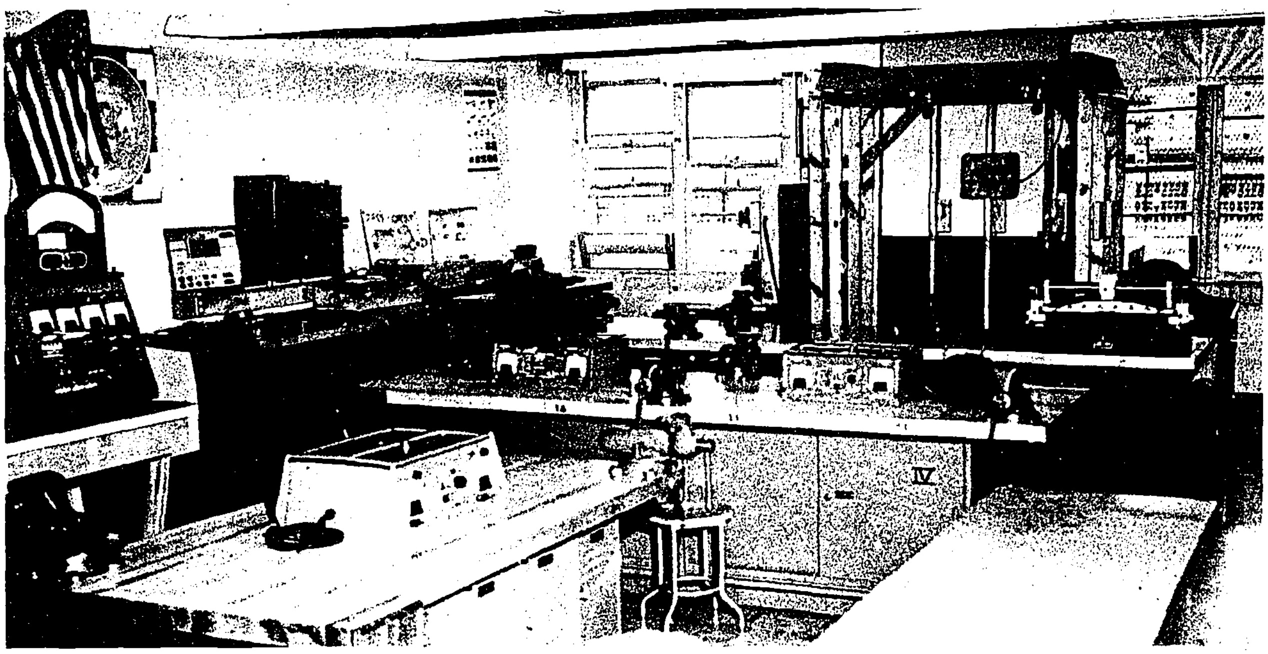
Each safety examination should serve as a valuable teaching device as well as the means of determining the extent of the pupil's knowledge. A discussion period should follow the administration of each test. A review of demonstrations and other techniques should be used to clarify the student's understanding of the underlying safety principles.

Alternate test forms should be developed by the teacher to provide examinations of similar content for students who may have to repeat a safety test because of failure or absence.

Students who display a limited understanding and limited skill in the use of any machine may be permitted to operate the machine under the direct supervision of the instructor and at the option of the teacher in charge of the class. Such limited or restricted permission should be noted on the class record card.

SUGGESTED SAFETY RULES FOR THE ELECTRICITY-ELECTRONICS SHOP

1. I will report all accidents, no matter how small, to the teacher *immediately*.
2. I will not use any test equipment, plug in anything, or throw any switches without the teacher's permission.
3. I will use only those tools that the teacher has shown me how to use.
4. At a signal from the teacher, I will stop all working, walking, and talking. I will wait for the teacher's instructions.
5. I will always keep the work area as neat and as safe as possible. I will report all hazards to the instructor and safety engineer.



A well-organized electronics laboratory contributes to the success of the industrial arts program.

6. I will always wear an apron whenever I work in the shop. I will wear goggles when using any machine, or if there is a possibility of flying particles that could get into my eyes.
7. I will hand tools to my classmates. Someone might be injured if tools or materials were to be thrown across the shop. Sharp tools are to be passed—handle first. Sharp tools should be carried point down, and away from the body.
8. I know that proper conduct in the shop demands orderly and workmanlike attention to the job being done. Conduct of any other type is considered disorderly.
9. If I am ever in doubt about the safe way to perform any operation or test, I will ask the teacher for instructions.
10. I realize that I am responsible for all other safety rules given me. I will learn and observe all other safety rules about specific tools and operations that I am given during the term.

PLEDGE

This is to certify that I have received both oral and printed instructions in electricity-electronics shop safety which I understand. I realize that failure to observe these rules may lead to serious consequences. Therefore, to avoid injury to myself and others I promise to observe these rules carefully and faithfully.

Pupil's signature: ________________________ Date: ____________

I know that my child has received oral and printed instructions in electricity-electronics shop safety, that he understands these rules, and promises to follow them.

Parent's signature: ________________________ Date: ____________

SAMPLE ELECTRICITY-ELECTRONICS SHOP SAFETY TEST

Fill in the blanks with the missing words or sentences.

1. What should you do if you have an accident in the shop?

____

2. What is needed before using test equipment, plugging things in, or throwing switches?

____

3. Which tools may you use?

____

4. What four things are you to do upon the teacher's signal, or when you hear fire or shelter signals?

   A. ____________________ C. ____________________

   B. ____________________ D. ____________________

5. What should you do if you are ever in doubt about the safe and proper way to use a tool or a piece of equipment?

____

6. How should the work area be kept?

____

7. What should you do if you see a shop hazard?

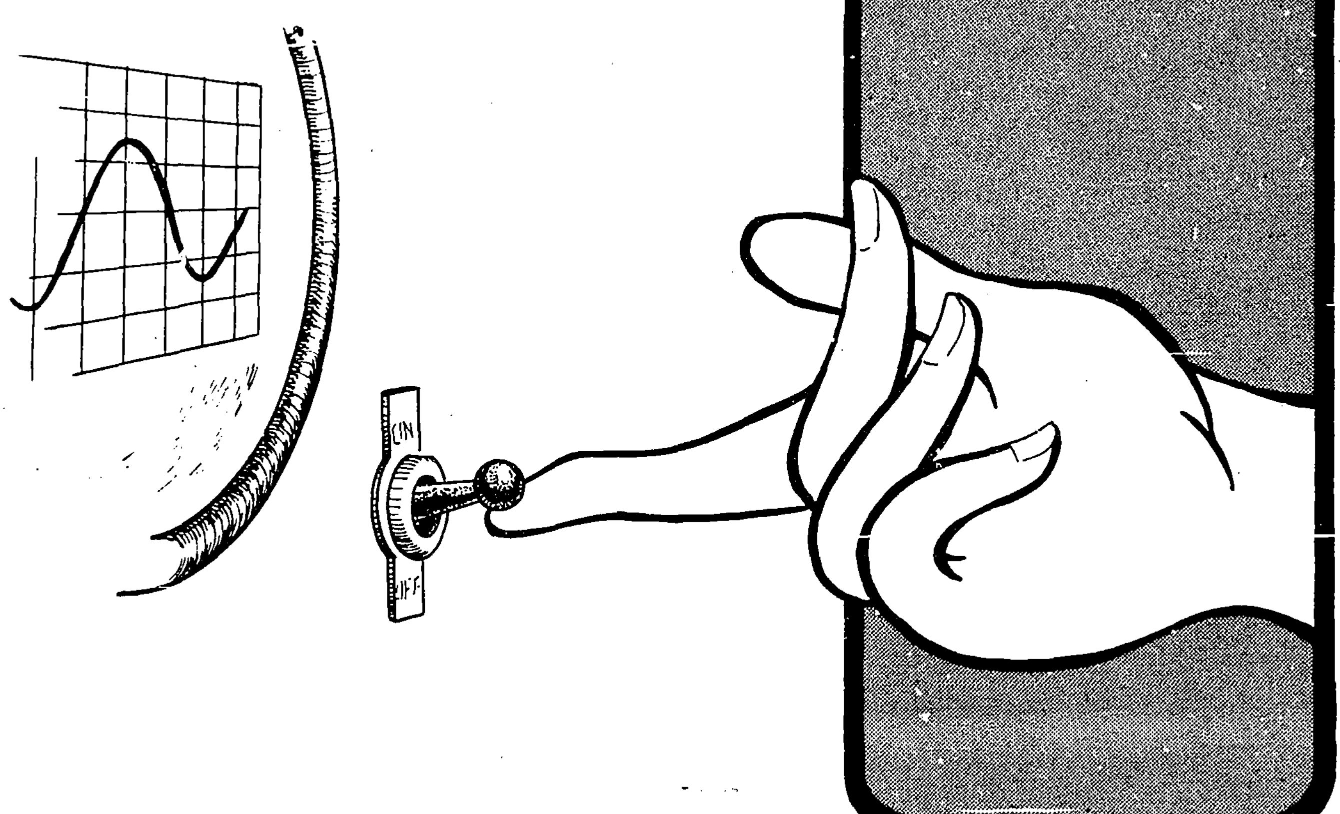
____

8. What equipment should be worn when a machine is operated?

____

7

Orientation



SAMPLE LESSON PLAN

Week: 1

Day: 1

Unit: Orientation

Topic: Introduction to the Electricity-Electronics Shop

Aim: To acquaint the students with the routines and practices of the shop through discussions, demonstrations, displays, and tours.

Procedure:

Assign temporary stations until interclass transfers are stabilized. Check Industrial Arts Shop Cards.

Register pupils. (Some teachers prefer to use a class list for attendance-taking during the first few weeks until registers are stabilized. The Number 11 attendance book or Delaney book is suggested. Teachers may find record keeping convenient when the students are seated alphabetically by official classes.)

Use a motivational device, and/or demonstrate various projects constructed in the shop to stimulate student interest, i.e., induction coil, Jacob's ladder, Tesla coil, Van de Graaff generator, amateur radio transmission and reception, magnetic attraction and repulsion, electrostatics, etc.

Demonstrate working samples of some of the shop-made projects.

Discuss shop routines. Establish as a shop routine that the students should expect a demonstration of some interesting electrical facts or phenomena at the start of each double period. There may be brief notes prepared on the chalkboard for students to transcribe into their notebooks as soon as they walk into the room. These notes may be limited to no more than what the slowest student can do in three minutes. They may take the form of review of previous material, diagrams, questions, problems, or assignments. Other routines which should be established immediately concern entry into the classroom, arrangement of notebooks, care of aprons, proper dress, transcription of notes from the board, and keeping of attendance. Cleanup routines that should be discussed are: stopping work at the signal, returning tools and projects to storage, performing cleanup assignments, collecting books, being seated for dismissal.

Discuss printed safety rules that the students will paste into their notebooks. Discuss the written safety test the students will take when they next come into the shop.

Tour the shop, and investigate all electrical test equipment.

Discuss your pupil personnel plan with the class. A well-run shop is usually organized so that as many details and services as possible are delegated through the general superintendent to the pupils in the class. This allows the teacher greater opportunity to work directly with the pupils requiring assistance.

Explain the problems and procedures involved in tool usage, storage, and responsibility. Discuss procedures and problems in project storage and identification.

Assign class project storage area. It is preferable that each class store its projects in a separate, locked closet.

Discuss industrial arts and the part electricity-electronics plays in it. Explain the objectives of the program.

Give directions for emergency and fire drills. New teachers should make a point of learning drill procedures and signals as quickly as possible.

Check on special category pupils, i.e., those who are physically handicapped, retarded, disciplinary cases, emotionally disturbed, underachievers, or gifted.

Long-term student assignments and those specific to the next session should be discussed.

Demonstration:

1. Show and discuss projects that the student will make in the shop.

2. Demonstrate a piece of equipment in the shop that will interest the students; e.g., induction coil, Jacob's Ladder, Tesla coil, Van de Graaff generator.

Assignment:

Prepare a list, or write a few brief paragraphs on what would happen if the utility company's generators were to fail and take 24 hours to repair.

References:*

Buban and Schmitt, pp. 1-5.
School Shop Safety Manual, pp. 99-116.
Teacher's Guide to Industrial Arts Shop Management, pp. 33-39.

* Complete information concerning publications listed here and in succeeding lesson plans appear in the Bibliography.

SAMPLE LESSON PLAN

Week: 1

Day: 2

Unit: Orientation

Topic: Electron Theory

Aim: To describe an electric current in terms of the electron theory

Procedure:

Review the shop safety rules.

Administer the written safety test. It is suggested that the teacher have several forms of the safety test suited to the varying abilities of the students in his school. The teacher should check every paper. It is important that all safety tests be kept on file for at least three years. If a student has been involved in an accident, his papers must be retained until the case is settled.

Review the theory of matter. Say, "All matter is made up of elements. Elements are made up of molecules. Molecules are made up of atoms; atoms, of protons, electrons, and neutrons. Our first concern in electricity-electronics is with the electron (the negative charge)."

Electrons move from a point where there are too many to a point where there are too few, that is, from the negative pole to the positive pole.

Analogy: The free-moving piston in a closed-loop pipe system illustrates that as well as an excess of electrons on one side of a moving piston exerting a push, a deficiency of electrons on the other side of the piston exerts a pull.

Electrical current is the movement of electrons.

Electrical energy, or the ability to do work, exists in the flow of electrons from a point where there are too many to a point where there are too few.

Show the basic project to the class. It will be a battery-operated continuity tester. Distribute the project bases to the class and have the students mark their name and shop group on them. Each student should know the name of the project, what it does, and why he is making it.

If time permits, the students should begin the layout of the project base.

At the end of the period you might take a few minutes to discuss the previous day's homework assignment.

SAMPLE LESSON PLAN

Week: 2

Day: 1

Unit: Orientation

Topic: Units of Electricity

Aim: To help students understand the basic electrical unit of measurement.

Apperception: Relationship of the structure of an atom to a solar system is discussed.

Motivation: Demonstrate a model of electron flow, using a marble board.

Preparation: "Marble Board" (Buban and Schmitt, p. 131); provision for new words on the chalkboard; galvanoscope, leads, dry cells, two resistors (3,000 ohm and 15,000 ohm); galvanometer 30-0-30.

Demonstration: Galvanoscope (Buban and Schmitt, pp. 124-127); seeing effects of electricity; hearing effects of electricity.

Points for Development:

The ampere is the electrical unit which measures the rate of electron flow.
The volt is the electrical unit which measures the amount of electrical pressure (or potential difference).
The ohm is the electrical unit of resistance.
Direct current, or DC, is the flow of electrons in one direction only.
Alternating current, or AC, is the flow of electrons, first in one direction and then the other, periodically alternating in direction.

New Terms:

negative charge
positive charge
ampere
volt
alternating current, AC
direct current, DC

Summary:

Electron flow is from negative to positive.
Electrical current is the movement of electrons. It is measured in amperes.
Electrical pressure is measured in volts.
Direct current is the flow of electrons in one direction only.
Alternating current is the flow of electrons in one direction, and then the other, and periodically alternating direction.

Student Activity:

Students may do a layout of the project base for their first project, the continuity tester. Templates or overlays may be used.

Assignment and/or Enrichment:

Students may prepare a listing of voltages derived from these sources:

- flashlight battery
- lantern battery
- automobile battery
- bell transformer
- household outlet
- television set power supply for picture tube

References:

Buban and Schmitt, pp. 115-127.
Gerrish, pp. 4-11.
Miller and Culpepper, pp. 15-24.

Electricity shops are equipped with modern instruction aids for use by pupils and teachers.

SAMPLE LESSON PLAN

Week: 2

Day: 2

Unit: Orientation

Topic: Conductors and Insulators

Aim: To help the students understand that electricity can be made to do various things by selecting the material it flows through.

Apperception: The students' experience with different types of wire covering and conductors may be utilized.

Motivation: Demonstrate a lamp lighting at different intensities or not lighting at all as test probes are put across lengths of various materials.

Preparation: Continuity tester, various materials such as copper, iron, nichrome, wood, plastic, rubber, glass, water, wool thread, etc.

Demonstration: Use the continuity tester to discover how electricity is constructed.

Points for Development:

Electrons can be made to do various things according to the material through which they flow. This information is used in designing various devices to meet our needs.

Copper allows electrons to pass from one atom to another without much difficulty; therefore, we use it for wire and call it a good conductor.

Nichrome offers opposition to the passage of electrons; thus, we toast bread with the heat energy the flow of electrons releases as it tries to pass through the wire.

We light homes with the white light given off as electrons are forced through fine tungsten wire in our incandescent lamps.

We use rubber or plastic to cover wires because they provide much opposition to the flow of electrons, and they block the passage of electrons.

Any material that does allow electrons to pass through it is a conductor.

Any material that does not allow electrons to pass through it at all is an insulator.

New Terms:

conductor
insulator

Summary:

Electrons can be made to do various things according to the material through which they pass.

Conductors allow electricity to pass through them.

Insulators do not allow electricity to pass through them.

Application:

When projects are designed, the materials are selected according to whether or not electrons are to pass through them easily, with difficulty, or not at all.

Student Activity:

Students lay out and construct the metal parts for the continuity tester.

Students may test various other materials to determine whether or not they conduct electricity.

Assignment or Enrichment:

The area of "superconductivity." Certain materials become almost perfect conductors, with almost no resistance at all, at temperatures near 0° Kelvin, about minus 415° F.

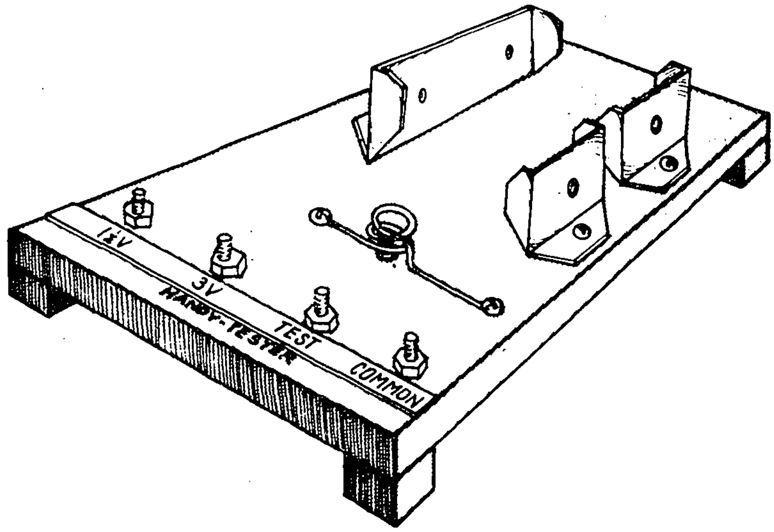
The area of semiconductors. Those materials which are good conductors under certain conditions, and poor conductors under others.

References:

Buban and Schmitt, pp. 127-131.
Gerrish, p. 6.

HANDY TESTER

TOOLS:
hand drill with 1/8″ drill
tinners' snips
screwdriver
5/16″ nutdriver
round nose pliers
3/8″—16 bolt
center punch
hammer
hand punch with 1/8″ punch



MATERIALS:

base, hardboard, 4″ x 8″
tinplate, two pieces, 1¾″ x 2½″
tinplate, one piece, 1¾″ x 4½″
six 6-32 x ½″ R.H. machine screws
four 6-32 x ¾″ R.M. machine screws
ten 6-32 nuts
one paper fastener
30″ of #20 annunciator wire
rubber cement
top sheet

PROCEDURE:

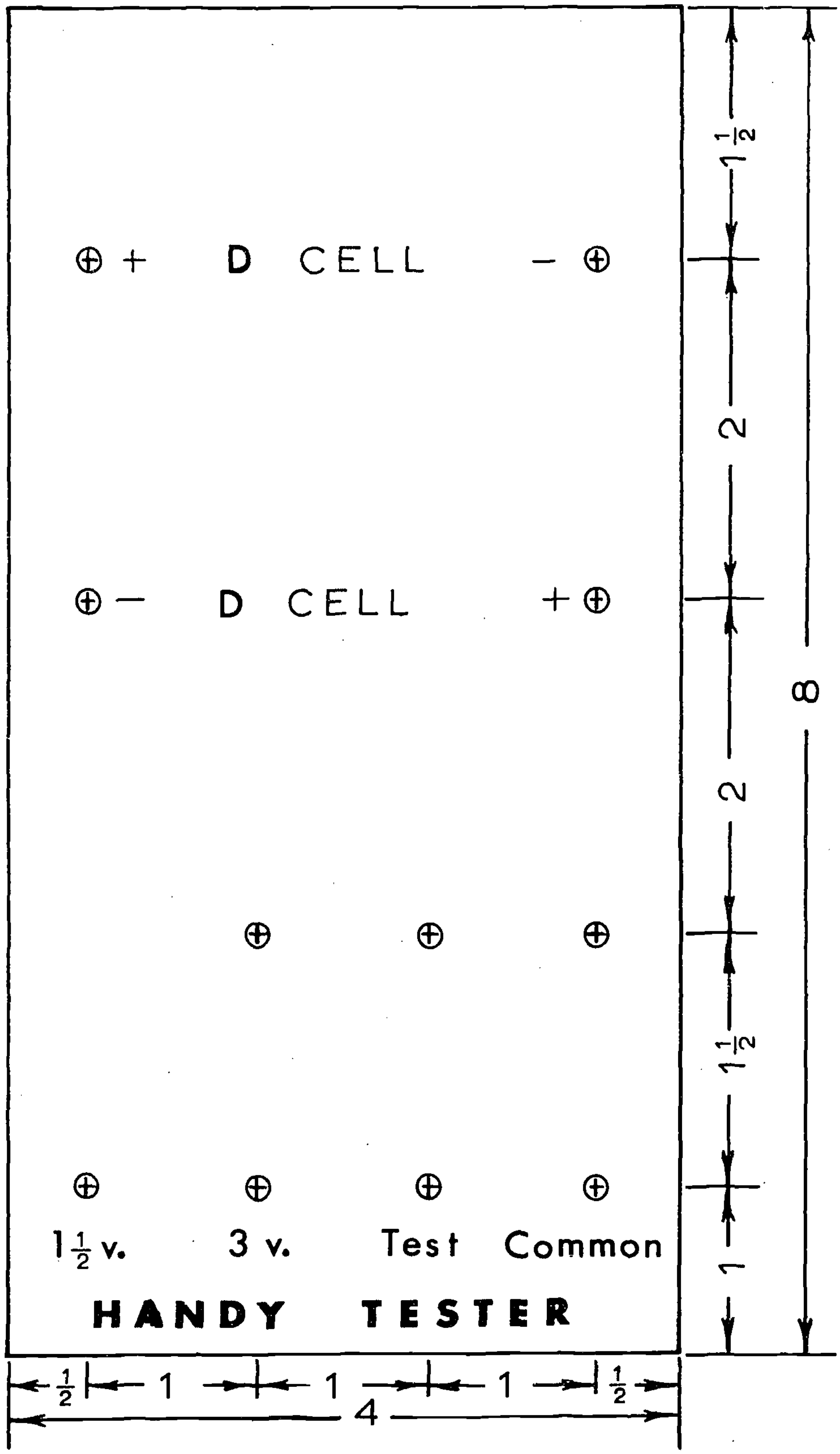
1. Obtain materials from instructor.
2. Print your name, class, and number on the rough side of base.
3. Cement top sheet to project.
4. Lay out top of project.
5. Have your instructor check project.
6. Center punch all holes.
7. Drill all holes with 1/8″ drill or punch.
8. Make the three battery holders using instruction sheet.
9. Make the lamp holder following the instruction sheet.
10. Mount all parts on top of base.
11. Wire your project at bottom of base.
12. Put two "D" cells and a #14 flashlight lamp into their holders.
13. Test your project.
14. Have project checked by instructor.

OPERATING INSTRUCTIONS:

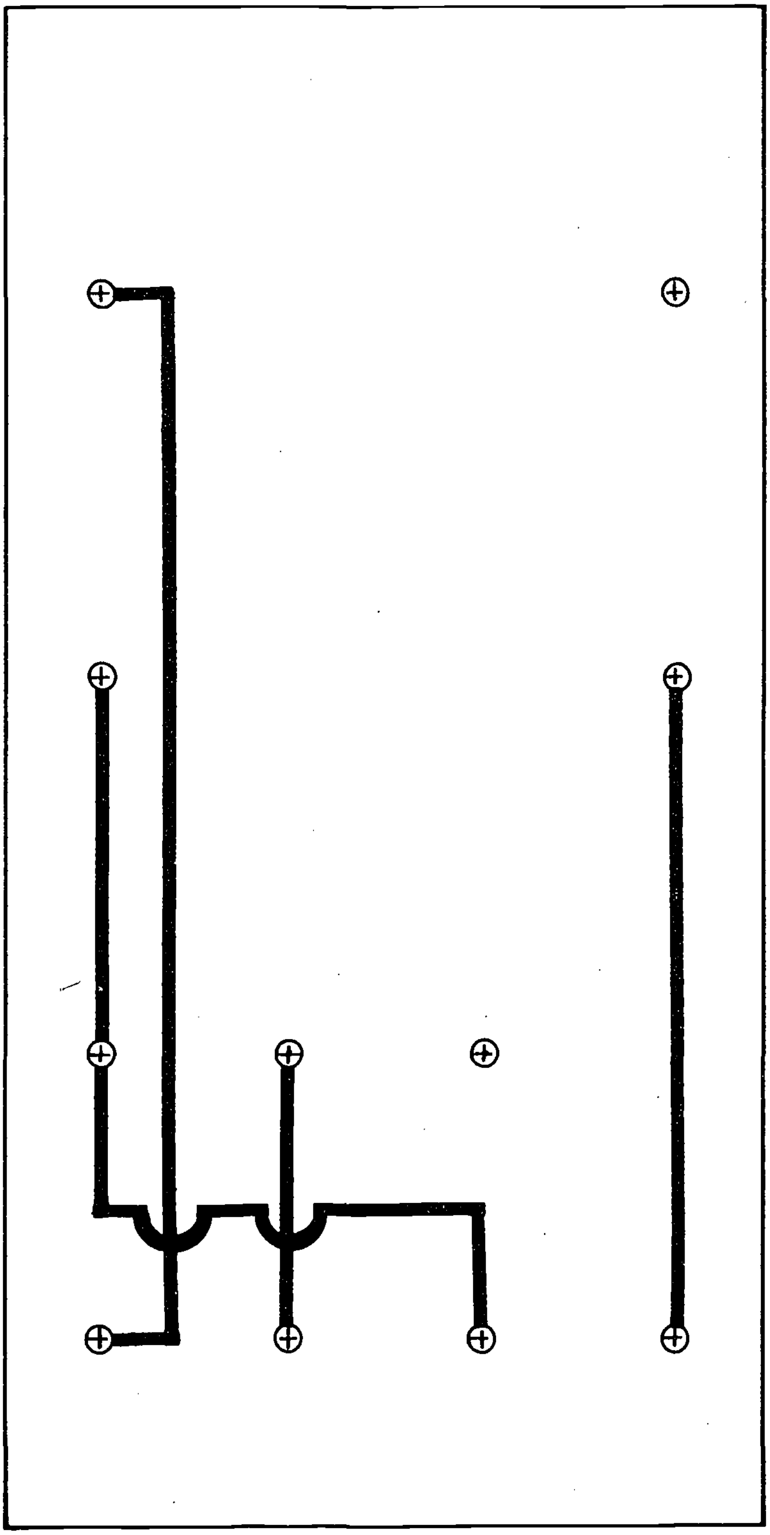
For a continuity check—connect one wire to the "Common"; connect other wire to "Test."
For a 3-volt power source—connect one wire to the "Common"; connect other wire to "3V."
For a 1½-volt power source—connect one wire to the "Common"; connect other wire to "1½V."

The project combines a dual DC power source for operating other projects, and for experimentation with a continuity tester for checking other projects to be constructed. This project should be left in the student's locker through the term for checking of other projects.

Handy Tester Layout



Handy Tester — Wiring Diagram



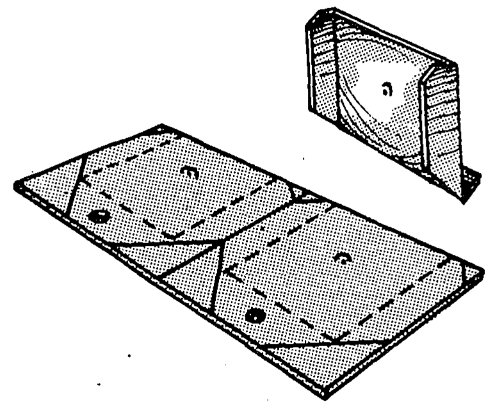
STANDARD BATTERY HOLDER

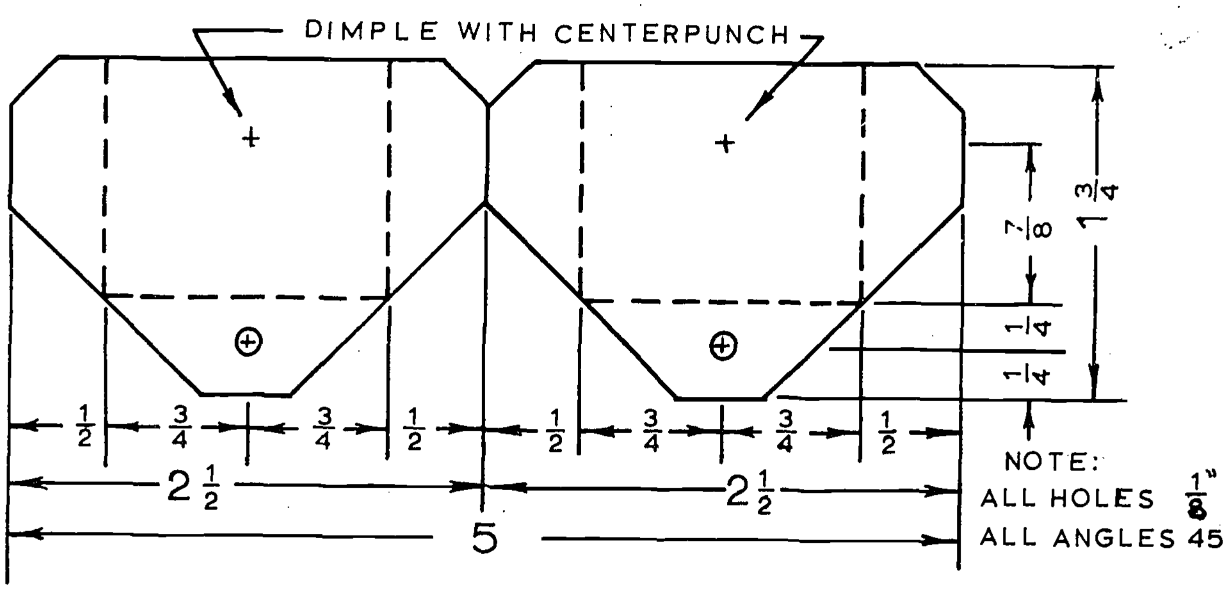
(Instruction Sheet)

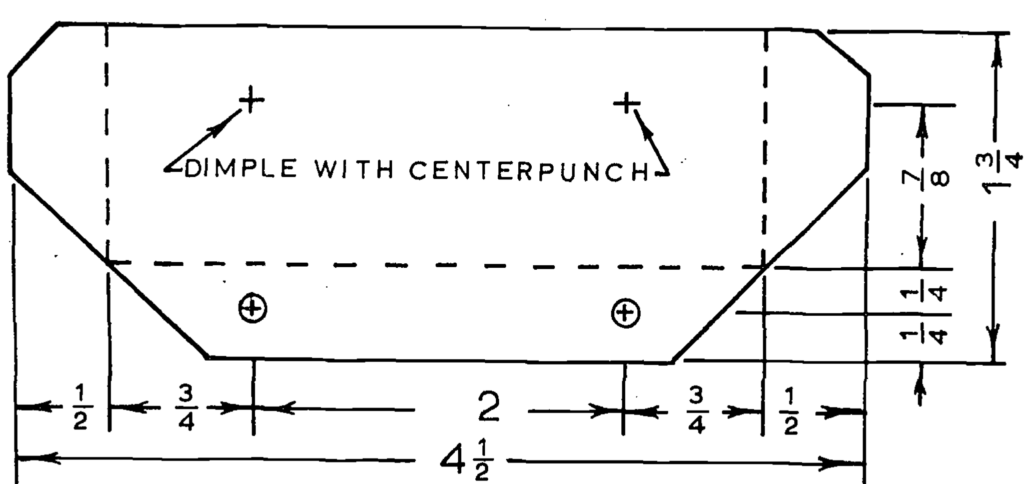
MATERIALS:
Single—tinplate 1¾ x 2½
Double—tinplate 1¾ x 4½

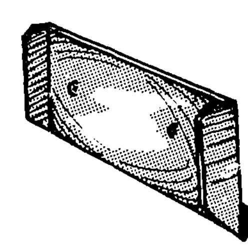
TOOLS:
ruler, pencil, tinners' snips, punch, hammer, ⅛" twist drill, hand drill, scrap block

PROCEDURE:
1. Obtain materials from the instructor.
2. Lay out all metal pieces.
3. Cut to shape.
4. Punch and drill holes.
5. Bend to shape.

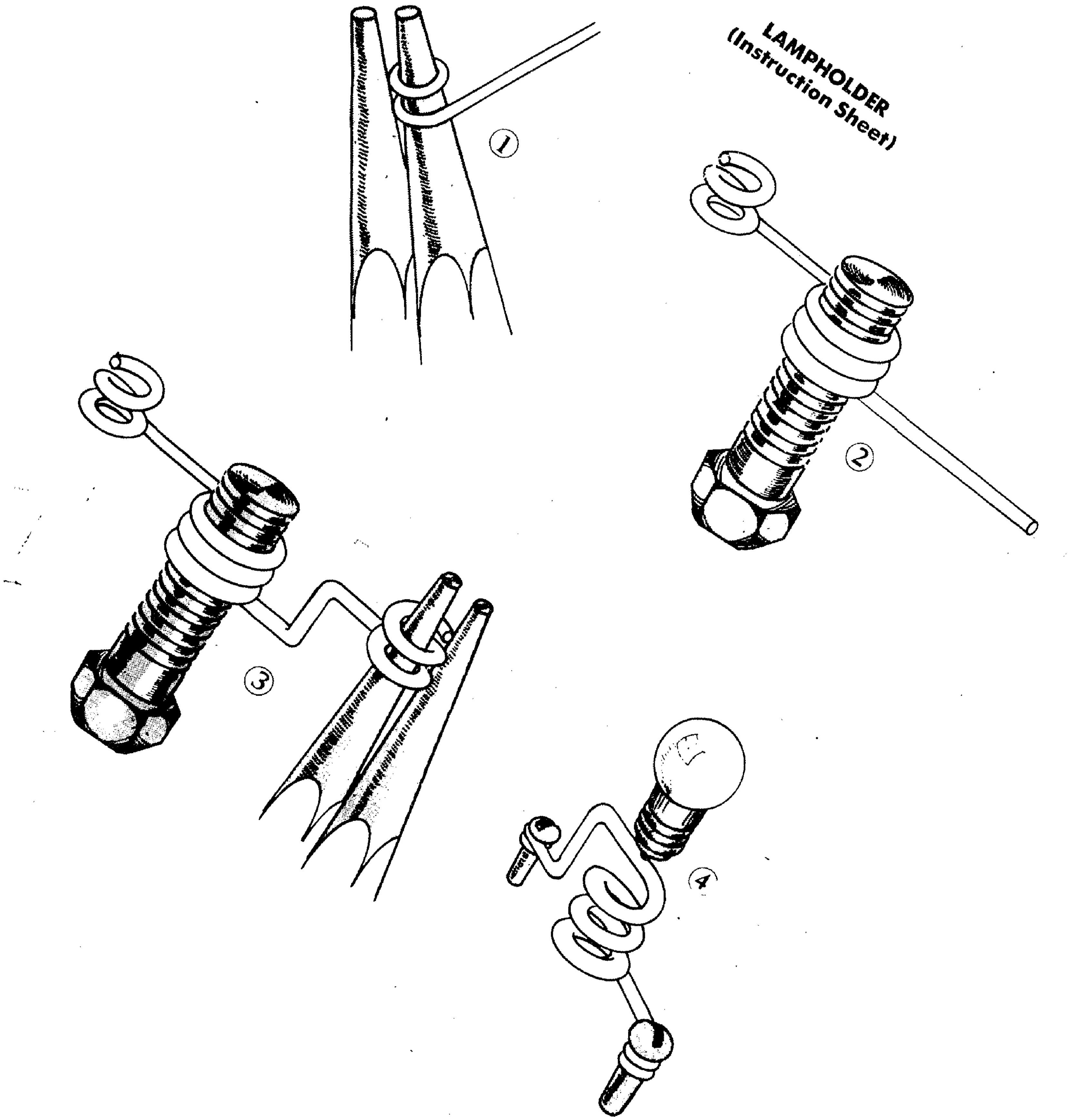




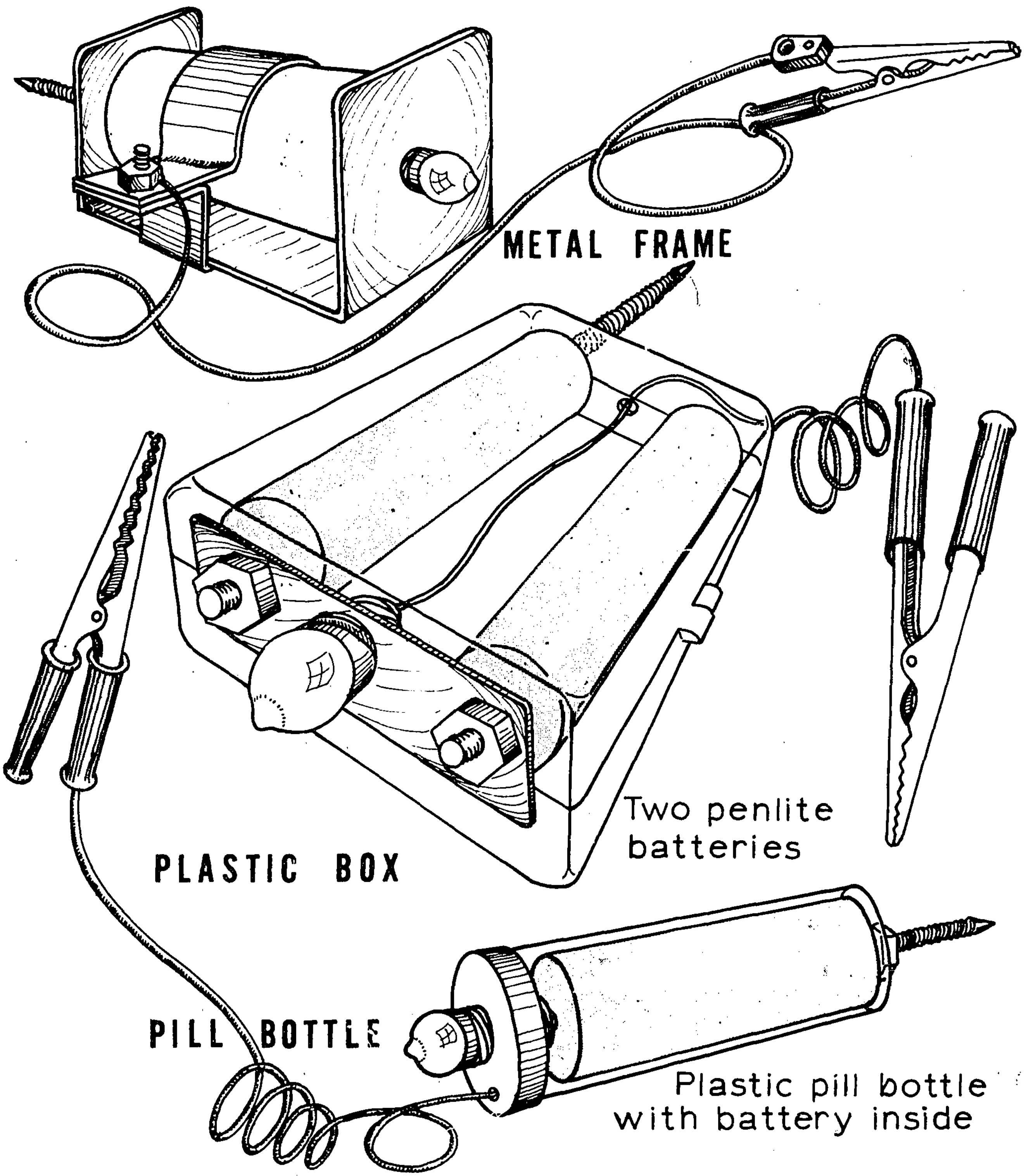




LAMPHOLDER
(Instruction Sheet)



ALTERNATE CONTINUITY TESTER

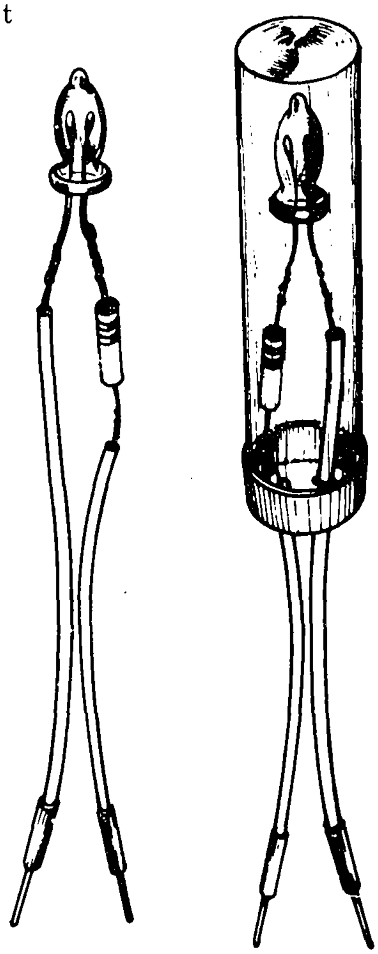


NEON TESTER

MATERIALS:
NE-2 glow tube
220,000 ohm resistor
2 phone tips
2 12" pieces of stranded wire
plastic pill bottle or very small plastic box
clear cement

TOOLS:
diagonal cutting pliers
flat nose pliers
hand drill
¼" twist drill
soldering iron
electrical tape

DIAGRAM

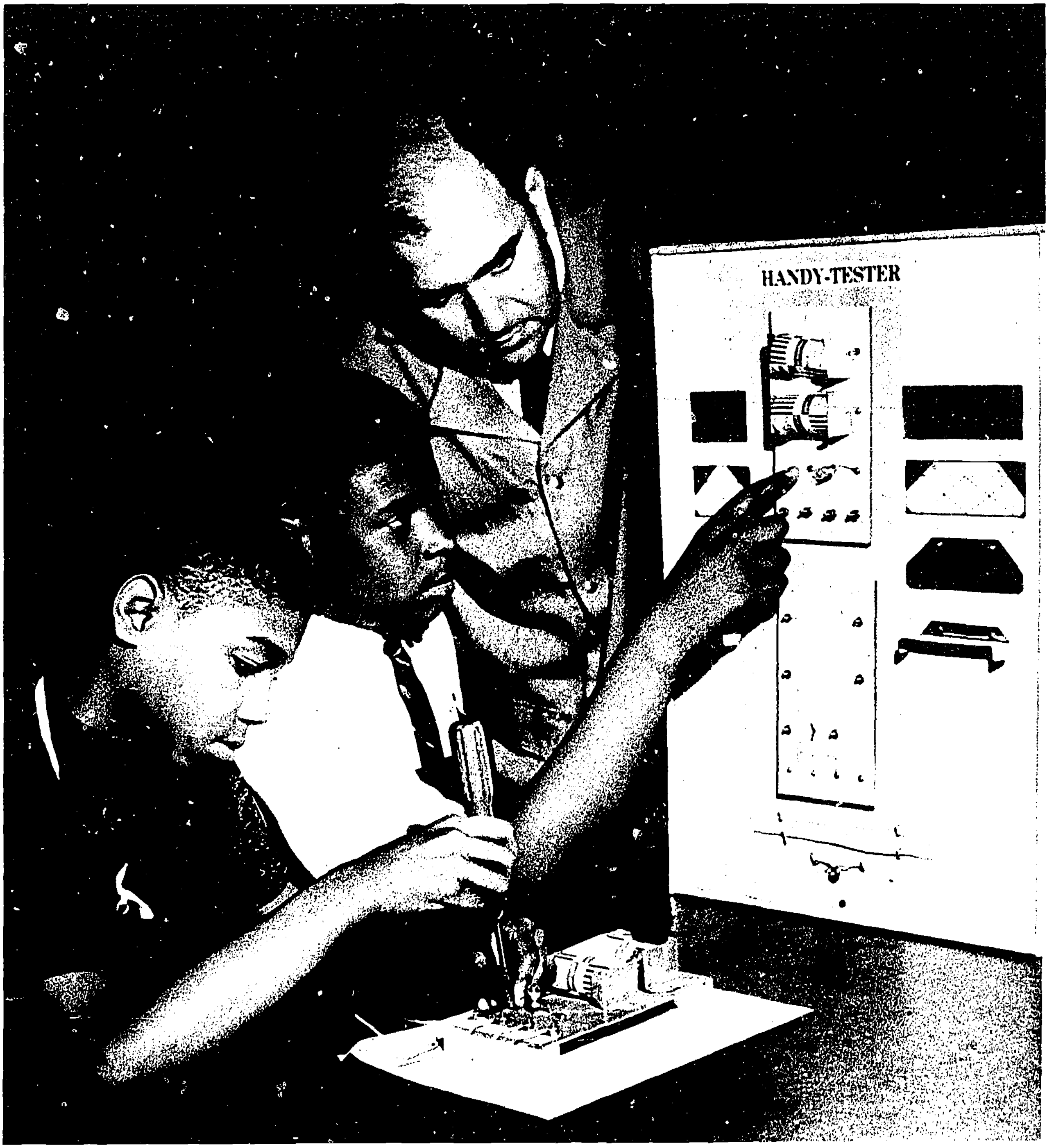


PROCEDURES:
1. Obtain materials from the teacher.
2. Drill a ¼" hole in the bottle cap.
3. Strip insulation 1" back from all wire ends.
4. Tin all wire leads.
5. Solder a phone tip to one end of each wire.
6. Solder all components in place as in diagram.
7. Insulate wires with electrical tape.
8. Slide each cap-up wire from the tip to the resistor.
9. Assemble the project by fitting the cap on the bottle.
10. DO NOT PLUG THIS PROJECT IN UNTIL THE TEACHER CHECKS IT.
11. After the project has been checked and tested by the teacher, cement the cap on the bottle.

THIS NEON TESTER MAY BE USED TO TEST HIGH VOLTAGE AC AND DC FUSES WHICH ARE BLOWN.

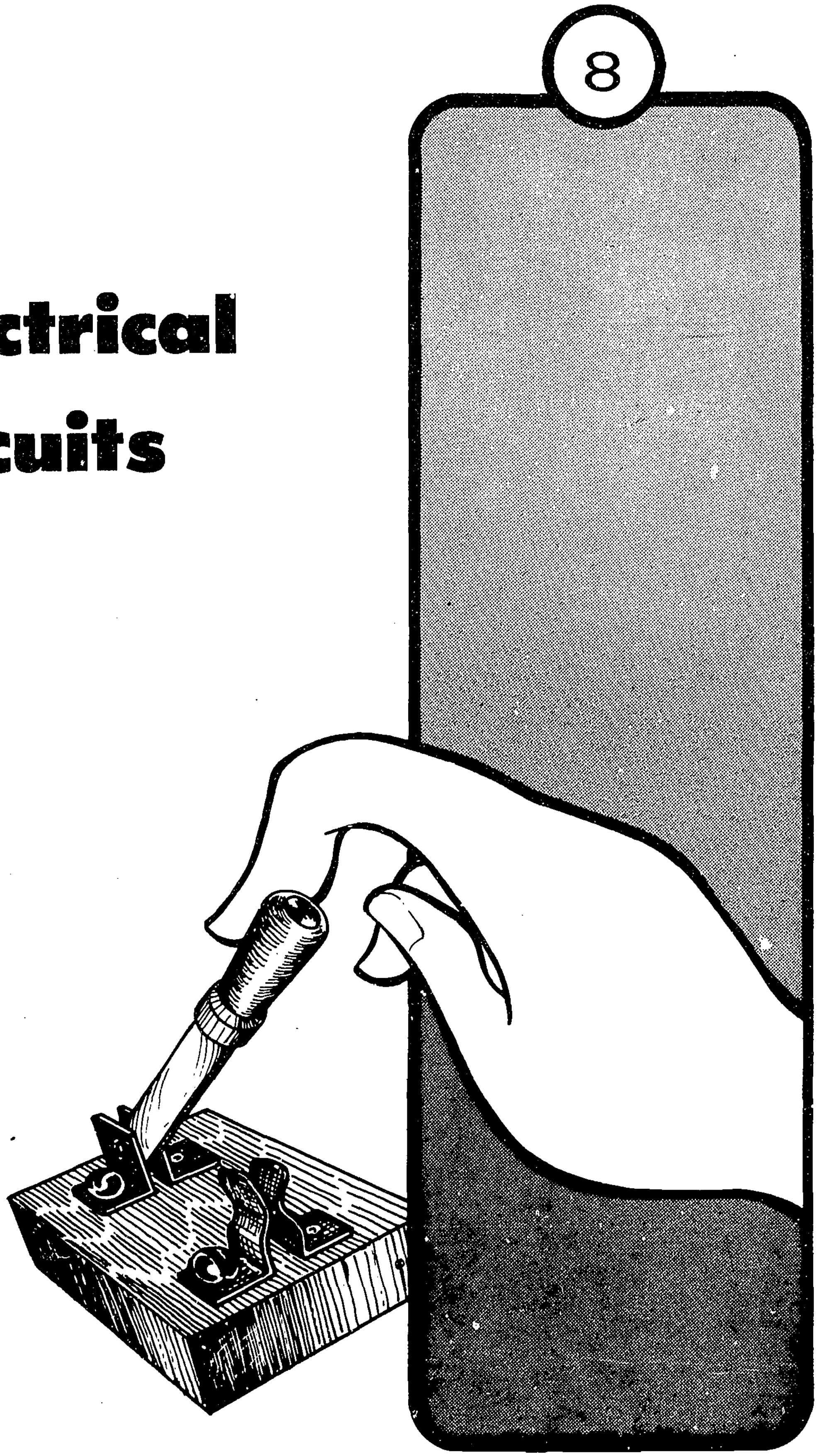
OPERATING INSTRUCTIONS

1. The neon lamp should light when the test prods touch a source of electricity or are plugged into a standard wall outlet. Lighting indicates the presence of at least 90 volts at this receptacle. If the neon lamp fails to light, check to be sure that the test prods are actually making contact before assuming that there is no voltage present. The neon lamp will not light if the electromotive force is less than 90 volts.
2. Both elements of the neon lamp light when AC is present. Only one element lights when DC is present.
3. A neon tester will not light when placed across the fusebox terminal connection of a good fuse. The neon tester will light when placed across the fusebox terminal connections of a bad fuse.
4. High voltage in excess of 1,000 volts-60 cycle AC may be determined by holding the lamp portion of the neon tester near a source of very high voltage. The neon gas will light to indicate the presence of high voltage discharge even though the test leads are not physically connected to the source.



This tester is a beginning project which has useful applications for electrical work in the school and at home.

Electrical Circuits



SAMPLE LESSON PLAN

Week: 3

Day: 1

Unit: Electrical Circuits

Topic: Electrical and Electronic Symbols

Aim: To acquaint the students with the international system of electrical and electronic symbols.

Apperception: Students are already acquainted with a number of mathematical symbols (+, −, =), financial symbols ($, ¢), etc.

Motivation: Exhibit a foreign language electronics magazine using standard symbols. Or have three students come to the board, and have each one draw a picture of a variable capacitor.

Preparation: Wall chart, sheet of standard symbols for students to paste into notebook, samples of various items the symbols of which will be utilized in the lesson.

Demonstration: Show how much easier and clearer it is to use standard symbols, rather than individually drawn pictures.

Points for Development:

A symbol is a simple sign or picture that represents a component.

Standard symbols are internationally accepted and used. Thus, a transistor radio circuit could be designed in the United States, made in Japan. and sold and repaired in Mexico.

Some electrical symbols to be studied are those for the:

- battery
- switch
- lamp
- bell
- ground

Some electronic symbols are:

- antenna
- coil
- capacitor
- resistor
- diode

A schematic diagram uses standard symbols to *illustrate* a *circuit*. A pictorial diagram uses pictures or actual drawings to show the same circuit.

New Terms:

symbol
schematic diagram
pictorial diagram

Summary:

A symbol is a sign or picture that represents something.
Standard symbols are used and understood in every country of the world.

Application:

Symbols are used in electrical circuit diagrams for the wiring of homes, schools, factories, radios, televisions, and phonographs.

Student Activity:

Work on electric quiz, electric baseball, electric football, computer.

Reference:

Buban and Schmitt, pp. 14-17.

Courtesy Fenwal Electronics, Inc.

Glass encapsulated thermistors of the sub-mini-probe type are designed for oceanographic use.

SAMPLE LESSON PLAN

Week: 3
Day: 2

Unit: Electrical Circuits

Topic: The Circuit

Aim: To help students understand the general nature of circuits.

Apperception: Comparison of an electrical circuit to a series of roads and streets. Use a road map.

Preparation: Circuit board with several devices, sources, switches, and connecting leads.

Demonstration: Show, step by step, the parts of circuit and how to connect them properly.

Points for Development:

A circuit is a path for the flow of electricity.

Every circuit should have a source, a switch, a load, and interconnecting leads.

Many circuits have more than one load.

In order to properly connect any circuit:
- First, connect one side of the source to the switch.
- Next, connect the other side of the switch to one side of the load.
- Finally, connect the other side of the load to the other side of the source.

Types of circuits are series circuits, parallel circuits, and series-parallel circuits.

New Terms:
- circuit
- source
- switch
- load

Summary:

The essential parts of any circuit, when properly connected, form the path for the flow of electricity.

Application:

Every electrical and electronic device uses at least one circuit.
Note projects constructed in shop.

Student Activity:

Construct a handy-tester or a quiz game (baseball, football, computer).

Enrichment:

Investigate, discuss, and demonstrate modern printed circuits and integrated circuits.

References:

Buban and Schmitt, pp. 17-26.
Miller and Culpepper, p. 16.

Circuitry and switches provide a challenge to students who are learning fundamental concepts.

SAMPLE LESSON PLAN

Week: 4

Day: 1

Unit: Electrical Circuits

Topic: Connecting Sources and Loads in Series

Aim: To study the effects of adding or removing sources or loads connected in series.

Apperception: Students' experience with strings of Christmas lights may be utilized.

Motivation: Why do all the lamps in this series of lights go out when one lamp is removed?

Preparation: Demonstration board, cells, sockets, lamps, ammeter, voltmeter, string of Christmas tree lamps.

Demonstration: Use demonstration board with a number of lamps connected in series, using a few cells as the source. Show what happens when any lamp is unscrewed. Check voltage and current at various points in the series circuit. Show what happens when additional cells are added in series and then what happens as cells are removed one by one.

Points for Development:

A series circuit has only one path for the flow of electricity.

In a series circuit the intensity of electron flow (current in amperes) is constant at all points.

In a series circuit the source voltage is divided among the loads.

In a series circuit the total resistance is equal to the sum of all the resistances in the circuit.

When sources, such as dry cells, are connected in series, the total voltage is equal to the sum of all the individual voltages.

Cells are connected in series to produce a higher voltage than a single cell produces. (Cells connected together are called a battery.)

New Terms:

series circuit
source
load
battery

Summary:

A series circuit has only one path for the flow of electrons.

Although the current is constant in a series circuit, the voltage is divided among the various loads.

We may obtain higher voltages by connecting cells in series.

Application:

Students now know why a whole string of lamps, or tubes, goes out at once when only one is open.

They know that they will have to check the continuity of each load in the circuit until they find the one that is not functioning.

Student Activity:

Those students who have advanced toward completion of the basic project should begin wiring board experience using exercise sheets. Each student should complete several circuits, obtaining the teacher's approval each time, and then answer several questions about what he has learned. By midterm each student in the class should have completed and been marked on series wiring boards.

Assignment and Enrichment:

Students may do several series circuit diagrams at home using standard symbols.

Students may prepare a listing of specific applications of series circuits.

References:

Buban and Schmitt, pp. 146-147, 149-150, 215-216.

Gerrish, pp. 21-25.

Miller and Culpepper, pp. 32-33.

SAMPLE LESSON PLAN

Week: 4
Day: 2

Unit: Electrical Circuits

Topic: Connecting Sources and Loads in Parallel

Aim: To study the effects of adding or removing sources or loads connected in parallel.

Apperception: In a series circuit when one lamp burns out, all the others go out. In your home when one lamp burns out, the others continue to burn.

Motivation: What happens to all the other lamps when one lamp from this circuit is unscrewed?

Preparation: Parallel circuit demonstration board, lamps, cells, ammeter, voltmeter.

Demonstration: Show the properties of a parallel circuit. Show what happens when one, two, or three lamps are disconnected. Then show what happens to the brightness of the lamps when another cell is added in parallel. Show what happens when several cells are taken away. Repeat this procedure showing ammeter and voltmeter readings.

Points for Development:

A parallel circuit has more than one path for the flow of electrons.

In a parallel circuit the intensity of electron flow (current in amperes) is divided among the branches of the circuit. The total current in a parallel circuit is equal to the sum of the currents across the loads.

In a parallel circuit the voltage is constant at all points.

In a parallel circuit the total resistance is always less than the resistance of the lowest value resistor.

Cells connected in parallel yield the same voltages as one cell, but they provide greatly increased current capacity.

Parallel circuits are used for most wiring in homes, offices, commercial establishments, and factories.

New Terms:

parallel circuit
intensity

Summary:

A parallel circuit has more than one path for the flow of electrons.

In a parallel circuit the voltage is the same at all points; the source current is divided among the branches.

Cells are connected in parallel to yield greater current.

Application:

Parallel circuits are used in the wiring of our homes, automobiles, businesses so that we can have complete control over the number of loads that are operating at any one time.

Student Activity:

Work on continuity tester.
Work on parallel wiring board.

Assignment and/or Enrichment:

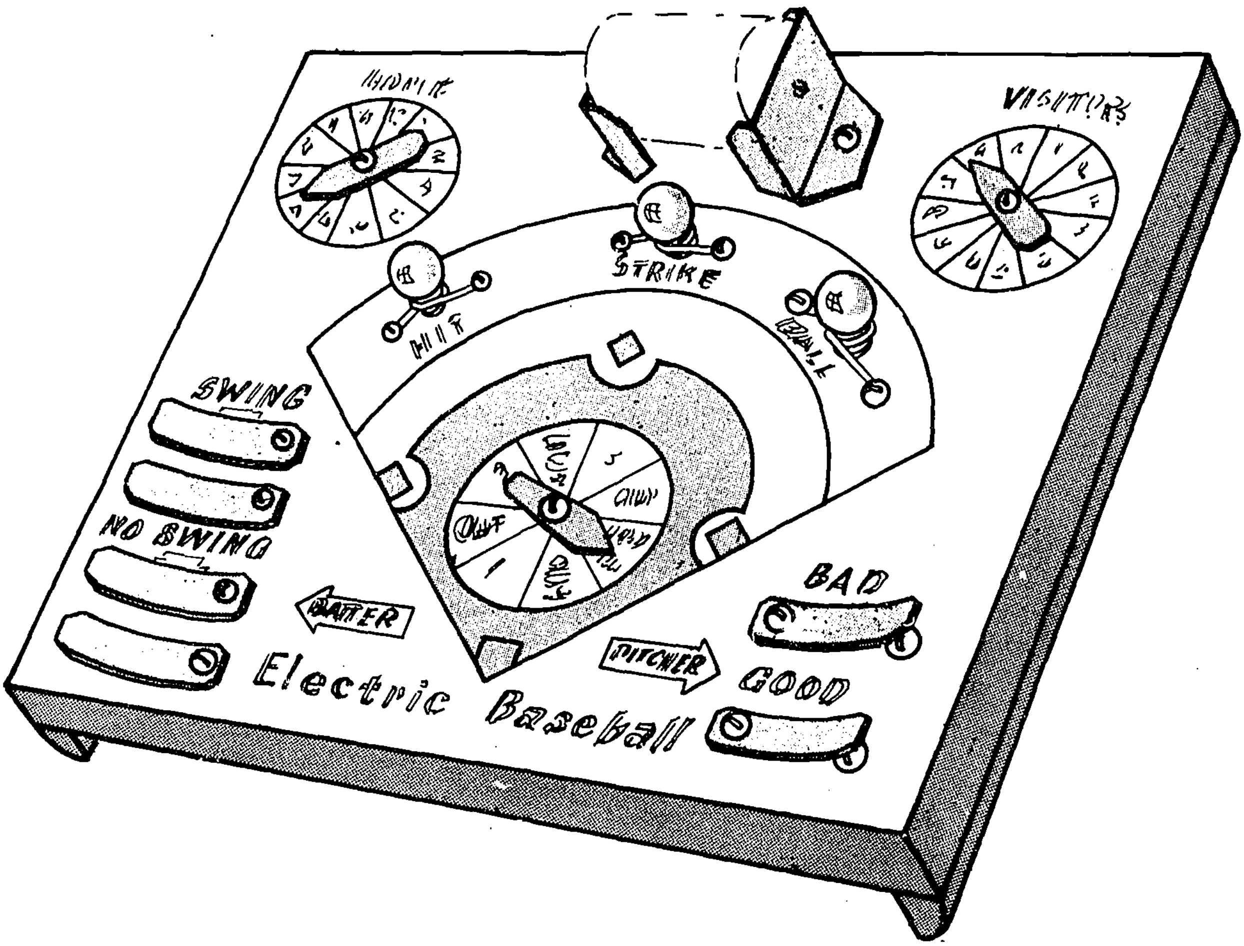
Students may prepare schematic diagrams of several parallel circuits at home.

Students may be asked to compute the voltage and current present across several equal loads in a given circuit.

References:

Buban and Schmitt, pp. 147-151.
Gerrish, pp. 26-31.
Miller and Culpepper, pp. 33-36.

ELECTRIC BASEBALL



TOOLS:

center punch
hammer
hand drill with ⅛" drill
hand punch with ⅛" punch
screwdriver
5/16" nutdriver
⅜"—16 bolt
tinners' snips
pencil and ruler

MATERIALS:

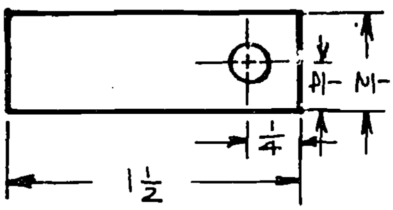
base, hardboard, 8½" x 11"
tinplate, two pieces, 1¾" x 2½"
17 ½" x 6-32 R.H. machine screws
17 6-32 nuts
9 paper fasteners
3 No. 6 washers
iron strapping, seven pieces, ½" x 1½"
iron strapping, piece, ½" x 1"
60" No. 20 hookup wire
21" No. 18 solid copper wire

PROCEDURE:

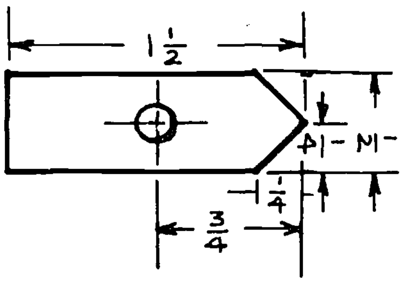
1. Obtain materials from the instructor.
2. Print your name, class, and number on the rough side of base.
3. Cement top sheet to project, or
4. Lay out top of project.
5. Have the instructor check project.

6. Center punch all holes.
7. Drill all holes with 1/8" drill or punch.
8. Make three battery holders, using instruction sheet.
9. Make three lampholders.
10. Make six switches.
11. Make three spinners.
12. Mount all parts on top of base.
13. Wire the project on bottom of base.
14. Put one D cell and three No. 112 or No. 114 lamps into their holders.
15. Test the project.
16. Have the project checked by the instructor.

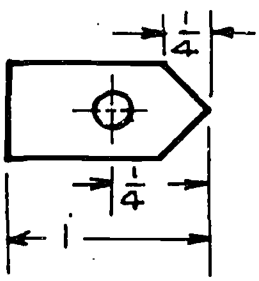
LAYOUT OF PARTS



Contacts
1. Cut 6 pieces of iron strapping, 1½" long.
2. Round off corners with file.
3. Punch 1/8" diameter hole.



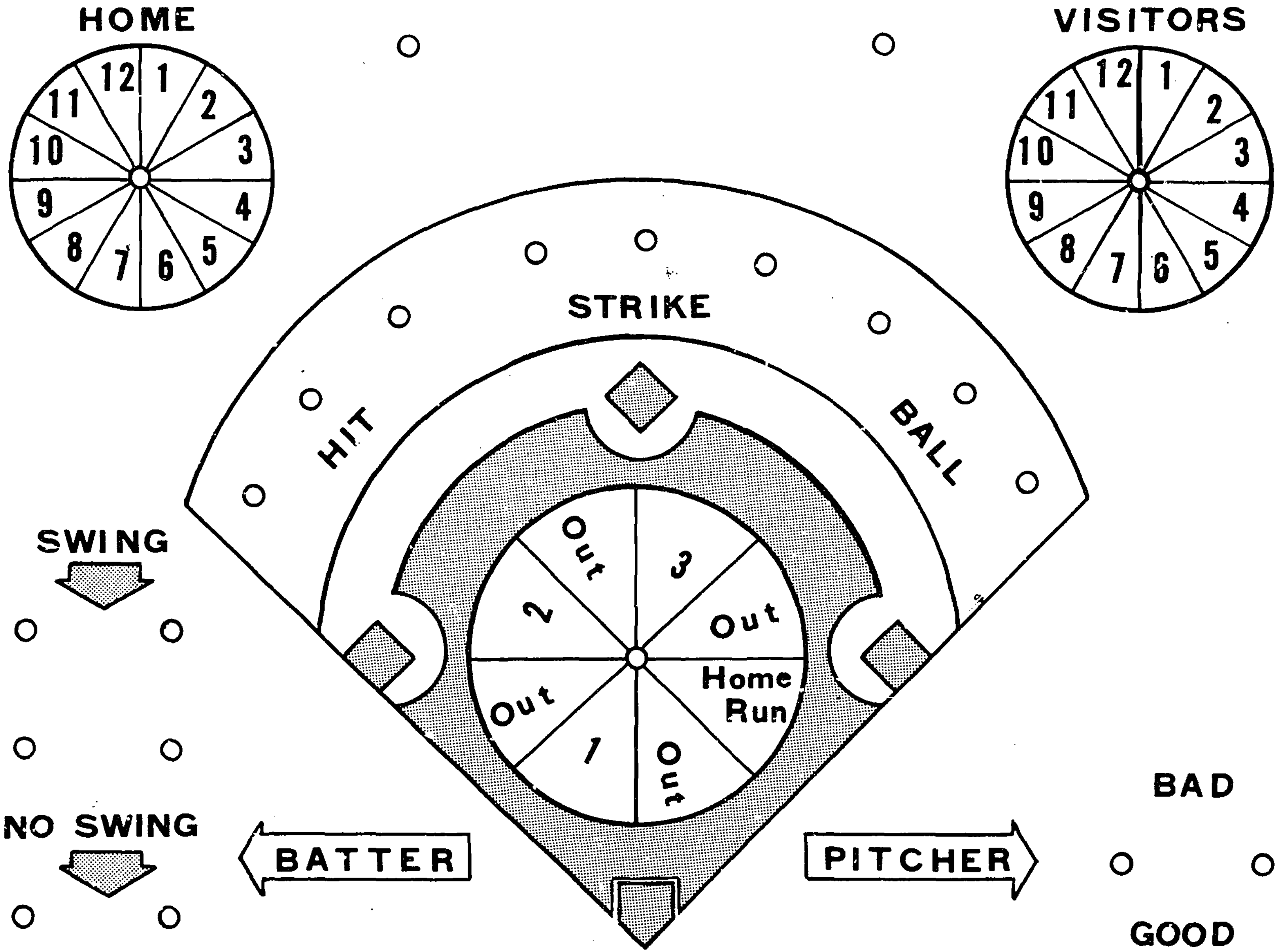
Spinner
1. Cut iron strapping, 1½" long.
2. Punch 1/8" diameter hole in center.
3. Cut point with tinsnips.
4. Round corners on opposite end with file.



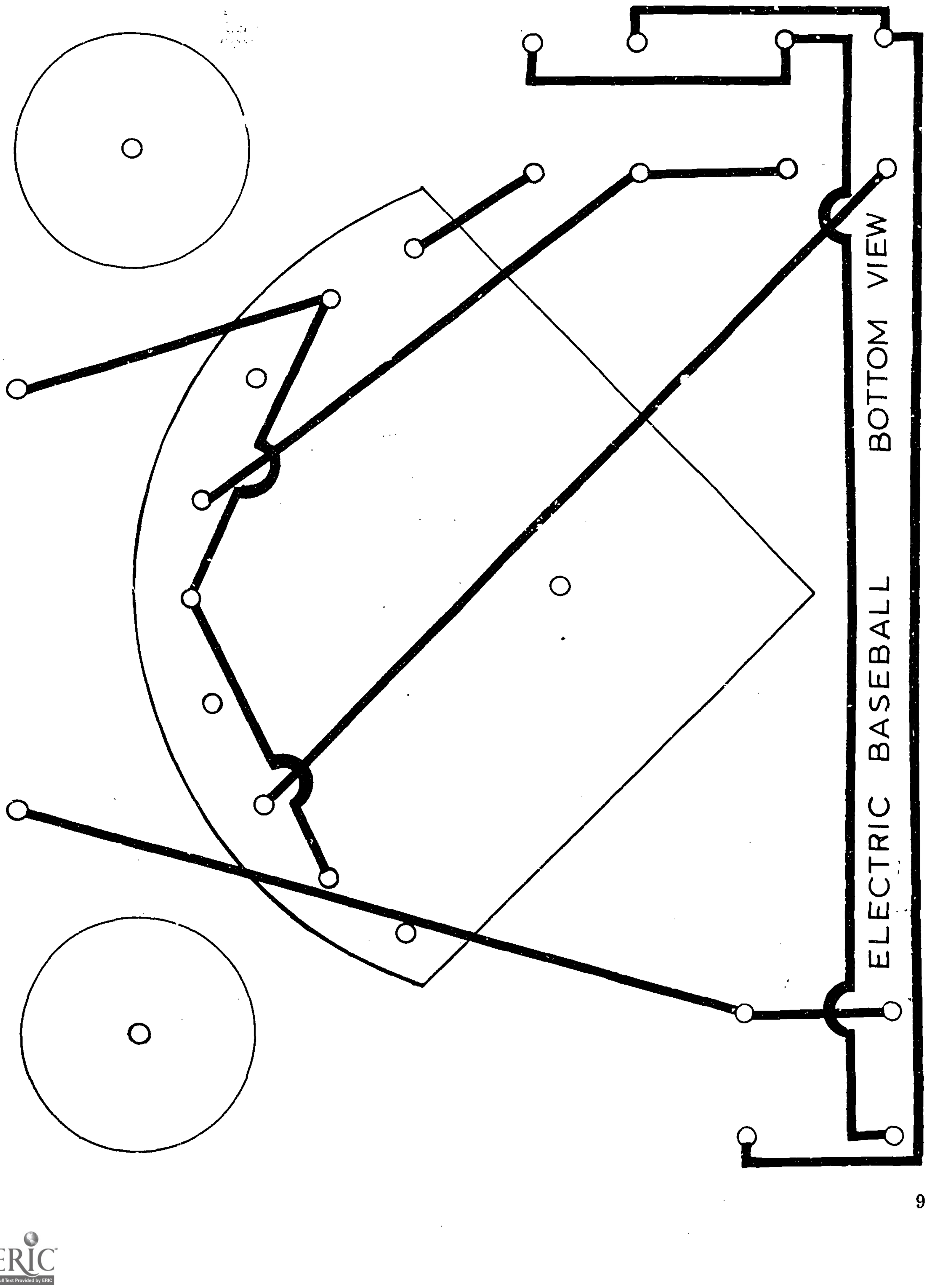
Run Indicator
1. Cut 2 pieces of iron strapping, 1" long.
2. Punch 1/8" diameter hole in center.
3. Cut point with tinsnip.
4. Round corners on opposite end with file.

OPERATING INSTRUCTIONS:

This project is a game to be played by two persons. Each sits at the opposite end of the board and covers the action of his switches with one hand. At the signal each presses the switch for his move. The pitcher may pitch either a good or a bad ball. The batter must press both switches for SWING or both switches for NO SWING. A lamp will light showing a ball, strike, or hit. The game is played by following the standard rules of baseball. When a player makes a hit, he may spin the center spinner to determine the value of the hit. After three outs the side is retired, and the players change sides. Score is kept on the two spinners on the top. Checkers may be used to show the positions of the players on base.



Electric Baseball


ELECTRIC BASEBALL BOTTOM VIEW

ELECTRIC FOOTBALL

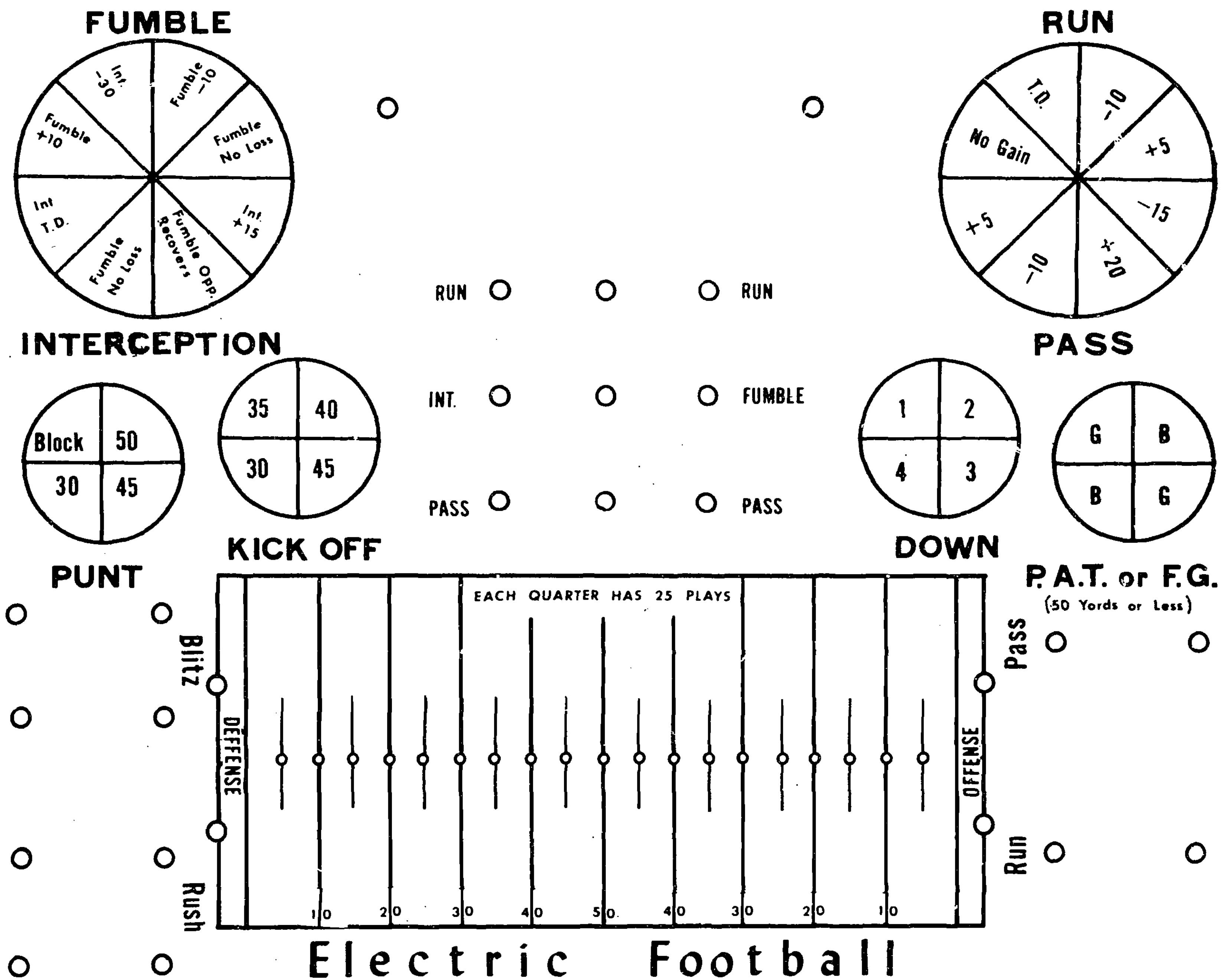
MATERIALS:

1 size "D" flashlight cell
3 No. 112 or No. 114 flashlight lamps (screw type)

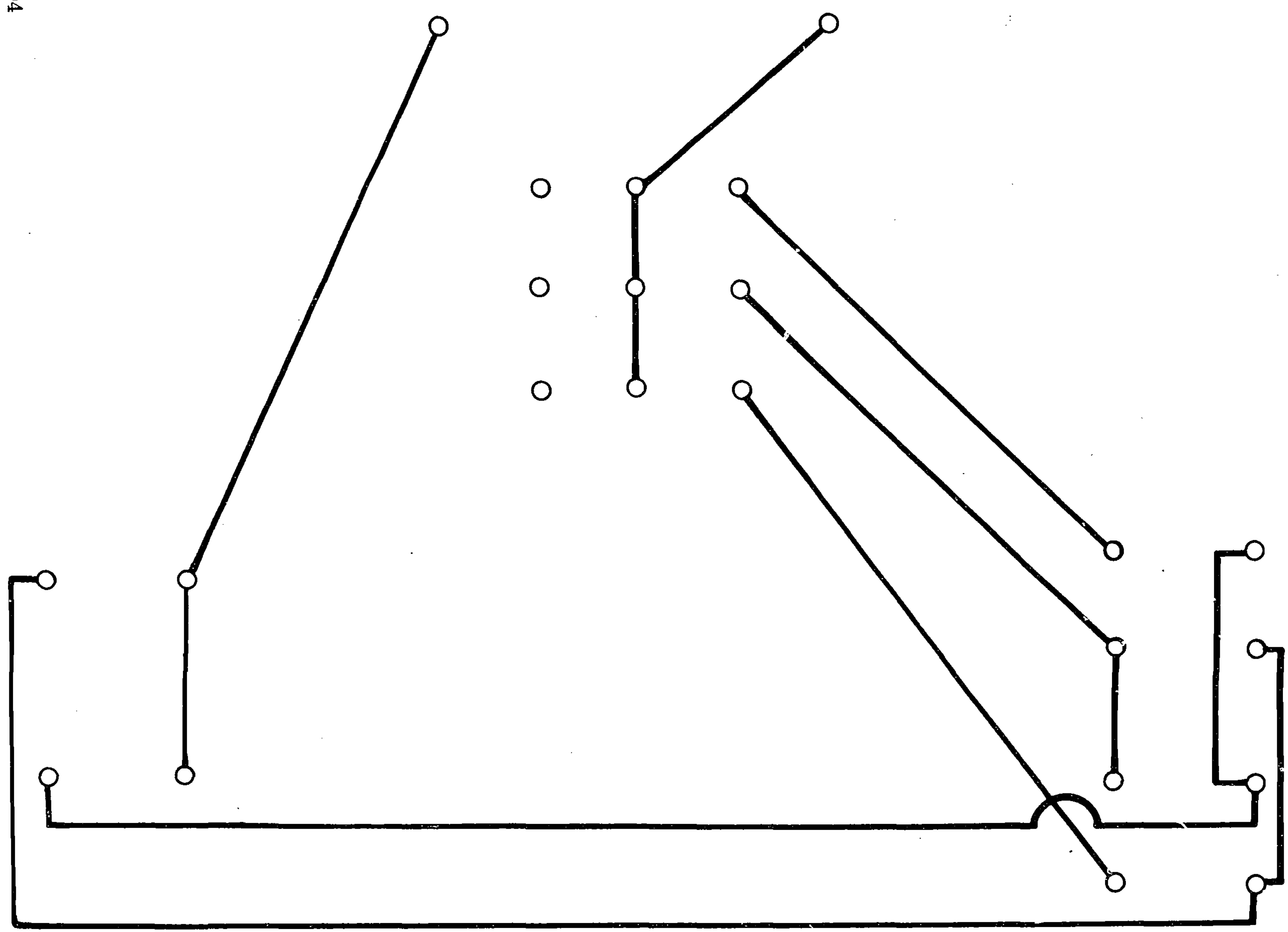
See Electric Baseball, page 88, for suggested tools and additional materials.

OPERATING INSTRUCTIONS:

1. To start the game flip a coin to determine which side is the offensive and which is the defensive.
2. The defense kicks off from the 40 yard line. Spin "Kick-Off" spinner to determine the number of yards of kick-off. For example, if the spinner stops on 30 yards, move the ball 30 yards to the offensive team's 30 yard line.
3. Place "Down" spinner on No. 1. The offensive team can either pass or turn. He must press either one or the other contact, not both. The defensive team can either blitz or rush. To do either the defensive team must push down both contacts for that particular play.
4. If the offensive team pushes "Pass" and the defensive team pushes "Push," the pass light will go on. Spin the "Run-Pass" spinner to determine the play. If the spinner stops at +5, move the football forward five yards. If the spinner stops at —10, move the football back ten yards.
5. You are now ready for the next play. Put "Down" on No. 2. If the offensive team pushes "Run" and the defensive team pushes the "Rush," the "In-Fumble" light will go on. To determine this play spin the "Fumble-Interception" spinner.
6. Continue playing the game until a team scores or has to punt. If it is the fourth down with yardage to go, the offensive team must punt. To do this, spin the "Punt" spinner to determine the distance of the punt and move the football accordingly.
7. Now the other team becomes the offense.
8. If you are within the fifty-yard line of the opposing team, you can kick a field-goal by spinning the "PAT-FG" spinner. (PAT stands for point after touchdown and FG stands for field goal. If the spinner stops on G, the field goal is good, and if it stops on B, it is bad. If a field goal is good, the team that scores kicks off from the forty-yard line. If the field goal is bad, the other team gets the ball on its own 20 yard line.
9. After each touchdown the PAT-FG spinner is spun to determine if the point after touchdown is good or not.
10. The length of the game is 100 plays (25 for each quarter). A play is determined when the light goes on.



FUMBLE
Int. -30
Fumble -10
Fumble +10
Fumble No Loss
Int T.D.
Int. +15
Fumble No Loss
Fumble Opp. Recovers
RUN
T.D.
-10
No Gain
+5
+5
-15
-10
+20
RUN
RUN
INT.
FUMBLE
PASS
PASS
INTERCEPTION
PASS
Block
50
30
45
35
40
30
45
1
2
4
3
G
B
B
G
PUNT
KICK OFF
DOWN
P.A.T. or F.G.
(50 Yards or Less)
EACH QUARTER HAS 25 PLAYS
Blitz
Rush
DEFFENSE
OFFENSE
Pass
Run
10
20
30
40
50
40
30
20
10
Electric Football

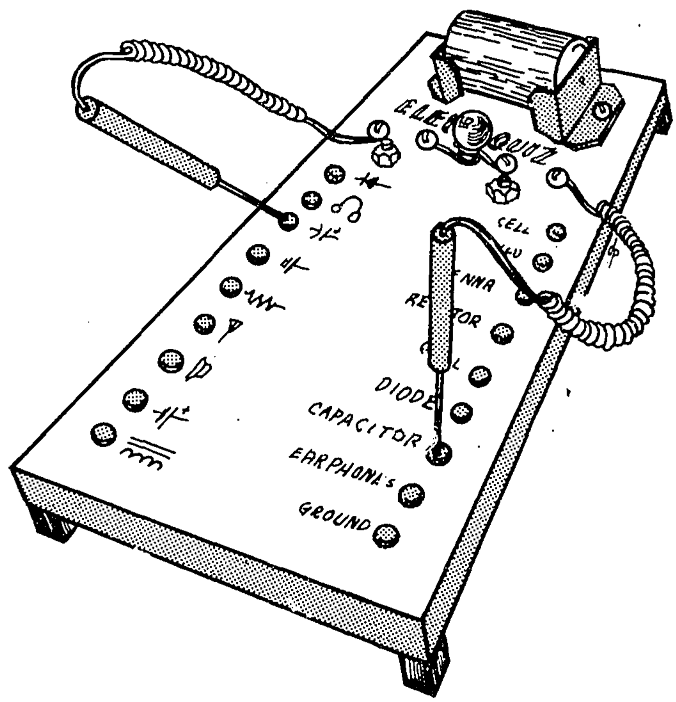


ELECTRIC FOOTBALL WIRING DIAGRAM

ELECTRIC QUIZ

TOOLS:

center punch
hammer
screwdriver
5/16" nutdriver
3/8"—16 bolt
tinners' snips
wire hookup
soldering iron
hand drill with 1/8" drill
hand punch with 1/8" punch



MATERIALS:

base, hardboard, 4" x 8"
tinplate, two pieces, 1 3/4" x 2 1/2"
7" No. 18 bare solid copper wire
19 paper fasteners
8 1/2" x 6-32 R.H. machine screws
8 6-32 nuts
24" annunciator wire
24" stranded copper wire
solder (rosin core)
legs

PROCEDURE:

1. Obtain materials from the instructor.
2. Print your name, class, and number on the rough side of the base.
3. Cement top sheet to project, or
4. Lay out the top of the project.
5. Have the instructor check project.
6. Center punch all holes.
7. Drill all holes with 1/8" drill or punch with 1/8" punch.
8. Make two small battery holders. See instruction sheet.
9. Make one lampholder. See instruction sheet.
10. Mount all parts on top of base.
11. Wire your project on bottom of base.
12. Put one "D" cell and one No. 112 or No. 114 lamp in their holders.
13. Test the project.
14. Have the project checked by your instructor.

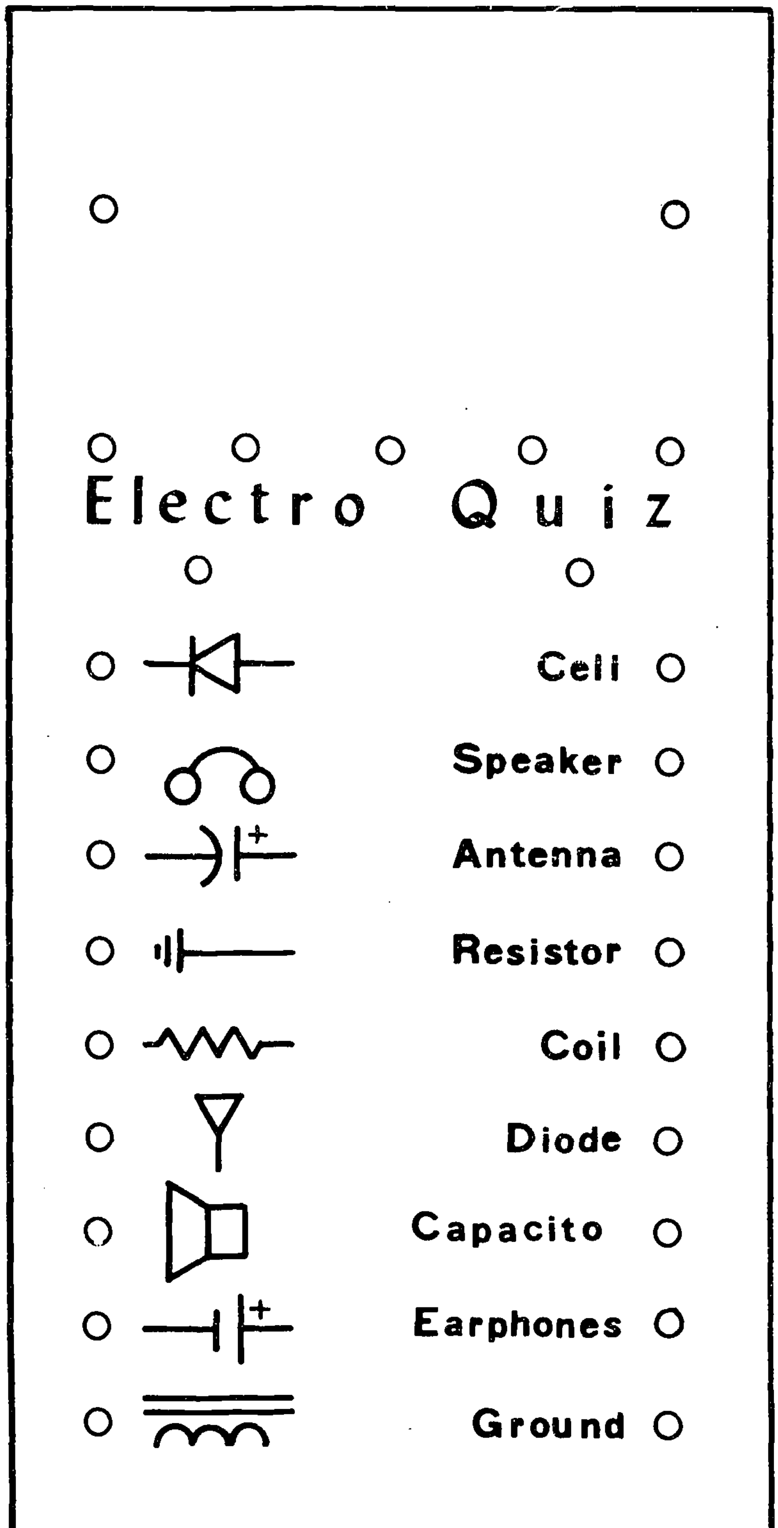
OPERATING INSTRUCTIONS:

This project is a learning device to be used by one person at a time. The left probe contacts in turn the various terminals on the left side. The right probe contacts the proper terminal on the right side of the board. When the proper terminals are touched, the lamp lights.

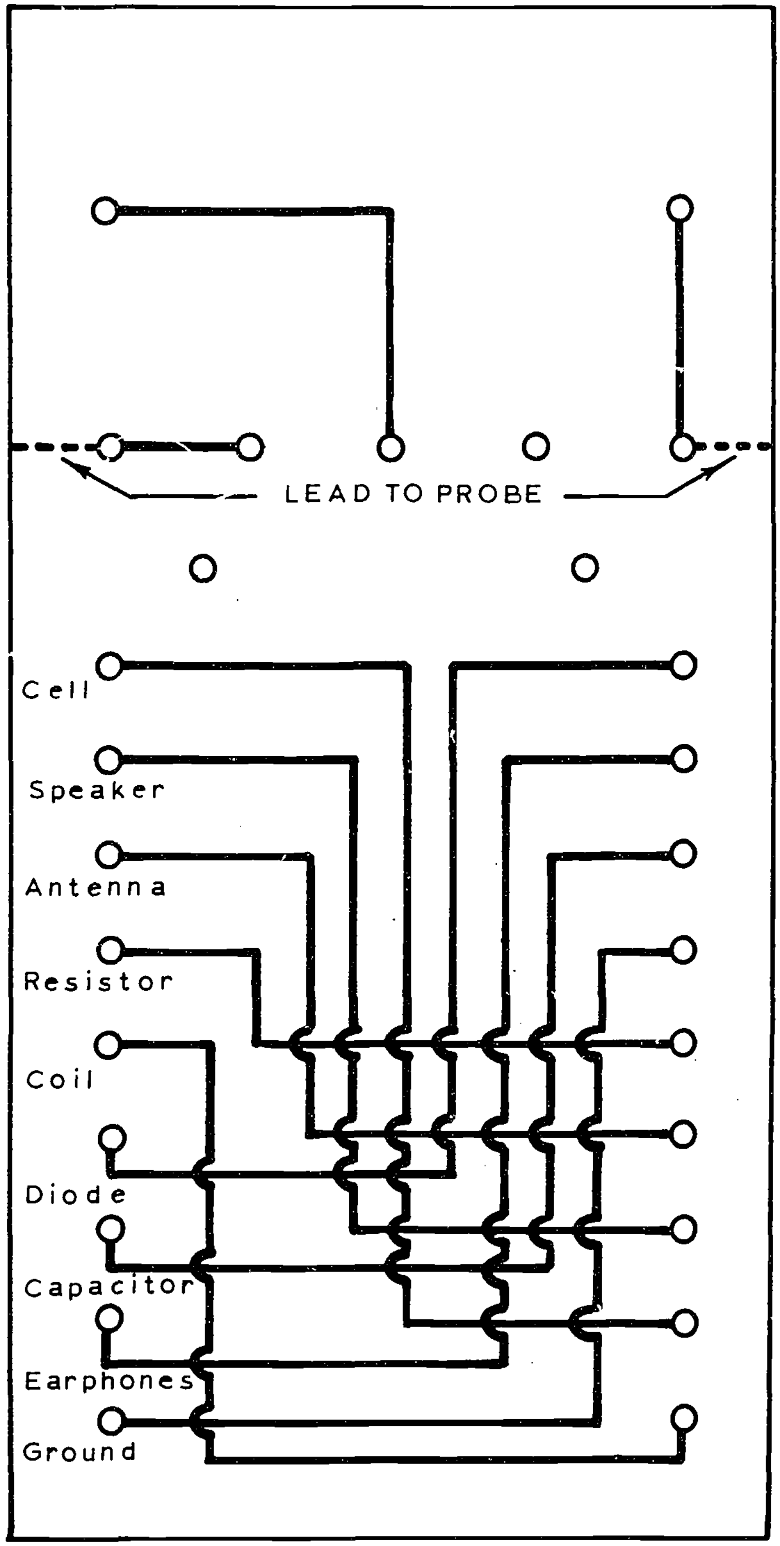
It is possible to prepare extra questions and answers on 2 1/2 by 5 inch cards. These cards may be held to the board using the two screws face up.

This project may also be used as an emergency continuity tester.

Electro Quiz — Layout



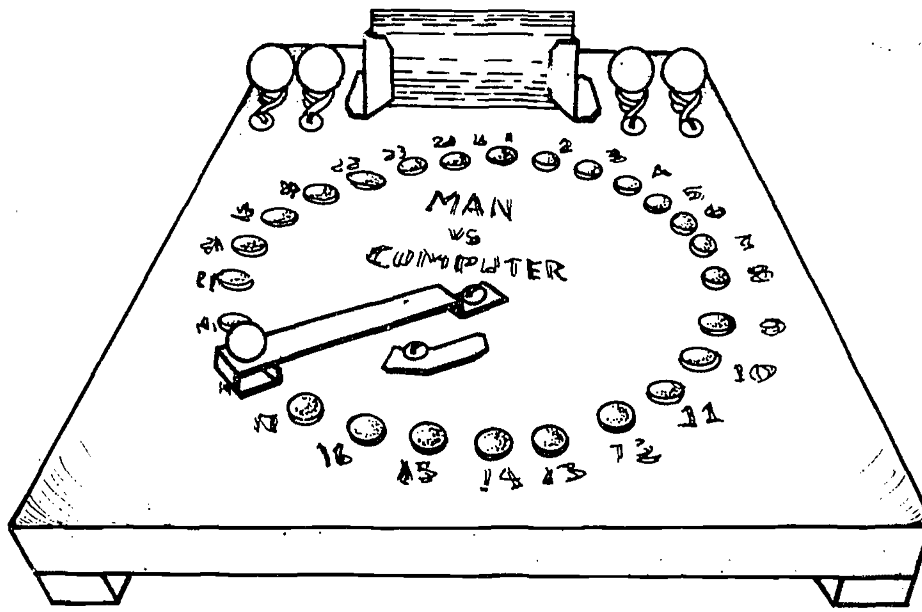
Electro Quiz — Wiring Diagram



MAN vs COMPUTER

TOOLS:

center punch
hammer
tinners' snips
diagonal cutting pliers
soldering gun
hand punch with 1/8" punch
hand drill with 1/8" drill
round nose pliers



MATERIALS:

base, hardboard, 8½" x 11"
30 paper fasteners
13½" 6-32 machine screws
13 6-32 nuts
tinplate, two pieces, 1¾" x 2½"
28" No. 18 solid copper wire
iron strapping, one piece, ½" x 2"
iron strapping, one piece, ½" x 4½"
two No. 6 washers
one wooden bead

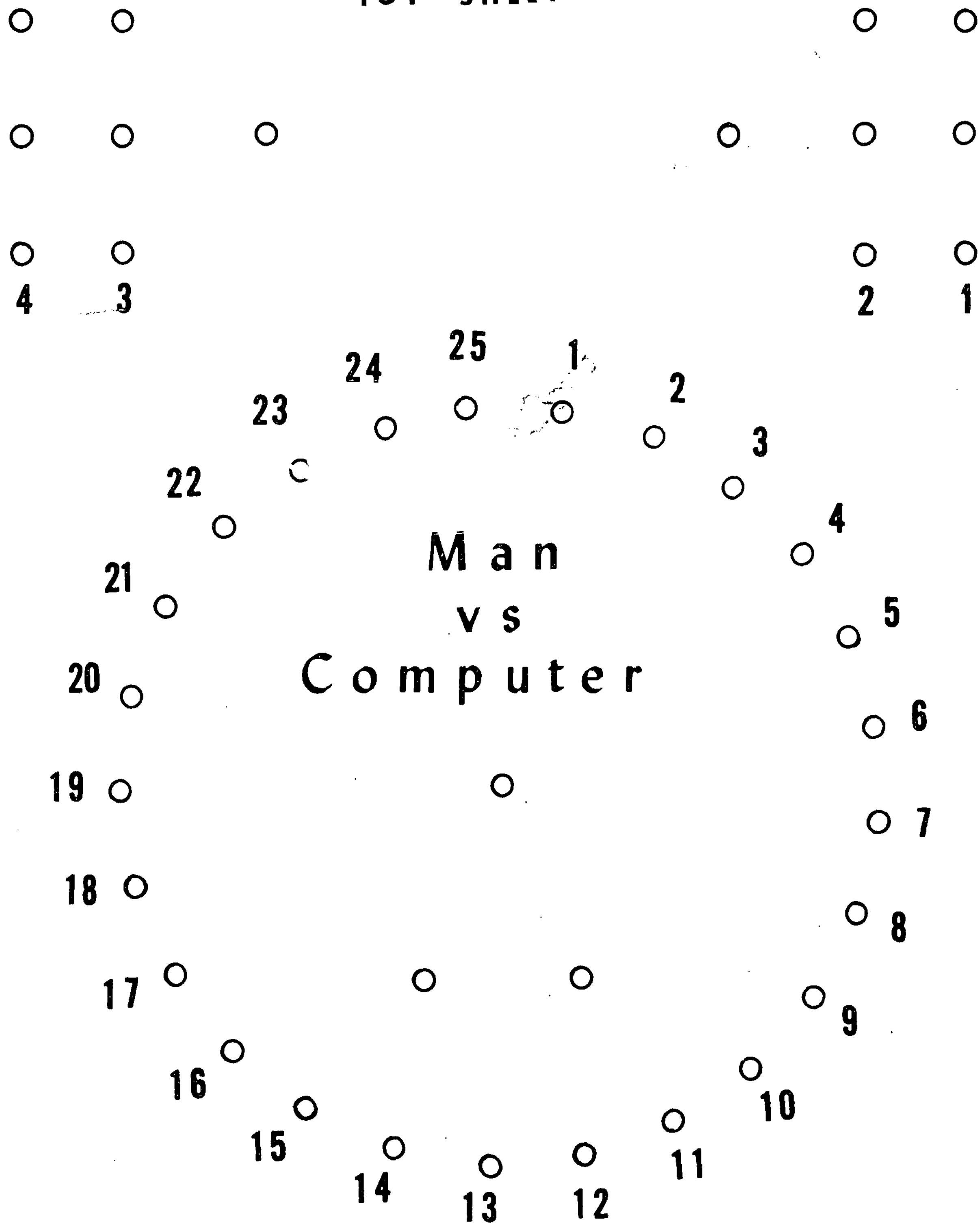
PROCEDURE:

1. Obtain materials from the instructor.
2. Print your name, class, and number on the rough side of the base.
3. Cement top sheet to project, or
4. Lay out top of project.
5. Have instructor check project.
6. Center punch all holes.
7. Drill all holes with 1/8" drill or punch.
8. Make two small battery holders, using instruction sheet.
9. Make four lampholders, following the instruction sheet.
10. Make the switch and the rotor bar, using instruction sheet.
11. Mount all the parts on top of base.
12. Wire your project on bottom of base.
13. Put one "D" cell and four No. 112 or No. 114 lamps into their holders.
14. Test the project.
15. Have the project checked by the instructor.

OPERATING INSTRUCTIONS:

The "Computer" is a game played by one person against the device. The object of the game is to make the proper series of moves so that the computer is left with the last terminal, No. 1.
The game is started with the rotor on terminal No. 25. Either the device or the player may move first. For the Computer's move it is necessary to press the switch and see which lamp lights. Each player may move 1, 2, 3, or 4 terminals at a time towards terminal No. 1. The game continues until the player left with the last (No. 1) terminal has lost the game. *Note:* To win, go first, and make your moves 4-4-3-4.

TOP SHEET



4
3
2
1
Man
vs
Computer
1
2
3
4
5
6
7
8
9
10
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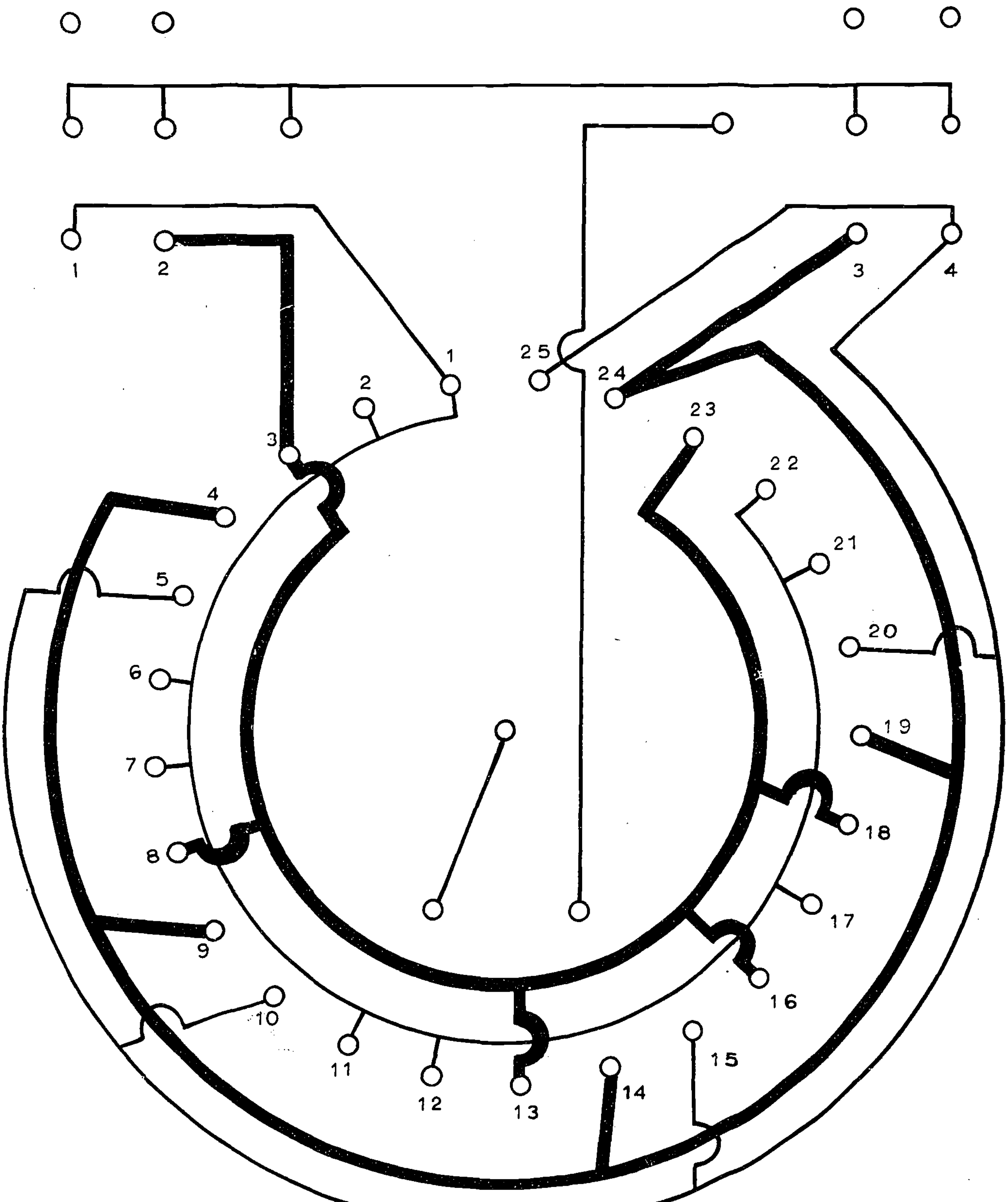
20
21
22
23
24
25

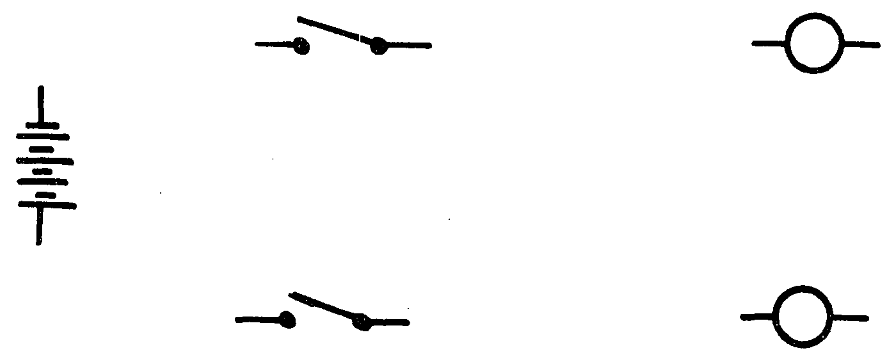
Man vs Computer — Wiring Diagram



SAMPLE ASSIGNMENT

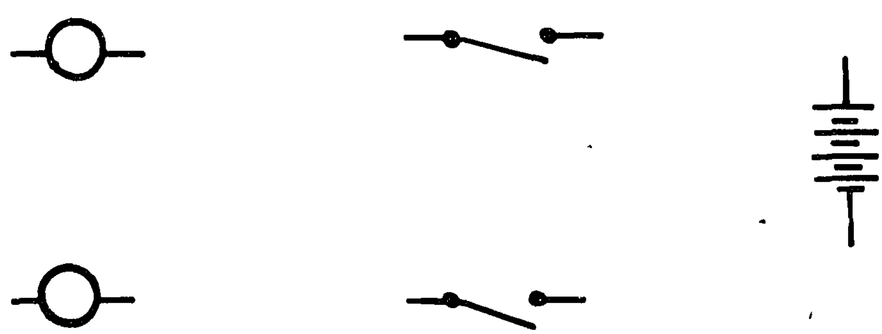
Series Circuit

A series circuit has only one path for the flow of electricity. Complete the following circuit, using pencil and ruler, so that it becomes a series circuit.



Parallel Circuit

A parallel circuit has more than one path for the flow of electricity. Complete the following circuit, using pencil and ruler, so that it becomes a parallel circuit.



Have the instructor check both diagrams and initial the sheet. ____________

Obtain one wiring board and the necessary components. Wire the series circuit. Have the teacher check the circuit before you turn on the power, and initial here. ____________

Obtain the wiring board and necessary components. Wire the parallel circuit. Have the teacher check the circuit before you turn on the power, and initial here. ____________

SAMPLE QUIZ A

Units 1 and 2

Week: 4
Day: 2

1. All accidents are to be
   - a. ignored
   - b. treated by the foreman
   - c. reported to the teacher immediately.
   - d. self-treated

2. The part of the atom with the negative (—) charge is the
   - a. ion
   - b. electron
   - c. nucleus
   - d. proton

3. The electrical unit of resistance is the
   - a. ohm
   - b. ampere
   - c. volt
   - d. watt

4. The flow of electrons in one direction only along a conductor is
   - a. AC
   - b. a circuit
   - c. static electricity
   - d. direct current

5. A good conductor has ____________________ to the flow of electricity
   - a. low resistance
   - b. high resistance
   - c. medium resistance
   - d. complete resistance

6. The symbol for a battery is
   - a. |ı|ı|ı
   - b. |
   - c. +
   - d. =

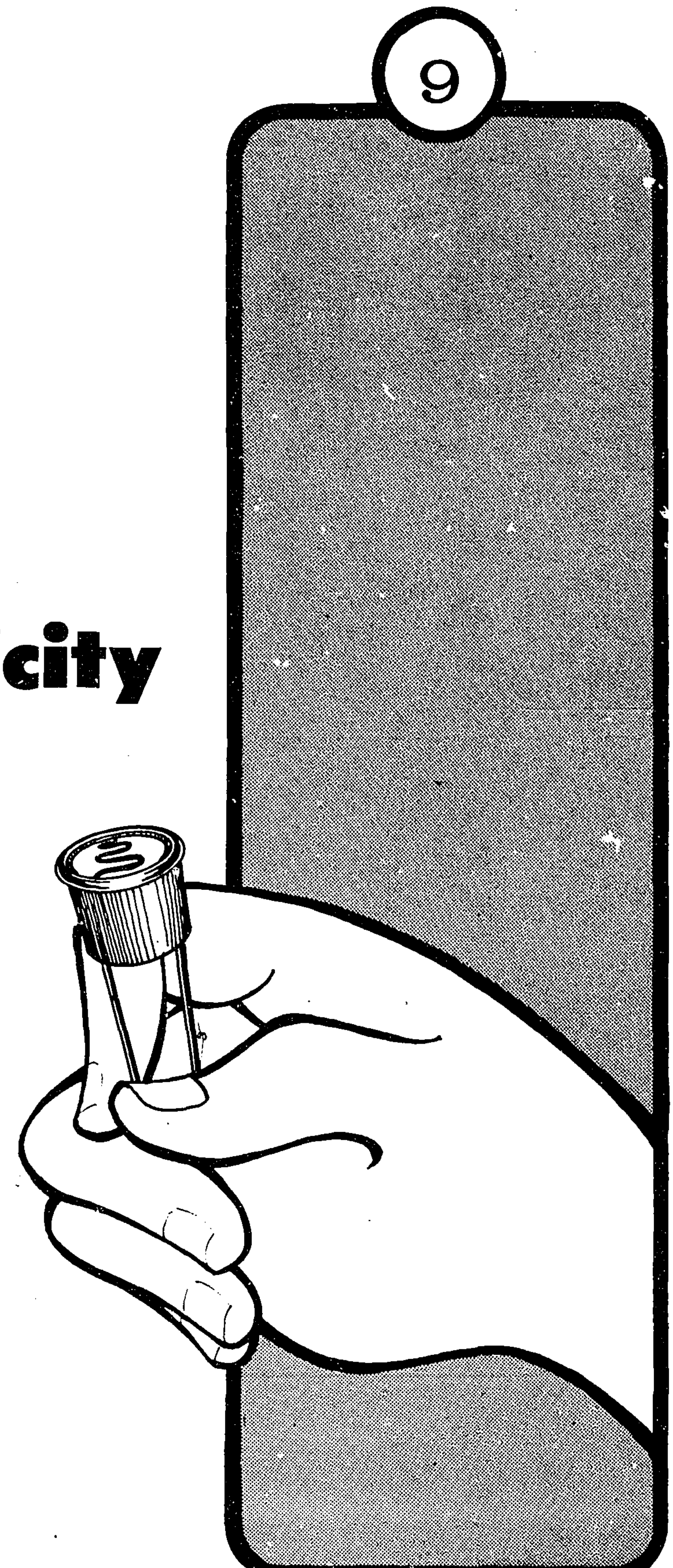
7. The symbol for a ground is
   - a. +
   - b. =
   - c. |ı|ı|ı
   - d. ⏚

8. Every circuit must have a source, conductors, switch, and
   - a. space
   - b. battery
   - c. load
   - d. shunt

9. The dry cells connected in series will produce a voltage of
   - a. 1½ volts
   - b. 3½ volts
   - c. 3 volts
   - d. 4½ volts

10. A circuit that has more than one path for the flow of electricity is known as a
    - a. parallel circuit
    - b. open circuit
    - c. series circuit
    - d. complete circuit

Sources of Electricity



SAMPLE LESSON PLAN

Week: 5
Day: 2

Unit: Sources of Electricity (Other Than the Generator)

Topic: Obtaining Electricity from Chemicals

Aim: To help the students understand that it is possible and practical to produce electricity from a variety of chemical sources.

Apperception: Most students are aware that electricity for their homes is produced by generators and that their portable radios and flashlights are powered by batteries.

Motivation: Is it possible to make electricity with a lemon and two pieces of metal?

Preparation: Lemon, piece of copper, piece of zinc, leads, galvanometer 0-500 ma, Burgess Battery Kit (S-1 List 14-2478). Other materials for use instead of lemon are: cheese, frankfurters, salmon, most fruit and vegetables.

Demonstration: Show a working cell that will deflect a meter or light a flashlight lamp. Clean off the plates and give several students an opportunity to try some other types of cells.

Points for Development:

An electric cell changes chemical energy into electrical energy.

The voltage produced by any cell is a constant that is directly related to the materials used in the construction of that cell. Any other cell made of the same materials will have an identical voltage.

The voltage of any cell remains constant no matter how large you make it, but the current capacity of any cell is proportional to its size.

Primary cells cannot be recharged after they have been exhausted.

However, a small recharging current can depolarize a primary cell and thus improve its condition. Battery recharges that are sold to be used with flashlight and transistor radio batteries do not recharge the battery; they only return the coating of hydrogen bubbles surrounding the positive terminal into the electrolyte, thus reducing the internal resistance of the cell.

There are many types of dry cells: carbon-zinc battery; magnesium cell; mercury cell; alkaline cell; reserve cell. Each has specific applications.

The lead-acid wet cell is an example of a secondary cell. A secondary cell is an electrical source that can be recharged to restore it to its original condition.

The nickel-cadmium cell is a secondary cell used in many portable power tools. Its advantages are portability and rechargability. It is more expensive than the lead-acid cell.

New Terms:

cell
battery
primary cell
secondary cell
dry cell
wet cell
electrolyte
plate

Summary:

A dry cell is a primary cell that makes electricity from a chemical source, but cannot be recharged.

A lead-acid storage cell is a secondary cell that makes electricity from a chemical source, yet can be recharged.

Application:

Transistor radios,flashlights, portable electric shavers, and power tools use a chemical source of electricity, that is, a battery, because it is portable and safe.

Student Activity:

Construct various types of cells in the shop and test them for voltage and current output.

Construct a usable dry cell from the Burgess Battery Kit.

Assignment:

Clip pictures of five battery-operated devices from the newspaper and paste them into your notebook. If you can, identify the type of cell that each uses.

References:

Buban and Schmitt, pp. 208-218.
Gerrish, pp. 32-36.
Miller and Culpepper, pp. 139-145.

SAMPLE LESSON PLAN

Week: 6
Day: 2

Unit: Sources of Electricity (Other Than the Generator)

Topic: Other Sources of Electricity: Photoelectricity and Thermoelectricity

Aim: To help the students understand that electrical energy can be made from light or heat energy.

Apperception: Consider the students' familiarity with electric-eye cameras, light-controlled streetlights, automatic door openers, burglar alarms, light-controlled drinking fountains, and hand dryers.

Motivation: Demonstrate photoelectric unit controlling a lamp or burglar alarm.

Preparation: Photoelectric demonstrator (Buban and Schmitt, p. 235), kiln pyrometer.

Demonstration: Using a thermocouple, demonstrate how heat energy can be converted into electrical energy.

Points for Development:

Certain substances release electrons when they are struck by light.

Electricity produced in this manner is known as photoelectricity.

This source of electricity is used to control the shutter aperture of cameras, to light street lamps, to open doors, to control safety devices in industry.

Selenium is used as a photoemissive substance in phototubes and photocells.

Photoconductive materials, such as cadmium sulphide, the resistance of which varies with the light intensity on its surface, is also used.

Thermoelectricity is electricity made from heat.

The joining of dissimilar metals will produce an electric current when it is heated. This combination of dissimilar metals is known as a thermocouple.

A pyrometer, used to measure the temperature of an oven (kiln), is an example of a thermocouple.

New Terms:

photoelectricity
thermoelectricity
photocell
thermocouple

Summary:

Photoelectricity is electricity made from light.

Thermoelectricity is electricity made from heat.

Application:

Photoelectricity: electric eye cameras, street light controls, burglar alarms, safety devices in industry
Thermoelectricity: thermocouple pyrometer to measure temperature of ovens and kilns

Student Activity:

Construct a solar-powered radio, sunlight-controlled relay, burglar alarm, TV "Space Commander."

Assignment and/or Enrichment:

Research how and where these two methods of producing electricity are used in our aerospace program.

References:

Buban and Schmitt, pp. 228-236.
Gerrish, pp. 38-39.

SAMPLE LESSON PLAN

Week: 6
Day: 1

Unit: Sources of Electricity (Other Than the Generator)

Topic: Other Sources of Electricity: Piezoelectricity and Bioelectricity

Aim: To help the students understand that electricity is produced within their bodies, within the bodies of animals and certain bacteria, and within certain crystal materials when they are twisted or compressed.

Apperception: Discuss students' experiences in seeing an electric eel light a bank of lamps at the aquarium.

Motivation: Display a picture of an electric eel, and discuss the eel as a good example of bioelectricity.

Preparation: Photograph, oscilloscope (if available), Rochelle salt crystal, NE-2 lamp, phonograph cartridge, earphones, VOM.

Demonstration: Show the piezoelectric effect with a phonograph feeding into an oscilloscope, or a phonograph cartridge feeding first into an earphone and then into a VOM. It is possible to light the NE-2 lamp with the voltage from a Rochelle salt crystal.

Points for Development:

All piezoelectric materials have two properties.

They can convert mechanical pressure into electricity, as in the phonograph cartridge.

They can convert an electrical charge into mechancial movement as in sonar, ultrasonic cleaners, and similar high frequency, vibration-producing devices.

All living creatures generate electricity and make use of it within their body systems.

Bioelectricity is the study of electricity in living organisms. Bioelectricity is shown best in electric fish, electric eels, electric action of muscle, heart, and sensory system of your body.

A biological fuel cell can produce quantities of electricity using only membranes, electrodes, and an electrolyte containing living organisms, such as yeast or even swamp water.

New Terms:

piezoelectricity
bioelectricity

Summary:

Piezoelectricity is electricity produced by pressure on a crystal.
Bioelectricity is electricity produced by living organisms.

Application:

Piezoelectricity: phonograph crystals, ultrasonic cleansers
Bioelectricity: biocells, electric eels, human heart, nerves, muscles

Reference:

Buban and Schmitt, pp. 235-236.

Magnetism

SAMPLE LESSON PLAN

Week: 6
Day: 2

Unit: Magnetism and Its Applications

Topic: Principles of Magnetism

Aim: To help the students understand the basic principles of magnetism and how they use it.

Apperception: Magnetism as it operates in compasses, toys, bells, buzzers, chimes.

Motivation: How can we sort out pieces of iron from a box containing pieces of aluminum, copper, plastic, cotton, glass?

Preparation: Box with assorted materials, magnetic pickup stic' assorted permanent magnets, doorbell, buzzer, chime, rela ircuit breaker.

Demonstration: What materials are attracted by a magnet?
The poles of a magnet have greater attractive wer than the center.
The poles of a magnet behave differently.

Points for Development:

A magnet is a material that will attract iron, steel, nickel, or cobalt.

The ends of a magnet, where the strength is concentrated, are called poles. One is the north pole; the other is the south pole.

Opposite magnetic poles attract each other. Similar magnetic poles repel each other.

Permanent magnets are made of various alloys of magnetic materials.

Electromagnets are made by winding many turns of wire around a core, and passing an electric current through the windings. Electromagnets can be turned on or off and can be controlled in strength by regulating current flow.

The strength of an electromagnet is proportional to the size and type of core material, the number of turns of wire, and the quantity of current flowing through the coils.

New Terms:

magnet
poles
flux
field
line of force

Summary:

A magnet is an object which will attract iron, steel, nickel, cobalt.

The ends of a magnet are called poles. Opposite poles attract; similar poles repel.

The strength of an electromagnet depends upon the number of turns of wire, the strength of the current, and the size and type of the core.

Application:

Magnets are used in compasses, doorbells, buzzers, chimes, toys, motors, generators, television sets.

Student Activity:

Construct a telegraph set, clicker-buzzer relay, motor, electromagnetic broom, transformer.

Assignment:

List the devices in your house that use magnets. Identify each as a permanent magnet or an electromagnet.

References:

Buban and Schmitt, pp. 164-181.
Gerrish, pp. 38-42.
Miller and Culpepper, pp. 43-52.

SAMPLE LESSON PLAN

Week: 7
Day: 1

Unit: Magnetism and Its Applications

Topic: The Generator

Aim: To help the students understand the role and operation of generators in providing large quantities of electricity for our use.

Apperception: Discuss the generator on a child's bicycle, or rely upon the students' reading about or seeing a utility company's generator.

Motivation: Demonstrate a generator lighting a lamp. Elicit why this lamp is lit.

Preparation: Generator, lamp, coil or wire, several magnets, galvanometer.

Demonstration: Show how a relative movement between a magnetic field and a conductor produces an electric current. Show how this is done in a generator.

Points for Development:

A voltage is produced between the ends of a wire moved within a magnetic field.

An alternating current is produced by rotating a coil of wire between the poles of a permanent magnet. Alternating current generators use slip rings.

Direct current can be produced by feeding the output of the generator through a split ring commutator which acts as a mechanical switch.

The parts of a generator are: magnetic field, armature, coil, slip ring or commutator.

The output of a generator is dependent upon the size and strength of its field, the number of turns of wire in the armature coil, and the speed.

New Terms:

generator
slip ring
commutator
brush

Summary:

A wire cutting through a magnetic field causes the production of a voltage between the ends of the wire.

The parts of a generator are the magnetic field, the armature coil, and the slip rings or commutator.

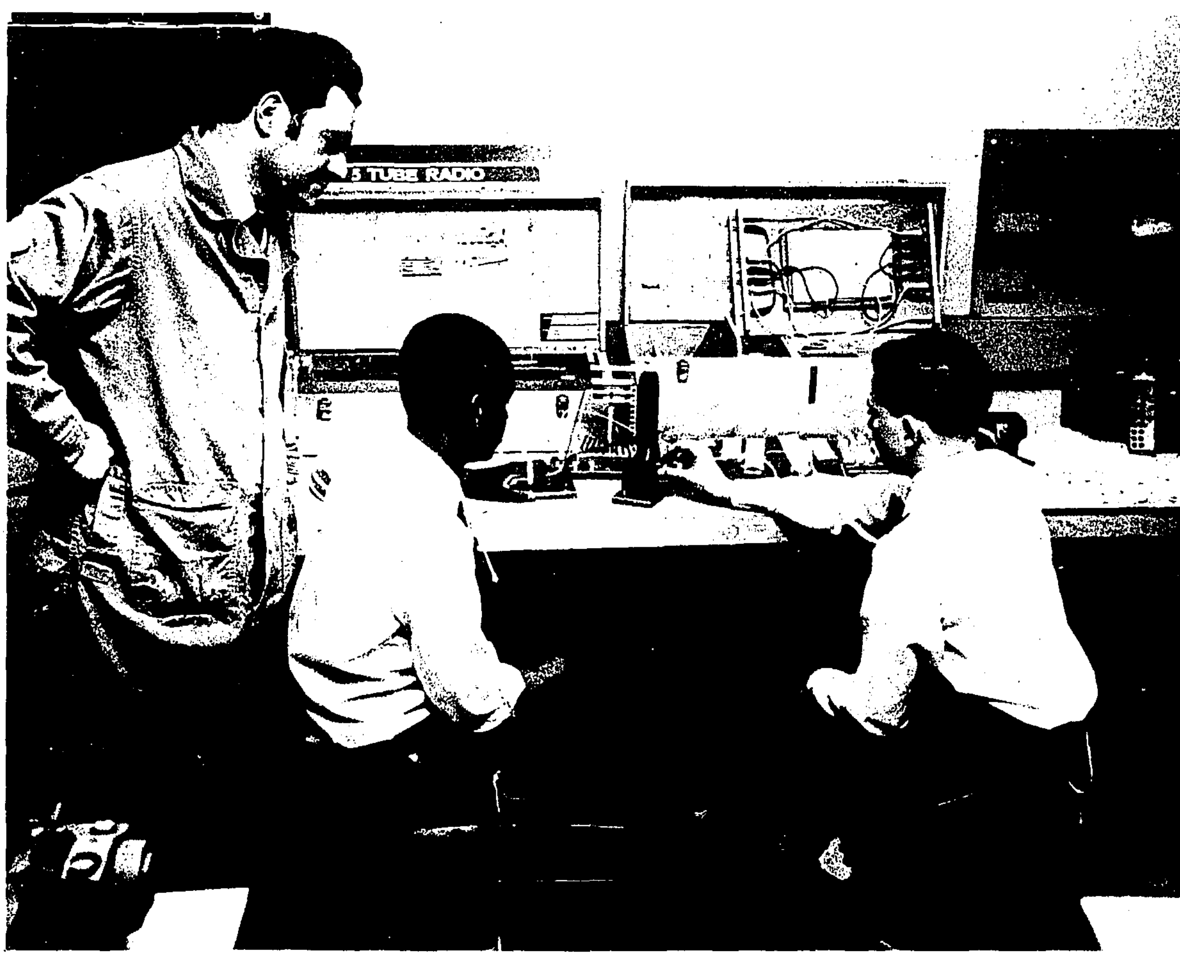
Generators with slip rings produce alternating current.

Generators with commutators have a direct current output.

Application:
Generators produce over 95% of all the electricity used in the United States. We use electricity made by generators to give light and power to our homes, offices, businesses, and factories.

Student Activity:
Make a generator. (See Buban and Schmitt, p. 227.)

References:
Buban and Schmitt, pp. 219-228.
Gerrish, pp. 59-65.
Miller and Culpepper, pp. 145-148.



Principles of electromagnetic forces are studied in a laboratory situation.

SAMPLE LESSON PLAN

Week: 7
Day: 2

Unit: Magnetism and Its Applications

Topic: The Transformer

Aim: To help students understand the role and operation of transformers in their daily lives.

Apperception: This lesson can be related to the toy train or racing car transformers that are familiar to a great many youngsters.

Motivation: Use a Jacob's ladder or induction coil to demonstrate high voltage arcing. How can we get such a high-voltage output from a low-voltage input?

Preparation: Jacob's ladder apparatus or induction coil, sample transformers, step-down transformer, ammeter-galvanometer, two large hollow coils of wire, suitable core materials.

Demonstration: Using the output from the step-down transformer, show that there is current flow in the primary coil. Next, show the current flow in the secondary coil. Show what happens as more core material is added.

Points for Development:

A transformer is a device for transferring energy from one coil to another.

A transformer can transfer energy from one coil to another inducing a voltage at the same, a higher, or a lower level.

A step-up transformer has more turns in the secondary than in the primary coil and raises the input voltage.

A step-down transformer has fewer turns in the secondary coil than in the primary and reduces the input voltage.

An isolation transformer is used for safety and has the same output voltage as input voltage.

Transformers are used to operate bells, buzzers, chimes, toy trains, racing cars, television sets, radios, oil burners.

New Terms:

primary
secondary
induction
isolation
transformer

Summary:

A transformer can transfer energy from one coil to another.

A step-down transformer has fewer turns in the secondary coil than in the primary coil.

Application:

Transformers are used in the operation of doorbells, buzzers, chimes, television sets, radios, oil burners, model racing cars.

Student Activity:

Make a transformer. (See Buban and Schmitt, p. 394.)

References:

Buban and Schmitt, pp. 181-188.
Gerrish, pp. 70-75.
Miller and Culpepper, pp. 75-78.

Electric motors on model racing cars are tested.

SAMPLE LESSON PLAN

Week: 8
Day: 1

Unit: Magnetism and Its Applications

Topic: The Motor

Aim: To help students understand the operation and place of motors in our daily lives.

Apperception: Electric motors are used in many homes to operate vacuum cleaners, refrigerators, clocks, fans, sewing machines, food mixers, etc.

Motivation: What force makes this motor turn? (Show a small appliance motor in operation.)

Preparation: Several motors (toy, experimental, commercial washing machine type, cutaway model).

Demonstration: Show a variety of working motors of various sizes and shapes.

Points for Development:

A motor is a device that changes electrical energy into mechanical energy.

Today, electric motors furnish more than 90% of the mechanical power used in the United States.

The motor begins to rotate through forces of magnetic attraction and repulsion.

The motor continues to rotate by means of a suitable arrangement of conductors carrying an electric current to the magnetic field, thus using the forces of attraction and repulsion to produce the continued rotation.

Commutators are used as automatic reversing switches, to keep the armature poles automatically reversed.

The size of motors is usually given in horsepower. Most motors we use are less than one horsepower, so they are called fractional-horsepower motors.

Some motors, such as those that operate subway trains, elevators, and drawbridges, are designed to operate on direct current only.

Others motors, such as those used in electric appliances, industrial machines and clocks, are designed to operate on alternating current.

Universal motors operate on either AC or DC. They are used for electric shavers, portable electric tools, sewing machines.

Summary:

Motors are used to change electrical energy into mechanical energy.

Motors operate on the principles of magnetic attraction and repulsion.

There are many different types of motors, each designed for a specific purpose.

Application:

Motors are used for household appliances, fans, electric tools, subways, elevators, toys, etc.

Student Activity:

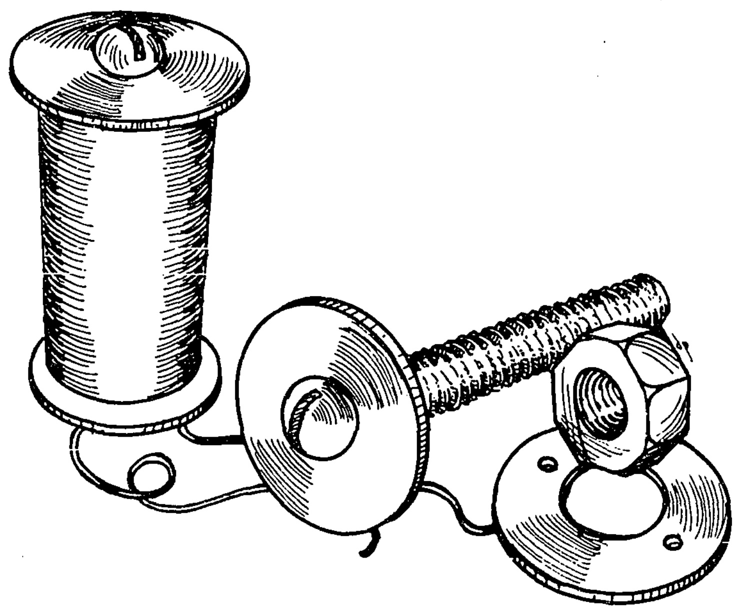
Construct a two pole motor (Buban and Schmitt, p. 390).

References:

Buban and Schmitt, pp. 274-281.
Gerrish, pp. 49-53.
Miller and Culpepper, pp. 154-159.

A student winds a coil for an experimental motor.

WINDING AN ELECTROMAGNETIC COIL



TOOLS:

hand punch with ¼″ punch
hand punch with ⅛″ punch
coil winder
diagonal cutting pliers
sandpaper

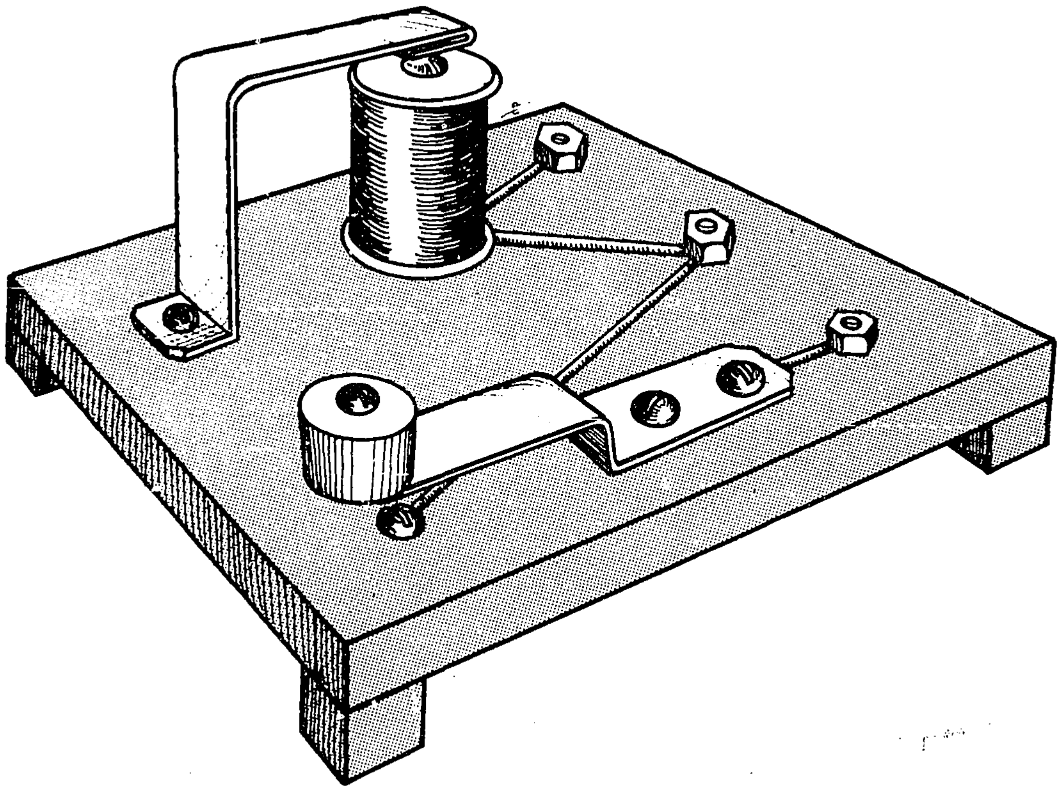
MATERIALS:

two black fiber washers, 1″ O.D.
¼″—20 R.H. Machine Screw 2″ long
¼″—20 nut
magnet wires #22 to #28
masking tape

PROCEDURE:

1. Enlarge center hole of each fiber washer to ¼″ with hand punch.
2. Put one washer on screw.
3. Put a layer of tape 1½″ wide on the screw.
4. Punch two ⅛″ holes in the second washer to allow wire to enter and leave.
5. Mount the washer on the screw.
6. Mount the nut.
7. Place the assembly on the coil winder.
8. Push about 8″ of wire through the bottom of washer.
9. Neatly wind about eleven layers of wire, or about 350 turns, until the coil is almost completely filled.
10. Cut off the wire leaving about 8″ for connections.
11. Bring this end of the wire through the remaining hole in the bottom washer.
12. Neatly cover the coils with a layer of masking tape.

TELEGRAPH SET



TOOLS:

ruler and pencil
hand drill with 1/8″ drill
hand punch with 1/8″ punch
hand drill with 1/4″ drill
center punch
hammer
snips
needlenose pliers

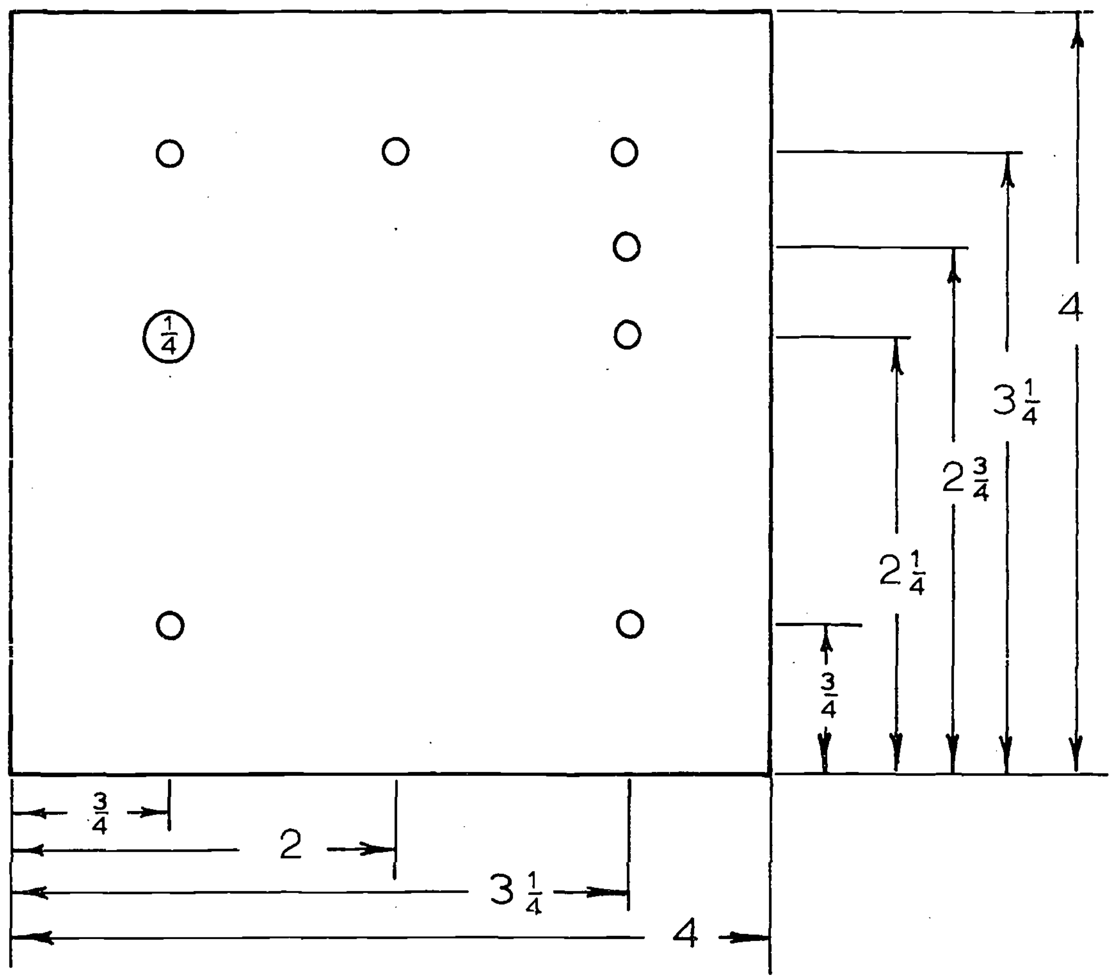
MATERIALS:

4″ x 4″ hardboard base
1 piece of spring steel 1/2″ x 3 3/4″
1 piece of spring steel 1/2″ x 3″
1/4″—20 R.H. machine screw and nut
2 black fiber washers 1″ O.D.
3 6-32 x 3/4″ machine screws
5 6-32 x 1/2″ machine screws
1 kindergarten bead
4″ of #18 annunciator wire
#24 magnet wire
8 6-32 nuts

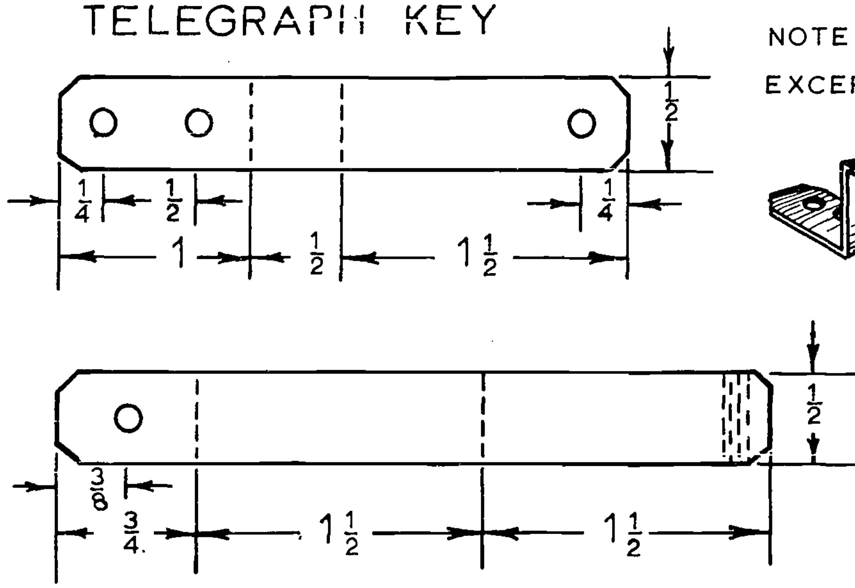
PROCEDURE:

1. Obtain materials from the instructor.
2. Print your name, class, and number on the rough side of the base.
3. Cement top sheet to project, or
4. Lay out the top of the project.
6. Drill or punch all holes as indicated.
7. Lay out the two pieces of metal, using instruction sheet.
8. Punch holes as shown.
9. Bend to shape.
10. Wind electromagnet using instruction sheet.
11. Carefully clean ends of wire to remove enamel coating.
12. Assemble your project.
13. Test your project.
14. Have your project checked by the instructor.

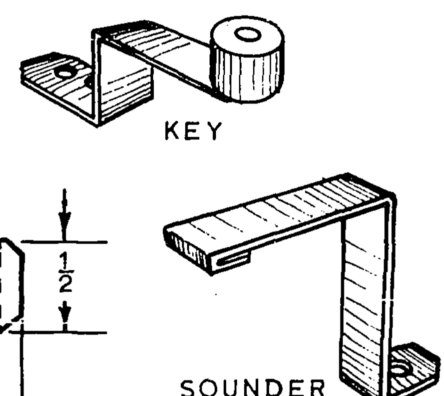
Telegraph Set — Layout



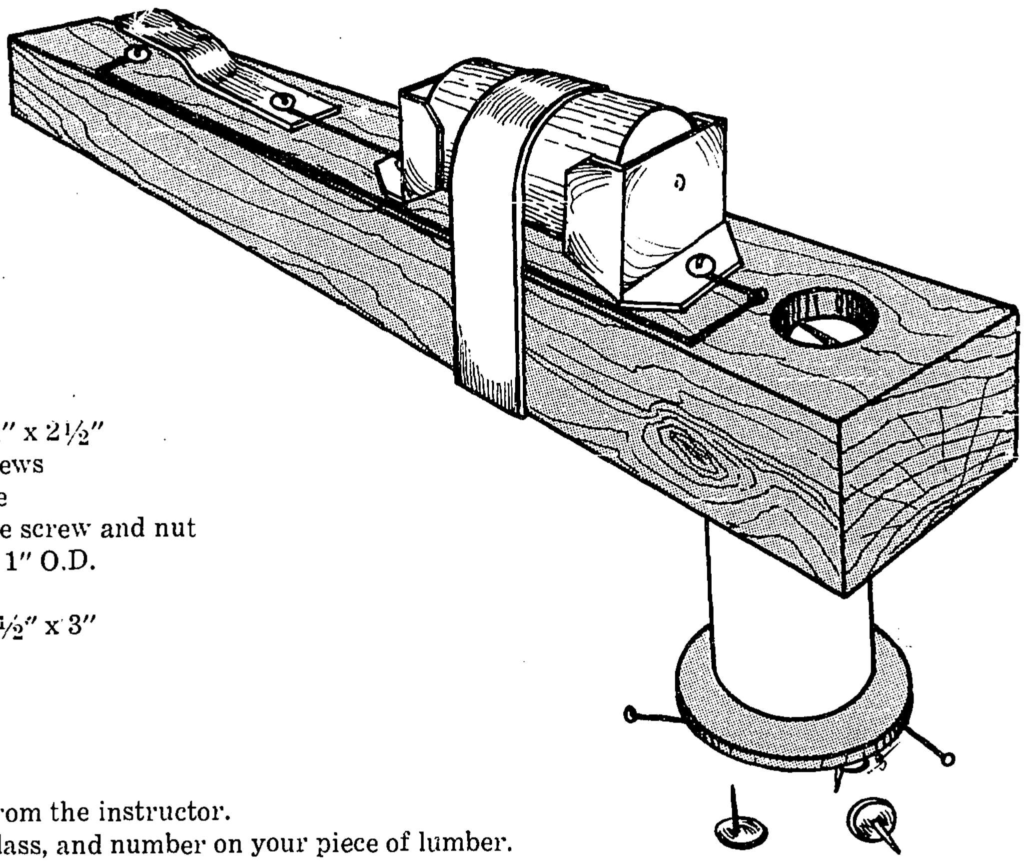
TELEGRAPH KEY



NOTE: ALL HOLES 1/8 EXCEPT AS SHOWN.



ELECTROMAGNETIC BROOM



TOOLS:

rule and pencil
hand drill
#36 twist drill
1/8" twist drill
center punch
hammer
tinners' snips
1/4" twist drill

MATERIALS:

lumber 9/16" x 1" x 12"
tinplate, two pieces, 1 3/4" x 2 1/2"
4 1/2" x #7 RH wood screws
masking or friction tape
1/4—20 x 2" RH machine screw and nut
two black fiber washers 1" O.D.
#24 magnet wire
tinplate or spring steel 1/2" x 3"

PROCEDURE:

1. Obtain materials from the instructor.
2. Print your name, class, and number on your piece of lumber.
3. Lay out the top of your project.
4. Have your instructor check the project.
5. Drill the holes.
6. Make the two battery holders, using instruction sheet.
7. Make the contact switch, using instruction sheet.
8. Make the electromagnet.
9. Mount all your parts on top of handle.
10. Wire your project.
11. Put one D cell into the battery holder.
12. Test your project.
13. Have your project checked by the instructor.

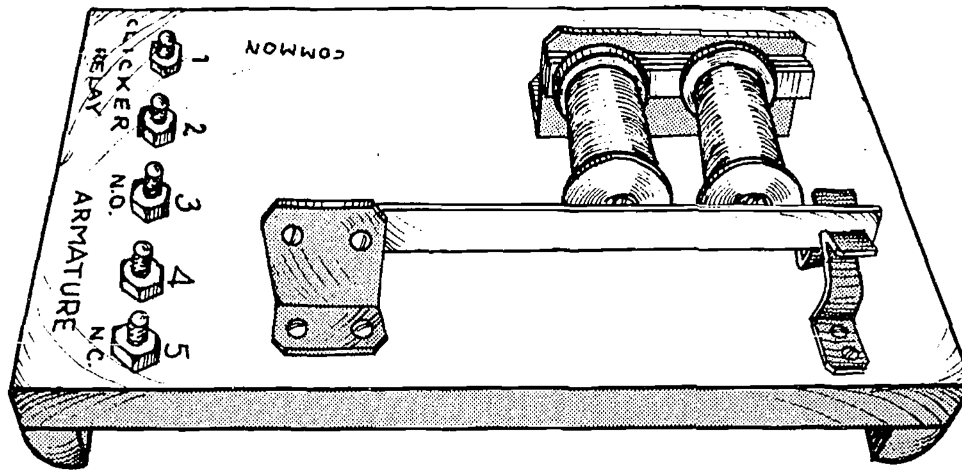
OPERATING INSTRUCTIONS:

The project is an electromagnetic device which may be used to pick up hairpins, thumb tacks, paper clips, and other small iron or steel objects. When the key switch is pressed, the circuit is completed, and the electromagnet is energized. The flow of electrons through the coils of wire results in the creation of an electromagnetic field surrounding the magnet. This field has the power to attract iron, steel, nickel and/or cobalt objects.

CLICKER-BUZZER RELAY

TOOLS:

pencil and rule
hand drill with 1/8" drill
hand punch with 1/8" punch
hand punch with 1/4" punch
coil winder
tinners' snips
screwdriver
combination pliers



MATERIALS:

base, hardboard, 4" x 8"
17" hookup wire
#24 magnet wire
one piece of tinplate 2" x 2"
one piece of tinplate 1" x 2"
three pieces of tinplate 1/2" x 2"
two pieces of tinplate 1/2" x 2 1/4"
one piece of spring steel or tinplate 1/2" x 5 1/2"
two 1/4—20 x 2 RH machine screws
two 1/4—20 nuts
sixteen 6-32 x 1/2" RH machine screws
twenty-one 6-32 nuts
four black fiber washers 1" O.D.

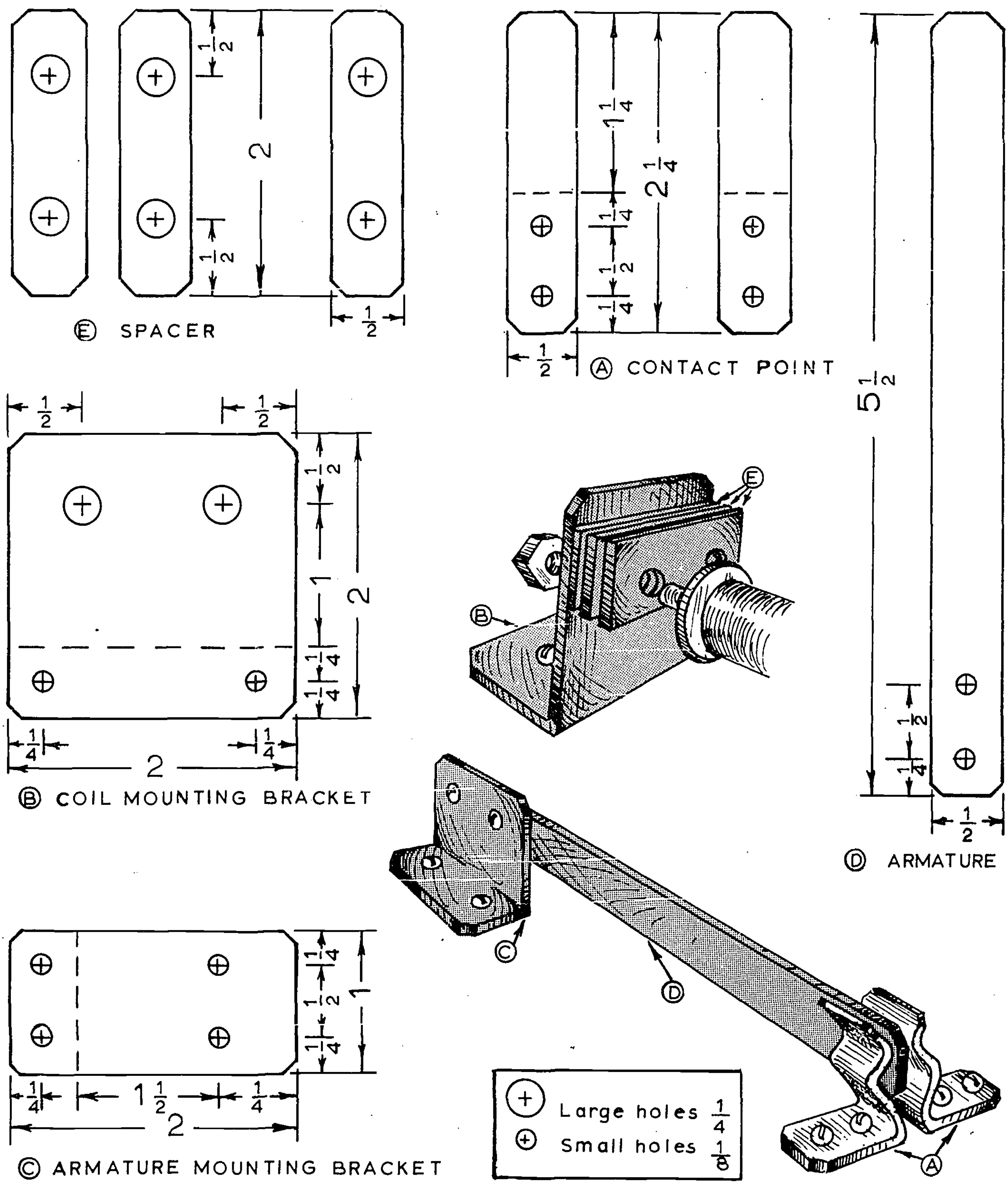
PROCEDURE:

1. Obtain materials from the instructor.
2. Print your name, class, and number on the rough side of the base.
3. Cement top sheet to project, or lay out the top of your project.
4. Have your instructor check the project.
5. Center punch all holes.
6. Drill all holes with the 1/8" drill.
7. Make the various sheet metal pieces following the instruction sheet.
8. Make the two electromagnets following instruction sheet.
9. Assemble your project.
10. Test your project.
11. Have your project checked by instructor.

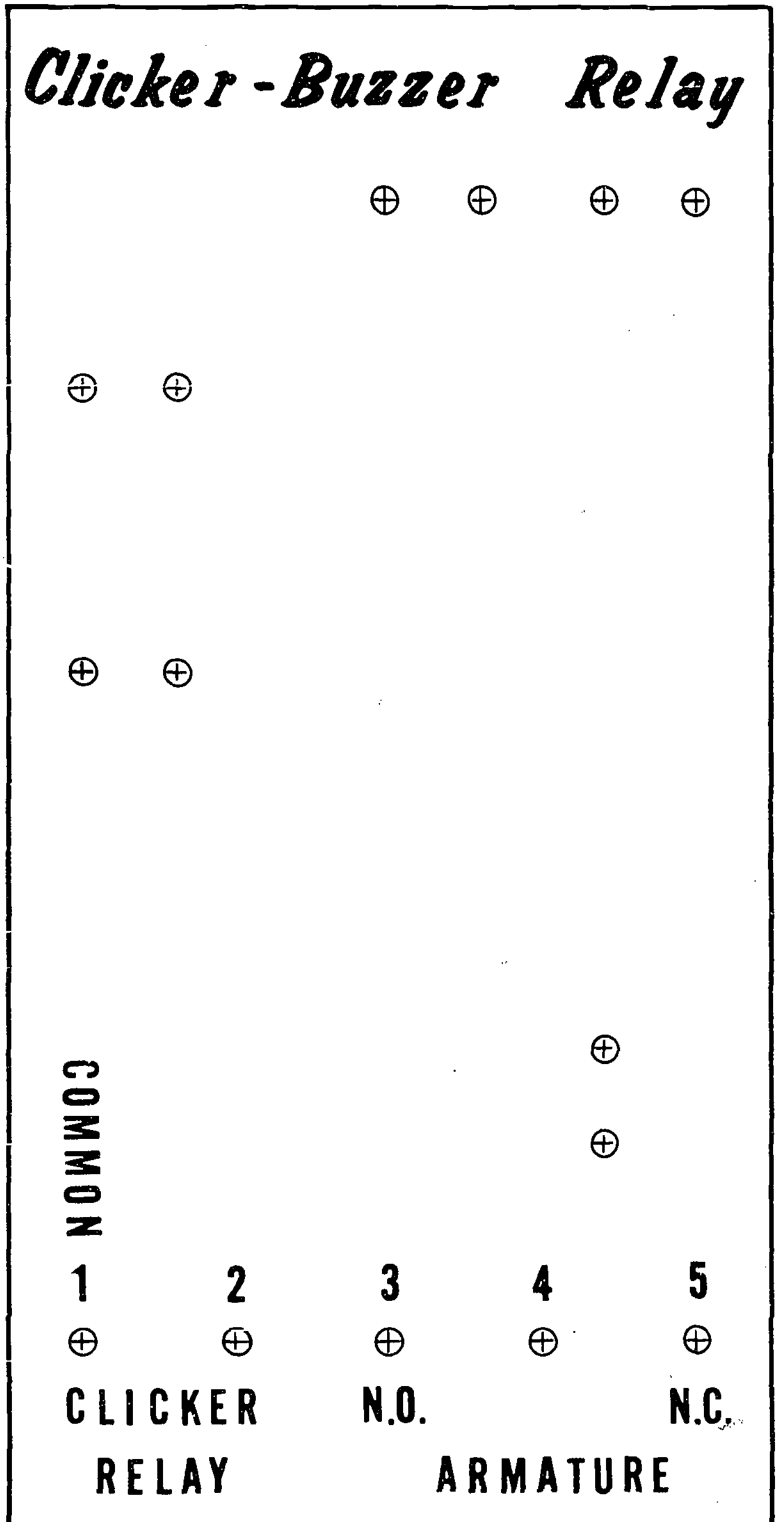
OPERATING INSTRUCTIONS:

The clicker-buzzer relay is a combination of three electromagnetic projects: the telegraph clicker, the buzzer, and the relay. For use as a standard telegraph clicker it is necessary to apply the power to terminals 1 and 2. When using it as a buzzer, the power is applied to terminals 1 and 5, with a short wire from terminals 2 to 4. To use this as a normally open relay it is necessary to connect the controlling circuit to terminals 1 and 2 and the controlled circuit to terminals 3 and 4. To use it as a normally closed relay it is necessary to connect the controlling circuit to terminals one and two and the controlled circuit to terminals four and five.

Clicker-Buzzer Relay — Parts Layout

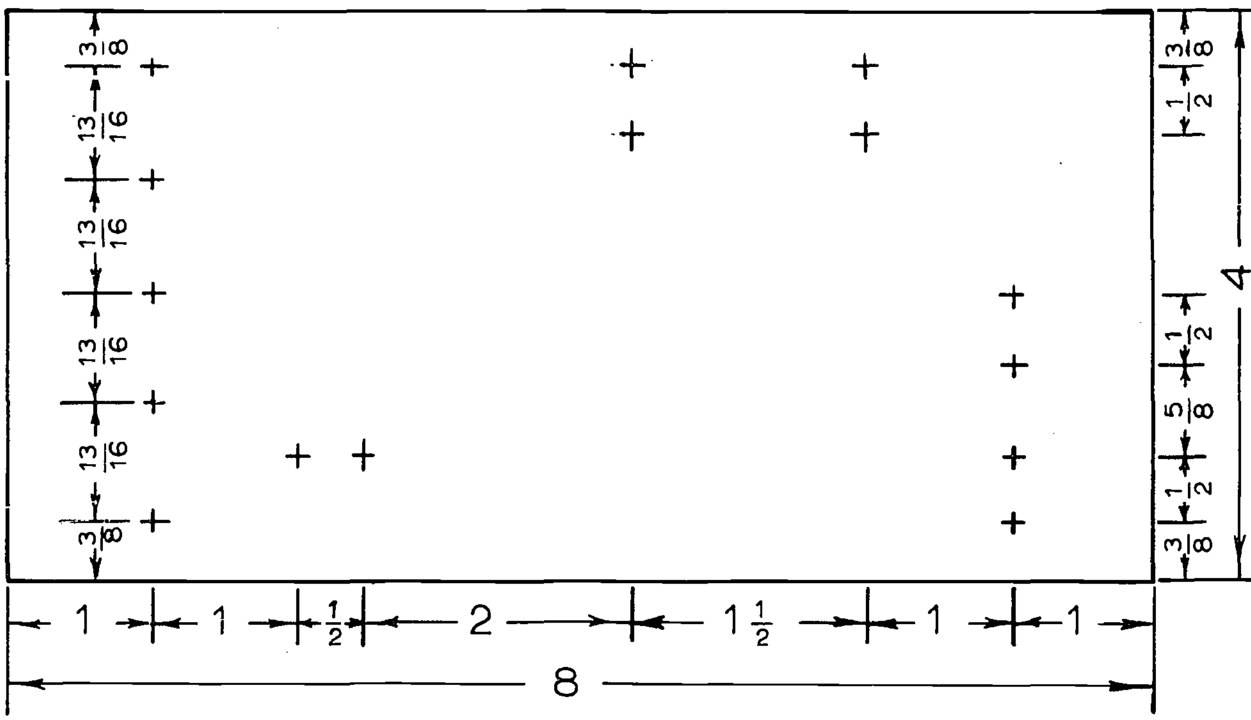


Clicker-Buzzer Relay — Top Sheet

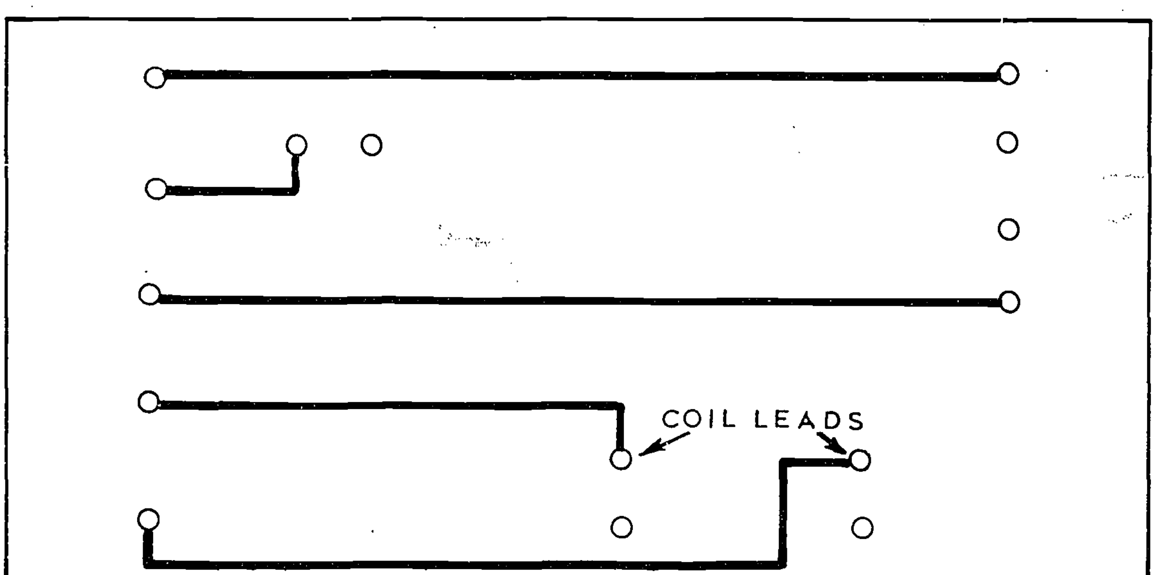


Clicker-Buzzer Relay

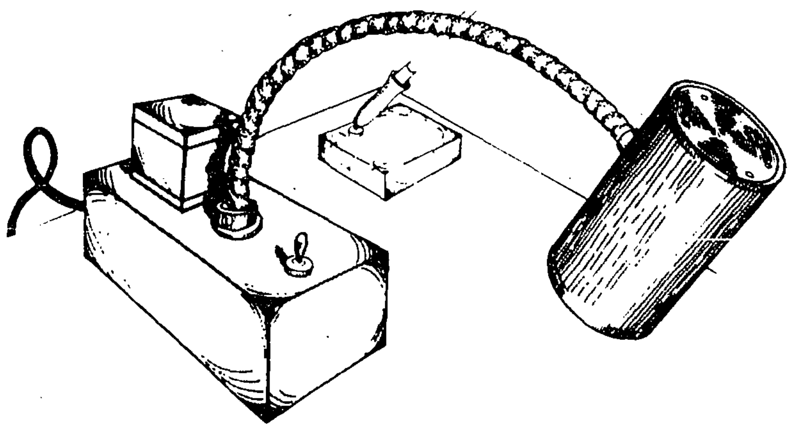
Layout



Wiring Diagram



HIGH INTENSITY LAMP

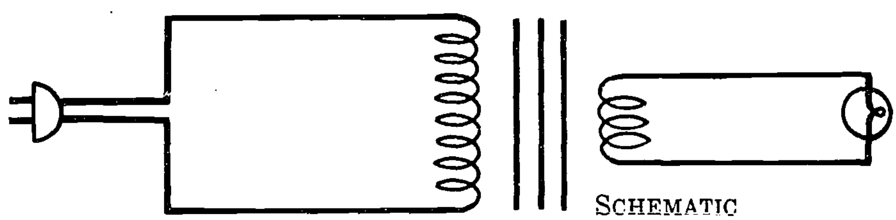


TOOLS:

hand drill
3/8" twist drill
chassis punch
pliers
screwdriver

MATERIALS:

transformer 6.3 volt with four-ampere capacity or greater
lamp-automobile GE 1133
lamp socket for above
toggle switch, single pole, single throw
lamp cord, about six feet
frozen juice can
BX—about 14" long
2 BX connectors
base metal box to fit
paint or other finish



SCHEMATIC

PROCEDURE:

1. Obtain materials from the instructor.
2. Lay out the holes on the metal base and on the can.
3. Have the instructor check the layout.
4. Drill all holes.
5. Punch larger holes with chassis punch.
6. Assemble the project.
7. Wire the project.
8. Have the instructor check the project.
9. Test the project in the presence of the instructor.
10. Finish the project with paint or other finishing material.

OPERATING INSTRUCTIONS:

The high intensity lamp is used to provide a very strong beam of light in a restricted area for use by photographers, model makers, draftsmen, and others who may do fine work. The principle of operation is the use of a transformer to lower the line voltage to a voltage that is usable with an automobile lamp. An automobile lamp is ideal for this application because it provides the proper light. Note: If the current capacity of the transformer is inadequate, the lamp will not light at all or will not light to full brilliance. An automobile lamp, such as the one listed, is capable of producing a light as intense as that of a 150 watt lamp.

SAMPLE QUIZ B

Units 3 and 4

Week: 8
Day: 1

1. Chemical energy is changed into electricity in a ______________________________
2. Light energy is changed into electrical energy in a ______________________________
3. Heat energy is changed into electrical energy in a ______________________________
4. Piezoelectricity is electricity made from ______________________________
5. Bioelectricity is electricity made from ______________________________
6. A material that is *not* magnetic is ______________________________
7. A permanent magnet can be destroyed by ______________________________
8. Mechanical energy is changed into electrical energy in a ______________________________
9. A step-down transformer will ______________________________
10. A machine that will change electrical energy into mechanical energy is the ______________________________

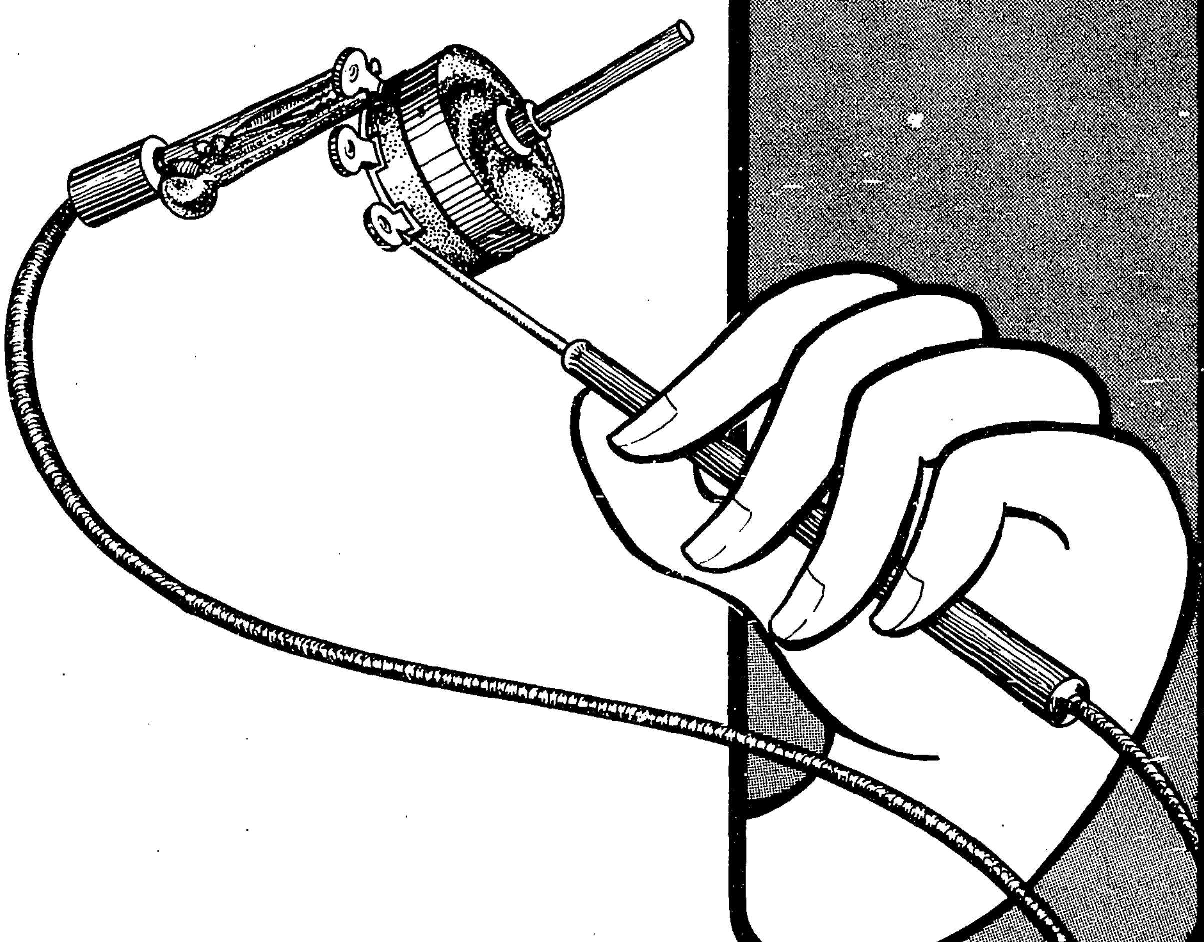
SOME ANSWERS ARE:

heat
hammering
pressure
biology
cobalt
flashlight cell
motor
lower voltages

living organisms
silver
raise voltages
thermocouple
iron
generator
steel
photocell

Testing and Measuring

11



SAMPLE LESSON PLAN

Week: 8
Day: 2

Unit: Testing and Measuring Electricity

Topic: Simple Electrical Tests

Aim: To help students understand how to make simple electrical tests on home appliances.

Apperception: Use the students' experience in testing various projects using the basic project, the continuity tester.

Motivation: This table lamp does not work. How can we check it to discover what is wrong?

Preparation: Table lamps, or similar devices, with a number of things wrong with them (broken filament in lamp, broken socket, break in wire between plug and socket, loose wire in plug, and an open fuse or circuit breaker on that branch line).

Demonstration: Show the inoperative appliance. Go through the various steps to find out what is wrong and correct the problems.

Points for Development:

Make a complete visual check of the appliance.
- Check and see if the device was plugged in.
- Check the plug to see if the wire is loose.
- Check the wire from the plug to the socket to see if it is broken.
- Check the incandescent lamp in another unit to see if it works.
- Check the soldered connections, if the device has any.

Check the device with a continuity test.

The continuity test may be made with a continuity tester or with an ohmmeter.

A low voltage continuity tester, similar to the one used for the basic project, may not be able to properly test a 110 volt device because of the great resistance in the line. For these items it is necessary to use an ohmmeter or a neon lamp continuity tester. Check the continuity of each leg of the circuit. Check with the switch on and again with the switch off. Check for complete, open, or short circuits.

Repair or replace the part which is not functioning properly.

Test again for short circuit before plugging in.

Summary:

Make a visual check of the device to see if the difficulty is apparent.

If a visual check is not successful, the device should be given an appropriate continuity test.

After repairing the device, check for continuity, and open or short circuits before plugging in the device.

Application:
The immediate application may be in the maintenance and repair of simple electrical devices forward in the home. An interest in this area may lead to further training or a career of electrical appliance repair.

Student Activity:
Rewire a lamp.
Bring in a device from home that is not working and check it.

Assignment:
Prepare a bibliography of four books from your school and public libraries which deal with electrical appliance repair.

References:
Buban and Schmitt, pp. 247-252.
Hertzberg, entire book.

Using testing equipment, students check parallel circuits under the supervision of the teacher.

SAMPLE LESSON PLAN

Week: 9
Day: 1

Unit: Testing and Measuring Electricity

Topic: Meters: Voltmeter, Ammeter, Ohmmeter, Multimeter

Aim: To help the students understand how to properly measure electrical quantities.

Apperception: Utilize students' experience with various types of meters in use during the first half of the term in shop.

Motivation: Question: What tool do you use to measure length? How do you determine weight? How do you measure speed?

Preparation: Several voltmeters – various ranges; several ammeters – various ranges; ohmmeter, volt-ohm milliammeter (multimeter). Several circuits which can be used in the demonstration of measurement of electrical quantities.

Demonstration: Show how to select the right type of meter for the specific application and how to properly connect it to the circuit. Emphasize that the instructor must be called before the circuit is energized.

Points for Development:

A meter is an electromagnetic device which causes its needle to move according to the amount of current passing through the meter circuit.

A voltmeter is used to measure electromotive force in volts. A voltmeter is always connected in parallel with the source or load to be checked.

An ammeter is used to measure the intensity of electron flow in amperes. An ammeter is always connected in series with the source and load to be checked. Milliammeters measure current to the thousandth of an ampere.

An ohmmeter is used to measure resistance in ohms. All sources of electricity must be removed from the circuit before connecting an ohmmeter.

The multimeter (or volt-ohm milliammeter, abbreviated VOM) is a combination voltmeter, ohmmeter, and ammeter all in one case.

Summary:

A voltmeter is always connected in parallel with the source or load.

An ammeter is always connected in series with the circuit.

All sources of electricity must be removed before using an ohmmeter.

A multimeter combines the voltmeter, ammeter, and ohmmeter all in one case.

Apperception:

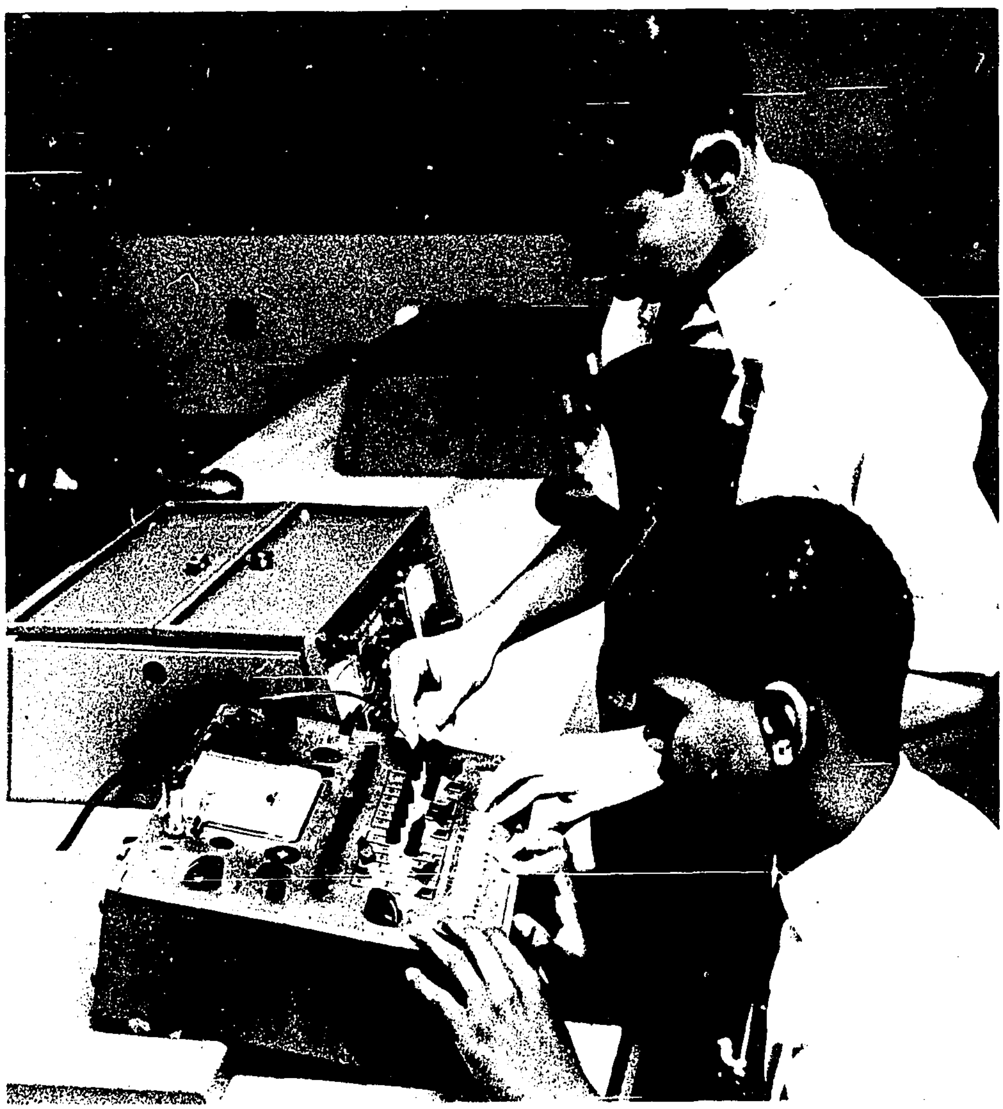
Meters may be used for almost all electrical tests and measurements.

Student Activity:

Selected students should be given the opportunity to conduct resistance, voltage, and current tests on a circuit under the teacher's direction.

References:

Buban and Schmitt, pp. 238-247.
Gerrish, pp. 54-58.
Miller and Culpepper, pp. 53-62.



The tube tester provides an opportunity to troubleshoot and make adjustments.

SAMPLE LESSON PLAN

Week: 9
Day: 2

Unit: Testing and Measuring Electricity

Topic: Electronic Test Instruments: Vacuum Tube Voltmeter, Oscilloscope Signal Generator, Signal Tracer, Tube Tester

Aim: To give the students an understanding and appreciation of electronic test instruments and their applications.

Apperception: Use students' experience in watching TV repairmen at work or in pictures and demonstrations he may have seen in which oscilloscopes and other testing instruments were used.

Motivation: How can the human voice be seen?

Preparation: Vacuum tube voltmeter, oscilloscope, signal generator, signal tracer, crystal microphone, superheterodyne dynamic demonstrator (or other suitable demonstration circuit), tube tester.

Demonstration: Show voice forms on the oscilloscope. Using the other test instruments, show how voltage measurements are taken without loading the circuit. How can a signal be injected? Trace a signal for radio and television repair. Go through the steps in checking a tube.

Points for Development:

A vacuum tube voltmeter (VTVM) is used to check electrical quantities in an electronic circuit without changing the value of the circuit. It is similar to a volt-ohm milliammeter, except that it has an electronic amplifier.

An oscilloscope is used to obtain a picture of the current in the circuit. It is a valuable instrument to the technician and the repairman.

A signal generator is a device which can produce an electrical wave at any frequency or amplitude within a given range. A signal generator is an amplitude modulated device.

A signal tracer is used to follow an electrical signal through from the antenna to the speaker of a radio. A signal tracer has a built-in amplifier to strengthen weak signals.

A tube tester is used to check the continuity and quality of a tube. Some tube testers can also be used to test the quality of transistors.

Summary:

A vacuum tube voltmeter is used to check electrical quantities in electronic circuits.

An oscilloscope is used to obtain a picture of the current in the circuit.

A signal generator produces electrical waves.

A signal tracer follows a signal through the circuit.

A tube tester checks the continuity and quality of tubes and transistors.

Application:

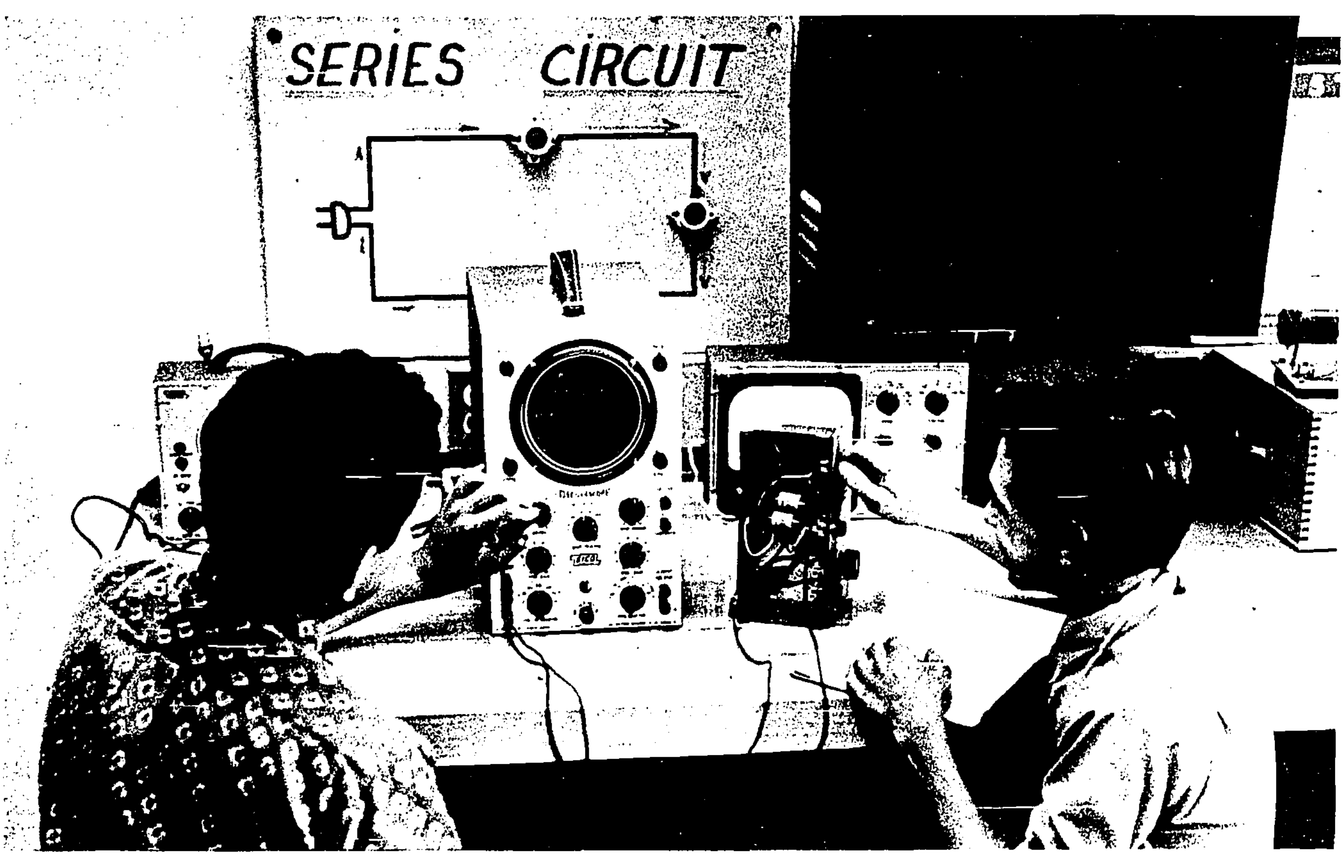
All electronic technicians and servicemen must be familiar with the use of these instruments. Many hobbyists use these instruments in their leisure time.

Student Activity:

Students should be given an opportunity to bring tubes in from home and check them. In addition, they should be encouraged to use other test equipment.

References:

Buban and Schmitt, pp. 255-259.
Gerrish, pp. 294-300.



Radio circuitry is tested on the oscilloscope.

SAMPLE INFORMATION SHEET

Electronic Test Equipment

VOLT-OHM MILLIAMMETER (VOM)

The VOM is also known as a multimeter. It measures resistance, voltage, and current in both AC and DC ranges. It is probably the most common test instrument in general use.

VACUUM TUBE VOLTMETER (VTVM)

The VTVM is very similar to the VOM. It is used for electronic circuit measurements. These meters are said to have high input resistance.

TUBE AND TRANSISTOR TESTER

The tube tester performs tests on vacuum tubes and transistors for open circuits, short circuits, filament continuity, and tube or transistor quality.

SIGNAL GENERATOR

The signal generator is a test instrument used to produce an electronic signal at a radio frequency. The frequency can be set exactly at any point within the range of the unit. The signal generator is used for aligning communications equipment and for repair of electronic devices.

SIGNAL TRACER

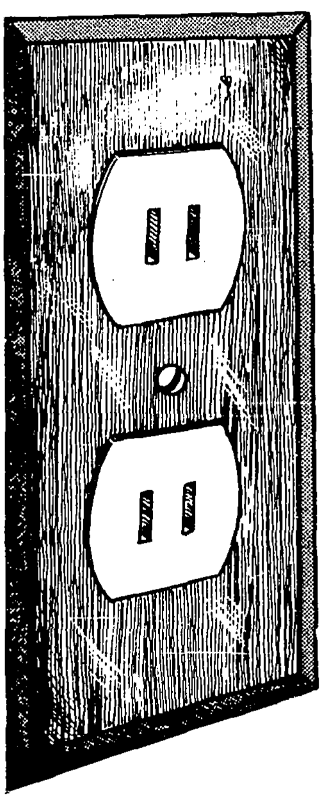
The signal tracer is a test instrument used to detect and amplify electronic signals. It is used in the repair of communications equipment.

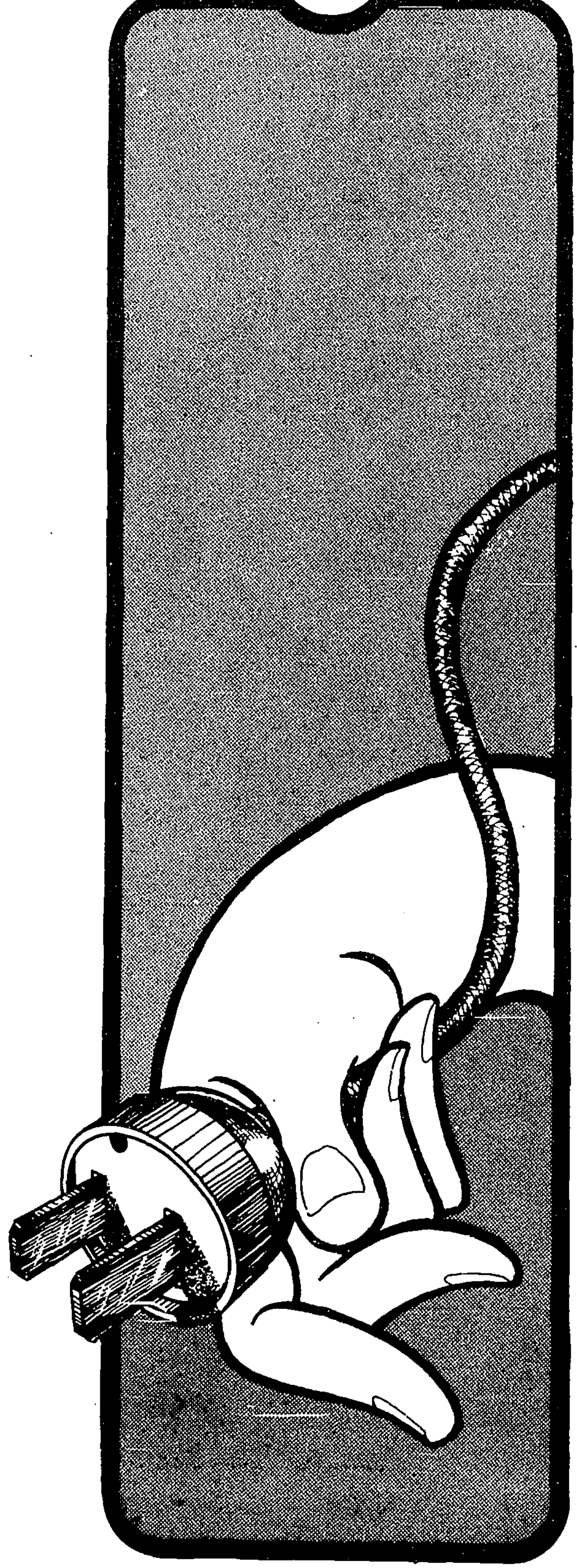
CAPACITANCE TESTER

The capacitance tester will test capacitors for open or short circuits and determine the value of a capacitor within certain ranges.

12

Electricity in the Home





SAMPLE LESSON PLAN

Week: 10
Day: 1

Unit: Electricity in the Home

Topic: Electrical Safety

Aim: To help students understand some principles of electrical safety.

Apperception: Many students are aware of the hazards of home accidents involving electric shock.

Motivation: Demonstrate the need for grounding home appliances by inducing a current leak to the metal case of a discarded appliance.

Preparation: Voltmeter, milliammeter, neon lamp, device prepared with current leakage to outside case, three-wire cord and plug, three-wire receptacle.

Demonstration: Show with use of instruments and lamp the danger of electrocution with ungrounded equipment.

Points for Development:

Never work on equipment that is plugged into an electric circuit. Always remove plug from the outlet, or open the circuit at the fusebox before working on a circuit.

All electrical appliances with metal cases should be grounded.

Never handle electrical equipment with wet hands.

Keep electrical appliances a good distance away from the sink or bathtub.

Loose electrical cords on the floor are a menace, especially to small children.

If electrical shock does not injure you, the recoil from the offending object may cause you to fall against something and cause a serious injury.

Find out why a fuse has blown before replacing it.

Always replace a fuse with another of the same ampere rating.

Always hold the plug to pull it out of the wall; never pull the wire attached to it.

Do not try to repair a television set. Voltages of some 20,000 volts remain in the set for some time after the set is disconnected.

Consider all electric wires as "live" until you have checked them.

Do not do any electrical wiring in your home. Only a licensed electrician may do your home wiring.

Have defective equipment, such as worn plugs and cords, repaired immediately.

Never close a main switch that somebody else has opened. It is possible that somebody is working on the same line in another part of the building where the switch is located.

Summary:

The best safety rule to follow is to avoid contacting "live" electrical wires, terminals, and connections.

Application:

Each student, his family, and friends live in a world filled with electrical appliances and other electrical devices. If each person follows these simple rules of safety, he may save himself from grief.

Student Activity:

Construct a fused switch box for use in experiments and for use with projects, tree lights, model racing cars, etc., which have a tendency to blow house fuses.

Ground an electrical appliance.

Assignment:

Make a list of unsafe electrical practices you have seen. Collect several newspaper articles referring to electrical safety.

References:

Buban and Schmitt, pp. 33-41, 270-271, 280-281.
School Shop Safety Manual, pp. 8-9, 71-77.

SAMPLE LESSON PLAN

Week: 10
Day: 2

Unit: Electricity in the Home

Topic: Protective Devices

Aim: To help students understand that in order to protect them and their homes, it is necessary to limit amperage in every circuit by an overcurrent device.

Apperception: Use students' experience with failure of lights, motors, and other electrical devices.

Motivation: Demonstrate what happens to a low-voltage circuit when the circuit is shorted.

Preparation: Source of low voltage, thin resistance wire, suitable lamp, screwdriver, paper house, fuse wire (S-1 List), different fuse types, circuit breaker.

Demonstration: Demonstrate how a fuse (fuse wire) protects the house in case of a short circuit. Show how the house can go up in flames if the wires are not properly fused.

Points for Development:

Any protective device must have a rating in amperes not greater than the capacity of the smallest conductor it protects.

A fuse is a short strip of metal which will melt, break the connection, and stop the flow of electricity when too much electrical current goes through it.

A dual-element time delay (lag-fuse) will carry an overload of one minute to allow a motor to start, but will open immediately for a small, continuous overload or a short circuit.

Since all standard fuse bases are interchangeable, a Fustat, which is a tamper-resistant-base fuse, was invented. It is impossible to put a higher rating fuse in a Fustat adapter without destroying it.

Cartridge fuses are of single or dual element types and have single use or replaceable element links.

Circuit breakers are protective devices which open the circuit in case of overcurrent. They can be reset easily once the source of difficulty has been removed.

Replace a fuse with one of the same rating.

If you cannot find the reason why the fuse has burned out, replace the fuse with an incandescent lamp and disconnect every appliance in the house until the lamp is dark.

All electric circuits should be fused.

Replacing a fuse is as simple as replacing an incandescent lamp.

It is possible to identify an open fuse by its broken link, or a blackening of the fuse window.

Summary:

Every circuit should be protected.

Replace fuses with other fuses of the same ampere rating.

When a fuse opens, it is an indication that there is something wrong with the circuit.

Application:

Every student is a consumer of electricity and should use overcurrent protective devices in his home.

Student Activity:

Identify an open fuse; select a proper replacement; replace the fuse under the teacher's direction.

Assignment:

Prepare a list of all the different kinds of protective devices that are available.

References:

Buban and Schmitt, pp. 37-41.
Gerrish, p. 167.
Miller and Culpepper, p. 16.

SAMPLE LESSON PLAN

Week: 11
Day: 1

Unit: Electricity in the Home

Topic: Electrical Codes in Home Wiring

Aim: To help the students understand the codes which govern electrical wiring and installation in New York City and throughout the nation.

Apperception: The need for laws, codes, and regulations to provide for the safety of persons and property.

Motivation: Who has the authority to wire homes for light or power?

Preparation: New York City Electrical Code
National Electrical Code

Points for Development:

New York City Electrical Code--Section B30-2.0

"Since there is danger to life and property inherent in the use of electrical energy, the electrical code is enacted to regulate the business of installing, altering or repairing wiring and appliances for electric light, heat or power in or on all real property within the building lines in the City of New York and the licensing of all persons who engage in such business."

All electrical work in New York City must follow the New York City Electrical Code.

All house and building wiring in New York City must be done by or supervised by a licensed electrician.

All electrical wiring and installation done in New York City must be inspected and approved by an inspector from the Department of Water Supply, Gas, and Electricity.

Many cities and counties outside of New York City have adopted their own electrical code systems.

Those areas that do not have electrical codes of their own usually use the National Electrical Code.

Electrical codes specify wire size, type of insulation, number of conductors allowed in a certain size conduit, color coding, grounding, overcurrent protection, splices, lengths of run, number of supports, etc.

Summary:

All home and industrial wiring in New York City must be done by a licensed electrician, and inspected by an electrical inspector to see if it conforms to the New York City Electrical Code. This may not be true outside of the City of New York.

References:

Buban and Schmitt, p. 34.
National Electrical Code.
New York City Electrical Code.

Students learn the fundamental skills of house wiring in a simulated frame structure.

SAMPLE LESSON PLAN

Week: 11
Day: 2

Unit: Electricity in the Home

Topic: Home Wiring Systems

Aim: To help students understand different wiring systems used in our homes.

Apperception: Use the analogy of an automobile being available with many different kinds of engine power options; each could do the job, but some are more powerful than the others.

Motivation: Why does a television picture shrink every time the broiler, toaster, or electric iron is turned on? What can be done to remedy this?

Preparation: Wiring booth, or mock-up panel, with wire service entrance, meter, distribution box, various branch circuits.

Demonstration: Show the path of electricity from the time it enters the house until it reaches lights, general appliances, and heavy duty appliances or machines requiring individual circuits.

Points for Development:

Electrical service consists of the conductors and equipment for delivering energy from the electricity supply company to the wiring system of the premises served.

The service entrance is made up of the service entrance cable, the kilowatt-hour meter, and the distribution center.

Electricity is distributed from the distribution center to all parts of the home through general purpose circuits, appliance circuits, and individual circuits.

The general purpose circuits serve the lights all over the house and convenience outlets everywhere except in the kitchen, laundry, and dining areas.

Appliance circuits are used for coffeemakers, refrigerators, toasters, irons, broilers, mixers, etc.

Individual circuits are used for the higher power equipment, such as washing machines, air conditioners, electric ranges.

There should be an adequate number of outlets for each room so that extension cords or multiple plug "octopus" receptacles are not necessary.

Only metallic tubing or rigid conduit may be used for home wiring in New York City today.

It is permissible to use surface raceway systems, such as Wiremold.

All outlets and switches are to be placed in switch boxes.

All wire connections or splices are to be made in junction boxes.

Only licensed electricians may do electrical wiring in New York City.

Summary:

Electricity enters the home through the service entrance, is metered at the kilowatt-hour meter, is distributed throughout the house through the distribution center to the general purpose circuits, appliance circuits, and individual circuits.

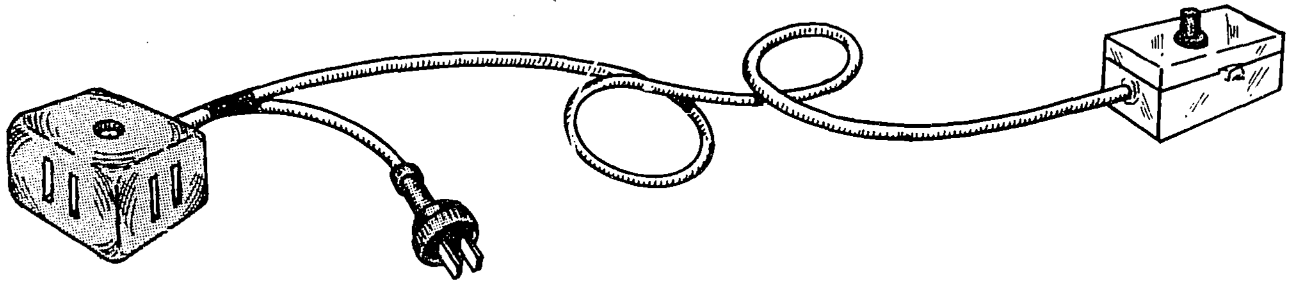
Student Activity:

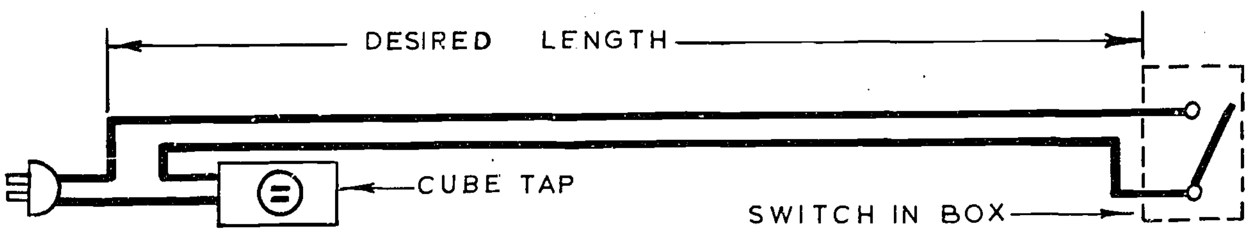
Work in the wiring booth. Reset a circuit breaker; replace a fuse, a switch, a receptacle, or a socket. Wire a bell system, alarm system, telephone circuit.

References:

Buban and Schmitt, pp. 261-274.
National Electrical Code.
New York City Electrical Code.
Simplified Home Wiring Handbook.

REMOTE TV AND APPLIANCE SWITCH





TOOLS:

diagonal cutters
screwdriver
¼" twist drill
hand drill
tapered reamer
brace

MATERIALS:

male plug
cube tap
SPST toggle switch
small plastic box
length of lampcord (desired length plus one foot)
electric tape

PROCEDURE:

1. Obtain necessary materials from instructor.
2. Cut one foot of lampcord from the length.
3. Wire the plug to one end of the one-foot piece, using the Underwriters' knot.
4. Wire the cube tap to the other end of the one-foot piece of wire.
5. At about the center of the one-foot cord, cut into one of the wires, separate, and strip the ends.
6. Separate and strip the ends of the long piece of wire.
7. Connect the leads at one end of the long wire to the two stripped ends at the center of the short wire.
8. Drill a ¼" hole in the center of the top of the box to admit the switch. Ream the hole until it is the proper size.
9. Drill another ¼" hole in the side or bottom of the box to admit the wire.
10. Bring the remaining end of the wire into the box, make a knot, and connect it to the switch.
11. Have your instructor check the project.

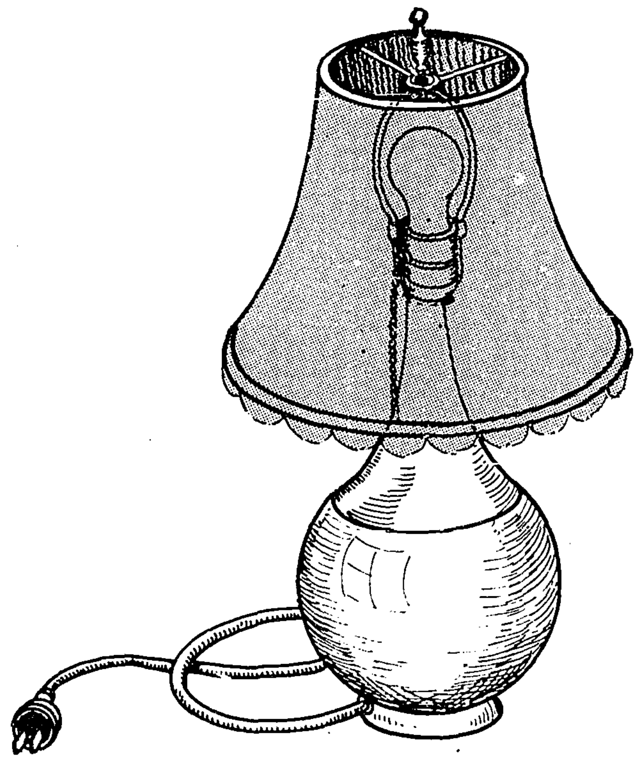
OPERATING INSTRUCTIONS:

The remote switch is, in reality, nothing more than an extension cord with a switch to interrupt the circuit. For use, the plug is inserted into the wall; the television or lamp is plugged into the cube tap and turned on. The length of wire is extended to the place where the control is desired.

BOTTLE LAMP

TOOLS:

3/16″ silicon-carbide masonry drill
hand drill
center punch
hammer
newspaper
1/8″ twist drill
3/8″ twist drill
8″ rattail file
wastepaper basket
safety goggles



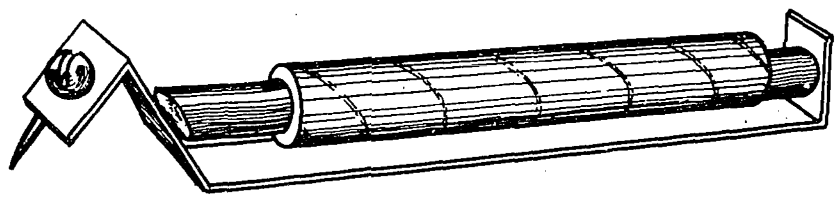
MATERIALS:

bottle—suitable size to hold assembly without tipping. (Best with metal cap.)
key socket
pipe nipple 1/8″
pipe locknut 1/8″
6′ lampcord
harp (optional)
finial (optional)
male plug

PROCEDURE:

1. Line a woodworking vise with paper; place a wastebasket beneath it.
2. Lay the bottle on the paper, and tighten the vise slightly on the bottle using as little force as possible; centerpunch a tiny dimple at a point one inch above the base.
3. Drill a 3/16″ hole through the bottle.
4. Smooth the hole edges with the file.
5. Centerpunch; then drill a 1/8″ hole in cap.
6. Enlarge the hole to 3/8″.
7. Put the nipple through the bottlecap; place the locknut beneath and the socket cap above it and tighten.
8. Feed the wire from the bottom through the bottle cap assembly and screw cap on.
9. Wire the plug, using Underwriters' knot.
10. Wire and assemble the socket.
11. Unscrew the cap and fill the bottle with gravel, or paint the outside of the lamp.
12. Have the instructor check the project.

ELECTRIC PENCIL



Names or initials can be written on tools and metal equipment with an easily made electric pencil. The vibrating action of the pencil point burns permanent marks on the metal. This electric metal marker provides a simple and easy way to personalize equipment. This device operates on 6 to 12 volts of alternating current.

MATERIALS:

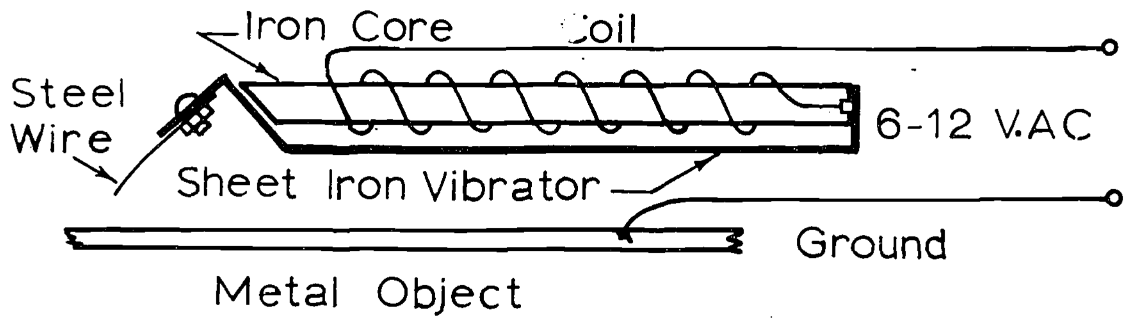
1—¼″ round iron stock, 4″ long
strip of tinplate, $\frac{5}{16}$″ x 5¼″
No. 24 magnet wire
1—½″ 6-32 screw and nut
plastic electricians' tape
steel wire, No. 20 or No. 22, 1″ long

TOOLS:

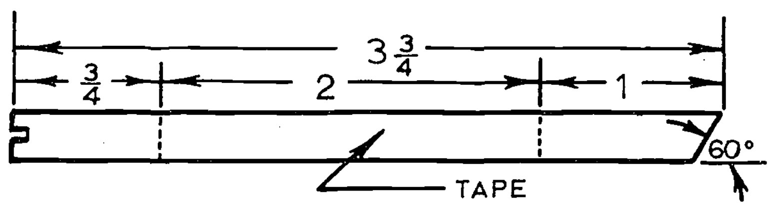
hacksaw
10″ second cut flat file
soldering iron and solder
⅛″ twist drill
hand drill
center punch
hammer

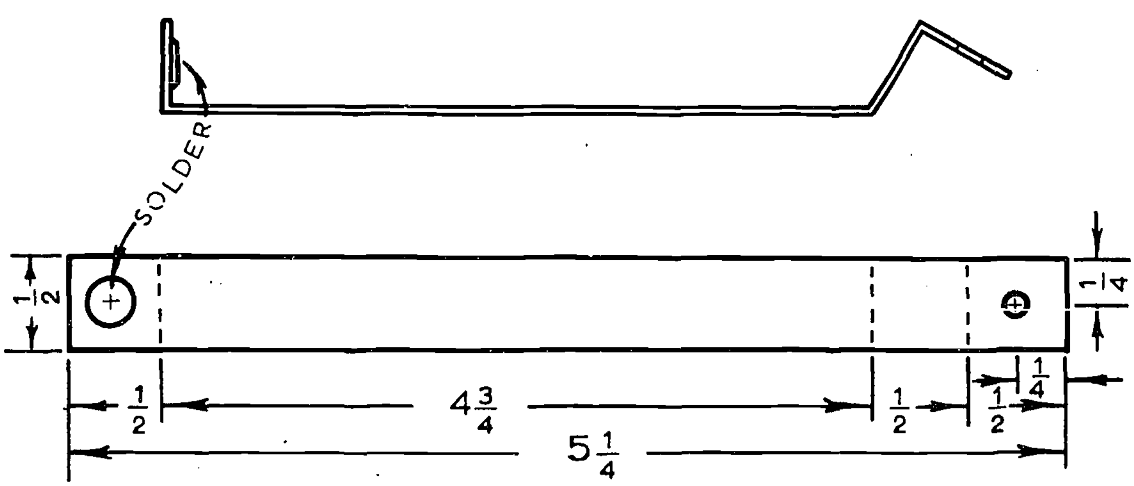
PROCEDURE:

1. Cut one-quarter inch round iron stock to four-inch length.
2. File one end to a 60 degree angle.
3. File other end smooth, straight, and square.
4. Hacksaw a small notch on straight end.
5. Wrap a layer of tape on round iron stock as shown in diagram.
6. Start the wire in the notch, leaving one inch out. Wind one layer of wire until the insulation is covered. Wind a second layer carefully over the first, winding back to where you started. Temporarily secure the wire by putting it into the notch.
7. Prepare the interrupter strip as in the sketch.
8. Prepare one end of the strip for sweat soldering.
9. Punch or drill a one-eighth inch hole in other end of the strip.
10. Solder the wire and the strip to the bar.
11. Tape the interrupter to the coil.
12. Insert the screw and burner point.
13. Clean the long end of the wire.
14. Make a cord with a clip on one end.
15. Connect the device to a 6-12 v.a.c. source as shown in pictorial diagram.
16. Have the instructor check the project.



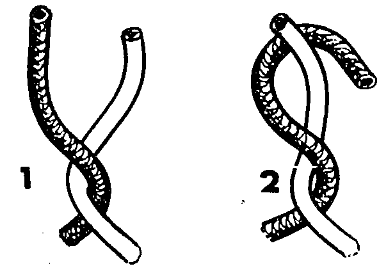
Electric Pencil — Layout





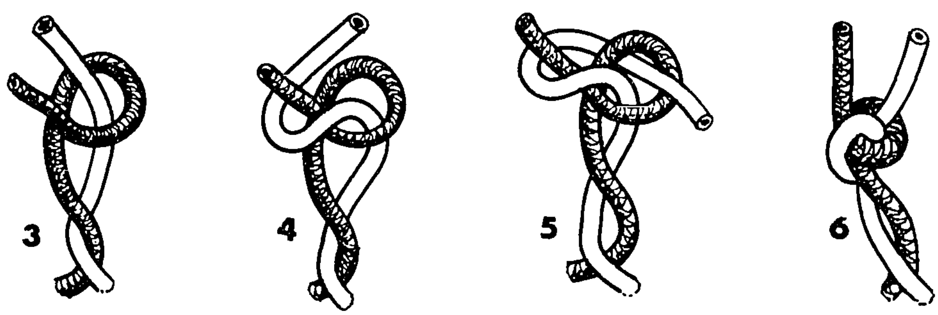
SAMPLE INSTRUCTION SHEET

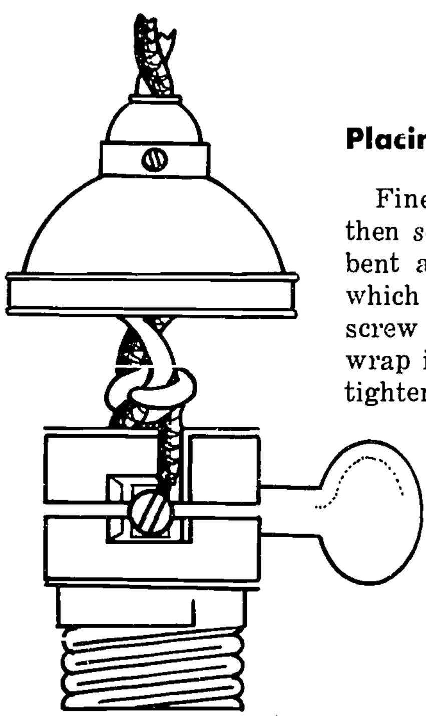
Underwriters' Knot



How to Tie an Underwriters' Knot

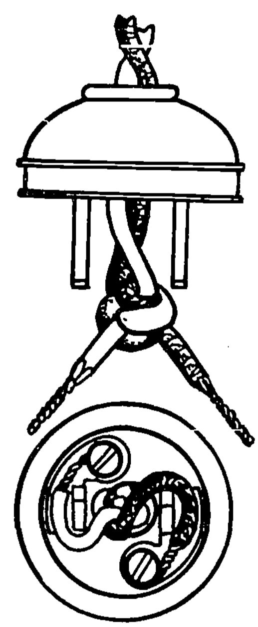
A knot is tied on the end of a cord inside a *socket* or *plug* to take the strain off the screws when a person pulls on the cord. This knot is called the *Underwriters' knot.* If the knot is too small to hold the cord in place, it should be made larger by wrapping it with tape.





Placing Wire Under Screw

Fine, loose wires should first be twisted and then *soldered* together. Next, the wire should be bent around the screw in a *clockwise* direction which is in the same direction that you turn the screw to tighten it. The wire will in this way wrap itself still tighter around the screw as it is tightened.



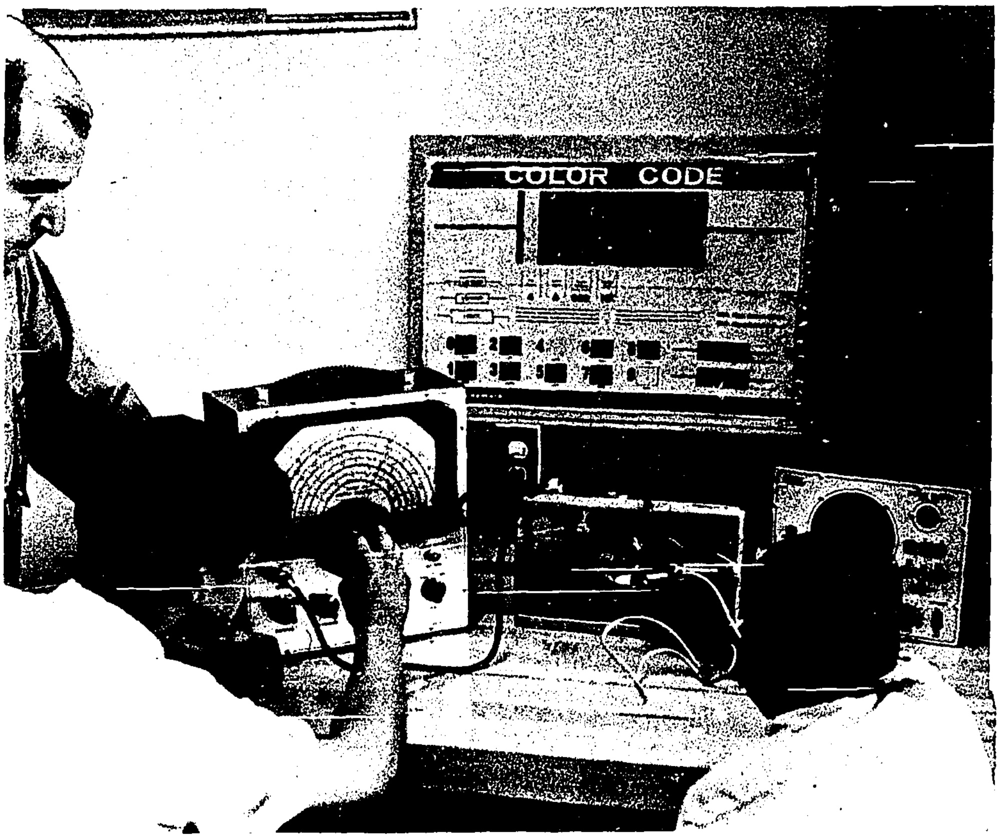
SAMPLE QUIZ C

Units 5 and 6

Week: 11
Day: 2

Answer one of the questions below.

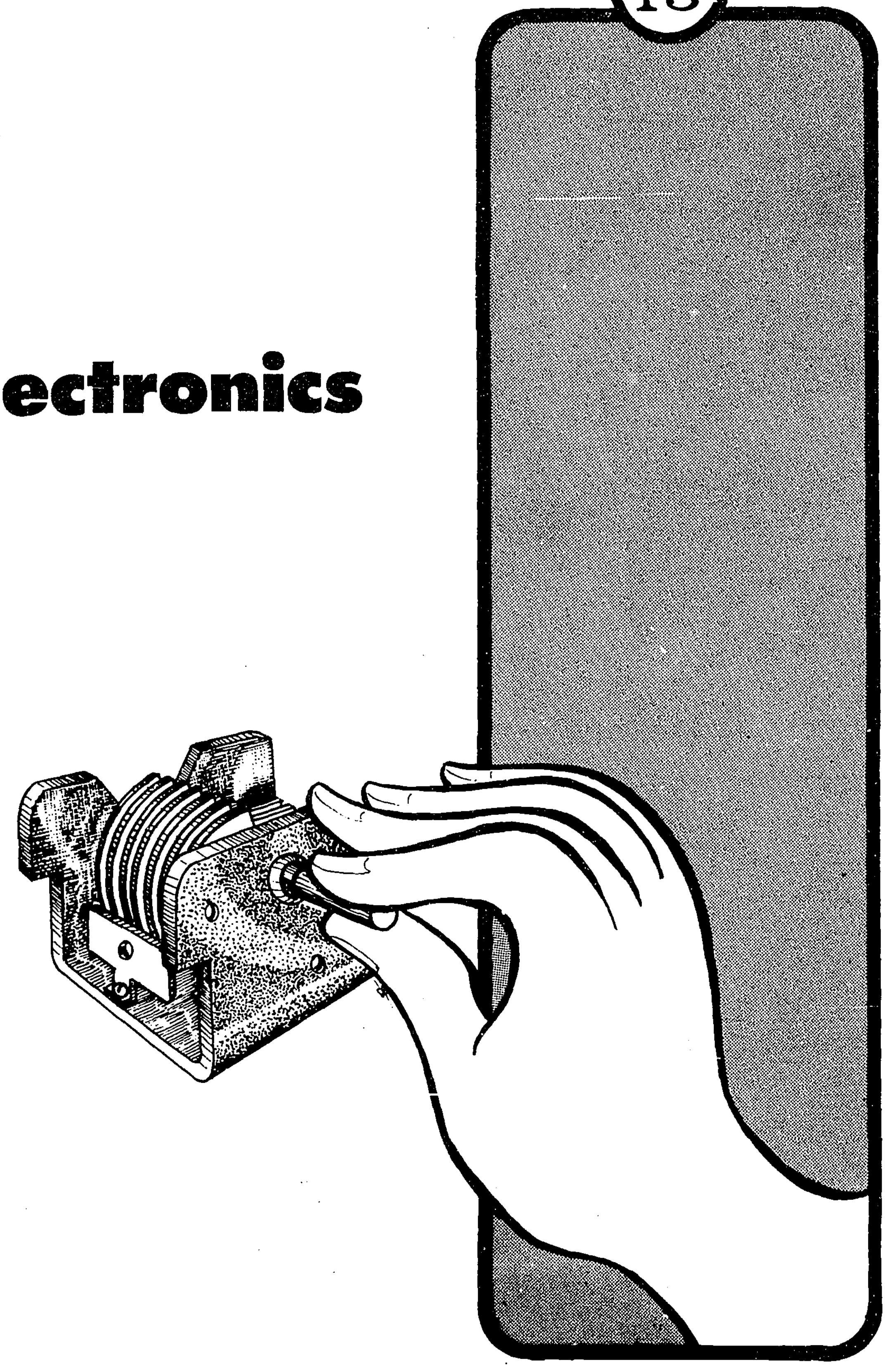
1. Describe the steps you would take to test a table lamp that does not work.
2. List three different types of meters used to measure electrical energy. Describe the use of each and how it is connected to the circuit.
3. List four types of electronic test equipment other than the meters in question 2. Tell what each does.
4. Describe six important rules of electrical safety in the home.
5. Describe how to identify an open fuse and replace it correctly.



Under the supervision of the teacher, students check radio circuitry.

13

Electronics



SAMPLE LESSON PLAN

Week: 12
Day: 1

Unit: Electronics

Topic: Vacuum Tube

Aim: To help the students understand the nature and functions of a vacuum tube.

Apperception: Most students have seen vacuum tubes in home radios and television sets, as well as in previous shop demonstrations.

Motivation: Use a signal tracer to show the amplification of the signal from tube to tube on a superheterodyne dynamic demonstrator.

Preparation: Various types of vacuum tubes, model of a vacuum tube, tube sockets, superheterodyne dynamic demonstrator, signal tracer.

Demonstration: Use signal tracer to show the amplification of the signal from tube to tube on a superheterodyne dynamic generator.

Points for Development:

Thomas Edison discovered the principle that a lamp could pass electricity from its filament to a metal plate on the top. This principle is called the "Edison Effect" in his honor.

This discovery was made into the diode tube, an improved detector of electromagnetic waves, by John Fleming.

Lee DeForest added a control grid to the diode tube and gave us a triode tube, which is able to make a signal stronger.

The first function of a diode rectifier tube is to change alternating current to direct current to allow electrons to pass in one direction only.

The second function of a tube is to amplify, or make a signal stronger.

Other functions of tube are mixing signals, separating signals, and making entirely new signals.

The number of a vacuum tube tells its filament voltage, what it does, and the number of internal elements connected to pins. For example, a 12SJ7 has a 12.6 volt filament,is an R.F. amplifier, and seven of the eight pins are connected to active elements; a 25W4 uses 25 volts in its filament, is a rectifier, and has four pins connected to active elements.

We can find all the information we need about a tube in a receiving tube manual.

We can find out which tubes are interchangeable by using a tube interchangeability manual.

The simplest test for a tube is filament continuity.

The second test for a tube is for short circuits within the various elements.

In order to check a tube for quality we must use a tube-testing device which can check how many electrons are given off each second and/or how well the tube amplifies.

Many tubes in use today have two or three different tubes, each equal to a separate tube within the same glass envelope.

Tubes range in size from less than an inch in height to more than a foot in height.

New Terms:

Edison effect
Thermionic effect

Summary:

The tube is an electronic device which can rectify, amplify, make new signals, and mix signals.

Application:

Vacuum tubes are used in most home radios, television sets, and many phonograph systems.

Student Activity:

Students may make a tube tester.

References:

Buban and Schmitt, pp. 11, 255-256, 332-336.
Pollack, pp. 13-103.
Receiving Tube Manual.

SAMPLE LESSON PLAN

Week: 12
Day: 2

Unit: Electronics

Topic: The Transistor

Aim: To help students to understand the nature and functions of the transistor.

Apperception: Use students' experience with portable radios and other electronic devices.

Motivation: Demonstrate shop-made transistor, radio, ukelele, or code practice oscillator.

Preparation: Demonstration transistor apparatus used for motivation.

Demonstration: Demonstrate shop-made transistor radio, ukelele, or code oscillator.

Points for Development:

The transistor is rapidly replacing the vacuum tube in many electronic devices.

Some reasons why transistors are preferred to tubes are:

a. greater ruggedness
b. smaller size
c. lesser weight
d. fewer batteries
e. lesser operating power
f. longer operating life
g. no warm-up period
h. lesser heat output
i. lesser expense

Transistors can do almost anything a vacuum tube can do, including:

a. detection
b. amplification
c. oscillation
d. relay switching

Portable radios now have from six to twelve transistors. As a rule of thumb, the quality of a transistor radio has a relationship to the number of transistors actively used in it.

Transistors are solid-state devices made from a semiconductor, such as germanium or silicon, with certain impurities added to give it special characteristics.

Drs. William Shockley, Walter Brattain, and John Bardeen of Bell Telephone Laboratories are credited with the development of the transistor in 1948.

The first commercial products using transistors were hearing aids.

When transistors are soldered, a heat sink, such as a pair of needle-nose pliers, should be placed between the soldering iron and the transistor.

The transistor may be damaged if it is improperly connected or if too much voltage is applied.

The three leads of the transistor are the emitter, the base, and the collector.

Summary:

Transistors are used in portable radios, television sets, home entertainment devices, such as tape recorders and photographs, hearing aids and automobile ignition systems.

Student Activity:

Construct radios, code practice oscillators, ukeleles, automobile flashers, metronomes, organs, burglar alarms, amplifiers, wireless transmitters.

Assignment:

Prepare a list of all the devices that use transistors.

Prepare a report on the history and development of the transistor.

References:

Buban and Schmitt, pp. 159-162.
Gerrish, pp. 268-279.
Pollack, pp. 104-119.

SAMPLE LESSON PLAN

Week: 13
Day: 1

Unit: Electronics

Topic: Radio Transmission

Aim: To give the student basic understanding of radio transmission.

Apperception: Use previous learning about amateur radio, citizens' band radio, or commercial radio as bases for discussion.

Motivation: Use a phono oscillator or short range transmitter to send a signal a few feet into a receiver in the shop.

Preparation: Phono oscillator, or short range transistor transmitter, radio receiver.

Demonstration: Show radio transmission.

Points for Development:

A radio transmitter makes it possible to send code, voice, and music through the air.

Voice and music are changed into electrical waves by a microphone.

An oscillator makes electrical waves, usually of a very high frequency.

The high frequency wave is modulated by the microphone signal.

The two types of modulation are amplitude modulation and frequency modulation.

The signal is made stronger by the amplifier.

The signal is sent to the antenna which converts it to the electromagnetic wave.

Electromagnetic waves travel through the air until they reach the receiving antenna.

Summary:

The microphone changes sound into electrical waves. Electrical waves modulate the high frequency waves from the oscillator; the waves are made stronger in the amplifier and are sent into the air from the antenna.

References:

Buban and Schmitt, pp. 312.
Miller and Culpepper, p. 186.

SAMPLE LESSON PLAN

Week: 13
Day: 2

Unit: Electronics

Topic: Radio Reception

Aim: To help students understand how a radio signal is received.

Apperception: Use the students' experience with their personal portable transistor radios, amateur radio receptions, etc.

Motivation: Show several types of receivers that can be built in the shop, such as the crystal receiver, the transistor receiver, or the tube-type receivers. Demonstrate their reception through earphones, a speaker, or a signal tracer.

Preparation: Crystal radio, one-transistor radio, two-transistor radio, six-transistor radio, five-tube radio, shortwave radio, earphones, speaker, signal tracer, five-tube superheterodyne dynamic demonstrator, various radio parts for identification.

Demonstration: Show how each set receives a signal. Show improvement of reception as amplification and intermediate frequency stages are included. Identify each section of the radio and explain generally what it does.

Points for Development:

The electromagnetic radio waves are changed into electrical waves by the antenna which received them.

The proper signal is selected by the tuner circuit which includes a capacitor and a coil.

The tubes or transistors make the signal stronger.

The resistors control the amount of electricity going to each part.

The capacitors can stop direct current but will pass alternating current.

The coils and choke can stop alternating current but will pass direct current.

Diodes or detectors will allow the electricity to pass in one direction only. Every radio must have some kind of detector.

Most radios we purchase use a superheterodyne circuit.

The earphones or speaker change electrical waves into sound waves.

Radio waves are measured in cycles per second. One cycle per second equals one Hertz, abbreviated Hz.
One thousand cycles per second is a Kilo Hertz, abbreviated KHz.

Summary:

The antenna changes the radio wave into an electrical wave. The tuner selects the proper station. The earphones or speakers change the signal from an electrical signal into a sound wave.

Application:

Most families own at least one radio.
Many students have their own radios.

Student Activity:

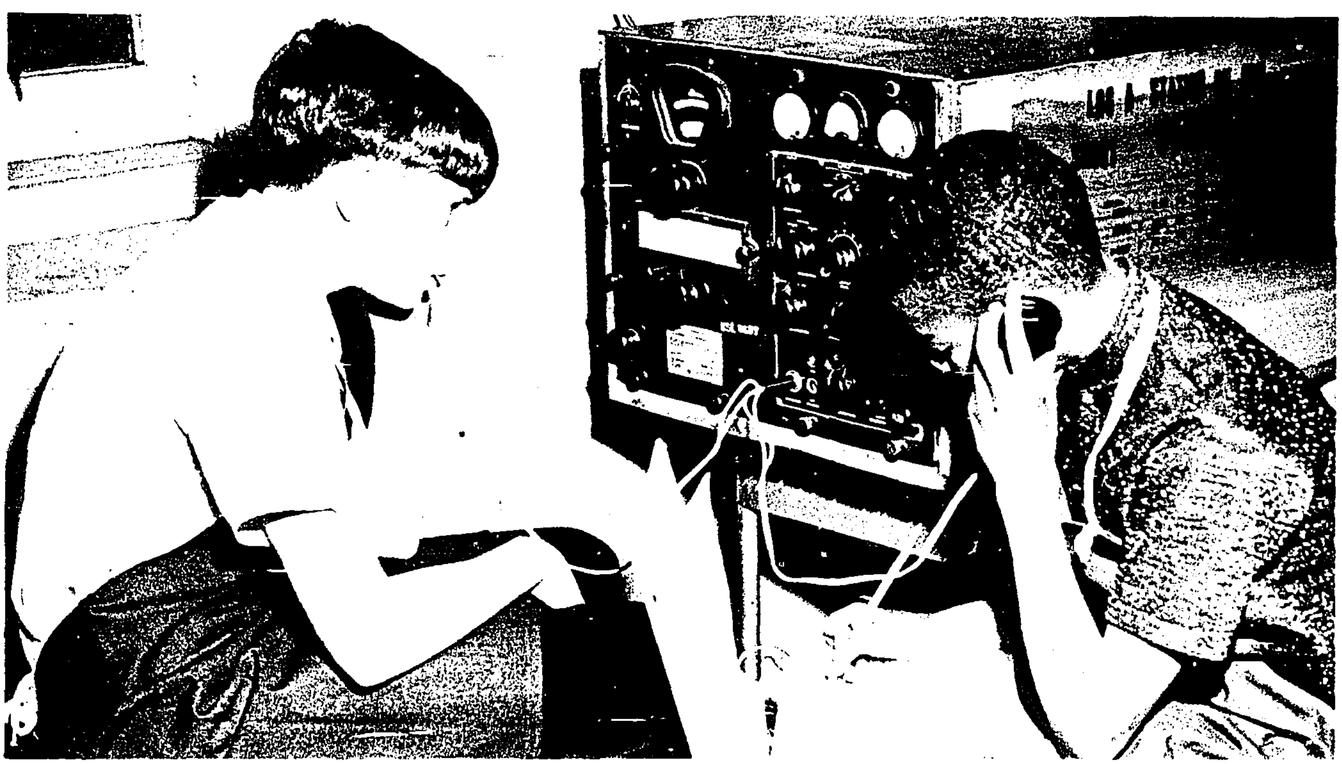
Students may build a crystal or transistor radio.

Assignment:

Prepare a report on the difference between amplitude modulation and frequency modulation.

References:

Buban and Schmitt, pp. 321-337.
Gerrish, pp. 231-254.
Miller and Culpepper, pp. 186-187.



Pupils take turns monitoring a shortwave receiver.

SAMPLE LESSON PLAN

Week: 14
Day: 1

Unit: Electronics

Topic: Amateur Radio

Aim: To give students an interest in and an understanding of amateur radio.

Apperception: Many students have heard of radio amateurs helping people hundreds of miles away during emergencies.

Motivation: Demonstrate receiving or transmitting amateur radio messages.

Preparation: Shortwave receiver (shortwave transmitter if teacher is a licensed operator and equipment is available,) key, code practice oscillator, code record and phonograph, log sheets, QSL cards.

Demonstration: Show class how to tune in and receive shortwave stations. See how many foreign or domestic stations can be identified by all classes in a week.

Demonstrate sending code on the key and oscillator.
Demonstrate receiving code on receiver.
Demonstrate proper logging of a station.

Points for Development:

Licensed amateur radio operators are called "hams."
The licensing of the amateur radio is controlled by the F.C.C.

"Ham" stations are the licensed amateur radio stations operated by "hams." The radio equipment consists of simple components for receiving and sending messages.

Amateur stations may be operated from any location, including boat or car, but may not be used for any business purpose. Amateur radio is for pleasure and emergency communications only.

Amateur radio operation is open to any citizen of the United States without regard to age if the person can pass the F.C.C. examination.

The types of amateur radio licenses are:

Novice

purpose: to give beginners an opportunity to gain a year of practical experience before taking the General License Examination

requirements: five words per minute code, simple test on radio theory and radio law
good for two years - not renewable - no fee

Technician

purpose: for persons interested in technical and experimental aspects of radio

requirements: five words per minute code, more difficult radio theory and law
good for five years - renewable - $4 fee

General

purpose: most commonly held license - most amateur privileges

requirements: thirteen words per minute in code, same radio theory and law as technician
good for five years - renewable - $4 fee

"The maximum penalty for violation of the rules and regulations of the Federal Communications Commission is a fine of not more than $10,000 or a jail term not exceeding two years, or both."

The purpose, rules, and regulations of Citizens Band Services are not the same as those of Amateur Radio Service.

A license is not needed to listen to shortwave broadcasts.

New Terms:

"ham"	hertz (Hz)	novice	general
QSL	megahertz (MHz)	technician	

Summary:

You must be licensed by the Federal Communications Commission as a novice, technician, or general class operator to be allowed to send radio signals on the amateur radio bands.

Application:

Knowledge of amateur radio is a good hobby and has led many people to employment in the electronics-communications field.

Student Activity:

Students may take fifteen minute turns trying to log as many different stations as possible. The keeping of an accurate logbook and the sending of QSL cards may be encouraged.

References:

American Radio Relay League. How to Become a Radio Amateur.
The Radio Amateur's Handbook.
The Radio Amateur's License Manual.

Berens and Berens. Building the Amateur Radio Station.
Getting Started in Amateur Radio.

TRANSISTORIZED CODE PRACTICE OSCILLATOR

This code practice oscillator enables students to practice the Morse code without disturbing others.

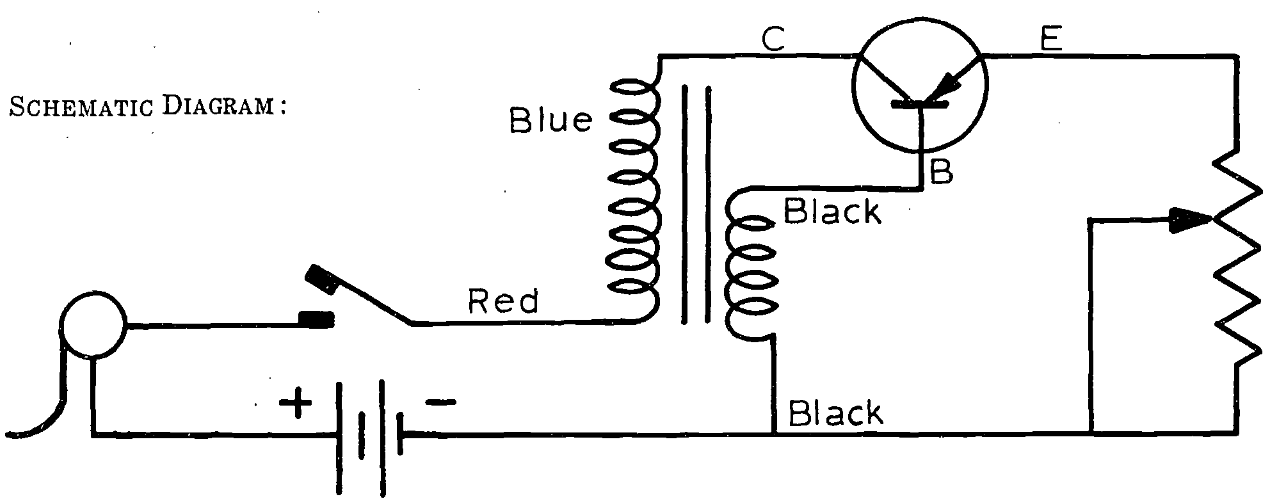
PARTS LIST:

PNP transistor (CK 722 or other PNP A.F. type)
U.T.C. SO-3 sub ouncer transformer
15,000 ohm potentiometer
3-volt battery
Code practice key
2,000 ohm earplug
Case (optional)

CK-722 CONNECTIONS

C—collector—adjacent to red dot
B—base—center lead
E—emitter—other lead

SCHEMATIC DIAGRAM:



EXTINCTION VOLTMETER

An extinction voltmeter is an inexpensive, reliable tool to measure voltage. Its operation is based upon the principle that a neon lamp will cease to glow when the voltage falls below a certain point. A variable resistor in the circuit permits continuous adjustment of the voltage drop to the point where the lamp is extinguished. The result is a fairly reliable voltmeter.

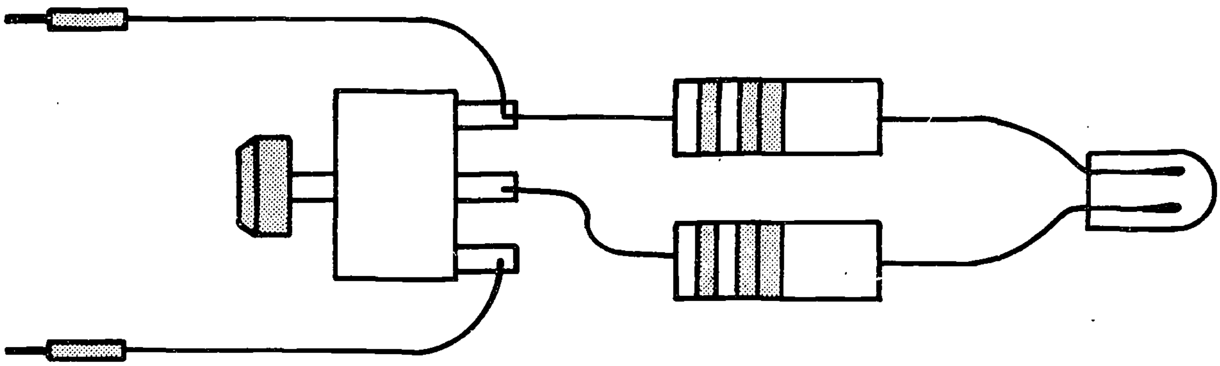
PARTS LIST:

1 250,000 ohm potentiometer
2 52,000 ohm carbon resistor
1 NE-2 glow lamp or equivalent
1 plastic case
2 stranded wire leads with probe tips

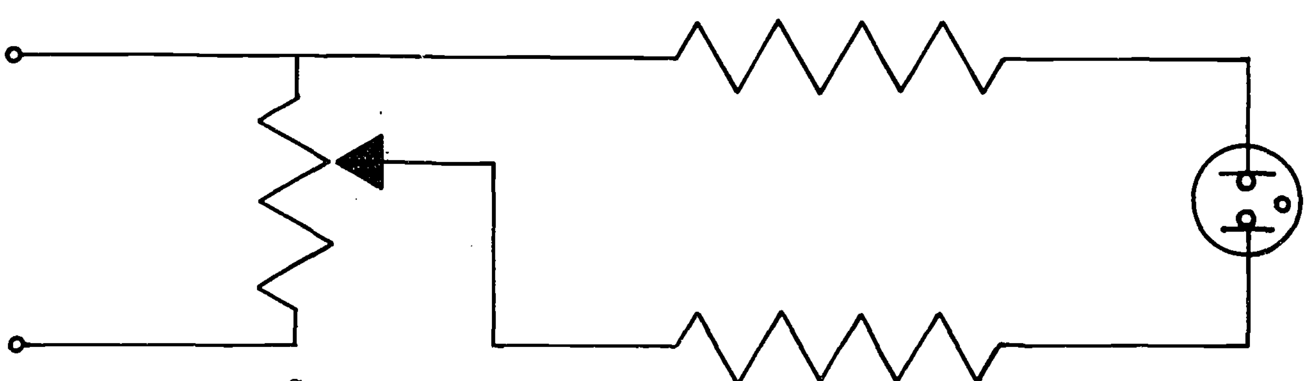
PROCEDURE:

1. Assemble and mount the various components in the case, as shown in the diagram.
2. Using a variable source of voltage, set the source at several different values.
3. Measure the value of the source with a reliable voltmeter.
4. Connect the extinction voltmeter and adjust it so that only the lamp goes out.
5. Mark the point on the scale with the voltage applied.
6. Repeat until the complete scale is developed.

Note: The neon lamp will allow you to distinguish between A.C. and D.C. in the circuit. Both plates of a neon lamp glow when A.C. is applied, while only one plate of the lamp will glow when D.C. is applied. Remember that it is possible to measure voltages.



PICTORIAL DIAGRAM:



SCHEMATIC DIAGRAM:

ELECTRIC SHAVER BOOSTER

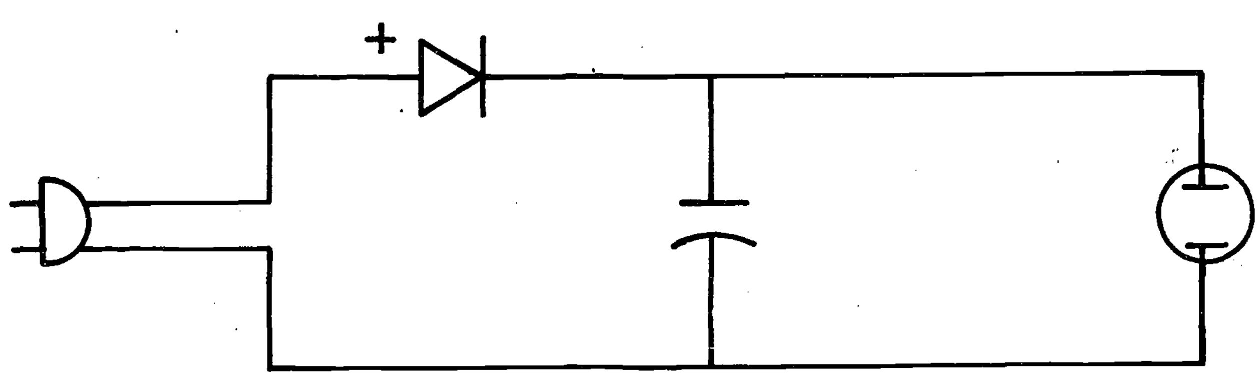
If your father's electric shaver lacks some of the speed it had when it was new, and if it has an A.C.—D.C. motor, this simple rectifier unit will convert alternating current to direct current and permit the razor to operate at a higher speed.

The rectifier allows the flow of electrons to go in one direction only, converting the A.C. to D.C. The capacitor smooths out the pulsations in the D.C. to make it as even as possible.

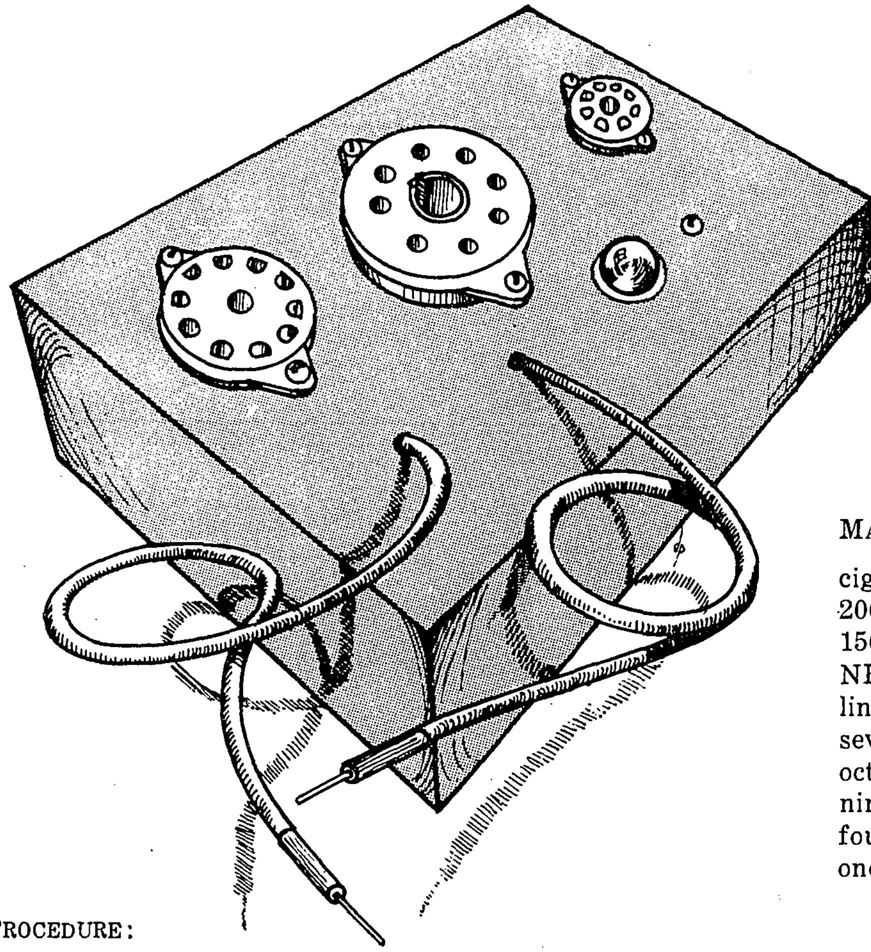
MATERIALS:

20 mfd. 150-volt capacitor
150 ma. selinium rectifier
amphenol type 6F receptacle
line cord and plug
appropriate case, at least as large as a cigarette box

SCHEMATIC DIAGRAM:



TUBE AND CONTINUITY TESTER



TOOLS:

pencil and ruler
hand drill
1/8" drill
3/8" drill
5/8" chassis punch
7/8" chassis punch
1 1/8" chassis punch
screwdriver
combination pliers
scissor
soldering iron

MATERIALS:

cigar box
200,000 ohm resistor
150,000 ohm resistor
NE-51 neon lamp
line cord with plug
seven-pin socket (miniature)
octal socket
nine-pin socket (miniature)
four lug terminal strip
one-half yard square of adhesive vinyl

PROCEDURE:

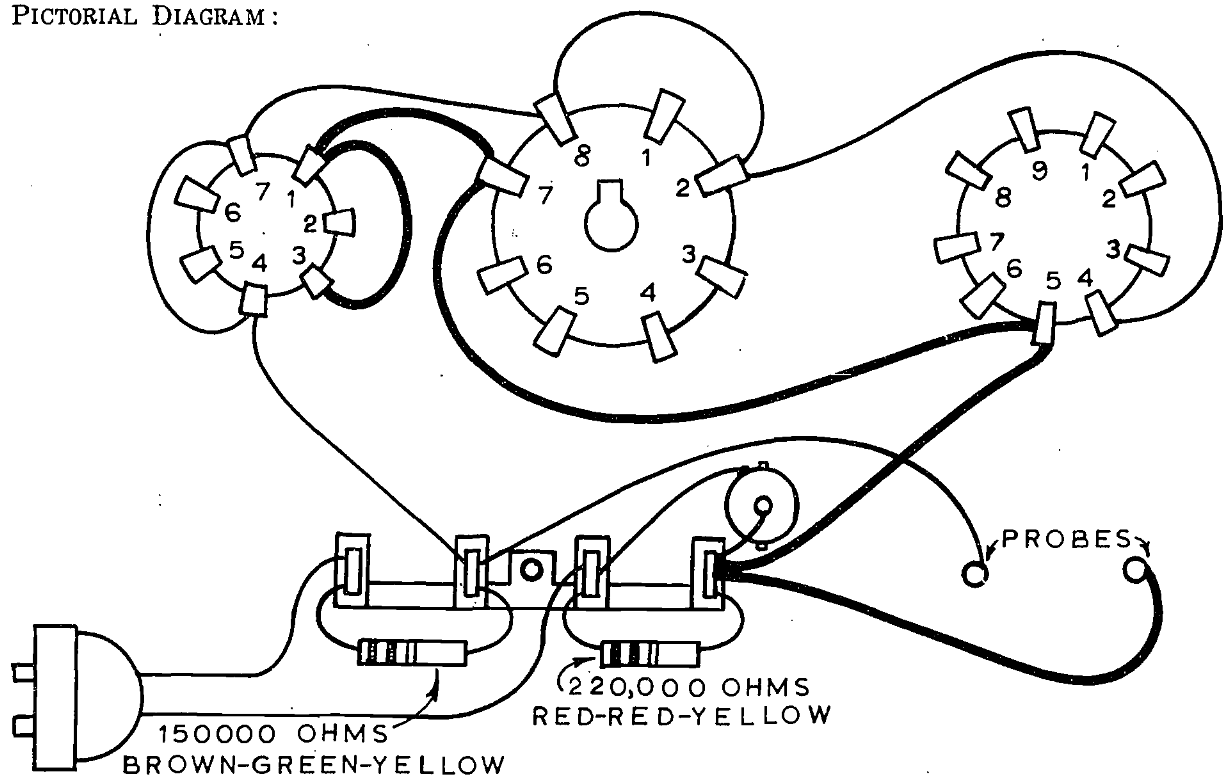
1. Obtain the proper materials from your instructor.
2. Lay out the holes on the bottom of the cigar box. Have instructor check them.
3. Drill large holes; then use chassis punches as indicated.
4. Cover the box with vinyl.
5. Open socket holes through vinyl and mount.
6. Mount the resistor on terminal strip and solder the line cord to the two center lugs. Mount the terminal strip in box.
7. Wire the project.
8. Have your instructor check the wiring.
9. Solder all joints, using rosin core solder.
10. Have the instructor check the project again.

OPERATING INSTRUCTIONS:

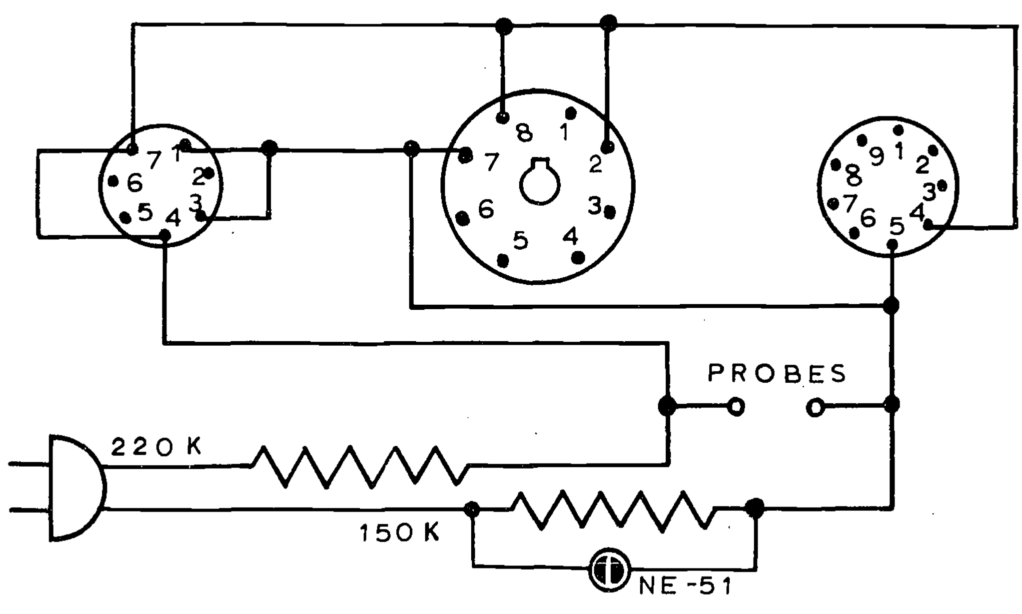
The tester will test the tube filament continuity of almost every popular tube except the 5U4. To test this tube, it is necessary to use the test probes on pins 2 and 8 of the tube base.

To test a tube, plug it into the tester. If the neon lamp lights, the tube filament continuity is complete. If it does not light, the tube is defective. To test for continuity in the 5U4 tube, coils, wires, appliances, fuses, lamps, etc. the two wire probes are used. Again, if the lamp lights, the circuit is complete. If the lamp does not light, the unit may be defective.

PICTORIAL DIAGRAM:



SCHEMATIC DIAGRAM:

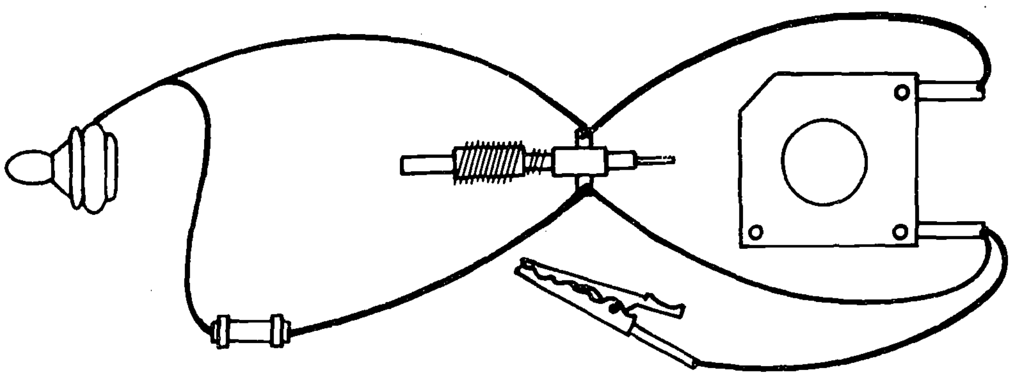


CRYSTAL RADIO

This radio is capable of offering as many as ten stations on the broadcast band. More than one station may be received at once because a crystal radio is not selective, which means that you cannot always tune in only the station you would like to listen to. This radio requires a good antenna, but a ground is not absolutely necessary. The antenna may be a long wire to the roof, the finger stop of a telephone, or even a bedspring, depending upon your location. You may decide to use all these parts, get a couple more, and construct a single-transistor personal radio.

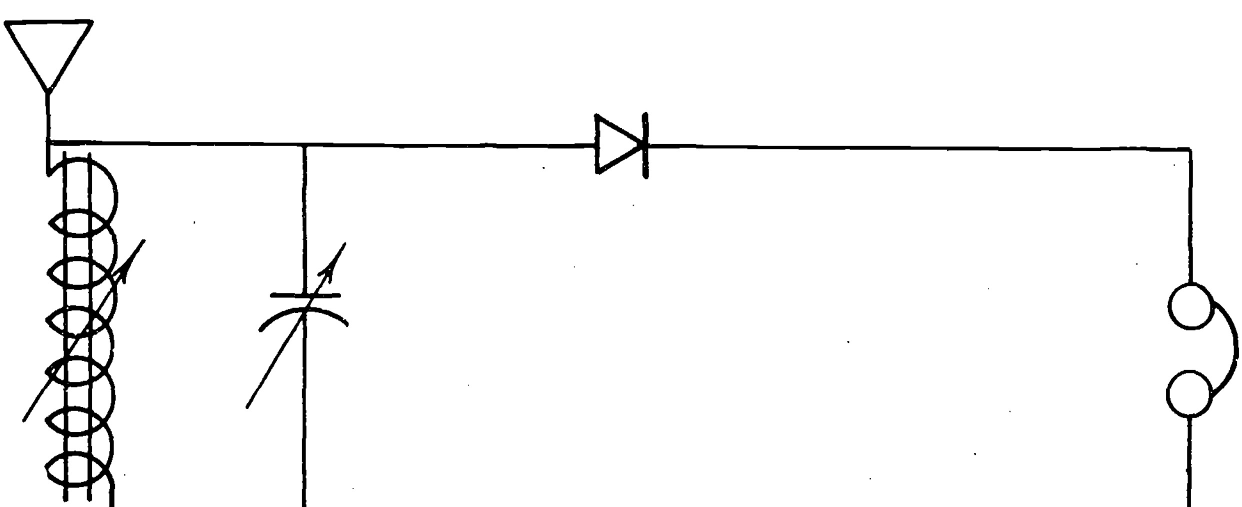
TOOLS:

center punch
hand drill
twist drills 1/4" and 1/8"
25 watt soldering iron
solder
needle-nose pliers
rattail file



PROCEDURE:

1. Obtain materials.
2. Lay out your holes on the plastic box.
3. Have the instructor check position of holes.
4. Lightly center-punch all holes.
5. Drill all holes.
6. Enlarge with a rattail file when necessary.
7. Put parts into place.
8. Connect wire leads according to diagrams.
9. Have the instructor check the wiring.
10. Solder all connections, using a 25-watt iron.
11. Test the radio on the master antenna in the presence of the teacher.



ONE-TRANSISTOR RADIO

Constructing a one-transistor radio is a possible project after the crystal radio. The one-transistor radio uses a circuit similar to that of the crystal radio, and the parts are the same except for the addition of the transistor and the battery. The one-transistor radio is more powerful than the crystal radio, but its use demands a very good antenna. With a good antenna a well-constructed, one-transistor radio can bring in more stations than a crystal radio. At least two transistors are needed for a portable set that does not require a very long wire antenna.

In this circuit the antenna converts the electromagnetic radio waves into a very weak electrical signal. The loopstick and the variable capacitor, acting together, allow only the desired signal to pass. The crystal detects the signal, the transistor and the battery amplify the signal, while the headphones convert the desired, detected, amplified signal into sound.

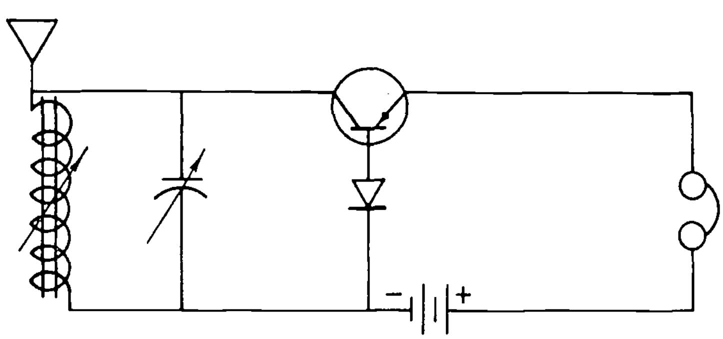
MATERIALS:

365 mmf. tuning capacitor
variable loopstick
silicon diode
2,000 ohm earplug
transistor, PNP, A.F.
2 penlight cells, No. 7, Z, or AA
alligator clip lead
plastic case, at least 3½" x 2" x 1"

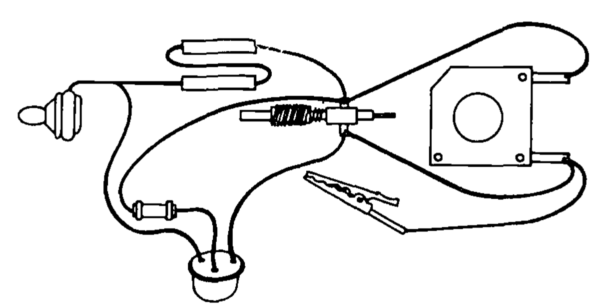
TOOLS:

center punch
hand drill
twist drills—¼" and ⅛"
soldering iron—25 watt
solder
needle-nose pliers
rattail pliers

SCHEMATIC DIAGRAM



PICTORIAL DIAGRAM



PROCEDURE:

1. Obtain materials.
2. Lay out your holes on the plastic box.
3. Have the instructor check the position of the holes.
4. Lightly center punch all holes.
5. Drill all holes.
6. Enlarge holes with a rattail file where necessary.
7. Put parts into place.
8. Connect wire leads according to the diagram.
9. Have the instructor check the wiring.
10. Solder all connections using a 25 watt iron. Use heat sink on transistor.
11. Test the radio on the master antenna in the presence of the instructor.

SAMPLE INFORMATION SHEET

Soldering

Rules for Soldering

Parts to be soldered must be clean physically and chemically.
Parts must be fitted together closely.
Parts must be held stationary during the soldering.
A sufficiently high temperature must be sustained.
A well-tinned copper is essential for successful soldering.

"Tinning" the Soldering Copper

Heat soldering copper by plugging it into a 120v electrical outlet.
Place on vise and file tip bright ¾" from the point.
Dip solder to the hot tip using sal-ammoniac block.
Wipe off excess solder with a heavy rag or steel wool until tip is clean and shiny.

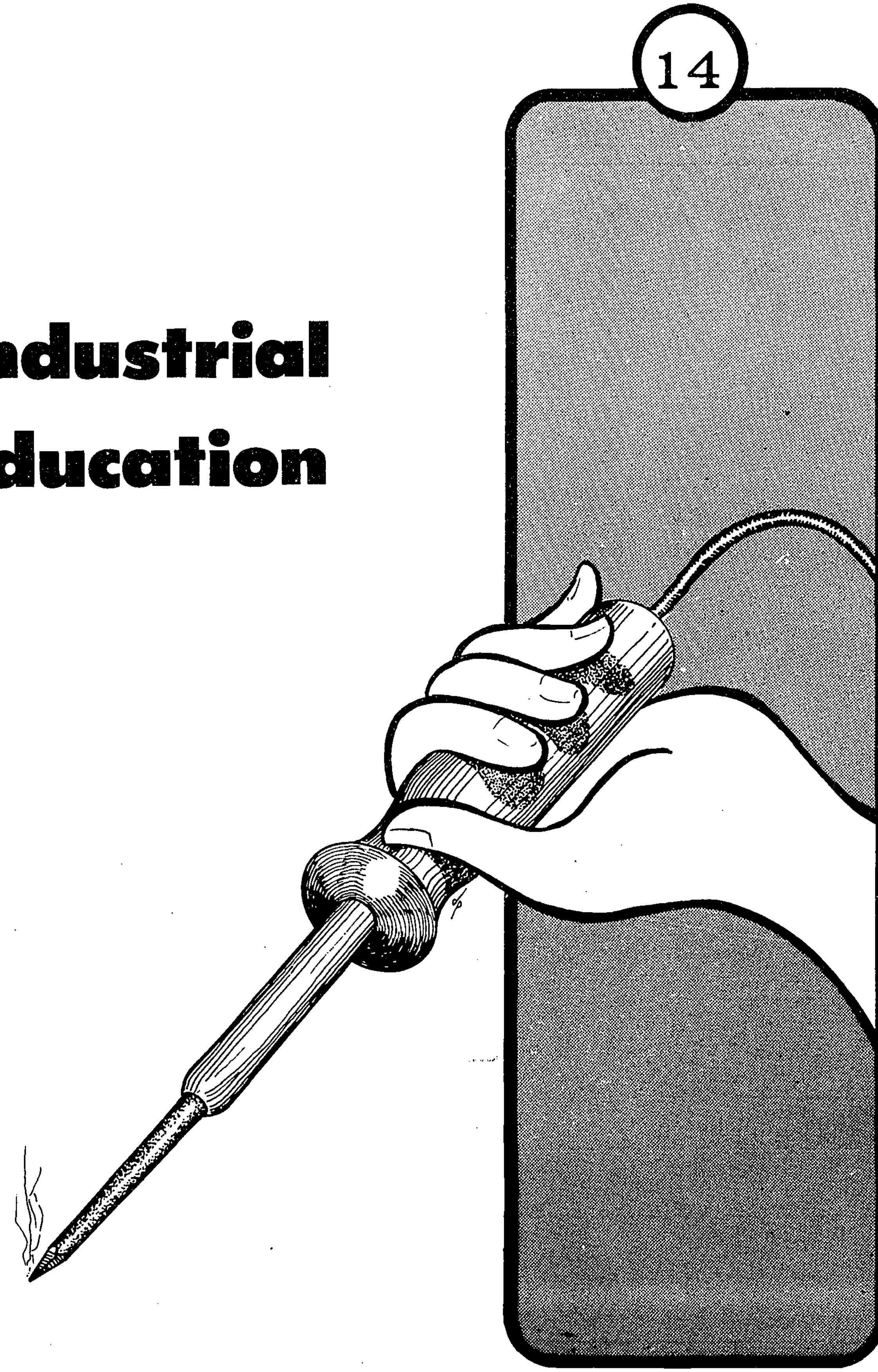
Safe Practices to Follow When Soldering

Always rest soldering copper on stand.
Always solder on a protective surface, such as asbestos or masonite.
Never hand anyone a soldering iron.
Never walk away from a hot iron and leave it unattended.
Protect yourself against the heat of soldering copper by wearing a shop apron.
Be careful of sharp wires, particularly when handling heavy gauge wire.
Wear goggles when there is a possibility of solder splattering.
Do not inhale fumes.
Wash hands immediately after soldering to prevent infection.

Questions and Review

What is meant by soldering?
What is solder?
How does an electrical soldering iron get its heat?
What proportions of tin and lead are used for electrical soldering?
What kind of flux do we use in electrical soldering?
How do we tin a soldering copper? Why?
What rules must be observed for soldering?
Give the safety rules that must be observed in handling a soldering copper.

Industrial Education



SAMPLE LESSON PLAN

Week: 14
Day: 2

Unit: Industrial Education

Topic: Automation

Aim: To help students understand the nature and problems of automation.

Apperception: Use the students' experience with automatic temperature control of refrigerators or heating systems.

Motivation: Write A __ T O M A T __ O N on the blackboard.
Question: What letters are missing from this word?
Answer: U (YOU) and I
Question: Why do many people consider automation a serious problem? What is automation?

Preparation: Motion picture projector and the film Automation available from the Bureau of Audio Visual Instruction.

Demonstration: After a preview present a short segment of the film to show students how an automated plant operates.

Points for Development:

The word automation means controlled operation of machines without human assistance.

The three things necessary for automatic control are:

a. a product
b. a machine to produce the product
c. a regulator to control the machine.

An example of automatic control is the home heating system.

a. The product is heat.
b. The machine is the furnace.
c. The regulator is the thermostat.

Automated machines produce the product and move it automatically to the next machine.

Automation is suited only to certain kinds of work. Machines cannot really think. They can do only what they are adjusted to do.

People will always be needed to design, build, and maintain automated machines. Many educated people are needed to work with automated equipment.

Automation can provide a higher standard of living for all.

Automation can create more jobs than it destroys.

Automation will require that each worker gets more education than his forebears.

Automation will require that many of us retrain for new jobs several times in our lives. Besides a greater degree of education, people will need a willingness to retrain to make the most of this new technological development.

Summary:

Automation means controlled operation of machines without human assistance.

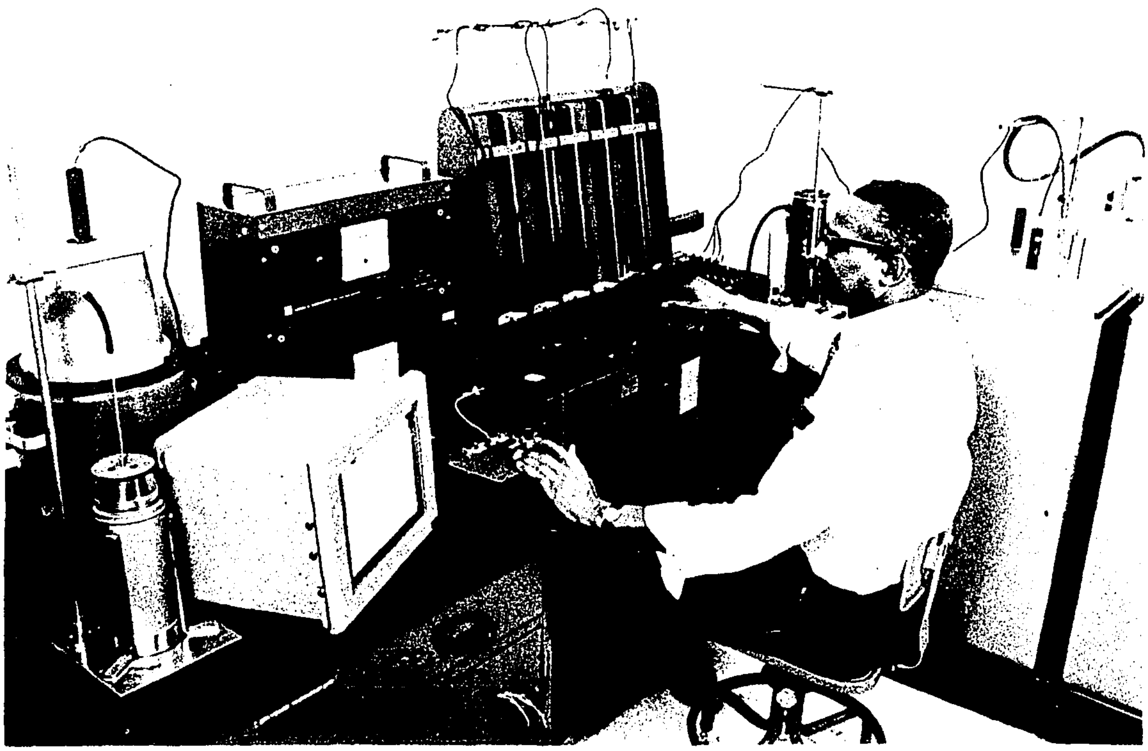
To gain the greatest benefits from automation we must get more education now and be prepared to go back to school to learn new things as we get older.

Application:

Students soon will work and will face the problems of automation.

References:

Buban and Schmitt, pp. 371-372.



Courtesy Leeds & Northrup Co.

A technician uses electronic equipment to check resistance thermometer calibration.

SAMPLE LESSON PLAN

Week: 15
Day: 1

Unit: Industrial Education

Topic: Educational and Vocational Guidance; Opportunities in the Electrical and Electronics Industries

Aim: To introduce students to electricity-electronics occupations and to indicate the training necessary for them.

Apperception: Many students are aware that there are excellent occupational opportunities in the electrical and electronics industries.

Motivation: Read "Help Wanted" section of a Sunday newspaper. Circle in red pencil each job connected with electricity or electronics.

Preparation: Occupational Outlook Charts, Occupational Outlook Handbook, Dictionary of Occupational Titles, "Help Wanted" sections of Sunday newspapers.

Note: Many teachers have found it a good practice to devote one bulletin board to occupational materials.

Points for Development:

An electrical engineer is concerned with the development, designing, planning, and supervision of production, operation, and maintenance of electrical equipment. At least five years of university training are needed to prepare for this job.

A technician works under an engineer and does the work that the engineer plans. To become a fully qualified technician, one should attend a technical institute or junior college that offers the technician course. Military training in this area is excellent.

The work of the electrician is a highly skilled and well-paid trade. A vocational course in high school, combined with five years of apprentice training (which includes night school), is frequently required.

Jobs in the electric light and power industry are concerned with the production, transmission, and distribution of electricity. A vocational training course in high school is recommended for these jobs.

Work as electrical household appliance servicemen includes repair and maintenance of air conditioners, refrigerators, washing machines, toasters, etc. Some companies will train men to service their product. A vocational training course is recommended.

The telephone industry employs thousands of men in the installation, maintenance, and repair of wiring and equipment. A vocational training course is suggested.

The communications industry employs thousands of people in radio and television broadcasting. There are thousands of additional jobs in the installation and servicing of radio and TV equipment. Vocational courses are available for this type of training.

The armed services need, train, and employ a large number of electrical and electronics workers. Military training schools are among the best in the world. Local recruiters have further information.

There is a growing need for teachers of industrial arts electricity-electronics. The requirement is a college degree in industrial arts education. This training is available at the City University of New York, New York University, and the State University of New York at Oswego.

<u>Summary:</u>

There are many well-paying jobs in the electricity-electronics area to suit the interests and abilities of many people.

<u>Student Activity:</u>

Prepare a shop or hall bulletin board on occupations in the electricity-electronics industries.

<u>Assignment:</u>

Prepare a report on an electricity-electronics occupation.

<u>References:</u>

Buban and Schmitt, pp. 38-388.
Gerbracht and Robinson, pp. 143-180.

SAMPLE LESSON PLAN

Week: 15
Day: 2

Unit: Industrial Education

Topic: Consumer Education: Purchasing an Electrical Appliance

Aim: To note some factors to be considered before purchasing an electric appliance.

Apperception: Students may have participated in the purchase of an electrical appliance with their family.

Motivation: How do you know that you are getting the best value for your money when you purchase an electrical appliance?

Preparation: Several similar devices of obviously different quality, The Consumer Report magazine, Annual Buying Guide, and similar publications.

Points for Development:

Units should be compared in terms of performance, overall quality, price, appearance.

Read the service contracts, warranties, and guarantees before making a choice.

Electrical appliances should carry Underwriters' Laboratories approval label, as well as the Underwriters' Laboratories cord.

A consumers' magazine should be consulted to compare one's findings with those of the experts before buying.

The price of the item you prefer should be investigated in several stores,if possible in different neighborhoods, for you to get the best value.

Summary:

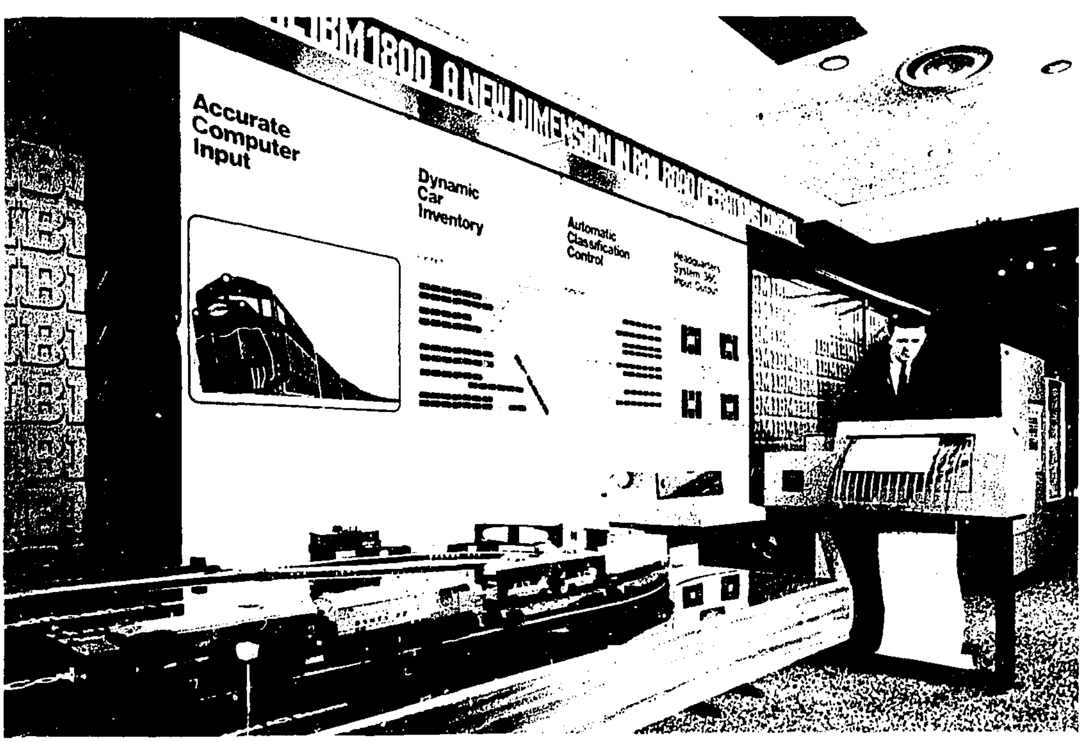
Investigate the item before you buy in terms of quality, performance, price, safety, service, and guarantee.

SAMPLE QUIZ D

Units 7 and 8 Week: 15 Day: 2

Identify each statement as true or false. If a statement is false, correct the underlined part of it.

1. The licensing of amateur radio is controlled by the F.B.I.
2. Amateur radio is open to any citizen of the U.S. without regard to age as long as he can pass the examination.
3. A license is not needed in order to listen to shortwave broadcasts.
4. A radio receiver can send code, voice, or music through the air.
5. Capacitors make the radio signal stronger.
6. The simplest test for a vacuum tube is the mutual conductance test.
7. Transistors are solid state devices made from a semiconductor material, such as germanium or silicon, with certain impurities added.
8. The word "automation" means automatic production, or machines that can control themselves.
9. The technician has five years of college training and designs various electrical and electronic devices.
10. A good guide to the quality of a radio is its case.



Courtesy International Business Machines Corp.

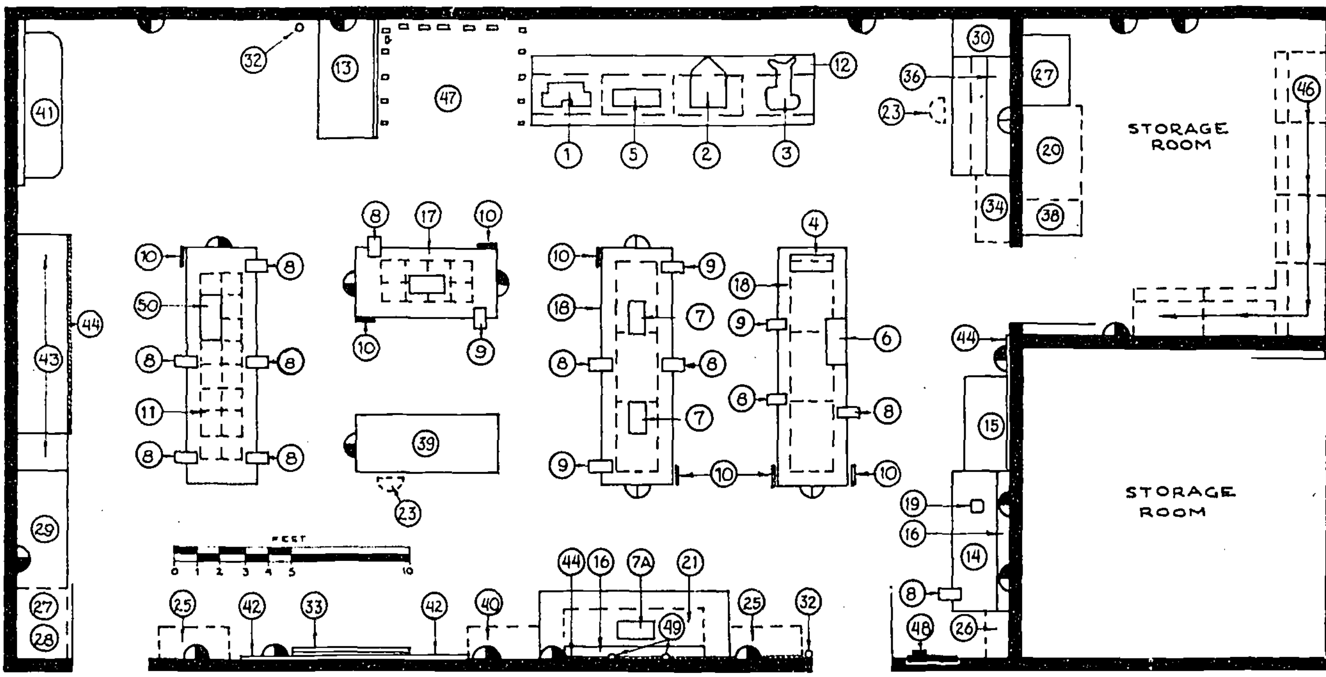
This model train is running in two places at the same time—on the rails and in an IBM computer.

An engineer inspects an early model of Telstar experimental communications satellite.

Courtesy A.T.&.T. Co.

Appendix

MASTER SPECIFICATIONS
JHS GENERAL ELECTRICITY SHOP



GENERAL ELECTRICITY SHOP

Ref. No.	Qty.	Description
1.	1	Grinder, 1725 r.p.m., bench-mounted
2.	1	Drill press, 15", bench-mounted
3.	1	Jigsaw, 24", bench-mounted
4.	1	Squaring shear, 24", bench-mounted
5.	1	Box and pan brake, 24", bench-mounted
6.	1	Bar folder, 20", bench-mounted
7.	3	Power packs, similar to Lab-Volt DF-392A, bench-mounted
7A.	1	Power pack, similar to Lab-Volt 205P/321, bench-mounted
8.	11	Vises, machinists, 3½", swivel, smooth jaws
9.	4	Vises, pipe, combination
10.	7	Vises, woodworking
11.	1	Bench, work, locker base, 36 x 120
12.	1	Bench, work, cabinet base, 36 x 144
13.	1	Bench, electric test, 30 x 60, similar to Brodhead-Garrett ET-5C
14.	1	Bench, soldering, cabinet base, asbestos top, 30 x 72
15.	1	Bench, finishing, 24 x 48
16.	2	Wiring tunnels, similar to Brodhead Garrett ET-100
17.	1	Bench, work, 36 x 72, locker under
18.	1	Bench, 36 x 120, cabinet under
19.	1	Furnace, similar to Johnson 118
20.	1	Metal storage rack, similar to Parent 4-30
21.	1	Bench, work, cabinet under 36 x 76
22.	1	Cart, portable, similar to Brodhead Garrett No. 251 (not shown)
23.	4	Chairs, 18"
24.	24	Stools, 18"
25.	2	Cabinets, display, with lighting, 16 x 36 x 84
26.	1	Cabinet, paint, 12 x 24 x 66
27.	3	Cabinets, storage, 24 x 36 x 78

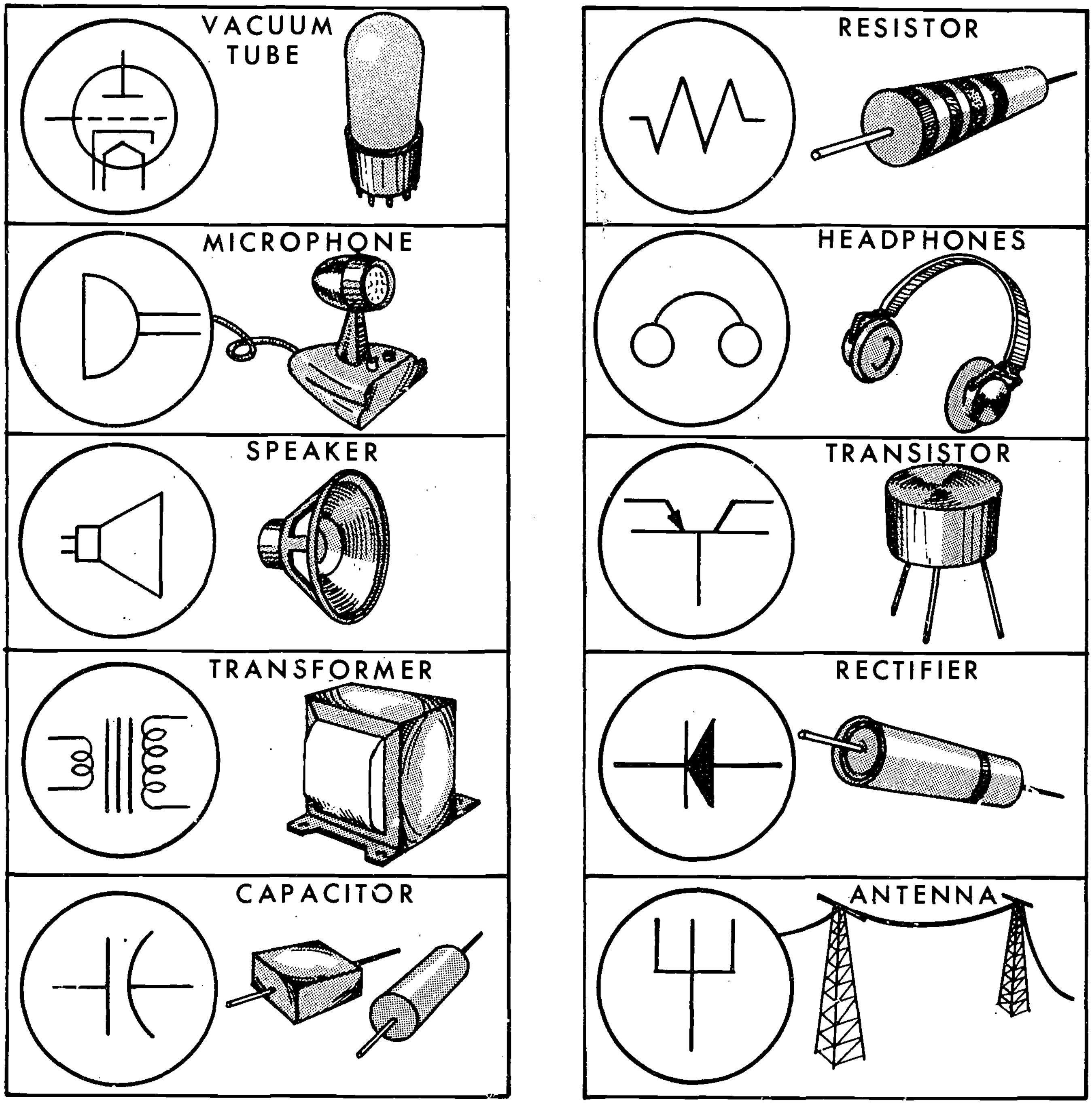
Ref. No.	Qty.	Description
28.	1	Drawing board insert for cabinet
29.	1	Cabinet, tool, similar to Brodhead Garrett TSE-13, complete with all tools and electronic equipment
30.	1	Cabinet, filing, 4 drawers, legal
31.	1	Waste disposal can (not shown)
32.	2	Fire extinguishers, dry-powder type (not shown)
33.	1	Projection screen
34.	1	Cabinet, drying, similar to Craftool 8011-BE
35.	1	Asbestos blanket (not shown)
36.	1	Planning center, similar to Brodhead Garrett PLCC
37.		Small tools, as per list (not shown)
38.	1	File cabinet, 2 drawers, legal
39.	1	Electrical demonstration desk, similar to Brodhead Garrett ET-631
40.	1	Cabinet, small parts, similar to Brodhead Garrett T34S
41.	1	Sink, 6′ long, 4 stations w/ bubbler and soap dispenser
42.	1	Chalkboard
43.		Students' wardrobe and teacher's locker
44.		Cork display boards
45.		Convenience outlets, panel board, four emergency-stop switches
46.		Storeroom shelving
47.		Wiring booth w/110-v. AC service box, 2 x 4 studs, 2 x 6 joists
48.		Electrical solenoid gas valve
49.		Antenna, TV, radio
50.	1	Bench-mounted punch press, similar to W. A. Whitney #91

When manufacturer and catalog numbers are specified, they indicate type and quality which meet pedagogical requirements. However, similar machines and items supplied by other manufacturers may also suffice.

FAMOUS MEN IN THE FIELD OF ELECTRICITY

Andre Ampere	1775-1836	Magnetism, electrodynamics	France
Edwin H. Armstrong	1890-1954	Superhetrodyne, FM	U.S.A.
John Baird	1888-1946	Inventor of television	England
Alexander Bell	1847-1922	Telephone	U.S.A.
Sir William Crookes	1832-1919	Cathode ray tube	England
Lee DeForest	1873-1961	Triode tube	U.S.A.
Thomas Edison	1847-1931	Incandescent lamp, phonograph	U.S.A.
Michael Faraday	1791-1867	Electric motor, generator	England
Philo Farnsworth	1906-	TV camera	U.S.A.
Benjamin Franklin	1706-1790	Electrical charges	U.S.A.
Luigi Galvani	1737-1798	"Animal Electricity"	Italy
William Gilbert	1540-1603	Magnetism	England
Joseph Henry	1797-1894	Electromagnetism	U.S.A.
Heinrich Hertz	1857-1894	Radio waves	Germany
Guglielmo Marconi	1874-1937	Wireless radio	Italy
James Maxwell	1831-1879	Electromagnetic theory	Scotland
Samuel Morse	1791-1872	Telegraph	U.S.A.
Hans Christian Oersted	1777-1851	Electromagnetism	Denmark
George Simon Ohm	1789-1854	"Ohm's Law"	Germany
Wilhelm Roentgen	1845-1923	Xray	Germany
Charles Steinmetz	1865-1923	Artificial lighting	Germany-U.S.A.
Nikola Tesla	1856-1943	"Tesla Coil," use of AC	Hungary-U.S.A.
Alessandro Volta	1745-1827	Battery—"Voltaic Pile"	Italy
Sir Robert W. Watt	1892-	Radar	England
Sir Charles Wheatstone	1802-1875	Telegraphy	England

ELECTRONIC SYMBOLS



Circle contains electronic symbol

COLOR CODE FOR FIXED RESISTORS

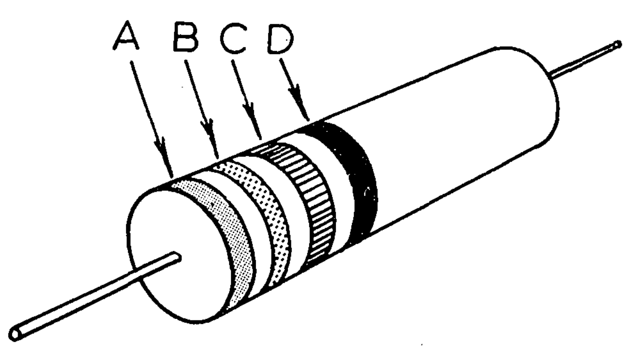
The OHM is the electrical unit for measuring resistance.

Color Band A	Digit	Color Band B	Digit	Color Band C	Multiplier
Black	0	Black	0		1
Brown	1	Brown	1	Brown	10
Red	2	Red	2	Red	100
Orange	3	Orange	3	Orange	1,000
Yellow	4	Yellow	4	Yellow	10,000
Green	5	Green	5	Green	100,000
Blue	6	Blue	6	Blue	1,000,000
Violet	7	Violet	7	Violet	10,000,000
Gray	8	Gray	8	Gray	.01
White	9	White	9	White	.1

Color Band D (Tolerance Code)

Gold	± 5%
Silver	±10%
No color	20%

Color Code for Fixed Resistor



INSTRUCTIONAL FILMS AND FILMSTRIPS

Listed here are several sources from which visual aids may be selected.

Board of Education, City of New York. *Instructional Films and Tapes*, Curriculum Bulletin No. 17, 1967-68 Series. New York: The Board, 1968.

Educational Media Council. *The Educational Media Index*. New York: McGraw-Hill, 1964.

Educators Guide to Free Films. Randolph, Wis.: Educators Progress Service.

U.S. Government Films: A Catalog of Motion Pictures and Filmstrips for Sale by the National Audiovisual Center. Washington, D.C.: National Audiovisual Center.

The sources below will be helpful in planning for visual aids. Although they are commercially produced and distributed, the films contain minimal advertising. Send for the catalogs.

Association Films, Inc., 347 Madison Avenue, New York, N.Y. 10017.

Coronet Films, Sales Dept., 65 E. Southwater Street, Chicago, Ill. 60601.

General Motors Corp., Public Relations Dept., Film Library, General Motors Building, Detroit, Mich. 48202.

International Film Bureau, Inc., 332 So. Michigan Avenue, Chicago, Ill. 60604.

Indiana University, Audiovisual Center, Bloomington, Ind. 47401.

Modern Talking Picture Service, 1212 Avenue of the Americas, New York, N.Y. 10003.

New York Telephone Company, Program Bureau, Public Relations Department

For Brooklyn, Queens, Richmond: 101 Willoughby Street, Brooklyn, N.Y. 11201.
(Phone: 396-5100, Ext. 2842)

For Manhattan, Bronx: 210 West 18th Street, New York, N.Y. 10011.
(Phone: 294-2917)

Universal Education and Visual Arts, 221 Park Avenue South, New York, N.Y. 10003.

Universal of Michigan, Audio-Visual Education Center, Ann Arbor, Mich. 48103.

Wayne State University, Audio-Visual Utilization Center, Detroit, Mich. 48202.

Western Electric, Public Relations Department, 195 Broadway, New York, N.Y. 10007.

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For the Teacher	Board of Education Book List Number
Buban, Peter, and Schmitt, Marshall L. *Understanding Electricity and Electronics.* New York: McGraw-Hill, 1962.	318-120
Gerbracht, Carl, and Robinson, Frank E. *Understanding America's Industries.* Bloomington, Ill.: McKnight & McKnight, 1962.	210-147
Gerrish, Howard H. *Electricity and Electronics.* Homewood, Ill.: Goodheart-Willcox, 1964.	318-487.3
———. *Electricity.* Homewood, Ill.: Goodheart-Willcox, 1964.	210-148
———. *Electronics.* Homewood, Ill.: Goodheart-Willcox, 1961.	210-148.1
Miller, Rex, and Culpepper, Fred W. *Energy, Electricity and Electronics.* Bloomington, Ill.: McKnight & McKnight, 1963.	325-432.49
Spielman, Harold S. *Electronics Source Book for Teachers.* New York: Hayden, 1965.	

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Arnold, Joseph P., and Schank, Kenneth L. *Exploratory Electricity.* Bloomington, Ill.: McKnight & McKnight, 1960.	
Epstein, Sam, and Epstein, Beryl. *First Book of Electricity.* New York: Franklin Watts, 1966.	276-659
Freeman, Ira. *All About Electricity.* New York: Random House, 1957.	276-116
Graf, Rudolf. *Safe and Simple Book of Electricity.* New York: Hayden, 1964.	272-997.49
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Notkin, Jerome, and Gulkin, Sidney. *How and Why Wonder Book of Electricity.* New York: Wonder Books, 1969.	
Pollack, Harvey. *Experimental Electronics for Young People.* New York: Hayden, 1962.	310-633.11
Scharf, Robert. *How and Why Wonder Book of Robots and Electronic Brains.* New York: Wonder Books, 1963.	
Steinberg, William, and Ford, Walter B. *Basic Electricity and Electronics.* Chicago: American Technical Society, 1964.	

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Johnson, Richard. *How to Build Electronic Equipment.* New York: Hayden, 1962.

Klein, Larry, and Gilmore, Ken. *It's Easy to Use Electronic Test Equipment.* New York: Hayden, 1962. 310-607.5

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———. *101 Ways to Use Your Signal Generator.* Indianapolis: Bobbs-Merrill, 1959. 310-610.2

———. *101 Ways to Use Your VTVM.* Indianapolis: Bobbs-Merrill, 1959. 310-610.3

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———. *Basic Electronics.* 5 vols. New York: Hayden, 1959. 310-539

———. *Basic Industrial Electricity.* 2 vols. New York: Hayden, 1959.

AMATEUR RADIO

American Radio Relay League. *Radio Amateur's Handbook.* Newington, Conn.: The League, 1969. (Revised annually.)

———. *How to Become a Radio Amateur.* 1968

———. *Radio Amateur's License Manual.* 1969

———. *Course in Radio Fundamentals.* 1960

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PUBLICATIONS OF THE NEW YORK CITY BOARD OF EDUCATION

School Shop Safety Manual. Curriculum Bulletin No. 13, 1964-65 Series.

Teacher's Guide to Industrial Arts Shop Management, Curriculum Bulletin No. 9, 1964-65 Series.

PERIODICALS

List numbers are from the *List of Magazines and Microfilms for Grades K-12* (Bureau of Supplies, Board of Education of the City of New York).

List Number	
93	*Consumer Reports* Consumers Union, Mt. Vernon, N.Y. 10550
	Electronic Hobbyist (Semiannual) Davis Publishing Co., 229 Park Ave. So., New York, N.Y. 10003
	Electronics Illustrated Fawcett Building, Greenwich, Conn. 06830
	Elementary Electronics Davis Publishing Co., 229 Park Ave. So., New York, N.Y. 10003
166	*Industrial Arts and Vocational Education* 400 N. Broadway, Milwaukee, Wis. 53201
190.5	*Journal of Industrial Arts Education* 1201 Sixteenth St., N.W., Washington, D.C. 20036
208	*Mechanix Illustrated* Fawcett Building, Greenwich, Conn. 06830
266	*Popular Electronics* 434 South Wabash Ave., Chicago, Ill. 60605
270	*Popular Science* Boulder, Colo. 80313
281	*QST* (Monthly amateur radio magazine) American Radio Relay League, Newington, Conn. 06111
305	*School Shop* (Available free to industrial arts teachers) 416 Longshore Drive, Ann Arbor, Mich. 48107
	Science and Electronics Davis Publishing Co., 229 Park Ave. So., New York, N.Y. 10003
309	*Science and Mechanics* Davis Publishing Co., 229 Park Ave. So., New York, N.Y. 10003

FREE WALL CHARTS

Monthly Progress Posters

General Electric Company
Production and Distribution Department
570 Lexington Ave.
New York, N.Y. 10022

Occupational Outlook Posters *(specific occupations and fields)*

Bureau of Labor Statistics
U.S. Labor Department
Washington, D.C. 20025

Parts of a Dry Cell

Clevite Corporation
Burgess Battery Division
Freeport, Ill. 61032

Wall Chart of IRE-EIA Electronic Schematic Symbols

EICO Electronic Instrument Company
131-01 39th Ave.
Flushing, N.Y. 11352

Equations Based on Ohm's Law

Sylvania Electric Products, Inc.
Emporium, Pa. 15834

Soldering
Electronic Schematic Symbols
Electronic Formulas
Color Code
5-Tube Radio

Graymark Enterprises, Inc.
P.O. Box 54343
Los Angeles, Cal. 90054

The Automotive Storage Battery and Electrical System
Parts and Assembly of a Lead Type Storage Battery

Exide Sales, Automotive Division
Box 6266
Cleveland, Ohio 44101

Standard Unit Symbols for Electronic Engineers

R.C.A. Electronic Components and Devices
415 So. Fifth St.
Harrison, N.J. 07029

CATALOGS

Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, N.Y. 11791

Allied Radio Corporation
110 N. Western Ave.
Chicago, Ill. 60680

Heath Company
Benton Harbor, Mich. 49022

Newark Electronics Corporation
223 West Madison St.
Chicago, Ill. 60606

Radio Shack Corporation
730 Commonwealth Ave.
Boston, Mass. 02117

Harrison Radio Corporation
225 Greenwich St.
New York, N.Y. 10017

Harvey Radio Corporation
103 West 43rd St.
New York, N.Y. 10036

Graymark Enterprises, Inc.
P.O. Box 54343
Los Angeles, Cal. 90054

EICO Electronic Instrument Company
131-01 39th Ave.
Flushing, N.Y. 11352

Brodhead Garrett Corporation
4560 E. 71 St.
Cleveland, Ohio 44105

Burstein Applebee Company
1012 McGee St.
Kansas City, Mo. 64106

Edmund Scientific Company
300 Edscorp Building
Barrington, N.J. 08001

Gem Electronics
57 Willoughby St.
Brooklyn, N.Y. 11201

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Consolidated Edison
4 Irving Place
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A 24-page booklet, suitable for grades seven through nine, telling why atomic energy is important to our industrial society, what the structure of the atom is, how heat is obtained from it, and what safety factors must be considered in the application of atomic energy to the generation of electricity.

How Man Put Electricity to Work

An illustrated leaflet describing the physics of electricity generation. Traces the history of electricity from amber to the atom. Suitable for grades seven through nine.

Nuclear Power at Consolidated Edison

An illustrated booklet describing the generation of electricity at the Indian Point Power Plants through the use of nuclear energy. Suitable for grades seven through nine.

PHOTOGRAPHS

Teachers may secure a set of photographs of men, equipment, and materials generating and transmitting electrical power in New York City.

TOURS (Call 460-6000 to arrange for either tour.)

Energy Control Center, 128 West End Ave., New York, N.Y. 10023.

The story, in film and displays, of how Consolidated Edison supplies electricity, gas, and steam to the city's millions. An hour program for sixth graders and older students. Limited to 35.

Indian Point Atomic Power Plant, Buchanan, N.Y.

The observation building overlooking the plant contains displays about atomic energy. A film is shown. Fifty students can be accommodated. Write for descriptive booklet. (Note: You will not see the interior of the plant.)

SPECIAL ASSIGNMENTS

Will provide pictures and information about Thomas Edison and his inventions and the beginning of the electric light business in New York.

For information on the following contact

Home Service Division
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BOOKLETS

Adequate Wiring
Study Guide for Students
Questionnaire and Wiring Diagram for Students
Meet Your Meters

FILM PRESENTATIONS

A Family Affair

A 30-minute presentation including a 25-minute educational, sound, and color film on adequate wiring. The film, a light domestic comedy, shows the difficulties encountered in the use of modern electrical appliances in an inadequately wired home.

The Eager Minds

A 30-minute sound and color film dealing with the past and future of electrical progress. The movie traces what has been done electrically since Edison introduced the incandescent lamp.

Careers in Engineering

A 30-minute program including a 15 minute sound and color film which outlines challenges in engineering with emphasis on four major areas: mechanical, electrical, chemical, and civil. It shows the kind of work engineers do in these areas, and the interrelationship that exists between the branches of engineering.

Your Date with Light

A 15-minute sound and color film to help teenagers plan a well-lighted and efficient study area.

FILM AND SLIDE

The Story of Modern Lighting

A 30-minute presentation and discussion of correct lighting for various situations in the home. It should enable students to recognize and correct such problems as dimness, glare, harmful shadows, or sharp brightness contrasts.

LECTURE DEMONSTATION

Electricity—Its Use in the Home

A 30-minute presentation of the correct handling of electrical equipment used in the home. A panel board is used to show the meter, load center panel, types of electrical appliances used in the home, the overloading of a home lighting circuit, and the correct way to change a fuse.

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Ten Men and the Telephone
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The Telephone in America
The Magic of Your Telephone
What It Means to Be a Research Scientist
The Transistor Age
The Story of the Bell Solar Battery
Satellite Communications Physics
Laser—The New Light

PICTURES AND DEMONSTRATIONS (Available for intermediate school assemblies)

How Your Telephone Works
The Laser
Space—Man's New Frontier

TOURS

Tours to telephone company buildings can be arranged for students at sixth grade levels and above. The students will see a telephone system at work. In most cases a location in the vicinity of the school can be visited. The tour is tailored to the grade level and the interests of students.

WALL CHART

How the Telephone Works (24" x 36")