AN IMPROVISED ELECTRICAL MULTI-CIRCUIT DEMONSTRATION GADGET: A TECHNICAL FEASIBILITY STUDY

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APPROVAL SHEET

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C. O. B.

DEDICATION

Lovingly dedicated to my wife,

NATIVIDAD, and our children,

CLEMENTE JR.,

NATHAN

SHERWIN and

CHERISH-JOY

ABSTRACT

This study attempted to devise an electrical multi-circuit demonstration gadget for lessons in electricity. Specifically, it aimed to answer the following questions: (1) What is an improvised electrical multi-circuit demonstration gadget? (2) What electrical circuit concepts can be demonstrated in this gadget? (3) What are the tools, supplies and materials needed in its construction? (4) How is this gadget constructed and operated? (5) What is the economic utility value of this gadget? This gadget is made up of an ordinary plywood 876cm x 89cm x 1.27cm for the board and a 76cm x 89cm x .39cm plywood for the back cover with the electrical component mounted on the board. The effectiveness of this gadget as a teaching device was originally tested before the members of the panel of examiners who selected at random the concepts demonstrated during the defense of this paper. The study had the following conclusions: (1) The gadget can be used to demonstrate twenty-four concepts in electric-circuit, (2) The gadget is efficient and effective in terms of teaching the students. Based on the findings and conclusions of this study, the researcher recommends the following: (a) further studies on improvisation of other teaching devices in industrial and electrical technology should be encouraged, (b) reproduction of this improvised electrical multi-circuit demonstration gadget immediately after its approval should be required of every instructor or teacher in electricity under the expense of the school with the electricity students providing the labor, and (c) the reproduction thereof should be considered as a group project of the electricity students.

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THE PROBLEM

Introduction

Electricity is one of the most difficult subjects and, therefore, needs sufficient instructional aids to concretize concepts. Fundamentals alone are not enough for workers in this field, they must also learn the application to present-day equipment. For this reason, lessons in electrical technology should not be presented by merely the chalk and blackboard method or illustration using charts, but with appropriate gadgets showing the actual methods of connecting to operation characteristics and industrial application of electrical machine controls and trouble-shooting.

Development in the field of electricity has considerably expanded and the changing demands of electrical work today, necessitate the use of gadgets in teaching electricity, to bring them in line with the current practice and modern equipment in electrical work. Casurao[1] states that education in the field of science in our country agree that the understanding and learning

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[1] Tydencio B. Casurao, "Development of Selected Apparatus in Mechanics", (unpublished seminar paper, Marikina Institute of Science and Technology, Marikina, Metro Manila, September, 1982), p. 1.

of concepts and principles in science can only be effective with the actual performance of experiments. By experimentation in science, for one thing, implies the use of apparatus and equipment to aid the teaching-learning process. He quoted further an opinion advanced by an American physicist who said that teachers should present dramatic demonstration of scientific principles and involve students deeply in them. They should dispense fewer facts and ask more questions to stir the intellect such that students will puzzle out the answer and remember them. Showmanship is an essential ingredient in teaching. Further, the importance of teaching device was reflected in the speech of Santos[2] during the opening program of the Instrumentation Workshop in Don Bosco Technical Institute, Mandaluyong, Metro Manila. To quote:

> We are now ready to construct fully improvised gadgets aimed at teaching shop courses and science with the help of your sympathetic attitude plus the effort as scientist and science lover, we will make teaching in the shop as modern, effective, as practical and functional as it ought to be for the young country like ours.

Considering the current economic difficulty and to alleviate the burden of using so many teaching devices during demonstration and practical application of

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[2]Angeles S. Santos, "Science Workshop," The Philippines Journal of Science Teacher, (Vol. 1, May 1980).

operation, improvised gadget will be a worthy alternative to original commercially produced gadget.

Basic concepts, principles and operations in electrical and industrial technology are best presented by means of demonstration, to provide opportunities for the students to experience for themselves the actual operations of electrical appliances and devices as electricity flows in the circuit. For every demonstration lesson, different teaching devices are assembled, new sets of materials are used which require lengthy preparation of instructional devices.

Among the problems that beset the instructor in carrying out the concepts of the lessons without using the gadget are: (1) high cost in the procurement of electrical supplies and materials, (2) production of teaching devices for every demonstration lesson entail so much time, (3) production of teaching devices for every demonstration lesson involves too much utilization of supplies and materials, (4) considerable delay in the connection of wire terminals and other electrical fixations, (5) maintenance of several sets of teaching devices seem laborious to the instructor.

To solve the above-mentioned problems, improvisation of gadget or gadgets is the most feasible undertaking an instructor in electrical technology and indus-

trial electricity can undertake in order to diminish the problems in the dissemination of the course content or even for practical application.

In consonance with this move, this study aims to demonstrate the effectiveness and efficiency of the improvised electrical multi-circuit demonstration gadget in simplifying and facilitating lessons on electrical circuits.

Theoretical Framework

Grab[3] expressed the importance of the relationship between the theory and the practical application of teaching concepts for skills training in electricity. He states that "theory is an important part of any electronics/electricity program, but theory without practical application does not serve the need of the electronics/electrical technician or serviceman". Concepts in electricity are enriched by practical application and factual information which may lead to a more effective performance.

Skills training for electrical occupations appears to be a simple task, but indeed quite complex. Technical skill training in particular, considers the element of teaching, (1) the teacher, making learning meaningful to

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[3]Bernard Grab, Electronic Circuit and Application, (New York: McGraw-Hill Book Company, 1982), p. ix.

the students, (2) subject matter, the essential factor of determining proper teaching strategies, (3) the student, as the central figure in skill training. These factors give us the idea of a teacher-student-subject matter relationship.

Based on principles, a teacher, in teaching concepts, should not depend merely upon reading to convey the meaning, but use materials to facilitate learning and make learning experience memorable. An example of these materials are gadgets, devices and the like, that when used intelligently can effect the most concrete learning on the part of the students.

Gadgets such as the electric multi-circuit demonstration gadget, are not only visual materials but also manipulative devices, constructed to facilitate effective learning of concepts, and their practical application. According to Haban, Finn and Dale, audio-visual materials when properly used in the teaching situation can accomplish the following: (1) they supply a concrete basis of conceptual thinking and hence reduce meaningless word-responses of students, (2) they have a high degree of interest for students, (3) they make learning more permanent, (4) they offer a reality of experience which stimulates self-activity on the part of the student, (5) they develop a continuity of thoughts, (6) they contri-

bute to other material and contribute to the efficiency depth, and variety of learning[4]. These materials indeed offer opportunity for improving learning.

Generally, the application of the concepts of electricity are practically found in all electrical occupations such as; factory work, service work, and technical field work. Factory work involves the production of electrical machines, and assembling of parts. Service trade is concerned with the installation, repair and adjustment of electrical machines, house wiring, motors, and maintenance devices. The technical field includes the highly specialized jobs and operations done by engineers and scientists.

These tasks are interesting and challenging, but they also involve certain hazards if the technician is careless in his work habits. It is therefore essential that student technicians should learn the principles of safety at the very start of his learning and practice these principles throughout their life. They should exercise good judgment and common sense and their life in the trade will be safe, interesting and rewarding.[5]

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[4]Edgar Dale, et. al., Audio-Visual Method in Teaching, (New York: Holt, Rinehart and Winston Inc., 1954), p. 65.

[5]Paul B. Zbar, Basic Electricity, A Test-lab Manual, (New York: Mc-Graw-Hill Book Co. Inc.,), p. xv.

Conceptual Framework

Input	Throughput	Output
The researcher	Identifying and listing the concepts	Technical Feasibility 1. easy to construct 2. easy to manipulate
24 Electrical Circuit Lessons	Construction of the demonstration gadget	3. minimizes expenses 4. saves time
Materials for the construction of the gadget	Testing the effectiveness of the gadget	5. facility of instruction 6. clarifies concept

Figure 1. This schematic diagram shows the concept of the study showing the input variable, the process involved and the expected outcomes of the study.

The diagram illustrates the three major frames representing the input-throughput approach to the desired outcomes of the study. The first frame representing the input shows the researcher, the 24 concepts of electric circuits, and the materials for the construction of the gadget. The second frame includes the throughput which consists of identifying and listing the concepts, the construction of the gadget, and the testing of its effectiveness. The last frame presents the output of the study in terms of technical feasibility of the gadget

and its value and usefulness to shop instruction i.e. ease of construction, economy of time, money and effort, facility of teaching and concreteness of learning.

Statement of the Problem

This study attempted to devise an electrical multi-circuit demonstration gadget for lessons in electricity. Specifically, the study aimed to answer the following questions:

1. What is an improvised electrical multi-circuit demonstration gadget?
2. What electrical circuit concepts can be demonstrated in this gadget?
3. What are the tools, supplies and materials needed in its construction?
4. How is this gadget constructed and operated?
5. What is the economic utility value of this gadget?

Assumptions

The study aimed to justify the following assumptions:

1. The gadget will lessen expenses in the preparation of teaching-learning devices for classroom demonstration in industrial electricity and electrical technology.

2. The gadget will awaken students interest in electricity, facilitate learning electrical circuit concepts and principles.

3. The students taught using the gadget as a device will learn more effectively the lessons on basic circuits and its application, trouble-shooting and safety precautions.

Significance of the Study

This study hopes to enlighten the teachers and instructors in electricity on the practicality of the use of the improvised electrical multi-circuit demonstration gadget in teaching 24 lessons on the following concepts: (1) single electric lamp circuit, single wire; (2) one bulb controlled by a single tumbler switch, single wire; (3) series circuit, single wire; (4) three bulbs in series controlled by a single tumbler switch, single wire; (5) parallel circuit, single wire; (6) three bulbs in parallel with individual control of single tumbler switch, single wire; (7) three bulbs in parallel with single-pole switch; (8) one bulb controlled by two 3-way switches, single wire; (9) one or more bulbs controlled by two 3-way and one 4-way switches, single wire; (10) open circuit, single wire; (11) closed circuit, single wire; (12) short circuit, (13) multi-grounded circuit, duplex

wire; (14) line to line circuit, single wire; (15) single electric lamp circuit, duplex wire; (16) one bulb controlled by a single tumbler switch, duplex wire; (16) series circuit, duplex wire; (18) three bulbs in series controlled by single tumbler switch, duplex wire; (19) parallel circuit, duplex wire; (20) three bulbs in parallel with individual control of single tumbler switch, duplex wire; (21) one bulb controlled by two 3-way switches, duplex wire; (22) one or more bulbs controlled by two 3-way and 4-way switches, duplex wire; (23) how to locate a blown fuse in a line to line circuit; (24) how to test a blown fuse in a multi-grounded circuit. In making electrical connections, safety precautions must always be observed and practised. Furthermore, students must be well acquainted with the presence of electric current; that when electric current is taken for granted it produces dangerous results. Therefore, safety precautions are also demonstrated in the use of this gadget.

Hopefully, this study will help the teacher or the instructor in Industrial Electricity and Electrical Technology courses simplify and facilitate demonstration lesson on electrical circuits.

This may serve as an immediate response to both the instructor's and the student's needs for an efficient and functional teaching device in the teaching-learning

process, specifically on concepts and principles in electric circuits. This will help the student visualize the various applications of electric circuit.

This gadget may pave the way to a much improved interaction between instructor and students in the shop or classroom.

Ultimately, this may result in the economy of time, effort and materials used in the teaching-learning process.

The production of this gadget is within the physical and financial capability of the school, instructor and students. Materials are available in local market. This gadget can be constructed by the students in industrial electricity and electrical technology students as projects and will automatically serve as a teaching aid in electrical circuit lessons when they themselves become teachers in electricity.

Scope and Delimitation of the Study

The study is focused on the improvisation of an electrical multi-circuit gadget. It includes the following: construction, specification of materials used, operation manual and the cost of production of the improvised demonstration gadget. The gadget will use local and discarded materials, such as pieces of dry wood as

insulators of plugs of cord wire for wiring connections.

The gadget will be used only as a device for demonstration of twenty-four lessons on the basic physical concepts and of electric circuits theory to make application meaningful.

This study is limited to the demonstration of concepts on electric lights, convenience outlets, including trouble-shooting and safety precautions on these concepts.

Due to the rapid changes in science and technology today, the gadget can be used effectively to demonstrate these twenty-four lessons at least for five years, of course not totally discarding the gadget, but only improving it further to keep pace with the changes, and complexity of the application of electric circuits.

Definition of Terms

Appliance. Current-consuming equipment, fixed or portable, such as; heating and cooking device, cooling device, and other operating equipment[6]. This includes incandescent and fluorescent lamps for lighting devices. Appliances have their own operating life, such as incandescent lamp which has an average life of 1000 hours

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[6]Arthur L. Abbott and C. L. Smith, National Electrical Code Handbook, (New York: McGraw-Hill Book Company, Inc., 1965), p. 5.

and fluorescent lamp with an average life of 7500 hours[7].

Banana jack. This is a piece of round metal at the end of an extension cord used to transmit current by inserting it to its corresponding input jack.

Circuit. The path for current to flow from its source.[8]

Closed-circuit. A circuit whose path carries completely around a course or through a cycle without break or continuity.[9]

Cord wire. A kind of electric wire made of several strands of fine conductors. It is manufacturer in single or duplex pliable wire.

Discarded materials. These are materials which are of the least value or of no value at all and are found among the garbage in dumping places.

Duplex wire. A wire made-up of two conductors separated by their insulation.

Electrical circuit. A circuit in line with electricity.

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[7] Ibid.

[8] Edgar C. Perry and H. V. Schafebook, Fundamental Jobs in Electricity, (New York: McGraw-Hill Book Co. Inc., 1952), p. 279.

[9] Merriam Webster, Webster's Third New International Dictionary, (Massachusetts: G & C Merriam C.), p. 424.

Equipment. A general term including materials, fitting, devices, appliances, fixtures, apparatus, and the like, used as a part of or in connection with an electrical installation.[10]

Four-way switch. A device used to control lights from more than two points or more places, in which case must be two connected between three-way switches. Four-way switches have four terminals and two blades.[11]

Gadget. A slang word applied to any small handy appliance or device.[12]

Grounded circuit. In electric circuit grounding simply means connecting a wire or piece of equipment to the earth, usually by connecting it to the water pipe or, in the absence of such pipe, to an "artificial ground" as the code used to call it, or a "made electrode" as the present code calls it. Grounds are made to promote safety both from shock and fire hazards.[13]

Improvise. To make or modify whatever is at hand usually for the purpose of reducing the cost.

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[10]Abbott, op. cit., p. 9.

[11]Frederic S. Crispin, Dictionary of Technical Term, (Milwaukee: The Bruce Publishing Company, 1952), p. 170.

[12]Ibid., p. 176.

[13]H. P. Rickter, Practical Electric Wiring, (New York: McGraw-Hill Book Company, Inc., 1960), p. 126.

Insulator. A material used in electrical job or installation to prevent the flow of electricity.

Local material. These are materials found in the locality and maybe secured for free or can be bought at a very low cost.

Material. The basic matter (as metal, wood, plastic, fiber) from which the whole or the greater part of something physical (as a machine, tool, building, fabric) is made.[14]

Multi-grounded circuit. A circuit in a grounded electrical system which requires at least two branch circuit per dwelling. It requires a minimum of two appliance outlets that shall be install in each home separated from the lighting circuit.[15]

Open circuit. A break in one of the conductors.[16]

Parallel circuit. A multiple circuit. A connection where the current is divided and part flows through its device connected to it.[17]

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[14] Merriam-Webster.

[15] National Electrification Administration (NEA) Wiring Standard for member owned wiring installation, Samelco II (See Appendix A).

[16] Perry and Schafebook, op. cit., p. 281.

[17] Wyne L. McDougal, R.R. Ranson and C.H. Dunlap, Fundamentals of Electricity, (Chicago: American Technical Society, 1953), p. 380.

Problem. Problem is any significant, perflexing and challenging situation, real or artificial, the solution of which requires reflective thinking. It is perflexing situation after it had been translated into a question or a series of question that help to determine the subsequent inquiry. In mathematics, it is a question whose answer requires reasoning from given element to unknown according to some set of definitions axiom and rules.[18]

Safety switch. A knife-blade switch enclosed in an iron box and operated externally.[19]

Series circuit. A circuit in which the same current flows through all the devices.[20]

Short circuit. The circuit that results when "live" wires make a metal-to-metal contact with each other.[21]

Supplies. Items or quality (as provision, clothing, arms, or raw material) available for use, exploitation, or development or especially set aside to

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[18] Carter V. Good, Dictionary of Education, (New York: McGraw-Hill Book Company, Inc., 1959), p. 414.

[19] Crispin, op. cit., p. 341.

[20] McDougal, et. al., op. cit., p. 380.

[21] Perry and Schafebook, op. cit., p. 282.

be dispensed at need.[22]

Technician. A technician is a worker on a level between the skilled trade worker and the professional engineer, he may design the mechanism, compute the cost, write the specification, organize the procedure, and test the finished products.[23]

Three-way switch. A device used when control is desired in two locations. This is usually used to control a bulb at the stairway of a two-storey house.

Trade skill. Trade skill is the ability to perform the manipulative operation connection with the given trade.[24]

Trouble-shooting. This term refers to investigating faults or defects in the wiring system.

Tumbler switch. Similar to a snap switch, it is a switch that makes or breaks a circuit by spring action.

Volt. The unit of electromotive force, being that force which will cause a current of one ampere to flow through a conductor whose resistance is one ohm.[25]

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[22]Good, op. cit., p. 554.

[23]Ibid., p. 593.

[24]Ibid., p. 537.

[25]David B. Curalnik, Webster's New World Dictionary, (Cleveland: The World Publishing Company, 1963), Modern Desk Edition, p. 529.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter includes relevant information on different types of wiring installation, improvisation of machine and science apparatus, and gadget invention.

LITERATURE

The book of Perry and Schafebook[26] illustrates some of the wiring installations which are as follows: (1) light controlled by a single-pole switch (wiremould installation). This method of wiring is often used to extend circuit after the building has been wired. It is also used in places where wiring cannot be concealed, (2) ceiling light controlled by a single-pole wall flush switch (concealed wiring: knob and tube work). This type of installation is used mostly in old houses. The wires are insulated with porcelain tubes passing through a joist and are fastened with porcelain split-knobs wherever access is possible. This is the simple type of electrical circuit. With the switch closed, the current flows from the lamp returns to the source of supply through the white wire, (3) series lighting (christmas

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[26] Perry, op. cit., 203.

tree, etc.). Series lighting circuit are used mostly for christmas-tree lighting outfits and in places where it is desired to use low-voltage bulbs on higher voltages. In a series circuit the lamp or other electrical devices are connected one after another on a single wire thus the voltage or pressure must pass through each part separately. With eight 15-volt bulbs, the bulbs connected in series can be used on a 120-volts circuit (8 x 15 = 120 volts). Another is that two 115-volt bulbs connected in series can be used on a 220-volt circuit, (4) single-pole switch installation (open wiring). This is the simple and most common type of circuit. It is used mostly in house wiring circuits and places where it is permissible to break just one side of the wires. The single-pole switch has two contacts, thereby closing the circuit and allowing current to flow to the lamp.

Crowford[27] also illustrated in his book another system of wiring installation: (1) Parallel circuit. This circuit is very common in house wiring. All the various lamps, the electric flat iron, the toaster, etcetera, in the average house, are really in parallel connection, on the main line. Parallel circuits have

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[27] John E. Crowford, Practical Electricity, (Milwaukee: The Bruce Publishing Company, 1951), pp. 20-21.

more than one possible current path. These various paths are commonly called branch part of the circuit. Each branch connects across the main line. In any house-lighting circuit, the main line deliver the same voltage to all floor and ceiling sockets, lamp plugs, and any other connections, (2) Open circuit. When a wire or a line breaks or burns out, the fault is called an open circuit. A new metallic connection must be made to repair the fault, (3) Short circuit. When some other parts are forces by current, other than the path properly provided, the circuit is said to be shorted. Short circuit causes the fuse to blow-out, fuse can be tested by means of a test lamp.

Furthermore, Schuller[28] illustrated two major wiring installation: (1) Two lights controlled from the two points by two three-way surface rotary switches. This system is generally used to control hall or stair-way lights from either of two floors, in a residence and garage, or to control lights in long passageways, such as are found in stores, warehouse, etcetera. The lights may be turned on or off by operating the switch at any time regardless of what position the other switch is in.

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[28]Albert A. Schuller, Electric Wiring, (New York: McGraw-Hill Book Company, Inc., 1943), pp. 174-179.

One side of the supply line is connected to the terminal of each receptacle, (2) Three lights controlled from three points by two three-way and one four-way surface rotary switch. In this system the three-way switch are placed at the ends of the control circuit, and the four-way switch is placed at any intermediate point. The wires are connected to the three-way switch in a manner similar to that used in controlling lights from two locations. The traveller wires, however, do not go directly from one three-way switch to another, for the four-way switch must be connected to them. Each pair of the traveller wires is brought into the opposite terminals of the four-way switch. The lights can be controlled at any of the three switches.

Harris[29] points out that the purpose of the laboratory work is to provide the opportunity for learning through participation and observation.

All these actual performance in shop classes, can be achieved by both Industrial Electricity and Electrical Technology students if the school has adequate facilities for class demonstration. But it is unfortunate to note, that most of the shop classes in vocational schools in the Philippines, especially in the rural areas, lack the

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[29]Norman C. Harris, Experiments in Physics, (New York: McGraw-Hill, Technical Education Series, 1963), p. 3.

necessary supplies and materials to satisfy the needs of the students who are in quest for knowledge about the diversity of electrical circuits and their application.

Simpson, as cited by Casurao[30] observed that apparatus need not be highly sophisticated in order to illustrate the concept of science. Simple locally-made apparatus enables the students to understand the basic principles more easily and make them aware that scientific principle applied to everyday things are not associated with special apparatus.

STUDIES

Many vocational schools throughout the country have been accused of failure to produce vocational competence among their graduates, because they are not fully equipped with training facilities necessary for job efficiency. The teachers also lack the resourcefulness in improvising gadgets that may substitute the commercial and expensive equipment[31].

Germones points out that some equipment may be improvised out of available materials from the locality.

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[30] Casurao, op. cit., p. 9.

[31] Dominador Q. Cabanganan, "Vocational-Technical Education: Focus on the In-Plant Training Program", (unpublished doctoral dissertation, Leyte State College, Tacloban City, March, 1982), pp. 304.

Improvised equipment may be less efficient than those commercially produced but in time of scarcity of resources, the important thing to remember is that an improvised equipment should serve in the development of the necessary skills.[32]

There are some gadgets used not only in the educational system for demonstration but also in some aspects of technology needed by some populace for their safety and security. Colmenares[33] published an article about a Filipino inventor who assembled an electronic safety and security device. It is Erano Evangelista's gadget that can tell the presence of an approaching car, and warn of carnapers. Attached at the board located on top of the backseat is a robot-like device which when activated, turns around and warns the driver of an approaching vehicle as far away as 500 meters by flashing its red light. The device is turned on when a light from an approaching vehicle beams on it. When a suspected carnaper forces open any of the three doors other than

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[32]Ireneo L. Germones, "An Improvised Wood Lathe Machine: A Technical Feasibility Study," (unpublished master's seminar paper, Marikina Institute of Science and Technology, Marikina, Metro Manila, March 1981), p. 2.

[33]Pinky Colmenares and M. Rodriguez, "Knight Rider, Filipino Style," Bulletin Today, February 24, 1984, p. 21.

the one beside the driver, an alarm is immediately sounded. If the burglar succeed in opening the door beside the driver's seat, the alarm is activated within slight seconds and of the same instant the car's engine comes to a halt. The same procedure is repeated even if the car is taken forcibly from a driver. The driver merely pushes a secret button and the car, now driven by the carnaper, will move for about two minutes. Afterwards, the engine goes dead again and the alarm is activated.

Relationship with the Present Study

The different wiring illustrations of Perry and Schafebook, Crowford, Schuller are very much closely related to the present study the fact that these are similar wiring connections and the concepts can be demonstrated by the gadget. The studies of Harris, Casurao, Germones, Cabanganan, and the articles of Colmenares and Rodriguez give the importance of improvised teaching devices and machines needed in our educational system. These related literatures and related studies lead to the improvisation of this electrical multi-circuit demonstration gadget.

Chapter 3

MATERIALS AND METHODOLOGY

Description of the Gadget

This gadget is made up of an ordinary plywood 76 cm. x 89 cm. x 1.27 cm. for the board and a 76 cm. x 89 cm. x .39 cm. plywood for back cover with 2.54 cm. x 5.08 cm. lumber for the frame. The sockets, safety switch (30 amperes), the tumbler switches, the 10.16 x 10.16 cm. junction boxes and convenience outlets are mounted on the board. For the wiring connection, instead of connecting the electric wire direct to the binding screws of the sockets and other fixtures an improvised input jack is permanently mounted on the board and connected to the binding screw where the corresponding improvised banana jack is connected to the cord wire and prepared for the wiring connection that will just be plugged-in after an electrical connection is made.

The wires that are used for the wiring connection is a cord, #16, and colored black and white. To demonstrate wiring using a single wire just like a single thermoplastic wire (TW) for knob and tube work, open wiring, a single cord wire #16 is used with improvised banana jack attached at both ends.

Following the modern way of electrical wiring installation system usually practised in the rural areas using the duplex solid wire (PD-X) being one of the approved types of wiring, the wire that is used in the gadget is an improvised duplex cord wire #16 to substitute the duplex solid wire (PD-X) because it is malleable and appropriate for a class demonstration in electrical wiring connection. The duplex wire is color-coded black and white to identify the hot wire and the neutral wire.

The fuse that is used at the safety switch is rated 10 amperes to cut it easily in case of short circuit.

Construction of the Gadget

Figure 2 shows the pictorial view of the electrical multi-circuit demonstration gadget. Figure 3 shows the orthographic drawing, illustrating the dimensions of the gadget. Figure 4 shows the parts labelled for proper identification.

Procedure:

1. Make a plan of the gadget and its accessories.

2. Secure the materials needed for the construction of the gadget.

3. Cut the 1.27 cm.-thick plywood for the board according to its dimension.

4. Make the frame for the board using the 2.54 cm. x 5.08 cm. lumber.

5. Cut the 0.39 cm. thick plywood for the back cover according to its dimension.

6. Make an improvised input jack according to its dimension.

7. Drill holes on the board of the gadget with a 0.5 cm. bit for the wiring connection from the receptacle and convenience outlets to the input jacks which connections are made inside the gadget.

8. Drill another hole on the same board for the input jack with a 0.5 cm. bit according to the plan.

9. Make another hole for the wiring connection from the safety switch to the input jacks. Two holes with a diameter of 0.9 cm. and another two holes with the size of 0.9 cm. x 1.5 cm. according to the plan.

10. Remove the knock-outs of the safety switch where the wires will pass through.

11. Mount all the parts of the gadget (safety switch, receptacles, junction boxes, single-pole tumbler switch, convenience outlets, 3-way switches and the 4-way switch) according to their dimensions.

12. Make all wiring connections from the safety switch, receptacles, single-pole tumbler switch, 3-way switch, 4-way switch and the convenience outlets to the

input jacks. The connection should be soldered.

13. Make 53 pieces of improvised banana jack out of discarded short pieces of electric wire #10, 2.8 cm. long.

14. Cut pieces of electric cord wire #16, single cord wire and an improvised black and white duplex cord wire for the electrical wiring connection. Specific number of pieces and length are as follows:

White cord wire, single:

3 pieces - 26 cm. long

2 pieces - 52 cm. long

Black cord wire, single:

6 pieces - 27 cm. long

2 pieces - 55 cm. long

2 pieces - 72 cm. long

1 piece - 83 cm. long

Duplex cord wire, black and white:

2 pieces - 39 cm. long

6 pieces - 51 cm. long

2 pieces - 60 cm. long

1 piece - 65 cm. long

1 piece - 71 cm. long

15. Solder the cord wires to the prongs of the improvised banana jacks.

16. Make a round insulation 1.4 cm. diameter out

of a discarded plastic material about 0.06 cm. diameter, to insulate the top of the input jacks.

17. Fasten the round plastic insulations on top of the improvised input jack with an epoxy and have it dried.

18. Connect one (1) meter of #14 PD-X and thermoplastic (TW) wires for the source with a male plug.

19. Polish it with a sandpaper #0.

20. Paint the surface of the board and the handle of the improvised banana jacks. Paint the board with yellow paint and the banana jacks with white for the white wire and black for the black wire of the cord wire.

21. Label the parts of the gadget with specific letters and numbers for identification.

22. Mark the cord wires with letters for identification.

Full view of the gadget. The full front view of the gadget is illustrated in Figure 2 showing the smaller components and their representative symbols.

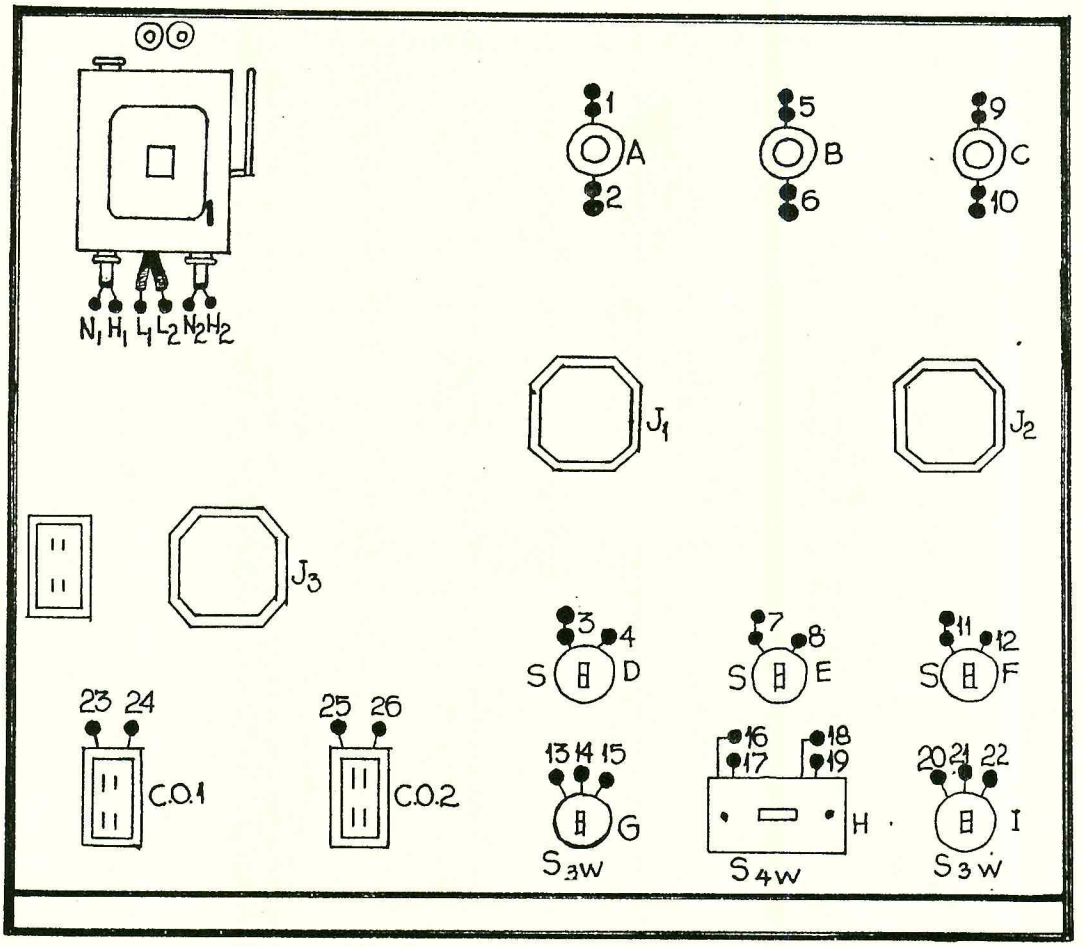


Figure 2. Front view of the Improvised Electrical Multi-Circuit Demonstration Gadget. The components and their corresponding symbols are described in detail on the next page.

N_1 H_1 indicates the safety switch load terminal for the convenience outlets connection, where N_1 is for the neutral wire which is connected at the ground lug and H_1 is for the hot wire or phase wire which is connected on one of the fuses for the grounded circuit. L_1 L_2 are the terminals for the line-to-line circuit which are connected at the two fuses. N_2 H_2 are the terminals for the lighting outlets, where N_2 is for the neutral side which is also connected to the ground lug and H_2 is the phase wire terminal connected to the other fuse. The letters A, B, and C are the names of the receptacles. J_1 J_2 and J_3 are the names of the junction boxes. Letters D, E, and F are the names of the tumbler switch, while S is the symbol of the single-pole tumbler switch. Letters G and I are the names of the two three-way switches with the symbol S_{3w}. Letter H is the name of the four-way switch with also the symbol S_{4w}. C.O.1 and C.O.2 are the convenience outlet for demonstrating the two appliance outlet as being provided by the National Electrification Administration Wiring Standard.

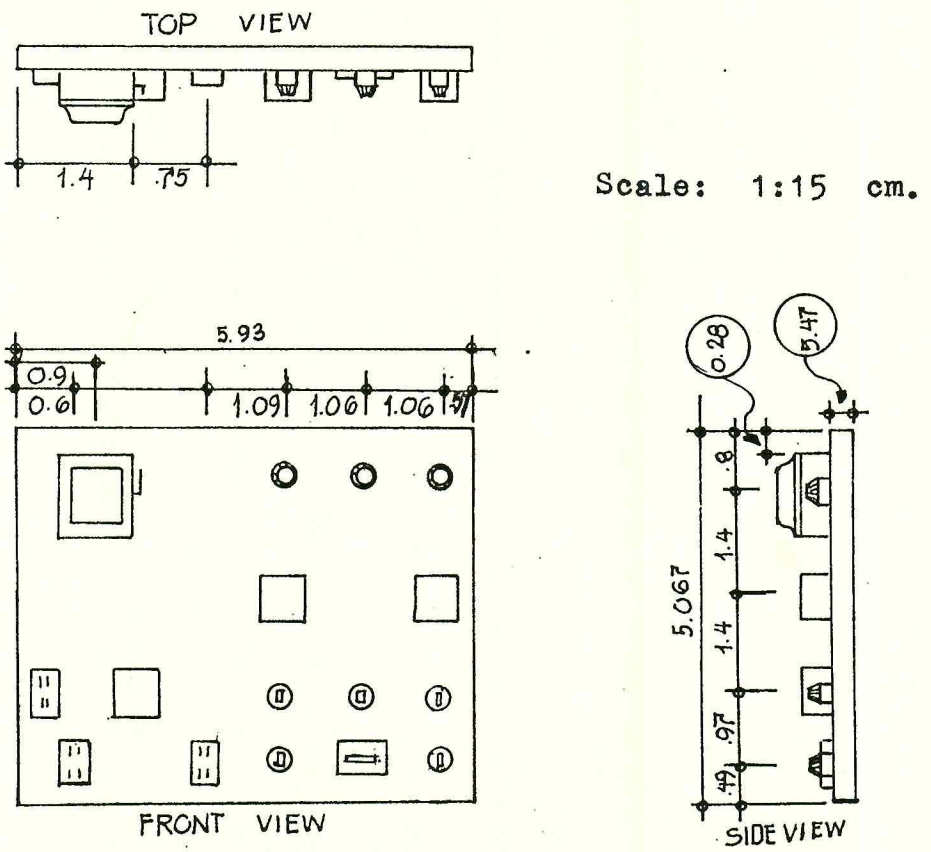
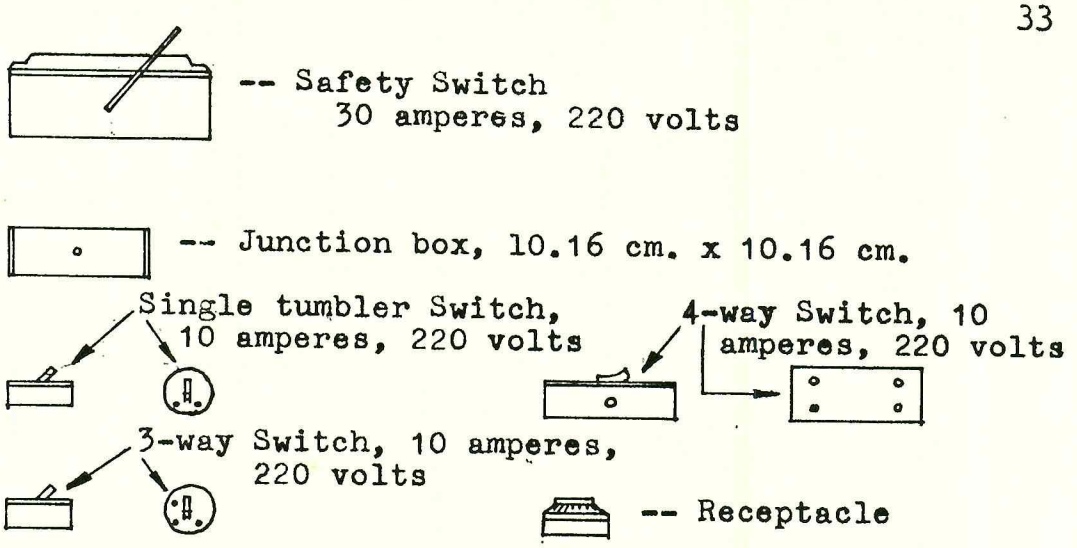


Figure 3. Orthographic drawing



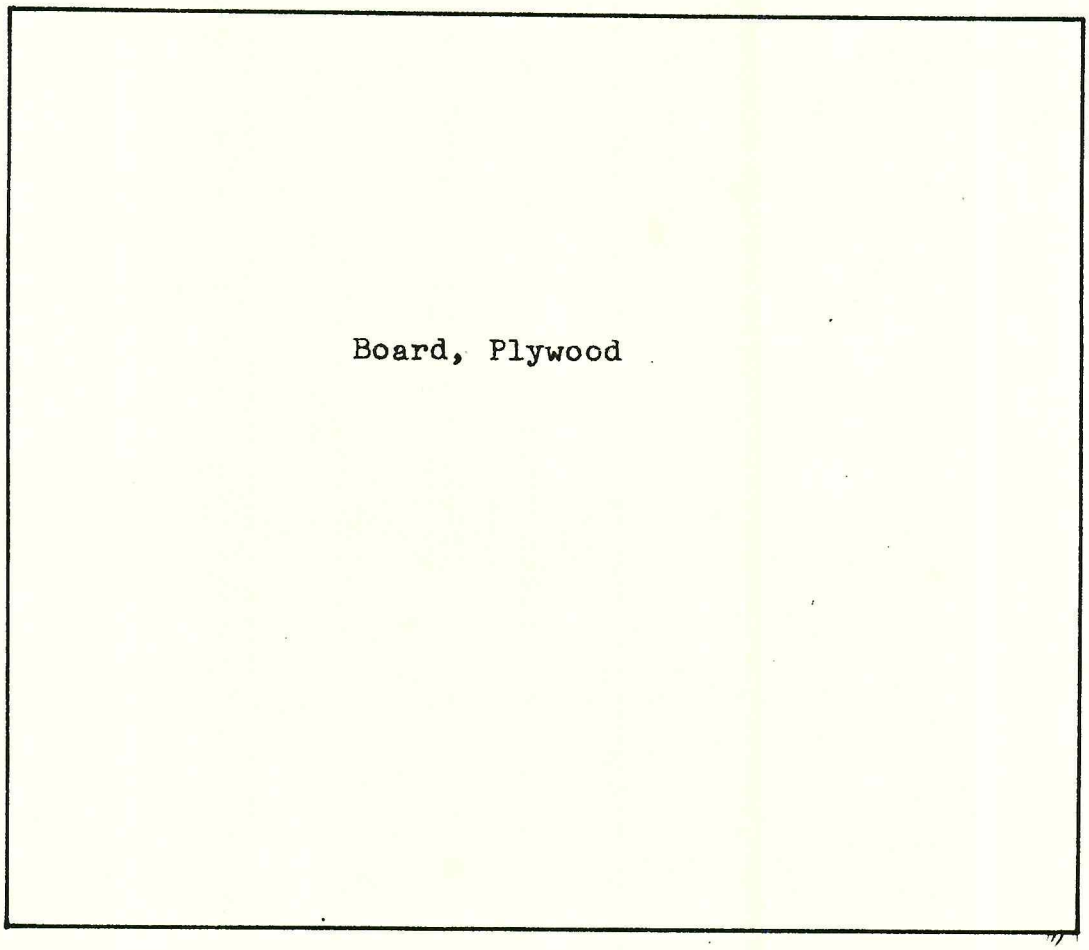


Figure 4. Parts of the gadget.

Figure 4. (continued)

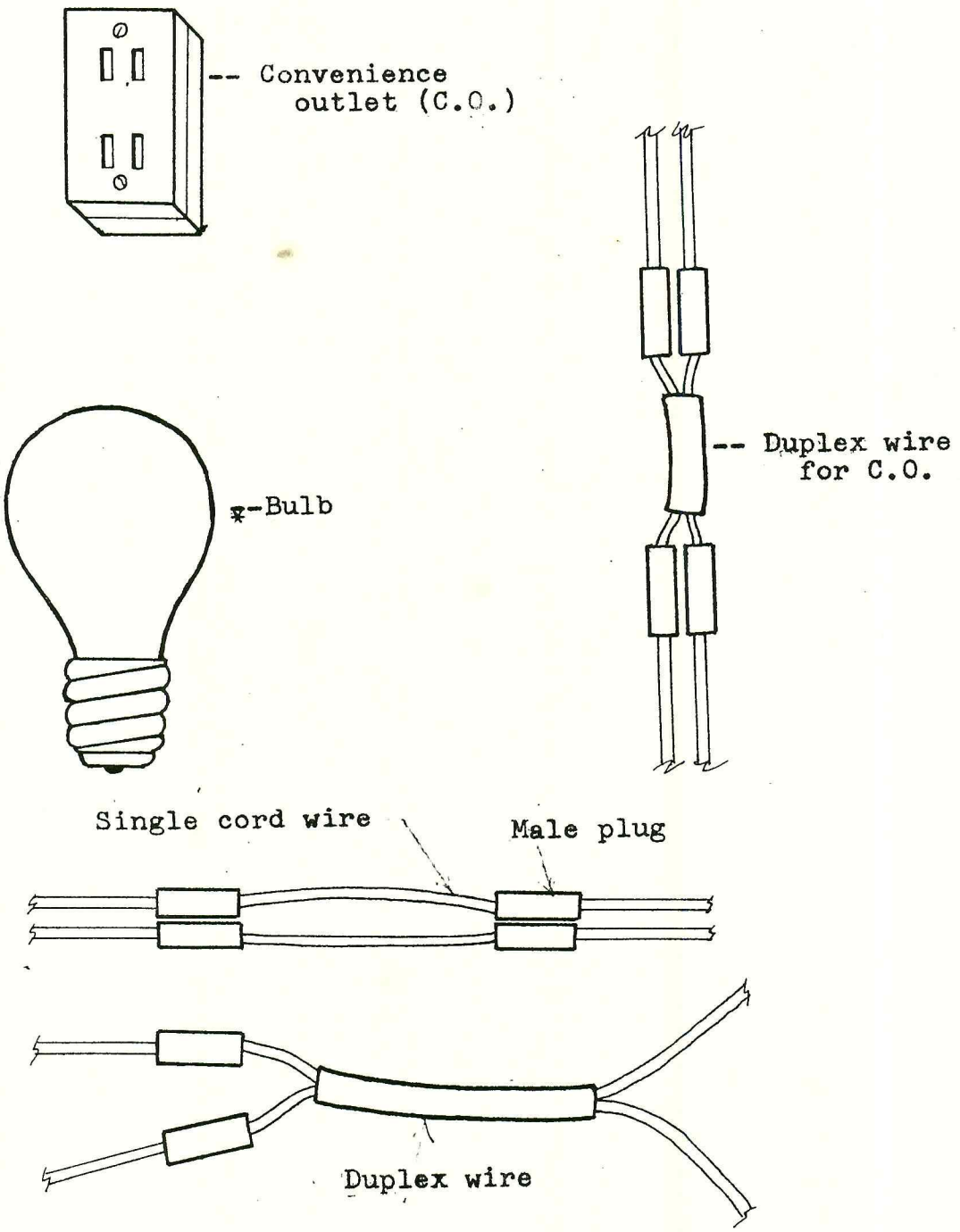
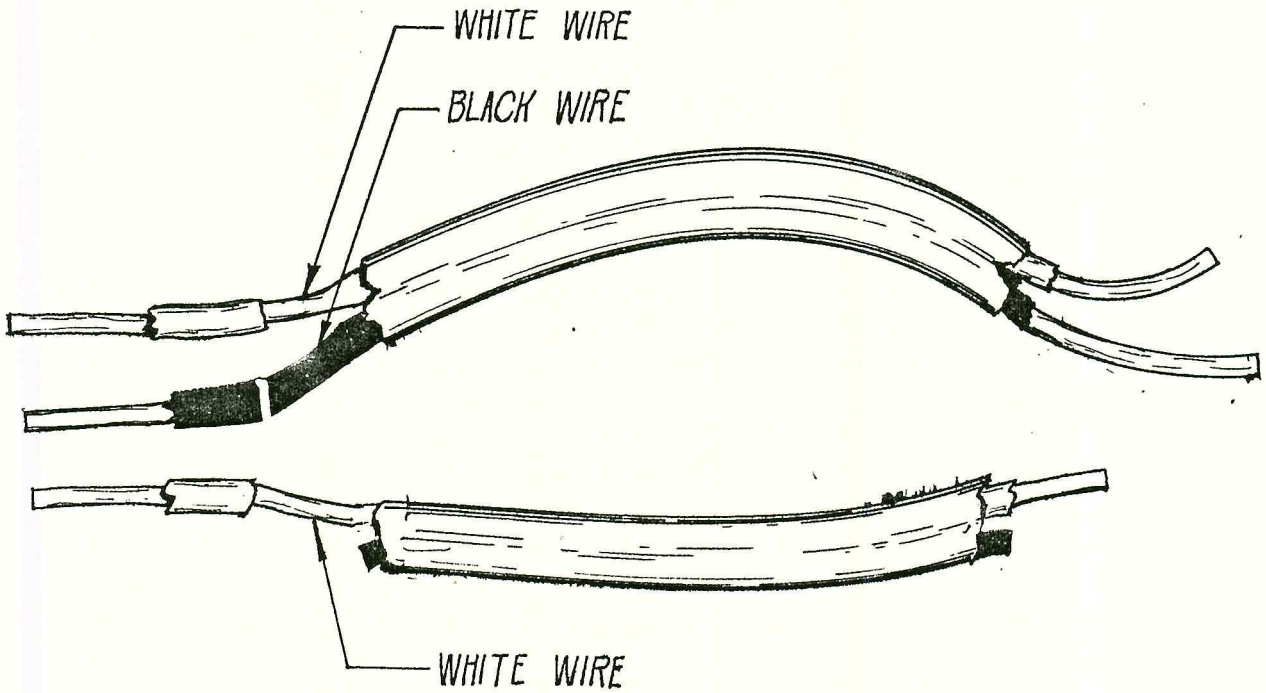
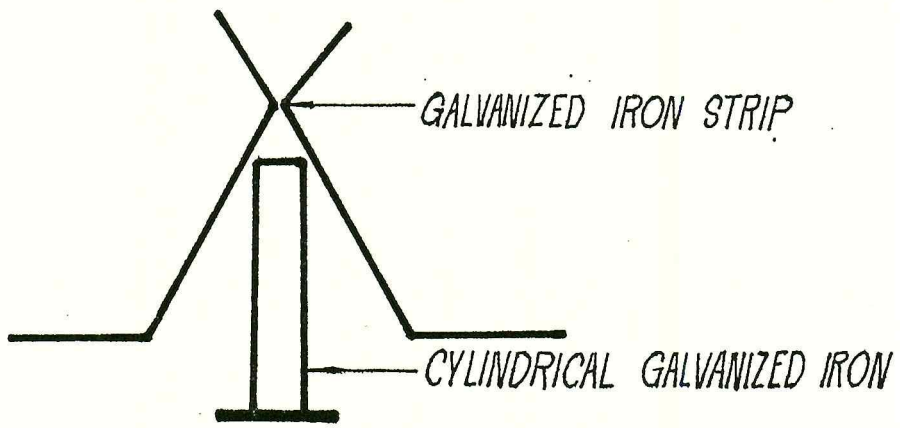


Figure 4. (continued)



DUPLEX WIRE



FEMALE PLUG (COMPONENT)

Schedule in the Production of One Unit of Electrical Multi-Circuit Demonstration Gadget

Figure 5 presents the schedule in producing one unit of electrical multi-circuit demonstration gadget, expressed in terms of number of days in preparation, assembly and installation of electrical components. This includes the painting and labelling of the parts. It is estimated that it would take eight days to produce one unit of electrical multi-circuit demonstration gadget.

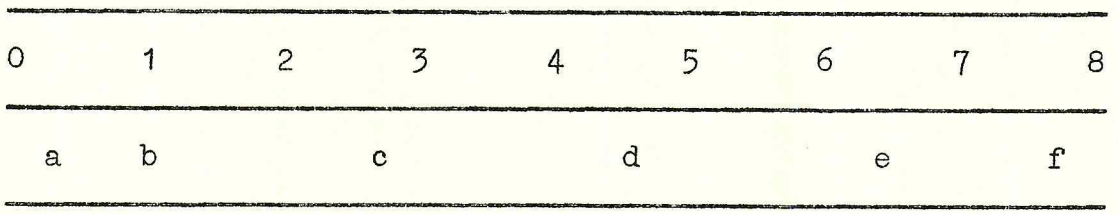


Figure 5. Estimated number of days for preparation assembly of component parts including painting and labelling of the parts.

Legend:

a - Assembly of the board and back cover.

b - Installation of the parts.

c - Improvised input jack assembly.

d - Extension cord with improvised banana jack assembly.

e - Painting of the component parts.

f - Labelling of the parts.

Parts of the gadget. The parts of the improvised electrical multi-circuit demonstration gadget as shown in figure 4 are as follows: (1) board, (2) 30 amperes safety switch, (3) porcelain sockets, (4) junction box, 10.16 cm. x 10.16 cm., (5) single-pole tumbler switch, (6) 3-way switch, (7) 4-way switch, (8) convenience outlet, (9) bulb, 50 watts, 220 volts and 25 watts, 110 volts, (10) ground lug, (11) fuse, (12) straight connector, (13) extension wire, #14 thermoplastic wire, (14) PD-X wire #14 an extension wiring for the source, (15) cord wire, #16 with improvised banana jack, single wire, (16) cord wire, #16 improvised banana jacks at one end, duplex, (17) cord wire, #16 with improvised banana jacks at both ends, duplex wire and (18) cord wire, #16 with improvised banana jack at one end and dead wire, duplex wire.

Tool and equipment needed. A. Tools: (1) Cross cut saw, (2) Handrill, electric ordinary, (3) Drill bits, (4) Screw driver, (5) Electrician pliers, (6) Long-nose pliers, (7) Soldering copper, electric or ordinary, (8) Electric soldering gun, 100 watts, 220 volts if available, (9) knife, (10) Smoothing plane, (11) Claw hammerm (12) Wood chisel, (15) Steel square, (16) Try square, (17) Auger brace, (18) Auger bit, (19) Tinner snip, straight, (20) Cold chisel and (21) Zigzag roll.

B. Equipment: (1) Grinder, electric or manually operated, (2) Anvil, if available and (3) Squaring shear machine.

Safety precautions. In the demonstration of the concepts of electric current, using this gadget, the demonstrator must observe the following safety precautions: (1) Put "Off" the main switch (safety switch) when making the electrical connection, (2) Do not interchange the connection for the white wire and the black wire, (3) use the right size of fuse, (4) Insulate all connections before energizing the gadget, (5) Stand on an insulator when operating the gadget, if possible, (6) Replace defective electrical fixtures such as socket, switch, convenience outlet and the like, with new ones, defective fixtures are electrical hazard, (7) Avoid loose contact on electrical connections, this will cause arcing and overheating at the connections making a destruction on the contact or connection and also increase the resistance of the circuit, (8) Use right tools for the right job, (9) Make a final check-up on the wiring before energizing the circuit, (10) Make a follow-through motion when switching "On" the main switch.

Chapter 4

CONCEPTS TESTED BY THE GADGET

Concept 1 -- Single Lamp Circuit Using A Single Black and White Wires

Brief information. This type of wiring is applicable in open wiring on insulators and concealed knob and tube work. Open wiring is a wiring method using cleats, knobs, tube and flexible tubing for the protection and support of insulated conductors run in or on buildings not concealed by building structure. It is usually used for temporary work. Concealed knob-and-tube wiring is a wiring method using knobs, tubes and flexible non-metallic tubing for the protection and support of insulated conductors concealed in hollow spaces of walls and ceiling of buildings.[34]

In connecting the receptacles and sockets, the identified circuit wire, which is always a grounded wire, must be connectec to the screw-shell,[35] as shown in figure 6.

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[34]Frank Stetka, NFPA Handbook of the National Electrical Code, (New York: McGraw-Hill Book Company, 1965), pp. 169-174.

[35]Schuller, op. cit., p. 159.

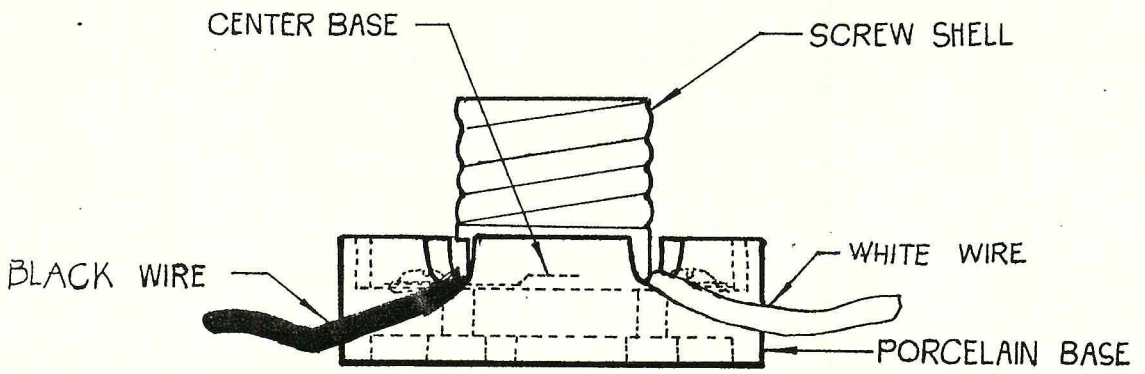

Figure 6. Wiring connection on the receptacle

Tools Needed.

1 screw driver

1 Electrician pliers

1 Pliers, Long-nose

Supplies and materials Needed

2 sets of cord wire, #16 (1 black and 1 white)

1 piece 50 watts, 220 volts

the gadget itself

Wiring Diagram.

Wiring diagram.

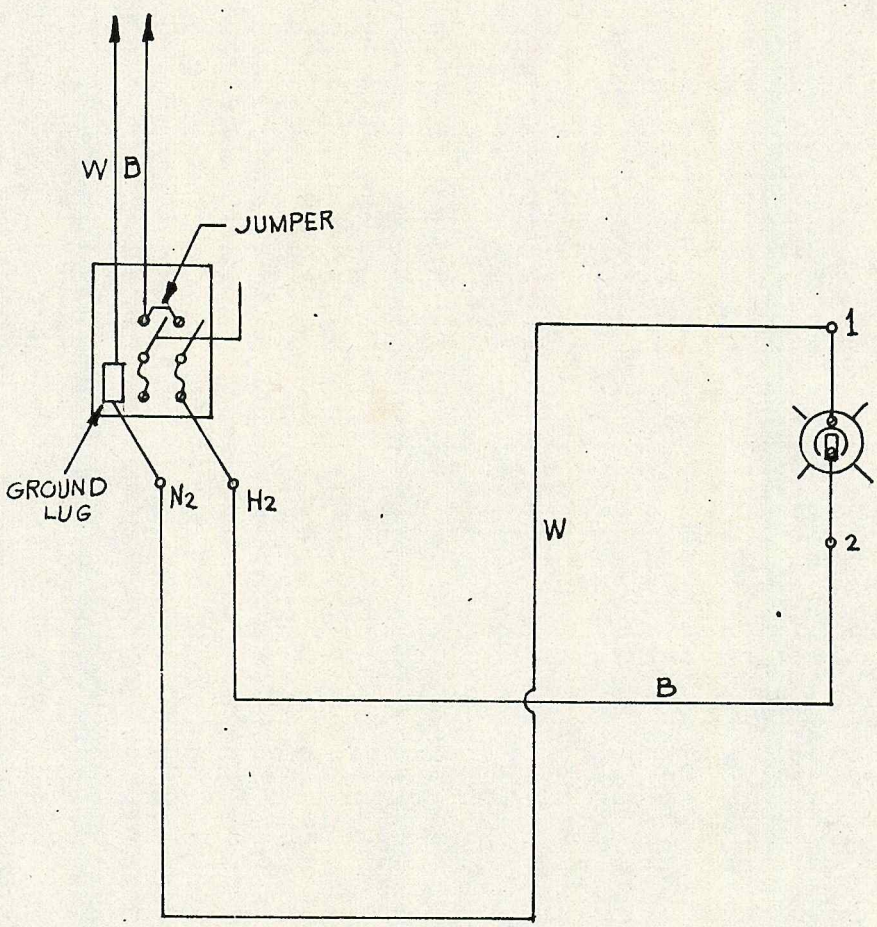

Figure 7. Single lamp circuit.

Procedure.

(1) Check the safety switch and be sure that it is at "Off" position.

(2) Check and be sure that all binding screws are tight.

(3) Connect one end of the white wire marked letter J to input jack marked No. 1.

(4) Connect the other end of the white wire to input jack marked letter N_2 (neutral end) of the safety switch.

(5) Connect one end of the black wire marked letter L to input jack marked No. 2.

(6) Connect the other end of the black wire to input jack marked H_2 (hot end) of the safety switch.

(7) Check the wiring connections.

(8) Mount the bulb.

(9) Test the wiring connections.

Concept 2 -- One Bulb Controlled by a Single-Pole Tumbler Switch Using a Single Black and White Wire

Brief information. This kind of connection is usually applied in any portion of the house in open or concealed wiring in knob and tube work. In this system, a direct-line wire is brought from the cut-out or the

branch line to one binding screw of the receptacle. The remaining line wire is brought to one terminal of the switch. A section wire is run between the remaining terminals of the switch and the receptacle, respectively. It is obvious that the switch controls only one side of the circuit and that the other side is always "live". A switch of this type should not be used on ungrounded circuits located in damp places or cut of doors, because there is always a possibility of danger due to grounds. Should the "live" wire to the receptacle be the ungrounded with of the supply system, and the lamp section wire become grounded, a completed circuit would occur in the receptacle even though the switch is in the "Off" position. A short circuit will occur in this system if an accidental ground will also occur on the ungrounded wire of the supply system regardless of the position of the switch. In a more modern system, which are now grounded, the switch must be connected in the ungrounded side of the line. The direct-line wire would therefore be the grounded wire in such a system.[36] The purpose of this is to have the receptacle "dead" while working on it by putting the tumbler switch "Off". One of the advantage of this type of wiring is that, it is cheaper.

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[36] Ibid., p. 165.

Tools needed

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

1 set of white cord wire

2 sets of black cord wire

1 piece 50-watt bulb, 230 volts

the gadget itself

Wiring diagram. (See next page)

Procedure

(1) Check the safety switch, and be sure that it is at its "Off" position.

(2) Connect one end of the white wire marked letter J to input jack No. 1.

(3) Connect the other end of the same wire to input jack marked letter N_2 of the safety switch.

(4) Connect one black wire marked letter L at input jack No. 2.

(5) Connect the other end of the black wire to input jack No. 4 at the tumbler switch.

(6) Connect another black wire marked letter M at input jack No. 3.

Wiring diagram.

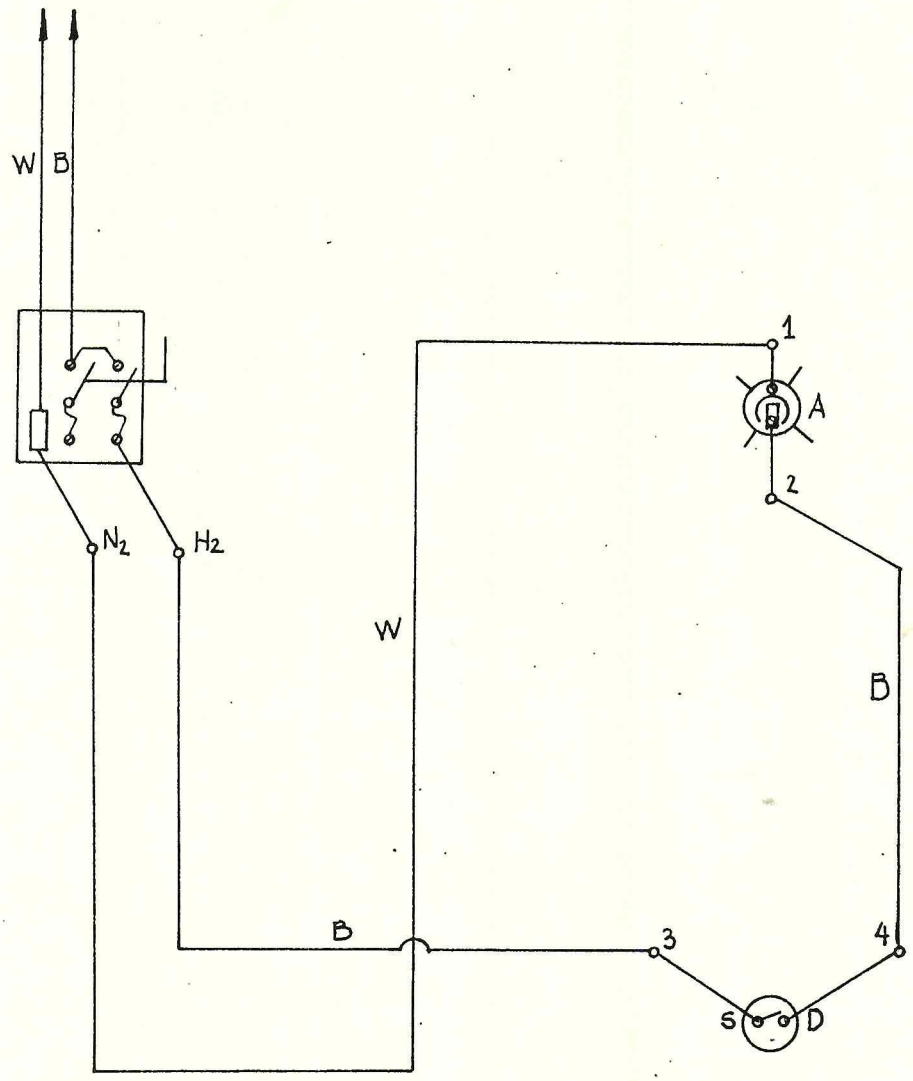

Figure 8. One bulb controlled by a single-pole tumbler switch using a single black and white wires.

(7) Connect the other end of the same wire to input jack H_2 of the safety switch.

(8) Check-up wiring connection.

(9) Mount the bulb.

(10) Test wiring connection.

Concept 3 -- Series Circuit Using Single Wire

Brief information. This circuit uses two bulbs having a working voltage of 110 volts connected in series for a 220 volts line voltage. Series circuit in an alternating current does not observe polarity, where positive and negative terminal connections should be followed. In this kind of circuit the positive terminal is connected to the negative terminal.

In practice, it is desired to use a bulb marked 110-V. Since the line voltage is 220 volts and the lamp is only 110 volts, it is necessary to put one more 110-volt lamp in series in order to match the 220 volts of the line. The 110-volt lamp alone cannot stand because too much current would go through it and it would burn out.

The most common application of the principle of series connection is the christmas-tree lighting outfit and other decorative lights where it is desired to use low voltage bulbs on higher voltages.

Series circuit as one of the electrical connections

having the following advantages: (1) economical in the sense that the same amount of current is used in all parts of the circuit, (2) different degrees of light intensity may be obtained by varying the connection, and (3) there is less danger of overloading the line.

This kind of circuit has also the following disadvantages: (1) when a device gets out of order, the whole connection is put out, (2) when devices or appliances of different capacities are connected together they do not give the same degree of performance, (3) more wire is used because as one more device is connected in the series the wire becomes longer, and (4) less power is obtained because devices so connected give higher resistance and consequently less current.[37]

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

2 sets of single white cord wire

1 set of single black cord wire

3 pieces of 50-watt bulb, 220 volts

the gadget itself

Wiring diagram. (See next page)

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[37] P. N. Duzon, General Electricity, Course I, (Manila: Philippine Book Company, 1978 Edition), p. 48-52.

Wiring diagram.

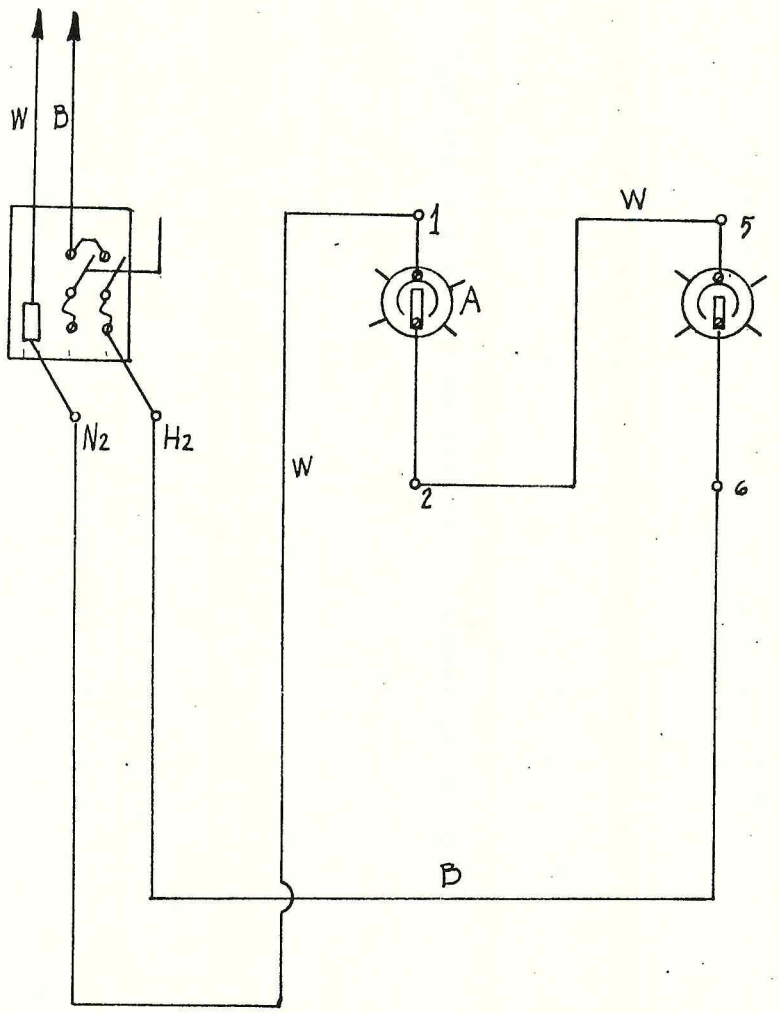

Figure 9. Two bulbs connected in series.

Procedure

(1) Check the safety switch that it is at "Off" position.

(2) Connect one end of the white wire marked letter J to input jack marked N_2.

(3) Connect the other end of the same wire (J) to input jack marked No. 1.

(4) Connect one end of another white wire marked letter C to input jack marked No. 2.

(5) Connect the other end of the same (C) to input jack marked No. 5.

(6) Connect one end of the black wire marked letter N to input jack marked No. 6.

(7) Connect the other end of the same wire N to input jack marked H_2.

(8) Check the wiring connections.

(9) Mount the bulbs.

(10) Test the wiring connections.

Concept 4 -- Two Bulbs in Series Controlled By a Single-Pole Tumbler Switch Using a Single Wire

Brief information. In order to control the operation of the lamp, it is desired to connect it with a switch. The lamp can be put "Off" when not in use and put "On" when light is needed. This is an energy conservation.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

2 sets of single white cord wire

2 sets of single black cord wire

2 pieces bulb, 50 watts, 220 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check the safety switch and be sure that it is at "Off" position.

(2) Connect one end of the white wire marked letter J to input jack marked letter N_2.

(3) Connect the other end of the same wire J to input jack marked No. 1.

(4) Connect one end of another white wire marked letter C to input jack marked No. 2.

(5) Connect the other end of the same wire (C) to input jack marked No. 5.

(6) Connect one end of another black wire marked letter L to input jack marked No. 6.

(7) Connect the other end of the wire to input jack marked No. 4 of the tumbler switch.

Wiring diagram.

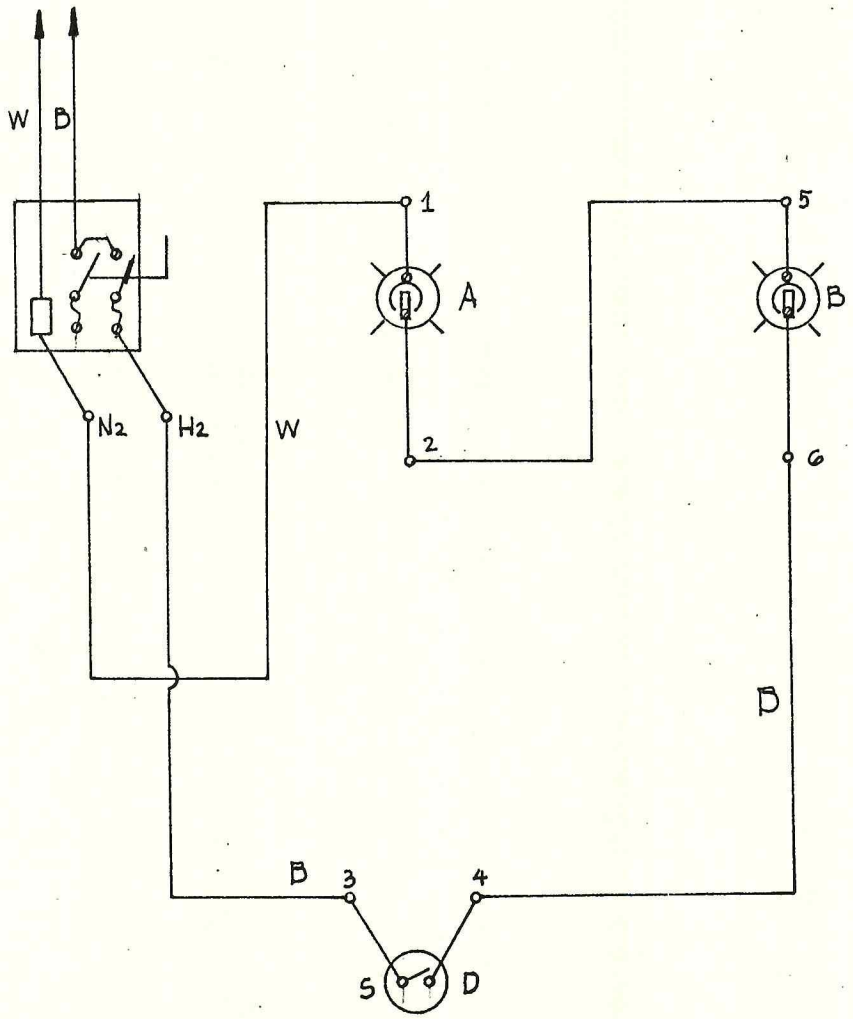

Figure 10. Two bulbs in series ciruit controlled by a single-pole tumbler switch using a single wire.

(8) Connect one end of the black wire marked letter M to input jack marked No. 3.

(9) Connect the other end of the same wire (M) to input jack marked H_2.

(10) Check-up the wiring connection.

(11) Mount the bulbs.

(12) Test the wiring connections.

Concept 5 -- Parallel Circuit Using Black and White Single Cord Wire

Brief information. The parallel connection eliminates the undesirable feature of the series connection.

In the parallel connection, the current has two or more paths, thus making it possible for other appliances in the connection to continue operating even though one or two of the devices in the connection get out of order.

A distinctive feature of the parallel connection is the fact that the intensity of illumination of lamps of different ratings is never affected at all, as long as the voltage rating of a lamp is that of the line or a little over.[38]

In parallel circuit, power consumption increases as the number of bulbs (appliance) connected in parallel

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[38] Ibid., p. 53.

increases.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

3 sets of single black cord wire

3 sets of single white cord wire

3 pieces bulb, 50 watts, 220 volts

The gadget itself

Wiring diagram. (See next page)

Procedure

(1) Check the safety switch and be sure that it is at the "Off" position.

(2) Connect one end of the white wire marked C to input jack marked No. 1.

(3) Connect the other end of the same wire (C) to input jack marked No. 5.

(4) Connect one end of the white wire marked letter D to the other input jack No. 5.

(5) Connect the other end of the same wire (D) to input jack marked No. 9.

(6) Connect one end of the black wire marked letter A to input jack No. 2.

Wiring diagram.

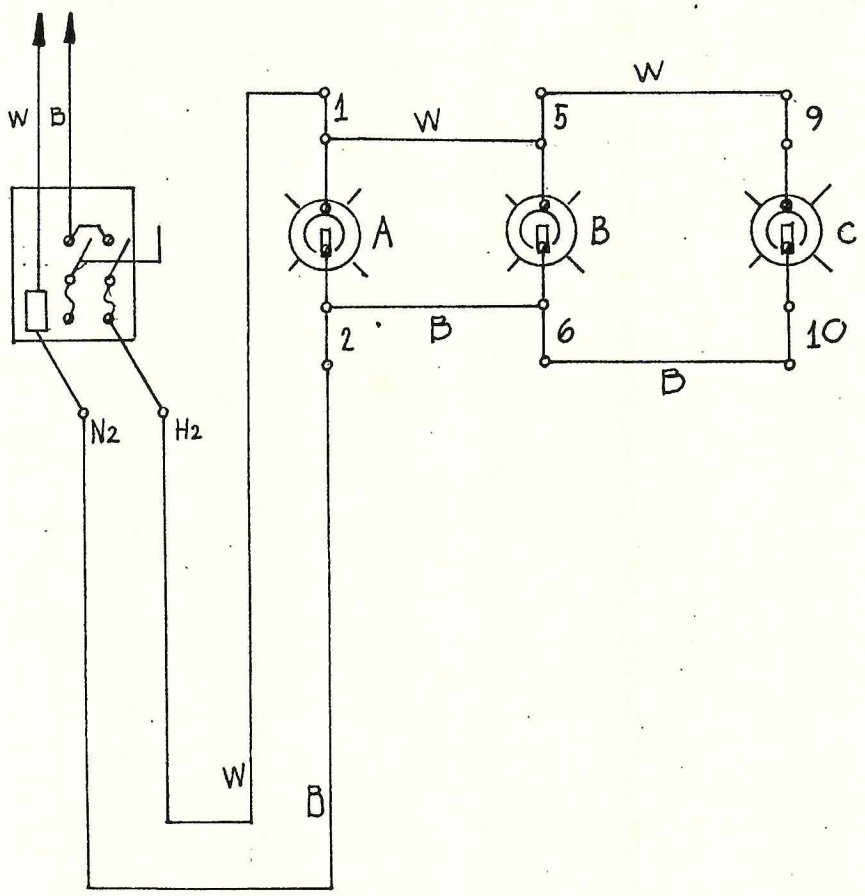

Figure 11. Parallel circuit using single black and white wires.

(7) Connect the other end of the same wire (A) to input jack marked No. 6.

(8) Connect one end of the black wire marked letter B to the other female plug marked No. 6.

(9) Connect the other end of the same wire (B) to input jack marked No. 10.

(10) Connect one end of the white wire marked letter J to the other input jack marked No. 1.

(11) Connect the other end of the same (J) to input jack marked letter N_2.

(12) Connect one end of the black wire marked letter L to input jack marked No. 2.

(13) Connect the other end of the black wire (L) to input jack marked H_2.

(14) Check-up the wiring connections.

(15) Mount the bulbs.

(16) Test the wiring connection.

Concept 6 -- Three Bulbs in Parallel Circuit Controlled by a Single-Pole Tumbler Switch Individually

Brief information. This is a kind of wiring connection usually done in house wiring installation where electric lamps installed in each room are controlled by a switch separately from the other lamps in a certain

wiring installation. In this wiring method the room will have an independent lighting and its control switch.

The advantage over this wiring method is that, the lighting system of a room will not affect the lighting of the other rooms in a house.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

3 sets of single white cord wire

6 sets of single black cord wire

3 pieces of bulbs, 50 watts, 230 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check the safety switch and be sure that it is at the "Off" position.

(2) Connect one end of the white wire marked letter C to input jack marked No. 1.

(3) Connect the other end of the white wire to input jack marked No. 5.

(4) Connect one end of the white wire marked letter D to the other input jack No. 5.

Wiring diagram.

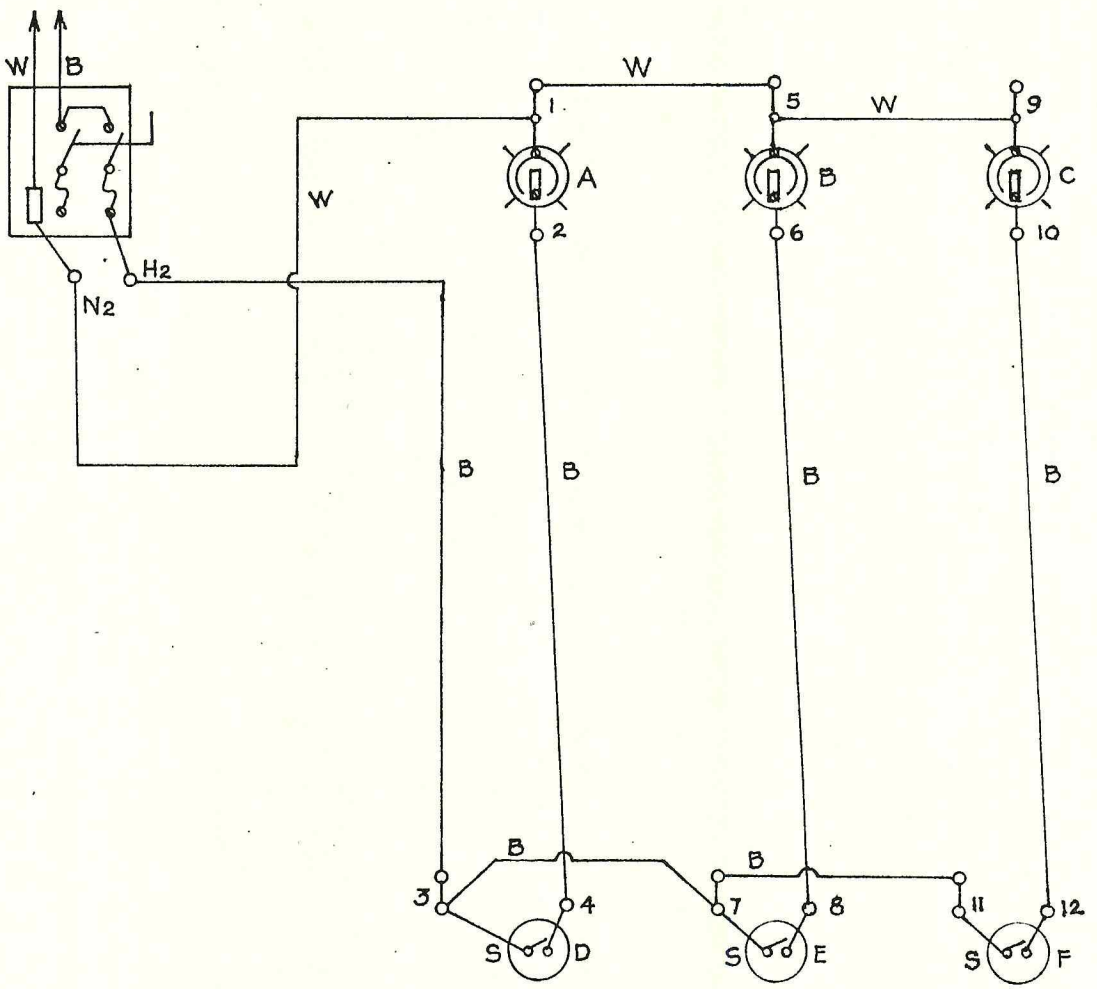

Figure 12. Three bulbs in parallel with individual control of single-pole tumbler switch using a single thermoplastic wire (TW).

(5) Connect the other end of the same wire (D) to input jack marked No. 9.

(6) Connect one end of the black wire marked letter A to input jack No. 3.

(7) Connect the other end of the same wire (A) to input jack No. 7.

(8) Connect one end of the black wire marked letter B to the other input jack marked No. 7.

(9) Connect the other end of the black wire to input jack marked No. 11.

(10) Connect one end of the black wire marked letter L to input jack marked No. 4.

(11) Connect the other end of the same wire (L) to input jack marked No. 2.

(12) Connect one end of the black wire marked letter M to input jack marked No. 8.

(13) Connect the other end of the same wire (M) to input jack marked No. 6.

(14) Connect one end of the black wire marked letter N to input jack marked No. 12.

(15) Connect the other end of the same wire (N) to input jack marked No. 10.

(16) Connect one end of the white wire marked letter J to input jack marked No. 1.

(17) Connect the other end of the white wire

to input jack marked letter N_2.

(18) Connect one end of the black wire marked letter O to the other input jack marked No. 3.

(19) Connect the other end of the black wire (O) to input jack marked H_2.

(20) Check-up the wiring connections.

(21) Mount the bulbs.

(22) Test the wiring connection.

Concept 7 -- Three Bulbs in Parallel Circuit Controlled by a Single-Pole Tumbler Switch Using a Single Wire

Brief information. This kind of connection is usually applied to wide space where one or two lamps are not sufficient to light the area. Single wire can be used here also as one of the approved type of wiring in open wiring installation.

In this method the lamp will function simultaneously.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

3 sets of single white cord wire

4 sets of single black wire

3 pieces of bulbs

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check the safety switch and be sure that it is at the "Off" position.

(2) Connect one end of the white wire marked C to input jack marked No. 1.

(3) Connect the other end of the same wire (C) to input jack marked No. 5.

(4) Connect one end of the white wire marked letter D to the other input jack marked No. 5.

(5) Connect the other end of the same wire D to input jack marked No. 9.

(6) Connect one end of the black wire marked letter A to input jack No. 2.

(7) Connect the other end of the same (A) to input jack marked No. 6.

(8) Connect one end of the black wire marked letter B to the other input jack marked No. 6.

(9) Connect the other end of the same wire (B) to input jack marked No. 10.

(10) Connect one end of the white wire marked

Wiring diagram.

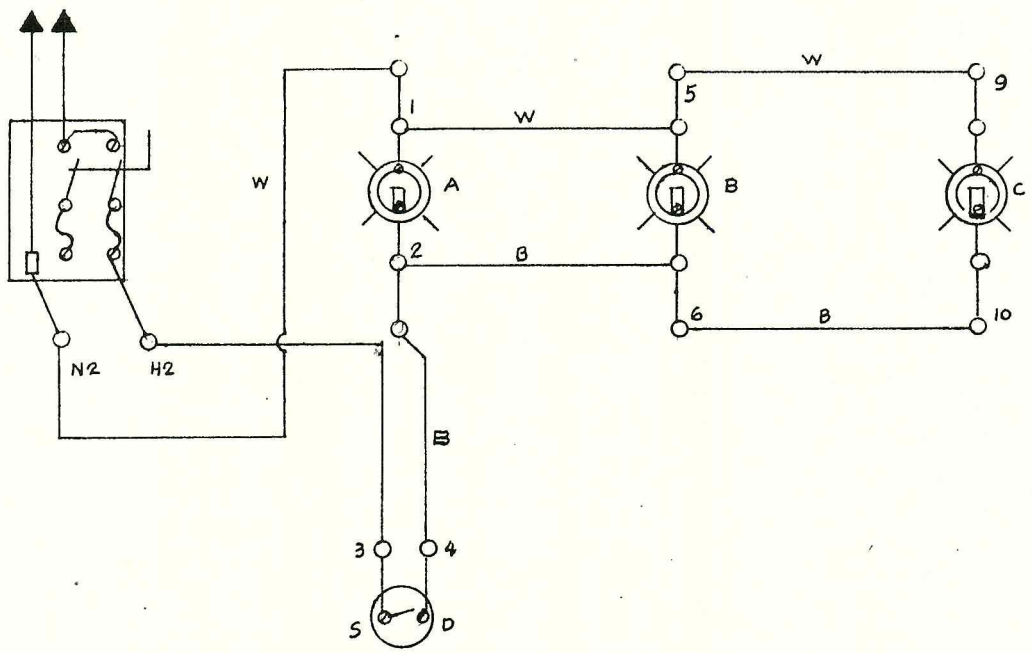

Figure 13. Three bulbs in parallel circuit controlled by a single-pole switch with single wire.

letter J to the other input jack marked No. 11.

(11) Connect the other end of the same wire to input jack marked letter N_2.

(12) Connect one end of the black wire marked letter L to input jack No. 2.

(13) Connect the other end of the same (L) to input jack No. 4.

(14) Connect one end of the black wire marked letter M to the input jack No. 3.

(15) Connect the other end of the same wire to input jack marked H_2.

(16) Check the wiring connections.

(17) Test the wiring connection.

Concept 8 -- One Bulb Controlled by Two Three-Way Switches Using Single Black and White Wires

Brief information. This circuit is used for the convenience it gives in controlling a light from more than one location. In modern homes the lights in the living and dining rooms as well as the hall are controlled by three-way switches. In some cases garage are wired with this circuit so that the lights may be controlled from either home or garage.[39] The stairway of a two-

[39] Perry, op. cit., p. 162.

storey house is wired with this circuit so that it can be lighted when going up and going down the stair and can be switch "Off" when lights are no longer needed.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

1 set of single white cord wire

4 sets of single black cord wire

1 piece bulb, 50 watts, 230 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check the safety switch and be sure that it is at its "Off" position.

(2) Connect one end of the black wire, marked letter O to input jack No. 2.

(3) Connect the other end of the same wire (O) to input jack marked No. 21.

(4) Connect one end of another black wire marked letter L to input jack marked No. 13.

(5) Connect the other end of the same wire (L) to input jack marked No. 20.

(6) Connect one end of another black wire marked

Wiring diagram.

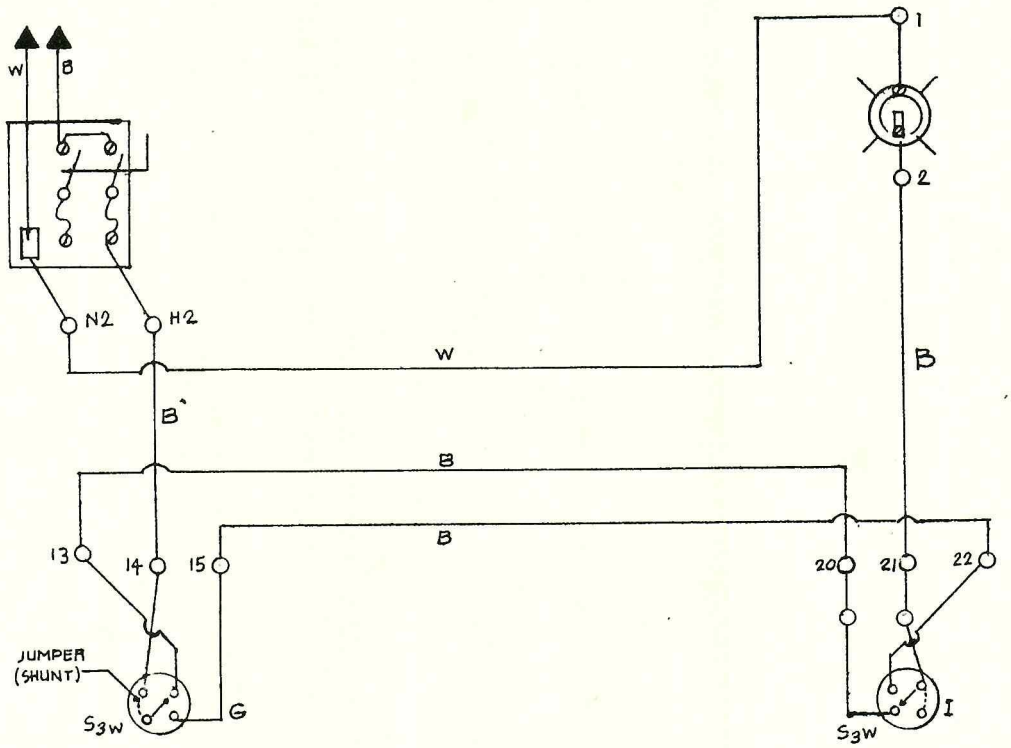

Figure 14. One bulb controlled by two three-way switches using single black and white wires.

letter M to input jack marked No. 15.

(7) Connect the other end of the same wire (M) to input jack marked No. 22.

(8) Connect one end of the white wire marked letter J to input jack marked No. 1.

(9) Connect the other end of the same wire (J) to input jack marked letter N_2.

(10) Connect one end of the black wire marked letter N to input jack marked No. 14.

(11) Connect the other end of the same wire (N) to input jack marked H_2.

(12) Check the wiring connections.

(13) Mount the bulb.

(14) Test the wiring connections.

Concept 9 -- One Bulb Controlled by Two Three-Way and a Four-Way Switches Using a Single Black and White Wires

Brief information. The four-way switch circuit is used mostly in connections with two three-way switches. This circuit is used for controlling lights from three or more locations. An example is a light in the second floor hall of a three storey building, to be controlled from each floor. The three-way switches must always be at the end of the circuit with the four-way switch in

between.[40]

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

1 set of single white cord wire

6 sets of single black cord wire

1 piece bulb, 50 watts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check the safety switch and be sure that it is at its "Off" position.

(2) Connect one end of the black wire marked letter O to input jack marked No. 2.

(3) Connect the other end of the same wire to input jack marked No. 21.

(4) Connect one end of the black wire marked letter A to input jack marked No. 13.

(5) Connect the other end of the same wire (A) to input jack marked No. 16.

(6) Connect one end of the black wire marked

---

[40] Ibid., p. 163.

Wiring diagram.

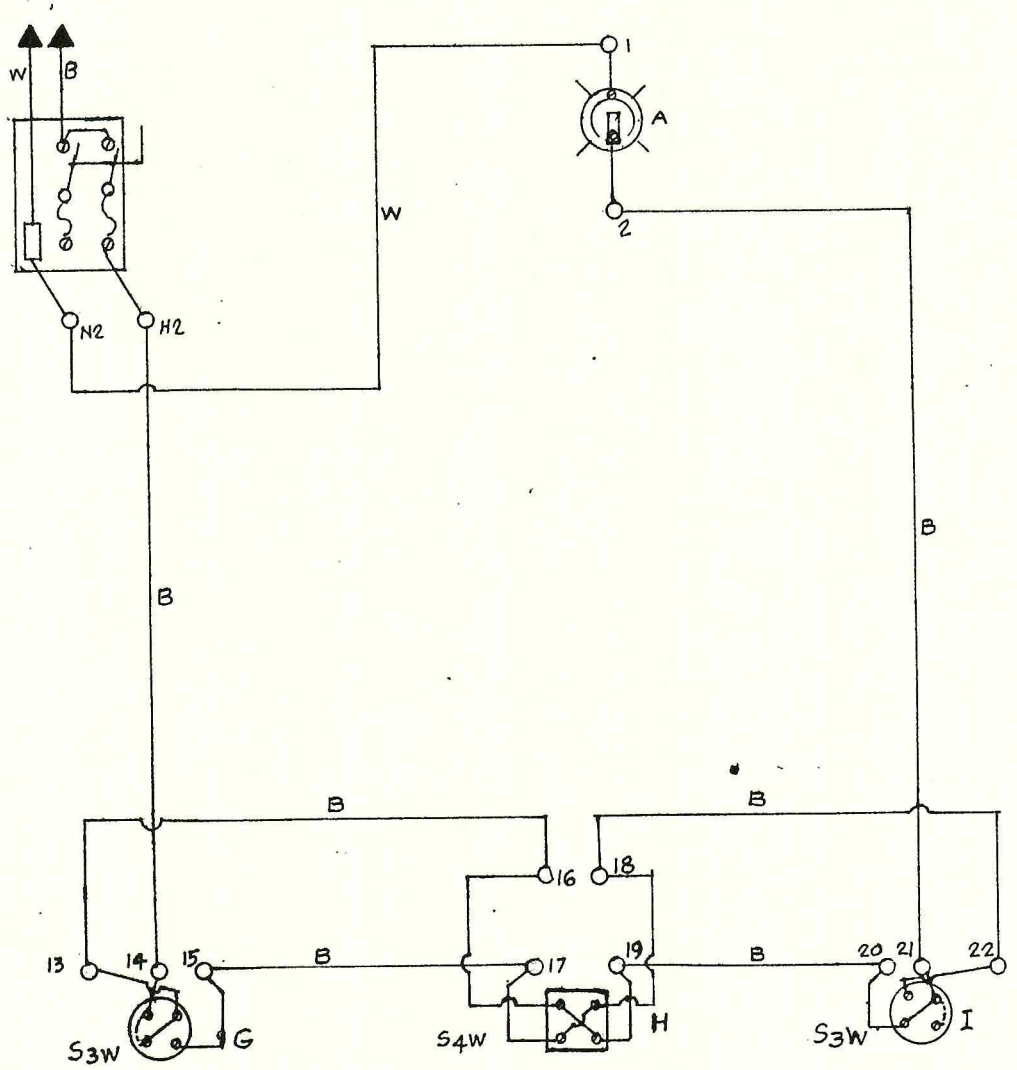

Figure 15. One bulb controlled by two three-way and a four-way switches using a single black and white wires.

letter B to input jack No. 15.

(7) Connect the other end of the same wire (B) to input jack No. 17.

(8) Connect one end of the black wire marked letter E to input jack No. 18.

(9) Connect the other end of the same wire (E) to input jack No. 22.

(10) Connect one end of the black wire marked letter G to input jack No. 19.

(11) Connect the other end of the black wire (G) to input jack No. 20.

(12) Connect one end of the white wire marked letter J to input jack No. 1.

(13) Connect the other end of the white wire (J) to input jack marked N_2.

(14) Connect one end of the black wire marked letter N to input jack No. 14.

(15) Connect the other end of the same wire (N) to input jack H_2.

(16) Check the wiring connections.

(17) Mount the bulb.

(18) Test the wiring connections.

Concept 10 -- Open Circuit

Brief information. Open circuit is a break or a cut in the wiring connection. This is one of the troubles in electrical wiring installation. When this occur, the lamp will not light like any other electrical appliances because no current can flow from the source.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

1 set of single white cord wire

1 set of single black cord wire

1 piece bulb, 50 watts, 230 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check the safety switch and be sure that it is at its "Off" position.

(2) Connect one end of the white wire marked letter J to input jack No. 1.

(3) Connect the other end of the same wire (J) to input jack N_2 of the safety switch.

(4) Splice the wire terminal similar to western union of the black wire marked H and I.

Wiring diagram.

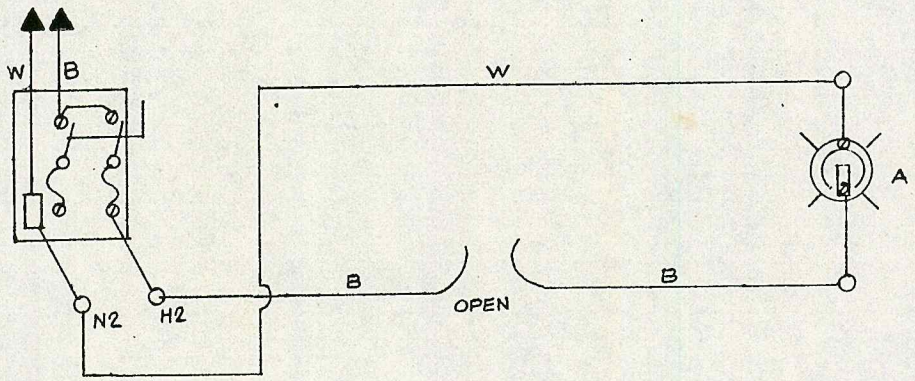

Figure 16. Open circuit.

(5) Connect one end of the spliced wire to input jack No. 2 and the end to input jack marked H_2.

(6) Break the splice of the two wires. There is now an open circuit.

Concept 11 -- Close Circuit

Brief information. A close circuit is a circuit where current can flow from the source then return to the source. Here the lamp, like other appliances, will function as the current will flow when the circuit is close or complete.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

1 set of single white cord wire

1 set of single black cord wire

1 piece bulb, 50 watts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check the safety switch and be sure that it is at the "Off" position.

Wiring diagram.

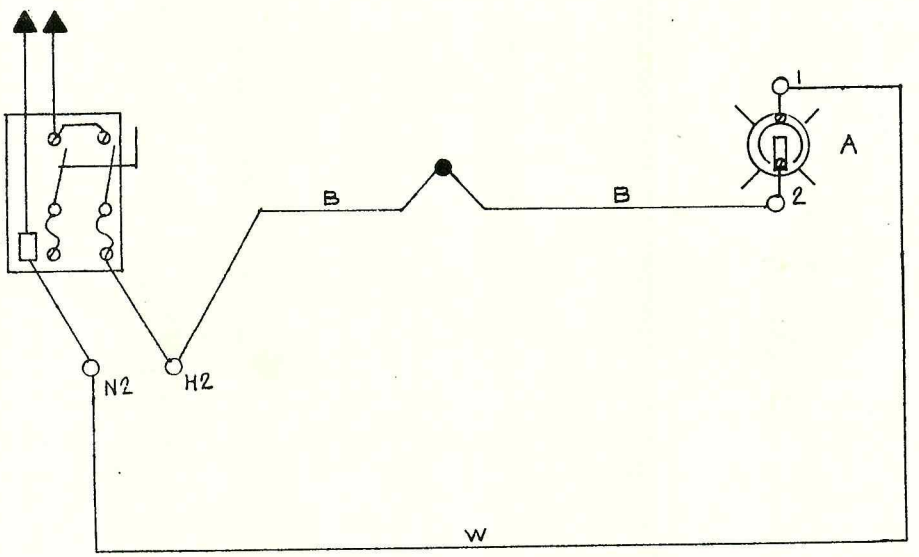

Figure 17. Close circuit

(2) Connect one end of the white wire marked letter J to input jack No. 1.

(3) Connect the other end of the same wire (J) to input jack N_2 of the safety switch.

(4) Connect one end of the black wire marked letter H to input jack No. 2 with the other end opened.

(5) Connect another black wire marked letter I to input jack H_2 with the other end also opened.

(6) Put "On" the safety switch. The bulb will not light because there is no complete circuit.

(7) Put "Off" the safety switch.

(8) Connect the opened terminals of the wires H and I similar to the western union splice.

(9) Put "On" the safety switch. The bulb now will light because the line is complete. There is now a close circuit.

Concept 12 -- Short Circuit

Brief information. A short circuit is an electrical trouble that will occur when two conductors carrying current will be on contact with each other. The effect on this trouble will make the fuse blown out. It

is self-destructive, hence it opens the circuit when there is short circuit and overloading.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

2 sets of single white cord wire

2 sets of single black cord wire

1 piece bulb, 50 watts, 230 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at "Off" position.

(2) Check and be sure that all binding screws are tight.

(3) Connect one end of the white wire marked letter J to input jack No. 1.

(4) Connect the other end of the same wire (J) to input jack marked N_2 of the safety switch.

(5) Connect one end of the black wire marked letter L to input jack No. 2.

(6) Connect the other end of the same wire (L) to input jack H_2 of the safety switch.

Wiring diagram.

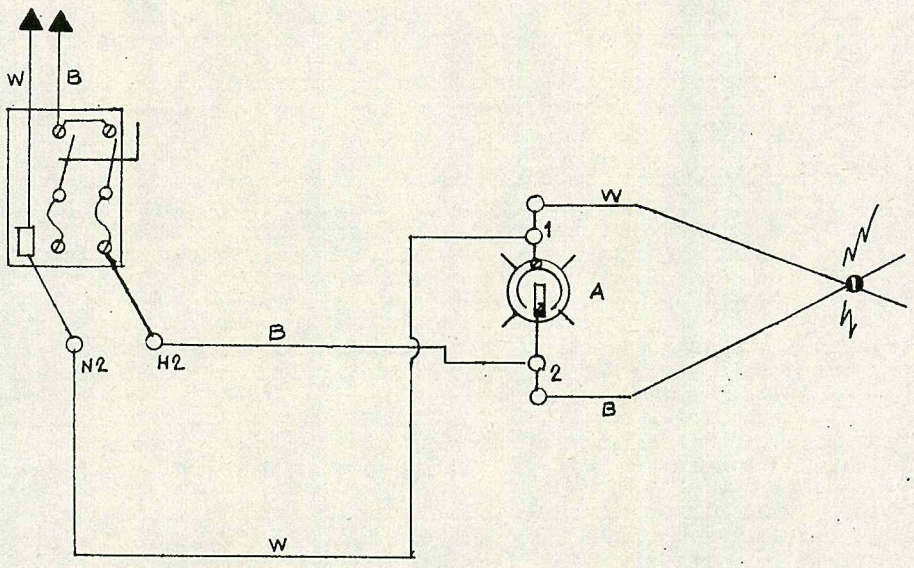

Figure 18. Short circuit.

(7) Connect one end of the white wire marked letter K to input jack No. 1.

(8) Connect one end of the black wire marked letter M to input jack No. 2.

(9) Mount the bulb.

(10) Put "On" the safety switch.

(11) Make a metal-to-metal contact on the black and white cord wires K and M. This is a short circuit. The weakest point in the circuit will cut off. Mostly, the part included in the circuit that will be blown is the fuse.

Concept 13 -- Multi-Grounded Circuit Using a Duplex Wire

Brief information. A multi-grounded circuit is a type of wiring installation approved and provided by the National Electrification Administration (NEA) for barangay house wiring installation. Here the two fuses of the safety switch are utilized for the two branch circuits. One fuse is for the lighting circuit and the other fuse for the convenience outlet circuit where the phase wire or the hot wire of such circuit passes through. The neutral or the ground wire is fastened with a ground lug on the case of the safety switch.[41]

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[41] See Appendix A.

The advantage of this circuit is that when a fuse of a circuit is blown there is still one circuit that can be utilized for an electrical purposes. Another advantage is that heavier loads for example, refrigerator, electric stove and the like will be separated from the lighting circuit which such heavy electrical appliances need heavier wire and bigger fuse.

There are several NEA wiring standard for member owned wiring installation. To state a few, the entrance wire from the kilowatt-hour meter to the disconnect switch must be a PD-X type, 30 amperes capacity or larger, branch circuit wire shall be of 15 amperes capacity or larger, disconnect switch must be rated 30 amp. capacity or larger and must permit manual operation by individual handle, and a minimum of two appliance outlets must be installed in each home and must have a rating of not less than 10 amperes and 220 volts.[42]

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

6 sets of duplex wire

---

[42] Ibid.

75 cm. of plastic tape

1 piece bulb, 50 watts, 220 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at "Off" position and be sure that the binding screws are tight.

(2) Connect a duplex wire marked letter A to receptacle A, the black wire to input jack marked No. 2 and the white wire to input jack No. 1 and bring the other end of the duplex wire inside junction box marked J_1.

(3) Connect a duplex wire marked letter B to tumbler switch marked D, the black wire to input jack No. 4 and the white wire to input jack No. 3 and bring the other end inside the junction box J_1.

(4) Connect a duplex wire marked letter C to the safety switch (source), the black wire at input jack H_2 and the white wire at the input jack N_2 and bring the other end inside junction box J_1.

(5) Connect the black wire from the receptacle

Wiring diagram.

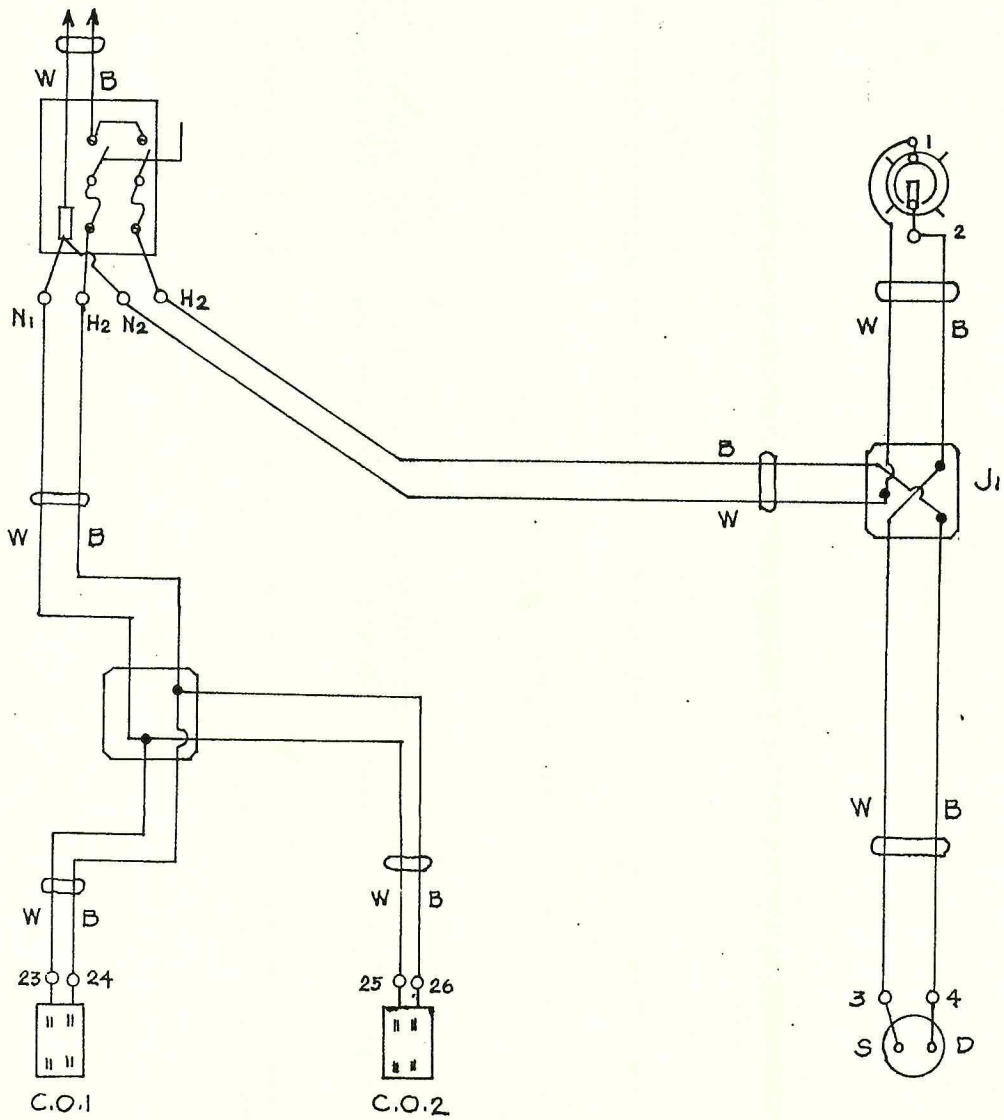

Figure 19. Multi-grounded circuit.

to the white wire from the switch. Then connect the white wire from the receptacle to the white wire from the switch (source) and finally connect to the black wire from the tumbler switch to the black wire from the switch (source). Cover the joints with an electrical tape.

(6) Connect a duplex wire marked letter D to the convenience outlet (C.O.), the white wire to the input jack No. 23 and the black wire to input jack No. 24 and bring the other end to junction box J_3.

(7) Connect another duplex wire marked letter E to C.O. No. 2, the white wire to input jack No. 25 and the black wire to input jack No. 26 and bring the other end to junction box J_3.

(8) Connect a duplex wire marked letter F to the source, the white wire to input jack marked N_1, and the black wire to input jack marked H_1 and bring the other end to junction J_3.

(9) Connect the wire terminals inside J_3, the white wires from C.O. 1 and C.O. 2 is connected to the white wire from the source

and the black wires of the same outlets is connected to the black wire from the source also.

(10) Check the wiring connections.

(11) Cover the joints with an electrical tape.

(12) Mount the bulb.

(13) Test the wiring connections.

Concept 14 -- Line-to-Line Circuit Using a Single Wire

Brief information. A line-to-line circuit is a type of circuit which the two wires of a main line (source) are a phase or hot wire. This type of circuit is applicable when using a small single-phase generator or when the neutral voltage is very low for an appliance, for example phase voltage is 220 volts and from line to ground (neutral) voltage is only 110 volts, and then the appliances are rated 220 volts, the circuit suited for the installation is a line-to-line circuit. Here the two fuses of the safety switch are used for the two lines of the circuit per regulation of the NEC, that phase or hot wire must be fused from the disconnect.[43]

Tools needed.

1 Screw driver

---

[43] Abbott, op. cit., p. 103.

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

2 sets of single black cord wire

1 piece bulb, 50 watts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at "Off" position and be sure that the binding screws are tight.

(2) Remove the jumper at the line side of the safety switch and cover it with a tape.

(3) Connect one end of the black wire marked letter L to input jack No. 1.

(4) Connect the other end of the same wire (L) to input jack marked L_1.

(5) Connect another black wire marked letter M to input jack No. 2.

(6) Connect the other end of the same wire (M) to input jack marked L_2.

(7) Connect the source of the main line to the two binding screws to the line side of the safety switch.

(8) Check the wiring connections.

Wiring diagram.

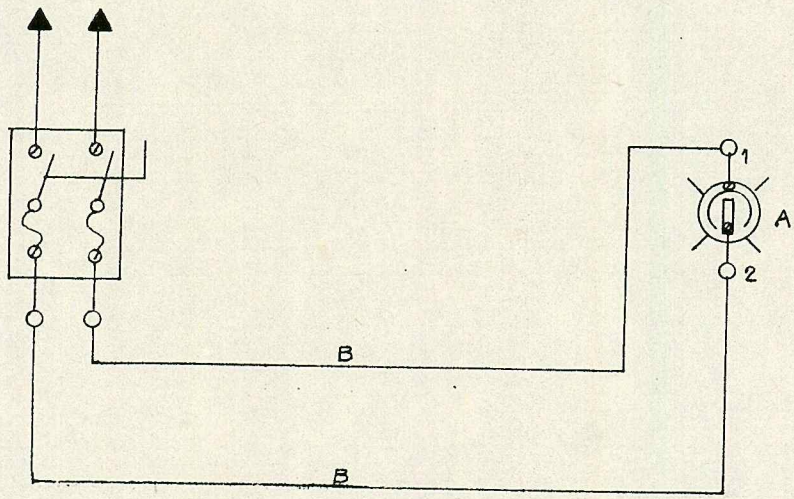

Figure 20. A line-to-line ciucuit.

(9) Mount the bulb.

(10) Test the wiring connections.

Concept 15 -- Single Electric Lamp Circuit Using a Duplex Wire

Brief information. This type of installation is applicable in pilot-light circuit which is used most in connection with cellar-light circuits or other lights that are often forgotten, Sometimes, the pilot is installed away from the switch in a location where it can readily be seen.[44]

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

2 sets of duplex cord wire, black and white

1 roll plastic tape

1 piece bulb, 50 watts, 220 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at "Off" position and be sure that the binding

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[44]Perry, op. cit., p. 186.

Wiring diagram.

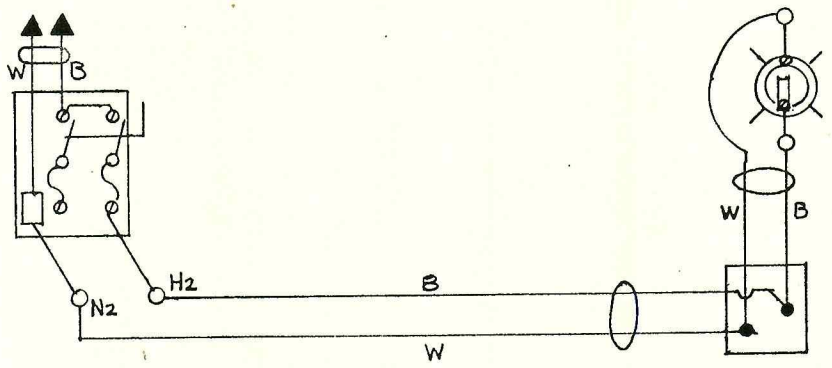

Figure 21. Single electric lamp circuit using duplex wire.

screws are tight.

(2) Connect the jumper to the line side of the safety switch for the grounded system connection.

(3) Connect a duplex wire marked letter A to the receptacle A, the black wire to input jack No. 2 and the white wire at input jack No. 1.

(4) Connect a duplex wire marked letter B to the safety switch, the white wire to the input jack marked N_2 and the black wire to the input jack marked H_2 and bring the other end to junction box J_1.

(5) Inside the box joint the black wire from the receptacle with the black wire of the source and the white wire from the receptacle with the white wire from the source.

(6) Check the wiring connections.

(7) Mount the bulb.

(8) Test the wiring connections.

Concept 16 -- One Bulb Controlled by a Single-Pole Tumbler Switch Using a Duplex Wire

Brief information. This type of wiring is usually used when installing an electric lamp controlled

by a single-pole switch using a PD-X wire following the barangay house wiring method. It is an example of a light installed in a room. This wiring installation follows a color coding.

The advantage of this type of wiring installation is that it is neat, as it is run flat on the surface of the house partitions or other parts of the house.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

3 sets of duplex cord wire

1 piece bulb, 50 watts and 220 volts

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at the "Off" position and be sure that the binding screws are tight.

(2) Connect duplex wire marked letter A to receptacle A, the white wire to input jack No. 1 and the black wire to input jack No. 2 and bring the other end of the wire inside the junction box.

Wiring diagram.

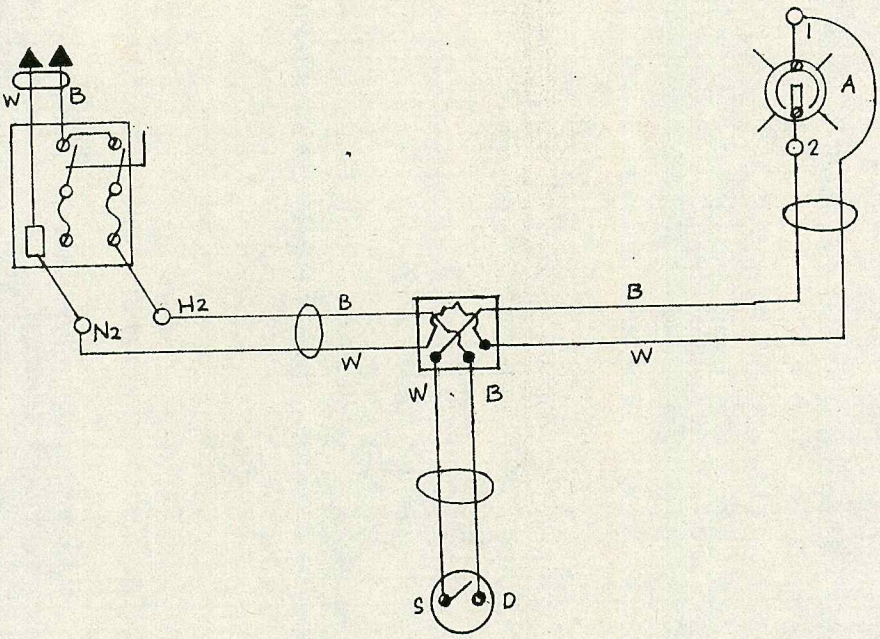

Figure 22. One bulb controlled by a single-pole tumbler switch using duplex wire.

(3) Connect another duplex wire marked letter B to the tumbler switch D, the black wire at input jack No. 4 and the white wire at input jack No. 3. The wires here can be interchange. Bring the other end of the wire inside the box.

(4) Connect another duplex wire marked letter C to the safety switch, the white wire to input jack marked N_2 and the black wire to input jack marked H_2 and bring the other end of the duplex wire inside the box.

(5) Inside the junction box, connect the black wire from the receptacle to the white wire from the tumbler switch. Then connect the black wire from the tumbler switch to the black wire from the safety switch. And finally, connect the white wire from the receptacle to the white wire from the safety switch.

(6) Check the wiring connections.

(7) Mount the bulb.

(8) Test the wiring installation.

Concept 17 -- Series Circuit
Using Duplex Wire

Brief information. The application on this circuit is the same as the series circuit which uses a single wire. Duplex wire is used in the installation when it is required by the local or national electrical regulation, as what is being practiced and required in the barangay house wiring installation as required, a PD-X, a duplex wire must be used. PD-X wire is more advantageous than a single wire because the conductors are already color coded for the neutral and hot wire connection.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

3 sets of duplex wire, black and white

2 pieces of bulbs, 50 watts, 110 volts

1 roll of electrical tape

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at the "Off" position and be sure that the binding screws

Wiring diagram.

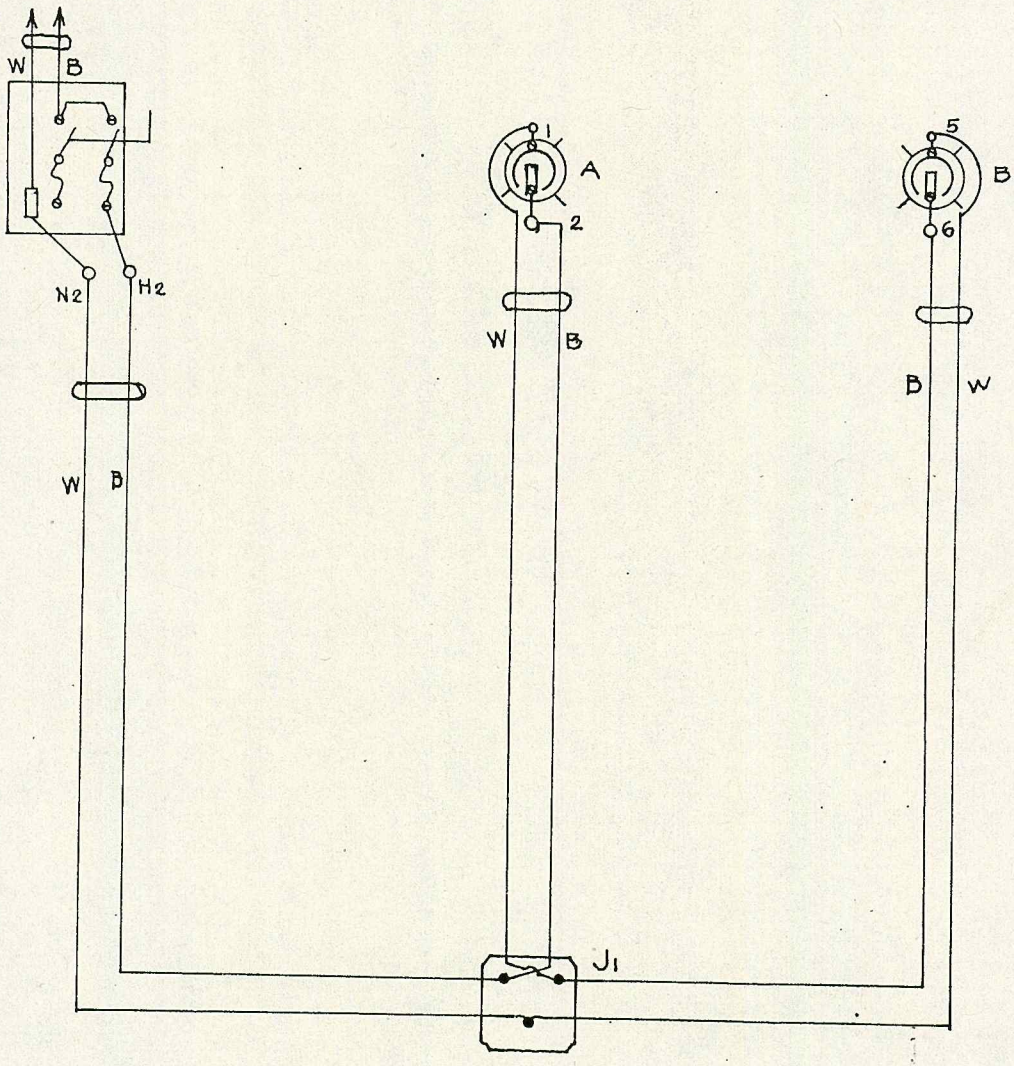

Figure 23. Series circuit using duplex wire

are tight.

(2) Connect a duplex wire marked letter A to receptacle A, the white wire to input jack marked No. 1 and the black wire to input jack No. 2 and bring the other end of the duplex wire inside the junction box J_1.

(3) Connect another duplex wire marked letter B to the receptacle B, the white wire to input jack No. 5 and the black wire to input jack No. 6 and bring the other end of the duplex wire inside the junction box J_1.

(4) Connect another duplex wire marked letter C to the safety switch, the white wire to input jack marked N_2 and the black wire to input jack marked H_2 and bring the other end to box J_1.

(5) Inside the junction box, connect the black wire from the receptacle to the black wire of the source. Connect the white wire from receptacle A to the black wire from receptacle B and finally, connect the white wire from receptacle B to the white wire of the source.

(6) Check the wiring connections.

(7) Cover the wiring connections with electrical tape.

(8) Mount the bulbs.

(9) Test the wiring connections.

Concept 18 -- Two Bulbs in Series Controlled by a Single Tumbler Switch Using a Duplex Wire

Brief information. The application of this type of wiring installation is similar to a bulbs in series circuit using a single wire. Duplex wire, like PD-X wire is used when it is required by the local or national electrical regulation as what is being practiced and required in the barangay house wiring installation.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

4 sets of duplex cord wire, black and white

2 pieces bulbs, 50 watts, 110 volts

1 roll electrical tape

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at the "Off" position and be sure that the binding screws

Wiring diagram.

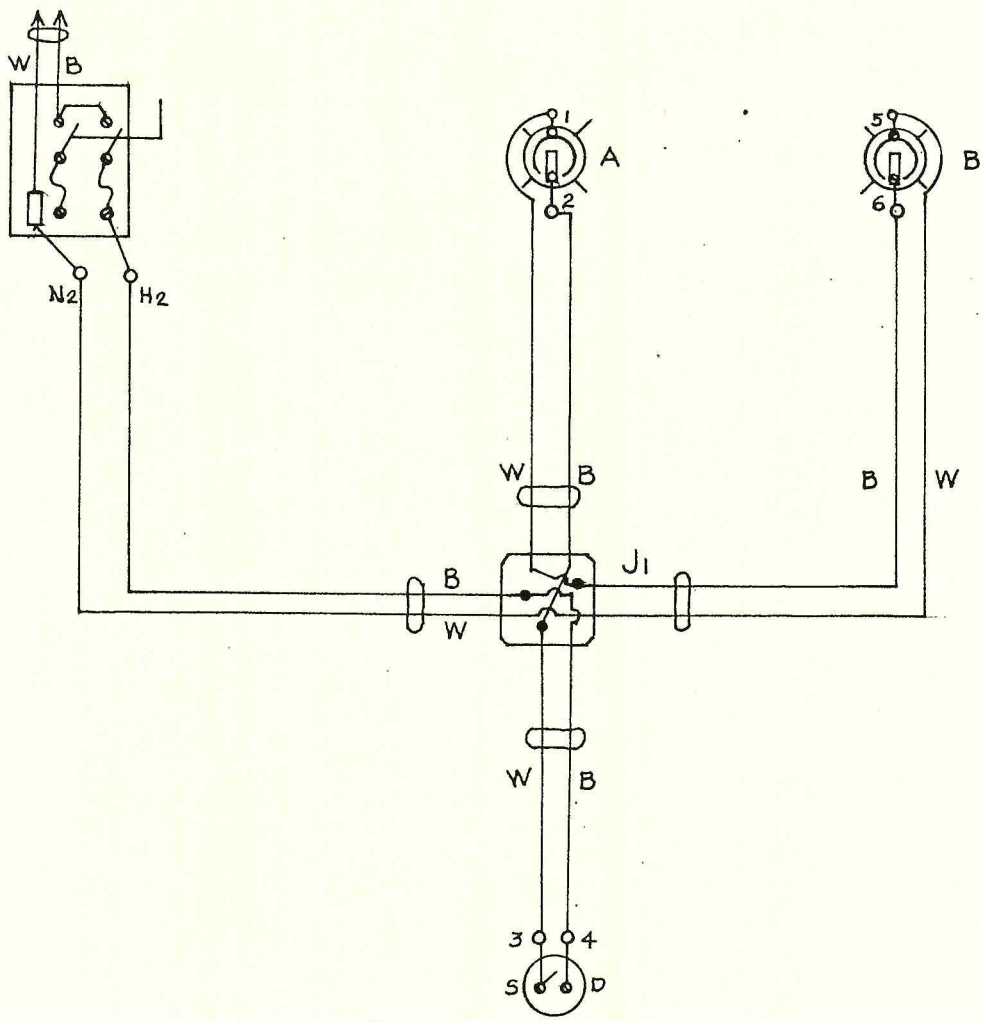

Figure 24. Two bulbs in series controlled by a single-pole tumbler switch using a diplex wire.

are tight.

(2) Connect the duplex wire marked letter A at receptacle A, the white wire to input jack marked No. 1 and the black wire to input jack No. 2 and bring the other end of the duplex wire inside the junction box J_1.

(3) Connect another duplex wire marked letter B to the receptacle B, the white wire to input jack No. 5 and the black wire to input jack No. 6 and bring the other end of the duplex wire inside the junction box J1.

(4) Connect another duplex wire marked letter E to the tumbler switch D, the white wire to input jack No. 3 and the black wire to input jack No. 4 and bring the other end inside the box J_1.

(5) Inside the junction box, connect the black wire from receptacle A to the white wire from the tumbler switch, connect the white wire from receptacle A to the black wire from receptacle B to the white wire from the safety switch and finally, connect the black wire from the source to the black wire from the tumbler switch.

(6) Check the wiring connections.

(7) Cover the wire joints inside the junction box with electrical tape.

(8) Mount the bulbs.

(9) Test the wiring connections.

Concept 19 -- Three Bulbs in Parallel Controlled by a Single-Pole Tumbler Switch Using a Duplex Wire

Brief information. This type of wiring installation is applicable in barangay house wiring installation following the NEA wiring standard where two or more lamps light simultaneously. The wire that will be used is a PD-X wire.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

5 sets of duplex cord wire, black and white

3 pieces bulb, 50 watts, 230 volts

1 roll electrical gadget

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at "Off" position and be sure that the binding

Wiring diagram.

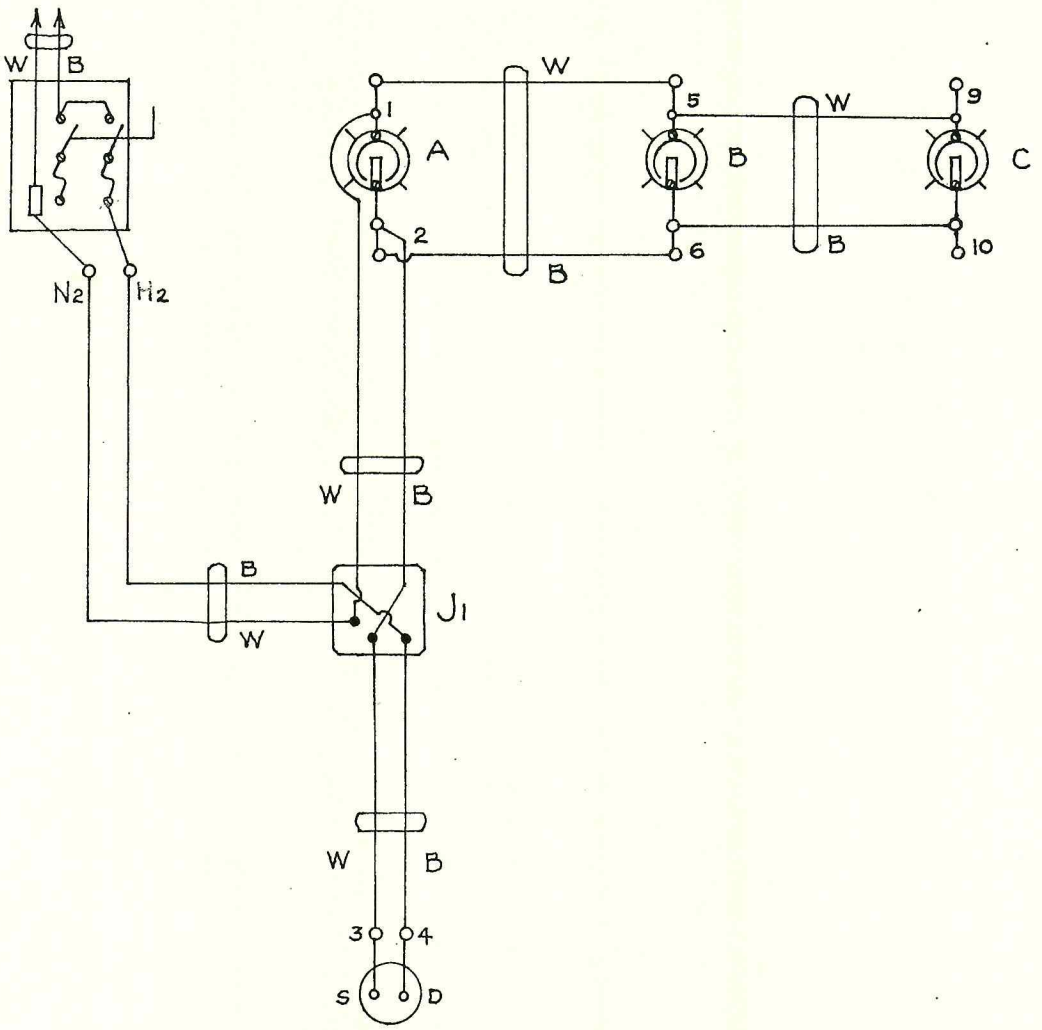

Figure 25. Three bulbs in parallel controlled by a single-pole switch using a duplex wire.

screws are tight.

(2) Connect a duplex wire marked letter A to receptacle A, the white wire to input jack No. 1, the black wire to input jack No. 2 and bring the other end of the duplex wire inside the junction box J_1.

(3) Connect a duplex wire marked letter K, the white wire to the other input jack No. 1 and the black wire at input jack No. 2 and connect the other end to receptacle B, the white wire to input jack No. 5 and the black wire to input jack No. 6.

(4) Connect another duplex wire marked letter L to receptacle B, the white wire to the other input jack No. 5 and the black wire to the other input jack No. 6 and connect the other end to receptacle C, the white wire to input jack No. 9 and the black wire to input jack No. 10.

(5) Connect another duplex wire marked letter E to single-pole switch D, the white wire to input jack No. 3 and the black wire to input jack No. 4 and bring the other end to junction box J_1.

(6) Connect another duplex wire marked letter

C to the safety switch, the white wire to input jack marked N_2 and the black wire to input jack marked H_2.

(7) Inside the junction box J_1, connect the black wire from receptacle A to the white wire from the tumbler switch D, then connect the white wire from the same receptacle to the white wire from the source and finally, connect the black wire of the tumbler switch to the black wire from the source (safety switch).

(8) Check the wiring connections.

(9) Cover the joints with electrical tape.

(10) Mount the bulbs.

(11) Test the wiring connections.

Concept 20 -- Three Bulbs in Parallel with Individual Control of Single-Pole Tumbler Switch Using a Duplex Wire

Brief information. This type of wiring installation is applicable when making the house wiring installation in rural areas following the NEA wiring standard. With individual control switch the bulb in each room can have its operation independently.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

8 sets of duplex cord wire, black and white

3 pieces of bulb, 50 watts, 230 volts

1 roll of electrical tape

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at "Off" position and be sure that the binding screws are tight.

(2) Connect one set of duplex wire marked letter A to receptacle A, the white wire to input jack No. 1 and the black wire to input jack No. 2 and bring the other end of the duplex wire inside the junction box J_1.

(3) Connect another duplex wire marked letter B to the single-pole switch D, the white wire to input jack No. 3. Then bring the other end of the duplex wire inside the junction box J_1.

(4) Connect another duplex wire marked letter H to the safety switch, the white wire to the input jack marked N_2 and the black wire

Wiring diagram.

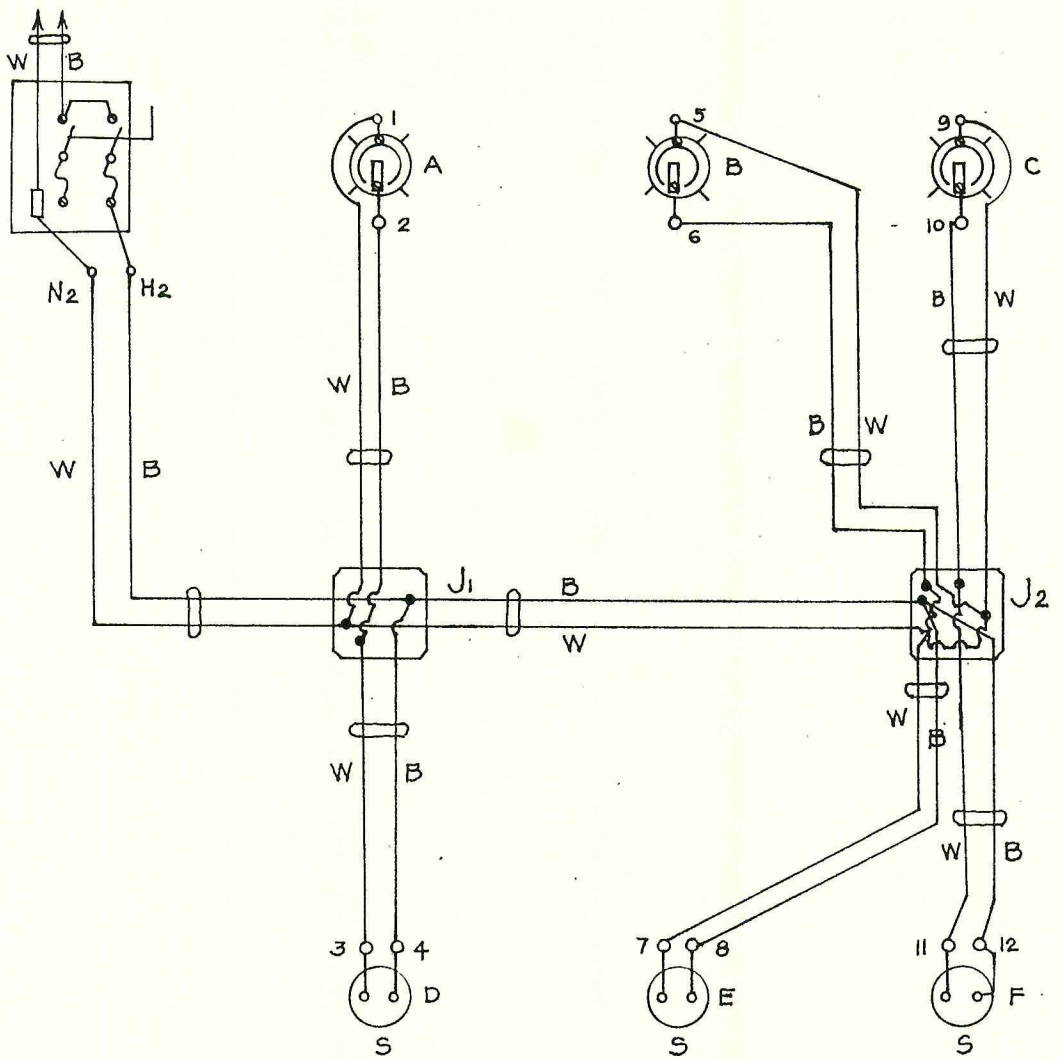

Figure 26. Three bulbs in parallel with individual control of single-pole tumbler switch using a duplex wire.

to the input jack marked H_2.

(5) Inside the junction box connect the black wire from receptacle A to the white wire from the tumbler switch D, connect the white wire from receptacle A to the white wire from the source and finally, connect the black wire from the tumbler switch to the black wire from the source.

(6) Connect another duplex wire marked letter J at junction J_1, the black wire is connected to the black wire from the source and the white wire from the sources, then bring the other end of the duplex wire (J) to junction box J_2.

(7) Connect another duplex wire marked letter D to receptacle B, the white wire to input jack No. 5 and the black wire to input jack No. 6 and bring the other end of the duplex wire inside the box J_2.

(8) Connect another duplex wire marked letter E to the single-pole tumbler switch E, the white wire to input jack No. 7, the black wire to input jack No. 8, then bring the other end of the duplex wire inside junction box J_2.

(9) Follow procedure No. 5 for the wiring connection of receptacle B and single-pole tumbler switch E to the source.

(10) Connect another duplex wire marked letter F to receptacle C with the white wire to input jack No. 9 and the black wire to input jack No. 10, the other end to junction box J_2.

(11) Connect another duplex wire marked letter C to single-pole tumbler switch F, the white wire to input jack No. 11 and the black wire to input jack No. 12.

(12) Follow procedure No. 5 for the wiring connection of receptacle C and single-pole tumbler switch F to the source.

(13) Check the wiring connections.

(14) Cover the wire joints with electrical tape.

(15) Mount the bulbs.

(16) Test the wiring connections.

Concept 21 -- One Bulb Controlled by Two Three-Way Switches Using Duplex Wire

Brief information. This is another type of wiring installation in barangay house wiring installation using a PD-X wire. A lamp is controlled by three-way switches when it is desired to control it in two locations. An

example to this is a lighting on the stairway of a two-storey house where the lamp can be controlled either up-stair or down-stair. Note that there is always one extra black wire at the three-way switch when using a PD-X wire.

The advantage of this wiring is that, when the lamp is switch "On" at the second floor when going down-stair it can be switch "Off" upon reaching the first floor and vice versa.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

6 sets of duplex cord wire, black and white

1 piece bulb, 50 watts, 230 volts

1 roll plastic tape

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at the "Off" position and be sure that the binding screws are tight.

(2) Connect a duplex wire marked letter A to receptacle A, the white wire to input jack

Wiring diagram.

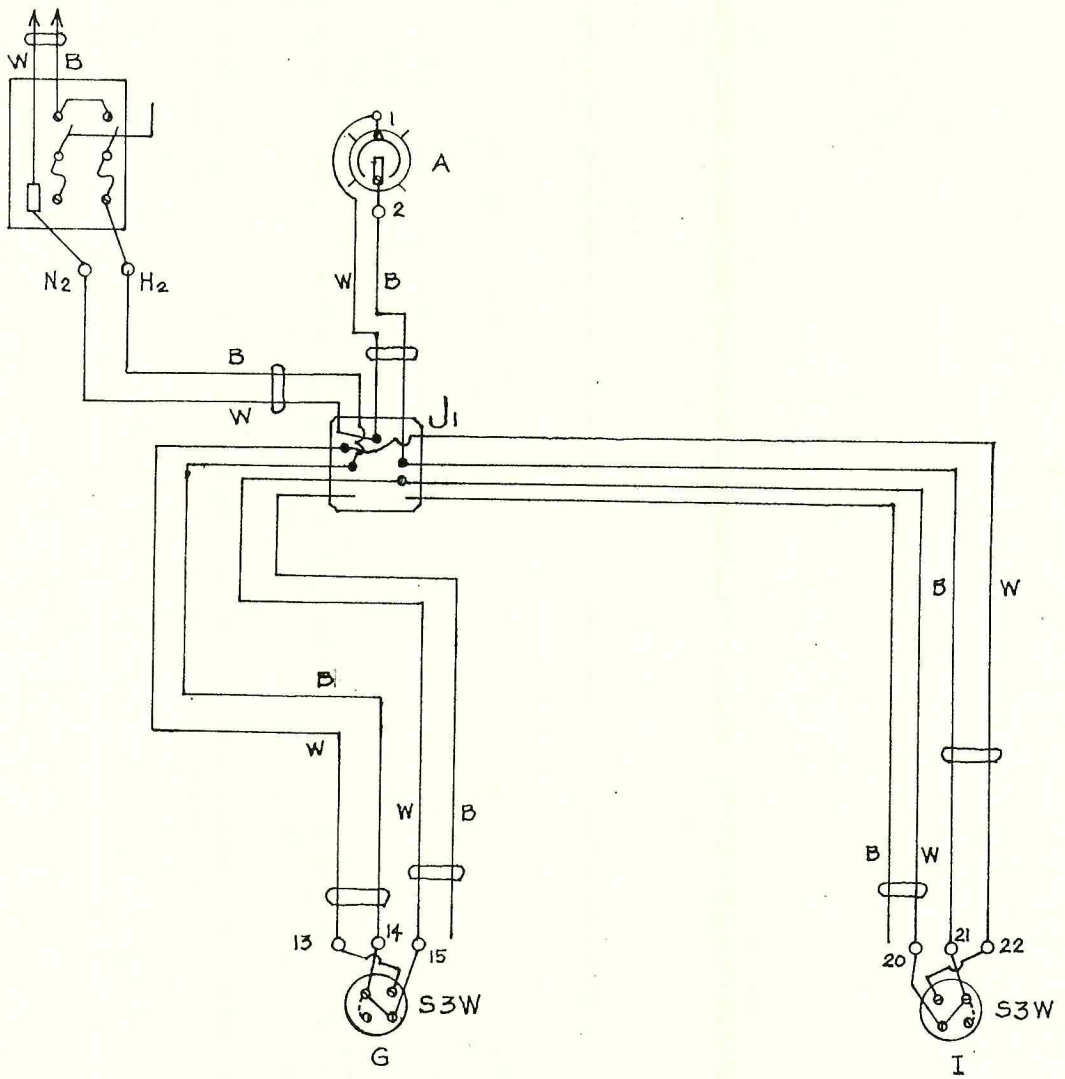

Figure 27. One bulb controlled by two three-way using a duplex wire, black and white.

No. 1 and the black wire to input jack No. 2 and bring the other end of the duplex wire A inside the junction box J_1.

(3) Connect the two. sets of duplex wire marked letter E and G to the three-way switch marked G, one white wire to input jack No. 13, the black wire to input jack No. 14 and the other white wire to input jack marked 15, then bring the other ends inside junction box J_1.

(4) Connect another two sets of duplex wires marked H and I to three-way switch marked letter I, one white wire to input jack No. 20, the black wire to input jack No. 21 and the other white wire to input jack No. 22.

(5) Connect another duplex wire marked letter C at the safety switch, the white wire to input jack marked N_2 and the black wire to input jack marked H_2 and bring the other end of the duplex wire (C) inside the junction box J_1.

(6) Inside the junction box connect the black wire from receptacle A to the black wire from the three-way switch I. Connect the

white wire from receptacle A to the white wire of the source. Connect the two white wires from three-way switch G to the two white wire from the three-way switch I. And finally, connect the black wire from the three-way switch G to the black wire of the safety switch.

(7) Check the wiring connections.

(8) Cover the joints with electrical tape.

(9) Mount the bulb.

(10) Test the wiring connections.

Concept 22 -- One or More Bulbs Controlled by Two Three-Way and One Four-way Switches Using Black and White Duplex Wire

Brief information. This circuit is used where it is desired to control a light from three different locations, as for a hall light in a three-storey house with a switch on each floor. In this circuit the two three-way switches are connected in regular way, with the two shunt wires connecting both switches, The four-way switch is connected in the shunt wires between the two three-way switches and acts as a pole changer; in one position it allows the shunt wires to be connected straight through, and in the next position is reverses the connections of the shunt wires.[45]

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[45] Perry, op. cit., p. 191.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

8 sets of duplex cord wire, black and white

1 piece bulb, 50 watts, 230 volts

1 roll electrical tape

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Check that the safety switch is at the "Off" position and be sure that the binding screws are tight.

(2) Connect a duplex wire marked letter A to receptacle A, the white wire to input jack No. 1 and the black wire to input jack No. 2 and bring the other end of the duplex wire A inside the junction box J_1.

(3) Connect the two sets of duplex wires marked letter E and G to the three-way switches marked G, one white wire to input jack No. 13, the black wire to input jack No. 14 and the other white wire to input jack No. 15, then bring the other ends inside junction

Wiring diagram.

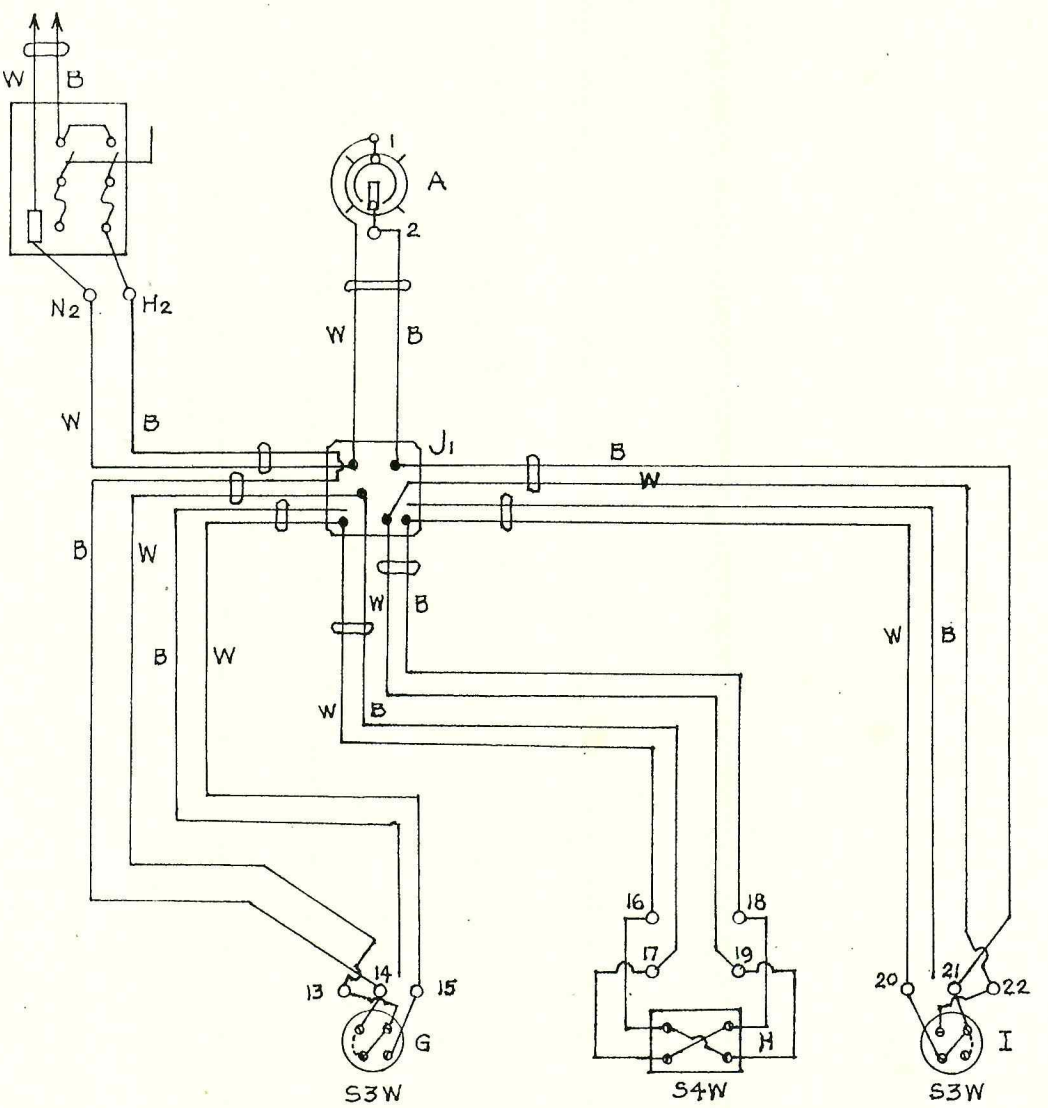

Figure 28. One bulb controlled by two three-way and one four-way switches using a duplex wire, black and white.

box J_1.

(4) Connect another two sets of duplex wires marked H and I to three-way switch marked letter I, one white wire to input jack No. 20, the black wire to input jack No. 21 and the other white wire to input jack No. 22.

(5) Connect one duplex wire marked letter D to four-way switch marked letter H, the white wire to input jack No. 16 and the black wire to input jack marked No. 17, then bring the other end of the duplex wire inside the junction box J_1.

(6) Connect another duplex wire marked letter F to the four-way (H) with the white wire to input jack No. 18 and the black wire to input jack No. 19, then bring the other end of the duplex wire (F) inside the junction box J_1.

(7) Connect another duplex wire marked letter C at the safety switch, the white wire to input jack marked N_2 and the black wire to input jack marked H_2 and bring the other end of the duplex wire (C) inside the junction box J_1.

(8) Inside the junction box, connect the black wire from receptacle A to input jack No. 21 of the three-way switch (I). Connect the white wire from input jack No. 20 to the white wire from input jack No. 18 of the four-way switch (H). Connect the white wire from input jack No. 22 of three-way switch (I) to the black wire from input jack No. 19 of the four-way switch. Connect the black wire from input jack No. 17 of the four-way switch to the white wire of the input jack No. 13 of three-way switch G. Connect the white wire from input jack No. 16 of the four-way switch to the white wire from input jack No. 15 of the three-way switch G. Connect the white wire from receptacle A to the white wire from the safety switch. And finally, connect the black wire from input jack marked No. 14 of the three-way switch (G) to the black wire from the safety switch.

(9) Check the wiring connections.

(10) Cover the joints with electrical tape.

(11) Mount the bulbs.

(12) Test the wiring connection.

Concept 23 -- How to Locate a Blown Fuse in a Line-to-Line Circuit

Brief information. A fuse in any electrical circuit act as a safety valve to protect electrical appliances from being damaged by excessive current flow or short circuits. When a short circuit occurs or excess current flows, the metal strip in the fuse melts, thereby breaking the circuit and stopping current flow. The fuse should be the weakest link in the circuit in order to give the protection for which it is designed.[46] Figure 29 shows a ferrule type of cartridge fuse and a fuse link. The fuse link will cut when there is a short circuit or over loading in the circuit.

Tools needed.

1 Screw driver

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

1 weatherproof socket

1 bulb

1 blown-out fuse

2 good fuse

the gadget itself

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[46] Ibid., p. 133.

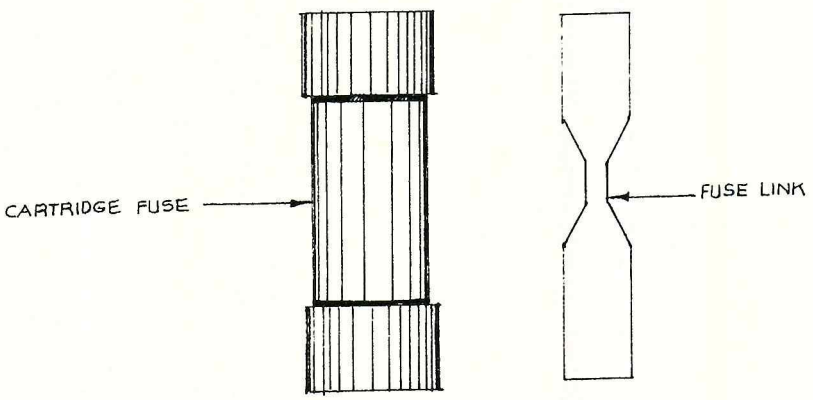

Figure 29. The ferrule type of cartridge fuse and fuse link.

Wiring diagram.

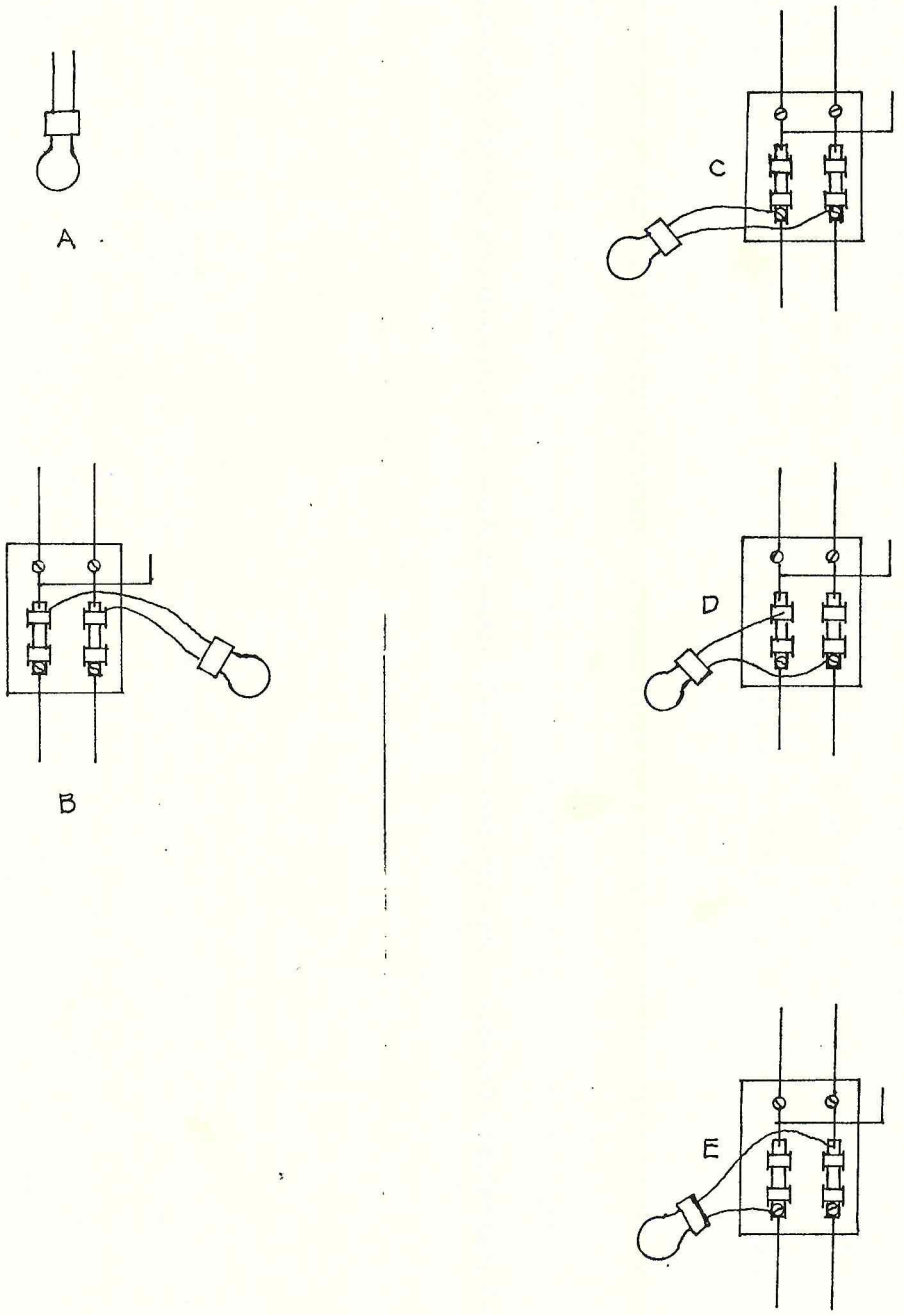

Figure 30. How to test a blown fuse in a line-to-line circuit.

Procedure.

(1) Assemble a test lamp as shown in Fig. 30-a.

(2) Remove the end terminal of the jumper on the line side of the safety switch and cover it with a tape.

(3) Test the line side of the safety switch if it has current as shown in Fig. 30-b.

(4) Test the load side of the safety switch as shown in Fig. 30-c. If the test lamp will not light it is an indication that one or both fuses are blown.

(5) To test for a defective fuse, place the leads of the tester as shown in Fig. 30-d. If the test lamp lights, the fuse on your right is not blown off.

(6) Reverse the leads of the tester as shown in figure 30-e. If the test lamp fails to light, fuse on your left is blown and needs replacement. Be careful when removing fuses not to touch any of the other fuses or the side of the metal box. If possible always put "Off" the safety switch when replacing fuses.

(7) If fuses continue to blow, remove the fuse and insert a low-wattage lamp bulb. This

> bulb will continue to light for as long as the short circuit remains. Next go from room to room and disconnect any lamp cords or appliances that are defective. After the defects that caused the short circuit are removed, the lamp bulb will be put out, and then you can insert a new fuse.[47]

Concept 24 -- How to test a Blown Fuse in a Multi- Grounded Circuit

Brief information. Multi-grounded circuit differs from line-to-line circuit because the two fuses on the safety switch is used for the two branch circuit in a house wiring installation. In this type of circuit the hot or the phase wire is fused at the disconnect and the other wire (neutral) is connected direct to the load through the ground lug fastened on the case of the safety switch.

To test a defective fuse, one test lead will be on the fuse to be tested and the other test lead will be on the ground lug or on the metal case where the neutral wire is connected for grounding purposes.

Tools needed.

1 Screw driver

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[47] Ibid., p. 132.

1 Pliers, Electrician

1 Pliers, Long-nose

Supplies and materials needed.

1 weatherproof socket

1 blown-out fuse

1 good fuse

the gadget itself

Wiring diagram. (See next page)

Procedure.

(1) Assemble a test lamp as shown in Fig. 31-a.

(2) Reconnect the jumper on the line side of the safety switch.

(3) Test the line side of the safety switch by placing the leads of the test lamp as shown in Fig. 31-b. If the test lamp lights it is an indication that there is current on the line side of the safety switch.

(4) To test the fuse of circuit 1 (C1), place the leads of the test lamp such as one is on the case or on the ground lug of the safety switch and the other lead at the load side of C1 as shown in Figure 31-c. If the test lamp fails to light the fuse is blown and needs replacement.

Note: Be careful in removing the

Wiring diagram.

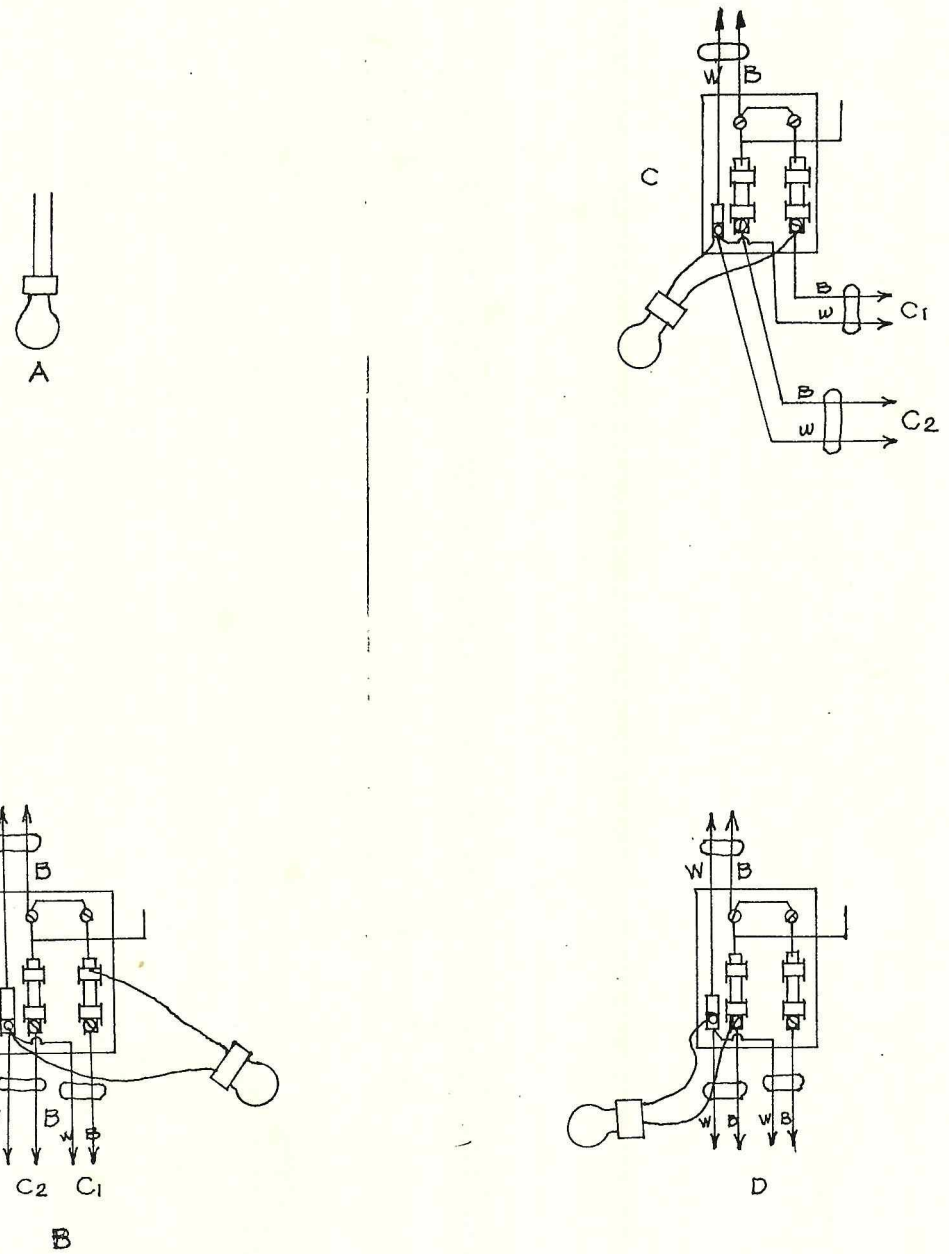

Figure 31. Testing fuse in a multi-grounded circuit.

fuses not to touch the side of the metal box. If possible switch "Off" the safety switch when replacing the fuses.

(5) To test the fuse of circuit 2 (C2), place the leads of the test lamp such as one lead is on the case or at the ground lug of the safety switch and the other lead at the load side of C2 as shown in Fig. 31-d. If the test lamp fails to light it is an indication that the fuse of C2 is blown and also needs replacement.

(6) If the fuse continue to blow in the particular circuit, remove the fuse and insert a low-wattage lamp bulb. This bulb will continue to light for as long as the short circuit remains. Next go from room to room and disconnect any lamp cords or appliances that are defective. After the defects that caused the short circuit are removed, the lamp bulb will be put out, and then you can insert a new fuse.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The high cost of electrical supplies and materials coupled with the inability of many schools to purchase supplies and materials to provide the needs for teaching devices are pervading problems that are often encountered by teachers and instructor in electricity. With the desire to alleviate the problem this study was conducted.

The purpose of the study is to develop a gadget in electric circuits for demonstration. Specifically, this study attempts: (1) to design and construct a gadget in electric circuits for demonstration lessons using local available materials and recycled discarded electrical materials, (2) to utilize the gadget for demonstration lessons in electric circuits, (3) to develop skills on the students in the exercise of practical operation and application of circuit connections, and (4) to test the gadget to ensure relevant criteria of excellence is attained.

The study is limited to the construction of electrical multi-circuit demonstration gadget out of local and discarded materials. The construction, specification

of materials design, operation manual and the cost of production are included. Twenty-four electric circuits demonstration lessons including trouble-shooting were designed to test the effectiveness of the gadget.

Conclusion

On the basis of the findings, the following conclusions are drawn: (a) the gadget can be used for twenty-four demonstration lessons in electric circuits, namely; (1) single electric lamp circuit using single wire, (2) One bulb controlled by a single-pole tumbler switch, single wire, (3) series circuit, single wire, (4) three bulbs in series controlled by a single-pole tumbler switch, single wire, (5) parallel circuit, single wire, (6) three bulbs in parallel circuit controlled by a single-pole tumbler switch individually, single wire, (7) three bulbs in parallel controlled by a single-pole tumbler switch, single wire, (8) one bulb controlled by two 3-way switch, single wire, (9) one or more bulbs controlled by two 3-way and one 4-way switch, single wire, (10) open circuit, (11) close circuit, (12) short circuit, (13) multi-grounded circuit, using duplex wire, (14) line-to-line circuit, (15) single electric lamp circuit, duplex wire, (16) one bulb controlled by a single-pole tumbler switch, duplex wire, (17) series circuit, duplex wire, (18) two

bulbs in series controlled by single-pole tumbler switch, duplex wire, (19) three bulbs in parallel controlled by a single-pole tumbler switch, duplex wire, (20) three bulbs in parallel with individual control of single-pole tumbler switch, (21) one bulb controlled by two 3-way switch, duplex wire, (22) one or more bulbs controlled by two 3-way and one 4-way switch, duplex wire, (23) how to locate blown fuse in a line-to-line circuit, and (24) testing blown fuse in multi-grounded circuit and proven to be functional in all operation; (b) the improvised multi-electric circuit demonstration gadget can be constructed utilizing locally available and discarded materials; (c) the expenses in the construction of teaching devices in electricity on lamp circuit and convenience outlet connections including trouble-shooting of the safety switch was minimized; (d) time consumption in demonstration of electric circuit lesson was likewise minimized; (e) the gadget awaken students interest in the application of concepts in electricity; (f) the student taught using the gadget as a device learned effectively the application of the basic circuits, trouble-shooting and safety precautions.

Recommendation

In the light of the results revealed by this study, on the basis of observations made the following

recommendations were formulated:

(1) Further studies on improvisation of other teaching devices in industrial electricity and electrical technology be encouraged.

(2) Production of the improvised electrical multi-circuit demonstration gadget be encouraged.

(3) Industrial electricity and electrical technology instructors should reproduce the gadget with the school to provide the materials needed for the production, utilizing students in the construction as a project, of course under the supervision and guidance of the instructor.

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A P P E N D I C E S

APPENDIX A

SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

December 7, 1983

The Acting Dean of Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar

S i r :

In my desire to start writing my seminar paper proposal, I have the honor to request approval of one of the following topics for my thesis; preferably topic No. 1.

1. AN IMPROVISED ELECTRICAL MULTI-CIRCUIT DEMONSTRATION GADGET: A TECHNICAL FEASIBILITY STUDY

2. IMPROVISED ELECTRIC SOLDERING GUN

3. STATUS OF THE FOURTH YEAR SECONDARY INDUSTRIAL ELECTRICITY STUDENTS OF THE SAMAR STATE POLYTECHNIC COLLEGE FOR INDUSTRIAL EMPLOYMENT

I hope for your early favorable action on this request.

Very truly yours,

(SGD.) CLEMENTE O. BAO

Recommending Approval:

(SGD.) ALEJANDRO E. CANANUA
Acting Director
Research and Extension Services

APPROVED:

(SGD.) DOMINADOR Q. CABANGANAN, Ed. D.
Acting Dean, Graduate Studies

APPENDIX B

Republic of the Philippines
SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

GRADUATE SCHOOL

APPLICATION FOR ASSIGNMENT OF ADVISER

NAME BAO, CLEMENTE OLANO
Family Name First Name Middle Name

CANDIDATE FOR DEGREE IN M.A.T.

AREA OF SPECIALIZATION Electrical Technology

TITLE OF PROPOSED THESIS IMPROVISED ELECTRICAL MULTI-CITCUIT DEMONSTRATION GADGET

NAME OF REQUESTED ADVISER Asso. Prof. Alejandro E. Cananua

APPROVAL OF ADVISER ALEJANDRO E. CANANUA .DISAPPROVAL.

(SGD.) ALEJANDRO E. CANANUA .....
Signature Signature

Approved: (SGD.)DOMINADOR Q. CABANGANAN, Ed.D. Date Dec. 16, 1983
Dean, Graduate Studies

APPENDIX C

SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

April 20, 1984

The Dean of Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar
(Through the Adviser)

S i r :

I have the honor to request that I be scheduled for Pre-Oral Examination on my seminar paper entitled "AN IMPROVISED ELECTRICAL MULTI-CIRCUIT DEMONSTRATION GADGET" on or before May 31, 1984.

In this connection, I am submitting five copies of my research proposal for distribution to the Dean, to the panel members and to my adviser.

I hope for your early favorable action on this request.

Very truly yours,

(SGD.) CLEMENTE O. BAO
Researcher

Recommending Approval:

(SGD.) ALEJANDRO E. CANANUA, M. ed.
Adviser

APPROVED:

(SGD.) DOMINADOR Q. CABANGANAN, Ed. D.
Dean of Graduate Studies

APPENDIX D

SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

February 10, 1986

The Dean of Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar
(Through the adviser)

S i r :

In my avowed desire to graduate this school year, I have the honor to request that I be scheduled for the Final Defense of my seminar paper entitled "AN IMPROVISED ELECTRICAL MULTI-CIRCUIT DEMONSTRATION GADGET" on or before February 20, 1986.

In this connection, I am submitting six copies of my seminar paper for distribution to the Dean, to the panel members and to my adviser.

I hope for your early favorable action on this request.

Very truly yours,

(SGD.) CLEMENTE O. BAO
Researcher

Recommending Approval:

(SGD.) ALEJANDRO E. CANANUA, M. Ed.
Adviser

APPROVED:

(SGD.) DOMINADOR Q. CABANGANAN, Ed. D.
Dean of Graduate Studies

APPENDIX E

SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

April 11, 1986

The Dean of Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar

S i r :

I hereby certify that Asst. Prof. Clemente O. Bao has completed the finally corrected and edited copy of his seminar paper entitled "AN IMPROVISED ELECTRICAL MULTI-CIRCUIT DEMONSTRATION GADGET" and that he has properly considered the comments and incorporated the suggestions of the panel examiners.

I, therefore, recommend his seminar paper for approval and reproduction to the prescribed number of copies.

I hope for your early favorable action in this regard.

Very truly yours,

(SGD.) ALEJANDRO E. CANANUA, M. Ed.
Adviser

APPROVED:

(SGD.) DOMINADOR Q. CABANGANAN, Ed. D.
Dean, Graduate Studies

APPENDIX F

NEA WIRING STANDARD FOR MEMBER OWNED WIRING INSTALLATION

1. Service entrance wire from the kilowatt-hour meter to the disconnect switch shall be of the PD-X type, 30 amperes capacity or larger. Branch circuit wire shall be of 15 amperes capacity or larger, #10 and #14 respectively.

2. Length of service entrance wire must be 3 meter for residential houses and 5 meters for commercial building.

3. Disconnect switch must be rated 30 amperes capacity or larger and should permit manual operation by individual handle. The energized component of the switch must be enclosed in a weather-proof enclosure. Preferably, porcelain material should be used or the insulated base for the switch.

4. Phase wire (ungrounded wire) of each circuit must be fuse at the load side of the disconnect switch. Fuse must be at the load side of the disconnect switch. Fuse must not be larger than the rated conductor of the circuit conductor.

5. Neutral wire shall not be fused and shall be continuous to the wiring work. Switching circuit shall be for the phase wire only.

6. There must be at least two branch circuit per dwelling.

7. Not less than one lamp fixture shall be installed in each room of the dwelling. A junction box be used to support the fixture and conceal the connection.

8. A minimum of two appliance outlets shall be installed in each home and shall have a rating of not less than 10 amperes, 220 volts.

9. Insulated cable straps or electrical staples shall be used to support all wiring conductors. For readily accessible 6 inches apart, and a distance not greater than 12 inches in inaccessible location.

APPENDIX F (Continued)

10. All metal enclosure or fixtures shall be grounded by use of a connection to the neutral wire with solderless connectors.

11. Junction boxes should be the non-metallic, heat resistance type.

12. All fixtures, switches, outlets and junction box shall be mounted in their permanent position by use of not less than two screws or bolts.

13. All connections of conductors should be made with insulated wire connectors and shall be or the solderless type.

14. Service entrance conductors and all conductors installed within the dwelling shall be insulated and of the type designed for use in exposed location, heat and water resistance. The white colored insulated conductor is always the neutral.

15. All eletrical apparatus, switch outlets and fixture shall be designed for use on a 240-volt system.

16. In masonry constructed home, cables shall be located with wood strips of not less 1/4 inch thickness and 1 inch width.

17. Cable should enter the side or bottom of wall-mounted switch or outlets.

18. Frames of permanently mounted electric motor shall be grounded by a connection to the neutral wire.

19. The length of connecting wire from junction box to light fixtures or for wire connection in the junction box, be not less than 6 inches.

20. In addition to the above standards, all wiring shall be done in compliance with provisions of the Philippine Electrical Code (PEC).

APPENDIX G

ELECTRICAL SYMBOLS USED IN THE WIRING DIAGRAM

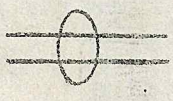
S_{3w} . . . . . 3-way switch

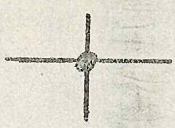
S_{4w} . . . . . 4-way switch

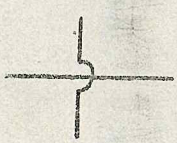
S . . . . . Tumbler switch, single-pole


. . . . . Ceiling light outlet or receptacle

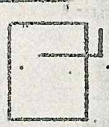
. . . . . Electric wire, single


. . . . . Electric wire, double


. . . . . Electric wire, connected


. . . . . Electric wire, not connected


. . . . . Junction box


. . . . . Safety switch

APPENDIX H

SAFETY PRECAUTIONS

The demonstrator must observe the following safety precautions:

1. Put "Off" the main switch (safety switch) when making the electrical connection.

2. Do not interchange the connection for the white wire and the black wire.

3. Use the right size of fuse.

4. Insulate all connections before energizing the gadget.

5. Stand on an insulator when operating the gadget if possible.

6. Replace defective fixtures such as socket, switch, convenience outlet and the like, with new ones, defective fixtures are electrical hazard.

7. Avoid loose contact on electrical connections, this will cause arcing and overheating at the connections making a destruction of the contact or connection and also increase the resistance of the circuit.

7. Avoid loose contact on electrical connections, this will cause arcing and overheating at the connections making a destruction of the contact or connection and also increase the resistance of the circuit.

8. Use right tools for the right job.

9. Make a final check-up on the wiring before energizing the circuit.

10. Make a follow-through motion when switching "On" the main switch.

APPENDIX I

MAINTENANCE OF THE GADGET

In order that the gadget will be always in good condition the following recommendations are hereby enumerated:

1. Apply just enough grease at the switch contact blades.

2. Check all contactors if they are still strong enough ready for the next demonstration.

3. Keep the gadget free from dust by covering it with plastic case after using.

4. Place the gadget beyond the reach of the children.

5. Check from time to time that no insects may attack the board.

APPENDIX J

BILL OF MATERIALS FOR THE CONSTRUCTION OF THE IMPROVISED ELECTRICAL MULTI-CIRCUIT DEMONSTRATION GADGET

Quantity	Materials and Specification	Cost*
1 pc.	Safety switch, 30 amperes, metal	₱80.00
3 pcs.	Straight connector, 0.95 cm.	19.50
1 pc.	Ground lug	11.00
3 pcs.	Tumbler switch	25.50
1/2 meter	Circular loom	2.50
2 pcs.	Switch, 3-way	32.00
1 pc.	Switch, 4-way	31.00
3 pcs.	Well sockets, porcelain	21.00
3 pcs.	Junction box, 10.16 cm. x 10.16 cm. x 3.81 cm.	33.00
1 meter	PD-X wire #14	8.00
1 roll	Plastic tape	12.00
2 pcs.	Male plug	4.00
9 $\frac{1}{2}$ meters	Electric cold wire, #16, double	45.00
3 meters	Soldering wire, 60-40 solder	18.00
3 pcs.	Bulb, 50 watts, 220 volts	24.00
2 pcs.	Bulb, 50 watts, 110 volts	16.00
1 pc.	Plywood, ordinary, 76 cm. x 89 cm. x 1.27 cm.	31.00
1 pc.	Plywood, ordinary, 76 cm. x 89 cm. x .39 cm.	11.00

APPENDIX J (Continued)

Quantity	Materials and Specification	Cost*
2 pcs.	Sandpaper, wood, #0	₱ 4.00
152 pcs.	Wood screw, 0.25 cm. x 1.2 cm.	15.20
34 pcs.	Wood screw, 0.35 cm. x 1.92 cm.	8.50
1/8 kilo	Nail, 5.08 cm., common	1.50
1 pc.	Epoxy	21.00
2 pints	Paint, enamel, yellow	34.00
60 cc.	Paint, enamel, white	7.00
60 cc.	Paint, enamel, black	7.00
60 cc.	Paint, enamel, silver	7.00
Total		₱531.95

*Based on current prices.

CURRICULUM VITAE

NAME	:	CLEMENTE OLANO BAO SR.
PLACE OF BIRTH	:	Tanjay, Negros Oriental
DATE OF BIRTH	:	November 23, 1939
WIFE	:	Natividad Cabanatan Bao
CHILDREN	:	Clemente Jr. 15
		Nathan 14
		Sherwin 13
		Cherish-Joy 7

EDUCATIONAL BACKGROUND

Elementary	East Negros Institute Tanjay, Negros Oriental 1953
Secondary	East Negros Institute Tanjay, Negros Oriental 1957
College.	East Visayan School of Arts and Trades, Dumaguete City, 1961 Three-Year-Trade Technical Graduate, Electrical Technology (Major) Cebu School of Arts and Trades, Cebu City, 1964 Bachelor of Science in Industrial Education, Electrical Technology (major)
Graduate Studies	Marikina Institute of Science and Technology, Marikina, Metro Manila, Master of Arts in Teaching Electrical Technology (42 units), 1978

Samar State Polytechnic
College, Catbalogan, Samar
Master of Arts in Teaching
Electrical Technology
(12 units), 1984

SCHOLARSHIP GRANT

DEC Integrated Graduate Program, Marikina Institute of Science and Technology, Marikina, Metro Manila, Master of Arts in Teaching Electrical Technology, 1978

HONORS AND AWARDS

Certificate of Appreciation (Outstanding work as chairman of Light and Public Address System during the 1966 Samar Provincial Athletic Meet), Catbalogan, Samar, 1966

Certificate of Appreciation (Chairman, Committee on Sound System, National Sports and Physical Fitness Festival), Catbalogan, Samar, 1967.

Certificate of Appreciation (Chairman, Sound System Committee, Samar Division Sports Clinic), Catbalogan, Samar, 1976.

Certificate of Appreciation (Sound System Committee, Echo Seminar-Workshop in Guidance), Samar School of Arts and Trades, Catbalogan, Samar, 1978.

Certificate of Appreciation (Meritorious contribution to the development of the Cultural Heritage of the Province as an active member of the Samar Provincial Choristers), Office of the Governor, Catbalogan, Samar, 1980.

Merit Award (Valuable and Outstanding services in making the ONE-DAY CONFERENCE ON ADMINISTRATIVE AND PROFESSIONAL MATTERS a success), Samar School of Arts and Trades, Catbalogan, Samar, 1981.

Certificate of Merit (Chairman, Electricity, FFP-FAHP-FFPCC), Samar School of Arts and Trades, Catbalogan, Samar, 1981.

Certificate of Merit (Chairman, Sound, Music and Light during the Regional FFP/FAHP/FFPCC Work-Conference) Samar School of Arts and Trades, Catbalogan, Samar, 1981.

Certificate of Commendation (Chairman, Light and Sound System Committee, Third Regional Youth Science Camp) Samar School of Arts and Trades, Catbalogan, Samar, 1982.

Certificate of Commendation (Chairman, Skill Contest in Electricity, FFP/FAHP/FFPCC Week Celebration), Samar School of Arts and Trades, Catbalogan, Samar, 1982.

Certificate of Merit (Active Member of the Samar Provincial Choristers), Office of the Governor, Catbalogan, Samar, 1982.

Certificate of Appreciation (Chairman, Sound System, Farmers and Homemakers Organization), Samar State Polytechnic College, Catbalogan, Samar, 1984.

CULTURAL PARTICIPATION

MECRO 6th Anniversary Celebration - Cultural Activities, Tacloban City, 1981.

CIVIL SERVICE ELIGIBILITIES

Secondary Teacher, 1965 . . . . . 71.4%

Master Electrician, 1977 . . . . . 83.0%

TEACHING EXPERIENCE

Samar State Polytechnic College, Catbalogan, Samar
1965 - to present.

PRESENT POSITION

Instructor . . . . . Samar State Polytechnic College, Catbalogan, Samar 1984

IN-SERVICE TRAINING ATTENDED

Echo Work-Conference on Audio-Visual Education, 1965.

Echo Seminar for Senior Scouts, 1973.

Regional In-Service Training in Electricity, 1973.

Sports Clinic of Physical Development of Supervisors and Coaches, 1975.

Mini-JET District Seminar, 1975.

Seminar Workshop on the Re-Appraisal of the Technician Education Curricula, 1976.

Echo-Seminar Workshop on Various Subjects to Increase Teachers-Employees Competences, 1977.

Sixth Refreshal Course on Motor/Transformer Rewinding, 1977.

JET Training Institute Level IV, 1978.

Echo-Seminar-Workshop on Guidance, 1978.

Seminar-Workshop in Curriculum Design and Development Including Achievement Testing (Phase II - A), 1979.

One-Day Conference on Administrative and Professional Matter, 1981.

STANDING MEMBERSHIP ON ORGANIZATION

Member . . . . . Visayas-Mindanao Association of Teachers and Instructors, 1974.

Member . . . . . Personnel Association for Vocational Education, Inc., C/O Bureau of Secondary Education, Arroceros St., Manila, 1984.

Member . . . . . Parents-Teachers Association, Catbalogan I Elementary School, Catbalogan, Samar, 1984.

Member . . . . . Samar Provincial Choristers, Catbalogan, Samar, 1984.

LIST OF FIGURES

LIST OF FIGURES (Continued)