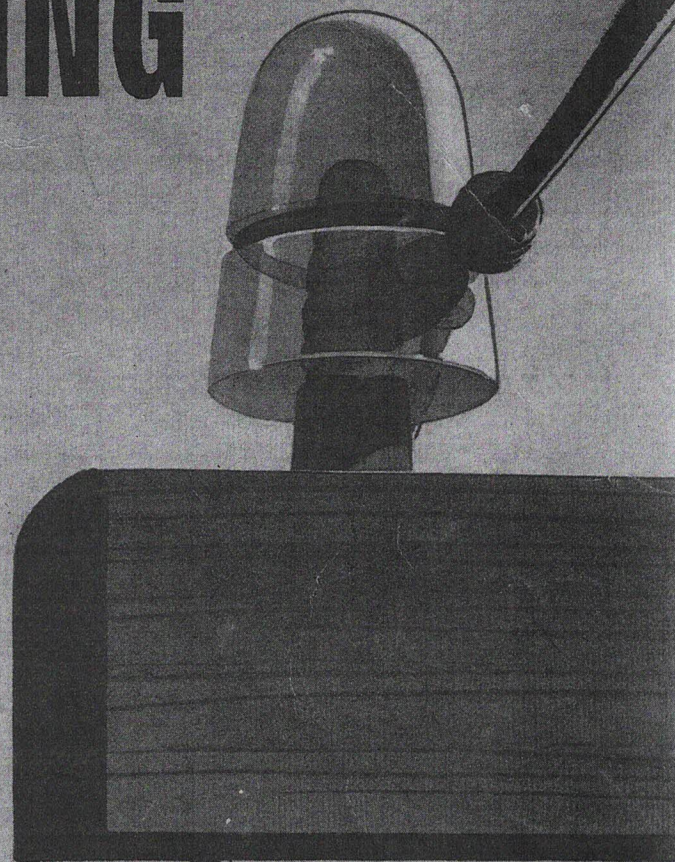


# HOUSE WIRING MADE EASY

**A PRACTICAL GUIDE  
FOR THE ELECTRICIAN  
AND HOME OWNER**



**SEARS, ROEBUCK AND CO.**





## *Foreword*

The use of electricity is ten times greater today than it was a quarter of a century ago. New uses and new types of electrical equipment are constantly being brought before the public—all of these new uses and devices have steadily increased the current load. Power Companies have been forced into a continuous program of expansion which requires increasing the wire size of the high line feeders so as to provide uniform voltage to their customers. Unfortunately, the customer in most cases has failed to take his own added demands into consideration and when wiring his house has provided only for his immediate use without consideration for the future.

It is our hope in writing this book that the reader who contemplates wiring his home will do so with considerable thought for the future.

We have tried in this book to give the reader a clear picture of what materials are necessary to complete an adequate wiring job and have suggested what we believe to be the simplest method of wiring an existing building. We have eliminated so far as possible all technical phrases and references which may confuse the mind of the average non-technical person reading this book.

# CHAPTER ONE

## HOUSE WIRING MADE EASY

The purpose of this book is to familiarize you with the most common terms concerning electricity and electrical merchandise, and explain the ordinary methods used in house and farm wiring. Lengthy, technical discussions about electricity are avoided; the simple A B C's which should be common knowledge will be elaborated on as fully as possible.

As a preliminary to the chapters to follow on the use and application of electrical materials, it is important first to become familiar with some of the important facts and terms used with electricity.

### ELECTRIC CURRENT

Electricity with which we commonly deal is a form of energy that may be transferred into heat, light or motion—(motion for instance, such as in an electric motor). Since electricity cannot be seen it will be compared to water in some of the explanations to follow.

### DIRECT CURRENT

Direct current (D.C.) is a continuous flow of electricity in one direction and may be generated in an electric dynamo. However, we are most familiar with it as it comes from a storage battery such as is used in an automobile. It is not generally used for power and light because it cannot be transmitted over great distances economically. Direct current may be compared to the steady flow of water through a pipe.

### ALTERNATING CURRENT

Alternating current (A.C.) is a flow of electricity that reverses its direction several times a second. The most common type in use today is 60 cycle, in which the direction of the flow is reversed 120 times every second. Alternating current is generally used today because it can be transmitted at high voltages over great distances economically, and can be transformed to lower voltage for the home by use of comparatively inexpensive transformers. The movement of alternating current in a wire can be compared to that of water in a reciprocating water pump.

### VOLT

A volt is the unit of *pressure* in measuring electrical force. It may be compared to pounds per square inch in measuring water pressure.

### AMPERE

An ampere is the unit used in measuring the *rate of flow* of electricity just as the expression gallons per minute is used in measuring the rate of flow of water.

### WATT

A watt is the unit of *power* representing work that is done by a current of one ampere under a pressure of one volt. Approximately 746 watts equals one horse power.

### KILOWATT

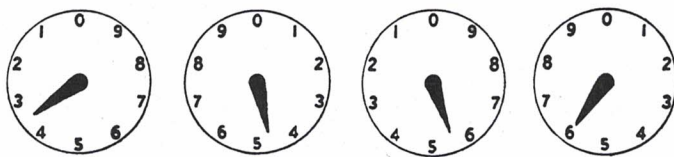
A kilowatt is the equivalent of 1000 watts. A kilowatt hour is 1000 watts of electricity used for one hour. Electricity rates are based on kilowatt hours.

### COST OF OPERATING AN APPLIANCE

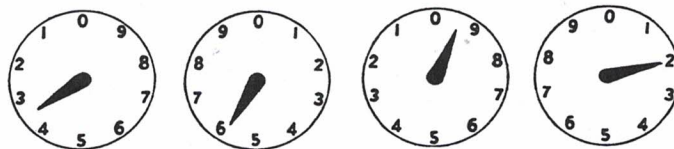
All Underwriters' Approved electrical merchandise bears a label which gives the watt or the volt and ampere rating of the appliance. The wattage, in the latter instance, can be determined for resistance appliances such as irons by multiplying the volt figure given by the ampere figure given. An iron, for example, with the following information on the name plate: 6 Amperes—110 Volts would be a 660-Watt appliance. To arrive at the 660-Watt figure, it is only necessary to multiply the amperes by the volts, or  $6 \times 110$ , which gives the 660-Watts figure. To figure the cost of operating this iron one hour, it is first necessary to determine the rate or cost of electricity from your power company. Assuming that the cost is 6c per kilowatt hour, and since 660 watts is approximately two-thirds of a kilowatt hour, it would mean that it would cost 4c per hour to operate the electric iron.

### HOW TO READ AN ELECTRIC METER

Your electric meter has four dials that look much like small clock faces. Each dial has a single pointer or hand. Read the dials from left to right.



Write down the number that the pointer has just passed on each of the dials. The reading on the above set of dials is 3456 kilowatt hours. Now assume that the above figures represent the reading at the first of the month. The first of the next month, the dials on your meter appear as follows.

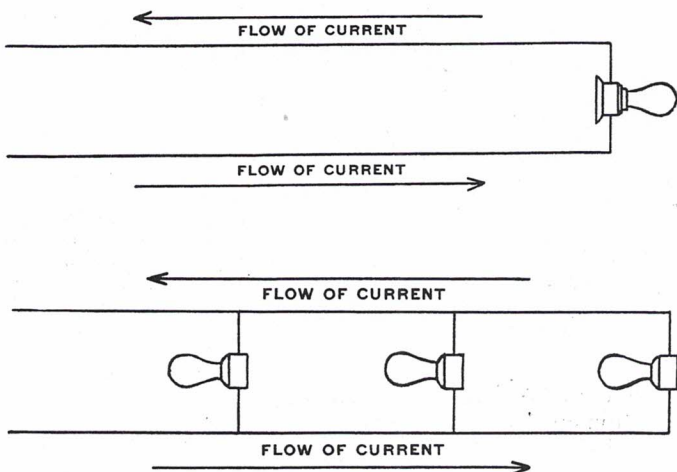


Reading them as before, we obtain 3592 kilowatt hours. The difference between these two readings is 136 kilowatt hours, which is the amount of electricity you used during a month's time.

To calculate your light bill, multiply 136 by your electricity rate. At 6c per kilowatt, your bill would be \$8.16.



Electrical energy is usually distributed by circuits having two conductors or wires with a voltage between them. Connecting any sort of electric device between these wires allows a current to flow from the source of voltage over one of the wires—through the device—and back to the source over the other wire or conductor. More than one appliance or device may be operated from one circuit as illustrated below.



## SWITCH



A switch is a device used to break a circuit in order to interrupt the flow of electricity. Switches are furnished in several types such as: single-pole, double-pole, three-way, and four-way. These switches can be obtained in weatherproof construction for outdoor use. Switches can be furnished in combination with convenience receptacles or pilot lights. Several switches mounted together in a common unit can also be obtained.

When selecting the types of switches for operation of your lights, it is advisable to keep in mind the various types and styles available.

If your room has but one entrance, a single pole toggle or push button switch mounted flush with the wall is adequate; if, however, your room is large and has more than one entrance it is sometimes more convenient to install two or more switches for control of the same lighting unit. When two switches are used to control the same light, whether it be in the same room as the switches or at some distant point, two three-way switches, must be used. If it is desirable to control light unit from more than two positions the following must be used: two three-way switches, and one four-way switch for every additional point of control desired.

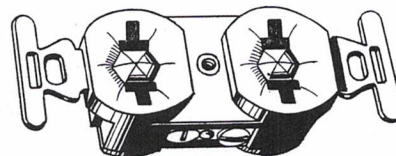
When a light is to be controlled from some distant point, such as light unit in basement, garage, or barn, with switch control located in kitchen or some other room, it will be found advantageous to install a combination toggle switch and pilot light. The pilot light will indicate when lights at

distant points are burning, preventing needless waste of electric energy.

Another method for preventing waste of electric energy especially in clothes and storage closets and attics, is to install an automatic door switch. An automatic door switch is placed in a door casing and turns the light unit on when door is opened, and off when door is closed; therefore when entering or leaving a room with your arms full of packages, it is not necessary to fumble around in the dark trying to locate a wall switch.

Poultry raisers will find that profits from the sale of eggs can be increased if they will install an automatic unit switch to turn on their lights early in the morning (and in winter when it begins to get dark in the evening)—thus extending the hours of light—giving their chickens more time in which to eat and exercise—thereby increasing the egg yield per year. Experience has shown that the expense of installing automatic time switches and the additional electric current cost has been more than offset within a few months by the additional egg yield obtained.

## RECEPTACLE



A receptacle is a convenient tap from which an electric current may be obtained by inserting a suitable plug. Receptacles are usually furnished in the duplex type; however, they may be obtained as single or triple units.

Convenience receptacles are made up in combination with switches, pilot lights and radio receptacles. Receptacles are obtainable in indoor, weather-proof and explosion-proof types and are made in a number of capacities.

Weatherproof convenience receptacles mounted on the outside of the house will permit yard or garden lighting during certain seasons of the year, such as Christmas or Easter, and ornamental garden lighting in the summer. Heavy duty weatherproof power receptacles mounted on the outside of barns and other out-buildings will make possible the operation of portable feed and ensilage grinders, portable electric saws and many other portable electric power machines.

Vapor-proof convenience receptacles located between stalls in dairy barns facilitate the operation of portable electric milking machines. Other types of receptacles may be located in the dairy to operate small churns, cream separators, and milk coolers.

Be sure that all the materials to be installed in your home and out-buildings are of high quality and are approved by Underwriters' Laboratory, Inc. The Underwriters' Laboratory insignia is your protection against low quality, dangerous, unapproved wiring materials, see Drawing No. 37, Page 28.

## FUSES

A fuse is a safety device placed in a circuit. It will blow and break the circuit in case of a short or overload. Fuses are used to reduce fire hazards just as safety valves are used on steam boilers to prevent an explosion.



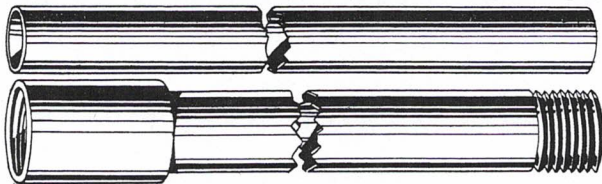
# CHAPTER TWO

## TYPES OF WIRING

### INDOOR WIRING

Coincident with the location and wiring of each outlet, a decision must be made on the type of wiring that should be used. There are three principal types of wiring used in house wiring—electrical conduit, both rigid and thin wall, cable of the armored and non-metallic sheathed types, and knob and tube, See Pages 13, 14, which is open wiring with ordinary house wire supported by porcelain fittings, each wire being run separately and in many cases supported by a separate insulator. Each of these types of wiring has its own certain advantages, depending in part on the nature of the building to be wired, what the building is to be used for and whether an installation is being made on a new structure or the rewiring of an old one. They are as follows—

### RIGID AND THIN WALL CONDUIT



This is probably the safest form of wiring to use under ordinary conditions. Rigid and thin wall conduit are both made of high grade steel and heavily coated with a rust-proof finish. The conduit is placed according to the location of the outlets and electrical current is carried through rubber covered wires drawn through the conduit. This gives a waterproof protection to the wires and protects them against mechanical injury. High material and installation cost limit the use of this form of wiring in rewiring or installing wiring in a structure already completed. Certain criticism also is placed against the use of conduit in barns because of the corrosive effect of the acid fumes on the metal, and some local or state codes demand the use of non-metallic system in these locations.

### ARMORED AND NON-METALLIC SHEATHED CABLE See Pages 8 and 11

Cable either armored or non-metallic sheathed consists of two or more rubber covered wires encased in a steel or non-metallic cover. Either type is very flexible and easy to install but because they are not watertight their use is limited to indoor installations only. They are most commonly used in house wiring, both old and new work, because of comparatively low cost and ease of installation.

### INSTALLATION OF RIGID CONDUIT

The restrictions in the National Electric Code, generally, are less on electrical rigid conduit than on any other form of electrical wiring. The heavy steel wall prevents damage to the wires. Under normal atmospheric conditions the conduit is practically rustproof, thereby protecting the wires from moisture. It therefore can be run indoors or outdoors—overhead or underground.

Two types of protective coatings are given to conduit. A black enameled substance that is baked onto the metal or a galvanized finish that is placed on the conduit in a molten state, or placed there by an electrolytic process. Because it has proven more enduring and rust resistant, a majority of engineers and contractors favor the galvanized finish even though it is slightly more expensive.

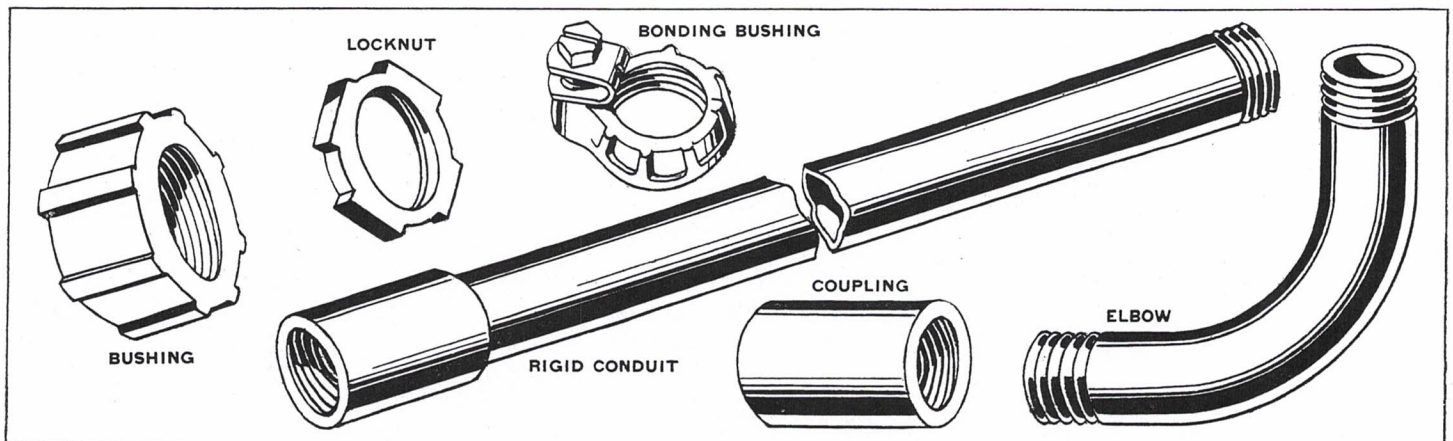
Rigid conduit can be bent, although it is more practical, on larger sizes in particular, to use Conduit Ells that are already bent (See Drawing No. 1) and shaped for immediate use. All sizes of electrical conduit are supplied in standard lengths of 10 feet each, electrical trade size, and for runs over 10 feet successive lengths of conduit are joined together with conduit couplings. Surface installations of rigid conduit are comparatively easy, particularly if there are few bends to make.

Rigid metal conduit may be used under any and all conditions subject to the following restrictions:

If conduit is exposed to corrosive fumes or vapors such as may exist in fertilizer rooms, hide cellars, salt storages, casing rooms and similar locations, conduit and fittings of corrosion-resistant material suitable for the conditions shall be used.

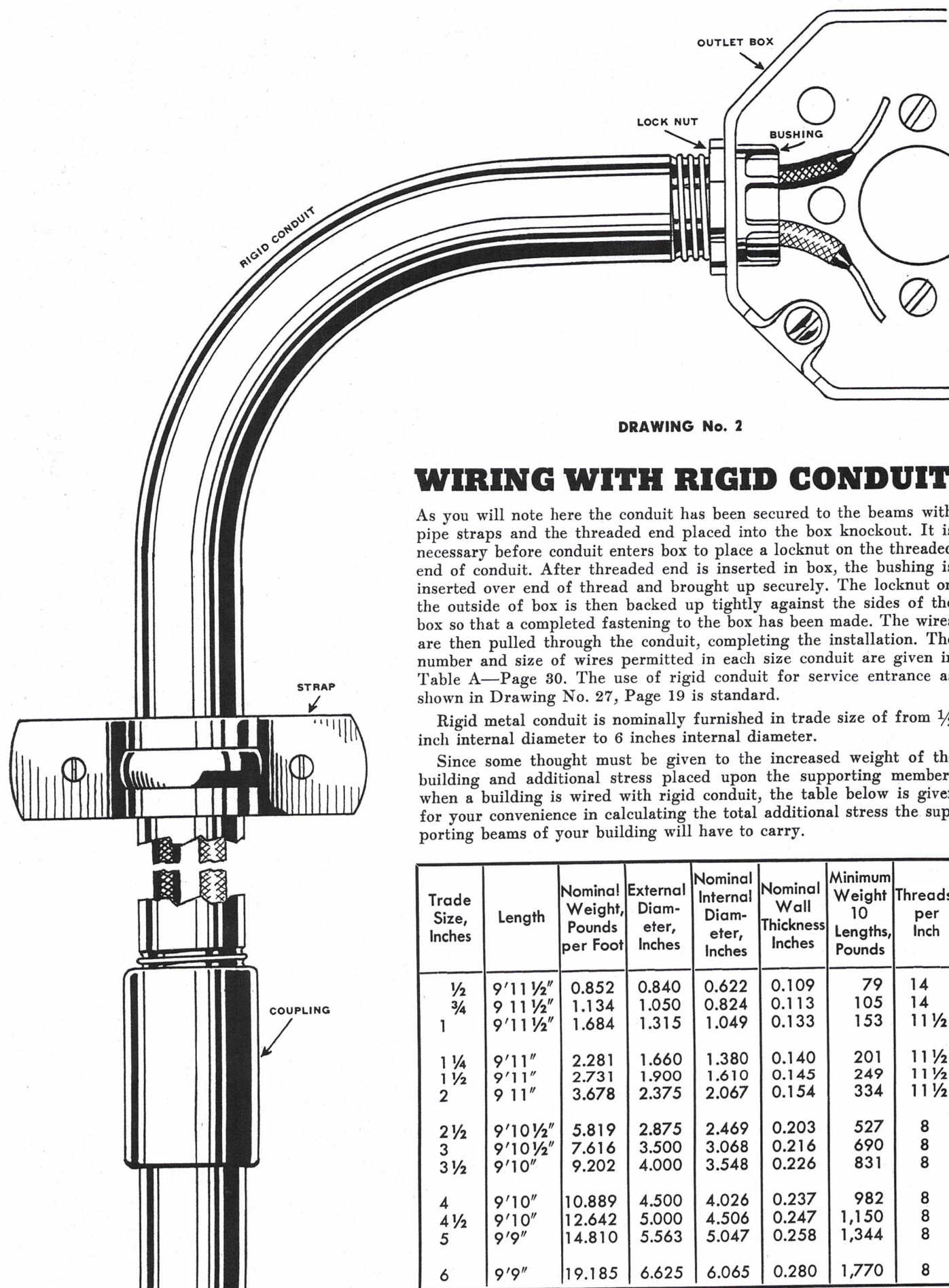
Conduit, unless of corrosion-resistant material suitable for the purpose, shall not be used in or under cinder fill where subject to permanent moisture unless protected on all sides by a layer of non-cinder concrete at least two inches thick or unless the conduit is at least 18 inches under the fill. In portions of dairies, laundries, canneries and other locations where excessive moisture is continuously or frequently present, and in other locations where walls are frequently washed, the entire conduit system, including all boxes and fittings used shall be made watertight.

All ends of conduit shall be reamed to remove rough edges. Where a conduit enters a box or other fitting, a bushing shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to afford equivalent protection.



DRAWING No. 1





DRAWING No. 2

## WIRING WITH RIGID CONDUIT

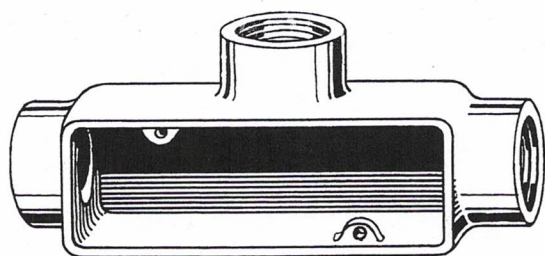
As you will note here the conduit has been secured to the beams with pipe straps and the threaded end placed into the box knockout. It is necessary before conduit enters box to place a locknut on the threaded end of conduit. After threaded end is inserted in box, the bushing is inserted over end of thread and brought up securely. The locknut on the outside of box is then backed up tightly against the sides of the box so that a completed fastening to the box has been made. The wires are then pulled through the conduit, completing the installation. The number and size of wires permitted in each size conduit are given in Table A—Page 30. The use of rigid conduit for service entrance as shown in Drawing No. 27, Page 19 is standard.

Rigid metal conduit is nominally furnished in trade size of from  $\frac{1}{2}$  inch internal diameter to 6 inches internal diameter.

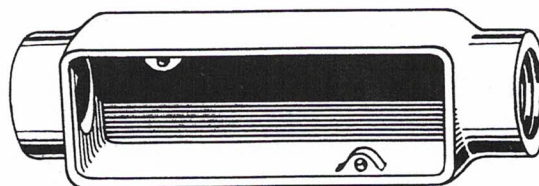
Since some thought must be given to the increased weight of the building and additional stress placed upon the supporting members when a building is wired with rigid conduit, the table below is given for your convenience in calculating the total additional stress the supporting beams of your building will have to carry.

Trade Size, Inches	Length	Nominal Weight, Pounds per Foot	External Diameter, Inches	Nominal Internal Diameter, Inches	Nominal Wall Thickness, Inches	Minimum Weight 10 Lengths, Pounds	Threads per Inch
$\frac{1}{2}$	9'11 $\frac{1}{2}$ "	0.852	0.840	0.622	0.109	79	14
$\frac{3}{4}$	9'11 $\frac{1}{2}$ "	1.134	1.050	0.824	0.113	105	14
1	9'11 $\frac{1}{2}$ "	1.684	1.315	1.049	0.133	153	11 $\frac{1}{2}$
1 $\frac{1}{4}$	9'11"	2.281	1.660	1.380	0.140	201	11 $\frac{1}{2}$
1 $\frac{1}{2}$	9'11"	2.731	1.900	1.610	0.145	249	11 $\frac{1}{2}$
2	9'11"	3.678	2.375	2.067	0.154	334	11 $\frac{1}{2}$
2 $\frac{1}{2}$	9'10 $\frac{1}{2}$ "	5.819	2.875	2.469	0.203	527	8
3	9'10 $\frac{1}{2}$ "	7.616	3.500	3.068	0.216	690	8
3 $\frac{1}{2}$	9'10"	9.202	4.000	3.548	0.226	831	8
4	9'10"	10.889	4.500	4.026	0.237	982	8
4 $\frac{1}{2}$	9'10"	12.642	5.000	4.506	0.247	1,150	8
5	9'9"	14.810	5.563	5.047	0.258	1,344	8
6	9'9"	19.185	6.625	6.065	0.280	1,770	8

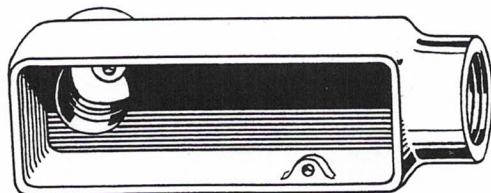




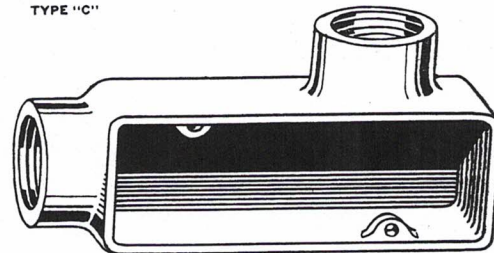
TYPE "T"



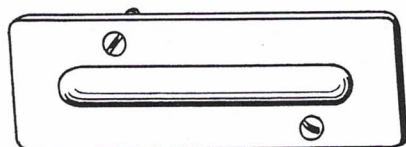
TYPE "C"



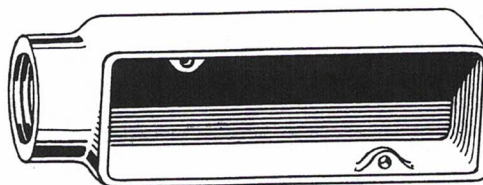
TYPE "LB"



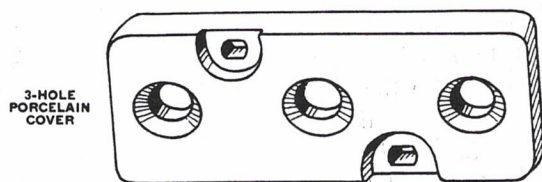
TYPE "LR"



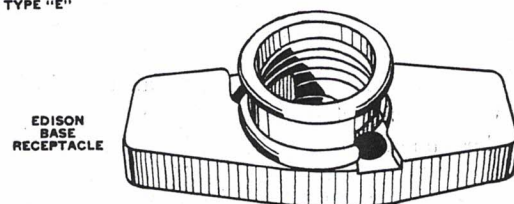
BLANK METAL COVER



TYPE "E"



3-HOLE  
PORCELAIN  
COVER



EDISON  
BASE  
RECEPTACLE

DRAWING No. 3

## CONDUIT FITTINGS AND COVERS

The above illustration shows conduit fittings used for surface wiring. They are used in conjunction with either rigid or thin wall conduit and can be furnished in a number of types and sizes. The five most common types of fittings and three most commonly used covers are shown above. They are sometimes used as part of conduit runs when a change of direction, attachment of a branch run, installation of a receptacle or drop cord is desired.

We will consider these fittings in the order in which they are illustrated above.

First the type "T" fitting is used to provide a connection between a continuous conduit run and a right angle branch run. The conduit fitting may then be covered with a blank plate if no other tap to the wires is needed; the three hole cover may be used either as a drop cord cover when it is necessary to install a drop light or receptacle to a conduit run, or it may be used to connect one, two or three open wires to a conduit run; the receptacle is attached to the fitting when a lighting unit directly attached to the conduit is desired. It is so designed that a shade holder may be clamped directly to the neck of the porcelain socket housing.

The type "C" fitting is used whenever it is necessary to attach a light to the conduit run, or when a connection to open wires or the installation of a drop cord is required.

The type "LB" fitting is used when it is necessary to change the direction of a conduit run. Usually used when

a conduit run is carried along one side of a wall surface to a point where it is necessary to change the direction of the run by piercing the wall at right angles to the wall surface. When used for no other purpose fitting is covered with a blank plate, however, the three hole or receptacle covers may be attached if required. The type "LR" fitting is used to make a right angle change of direction in a conduit run when both runs are to travel along the same wall face. It may be covered in the same manner as the type "LB" fitting.

The type "E" fitting is to be used at the end of a conduit run either for the attachment of a device or as a dead end to conduit run. When used as a dead end fitting, it is to be covered with a blank cover, however, either the three hole cover or the receptacle cover may be used.

Special fittings somewhat larger than these illustrated containing switches for the control of lights can be obtained. Fittings of various types are used for outdoor runs of conduit whenever the installation of weather-proof devices is required. They are usually much larger and heavier than the fittings illustrated on this page.

Special fittings are required by the code when conduit runs are installed in permanently moist locations, such as steam chambers, etc.; where fittings must be vapor-proof. and rooms containing explosive vapors, such as gasoline refineries where explosion-proof fittings must be used.



# WIRING WITH THIN WALL CONDUIT

Although the restrictions placed on the use of thin wall conduit by the National Code are more numerous than on rigid conduit, for purposes at least of ordinary residential and barn wiring, they are not any greater. One great distinction between the two types is the difference in thickness of the wall of the conduits with a corresponding difference in their weight. Thin Wall Conduit is considerably lighter and the thickness of the wall is not sufficient to safely have threads cut on it. For this reason, thin wall conduit is connected to boxes and fittings by threadless type couplings and connectors that clamp on to the outside wall of the conduit. See drawings below.

Thin wall conduit is supplied in standard 10-foot lengths manufactured in a galvanized finish only and is cut and bent in the same manner as rigid conduit. Ordinary installations rarely require the use of manufactured elbows as the smaller wall thickness permits easier bending.

## INSTALLATION OF THIN WALL CONDUIT

SEE DRAWING No. 5—Page 7

Shall comply with the following provisions: It may be used for both exposed and concealed work, but not where it will be subject to severe mechanical injury; such as in cinder concrete or fill unless protected on all sides by a layer of non-cinder concrete at least two inches thick, or unless the tubing is at least 18 inches under the fill; in any hazardous locations, in hoistways, or where exposed to corrosive vapor, except if tubing is exposed to corrosive fumes or vapors such as may exist in some fertilizer rooms, hide cellars, salt storages, casing rooms and similar locations, tubing and fittings of corrosion-resistant material suitable for the conditions shall be used.

In portions of dairies, laundries, canneries and other locations where excessive moisture is continuously or frequently present, and in other locations where walls are frequently washed, the entire tubing system, including all boxes and fittings used therewith shall be made watertight. Tubing shall not be coupled together nor connected to boxes, fittings or cabinets by means of threads in the wall of the tubing.

Threadless couplings and connectors used with tubing shall be made up tight and shall be of the watertight type if buried in masonry, concrete or fill, or if installed in wet places.

Bends in tubing shall be so made that the tubing will not be injured and that the internal diameter of the tubing will not be reduced.

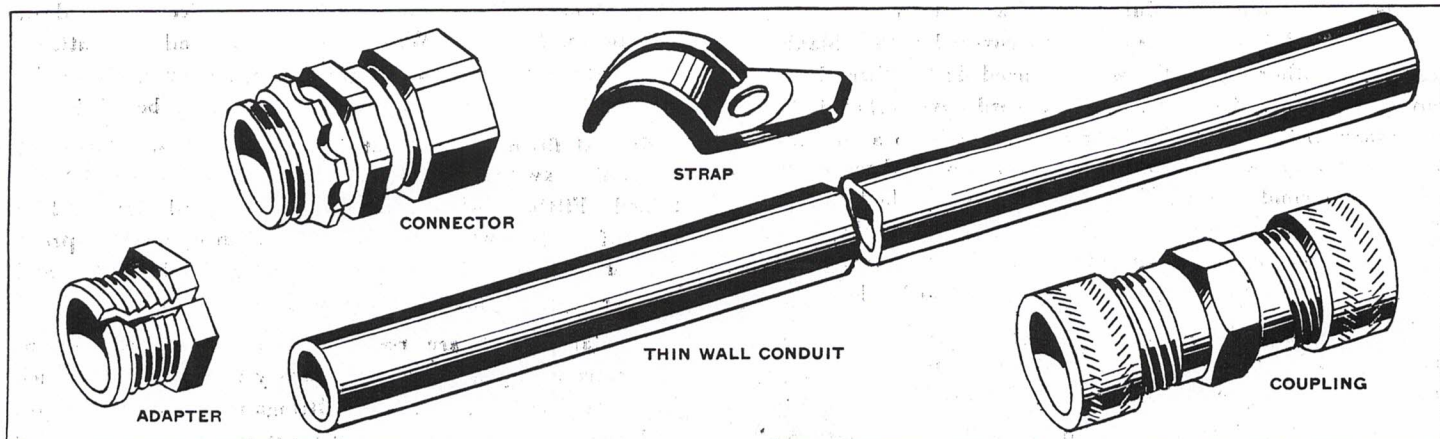
The illustration on the following page is a thin wall conduit installation in combination with an outlet box. Note the straps used in securing conduit to beams and closeup views of connection to box. Here the threadless connector is securely fitted over the conduit and securely clamped in place. The threaded end of connector has been placed through the box knockout and secured to the box by a locknut inside the box and over the threaded end of the connector. After runs have been made, wires may then be easily pulled through conduit and into box.

The number and size wires permitted in each size conduit are given in Table "A," Page 30.

In using thin wall conduit for service entrance, it is necessary to use an Adapter for fastening thin wall conduit to standard service entrance fittings. This adapter clamps on to the conduit and its threaded ends are drawn up into the standard fittings and clamps itself securely to the surface of the conduit. Straps should be used to support conduit every 4 feet.

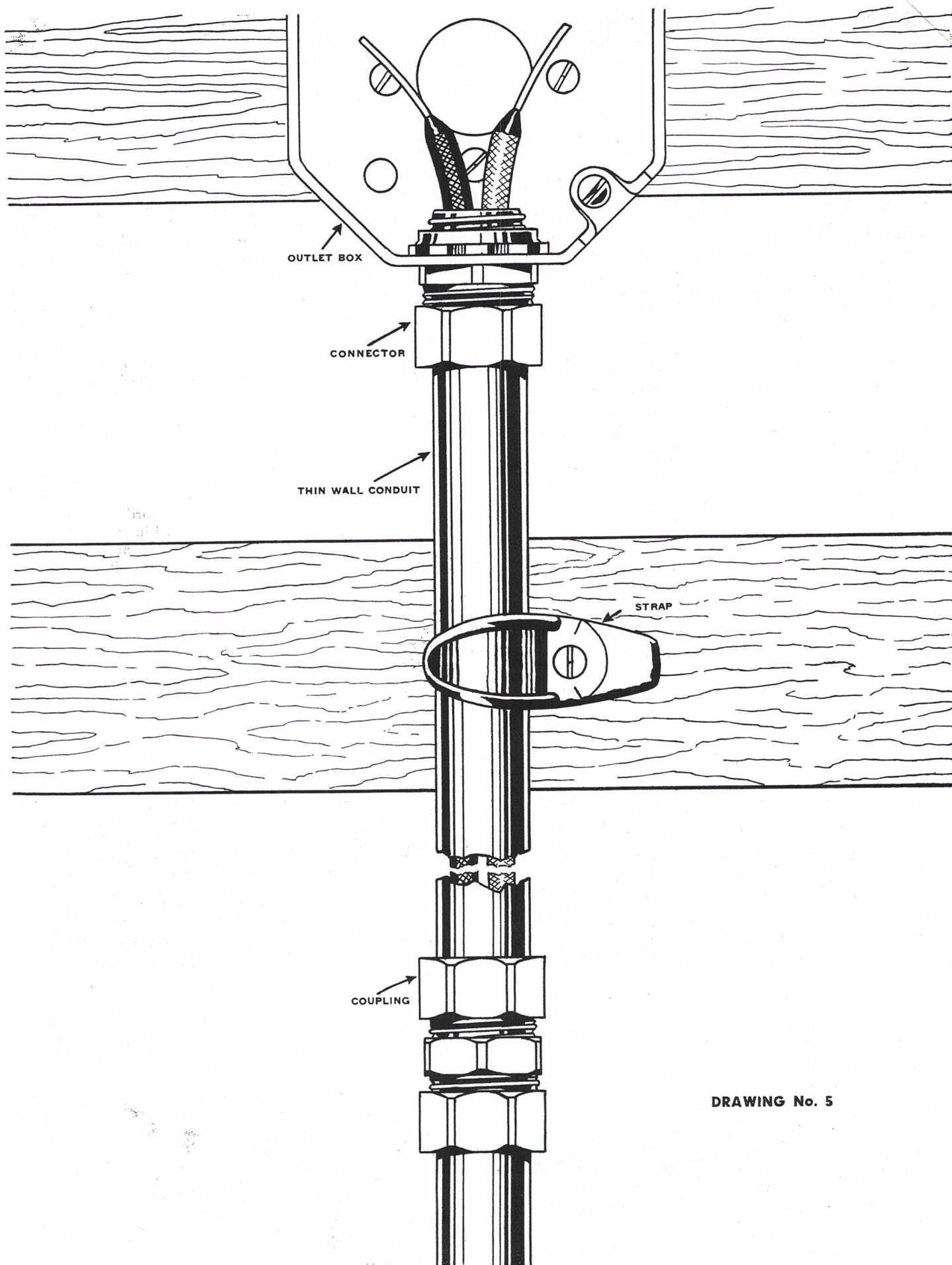
**Chart Showing Approximate Weight and Diameter of Thin Wall Conduit**

Size, Inches	Approximate Weight per 1,000 ft., pounds	Diameter, Inches	
		Internal	External
3/8	254	0.493	0.577
1/2	321	0.622	0.706
3/4	488	0.824	0.922
1	711	1.049	1.163
1 1/4	985	1.380	1.508
1 1/2	1141	1.610	1.738
2	1470	2.067	2.195



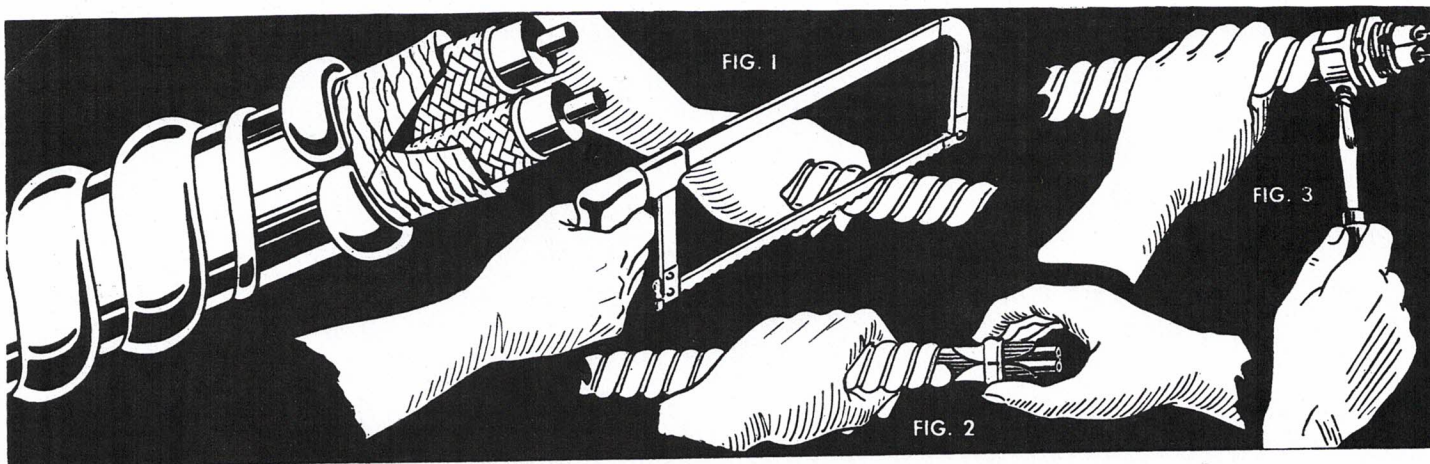
**DRAWING No. 4**





DRAWING No. 5





DRAWING No. 6

## ARMORED CABLE

Armored cable is one of the most widely used materials for house wiring both on new and old work chiefly because of its comparative low cost, ease in handling, low installation cost and adaptability of particular forms of wiring (see Drawings Nos. 7 and 51). As illustrated, you will note that it consists of two or more rubber covered wires running parallel to each other around which is wound a galvanized steel protective strip. Between the wires and the strip a moisture-proof paper wrapper is placed (known as Kraft paper).

Armored cable is not waterproof and its use according to the Code must be confined to indoors. Because it affords less mechanical protection to the wires than rigid or thin wall conduit, restrictions on its use are more numerous. Generally speaking, armored cable is suitable for use indoors on both exposed and concealed work providing there is not an excessive amount of moisture or humidity.

Installations of armored cable should comply with the following provisions: It may be used for both exposed and concealed work in dry locations; for under plaster extensions and embedded in plaster finish on brick or other masonry, except where subject to excessive humidity or moisture. Armored cable shall contain lead covered conductors, type ACL, if used where exposed to the weather or to continuous moisture, for underground runs and embedded in masonry, concrete or fill, in buildings in course of construction and where exposed to oil, gasoline or other materials having a deteriorating effect on rubber.

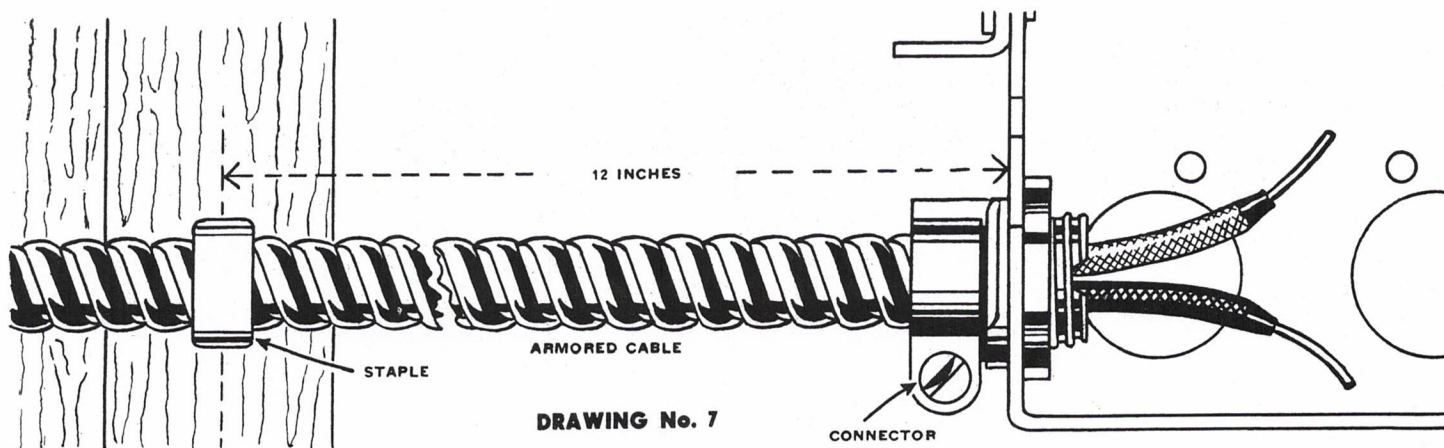
The illustration below shows the method of attaching the cable to an outlet box. The cable connector has been slipped over the end of the cable and fiber bushing and is secured by tightening up on the screw of the connector. The

threaded end of the connector is inserted into the box knockout and tightly secured by the connector locknut on the inside of the box.

## INSTALLATION OF ARMORED CABLE

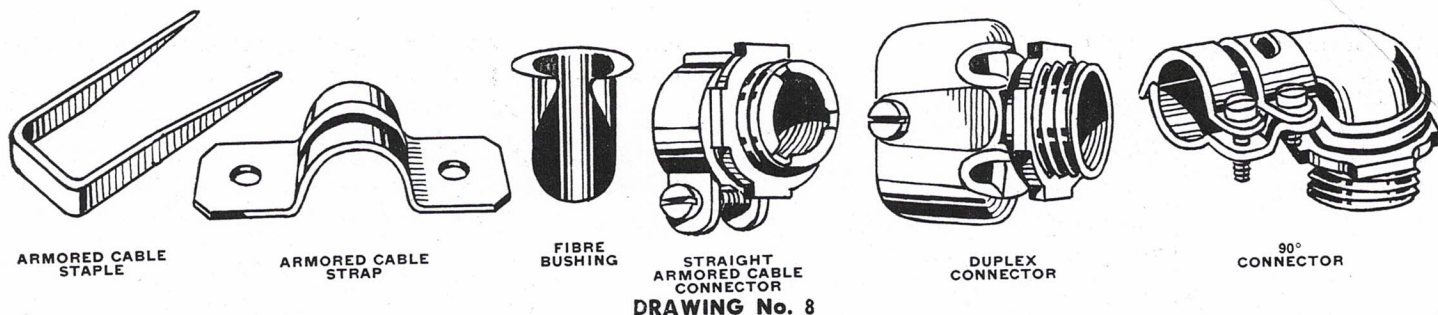
Because the steel strip is spirally wound around the wires, it is possible to easily remove this strip if we cut at angles as shown on illustration above. Taking an ordinary hack saw, simply place the blade on the cable as illustrated and partially cut through but one section of the armor only. Be sure not to cut the wires. Grasp the cable in both hands on either side of the cut portion and twist sharply. This will break the remaining uncut part of the cable and it can then be slipped off over the wire.

After the armor has been cut away from the wire, a very rough jagged part of the armor is directly in contact with the wire. So that there will not be any destruction of the insulation on the wire at this point, the Code demands some protection be given. Between the wire and the end of the armor a fiber bushing must be placed. There are several types of connectors listed for securing cable to metal boxes. A straight  $\frac{3}{8}$ -inch Connector may be used for cable sizes 14-2, 14-3, 12-2, 12-3 and 4-1. A 90 degree Connector is used where cable is brought down at an angle to the box in such a manner that it is impossible or impractical to use straight cable Connector. The 90 degree  $\frac{3}{8}$ -inch Connector will take cable sizes 14-2, 14-3, 12-2, and 10-2. The Duplex Connector is used where it is desired to bring two cables through same knockout of metal box. Connections to boxes supplied with clamps are simply made by removing the knockout and inserting the end of the cable through the opening and into the clamps. The clamp is pressed down at an angle on the cable by tightening the screw. Almost any



DRAWING No. 7





of the types of outlet and switch boxes available can be used for armored cable. See above for Connectors.

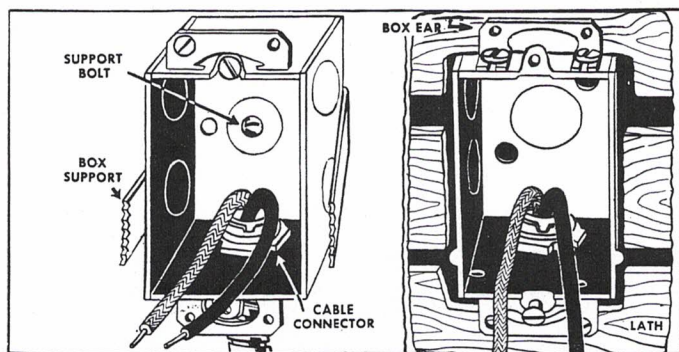
Armored cable must be supported at intervals not exceeding 4½ feet, and where run under building joist, as in basement installations, must be supported at each joist. A staple or clamp must be used (see Drawing No. 7) to fasten cable within 12 inches of every outlet, switch and receptacle box except in cases where greater flexibility is desired such as connection to motors, in which case not more than 30 inches shall be allowed between connection to box and first staple or strap. For securing cable to building surfaces, use either Cable Strap or Cable Staple (See Drawing No. 8).

Where cables are run through joist or sills, holes bored in the wood should be at not less than 20 degrees angle as this will eliminate any drag on the cable.

Exposed runs of cable shall closely follow the surface of the building finish or of running boards except lengths of not more than 24 inches at terminals where flexibility is necessary; in accessible attics and roof spaces for which the cable shall be installed as follows:

Where run across the top of floor joists or within 7 feet of floor or floor joist across the face of rafters or studding, the cables shall be protected by substantial guard strips which are, at least, as high as the cable. If the attic is not accessible by permanent stairs or ladders, protection shall not be required except within 6 feet of the nearest edge or scuttle hole or attic entrance. If carried along the side of rafters, studs or floor joists, neither guard strips nor running boards shall be required.

## Wall Outlet for Old Construction

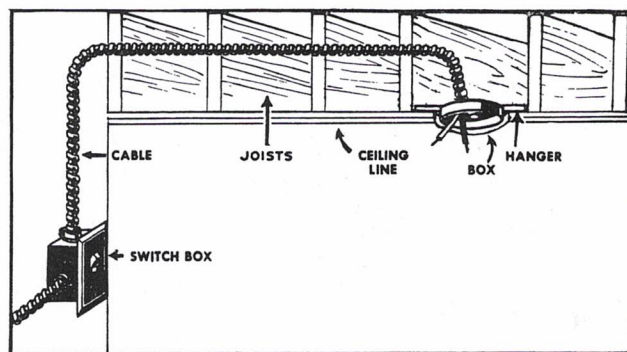


**DRAWING No. 9**

To put switches in plastered walls. (Above right.) Determine position of box and locate open space above and below lath. Place box open face towards wall directly over located lath, and trace outline of box. Cut center lath away and portion of top and bottom laths to accommodate box. Pull cable through opening and fasten to box. Place box in opening and fasten. For wallboard use support illus-

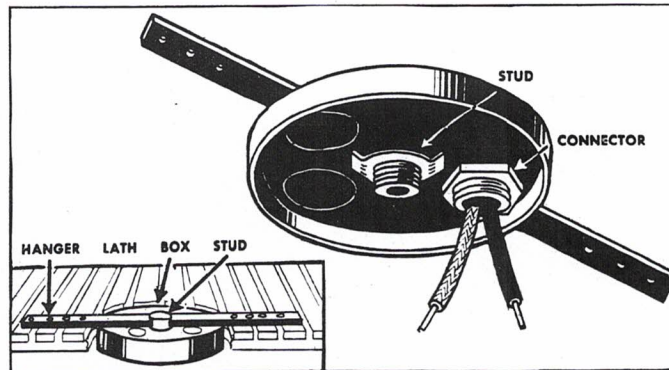
trated in Drawing No. 9. Attach to back of box by removing center knockout and inserting bolt and washer through inside of box. Attach clamp to bolt on the outside of box. Cut opening in wall exact size of box. Insert box and support. Tightening screw draws support firmly against wallboard from behind.

## Installing Ceiling Outlet in Old Construction



**DRAWING No. 10**

For installing ceiling outlets on alteration or extension work first locate the position where fixture will be installed and make a small hole about 1⅞ inches in diameter in the ceiling. If this fixture is to be controlled by a wall switch, select a convenient location for it and make a hole in the wall just large enough to accommodate the switch box for this switch. Run the cable from the ceiling hole to that made in the wall. If the cable can be run parallel with the rafters simply fasten the cable to the nearest rafter and run it along to the wall partition where the switch will be located. Drop the cable down from a point above the proposed switch outlet and draw cable through the hole already made.



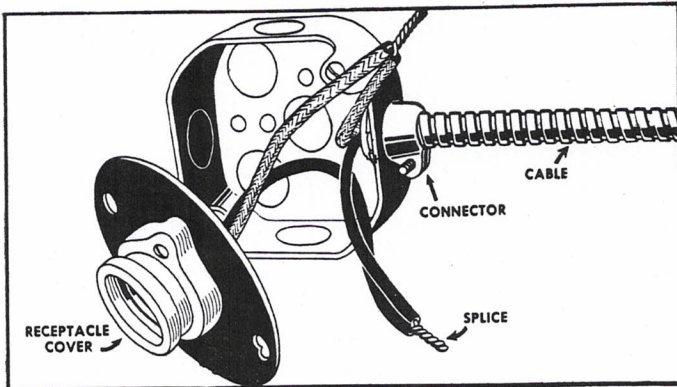
**DRAWING No. 11**



On such installations shallow 1/2-inch boxes are generally used in combination with a hanger and sliding fixture stud. Insert "old work" hanger and stud through ceiling opening, laying bar across the laths with stud in the center of opening. Pull cable through this opening and attach. With center knockout removed from box place box over stud and secure with locknut. Illustration shows ceiling cut away for box. Installation can also be made by simply laying box against ceiling and tightening up on hanger locknut.

To supply current to switch, run cable from the most convenient "live" outlet to opening in wall and attach to switch terminals and to cable from the ceiling outlet.

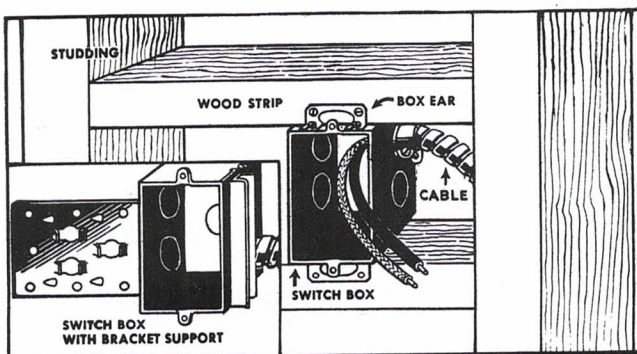
## SURFACE OUTLETS



DRAWING No. 12

Drawing No. 12, Page 10, shows a surface type outlet made with armored cable, outlet box and box cover receptacle. Galvanized boxes are recommended for locations subject to dampness and vapors. To install this outlet first locate position for desired light and securely fasten the outlet box to the surface. Extend cable along surface leading to box and fasten to surface with staples or straps. Next strip 1 1/2 inches of insulation from the two cable wires and the two wires leading from the box cover receptacle. Then splice, solder and tape them together. The receptacle cover is then attached to the box, completing the installation.

## WALL OUTLET FOR NEW CONSTRUCTION



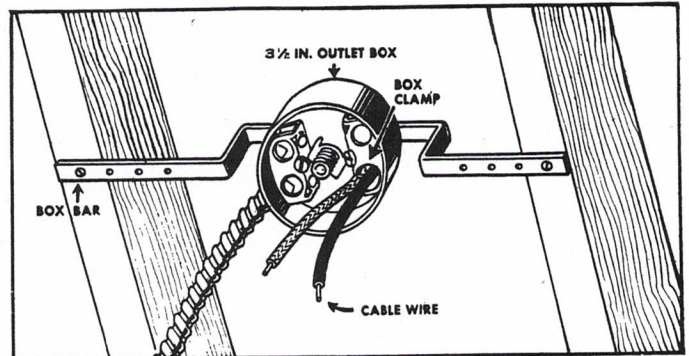
DRAWING No. 13

The above illustrates two methods of installing switch boxes for use with wall switches, receptacles or wall brackets. If the switch is to be located between the two studs as shown in the larger illustration proceed as follows: Fasten securely two wood strips not less than 7/8-inch thick to the studding, spaced to the dimension of the switch box length. If the installation is to be made in a deep partition,

use a 2 1/2-inch switch box. Two-inch switch boxes should be used in shallow partitions (See Page 15).

If the outlet is located next to studding, use switch boxes with bracket support. The bracket is fastened to the stud on one side and with the lath fitting into the slotted grooves on the opposite side of the box. The cable is attached to the box in the regular manner.

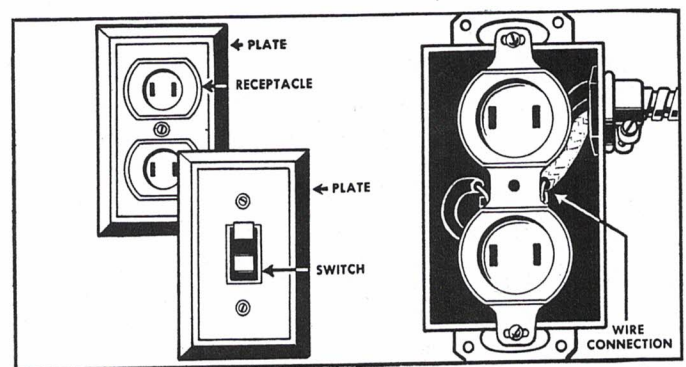
## CEILING OUTLET FOR NEW CONSTRUCTION



DRAWING No. 14

The boxes used for ceiling outlets must be at least 1 1/2 inches deep. These boxes should be so installed so that the lower edge of the box will not protrude below the finished plaster line. Offset steel bar hangers secured to the underside of the studding are recommended. Illustrated is the typical installation of ceiling outlet made with a combination box, stud and bar hanger. By loosening the stud the box can be adjusted to the desired position. After removing the knockout from the box where the cable will enter, fasten bar to the underside of the studs and secure the cable to the box. The outlet is then complete and ready for hanging the fixture.

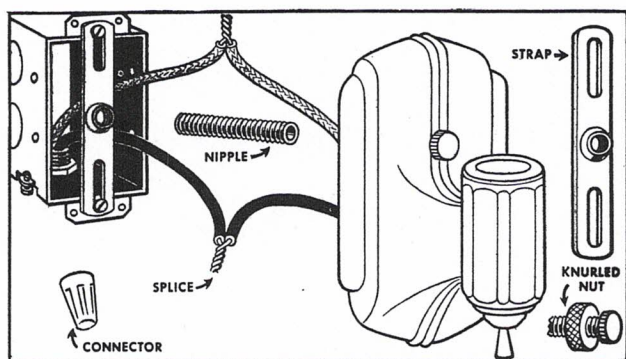
## INSTALLING SWITCHES, RECEPTACLES, PLATES



DRAWING No. 15

Wall switches and receptacles are of standard dimensions for installations in regular wall type boxes. After the wires are brought into the box, remove about 1/2 inch of the insulation from each wire and properly attach them to the contact screws on the switch or receptacle. Then push the wires back into the box and attach the switch or receptacle to the box. It is fastened by placing it across the face of the box and inserting screws through the holes at each end into the threaded holes of the switch box. Switches are available in two types—push button and toggle—each with its own type of wall plate.





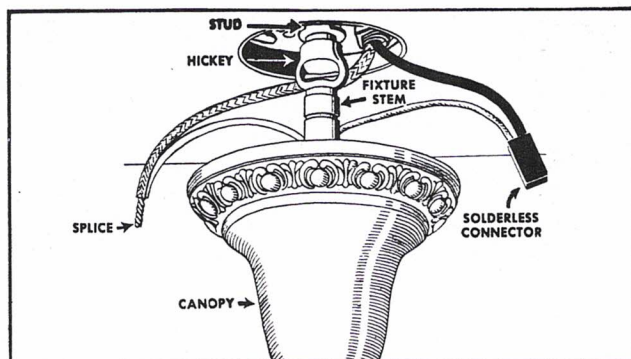
DRAWING No. 16

## INSTALLING WALL BRACKETS

Sears Fixtures are furnished with all fittings necessary to install. Shown are fittings and installation made with a bathroom or kitchen bracket. All brackets are usually installed in this manner. Connect the wires leading from the bracket to those terminating in the switch box, and push stripped ends of wires to be joined into connector. Then push and turn connector until tight. No solder or tape needed. Secure the strap to the box and fasten the nipple to the strap through the center hole. Then place the bracket over the box so that the nipple will extend through the hole in the bracket. Place the knurled cap over end of nipple and tighten.

## HANGING CEILING FIXTURES

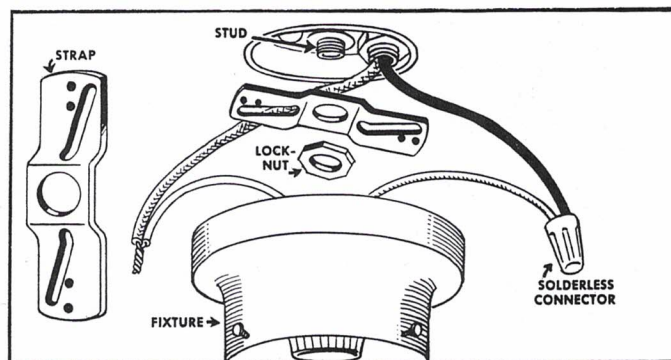
With the parts provided with your Sears LIGHTMASTER Fixture, proceed with installations as follows: Loosen the canopy from the fixture stem and attach to the end of the stem a fixture hickey. Next attach the hickey to the fixture stud. With solderless connectors, join the two wires that lead from the fixture to those in the outlet box. Make sure that exposed parts of wires are completely inside the connectors. Push the canopy so that it fits close to the ceiling and tighten nut on the side of the canopy against the center stem. Or if the canopy on your fixture is held up with a locknut at the bottom of the canopy simply tighten up on this locknut.



DRAWING No. 17

## HANGING KITCHEN CEILING FIXTURES

Furnished with this type fixture is one strap, one  $\frac{3}{8}$ -inch locknut, two machine screws and two solderless connectors. Install as follows: Place the hole in the center of the strap over the fixture stud in the box and fasten it there with the locknut. Then bring the fixture holder up to the ceiling and connect the wires from the box and fixture with the connectors. Place the holder next to the ceiling so that the small holes in the holder are directly over the threaded holes in the strap. Using the machine screws secure the holder tightly against the ceiling and then attach the glass shade to the holder.



DRAWING No. 18

# NON-METALLIC SHEATHED CABLE

DRAWING No. 19, PAGE 12

Non-metallic sheathed cable (often referred to as "Romex") may be used indoors the same as armored cable but should not be installed in masonry or plaster. A low cost wiring product, it is designed for use in residences, and small buildings. It consists of copper wires, with rubber insulation covered with a heavy cotton braid jacket impregnated with moisture and flame retarding compounds. Sheathed cable is particularly suitable for barns and out-buildings where moisture and acid vapors are prevalent. Easy to install, it can be attached to the surface, pulled through partitions or floor joists and can be used for power or lighting circuits.

Figure 1, Page 12, illustrates method of removing outer sheathing from wires. Inside the sheathing is a heavy rip-cord which when gripped and pulled splits the outer insulation, which then can be easily removed.

Figure 2 is the type of strap used to fasten cable to the surface.

Figure 3 is the usual type of connectors used to fasten cable to switch and outlet boxes. Simply insert end of cable into connector and tighten clamp screws. The locknut on the connector secures the connector to the box from the inside. The various types of installations shown here are used for both armored cable and non-metallic sheathed cable.



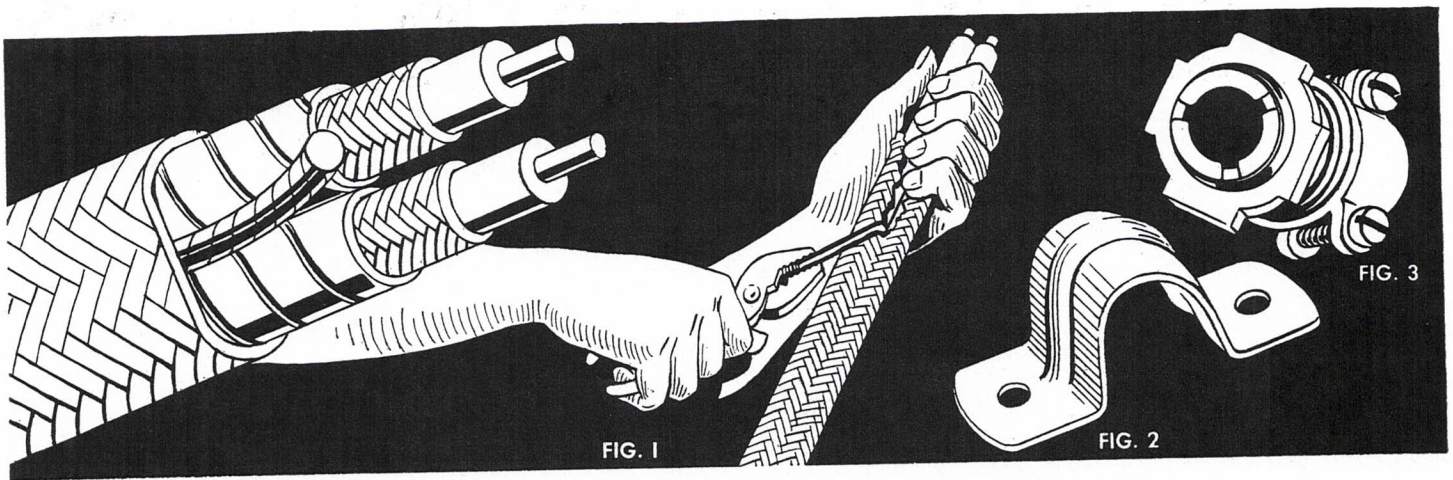


ILLUSTRATION No. 19

## INSTALLATION OF SHEATHED CABLE

Where cable enters an outlet box, outer protective covering is to be removed and Romex Connector securely fastened to the outside covering of cable (see Drawing below). The connector is then run through hole of outlet box, and locknut brought up tightly so that any possible vibration will not loosen same. In the wiring of a new home, straps must be used regardless of whether cable will be hidden or left exposed outside of joist or sills. All splices and connections shall be made within the enclosing wall of an outlet, switch or receptacle box.

If the cable is run at angles with joists in unfinished basements, assemblies not smaller than No. 6 or 3 No. 8 conductors may be secured directly to the lower edges of the joists. Smaller assemblies shall either be run through bored holes in the joists or on running boards. Where run parallel to joists, cable of any size shall be secured to the sides or face of the joists.

In exposed work, except under certain provisions which will be given below, the cable shall be installed as follows: The cable shall closely follow the surface of the building finish or of the running boards. It shall be protected from mechanical injury where necessary by conduit, pipe, guard strips or other means. If passing through a floor, the cable shall be enclosed in rigid conduit or pipe extending at least 6 inches above the floor. Cable in accessible attics or roof spaces shall be installed as follows: If run across the top of floor joists, or within 7 feet of floor or floor joists, across the face of rafters or studding the cable shall be protected by substantial guard strips, at least, as high as the cable. If the attic is not accessible by permanent stairs or ladders, protection will only be required within 6 feet of the nearest edge of scuttle hole or attic entrance.

If carried along the sides of rafters, studs or floor joists, neither guard strips nor running boards shall be required.

Bends in cable shall be so made, and other handlings shall be such that the protective covering of the cable will not be injured.

The cable shall be secured in place at intervals not exceeding  $4\frac{1}{2}$  feet and within 12 inches from every outlet box or fitting except that in concealed work in finished buildings where such support is impracticable the cable may be fished from outlet to outlet.

### DRAWING BELOW SHOWS INSTALLATION OF NON-METALLIC SHEATHED CABLE WITH SWITCH AND OUTLET BOX

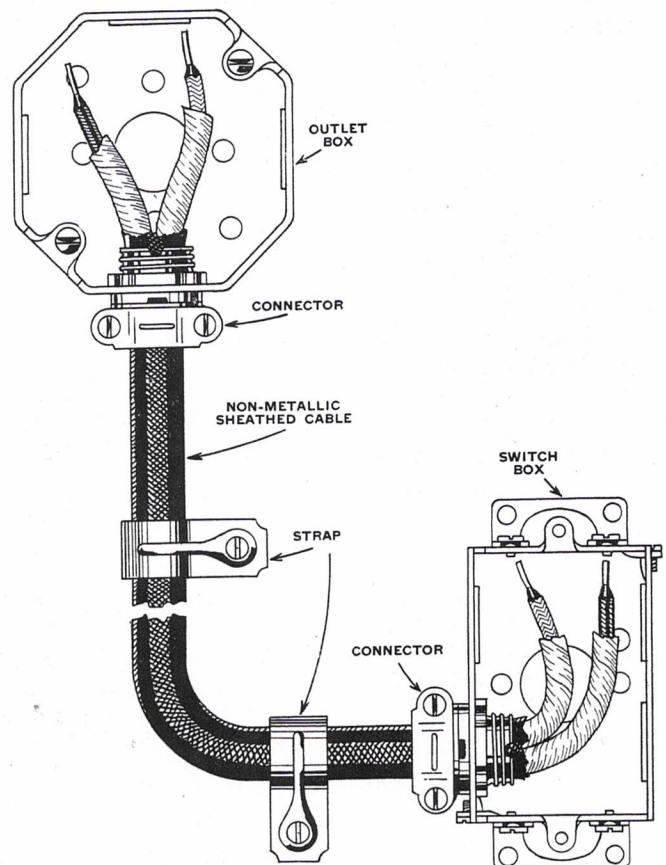
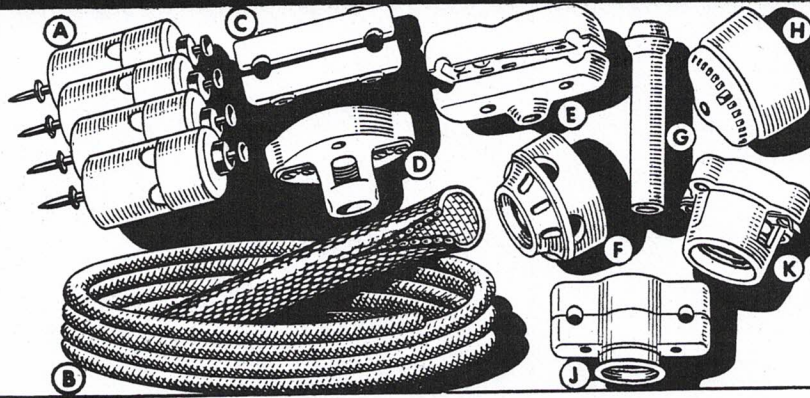


ILLUSTRATION No. 20



# KNOB AND TUBE WIRING

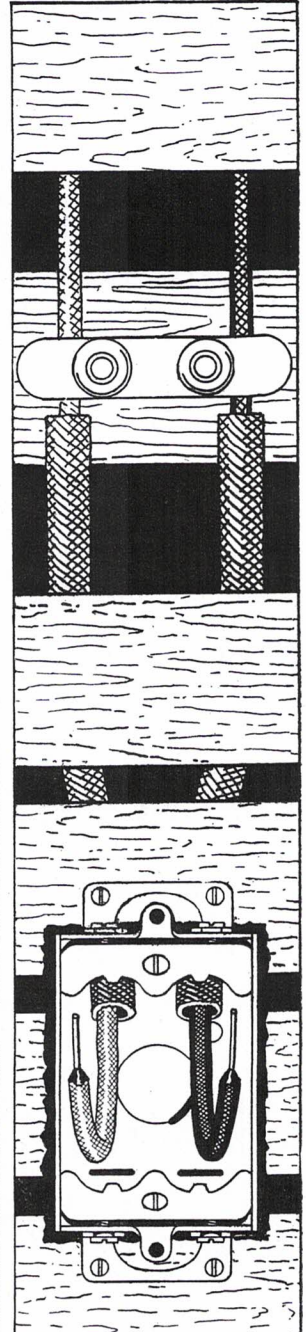
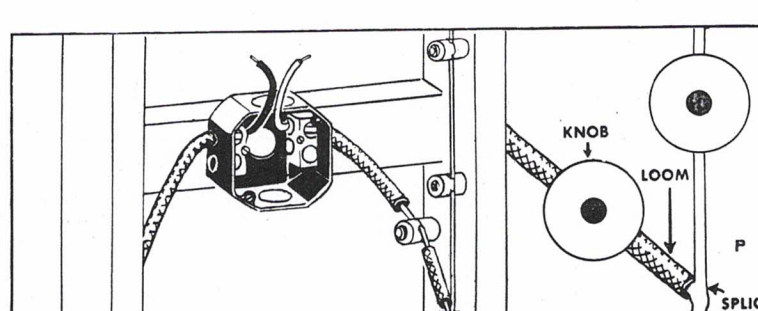
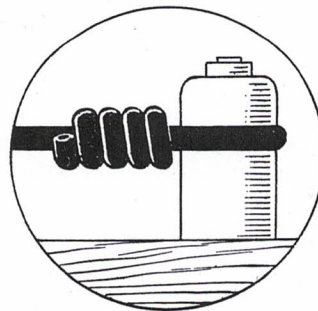
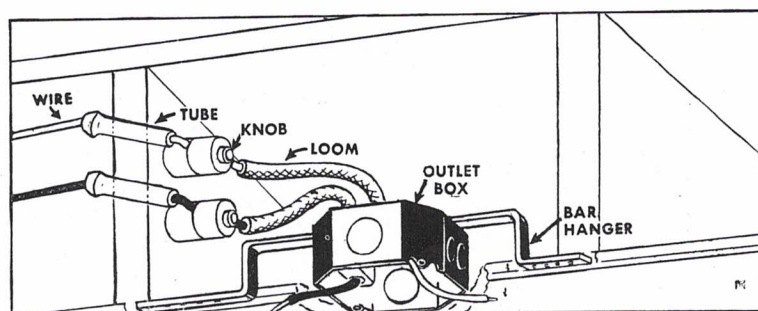
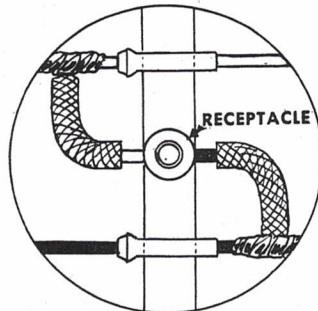
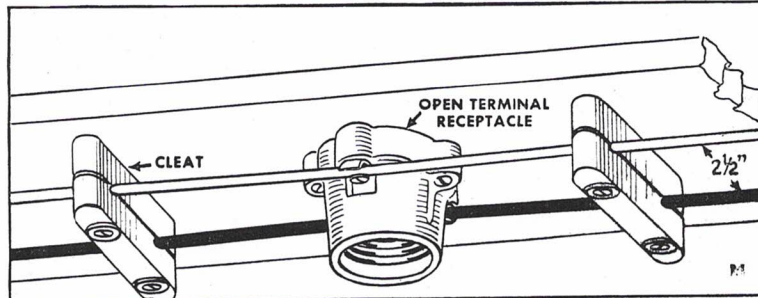
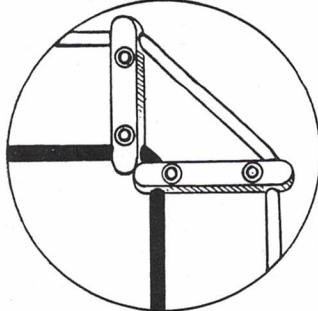
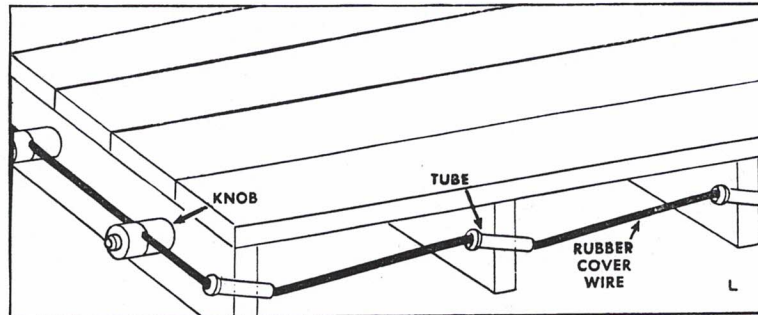
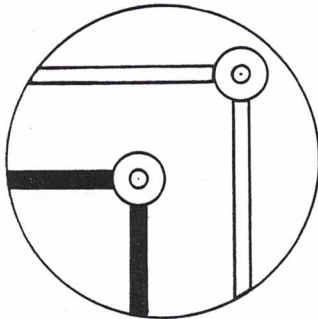


- (A) GLAZED SPLIT KNOBS
- (B) NON-METALLIC LOOM
- (C) TWO WIRE CLEATS
- (D) ONE-PIECE ROSETTE
- (E) DROP CORD CLEAT
- (F) RECEPTACLE
- (G) TUBES
- (H) DROP CORD ROSETTE
- (J) CLEAT RECEPTACLE
- (K) RECEPTACLE

Illustrated are the loom and porcelain accessories commonly used in "knob and tube" wiring. Rubber covered wire is used with knobs or cleats to hold the wire to the surface and must be at least  $2\frac{1}{2}$  inches apart when run over an exposed surface. If the wires are concealed, they must be not less than 5 inches apart and 1 inch from surface. When these dimensions cannot be followed each wire must be covered with loom.

Cleats and knobs supporting the wire must not be spaced further than  $4\frac{1}{2}$  feet apart, and the wires between such supports must not sag but should be pulled taut.

This type of wiring is not approved in all localities. Consult your local authority before making installation.





# KNOB AND TUBE WIRING

SEE PAGE 13—DRAWING No. 21

Knob and tube wiring is probably the oldest form of electrical wiring still being used in many locations today where local codes permit. Its chief advantage is low material cost because it requires only the use of rubber covered wire in combination with porcelain fittings and holders. The use of rubber covered wire and porcelain fittings in knob and tube wiring is subject to definite rulings by the National Board of Fire Underwriters. In the usual type of installation, rubber covered wire is used—other special heat resistant wires are specified where the constant temperatures exceed 120 degrees Fahrenheit.

Conductors should be supported at intervals not exceeding  $4\frac{1}{2}$  inches by knobs and tubes and separated at least 3 inches apart and maintained at least 1 inch from the surface. Where space is limited and this 3-inch separation cannot be maintained each conductor must be encased for its entire length within the wall surface in a non-metallic sheath known as "loom." Where practicable, conductors shall be run singly on separate timbers or studding. Wires passing through cross timbers in plastered partitions shall be protected by an additional tube extending at least 3 inches above the timber.

Illustration "L" shows an ordinary knob and tube installation on Page 13. Note the wires are drawn taut and the distance between wires is uniform and not less than  $2\frac{1}{2}$  inches. Holes have been made through the joists at a downward angle with tubes inserted so that the large end is at the higher level, preventing the tube from slipping out of the hole. Such tubes must always be used when running wires through joists or studding and can be had in various lengths to accommodate the thickness of the obstruction.

Illustration "M" shows surface installation and outlet made with cleats and open terminal receptacle. The wire is run through the grooves in the cleats spaced  $2\frac{1}{2}$  inches apart and drawn taut between cleats. When you have selected the location for the receptacle, place it between the wires and mark location on each wire, of the contact screws of the receptacle. Then strip a small part of the insulation from each wire, where marked and slip this under the receptacle contact screw. Complete installation by securing receptacle to surface.

Conductors in unfinished attics or roof spaces shall comply with the following: Conductors in unfinished attics and roof spaces shall be run through or on the sides of joists, studs and rafters except in attics and roof spaces having head room at all points of less than 3 feet in buildings completed before the wiring is installed. If conductors in accessible unfinished attics or roof spaces reached by stairway or permanent ladder are run through bored holes in floor joists, or through bored holes in studs or rafters within 7 feet of the floor or floor joists, such conductors shall be protected by substantial running boards extending at least 1 inch on each side of the conductors and securely fastened in place. If carried along the sides of rafters, studs or floor joists, neither running boards nor guard strips will be required.

Where wires run through joist and sills, the wires must be run through porcelain tubes as shown on Drawing No. 21. These tubes shall be placed through a beam or joist at an angle of not less than 20 degrees to the perpendicular. Split porcelain knobs or cleats must be used to securely fasten the wires before the connection to the porcelain fitting or receptacle or where a splice is made.

Illustration "N" shows ceiling outlet installation using knobs and tubes. A  $\frac{5}{8}$ -inch hole for each tube is drilled through the joist for the porcelain tubes through which the wires are run to the box. Note the use of loom where the wires are brought closer to each other and to the surface before entering the box. Use the same type of ceiling box as shown on Drawing 14 (Page 10). Instructions for installing are also given there.

Illustration "P" shows wall outlet installation in new construction using Rubber Covered wire, loom and porcelain fittings. The wires have been run along the studding and fastened with knobs up to the point where the box is located. The branch wires leading to the box have been spliced, soldered, taped, and fastened with a knob to the studding. As each wire leading from the splice to the box is closer to the surface or to the other wires than permissible, they have been covered with loom from the point where the splice is made, on up into the box.

## OUTLET, SWITCH AND JUNCTION BOXES AND FITTINGS

An outlet box is an enclosure in either round, square or octagon shape furnished with a number of knockouts so that cable or conduit may be connected with it. It serves as a protector against mechanical injury to the wires enclosed within its walls. Outlet boxes are used for the purpose of making splices or connections, and when covered with a blank plate are known as junction boxes. They are used to form the enclosure for protecting connections to fixture leads and are sometimes used in surface wiring for mounting switches and convenience receptacles.

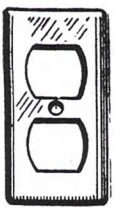
Switch or receptacle boxes, as their name implies are used to mount switches or receptacles either in the wall or on the surface and are protection for the wires connected

or spliced within their walls. Outlet and switches and receptacle boxes are made of steel, porcelain and bakelite. The use of porcelain and bakelite boxes is restricted. Before considering their use, check with your Power Company or Inspection Agency for their recommendations.

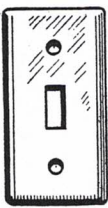
Steel boxes are furnished in either black enamel or galvanized finish. The galvanized finish is usually preferred as it permits better grounding of the box.

Steel switch or receptacle boxes are furnished in several sizes and types (see Drawings on Page 15), however, the most common are the  $2\frac{1}{2}$ -inch deep sectional switch or receptacle boxes. Sectional boxes are so named because their sides are removable permitting two or more box frames to

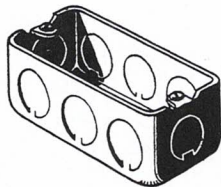




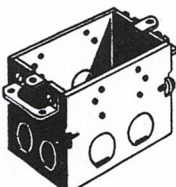
DUPLEX  
RECEPTACLE  
COVER



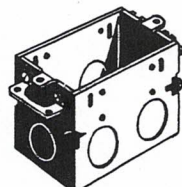
TOGGLE  
SWITCH  
COVER



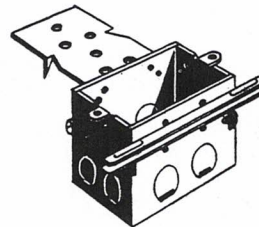
UTILITY  
BOX  
SURFACE MOUNTING



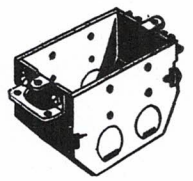
2 OR 2 1/4-INCH SWITCH  
OR RECEPTACLE  
BOX FOR CABLE



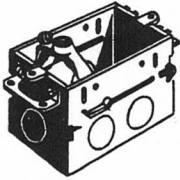
2 OR 2 1/4-INCH SWITCH  
OR RECEPTACLE BOX  
FOR CONDUIT OR  
CABLE



BRACKET BOX  
FOR NAILING TO STUD  
WITH LATH SUPPORT



LOOM SWITCH  
OR RECEPTACLE  
BOX



SWITCH BOX WITH  
ADJUSTABLE BRACKET  
FOR FIXTURE MOUNTING



SWITCH BOX  
PLASTER BOARD  
SUPPORT



OUTLET BOX  
FOR CABLE OR  
CONDUIT



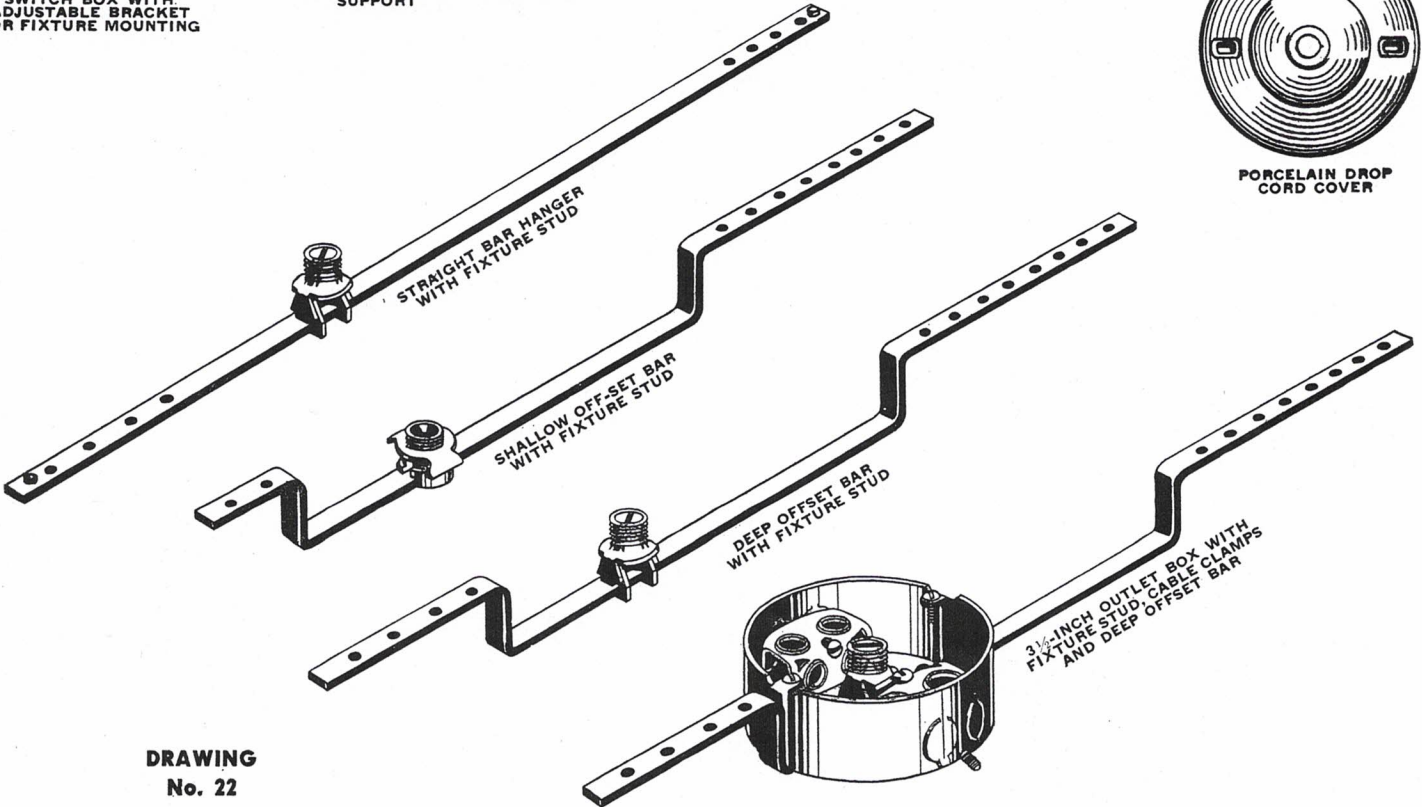
BLANK COVER



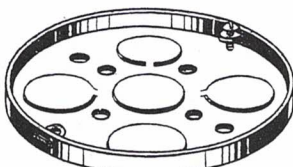
METAL DROP CORD  
COVER



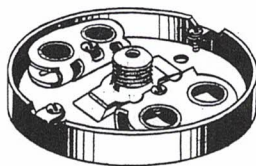
PORCELAIN DROP  
CORD COVER



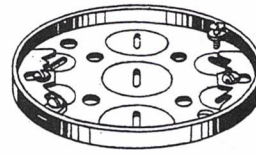
DRAWING  
No. 22



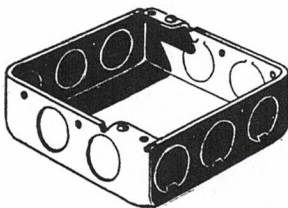
SHALLOW OLD WORK CEILING  
BOX FOR CABLE OR CONDUIT



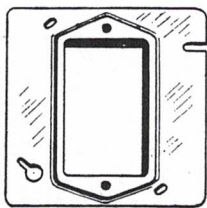
SHALLOW CEILING BOX  
WITH FIXTURE STUD AND  
CABLE CLAMPS



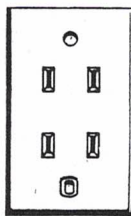
SHALLOW CEILING BOX  
WITH LOOM CLAMPS



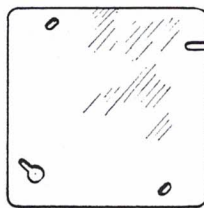
4-INCH SQUARE BOX  
FOR CONDUIT OR CABLE



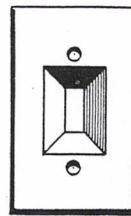
4-INCH SQUARE  
COVER FOR MOUNTING  
ONE DEVICE



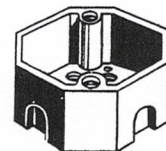
PORCELAIN  
DUPLEX  
RECEPTACLE  
AND COVER



4-INCH SQUARE  
BLANK COVER



PORCELAIN  
SWITCH  
COVER



BAKELITE OR  
PORCELAIN OUTLET  
BOX



BAKELITE  
OR PORCELAIN  
SWITCH BOX



FIXTURE  
STUD



be joined or ganged to make a larger box for mounting two or more switches or receptacles or both in one unit to be covered by one plate.

Boxes and fittings are installed at all outlet and switch points (see Drawing No. 22, Page 15). Round outlet boxes should not be used where conduits or connectors requiring the use of locknuts or bushings are to be connected to the side of the box. Boxes used to enclose receptacles or switches shall be of such design that they will be completely enclosed on back and sides and that substantial support for them will be provided. Outlet boxes for concealed work shall have an internal depth of at least  $1\frac{1}{2}$  inches except where the installation of such a box will result in injury to the building structure or is impracticable. Then a box not less than  $\frac{1}{2}$  inch internal depth may be installed. (If in doubt, inquire at your local inspection office.) In completed installations, each outlet box shall be provided with a cover unless a fixture canopy is used.

Non-metallic covers and plates shall be used with non-metallic outlet boxes except that a metal cover or plate may be used if covered on the exposed side with non-metallic material. Screws shall not be used for fastening such covers or plates to non-metallic boxes unless located in such positions that they cannot come in contact with live parts or live conductors in the box or unless the exposed screw heads are covered with non-metallic material. Boxes, fittings and cabinets shall be securely fastened in place. Boxes and fittings, not over 100 cubic inches in size which are attached to firmly secured exposed raceway by threading or other connections designed for the purpose are considered as so fastened.

In concealed work, outlet boxes and fittings, unless securely held in place by concrete, masonry or other building material in which they are embedded shall be secured to a stud, joist or similar fixed structural unit or to a metal or wooden support which is secured to such a structural

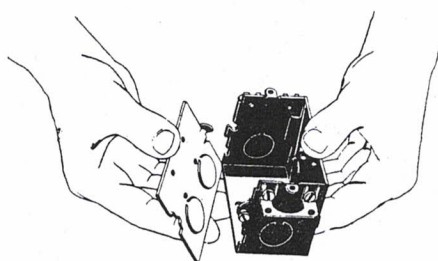
unit. Wooden supports shall not be less than  $\frac{7}{8}$  inch in thickness. Lack of wood, metal or composition shall not be considered a structural unit. In exposed work and in concealed work in existing buildings where conductors or cables are pulled and outlet boxes cannot be secured as provided in the above paragraph, without disturbing the building finish the boxes may be mounted directly upon the plaster surface if securely fastened in place.

Outlet boxes used where gas outlets are present shall be so fastened to the gas pipes as to be mechanically secure. In walls and ceilings constructed of wood or other combustible material, outlet boxes, fittings and cabinets shall be flush with the finished surface or project therefrom.

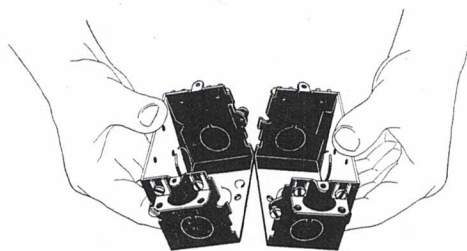
Where raceway or cable is used with metal outlet boxes, fittings or cabinets, the raceway or cable shall be secured to outlet boxes, fittings and cabinets and the conductors entering the box, fitting or cabinet shall be protected from abrasion and the openings through which the conductors enter shall be adequately closed.

Non-metallic outlet boxes may be used only with open work, concealed knob and tube work, non-metallic sheathed cable and with non-metallic waterproof wiring. In open wiring and knob and tube work, the individual conductors shall enter the non-metallic box through individual holes. Where flexible tubing is used to encase the conductor between the last support and the box, this may be run into the box or terminated at the wall of the box. Where non-metallic sheathed cable is used with non-metallic outlet boxes, the cable assembly shall enter the box through a knockout opening. Clamping of individual conductors or of cables to boxes is not required if supported within 6 inches of the box. In moist places, boxes, fittings and cabinets shall be so placed or equipped as to prevent moisture from entering and accumulating within the box, fitting or cabinet. Boxes, fittings and cabinets installed outdoors shall be weatherproof.

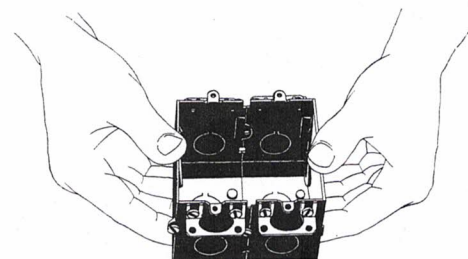
## GANGING OF SWITCH BOXES



FIRST STEP  
REMOVE END WALLS



SECOND STEP  
FIT BOXES TOGETHER  
DRAWING No. 23



THIRD STEP  
DRAW UP SCREWS  
(2 GANG BOX)

When more than one outlet is operated from a given point, as for instance two or more switches at one location, to operate lights in different rooms, it is desirable to group such switches, receptacles, etc. under one switch plate. This is called ganging.

Switch boxes are constructed so that any number of them can be ganged together. The two sides of each box are removable and can be fastened to each other by removing one side of each box, placing them together and tightening into place. Switch and outlet boxes are made in black enamel and galvanized finish.



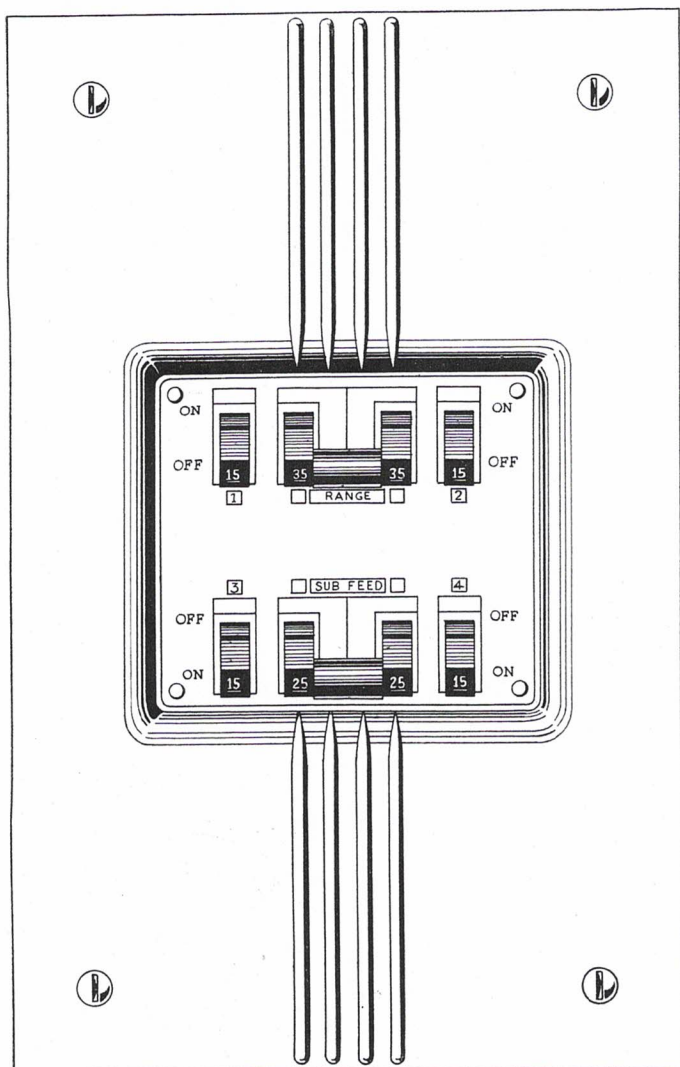
# CHAPTER THREE

## TYPES OF SERVICE ENTRANCE

Service entrance installations may be made with service entrance cable, electrical rigid conduit with rubber covered wire—and thin wall conduit with rubber covered wire. The materials you use depends entirely upon your state or local code requirements. Drawing No. 26, Page 18 illustrates an entrance service installation made with service entrance cable and fittings. The use of these materials for this purpose has increased tremendously during the past 2 years; its principal advantages are low material and installation costs, and should be installed as follows: An entrance head should be mounted not less than 15 feet from the ground and a three wire No. 6 armored service entrance cable type SE-ABN be run from entrance head to meter socket ring

ably also suggest the use of this size cable for a 60 ampere service. Service entrance cable can be supplied in either two or three wires, in various combinations of wire sizes. What you use depends upon the recommendations of your Power Company or local inspectors office. At the service head, the cable is stripped of its outer cover and fastened to this fitting with each of the three wires extending through the holes in the service head. In cutting the cable, allowance should be made to have these wires extend from the holes in the service head at least 24 inches.

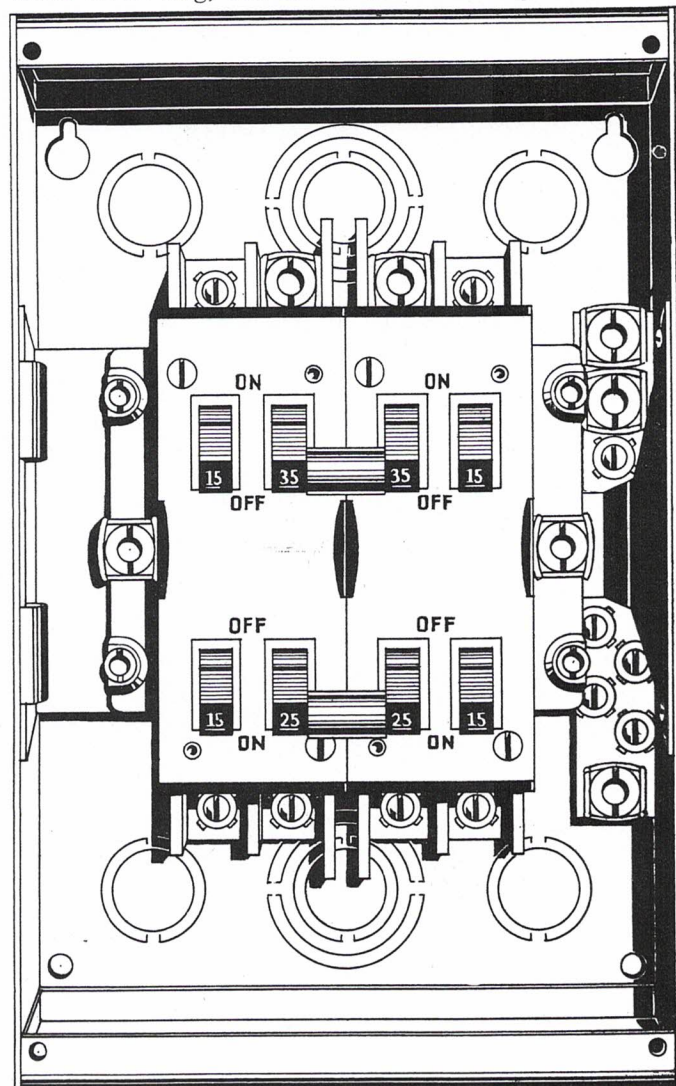
To hold service entrance cable in meter ring, it will be necessary to use two watertight connectors—one where cable enters ring, and one at bottom of ring where cable



**DRAWING No. 24**

mounted approximately 5 feet from ground. Drawing No. 26, Page 18 illustrates an enlarged section of service entrance cable showing its construction. This is a three wire cable, and you will note only two of the wires are insulated. The third wire consists of a number of small stranded wires that are wrapped around the two insulated wires. When it is necessary to attach this bare third wire to a switch or meter, the separate stranded wires are simply gathered together and twisted to form apparently one wire.

Note that we have used a cable consisting of 3 No. 6 wires on this installation. Your Power Company will prob-

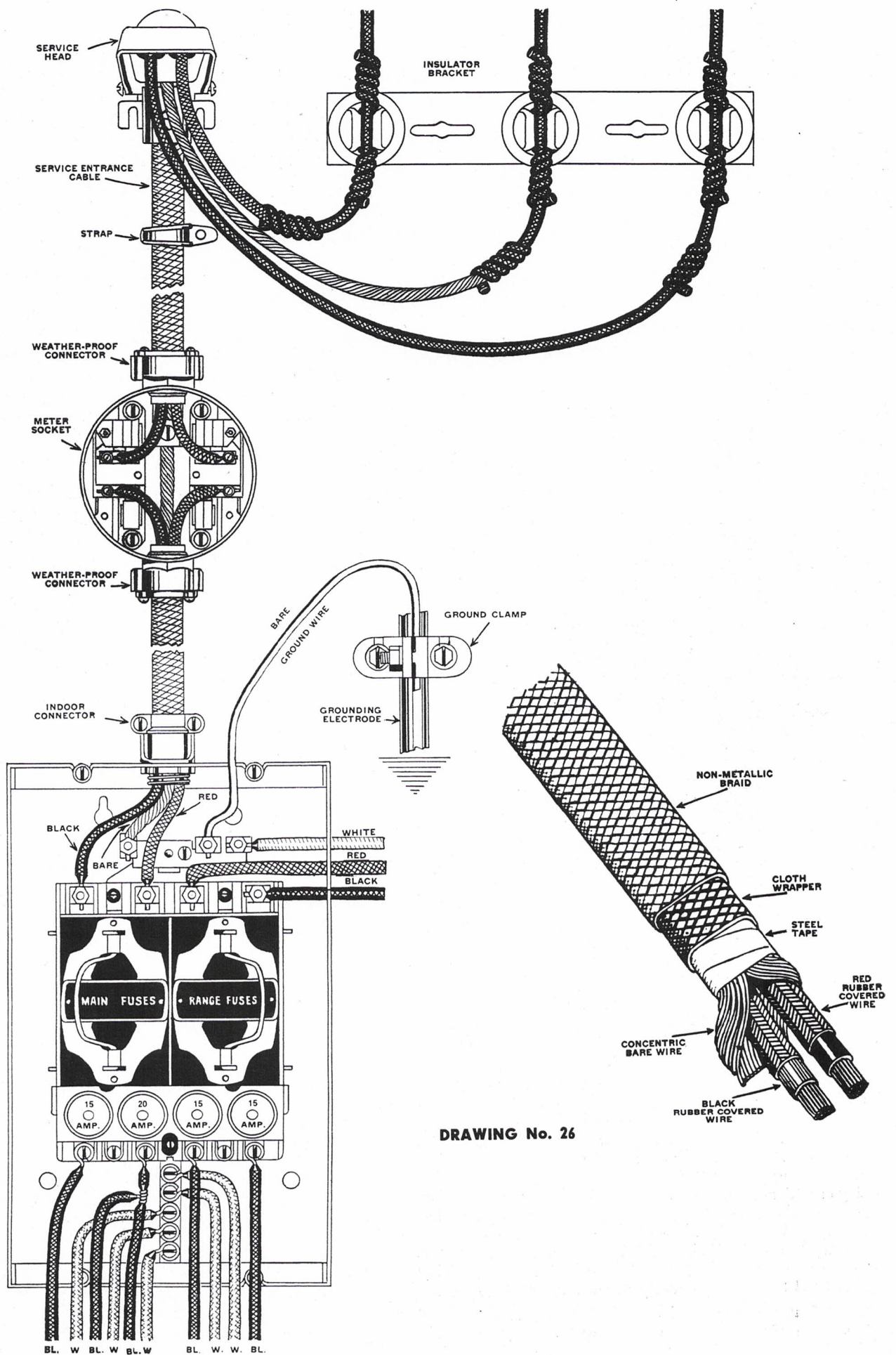


**DRAWING No. 25**

leaves meter ring. Service cable straps should be used to hold cable to building and spaced approximately every four feet. The cable is brought from bottom of meter ring through wall and into main service switch which should be located within one foot of where cable passes through outside wall of building. The cable is secured to main switch box through the use of one non-watertight service cable connector (See Drawing No. 26, Page 18).

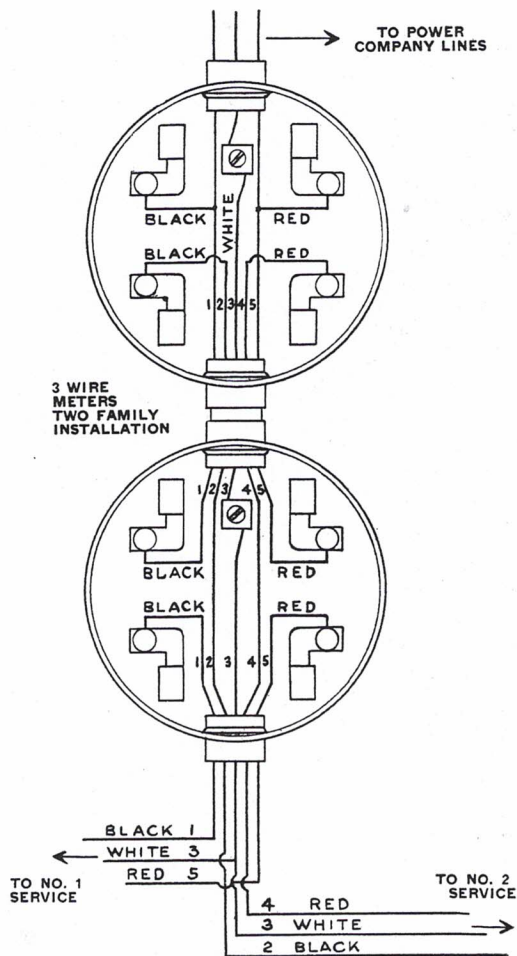
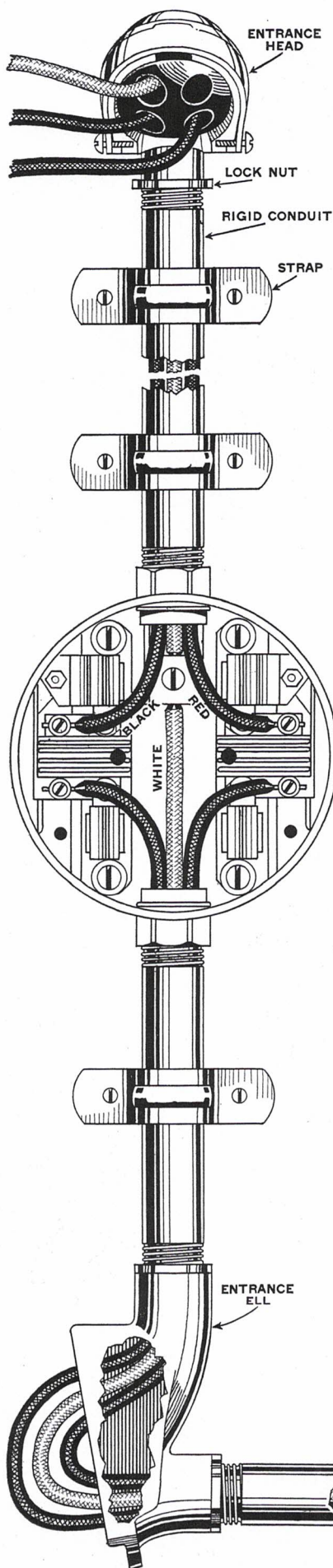
This switch is of 60 ampere capacity and is the same type that is often used on services of this size in combination with entrance cable. State, local and power com-



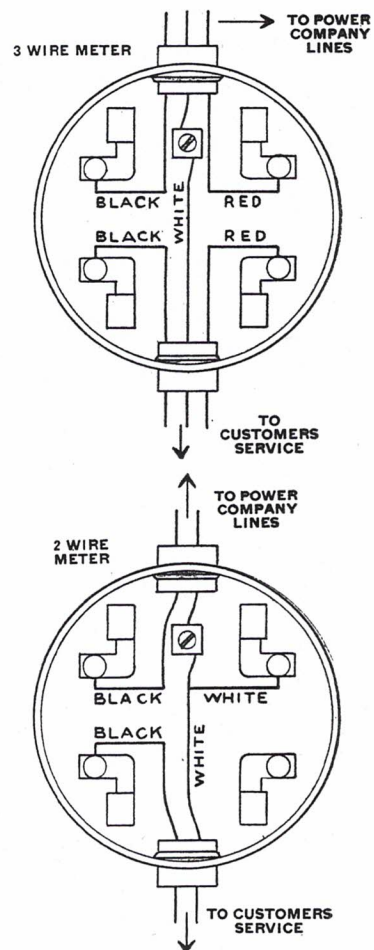


DRAWING No. 26

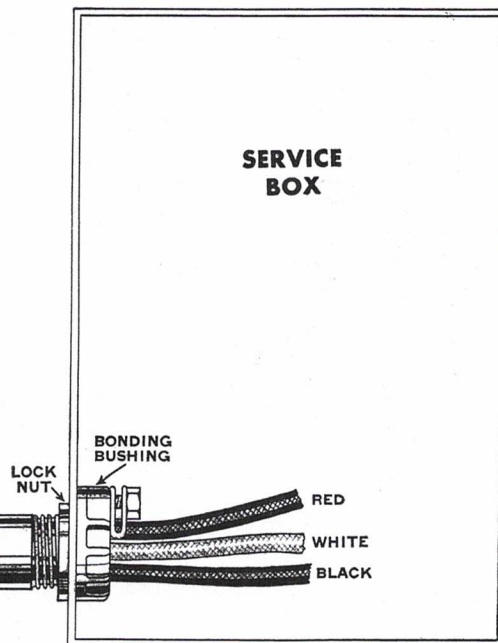




METER SOCKET CONNECTIONS



DRAWING No. 27





panies specifications cover the size and type of equipment you should use. Consult them before ordering a service switch. All Sears entrance switches are supplied with wiring diagrams. In selecting a type of service entrance switch, you have a choice between a fused switch and a new automatic protective switch known as a "No-Fuze" load center switch. The "No-Fuze" load center switch eliminates all fuses and protects the circuit by its automatic mechanism which is foolproof and tamperproof. See drawings Nos. 24 and 25, Page 17.

The function of this "No-Fuze" load center switch is: In the case of an overload or short in any circuit of your wiring, an automatic device trips out the switch, automatically relieving the pressure caused by the short or overload on said circuit. "No-Fuze" load center switch panels are provided in two types: A flush unit which permits the installation of your panel flush with the wall surface on your first or second floor, thereby in many cases reducing cost of wiring—or surface type for mounting in basement or out-buildings.

Connections of cable to main service switch used in Illustration No. 26, Page 18 are: Black wire of service entrance cable connected to left hand lug of 60 ampere main. Red wire is connected to right hand terminal of 60 ampere main. The concentric bare wire is twisted together and connected to nickel plated neutral bar located in top of switch box. A bare copper wire either No. 6 or No. 4 gauge is connected to neutral bar and run to either water or artificial ground (See Chapter No. 4 on Grounding). Your range connections will be: Black wire of range cable connected to right hand terminal of 45 ampere range circuit. Red wire is connected to left hand terminal of range circuit. White wire of range cable is connected to third lug of top neutral bar. There is a direct connection between top neutral bar and bottom neutral bar. All connections of 15 and 20 ampere branch circuits must be made as shown in drawing. With black wires connected to the fused terminals and white wires connected to the neutral unfused terminals, Drawing No. 26 shows that between each pair of branch fuses there is an additional lug which is fused only by the mains. This switch was purposely designed so that a 220 volt line could be run as a sub-feed to another switch located in some other position such as a safety switch for protection of pump motor or operation of electric water heater. Under no circumstances are any of your branch circuit lines to be connected to these unfused lugs.

## CONDUIT SERVICE ENTRANCE

Figure No. 27, Page 19 illustrates an entrance service installation made with galvanized rigid conduit and rubber covered house wire. Galvanized conduit is usually installed on outside of building although in some localities black enameled conduit may be used. The entrance cap is fastened to top of conduit with bottom of conduit run screwed into the meter ring; at bottom of meter ring another piece of conduit is installed which runs down to a point where the service is to enter building. At this end, an entrance ell is placed on conduit. This ell has two threaded holes corresponding to the conduit size with which it is used. Into the threaded hole running at right angle to conduit from the meter ring, another piece of conduit is placed which runs through a hole in the foundation and into the entrance switch in basement.

With the cover on the entrance cap removed, three rubber covered wires are pushed up the conduit from the meter ring

into and out of the service head allowing each wire to extend beyond service head at least 24 inches. Each wire is run through one of the holes in the cover and the cover replaced. The wire connections are then made in the meter ring and continued down through to Entrance Ell. To facilitate the running of these wires at right angle, the cover on Ell is removed and the wires pulled all the way through and then fed through conduit leading to switch.

## 30 AMPERE SERVICE

From a service head a 3 wire No. 8 service cable (3 No. 8 wires in conduit) is run through meter socket and outside wall of building and into an entrance service switch. It will be noted, see Drawing No. 28, Page 21, that there are three connections already made in this switch, therefore, it will be necessary to make only the following connections: Black wire from meter to left brass terminal at bottom of top section of switch. Red wire from meter to right brass terminal at bottom of top section of switch and bare (white in conduit wiring) wire from meter is connected to left nickel terminal at top of switch. A ground wire is attached to the right terminal at top of switch block.

The branch circuits are connected as follows: Black wires to the 4 brass terminals located one in each corner of the lower double block. White wires to nickel plated terminals at the bottom of branch circuit block. For 2 wire service, single pole solid neutral combination service entrance switch shall be used and connections shall be same as for the 3 wire except that there is no red wire nor is there any place in switch where it could be connected. Consult with your power company or inspection office representative as to the proper type service switch to be used in your locality.

## OUTDOOR POLE MOUNTED SERVICE

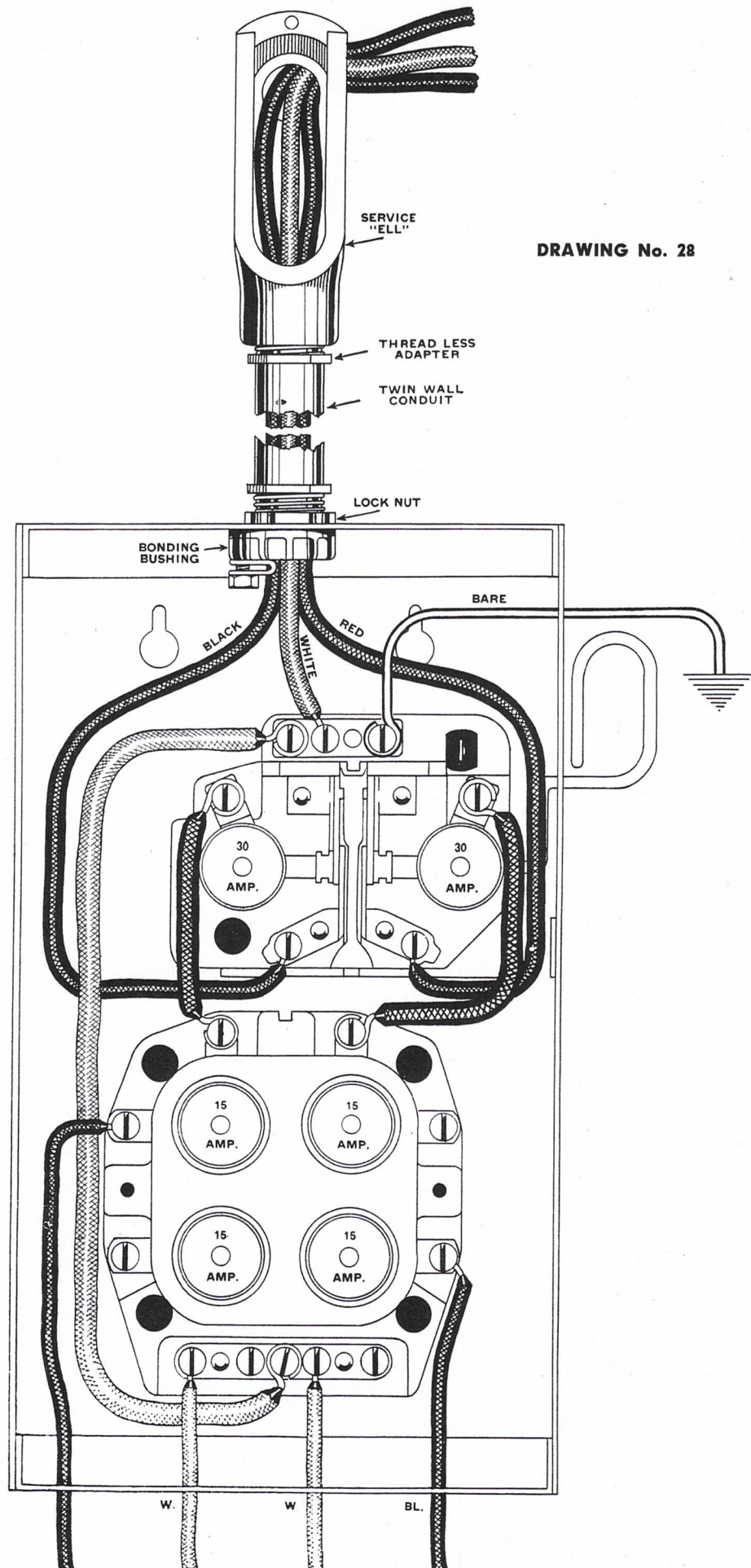
As shown in Drawing No. 29, Page 22, when an outdoor service switch is required or desired, it will be necessary to use a special switch known as "weatherproof" type. You will note in drawing that power company lines terminate at cross arm on pole and are there connected to leads of a three wire service cable (or 3 leads from a conduit run).

End of cable (or conduit) is protected by a weatherproof service head, which, in the case of service cable, is securely mounted on pole, and serves also as a support for the top of the cable. Whether conduit or service cable is used, service head should be mounted 15 feet above ground, and in no case, can it be lower than 10 feet from ground. Regardless of whether conduit or cable be used, supporting straps must be placed every 4 feet of run from head to meter socket. A short metal nipple may be used between meter socket and service switch.

A grounding agent in the form of armored bare wire, bare wire protected by conduit or other approved means connected to an 8 ft. driven ground rod should be used.

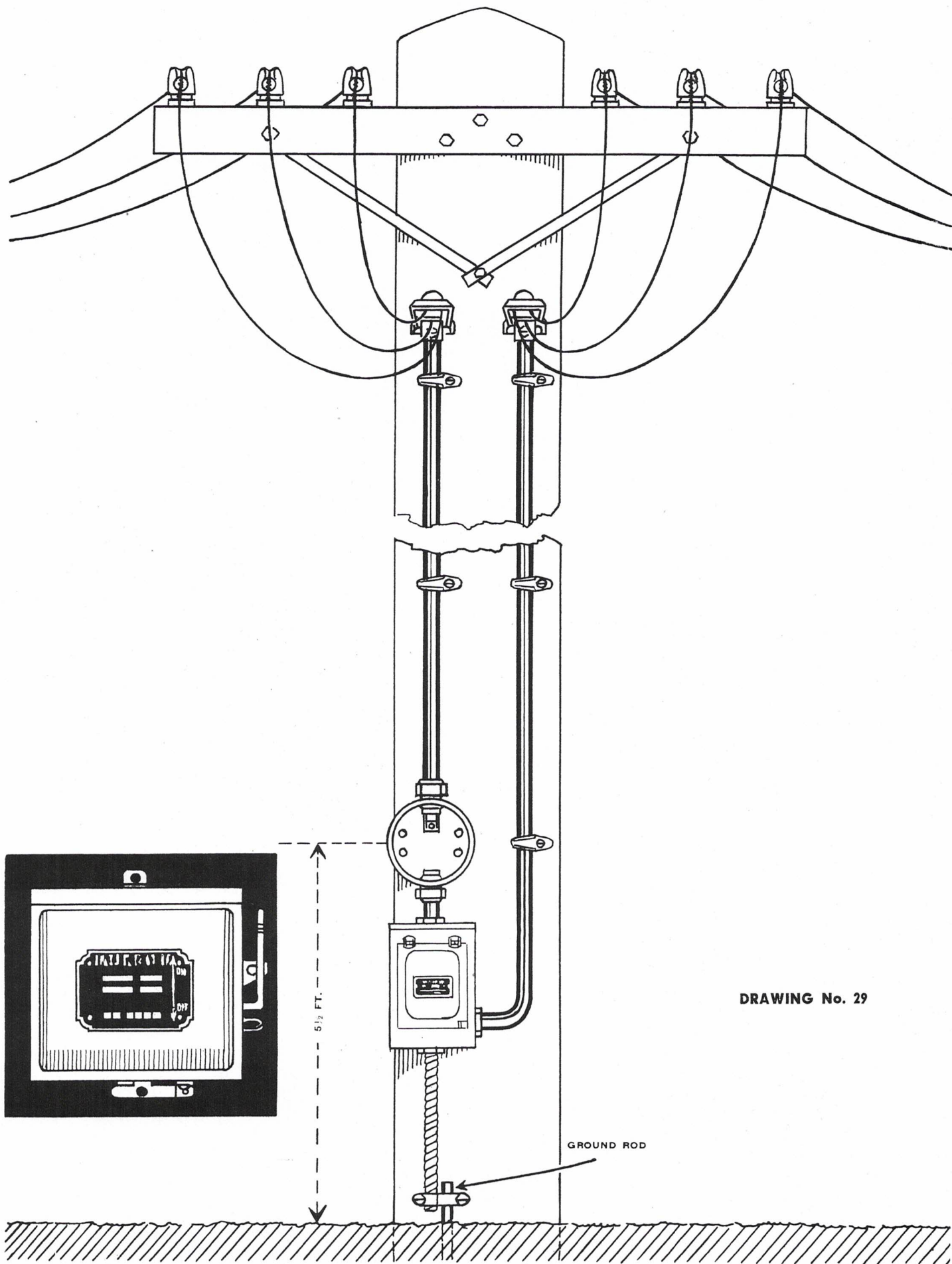
A duplicate of your entrance service run shall be returned up pole and lines then run to house. Where service enters house, another disconnecting switch shall not be necessary if there are not more than six circuits in house, and if branch circuit panel is located immediately adjacent to where service conductors enter building; however, it will be necessary to install a second grounding device.





DRAWING No. 28





DRAWING No. 29

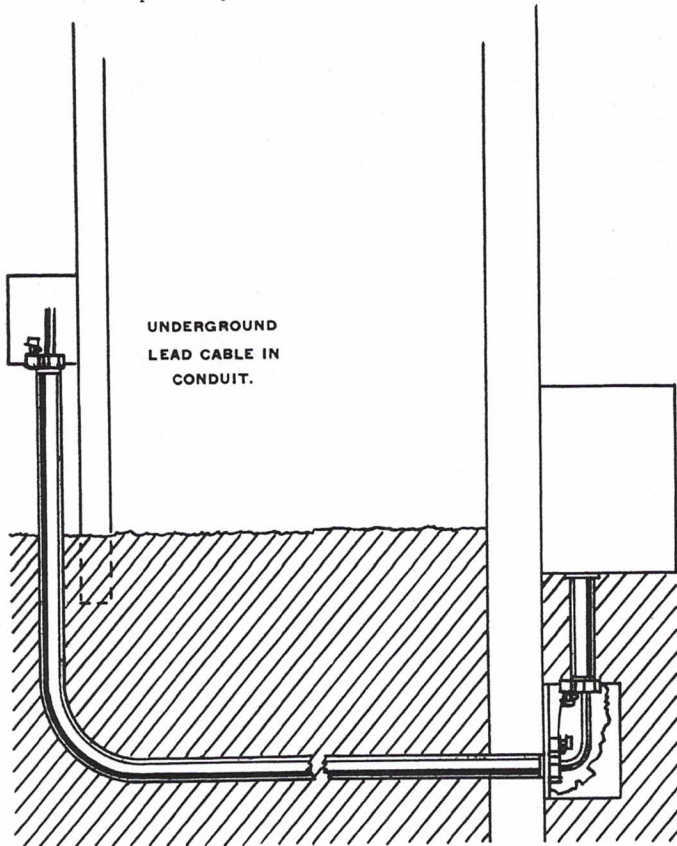


## UNDERGROUND SERVICES

Underground sub-services from one building to another must have conductors protected by one of the following coverings:

### LEAD CABLE IN CONDUIT—See Drawings Nos. 30 and 31

Consisting of two or more rubber covered conductors encased in a lead sheath and pulled through a metal conduit. This is the most common type of underground wiring. The initial cost of conduit and lead underground wiring is higher than either parkway or armored lead cables, but in the long



DRAWING No. 30

run is more practical. In the event of replacement of conductors, it is only necessary to attach the new conductors to the old, and as the old cable is withdrawn from the conduit, the new cable is pulled through.

Where cables of an underground service enter a building, they shall have mechanical protection in the form of rigid or flexible conduit, thin wall conduit, the metal tape of a service cable approved for underground installation or other approved protection.

Where an underground service raceway enters a building, the end within the building must be sealed with a suitable compound so as to prevent the entrance of moisture or gases. There shall be no splices within a conduit, and where conductors larger than No. 6 are used, they shall be stranded.

### ARMORED LEAD CABLE

Armored lead cable (type ACL) may be used under ground as a sub service feeder and consists of two or more rubber covered conductors encased in a lead sheath and the whole covered with a spirally wound flexible armor.

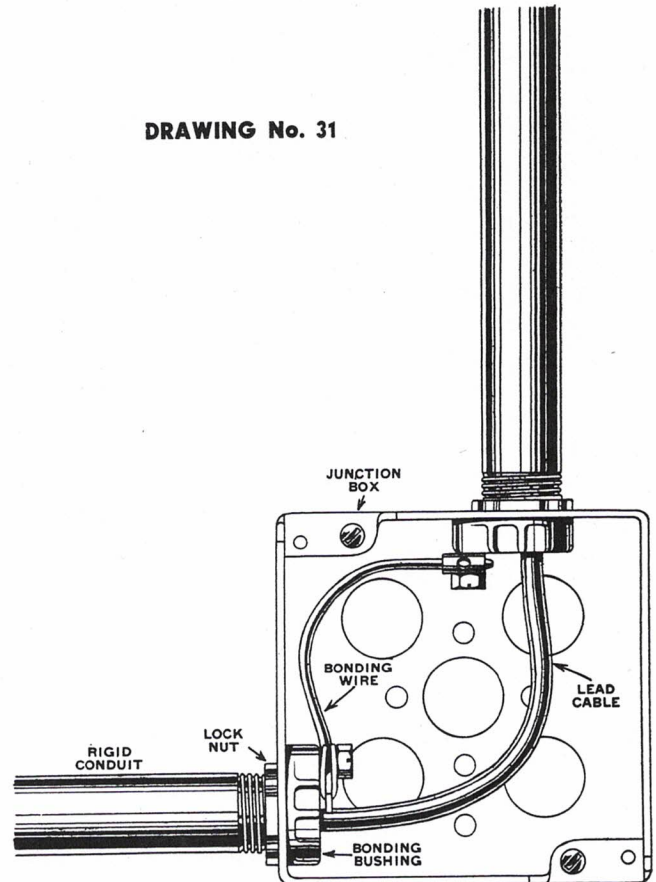
### PARKWAY CABLE

Parkway Cable is furnished in two types, the metallic or the non-metallic, and may be buried directly in the earth without further covering or protection except that in the case of

non-metallic cable where it enters a building, it must have mechanical protection in the form of conduit, flexible armor or other approved means of protection against mechanical injury. Both types are approved by the Code, however, before using either, inquire from your Local Power Company or inspection office as to which type is preferred in your locality.

When an underground service connects to Power Company lines on a pole, conduit or cable (properly protected against mechanical injury by conduit or other approved means) shall be run up pole to a minimum height of 8 inches

DRAWING No. 31



above ground. However, it is preferable to end run closer to Power Company cross arm or bracket so as to make a neater completed job. See your Power Company representative for his recommendations. Underground sub-service, if not continuous metallic shall be grounded at branch panel in out building.

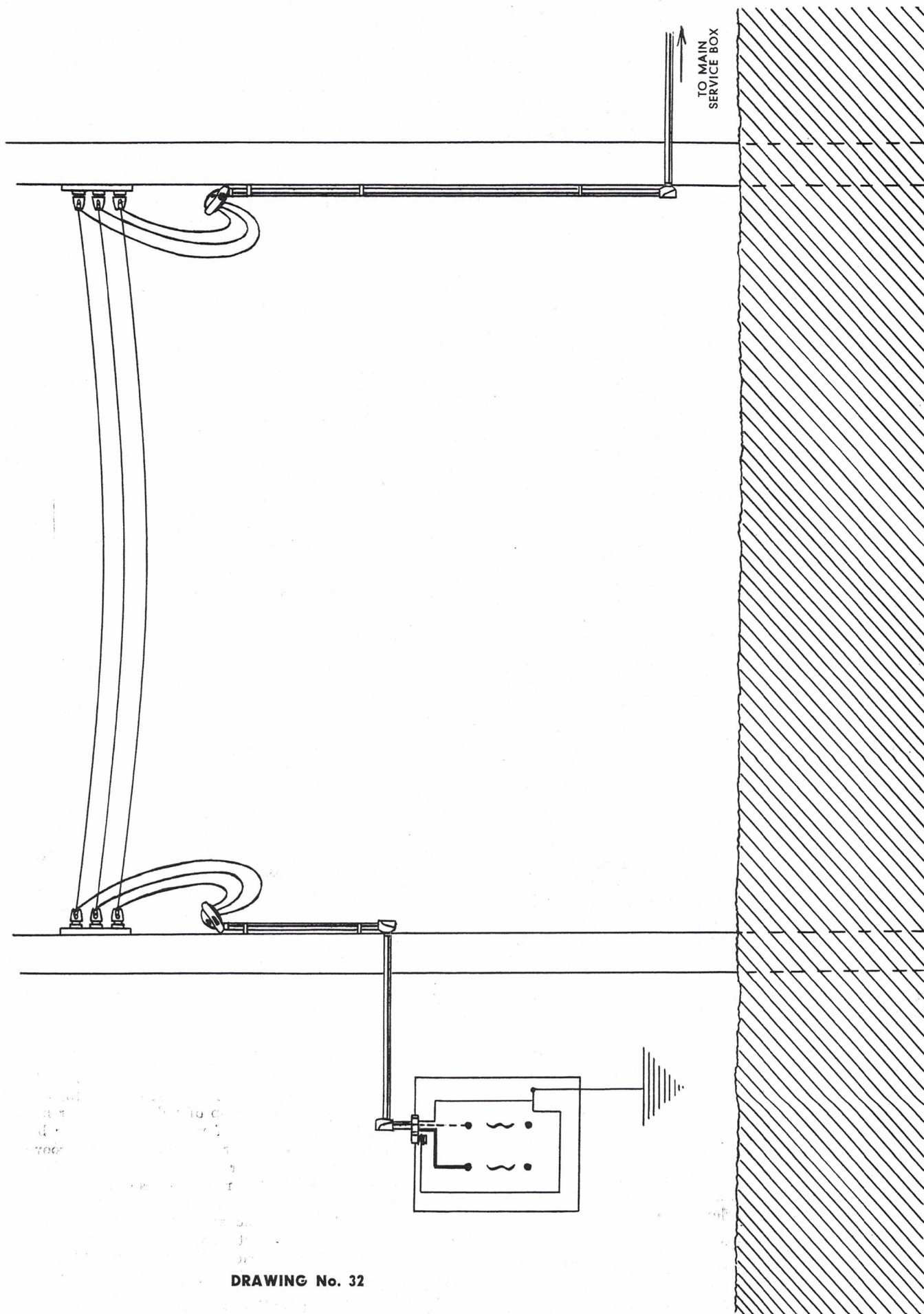
For outdoor overhead wiring, a weatherproof wire type WP shall be used. (See Drawing No. 32, Page 24, for outdoor work.)

## OVER-HEAD WIRING SEE DRAWING No. 33—Page 25

For pole line construction, the most economical method of placing insulators is: Place 1 Porcelain Insulator equipped with a 2½ inch screw on top of pole and one or more Insulators on opposite sides of pole, each insulator being at least 12 inches apart center to center of wire groove. The Oak Bracket used with porcelain Insulator is probably one of our oldest methods of carrying wires and is still accepted and approved by the Code. There are better means of supporting wires such as the above mentioned method or by the use of channel bracket on which two or three insulators may be screwed. This bracket is approved in most areas for short, overhead runs or for supporting wires on the sides of buildings.

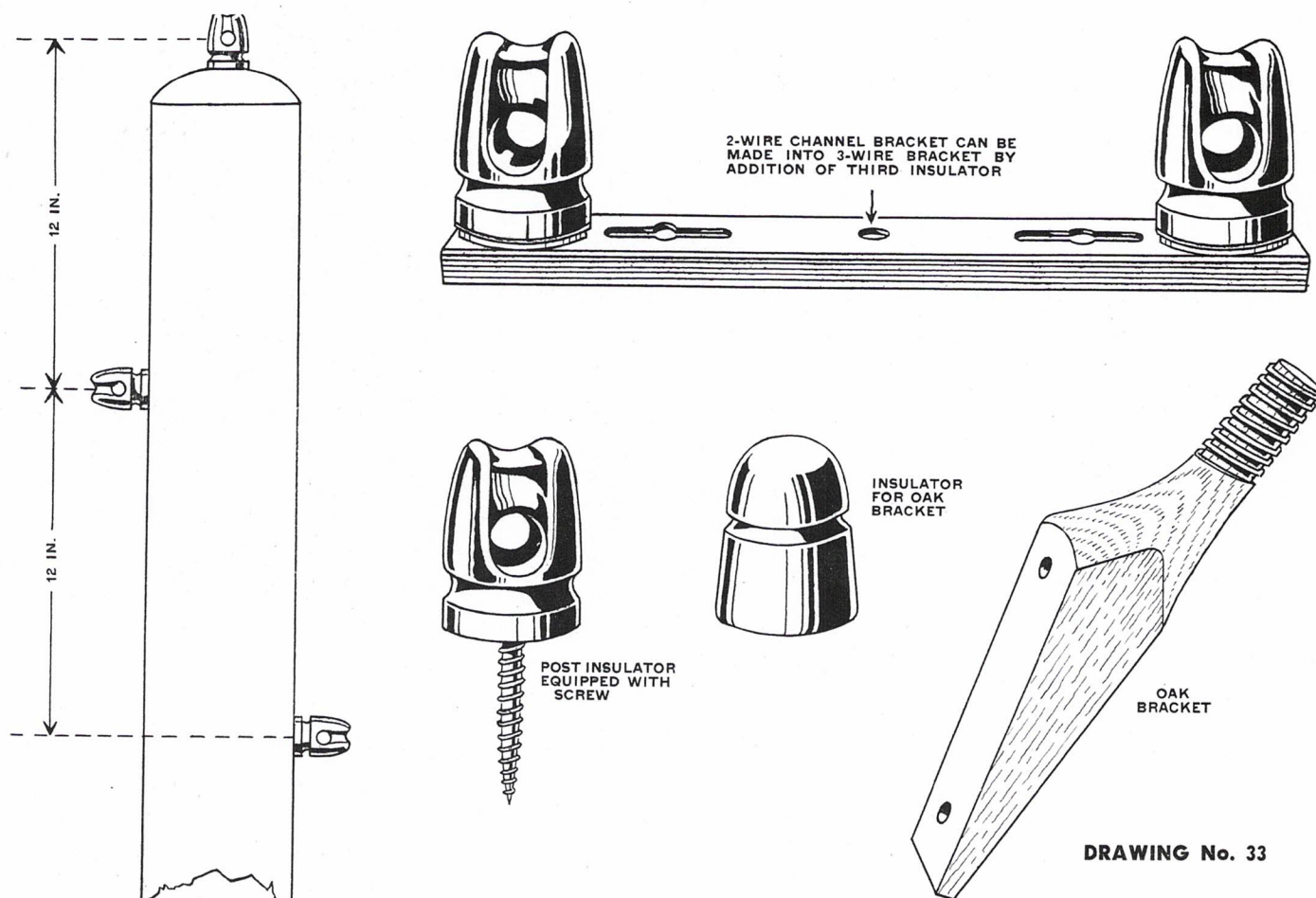
(Continued on Page 25)





DRAWING No. 32





(Continued from Page 23)

An overhead sub-service between two buildings on the same property should be installed in the following manner: Either conduit or service entrance cable may be used for vertical runs on the outside of house and outbuilding. Runs start from your main service panel, preferably from the unfused tap of panel, and are carried up outside wall of building to a service entrance head. A loop is made from head to a 2 or 3 wire insulator bracket located not less than 15 ft. from the ground. Wires are then carried overhead to similar equipment located on outbuilding (See Drawing No. 32, Page 24). Sub-service is then run to a branch service switch in outbuilding and distributed from there to outlets in building. It will be necessary to ground bushing holding conduit or service cable in branch service panel as well as the panel itself. This is required because there is not a continuous metallic ground from main service panel to branch service panel. When service is desired in other buildings, this procedure must be repeated with a protective device located in each building and grounded at each building.

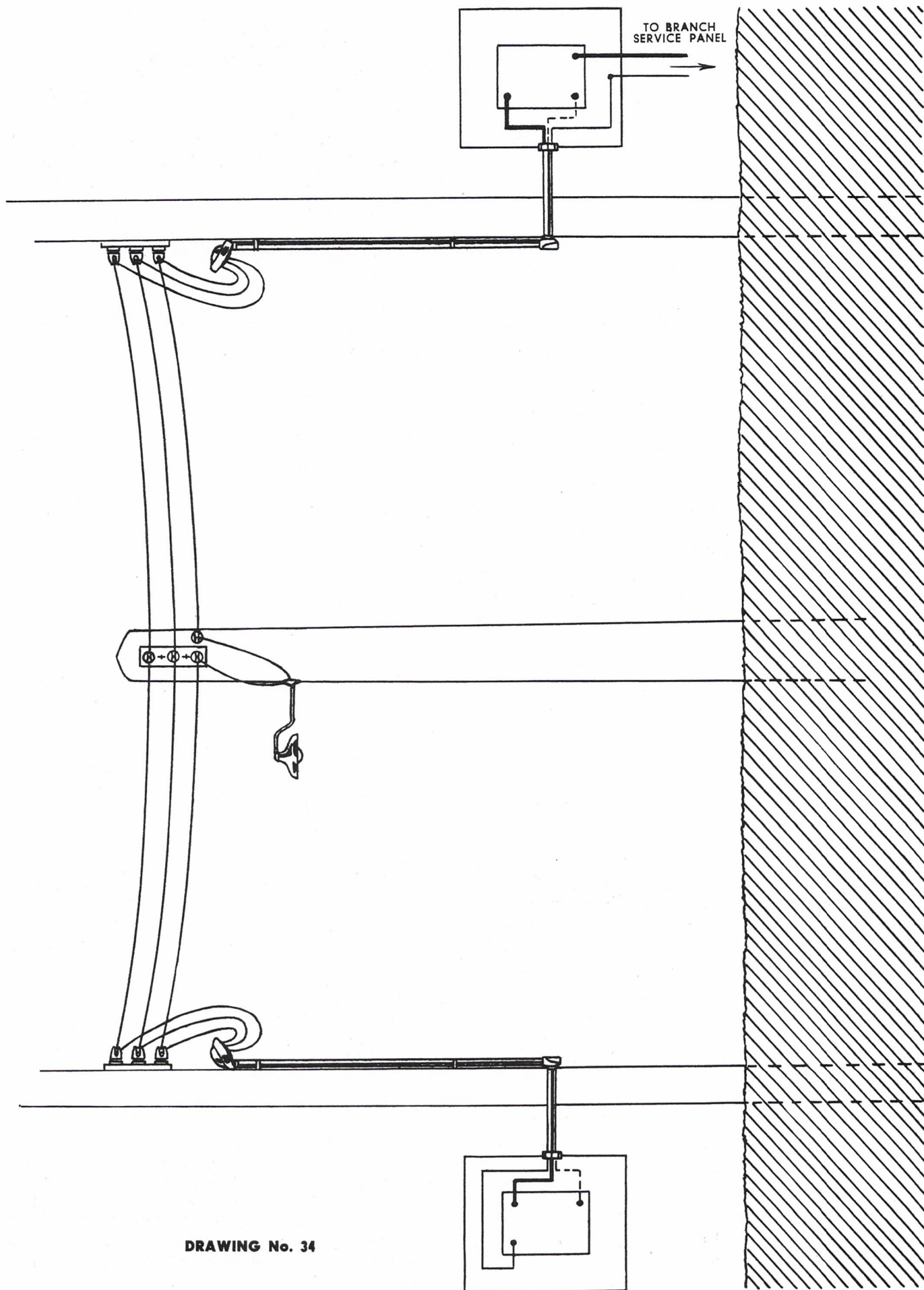
### 3-WAY CIRCUITS BETWEEN BUILDINGS

When a 3 way circuit for controlling a yard light from two buildings is desired, it will be necessary to follow this rule: A conduit or service entrance cable is run from 3 way switch in both buildings vertically on outside surface of

buildings terminating in a service entrance head. A loop made from a 3 wire bracket (See Drawing No. 34, Page 26) on which are mounted the following: One 3 wire bracket, one screw type Insulator and one Outdoor Heavy Duty Light Bracket.

The wiring shall be:—Two wires from branch circuit panel in house are run to 3 way switch in house; black wire connects to bronze terminal of 3 way switch; white wire to white wire from conduit (bare wire of service cable); black and white wires in conduit or service cable connect to brass terminals of 3 way switch. Wires are then run outside and overhead to pole in yard (outside wires must be weatherproof). Black wire from house 3 way switch is to be connected to top wire on bracket, we will call this wire No. 1; red wire is connected to second wire No. 2; white wire is connected to lowest wire No. 3, Wires No. 1 and No. 2 continue unbroken from house to barn; No. 3 from house is fastened to screw type Insulator and looped down to weather proof outdoor light bracket, there connected to the white wire of light bracket. Wire No. 3 from barn is fastened to lowest insulator of bracket mounted on pole, looped down to outdoor light bracket and connected to black wire of light bracket. It will be necessary to remove coating at both ends of white wire of 3 wire line in barn after run is made and you are sure of the identity of the wires. If service cable is used at barn end of 3 way circuit, it will be necessary to use a cable consisting of 3 insulated wires; the regular service cable of 2 insulated and 1 bare should not be used.





DRAWING No. 34



# CHAPTER FOUR

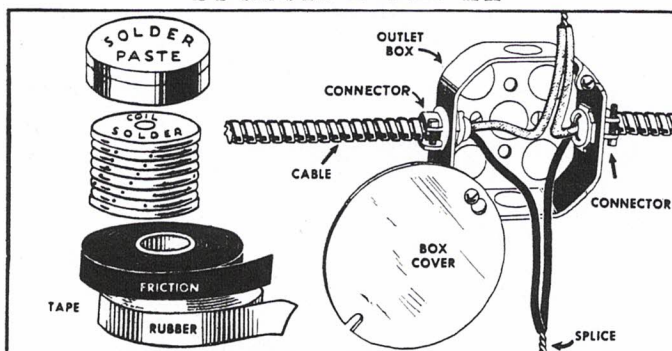
## SPlicing AND GROUNdING

### GROUNdING

Every splice or connection of wires except where fixtures are connected to leads from outlet boxes must be soldered and covered with both rubber and friction tapes. The use of both tapes is necessary for in stripping wires to make connections you have removed both rubber and cloth covering from the wires. This covering must be replaced, therefore, after splice is made and soldered, a piece of rubber tape is wrapped around splice and as each wrap is made tape is pulled very tightly around wire. At end of splice, end of tape is merely pushed down on insulation of wire where it will hold itself because of the elastic qualities. The rubber tape is then covered by friction tape which acts as a seal preventing air, as far as possible, causing a disintegration of the rubber.

Where drop cords are connected in outlet boxes and in sockets protection must be used to prevent stress or pull on the splice. One method of accomplishing this purpose is: the Underwriters' "Knot" as shown in Illustration No. 37, Page 28.

### SPlicing CABLE



DRAWING No. 35

Joints or splices made with cable must be in a steel box as shown. Remove required number of knockouts from box and fasten to surface. Measure cable to point where it will terminate in box allowing at least 8 inches extra for splicing. Strip armor from this portion of cable and insert fiber bushing and connector over end of armor. Fasten cable to surface with cable staples, not more than 4 feet apart, pulling the cable taut as each fastening is made. Place connector into box and fasten. Strip about 1½ inches of insulation from each of the 4 wires and splice as shown. Apply soldering paste to each splice and heat splice enough to melt solder as applied. Wrap splice with rubber and then with friction tape.

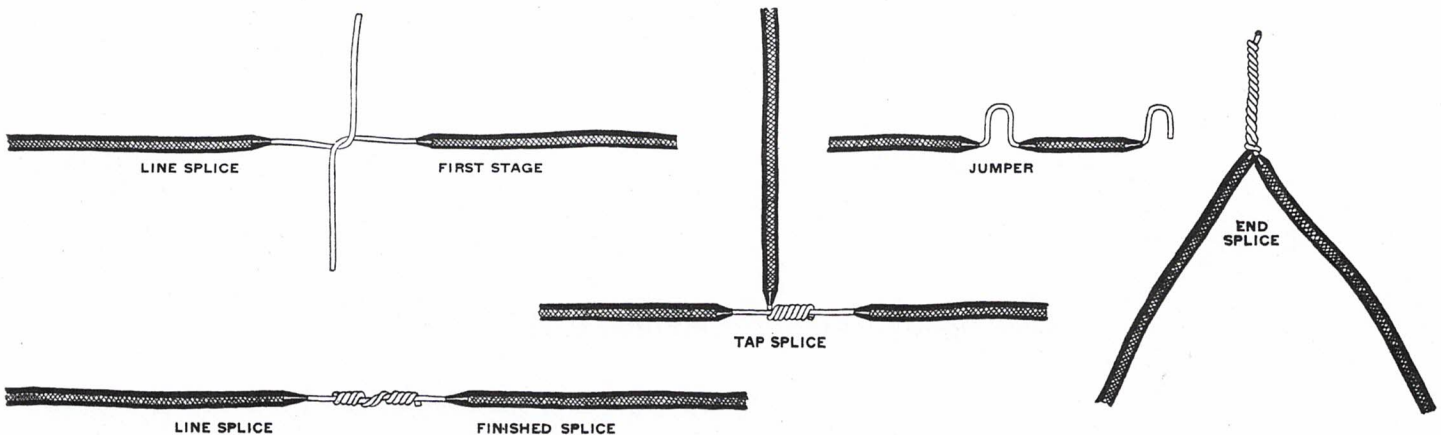
**Means of Grounding:** You must use a ground on every electrical system so as to give adequate protection to your wiring system—a protection against defects or deterioration in the transformer causing a voltage surge on your lines—or lightning striking the exterior lines, which, if there was not an effective ground on your house wiring system, might cause considerable damage to your wiring and electrical devices. The Underwriters have therefore laid down strict rules covering the construction of grounds and grounding devices for protection of your circuits. This, of course, is to your advantage.

The path to ground from circuits, equipment or conductor enclosures shall be permanent and continuous and shall be of a size great enough to safely conduct any current that it might be called upon to carry, and the wire used for grounding conductor shall be of the same size or larger than the wire used for service entrance. It shall be securely connected to clamps or other grounding devices, and grounding device located, in the case of an artificial ground, below the line of permanent moisture. This will be covered at greater extent in following paragraphs. For overhead services, the following shall be bonded together by means of bonding jumpers, clamps, or other devices (not locknuts and bushings) approved for the purpose:

- The service raceways or service cable armor or sheath.
- All service equipment enclosures containing service entrance conductors.
- Any conduit, pipe, or armor which forms part of the grounding conductor to the service raceway.

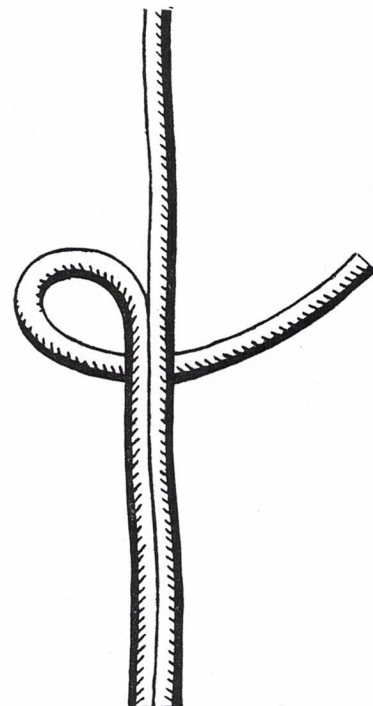
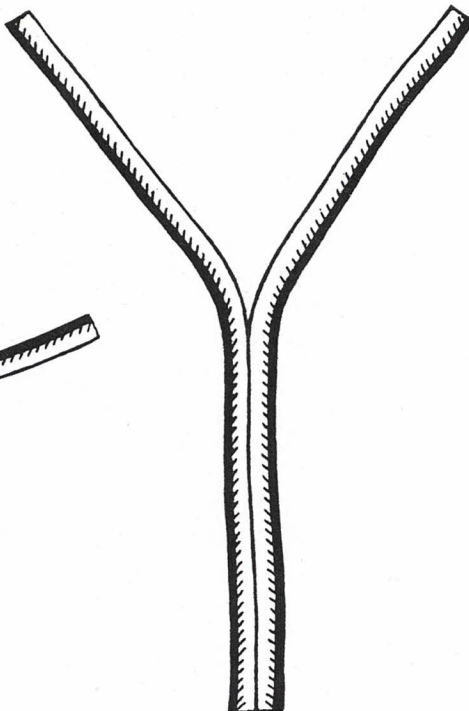
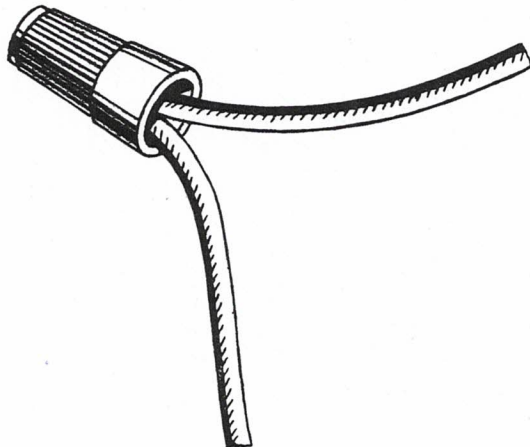
If there are cabinets, meter fittings, boxes or gutters interposed in the service raceway or armor, or in the grounding conductor of the service raceway or armor, the electrical continuity of the system shall be assured by one of the following methods:

- Threaded fittings with joints made up tight, where rigid conduit is involved.
- Threadless fittings, made up tight, for electrical metallic tubing.
- Bonding jumpers meeting the other requirements of this article.
- Other devices (not locknuts and bushings) approved for the purpose.

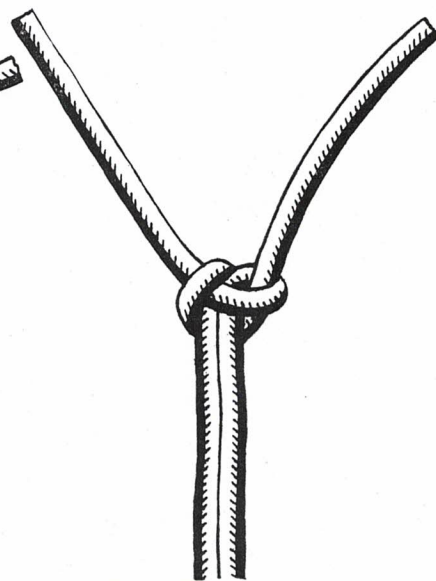
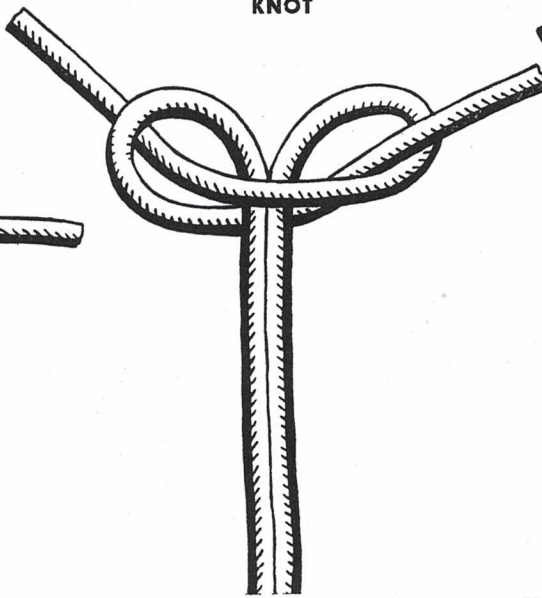
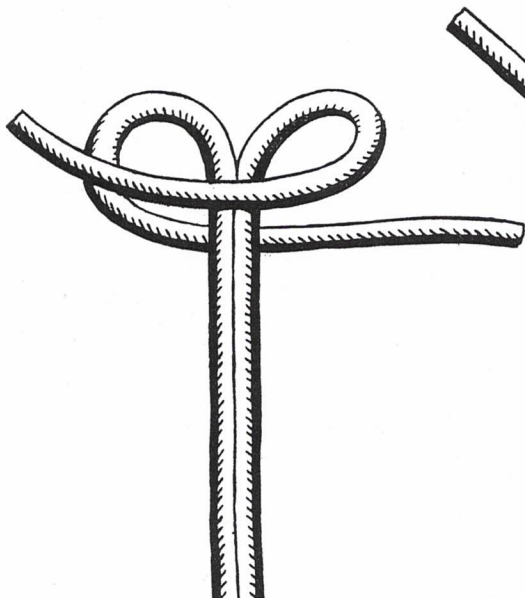


DRAWING No. 36

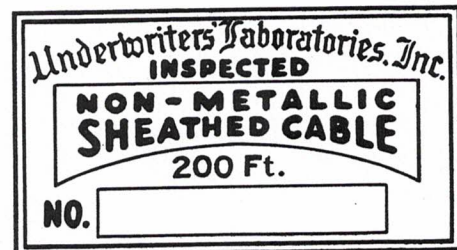
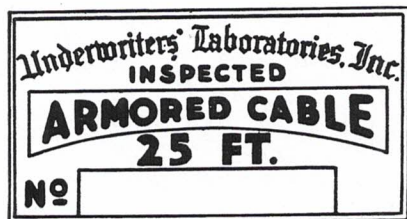
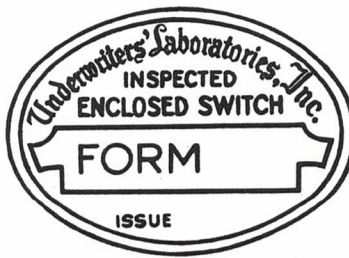
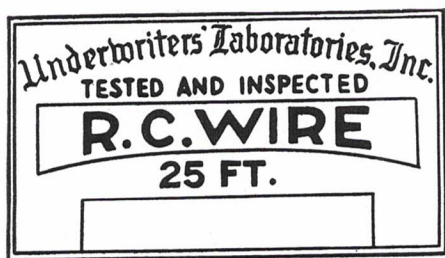




UNDERWRITERS  
KNOT



SOME UNDERWRITERS' LABELS—LOOK FOR THEM WHEN BUYING ELECTRICAL EQUIPMENT





## FOR UNDERGROUND CABLE:

Service conduit or metal pipe from underground supply is considered to be grounded if it contains metal sheathed cable bonded to a continuous underground metal sheathed cable system. The sheath or armor of service cable from underground supply is considered to be grounded if it is metallically connected to a continuous underground metal sheathed cable system.

## GROUNDING ELECTRODES:

Water Pipe: (See Drawing No. 38) A continuous metallic underground water piping system shall always be used as the path of the current to the ground where such piping system is available.

## ARTIFICIAL GROUNDS:

Where such a water piping system is not available the grounding connection shall be made in a manner to secure the most effective ground. Any one or combination of the following may be used:

- The metal frame of the building, if effectively grounded.
- A continuous metallic underground gas piping system.
- A local metallic underground piping system, metal well casing, and the like.
- An artificial ground whose electrode consists of a driven pipe, driven rod, buried plate, or other device approved for the purpose.

## GAS PIPING

### FOR FIXTURE GROUNDING

Gas piping may serve as the path to the ground for fixtures located at a considerable distance from water piping. Where gas piping is so utilized, it shall be bonded from the house side of the gas meter to the water piping system. If no

water piping is available, a bonding jumper shall be used around the gas meter. Gas piping need not be insulated from otherwise well grounded fixtures.

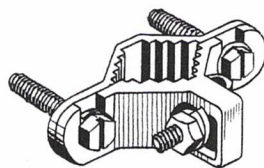
## COMMON ELECTRODE:

If buried plates or driven rods or pipes are used, the grounding conductor for conduit, cable armor, and other metallic race-way or wire enclosure, or for equipment shall have its own grounding device, separate from the grounding device of the wiring system or the secondary distribution system supplying it, unless such distribution system has, at least, one additional ground at the transformer or elsewhere.

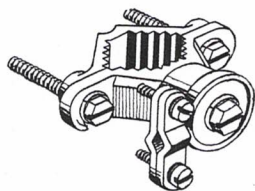
## SIZE AND LOCATION

Where artificial grounds are used the rods, pipes or plates shall, as far as practicable, be embedded below permanent moisture level. Each buried plate electrode shall present not less than two square feet of surface to exterior soil. Electrodes of plate-copper shall be at least 0.06 inch in thickness. Electrodes of iron or steel pipe shall be galvanized and not less than  $\frac{3}{4}$ -inch internal diameter. Electrodes of rods of steel or iron shall be at least  $\frac{3}{4}$ -inch minimum cross sectional dimension.

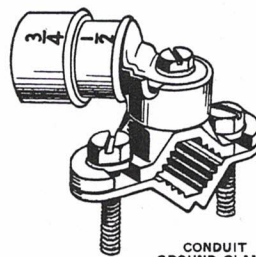
Approved rods of non-ferrous materials such as copper or their approved equivalent used for electrodes shall be not less than  $\frac{1}{2}$ -inch in diameter. Driven electrodes of pipes or rods, when of less than standard commercial length, shall preferably be of one piece and except where rock bottom is encountered, shall be driven to a depth of at least 8 feet regardless of size or number of electrodes used. Such pipes or rods shall have clean metal surfaces and shall not be covered with paint, enamel or other poorly conducting materials. Each electrode used shall be separated at least 6 feet from any other electrode, including those used for signal circuits, radio, lightning rods or any other purpose.



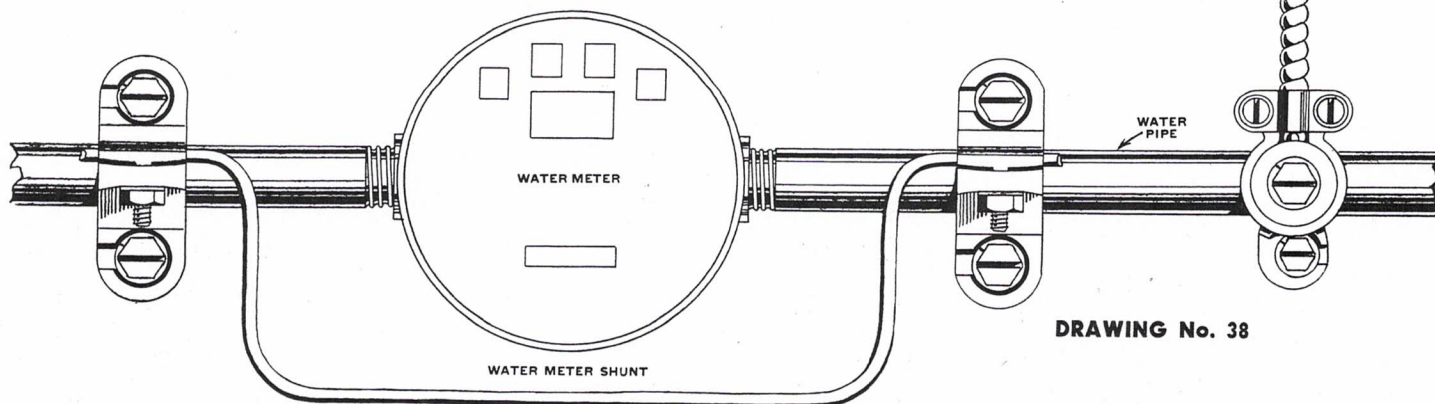
GENERAL PURPOSE  
GROUND CLAMP  
FOR BARE WIRE



GROUND CLAMP FOR  
ARMORED GROUND WIRE



CONDUIT  
GROUND CLAMP



DRAWING No. 38



## GROUNDING TO WATER PIPES

The point of attachment of a grounding conductor to a water piping system shall be on the street side of the water meter, or on a cold water pipe of adequate current carrying capacity, as near as practicable to the water service entrance to the building or near the equipment to be grounded, and shall be accessible except by special permission. If the point of attachment is not on the street side of the water meter, the water piping system shall be made electrically continuous by bonding together all parts between the attachment and the pipe entrance which are liable to become disconnected, as at meters and service unions (See Drawing No. 38, Page 29).

## GROUNDING TO GAS PIPES

The point of attachment of a grounding conductor to gas piping shall always be on the street side of the gas meter, and shall be accessible except by special permission. An exception to this requirement is given in a previous paragraph covering "Grounding of Fixtures."

**Means of Attachment:**—The grounding conductor, in its attachment to equipment and electrodes, shall conform to the following:

**To Equipment.** The grounding conductor shall be attached to circuits, conduits, cabinets, equipment, and the like, which are to be grounded, by means of suitable lugs, clamps, blocks or other approved means.

**To Electrode.** The grounding conductor shall be attached to the grounding electrode by means of (1) an approved bolted clamp of cast bronze or brass or of plain or malleable cast iron to which the conductor is soldered or otherwise connected in an approved manner or (2) a pipe fitting, plug, or other approved device, screwed into the pipe or into the fitting, or (3) other equally substantial approved means. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting unless the clamp or fitting is of a type approved for such use.

## GROUND CLAMPS

SEE DRAWING No. 38—PAGE 29

Ground Clamps shall conform to the following: a. For the grounding conductor of an interior wiring system, the sheet-metal-strap type of ground clamp is not considered adequate unless it has a rigid metal base seated on the water-pipe or other electrode, and the strap is of such material and dimensions that it is not liable to stretch during or after installation.

**Protection.** Ground clamps or other fittings, unless approved for general use without protection shall be protected from ordinary mechanical injury (1) by being placed where they are not liable to be damaged or (2) by being enclosed in metal, wood or equivalent protective covering.

## SEPARATE CLAMP

If the grounding electrode is also used for grounding lightning rods, as for example in case of continuous metallic water pipe systems, the grounding connection shall be entirely independent of, and separated from, the lightning rod connection to the piping system.

## COMMON CLAMP

If two or more grounding conductors are used under a condition where a common grounding conductor is permissible, a common connection to the grounding electrode may be employed. In all other cases each grounding conductor shall have an independent connection to the grounding electrode.

## BONDING JUMPERS

Bonding jumpers shall be installed as follows:

**Around Meters.** Bonding Jumpers between grounding electrodes and around water meters, gas meters, unions, and the like, shall be of copper or other non-corrodible metal and shall be of sufficient size to have current carrying capacity not less than is required for the corresponding grounding conductor. They shall be attached by the method as shown on Drawing No. 38.

**In Cabinets.** Bonding Jumpers in cabinets and the like shall be of copper wire or the equivalent and of such size as to have current-carrying capacity not less than is required for the corresponding grounding conductor. They shall be attached as shown in Drawing No. 31, Page 23.

## WATER METER SHUNT

A water meter shunt may be made by placing one Ground Clamp on each side of water meter and running a copper wire of not smaller than the size used for your service wires between the two clamps. Be sure that all connections are drawn up as tightly as possible and the clamps rigidly secured to water pipe (see Drawing No. 38).

TABLE "A"

Size of Conductors	Number of Conductors in One Conduit or Tubing								
	1	2	3	4	5	6	7	8	9
	Minimum Permissible Size of Conduit (Inches)								
14	1/2	1/2	1/2	1/2	3/4	3/4	3/4	1	1
12	1/2	1/2	1/2	3/4	3/4	1	1	1	1 1/4
10	1/2	3/4	3/4	3/4	1	1	1 1/4	1 1/4	1 1/4
8	1/2	3/4	1	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/2
6	1/2	1	1 1/4	1 1/4	1 1/2	1 1/2	2	2	2
4	3/4	1 1/4	1 1/4	1 1/2	2	2	2	2	2 1/2
2	3/4	1 1/4	1 1/2	1 1/2	2	2	2 1/2	2 1/2	2 1/2
1	3/4	1 1/2	1 1/2	2	2	2 1/2	2 1/2	3	3
0	1	1 1/2	2	2	2 1/2	2 1/2	3	3	3

Tables "A" and "B" are made up for your convenience. It is possible by a glance at Table "A" to tell exactly what size conduit is necessary to carry a given size and number of conductors. Table "B" will enable you, by the combined use of the formula shown on Page 31 and Table "B" to determine the size wire needed to carry a given load, a set distance and at a pre-determined voltage drop.

The copper loss (i.e. energy loss due to resistance of the conductors) depends on the resistance of the wire and the square of the current which is carried. If appliances such as refrigerators, washers, irons, ironers, roasters, etc. are expected to operate at maximum efficiency and minimum operating cost, it is to your advantage to determine before you begin to wire, the exact size wire needed to carry the current to your appliances with the lowest possible voltage drop.



**TABLE "B"**

Standard Sizes of Fuses, Enclosed Switches and Circuit Breakers for Lighting Circuits				
Conductor Size (A.W.G. Ga.)	Conductor Size (Circular Mils)	Circuit Breaker (Amperes)	Fuses (Amps.)	Switch (Amps.)
14	4,107	15	10-15	30
12	6,530	20	20	30
10	10,380	25	25	30
8	16,510	25	30	30
	16,510	35	35	60
6	26,250	50	45-50	60
	41,740	50	60	60
4	41,740	70	70	100
2	66,370	90	90	100
1	83,690	100	100	100
0	105,500	125	125	200

The method used to determine the size needed to carry a given load a given distance at a minimum voltage loss shall be as follows: Determine the distance the wire will have to run, then multiply by 2. In the case of a 3 wire

115-230 volt service, the same rule shall apply. This sum shall then be multiplied by the factor 10.79 which is the approximate resistance to the flow of current of 1 mil-foot of copper wire regardless of the size of the wire. This second total is then multiplied by the amperage needed at the outlet where the work is to be done. Your third total will be divided by the voltage loss permissible on this particular installation (on an alternating current of 115 volts a voltage loss of from 3 to 5 volts is usually permitted). After the division has been completed the result will be the circular mil size of the wire needed to efficiently carry the current.

By checking with the circular mil column of Table "B" the result of your figures will show the circular mil size of the wire needed. In the event the circular mil size obtained by your calculation is greater than that shown by the chart for any particular size of wire, the next higher figure shall be used. A Circular mil is the area of a circle 1/1000 inch in diameter. One circular mil-foot of wire is a wire 1/1000 inch in diameter and one foot long.

**Example:** A line is to be 200 feet long one way and must supply 20 amperes with not more than 5 volts loss, with a reading of 110 volts at point of starting run.  $200 \times 2 \times 10.79 \times 20 \text{ amperes} = 86320 \div 5 \text{ volts drop} = 17264$  circular mils. By comparison with table "B," it is found that 17264 circular mils is greater than the circular mil size of No. 8 wire, and since voltage drop must not be greater than 5 volts, we must use No. 6 wire.





# It Costs Very Little to Operate

## Sears Electrical Appliances

To show how little electricity costs for the most commonly used appliances on farms and in homes, this table shows the horsepower (where motor is used) and watt consumption per hour of use. \*Electric current cost is based on a rate of 4c per kilowatt hour. For example: The wattage of the iron is 700. There are 1000 watts in a kilowatt. So we divide 700 by 1000 to get the kilowatt hour consumption—.70 kilowatts. This multiplied by cost per kilowatt hour (4c) gives an hourly cost of operating an electric iron of about 3c. If your rate is more or less, see chart at right which shows how to figure costs at rates from 1c to 20c per kilowatt hour.

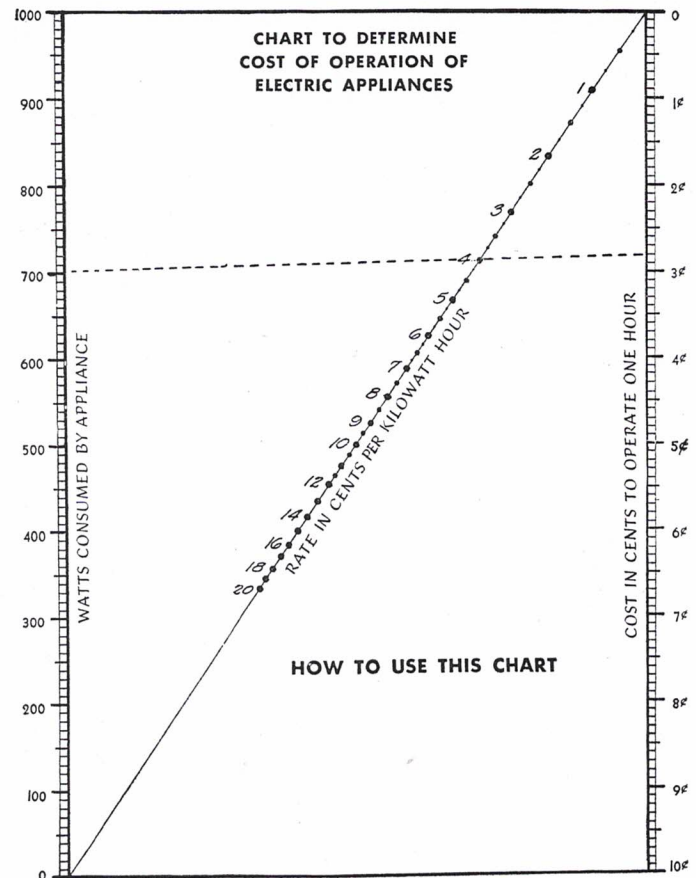
Appliance	Size of Motor H.P.	Watt Consumption Per Hour	Avg. Cost to Operate Per Hour
Iron.....		700	\$0.028
Sewing Machine.....		40	.0016
Washing Machine.....	1/4	340	.0136
Pump.....	1/4	340	.0136
Fan.....		40	.0016
Milking Machine.....	1	900	.036
Heating Pad.....		60	.0024
Range.....		1500	.06
Refrigerator.....	1/6	200	.008
Vacuum Cleaner.....		250	.01
Grinder.....	1/2	550	.0220
20-25 Watt Lamps.....		500	.02
Separator.....	1/4	340	.0136
Churn.....	1/6	200	.008
Toaster.....		450	.018
Radio.....		50	.002
Incubator.....		120	.0048

Isn't that startling? Can you imagine ironing a full hour at a cost of less than 3c? Less than 9c weekly for the average family ironing. About \$4.50 a year. Contrast the pleasure of ironing with an automatic electric iron that is always the right temperature with the old sadiron which must be reheated often. Or with a gasoline iron that is heavy, must be refueled, lit and cleaned. No comparison in comfort, convenience or in the quality of the ironing.

The cost of operating a vacuum cleaner is about 1/2c a day. Will a broom or carpet sweeper clean your rugs one-half as well, or as quickly? \$1.50 a month during hot summer months to operate a big 6 cubic foot Coldspot Refrigerator.

Could you buy ice for that amount? Can you afford to pump 1,000 gallons of water every day for 3c, or 300,000 gallons of water yearly for \$13.00? That's the average amount of water to care for the home, 5 horses, 40 steers, 8 milking cows, 300 chickens and 80 hogs.

The chart below shows how to ascertain the hourly cost of operating any appliance at rates from 1c to 20c per kilowatt-hour.



The above chart was prepared by Prof. Frank D. Paine for the Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa. It is published as a supplement to Rural Electric Report No. 6.

\*This will vary. Obtain average current cost from your power company.



# CHAPTER FIVE

## WIRING YOUR HOME

When considering wiring, both for convenience and safety, you must not lose sight of the fact that **THE WIRING IN YOUR HOME IS ONE OF THE MOST IMPORTANT FEATURES IN YOUR HOME.** Electricity can be your most valuable servant, provided your home is adequately wired, and can bring you all the conveniences, comforts and economies of modern lighting, modern appliances and modern labor saving devices. "Adequate wiring" means, a sufficient number of outlets to operate the electric iron, kitchen appliances, vacuum cleaner, floor and table lamps and many other electrical household necessities of today at the point where they are used; a sufficient number of switches to conveniently operate the lights in each room; large enough electric service into the home; wires large enough to safely and economically carry the current to all the various appliances and lights—and last but not least, plan for the future. Through shortsightedness and poor advice many homes wired ten years ago are out of date because the conductors cannot carry safely the current required by the numerous modern appliances and labor saving devices of today. Think of the uses you plan to make of electricity immediately and add those uses you think you will make in the future—then wire your home accordingly.

### SUGGESTED PLAN AND LAYOUT

Of first importance in wiring a home is a general plan showing where the outlets for fixtures, convenience outlets and switches are to be located. To make the plan more readable, symbols for the various types of outlets are used such as illustrated in lower corner of page.

The following pages will illustrate and describe a plan and layout for the wiring of a seven-room, two-story house. It is our intention to use, in this typical case, a home that has been standing for a number of years in which electricity is to be installed for the first time. It is important to keep in mind that outlets, in broad terms, are considered those that will be used for some current consuming devices such as an electric lighting fixture or convenience outlets used to operate appliances. Switches are not outlets, but merely devices for interrupting the current flowing through the outlet.

The outlets are located on circuits, which are simply paths for carrying electricity from the entrance service switch. The number of circuits to be used in a home depends on the number of outlets the home owner wishes to install, and the square feet of floor area of the building. The National Electric Code limits the number of outlets per circuit to 12 with the use of 14 gauge wire, with the exception that if one 15-ampere branch circuit is installed for each 500 feet of floor space, there is no limit to the number of outlets which may be placed on this circuit. Typical layout follows:

- Circuit No. 1—3 Basement Lights  
     2 Kitchen Lights  
     1 Upper Hall Light  
     2 Bedroom Lights (front)  
     2 Bathroom Lights  
     Total 10 Outlets
- Circuit No. 2—4 Living Room Receptacles  
     5 Bedroom Receptacles (front)  
     1 Bathroom Receptacle  
     1 Lower Hall Light  
     1 Porch Light  
     Total 12 Outlets

- Circuit No. 3—2 Laundry Receptacles  
     2 Kitchen Receptacles  
     4 Dining Room Receptacles  
     Total 8 Outlets

- Circuit No. 4—1 Basement Light  
     1 Dining Room Light  
     2 Bedroom Lights (back)  
     4 Bedroom Receptacles (back)  
     3 Living Room Lights  
     Total 11 Outlets

### NUMBER OF CIRCUITS REQUIRED

To determine the number of circuits needed for adequate wiring of a home, the following formula shall be used. Take the outside measurement of every finished area to be used for habitable purposes, including finished attics, game rooms or studies in basement and garages containing more than two cars.

When the total area has been determined it is to be multiplied by 2 (which is the minimum wattage required per square foot of floor area); to this sum must be added the total appliance load. Grand wattage total is to be divided by the voltage, result then being divided by 15 (which is the maximum amperage permitted on circuits other than appliance circuits). For example, consider a home having a total floor area of 4500 square feet and an appliance load of 1500 watts:

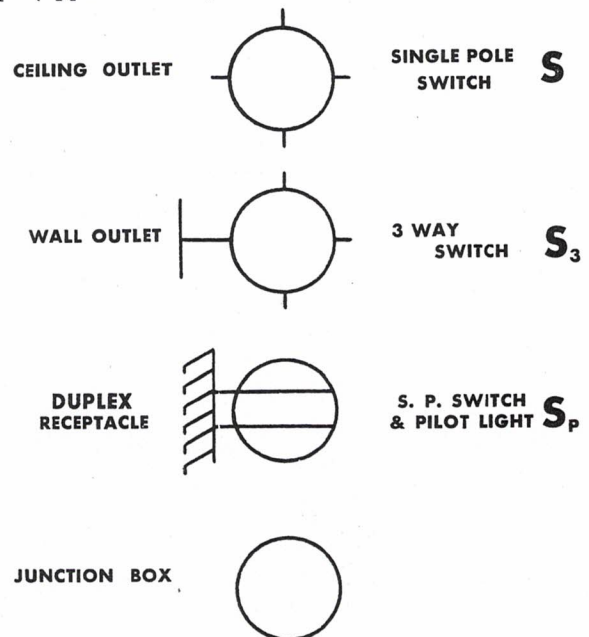
Lighting Load	4500 sq. ft. x 2	9000 watts
Appliance Load	Kitchen 500 watts	
	Laundry 500 watts	1500 watts
	Dining Room 500 watts	
	Total 10,500 watts	

### FOR 115 VOLT SERVICE

10,500 divided by 115 = 91.7 amps., or 5-15 amp. and 1-20 amp. (appliance load) circuits.

### FOR 230 VOLT SERVICE

10,500 divided by 230 = 46 amps., or 2-15 amp. and 1-20 amp. (appliance load) circuits.





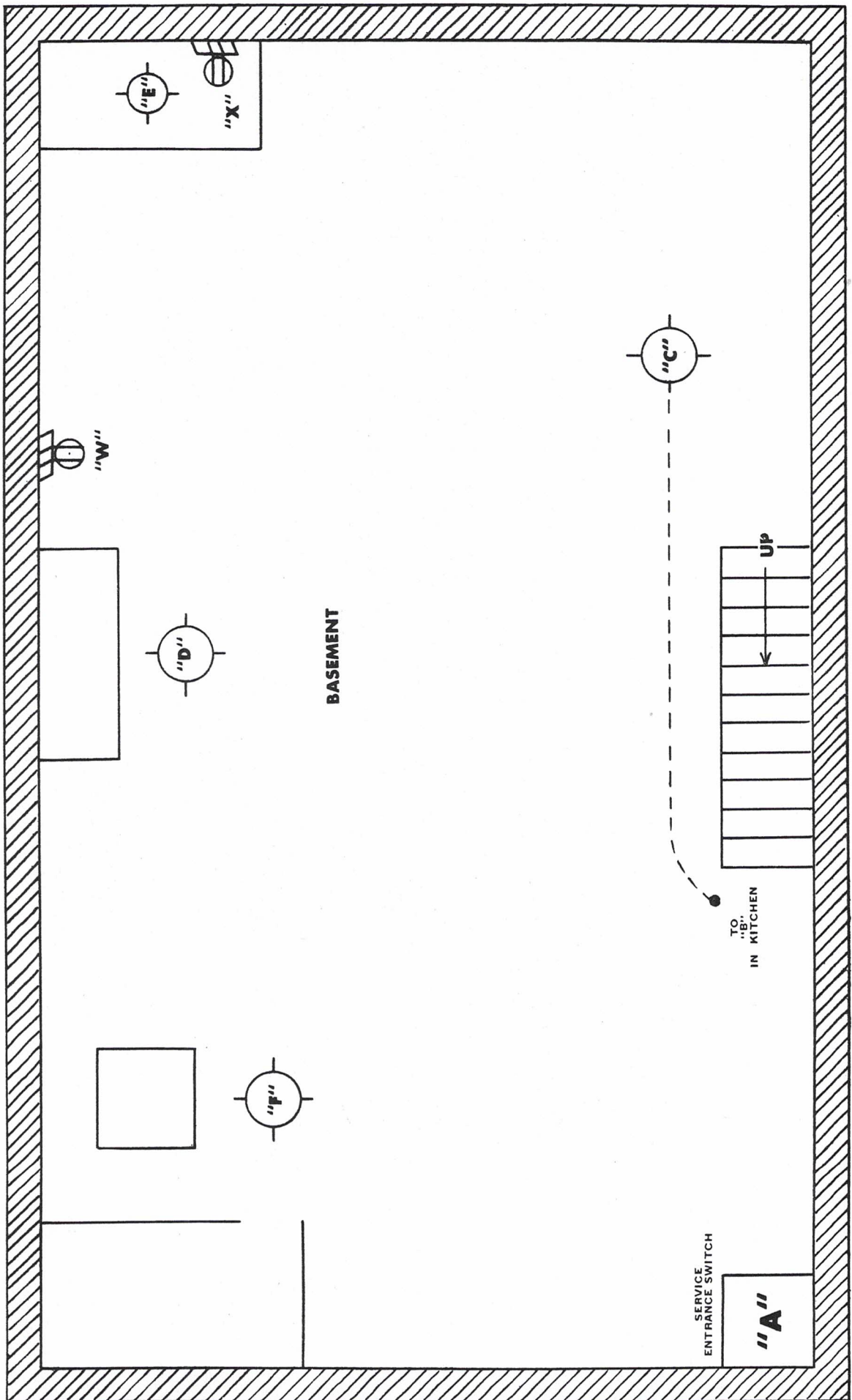
# CHAPTER SIX

## WIRING LAYOUT AND PROCEDURE

### INDEX OF OUTLETS, SWITCHES AND RECEPTACLES

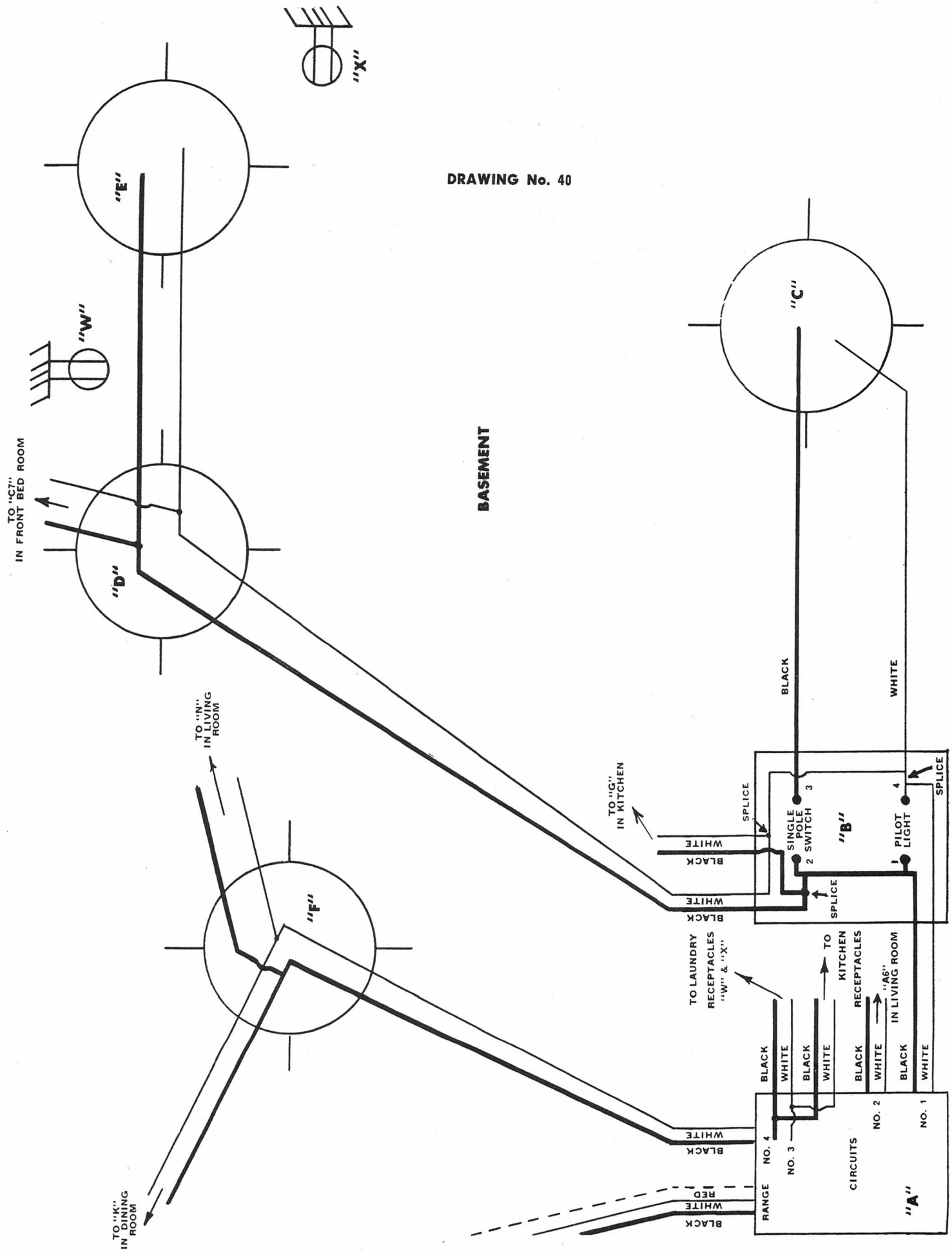
SYMBOL	ITEM	LOCATION	CIRCUIT NO.
A	Service Entrance Switch	Basement	
B	Combination Switch and Pilot Light	Kitchen	1
C	Outlet	Basement	1
D	Outlet	Basement	1
E	Outlet	Basement	1
F	Outlet	Basement	4
G	Single Pole Switch	Kitchen	1
H	Outlet	Kitchen	1
J	Outlet	Kitchen	1
K	3-Way Switch	Dining Room	4
L	3-Way Switch	Living Room	4
M	Outlet	Dining Room	4
N	3-Way Switch	Living Room	4
R	3-Way Switch	Living Room	4
S	Outlet	Living Room	4
T	Outlet	Living Room Bracket	4
V	Outlet	Living Room Bracket	4
W	Receptacle	Basement	3
X	Receptacle	Basement	3
Z	Receptacle	Kitchen	3
A1	Receptacle	Kitchen	3
A2	Receptacle	Dining Room	3
A3	Receptacle	Dining Room	3
A4	Receptacle	Dining Room	3
A5	Receptacle	Dining Room	3
A6	Receptacle	Living Room	2
A7	Receptacle	Living Room	2
A8	Receptacle	Living Room	2
A9	Receptacle	Living Room	2
B1	3-Way Switch	Lower Hall	2
B2	Single Pole Switch	Lower Hall	2
B3	Outlet (Bracket)	Porch	2
B4	3-Way Switch	Lower Hall	1
B5	3-Way Switch	Upper Hall	2
B6	3-Way Switch	Upper Hall	1
B7	Outlet	Upper Hall	1
B8	Single Pole Switch	Bedroom No. C	4
B9	Outlet	Bedroom No. C	4
B11	Outlet	Lower Hall	2
C1	Single Pole Switch	Bedroom No. D	4
C2	Outlet	Bedroom No. D	4
C3	Single Pole Switch	Bathroom	1
C4	Outlet	Bathroom	1
C5	Bracket Outlet	Bathroom	1
C6	Single Pole Switch	Bedroom No. A	1
C7	Outlet	Bedroom No. A	1
C8	Outlet	Bedroom No. B	1
C9	Single Pole Switch	Bedroom No. B	1
D1	Receptacle	Bedroom No. A	2
D2	Receptacle	Bedroom No. A	2
D3	Receptacle	Bedroom No. B	2
D4	Receptacle	Bedroom No. B	2
D5	Receptacle	Bedroom No. A	2
D6	Receptacle	Bathroom	2
D7	Receptacle	Bedroom No. D	4
D8	Receptacle	Bedroom No. D	4
D9	Receptacle	Bedroom No. C	4
E1	Receptacle	Bedroom No. C	4







DRAWING No. 40





# LOCATION OF OUTLETS

The location and number of outlets deserves careful thought since the greatest satisfaction and utility derived from electricity results from a sufficient number of outlets properly located. Those we recommend and place in this seven room house are installed with this thought in mind.

## BASEMENT PLAN

SEE DRAWINGS 39 AND 40—Pages 35 and 36

According to the basement plan and layout, four ceiling lights are to be installed. The one at the foot of the staircase will be controlled by a single switch at the head of the stairs on the kitchen side of the door. The lights near the furnace, over the laundry tubs and work bench will be pull chain and will not be switch operated. An outlet will be located near the laundry tub for operation of a washer or electric ironer and one will be located at the work bench for the operation of small motors or electrically driven tools.

## 1st FLOOR PLAN

SEE DRAWING 41—Page 38

In the kitchen on the first floor, there will be one ceiling light controlled by a single switch on the wall as you enter from the hall. There is to be a wall bracket type of fixture over the sink, controlled by a pull chain, and a convenience outlet over the drainboard to operate labor saving kitchen appliances. In the right hand corner is to be located another outlet to operate an electric refrigerator. It is our intention to have an electric range installed on the left hand side of kitchen. It will be connected directly to the entrance switch in the basement.

The dining room ceiling light will be controlled by two three-way switches, one located in the living room wall at the entrance to the dining room, and the other in the kitchen wall at the entrance to the dining room. These switches permit the operation of a dining room light from two different points. There are to be four convenience outlets to operate a vacuum cleaner or table appliances such as toasters, waffle irons, percolators, etc.

There will be a center ceiling light in the living room controlled by two three-way switches—one in the wall between living room and hall and one in back wall next to dining room switch. On either side of the fireplace there will be a lighting bracket to match the ceiling fixture. There are to be four convenience outlets located in this room to operate table and floor lamps and eliminate as far as possible unsightly wires from these lamps.

A ceiling light in the hall will be operated by two three-way switches, one downstairs and one at the head of the stairs on the second floor. The outdoor light will be controlled by a switch in the hall. One three-way switch for second floor hall light will be located with the downstairs hall and outdoor light switches. In each of the four bedrooms and one bath on the second floor for general illumination there will be a ceiling light controlled by wall switch located at entrance to the room. Convenience outlets in each of the bedrooms are for use with floor and bed lights and personal appliances such as curling irons, vibrator, etc. They are also located in such a manner that will permit easy cleaning of each room with a vacuum cleaner. On the right hand wall in the bathroom, there will be a bracket type light as well as the regular type convenience outlet on the same wall.

The light in the upper hall is to be controlled by a three-way switch located at the same points where the switches for controlling the downstairs hall lights are located.

## WIRING PROCEDURE

SEE DRAWING No. 40—Page 36

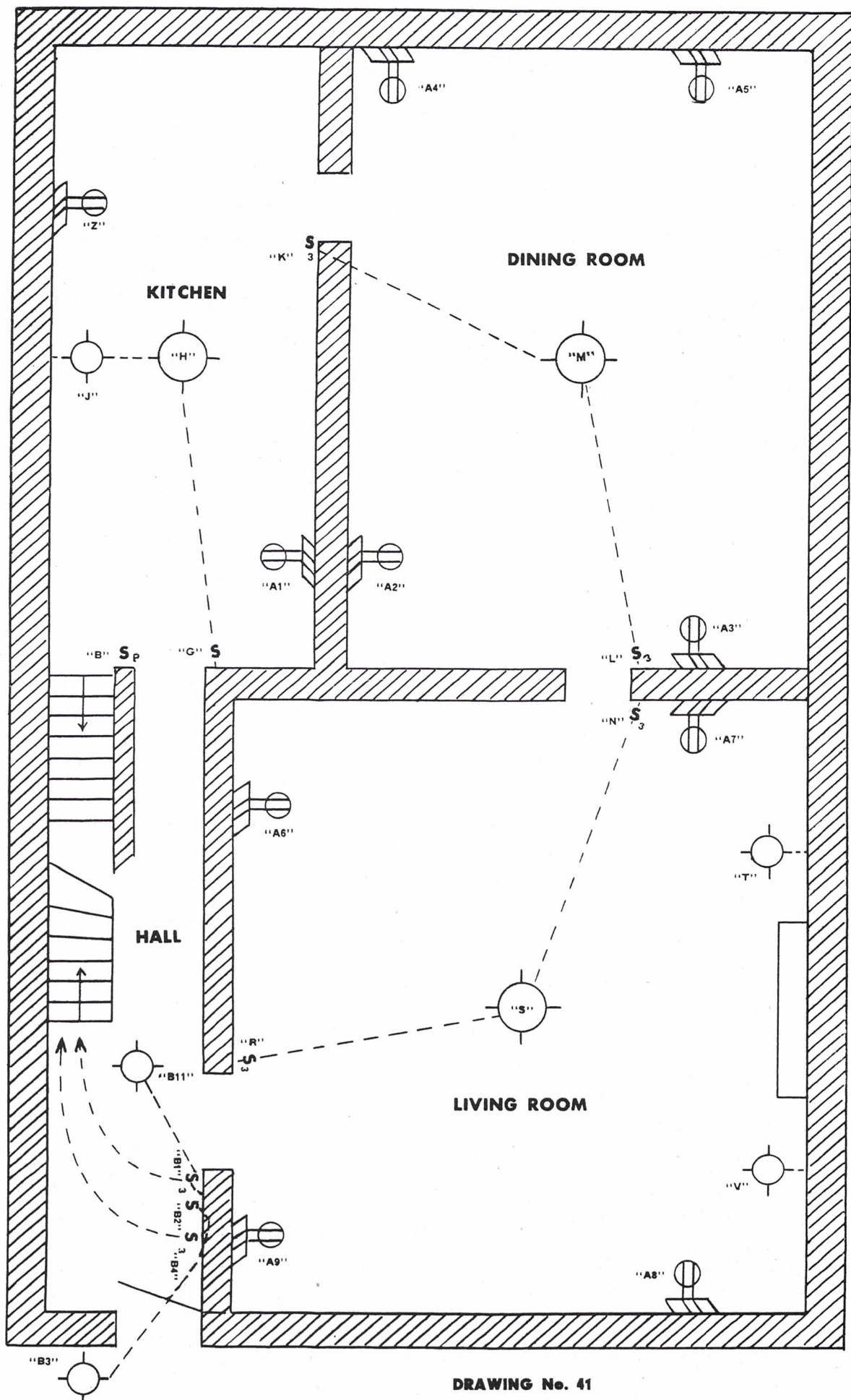
You will note in the layout for the branch circuit lighting in the basement we have greatly exaggerated comparative sizes of the outlets for the purpose of making more clear the wiring of each. The main switch and branch circuit box is located in the lower left hand corner, directly under the kitchen, and consists of a three wire circuit to be connected direct to the range as well as 4 two wire branch circuits that will control the lights and convenience outlets through the house. The wiring layout for each of these circuits is planned for wiring a home already built and differs slightly from recommendations that would be made for wiring a new home. The recommendations made for wiring this house are based on ease of installation plus economy in the use of wiring materials.

The two wires on circuit No. 1 will control the following outlets: 3 basement lights lettered C, D and F, 2 kitchen lights, 1 upper hall light, 2 front bedroom lights and 2 bath lights. You will note on the plan that basement light C is controlled by a single pole switch with a pilot light indicating when basement light is burning. The wiring of circuit No. 1 is as follows:—Two wires from main circuit panel lettered "A" are carried up to combination pilot light and switch in kitchen lettered "B". A black wire from main circuit panel "A" connects to brass terminal lettered 1 on left hand side of combination switch and pilot light. The insulation of this wire is removed for about  $\frac{3}{4}$  inch approximately six inches from end of wire and looped around 1 terminal. It is then continued on to brass terminal 2. Before connecting to 2, however, attach by splicing, Figure 40, Page 36, two black wires, one to go to outlets D and E and the other to kitchen light switch "G." The white wire from box A is attached to nickel plated terminal of combination pilot light and switch at point 4 which is a nickel plated terminal. Before connecting to 4, three white wires are spliced, running to outlets D and E and one to kitchen light switch and the other to outlet C. Circuit to outlet C is completed by running black wire from brass terminal 3 on right hand side of switch.

The black and white wires terminating at outlet D are connected to pull chain socket cover receptacle and by splicing to another pair of black and white wires in box located in outlet D are carried over and terminated in box at outlet E. Remember when splicing to attach black wires to black and white wires to white. From point D another pair of wires are spliced and carried up to outlet box C-7 in ceiling of bedroom A. The basement light lettered F is placed on circuit No. 4 so that in the event a fuse on circuit No. 1 is blown, the basement will not be in total darkness. Circuit No. 4 also controls 1 dining room light, 2 back bedroom lights, 4 back bedroom convenience receptacles and 3 living room lights. From circuit box A, 2 wires, one black and one white are run to and terminate on pull chain receptacle located in outlet box F.

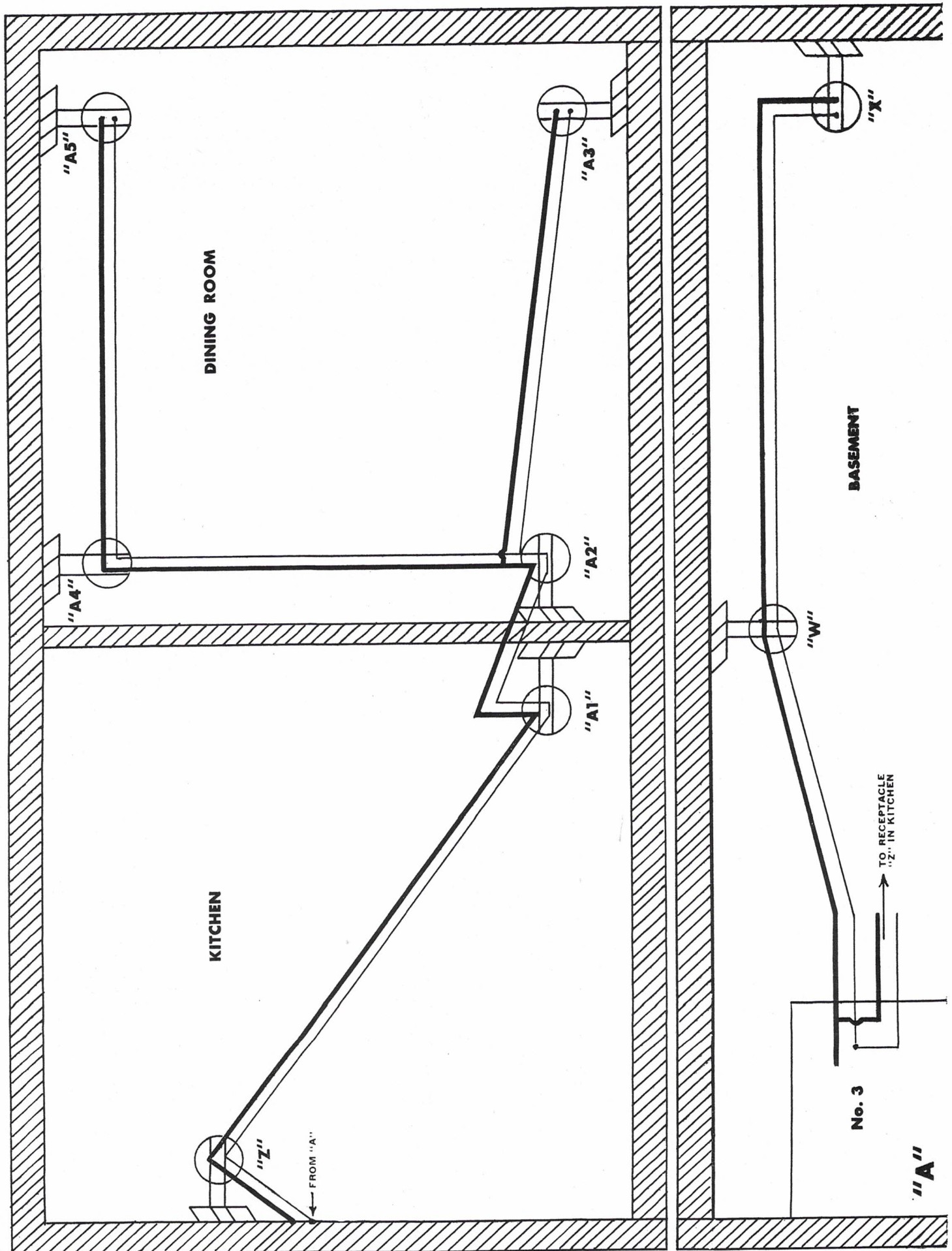
Two pairs of wires are spliced in box F to wires originating in box A before they are connected to pull chain receptacle at box F. One pair, black and white wires, continue from point F up to dining room switch point K, the other pair to living room switch No. N.





DRAWING No. 41





## BASEMENT KITCHEN, DINING ROOM RECEPTACLES

SEE DRAWING 42—PAGE 39

The basement receptacles will be placed on circuit No. 3 which also controls 2 convenience receptacles in the kitchen and 4 convenience receptacles in the dining room, and must be wired with No. 12 wire or larger. This circuit will be fused at 20 amperes because of the greater load which may be imposed upon it. There are no lighting outlets on this circuit nor convenience receptacles in any other rooms. Under the new National Electrical Code, it is required that all receptacles in the laundry, kitchen, dining room and breakfast room be protected independently of any other outlet in the home.

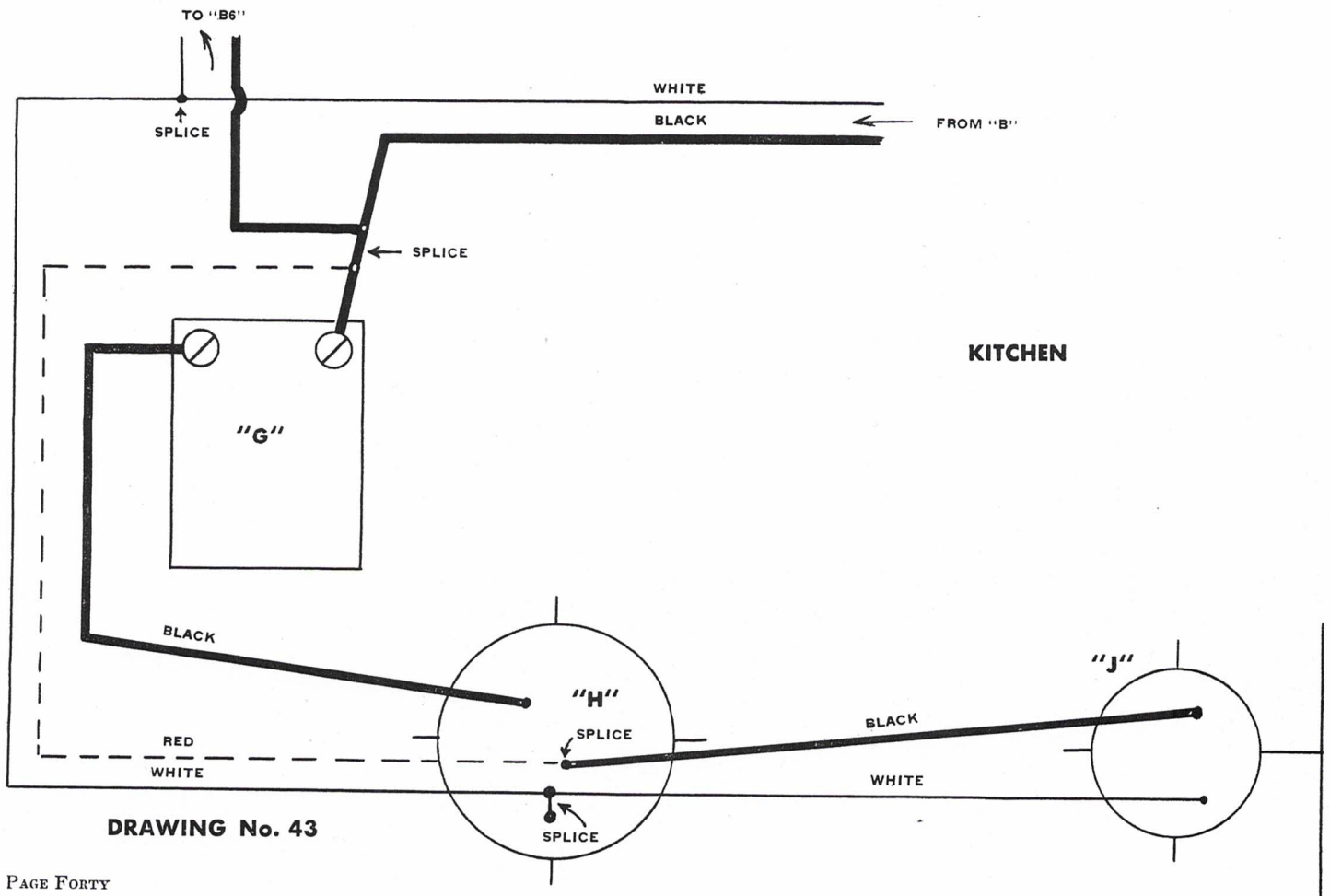
The wiring of basement outlets shall be as follows: 2 wires, one black and one white are run to outlet W in basement from circuit box A and connected directly to the brass and nickel contacts on the receptacles. Black wire to brass terminal—white wire to nickel terminal. Two other black and white wires are connected to the other pair of contacts on receptacle—black to brass, white to nickel and attached directly to the contact points on receptacle at location X. In circuit box A a black and white wire are spliced—black to black, white to white, to 2 wires leading to receptacle W. These two additional wires are run directly to receptacle outlet Z in kitchen and attached, black wire to brass, white wire to nickel contact points. Receptacle Z is connected to receptacle A-1 by 2 wires, black and white, connected on the remaining 2 contacts on receptacle Z to those on receptacle A-1, black to brass, white to nickel. Two more wires connect A-1 with receptacle A-2 in the dining room. From point A-2, see Drawings Nos. 42 and 51, connect receptacle A-3 by black wire connected to brass terminals on both receptacles, white wire connected to nickel

terminals on both receptacles. From A-2 a line must be run to supply current to receptacles A-4 and A-5. The procedure is as follows: (see Drawing No. 51, Page 48). A black wire is spliced to black wire from receptacle A-1 and the white wire is spliced in receptacle box A-2 to the white wire from receptacle box A-1. These two wires are then run to receptacle A-4 and connected, black wire to 1 brass terminal of A-4, white wire to 1 nickel terminal of A-4. Another black wire is then connected to other brass terminal of A-4 and one brass terminal of A-5. A second white wire is connected to the remaining nickel terminal of A-4 and at A-5.

## THE WIRING OF KITCHEN LIGHTS

SEE DRAWING 43—Page 40

As indicated on Drawing No. 40 showing wiring of basement light, 2 wires lead from switch and pilot combination "B" to switch controlling kitchen lights (point "G" in drawing). The black wire, before being attached to brass terminal at G is spliced to another black wire that leads to the second floor hall lights. A second wire, red in color, and forming 1 of 3 wires leading to outlet H is also spliced to this wire. The white wire from pilot switch "B" goes to box in which switch G is located but does not connect to switch. It is spliced to another white wire which goes to second floor hall lights and then spliced in box G to white wire from outlet H. The other terminal on switch G is connected to outlet H by a black wire. In reality, there are three wires running from switch G to outlet H. In box of outlet H the black wire from switch G terminates at connection to fixture. The red wire does not connect to fixture but is spliced to a black wire running to outlet J. White wire of fixture and white wire running to outlet J are spliced to white wire from switch box G. At outlet J, the black and white wires are joined with those leading to the fixture.

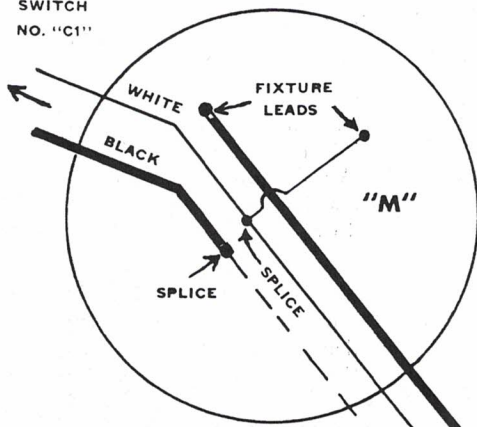


DRAWING No. 43

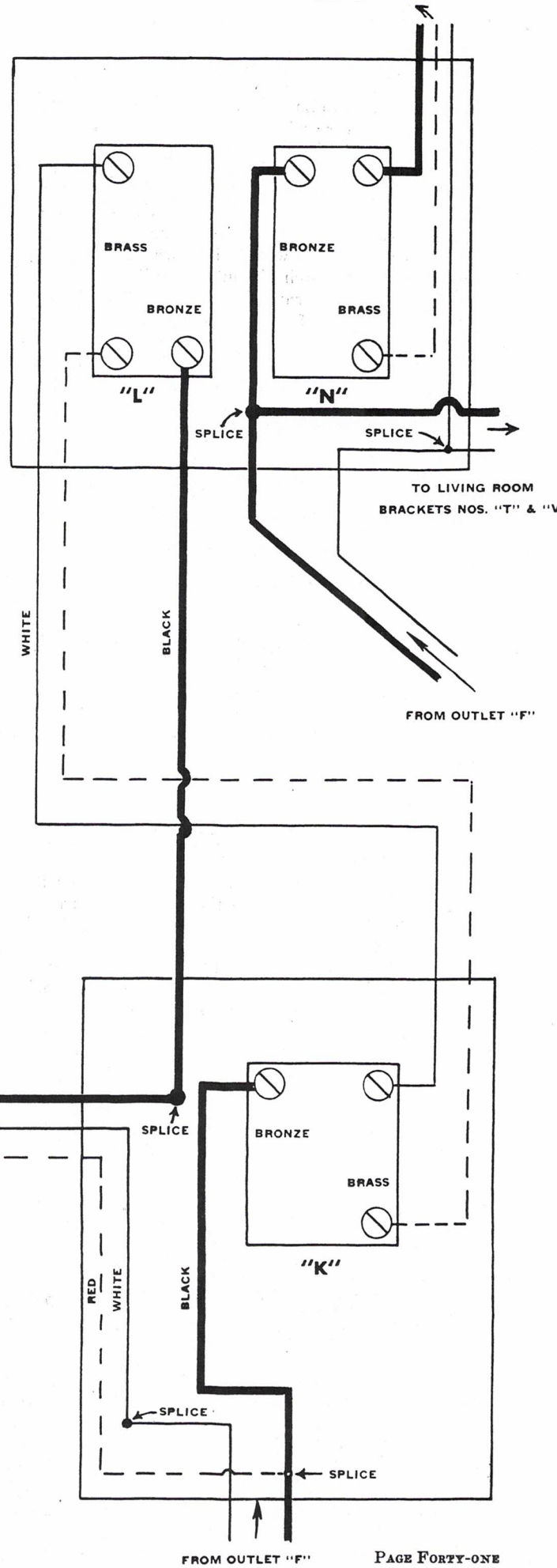


DINING ROOM

TO BEDROOM  
SWITCH  
NO. "C1"



DRAWING No. 44



## **WIRING DINING ROOM**

### **SEE DRAWING 44—Page 41**

From outlet F (see drawing of basement wiring) black and white wires lead up to box of switch K (see Drawing No. 44 of dining room fixture wiring). The black wire from outlet box F is spliced at "K" to a red wire leading to outlet M and then connected to bronze terminal of 3-way switch K. The white wire from basement is spliced to another white wire leading to outlet M in switch box K. From two brass terminals of switch "K" one red and one white wire run to two brass terminals at switch "L" located in living room wall next to 3-way switch N controlling living room lights. Attached to bronze terminal of switch "L" is a black wire running to box of switch "K" and there spliced to black wire which is connected to black wire from fixture "M". The white wire from fixture "M" is connected to white wire from box of switch K which is again spliced to white wire leading from box of outlet M to switch C-1 of bedroom D. The red wire from point K to outlet M is not connected to fixture but simply spliced to black wire leading to switch C-1 of bedroom D.

## **WIRING LIVING ROOM AND HALLWAY**

**SEE DRAWINGS 45 and 46—Pages 43 and 44**

### **LIVING ROOM LIGHTS**

From outlet F (see Drawing No. 40 basement wiring) black and white wires lead up to box of switch N located next to switch L (see Drawing No. 46). This also is a 3-way switch allowing control of lights from two different points. The black wire is spliced to the black wire leading to wall brackets T and V and then connected to bronze terminal on switch N. The white wire from outlet "F" is spliced in box of switch N to 2 other white wires—one leading with black wire to wallbrackets—the other to switch box of switch R where it is again spliced to white wire and run to outlet "S" and there it is connected to white wire of fixture. The 2 brass contacts on switch N are connected with one red wire and one black wire to the two brass terminals on switch R. From the bronze terminal on switch R a black wire is run and connected to black wire of fixture at outlet S. Note black and white wires from box of switch N are carried over to light brackets T and V. In box of bracket T black and white wires are spliced and carried to bracket V before they are connected to wires leading from light bracket at T.

### **LIVING ROOM RECEPTACLES**

The control of four living room convenience receptacles is placed on circuit No. 2 as are the 5 front bedroom convenience receptacles, one bath convenience receptacle, one lower hall light and one porch light. All receptacles must, under ruling of National Electrical Code, be mounted in a wall surface and not in either floor or baseboard unless special types of receptacles are used. Special types will not be considered here as use of them is usually limited to commercial or industrial installation.

The wiring of circuit No. 2 is as follows:—2 wires from circuit box "A" are carried up through inside of living room wall adjacent to hall and connected to convenience receptacle A-6 in left wall of living room. The black wire from circuit box "A" is connected to one brass terminal in receptacle box A-6, white wire being connected to one nickel plated terminal. Two wires running from other two terminals of same receptacle are carried to convenience

receptacle A-7 in back living room wall. Connections are made to the receptacle (see Drawing No. 51). From receptacle A-7, 2 wires are then carried across the room to front wall and connected to terminals of convenience receptacle A-8 (see Drawing No. 51). Two wires from receptacle A-7 are connected as follows:

Black wire from receptacle A-7 is connected to one brass terminal of receptacle A-8. White wire from receptacle A-7 is connected to one nickel plated terminal of receptacle A-8. Two additional wires are connected, black to brass terminal, white to nickel terminal of receptacle A-9 in left wall of living room and connected black to brass, white to nickel of A-8.

### **FRONT BEDROOM RECEPTACLES**

Two additional wires as noted in drawing No. 45 run from convenience receptacle A-8 in front living room wall up through outside wall to convenience receptacle D-1 located in wall surface of front bedroom A (Drawing No. 48). These wires are spliced as follows: black wire to receptacle D-1 is spliced to black wire from receptacle A-7 before it is connected to brass terminal of receptacle A-8. White wire to convenience receptacle D-1 is spliced in receptacle box A-8 to white wire from receptacle A-7 before it is connected to nickel plated terminal of receptacle A-8. (See Drawing No. 51, Page 48.)

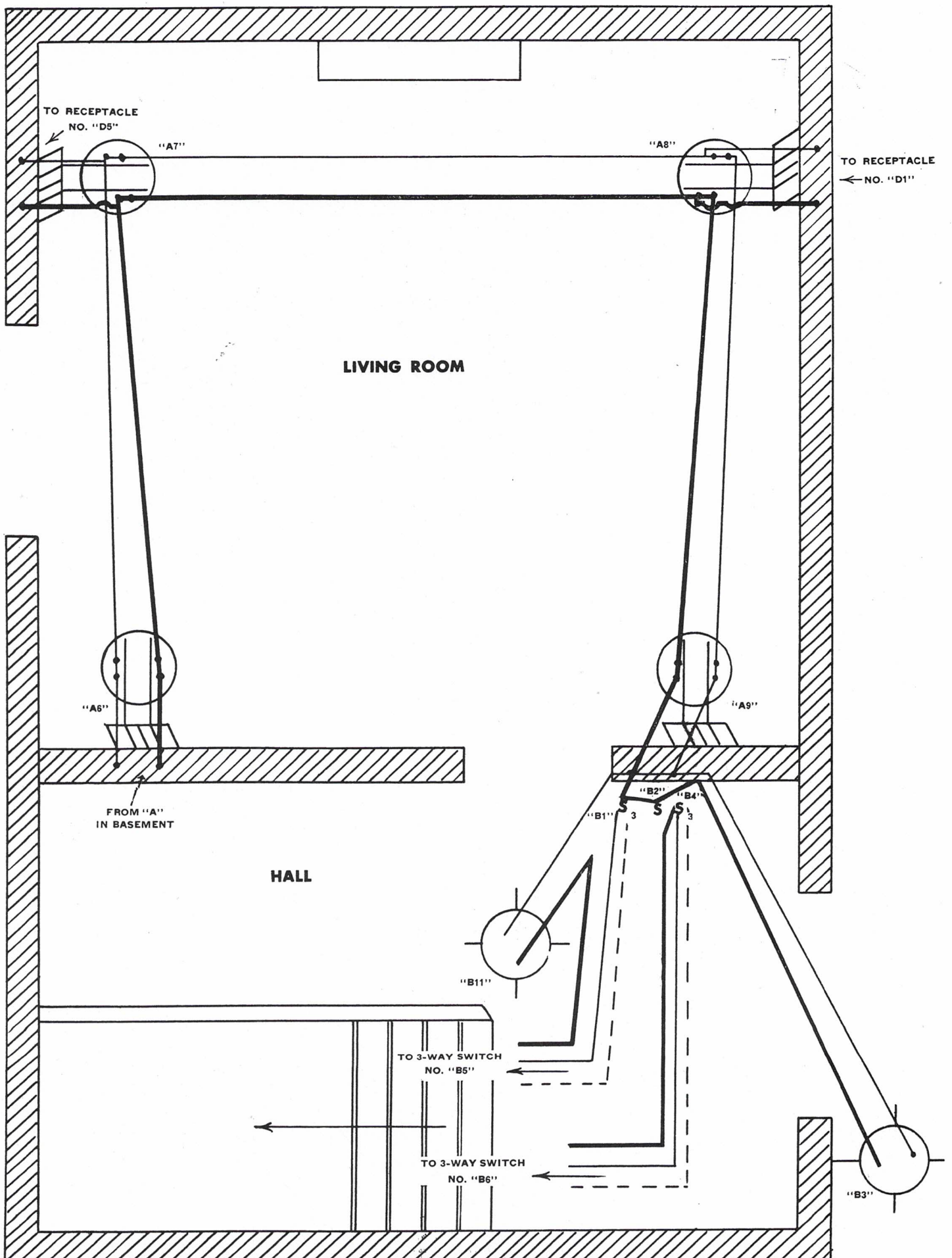
Two wires are connected, black to brass, white to nickel, in receptacle box D-1 and are carried overhead to left wall of bedroom A and there dropped to convenience receptacle D-2 and connected, black to brass, and white to nickel. A short run is then made between this receptacle and receptacle D-3 in wall of bedroom B. Another line is connected to receptacle D-3, black to brass, white to nickel and may be carried overhead and dropped to receptacle D-4 in back wall of bedroom B.

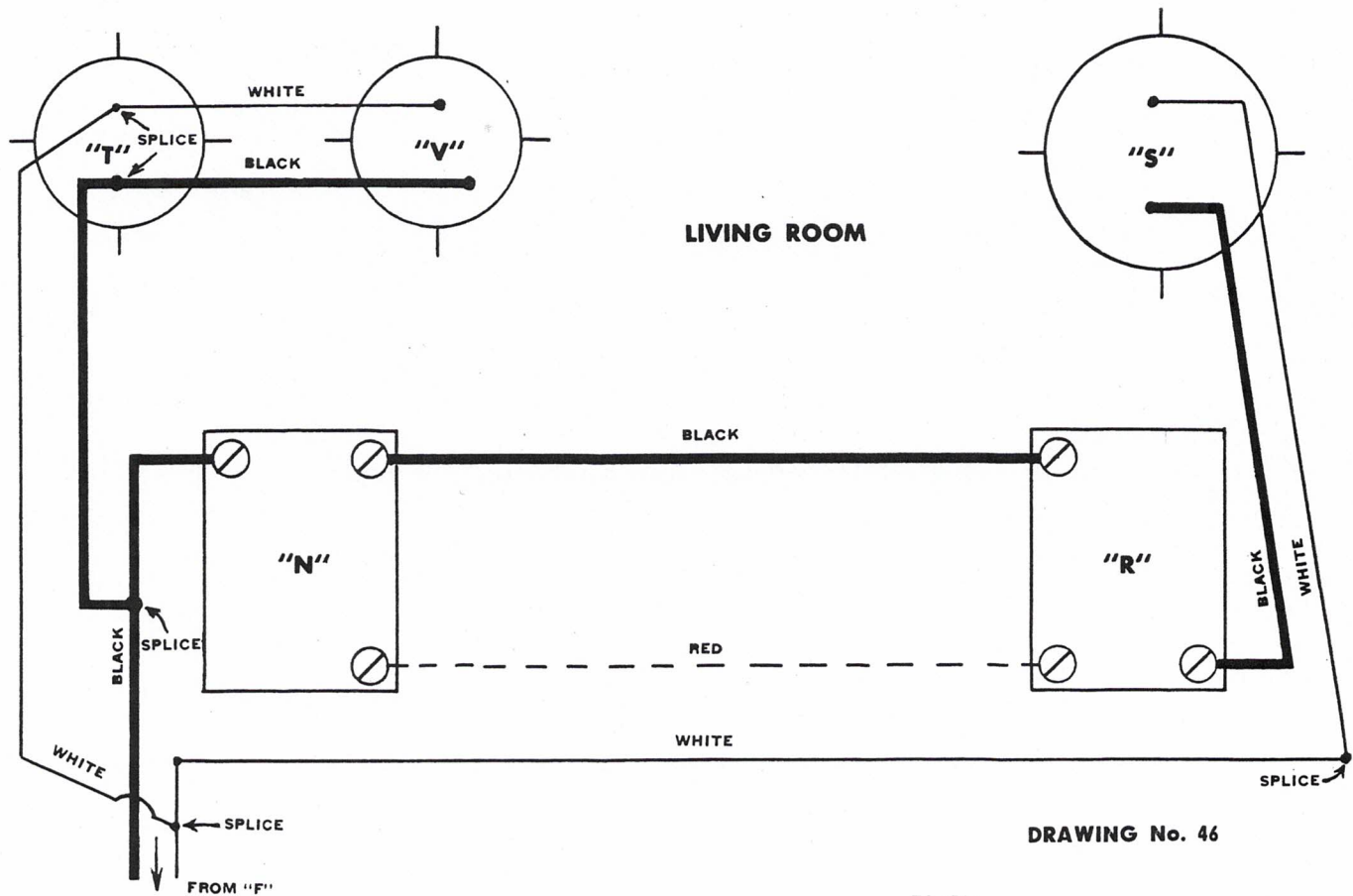
From receptacle A-7 in living room a 2 wire line is spliced black to black and white to white then run to receptacle D-5 in back wall of bedroom A. (See Drawings Nos. 45 and 51.) A short run is then made between receptacle D-5 in back wall of bedroom A to receptacle D-6 located in bedroom wall surface—maintaining our black to brass and white to nickel sequence.

### **HALL LIGHTS**

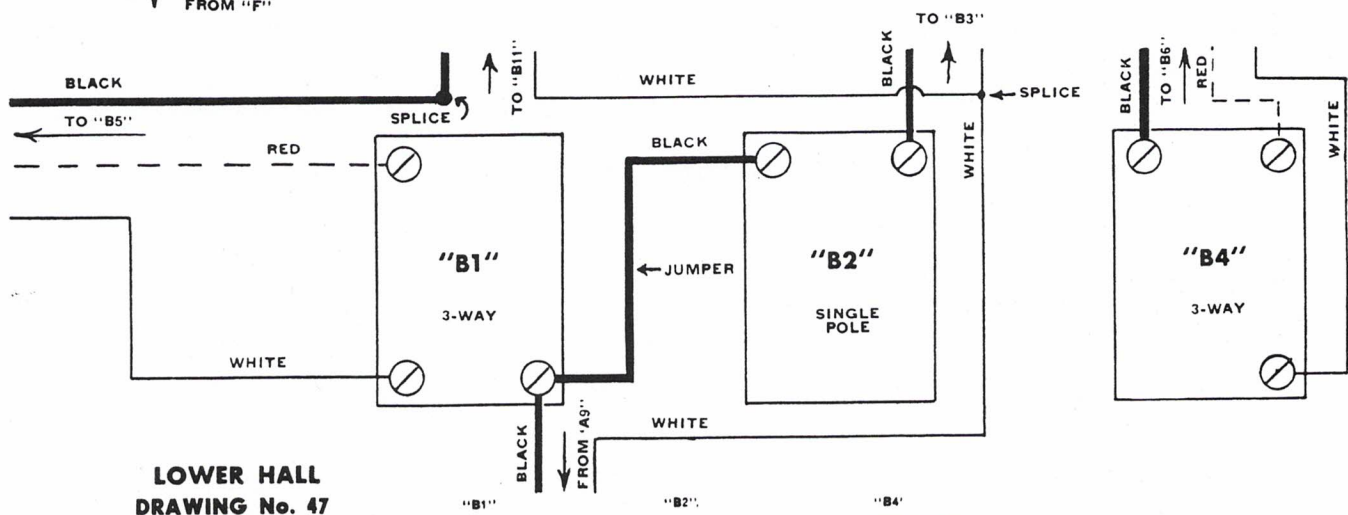
Two wires, black to brass, white to nickel, are run from receptacle A-9 to switch box in hall as shown in Drawings Nos. 47 and 47A, and are connected to 3-way switch B-1 for controlling lower hall light and single pole switch B-2 for controlling porch light B-3 as shown in Drawing No. 47. Black wire from receptacle A-9 is connected to bronze terminal of 3-way switch B-1 and looped to one brass terminal of single pole switch B-2. A black wire running to porch bracket outlet B-3 is connected to other brass terminal of single pole switch B-2 and to one wire of porch bracket in outlet box B-3. White wire from receptacle A-9 is spliced in switch box B-1 to a white wire running to porch bracket outlet B-3 and to a white wire running to lower hall ceiling outlet B-11. A red and white wire are connected between the terminals of 3-way switch B-1 in lower hall and 3-way switch B-5 in upper hall. A black wire is then connected to bronze terminal of 3-way switch B-5 in upper hall and returned to switch box B-1 in lower hall and there connected to a black wire leading to ceiling outlet box B-11 in lower hall. (See Drawing No. 45, Page 43.)



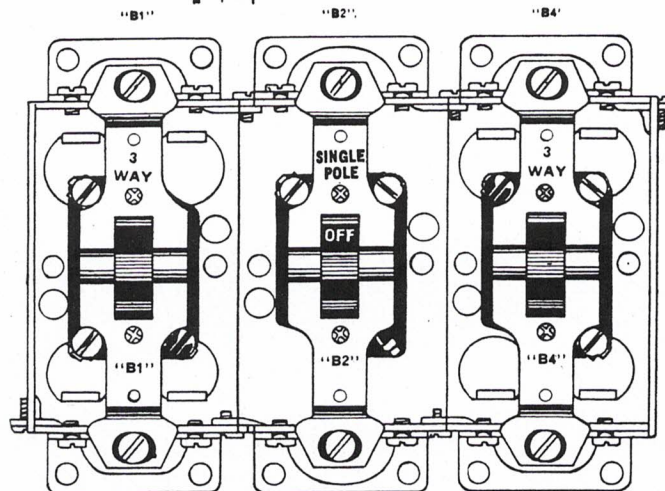




**DRAWING No. 46**



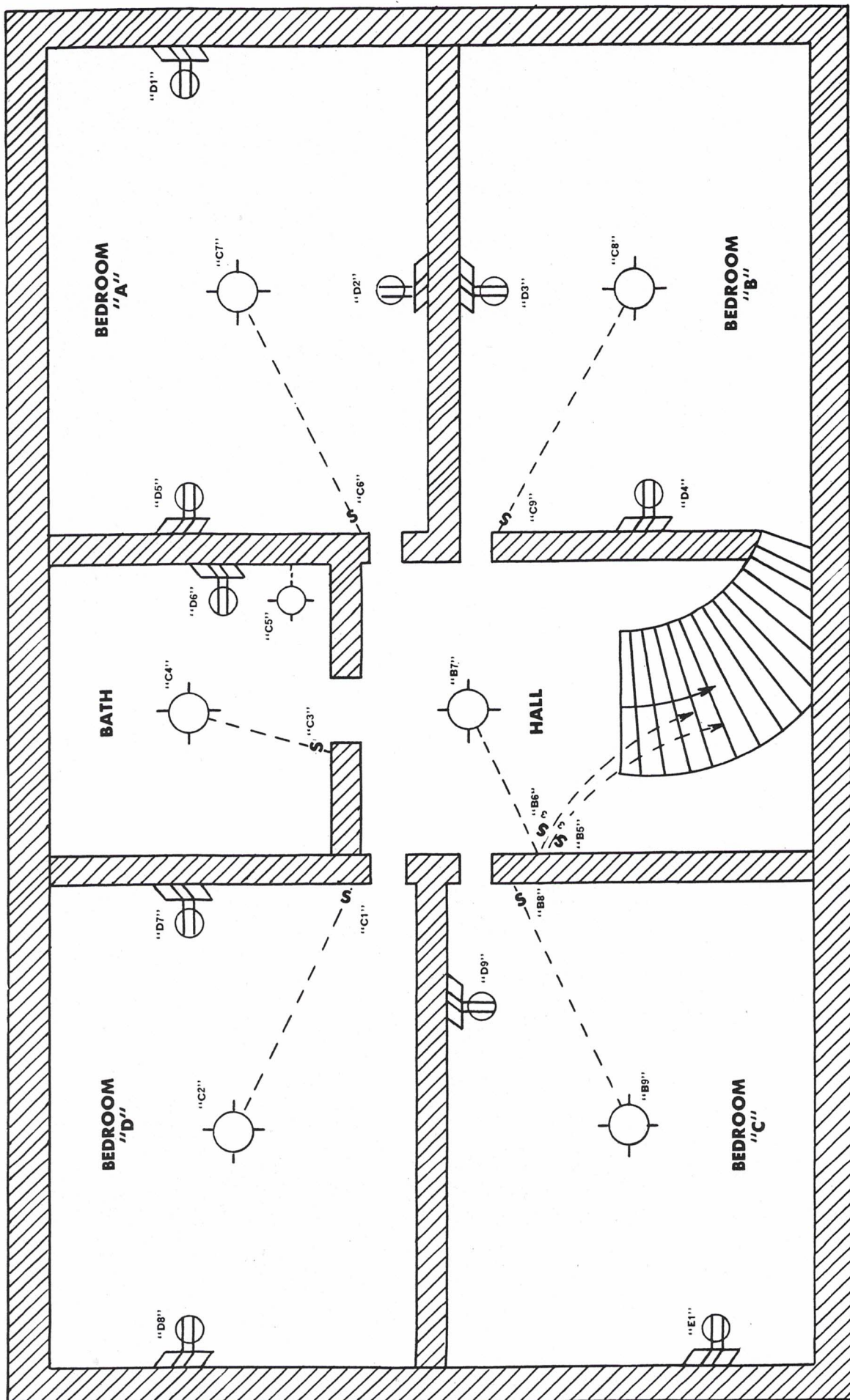
**LOWER HALL  
DRAWING No. 47**



**DRAWING No. 47A**

**ILLUSTRATIONS 47 AND 47A SHOW INSTALLATION OF THREE GANG SWITCH UNIT  
IN LOWER HALL**





**SEE DRAWINGS Nos. 48 AND 49—Pages 45 and 46**

In switch box C-9, black wire is connected to one terminal of single pole switch and the white wire after having the white coating scraped is connected to other terminal of switch in box C-9. It is then run to outlet box C-8 and after white coating is removed, it is connected to one lead of fixture installed on outlet box C-8. White wire from "C7" is con-

In wall outlet box C-5 of bathroom, two wires from outlet C-7 are spliced to two wires leading to bathroom ceiling outlet C-4, black wire to black, white to white, are then connected to leads of bracket fixture mounted on outlet C-5. In ceiling outlet C-4, black wire from outlet C-5 is connected to a black wire and run to switch box C-3 and there connected to one terminal of single pole switch. The white wire after having the white coating scraped off is connected to other terminal of single pole switch and run back to ceiling outlet C-4. There, after the white coating is removed, it is connected to one lead of fixture mounted on outlet C-4. White wire from outlet C-5 is connected in outlet C-4 to other lead of fixture mounted on outlet C-4.

**SEE DRAWINGS Nos. 48 AND 50 — Pages 45 and 47**

It will be remembered that from outlet box M in dining room a two wire line has been run to switch box C-1 in back bedroom D. Before black wire from outlet box M is connected to switch in box C-1, two black wires shall be spliced to it. These two black wires are then run, one to receptacle D-7 in back bedroom D, the other shall be run to switch box B-8 in back bedroom "C." The black wire from outlet box M is then connected to one brass terminal of single pole switch C-1. The white wire from outlet box M is spliced to 3 white wires in switch box C-1. One white wire will run to switch box B-8 in back bedroom C—the other white wire will run to receptacle box D-7 in back





bedroom D and connect to one nickel terminal of receptacle D-7—the third white wire running from switch box C-1 to outlet Box C-2 in back bedroom D, there connect to one wire of fixture mounted on outlet box C-2. The circuit to outlet C-2 is completed when a black wire connected to remaining fixture lead at outlet box C-2 is connected to remaining terminal of switch in box C-1. In outlet box D-7 a 2 wire line is connected to the remaining two terminals of D-7, black to brass, white to nickel, and run across room to another wall of bedroom D-7, there connected to a convenience receptacle D-8, black to brass, white to nickel.

In switch box B-8, before any connections are made to switch, it will be necessary to splice a black wire to black wire from switch box C-1, and then complete the run of black wire to convenience receptacle D-9 and there connect to one brass terminal of receptacle D-9. White wire from switch C-1 is connected by splice in switch box B-8 to 2 other white wires, one running to receptacle D-9 in wall of bedroom C, being connected to one nickel terminal at that point. The other white wire is run from switch B-8 to ceiling box B-9 in bedroom C. The black wire from Switch C-1 is then connected to one brass terminal of single pole switch located at B-8. Another black wire is connected to remaining terminal of B-8 and carried overhead to outlet B-9 in ceiling of bedroom C. A two wire line is run between receptacle D-9 and receptacle E-1 in bedroom C, connections being black to brass, white to nickel in both receptacles.

It is required by the code that No. 12 wire be used on circuit No. 3 because of the larger current consuming de-

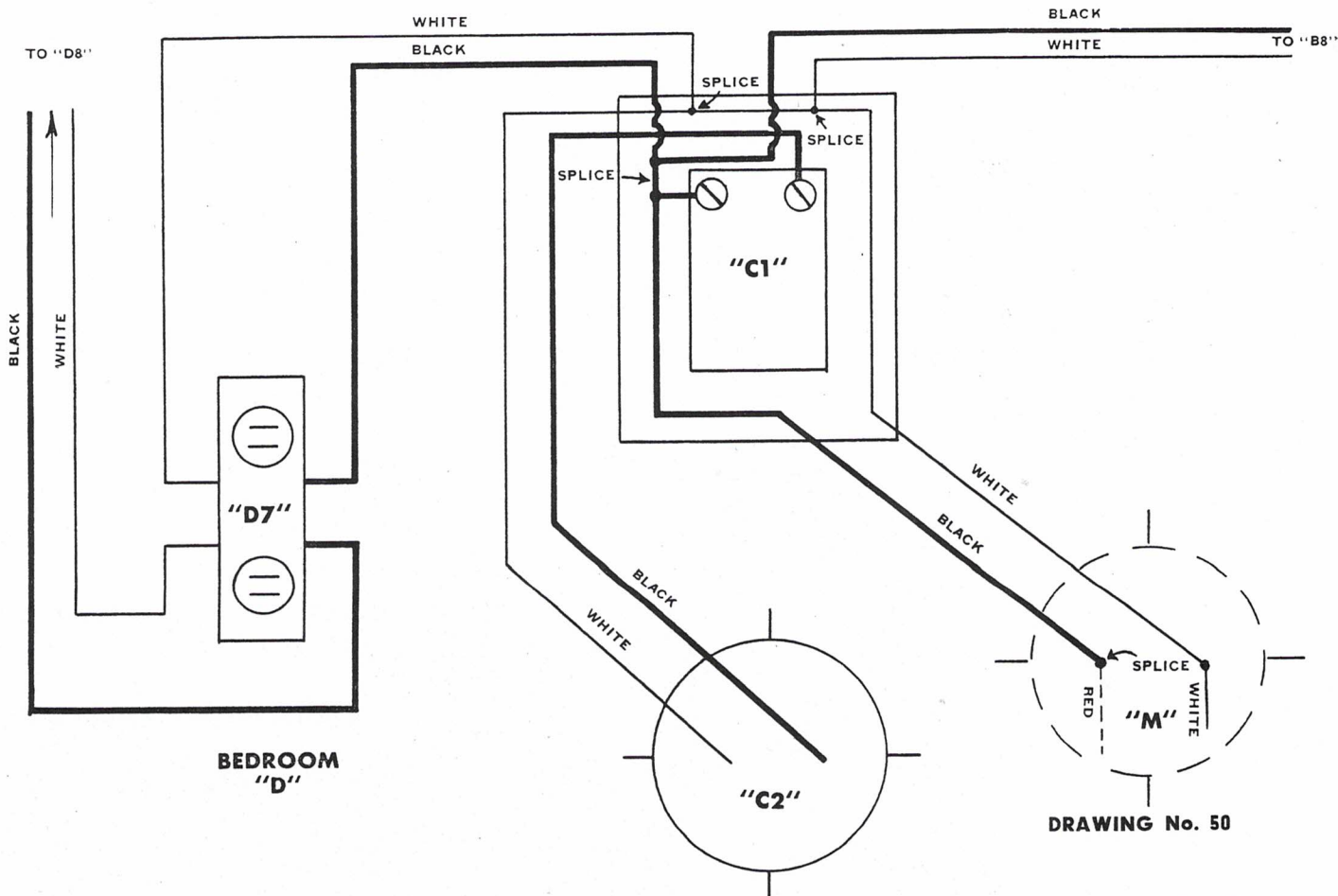
vices to be used on the convenience outlets and the fact that fusing will be 20 amperes. However, it is recommended that the wire size of the balance of the circuits also be No. 12 because of the greater number of lamps being used in the well lighted homes of today. As noted in the first pages of this book, too small wires only restrict the flow of current and adds to the cost of operation to say nothing of speeding up the deterioration of the insulation of your wires.

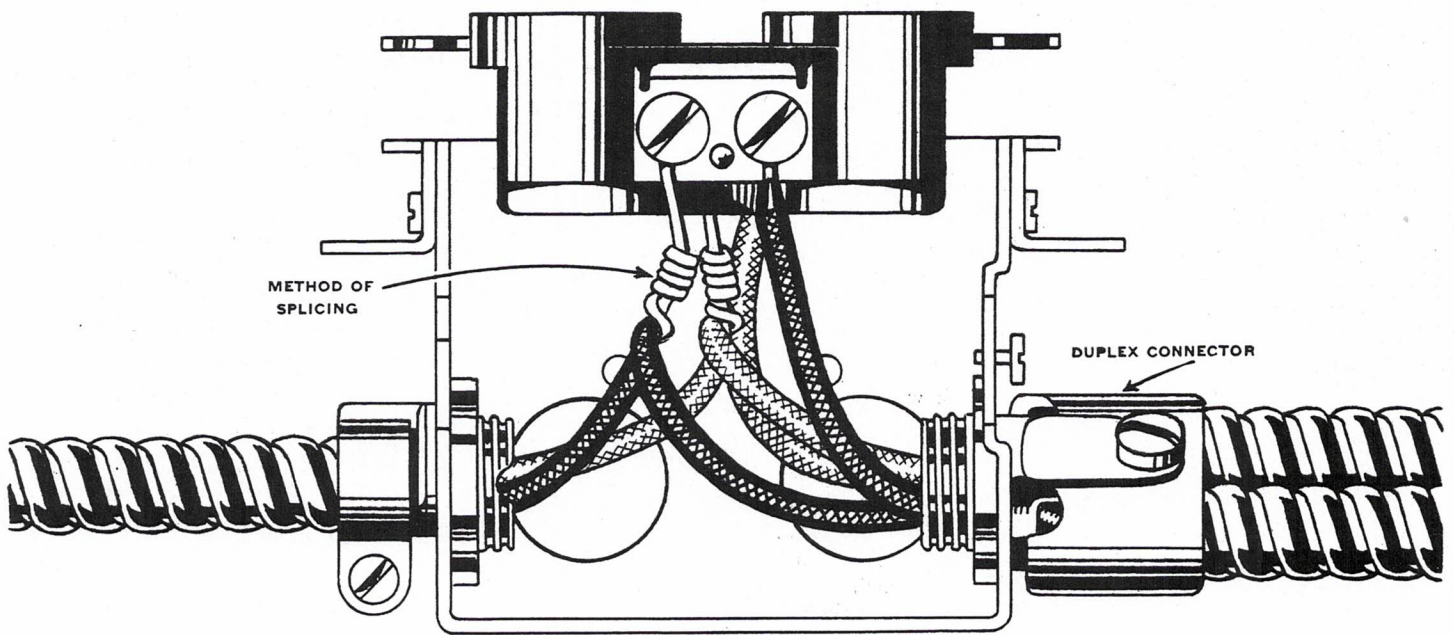
## WIRING OF 3-WAY SWITCH IN UPPER HALL

SEE DRAWING No. 52—Page 48

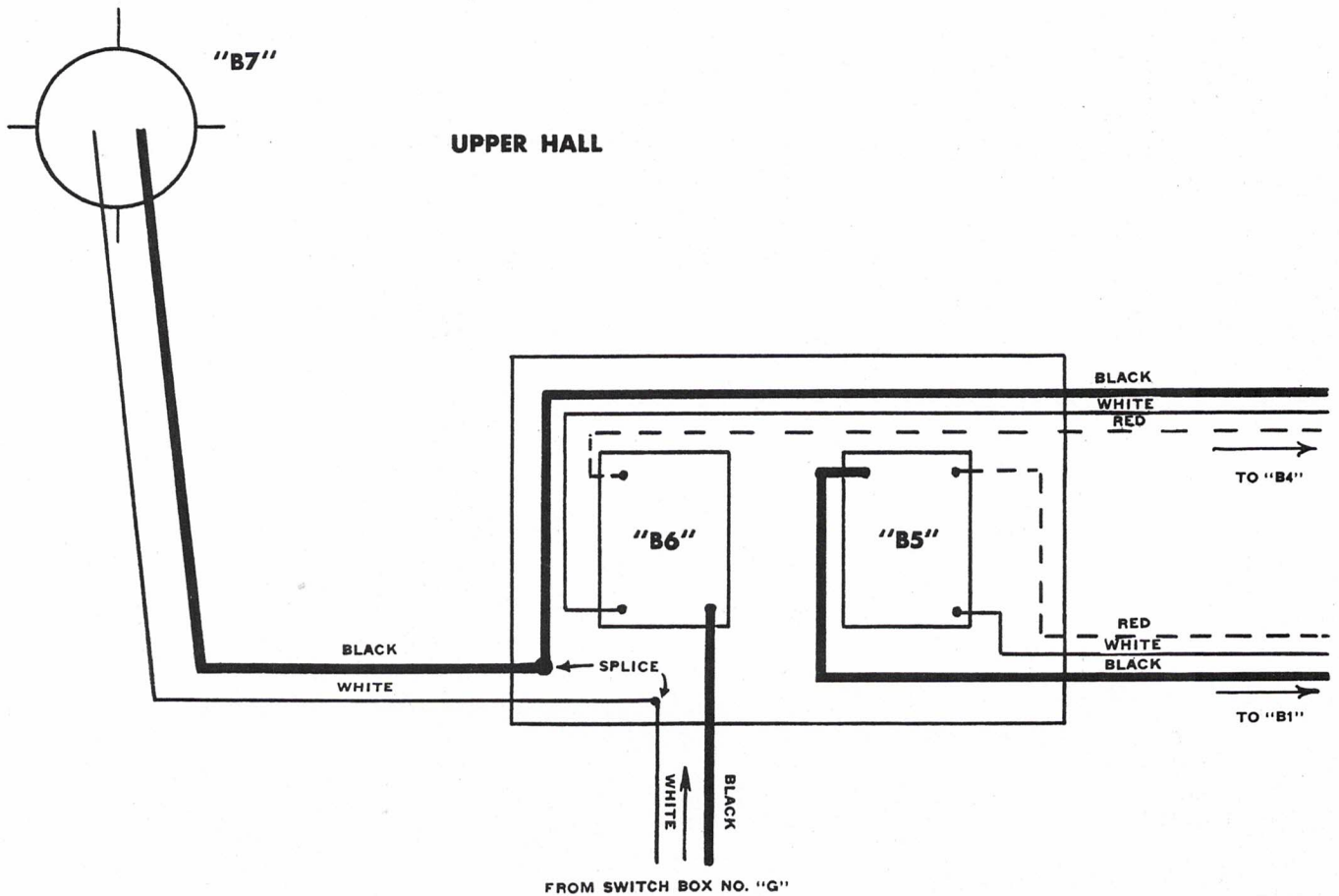
From switch box G in kitchen wall, two wires run up to switch box B-6 located at top of stairs in upper hall and then connected as follows:

Black wire from switch box G is connected to bronze terminal of 3-way switch in switch box B-6; white wire from switch box G is spliced to white wire running to outlet B-7 in upper hall ceiling. A 3-wire line is run from switch box B-6 in upper hall to switch box B-4 in lower hall and connected thus: red and white wires of 3 wire cable are connected to two brass terminals of 3-way switch in box B-6 and to two brass terminals of 3-way switch in box B-4, black wire in 3 wire cable is connected in switch box B-4 to bronze terminal of 3-way switch and back in switch box B-6 is spliced to a black wire running to ceiling outlet B-7. In ceiling outlet B-7, black wire is connected to one lead of fixture mounted on outlet B-7 wire. White wire from B-6 is connected to other lead of fixture at B-7.





DRAWING No. 51



DRAWING No. 52



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