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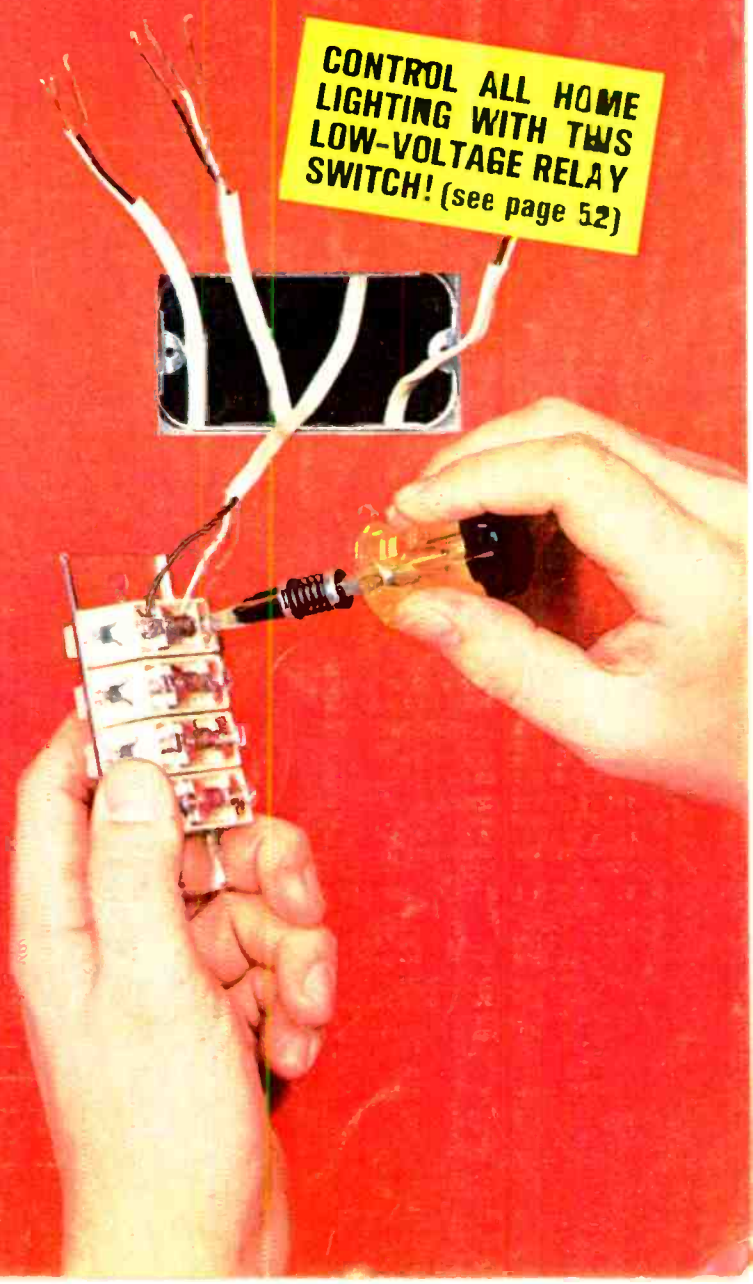

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ELECTRICAL HANDBOOK

A SCIENCE & MECHANICS ANNUAL

No. 689 1964 Edition

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ELECTRICAL HANDBOOK

CONTENTS

Add to Your Know-how

Master electricity, elementary electronics and appliance repair with the right home study course

IN a world that's dark, cold and idle until somebody gets the power going, there's not much doubt that practical electrical know-how is a gold-plated tool. As a matter of fact, it's money in the bank—whether you save it or earn it.

The only question about this kind of know-how is where to get it. Most books on the subject are long on theory, short on facts. Vocational and night schools often have the right approach, but they're not about to adjust their pace and their hours to meet your needs. So what's the answer? Maybe home study.

Appliance how-to course should include some work projects, may offer kits, testers, etc.

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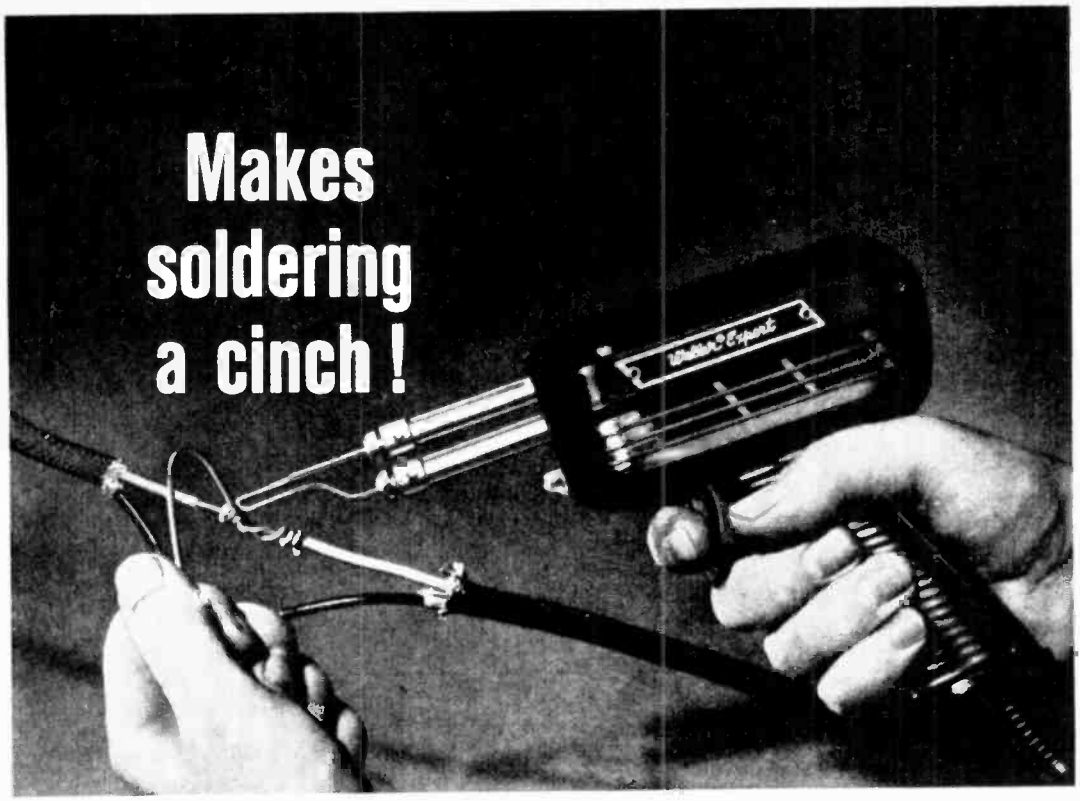
(Continued on page 10)



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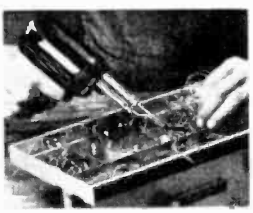
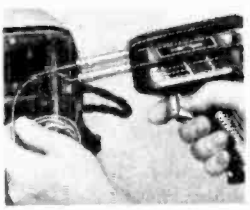


A must for hi-fi kit building. Assures noise-free connections. Use low heat when soldering near sensitive components, high heat for chassis connections.



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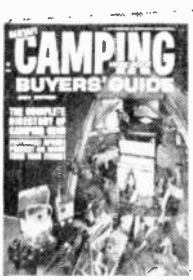

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Add to Your Know-how

(Continued from page 6)

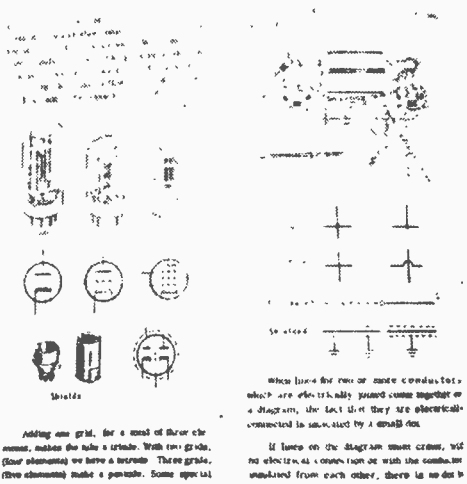
to do almost any job competently.

If what you're interested in is a new career or a better job, chances are home study can get it for you. According to independent surveys, three out of four graduates of home study schools *do* turn their training into bigger earnings, just like the ads say; and among these, some of the most successful are the graduates of courses in electricity, basic electronics, and electrical-appliance repair.

In short, the opportunity to parlay a handy-man talent into big savings and/or a profitable full-time or part-time career may be as close as the nearest coupon.

But before you leap for the scissors, take a good, honest look at yourself. In a home study course, the drive has to come from inside. Although you get plenty of encouragement and help from the instructors, you're essentially on your own; nobody's going to keep you after school if you don't do your homework. Many more people start courses than finish them, and about half the dropouts, one school reports, fall off right after Lesson No. 1. The man who stays with it is self-reliant and a plugger. Typically, he's in his early thirties, married, a father and employed—the kind of guy who has been around long enough to know that

(Continued on page 108)



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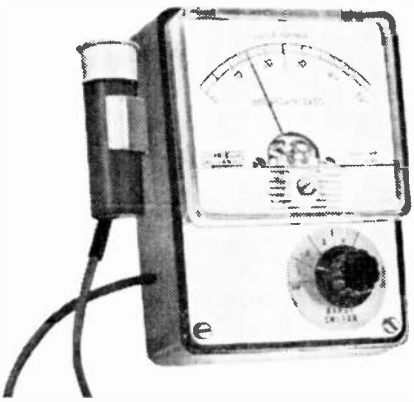

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YOUR HOME'S ELECTRICAL SYSTEM

How well do you know it? Is it adequate for the family's safety, comfort, convenience?

By RALPH TREVES

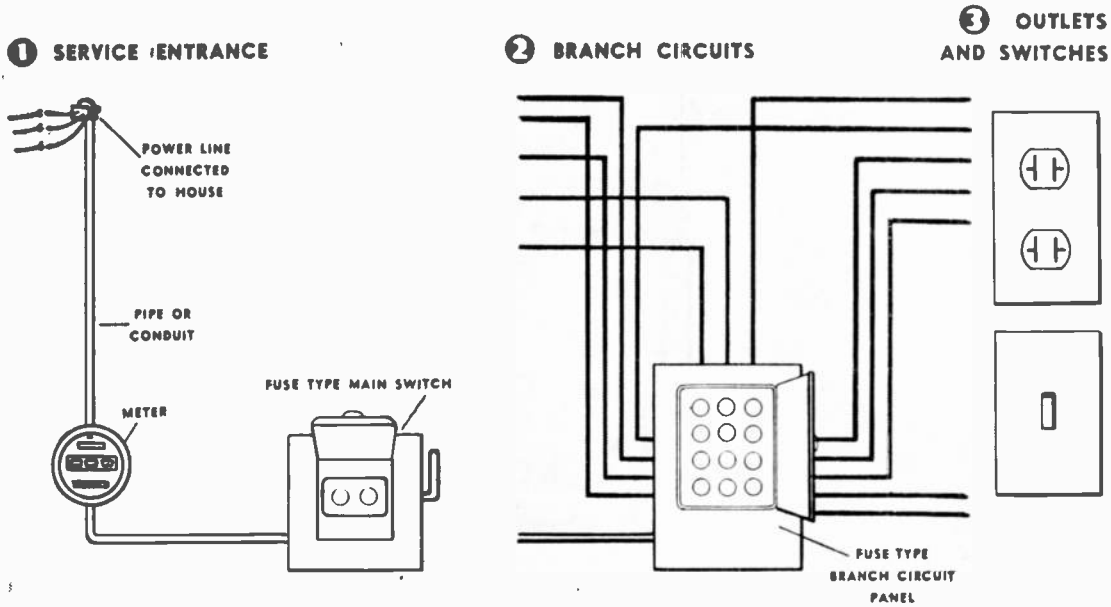
SUPPOSE you went out today and bought one of those new rotisserie broilers, something you wanted for a long time, and then found that as soon as you plug it in, the fuse blows. That would be a keen disappointment to your family, canceling out the advantage of using this appliance whenever you want to.

There's more to it than that. The overloaded circuit indicates that you must get along without the comforts and work-saving advantages of other electrical appliances that have become the basis and means of modern living, like an air conditioner, attic fan, freezer, clothes washer and dryer, dishwasher and many others.

Another thing—whatever appliances you now have may not be operating at their best because of voltage drop which results from too-small wires and an overloaded system. Motors overheat and burn out, requiring expensive repairs. Even the vacuum cleaner doesn't "pick up" as well as your neighbor's, which functions better because of full voltage.

The Diagnosis Is Clear: the wiring in your home simply can't handle the load because the service capacity and circuit wires aren't large enough to deliver all the electricity needed. When the amount of current drawn

YOUR ELECTRICAL SYSTEM HAS 3 PARTS



on a circuit by the various lights and appliances is greater than the rated load, the wire overheats and blows the fuse.

Frequent blowing of fuses tempts the homeowner to use higher-ampere fuses; then instead of the fuse blowing right away, as it should, the wire becomes red hot, melts and chars the insulation, often causing serious fires. Even if a blaze does not occur at once, the wiring system becomes damaged beyond repair, creates a real hazard because of sparking and short circuits, and may lead to a tremendous expense for installing new wiring in the entire circuit.

This book tells you how to determine your "electrical status" and what should be done to correct shortcomings, helps you to make needed changes with due concern for the limitations of a family budget. It offers suggestions for various alternatives, tells you how to overcome present difficulties and plan for future needs. Also, how to save money by doing most of the needed work yourself.

In some older homes, the wiring is so out-of-date that the use of electricity is strictly rationed. Junior can't even watch TV while Mother is ironing. And even one extra reading lamp in the living room can cause a fuse to blow. A house like that, with a 30-ampere service entrance, can have no more than four circuits with a maximum capacity of 1800 watts on only two of these circuits at a time, and an overall total of 4000 watts through the main fuse. Just check over the appliance list and see how many *single* items today exceed that total.

Most homes, however, have 60-ampere service which can run a refrigerator, washing machine, dryer and perhaps a hot water heater, but that's the limit—no more major appliances can be added.

Surveys show that fully 90% of the homes in America are inadequately wired to run the electrical equipment we want and need. Wiring that was intended only for lighting and a few small appliances like radio, vacuum cleaner and refrigerator, isn't able to take on the extra load of a dishwasher or air conditioner.

Appliance Ratings. The list in Table I gives approximate wattages used by popular home appliances. These vary, of course, according to size, make and model.

You can check the correct wattage by reading the name plate on every appliance, which is stamped with the specifications based on industry association standards and tests.

The capacity of a circuit equals volts times amperes. Figure it out for yourself, using the appliance table.

Your Home's Electrical System

Growing Demand for Power. The tendency today is for electrical devices to be designed for faster and more efficient operation, which generally means higher wattage. For example, old-style washing machines rarely exceeded 250 watts, while the modern automatic washers draw approximately 700 watts. Instead of using the radio, drawing 50 watts, the average family now keeps the television set going for hours, using 300 watts.

The electric utility industry is spending over three billion dollars a year to enlarge power plants and transmission lines because of the constantly growing demand for power. Much of this, of course, is for commercial and industrial use, but increased residential consumption also is a very large factor.

Why not share in the benefits and blessings from this huge expenditure, which would cost you almost nothing? You can do this only if your home is wired to receive this energy for your own use. It costs not one penny more a month for a top-notch system.

How Much Do You Have? Electrically speaking, this means: what is the size of your service wiring? You can check this right now by examining your fuse circuit box which is located near the meter. The equipment is different in most homes, depending on the year when it was installed and the manufacturer of the boxes used. But you will see one small main switch box between the meter and the fuse box.

This holds the main fuse that controls the entire house wiring. Most likely the fuse is red and round, with copper terminals at the end, held in spring clips on each side. You need not touch it to read the size. If there is just one fuse, that means you have a two-wire entrance service (Table 3), which up to recently was standard in most homes.

What matters is size of the wires feeding that service, and that can be determined by either the amperage rating stated on the fuse, or markings on the box itself. If the fuse is 30 amperes, then you have the minimum electrical service, installed with #8 wire.

The 30-amp. service dates back to the time when electricity was a great luxury and a 100-watt light bulb was an extravagance. Circuit wiring also was of the smallest, and only a few portable appliances like a sewing machine could be used without blowing the fuses.

Most likely you will find a single 60-amp. fuse, which is better and the standard for homes built before World War II. This is considered the absolute minimum today and will permit only enough circuits to take care of just a few major appliances like refrigerator, washing machine, dryer, and the oil burner, plus normal lighting and portable accessories.

A three-wire 60-amp. system is found in a few older homes, and then only in those that have an electric range. The system is marked by the fact that there are two separate 30-amp. main fuses.

Largest size fuse for residences in the 60-amp., but two of these on separate wires makes up the 100-amp. service. The standard for today's home is a three-wire, 100-amp. 240-volt service which provides sufficient capacity for 3000 sq. ft. of living space. It allows for all the needed lighting and appliance circuits, plus special three-wire 240-volt heavy-duty connections to electric range, air conditioner, clothes dryer, and stationary tools with plenty of reserve power. Very large homes, with electric heating and complete house air conditioning can be serviced by a 150 or even 200-amp. service.

Control Center. The main electric service enters the fuse or circuit box, where the current is distributed through individual

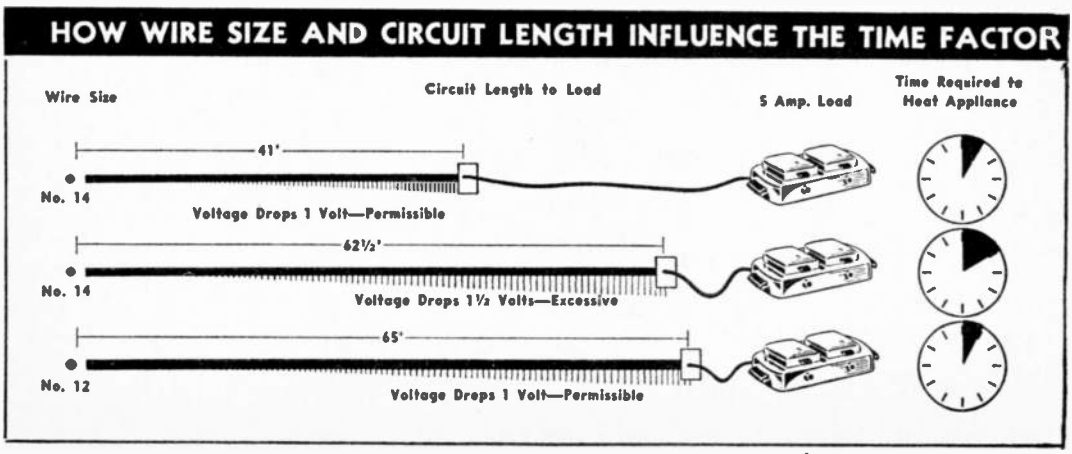


Table 1:
Approximate Appliance Wattage

Appliance	Watts Drawn
Washing machine	700
Hand iron	1000
Refrigerator	250
Radio	100
Ironer	1650
Audio system	75 to 200
Casserole	1350
Coffee maker (percolator)	1000
Television	300
Toaster	1100
Vacuum cleaner	125
Dishwasher	1000
Floor waxer	350
Waste disposal	400
Electric lawn mower	600
Freezer	350
Clothes dryer	4500
Attic fan	250 to 700
Air conditioner	750 to 900
Water heater	2000 to 4000
Large grill	1300
Rotisserie	1400
Sump pump	300
Power saw	500 to 700
Electric range	8000 to 16,000

Table 2: Circuit Capacities

Wire	Amperes	Watts
#14	15	1800
#12	20	2400
#10	30	4000
#10 (three-wire)	2/30	7200

Table 3. Capacity of Service Entrance System

Wire	Size of Service	Circuits	Total Wattage
#8	30 amp. (120 volt)	Two to four general purpose	4000
#6	60 amp. (120 volt)	4 lighting 2 major appl. circuits	7500
#2 or 3	100 amp. (240 volt)	Eight general purpose, four major appliances	24,000
#1/0 or 3/0	150 or 200 amp. (240 volt)	Ample for all lighting, major appliances.	40,000

branch circuits to various parts of the house, and for different purposes.

Each circuit has its own individual fuse, so that if there is an overload or short, only that particular circuit will go out of commission, rather than shutting down the entire house service. Under severe load conditions, or where a fuse of incorrect size has been used, an overload may blow the main fuse and leave the house in darkness.

The fuse contains a metal link through which the current flows. This element melts at a specific temperature, thus disconnecting the power on that circuit when too much power is called for.

Each size wire has a maximum current-carrying capacity, and that determines the size of fuse for that circuit. Thus, a #14 cable for lighting and small appliances can carry only up to 1800 watts. If the current draw of a group of appliances, on at the same time, exceeds that amount, resistance in the thin wire causes it to heat up, and the thermal strip melts in the fuse.

By substituting a fuse rated larger than the wires of that circuit can handle, this cancels the safety value of the fuse, allowing the insulation to burn up, destroying the house electric wiring and creating the risk of a serious fire.

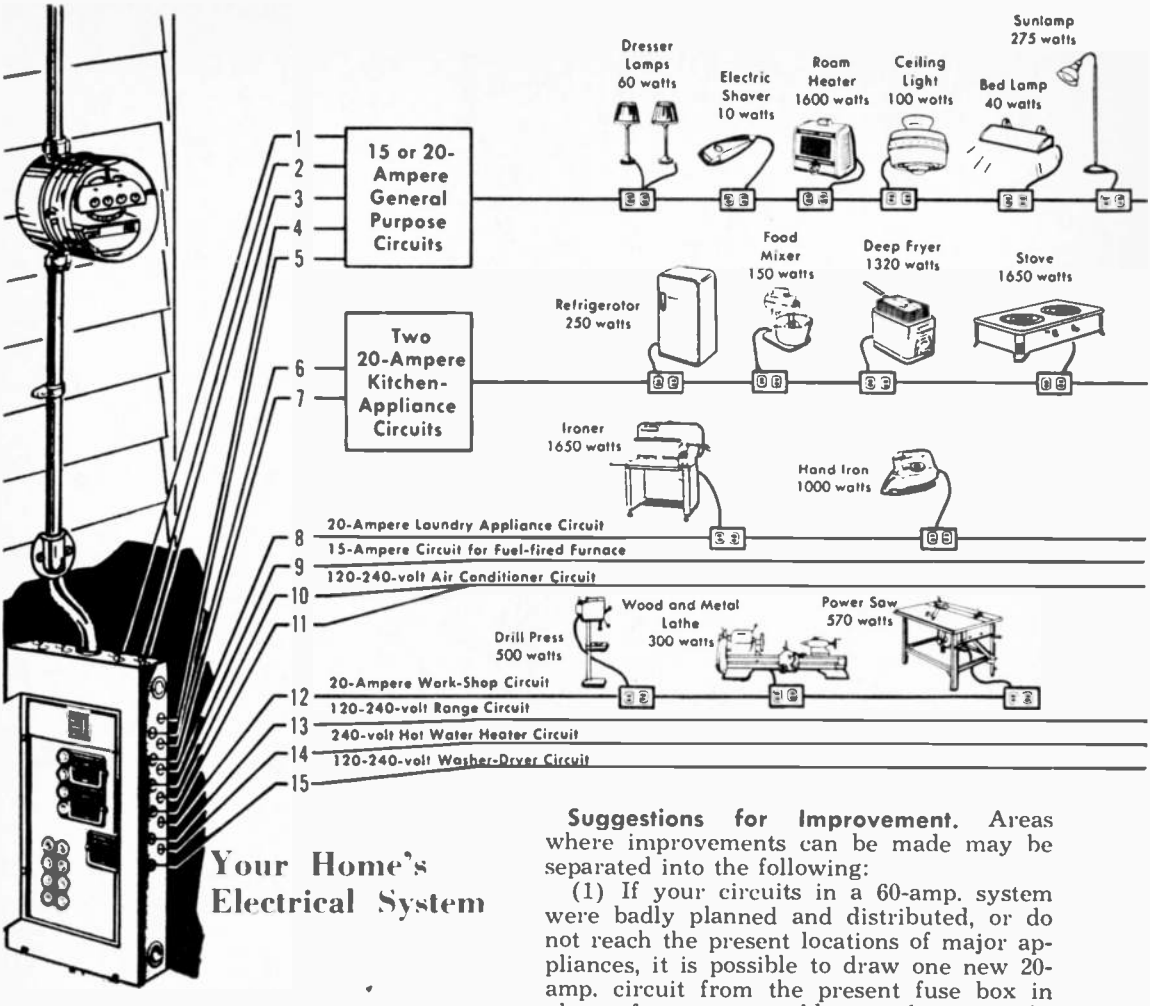
Circuit Distribution. In addition to the size of the service entrance, the kind of wire used in your home circuits is an important factor for electrical efficiency. At one time, almost all circuit wiring was #14 size, with a capacity of only 1800 watts.

In fact, some local codes once restricted residential installations to the #14 wire under the theory that the smaller wire permitted better fuse control. But the main factor was cost. The thin #14 wire was cheaper, and easier to install because it was more flexible than heavier wire, and took less time to make terminal connections. This is not true today. The larger #12 wire is even thinner because of new-type vinyl insulation.

The difference in cost between the two wire sizes is minimal in relation to the overall cost of installation. Much of this difference is made up today by using non-metallic cable rather than BX or conduit in some localities.

If your house has #14 circuits throughout, then it will be necessary to supplement them with one or two appliance circuits of #12 or #10 wire, to permit use of any major appliances.

Number of Circuits. The capacity of your service entrance strictly limits the number of branch circuits into which it can be divided.



Your Home's Electrical System

It's a matter of simple arithmetic. You can understand that a 30-amp. service divides into just two 15-amp. branches, so there should be two circuits. A 60-amp. service theoretically will be divided into four 15-amp. circuits, or three 20-amp. circuits.

Actually, there's a little leeway on that, under the assumption that all the circuits will not be pulling maximum current at the same time. Thus, a 60-amp. system could well handle four 15-amp. circuits plus one or two 20-amp. major appliance branches. In practice, we find that most homes with a 60-amp. feed have six circuits, either all 15-amp., or four 15-amp. and two 20-amp. circuits.

But that's the limit. You can't get more electricity simply by tieing in additional circuits except in certain cases where the original layout was very bad, with some circuits hardly used while others become overloaded. In that situation, an improvement may well be made by altering the distribution.

Suggestions for Improvement. Areas where improvements can be made may be separated into the following:

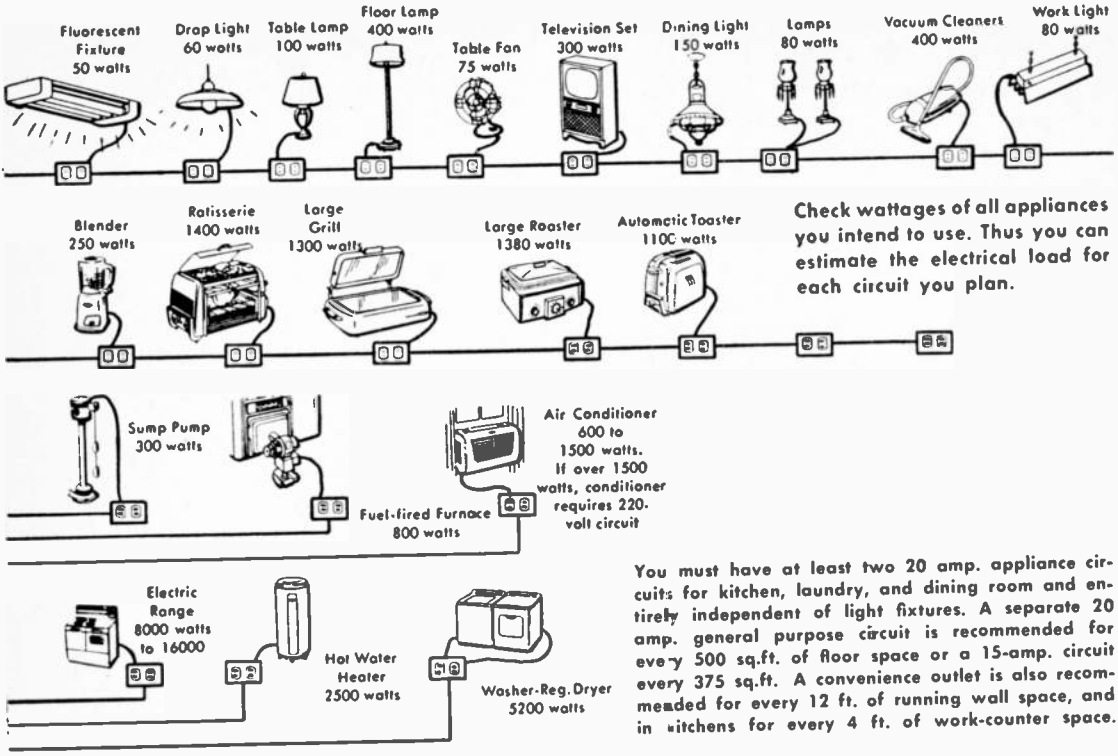
(1) If your circuits in a 60-amp. system were badly planned and distributed, or do not reach the present locations of major appliances, it is possible to draw one new 20-amp. circuit from the present fuse box in place of a present seldom-used circuit, directly to the required area.

This will usually be in a downstairs room such as the kitchen, or a basement laundry room, where concealed cable installation is no problem. Thus, changing the appliance load will lessen the current draw on the other branch, and both circuits will be free of overload.

One problem in connection with this is that the outlets on the discontinued circuit would be inoperative if disconnected. But that cable can be spliced into the new circuit at a junction box using the original cable—if it is still in good condition and if that old circuit will be used only for lighting or for small appliances, and at times when the major appliances are not in use.

Basement outlets near the fuse box, or even a kitchen installation to which the cable can be drawn through the kitchen floor up from the basement, are simple and inexpensive installations.

(2) If you have a 30-amp. service, there's



no alternative to making the basic change-over to a larger electrical service, because the total capacity leaves no room for any changes or improvements.

(3) Changing to adequate 100-amp. service can be done with minimum outlay if you're willing to do it in stages. That is, have the larger utility service installed, and just take off a couple of circuits needed immediately for major appliances.

The cost is surprisingly low because the larger service cables are brought right to the meter in your house by the utility company, without charge. All you need is to have a licensed electrician install a larger fuse box and main switch, and connect the new cable into the fuse box. He also will re-connect the present circuit cables into the new fuse box.

Cost of this part of the work varies according to area of the country, number of fuses in the box, how many new branch circuits you want installed now, and where they will go.

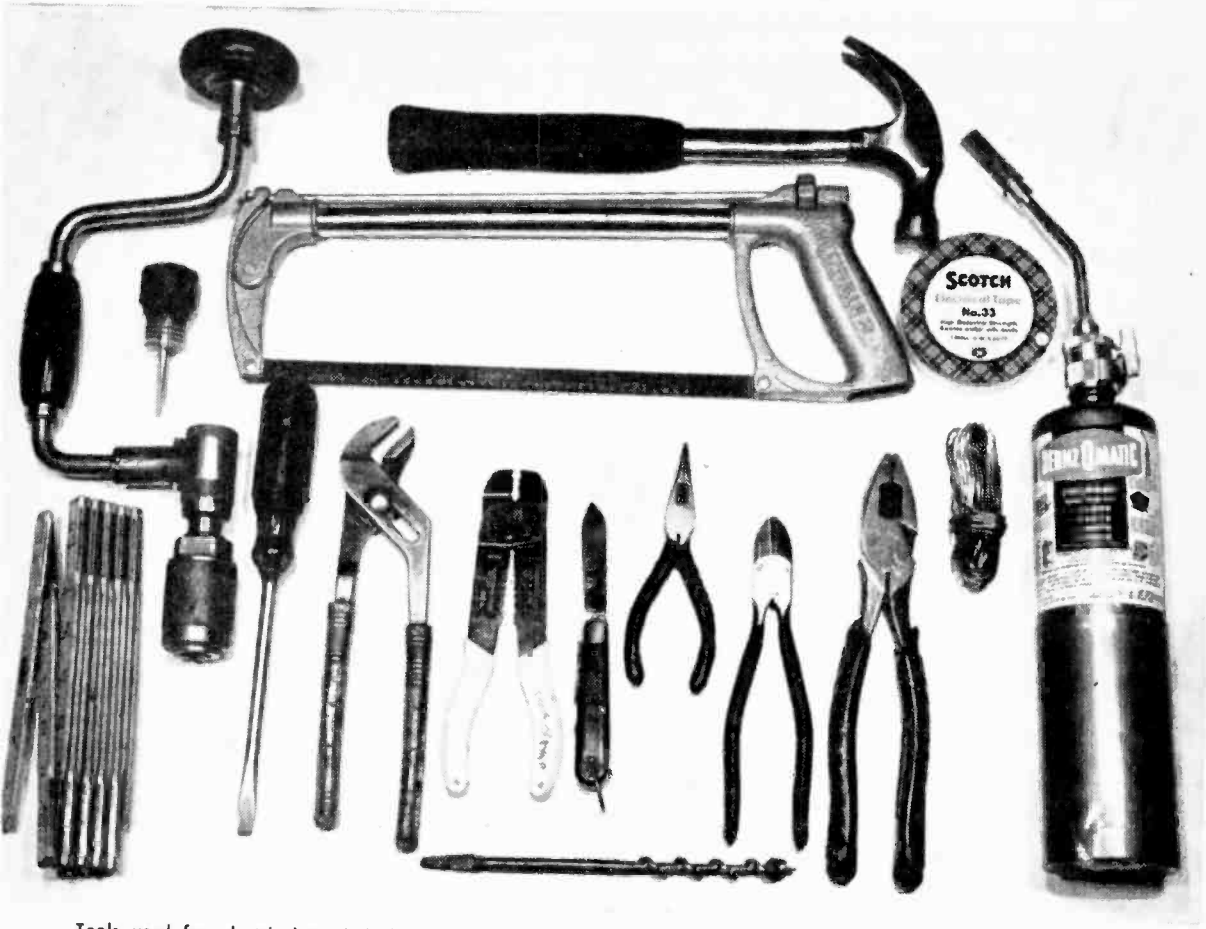
Thus, the charges for installing an efficient, up-to-date electric service may range from a minimum of $150, all the way up. Where the house is set far back from the road, there may be some charges by the utility company, especially if additional poles are needed to carry the cables.

Fortunately, most major appliances are used in the kitchen or basement laundry room, where access for the wiring is easy and inexpensive, as the cables can be fished through from the basement floor. A new three-wire system will enable you to have 240-volt current for faster clothes drying, and more efficient air conditioning. Sears, Roebuck will send you a free planning chart for electrical renovation.

If you need to supply current for an attic fan, or an air-conditioner in an upstairs bedroom, it will be less expensive to have the branch cable brought up outside the house, attached to the wall, rather than the more costly snaking of wires inside through the walls. In many areas you can do all or part of the work yourself, so the only expense will be for material.

Remember, the outlay for a 100-amp. service is not strictly an expense, but rather a capital investment, because it increases the value of your home, makes it more attractive to the knowing buyer if you ever want to sell, brings the house up-to-date and makes it more livable. Often the increase in a home's value far exceeds the total cost of modernizing the electrical circuit.

Meanwhile, you'll have the benefits of more modern appliances to make living easier, more pleasurable. And a good electrical system, that you'll find can function perfectly for many years without a single fuse blowing.



Tools used for electrical work include a folding rule, brace, screwdrivers, Channel-lock pliers, wire stripper and lug crimper, pocketknife, needle-nose pliers, linesman's pliers, propane torch, hacksaw, hammer and electrical tape.

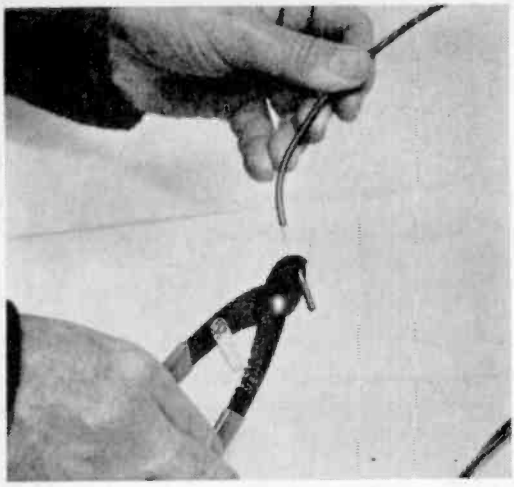
Tools of the Trade

GOOD tools make any job go quicker and easier, and with electrical work there's no need to build up an extensive collection of different types. As a matter of fact, ordinary everyday tools that are in every home workshop plus only a couple of inexpensive special items can see you through most of the work. Extra tools may be needed if you undertake a complete re-wiring, or come up against a difficult situation.

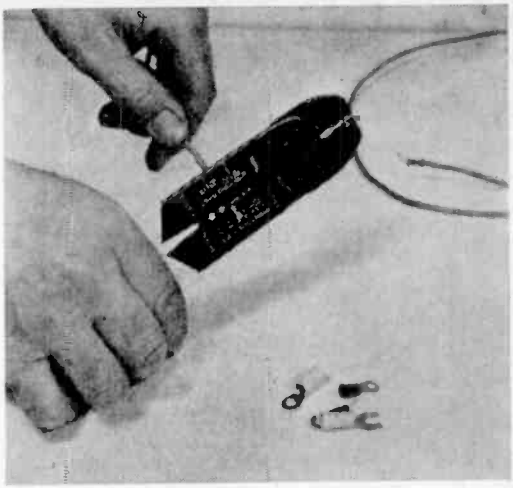
The special additional tools that will be very helpful for every job are a wire stripper and needle-nose pliers. Also, when using non-metallic cable, a cable ripper will speed stripping off the tough outer covering.

Wire Strippers are a marvel of efficiency, cutting through the insulation without even nicking the copper wire, then skinning the insulation cleanly in one pull. The basis for this is that the strippers are adjustable, or have different notches for each size wire, so the cut is made only to the right depth. In addition, the cutting edge is bevelled so that the remaining end of the insulation is not cut off square, but rather neatly tapered.

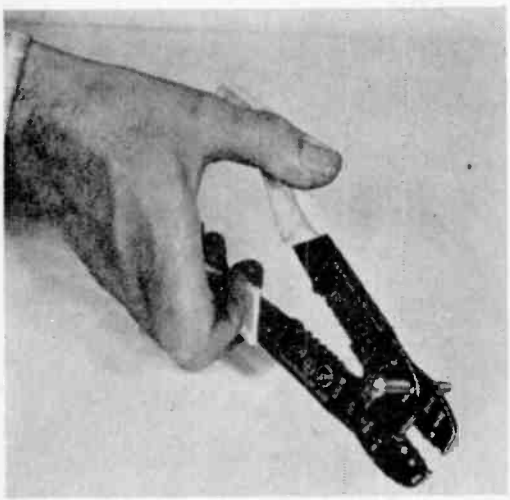
The more elaborate and efficient strippers are much more versatile. There is a series of notches which are marked for the wire gauge so no separate adjustment is ever needed. In one make, there are bolt-cutter holes—just turn the screw into the threaded hole to the right depth, leaving the desired length, and squeeze the handles to cut the



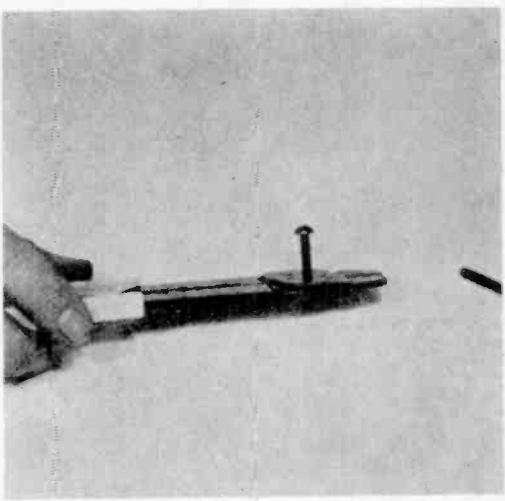
Insulation from various size wire can be removed by setting lever so it corresponds with the wire size.



Series of holes accommodate various size wires. It's important to have the right length of exposed wire.



Several tapped holes in this stripper enable you to cut screws to desired length by turning screw into



opening, then squeezing the handles to clip it off. Thread of screw is retained without any damage.

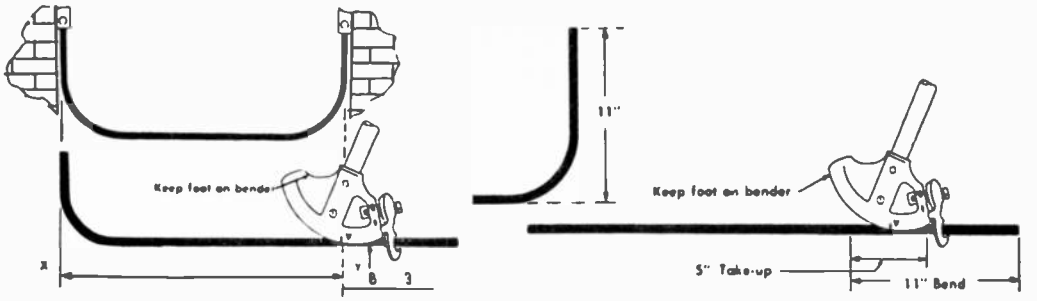
bolt at that point. Then turn out the screw, and the end is neat and square across, will easily thread into the nut. This stripper takes bolt sizes up to 1¼, and is a real convenience on the job as it eliminates hacksawing and the additional chore of filing the uneven end so it is flat.

In addition, the same stripper can be used to crimp wire lugs. A guide marker on the side shows just how far to strip the insulation for various size wires to fit the lug. Then just put in the wire, set it into the crimping jaws which are also marked for different size lugs and wires. It practically amounts to automation!

Needle-Nose Pliers. For looping solid wire around terminal screws the needle-nose pliers are very useful. They also come in very handy for pulling wire through a conduit when it's necessary to reach in to grip the ends. The pointed jaws can reach deeply into narrow places and make the pliers a "must" in most tool kits.

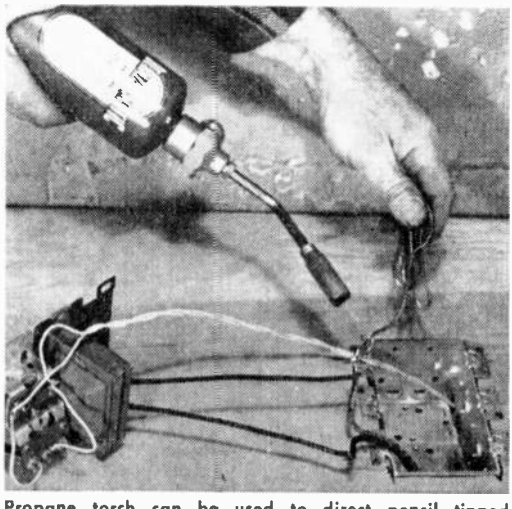
The pride of every electrician's equipment is his linesman's pliers of which the big name is Klein's. The pliers are usually quite large for good grip, give plenty of leverage for twisting heavy wires into a splice, clipping through the wires of any size, straightening, and other work. Most lineman's pliers come with insulated handles which contribute a safety factor.

A wonderful aid when putting in low-voltage bell and fire alarm wires is the Arrow



Many fittings can be eliminated and installation time reduced by making radius curves with a hickey.

This wire stapler has rounded fasteners that do not compress the low-voltage wire when it's put in place.



Propane torch can be used to direct pencil tipped flame on wire to make a lasting soldered connection.

Tools of the Trade

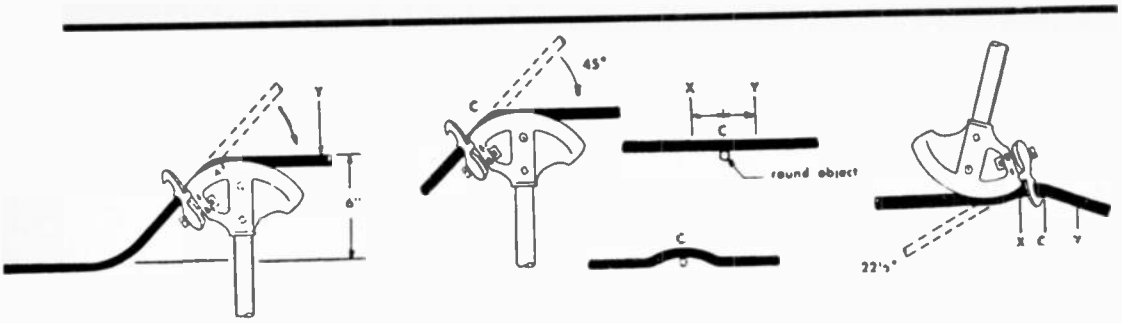
Most electrical work requires very few specialized tools

Model T-25 staple tacker, which drives a rounded staple just deep enough to hold the wire without damaging the insulation. This stapler is so designed that the head automatically is aligned on both sides of the wire. Staple sizes are $^3/_{16}$, $^1/_4$ and $^5/_{16}$ in.

Soldering Connections. For quick and dependable soldering, an electric soldering iron or a propane torch are both handy. Use a match or sparkler to light the torch in an instant, then shut it off soon as you're through so it won't burn fuel unnecessarily.

In contrast, a gasoline torch is a nuisance for electrical work, mostly because it is difficult to control the flame and it's cumbersome to handle. The propane torch, of which the Bernzomatic and Turner are best known, is light in weight, can be taken apart for packing into a tool bag, and has several different tips for various work requiring either a concentrated or spread flame. A tank of gas will last quite a long time, and costs less than $1 to replace.

Tube Benders. There are two types of benders that can be used. The Hickey-type is used for heavy wall conduit, and has hardened teeth in the face of the bender for non-slip grip. There is a notch in the radius to protect the conduit threads. The thin-wall conduit bender has smooth side walls that grip the tubing and minimize distortion. A step bracket is provided on the thin-wall bender



Handle is, of course, longer than indicated by these drawings.

to give extra leverage when pulling on the handle to make the required bend.

By bending the galvanized or aluminum conduit you can save a lot of time, and use less fittings to go around corners and to follow wall contours. Once you get the hang of using the tool, you can make critical bends like a professional.

Drills. A brace and bits, and an electric drill are used frequently to make holes in joists, studs and flooring.

In some cases, extension attachments are needed on drills to reach through from one floor to another where there is no access above. Carbide-tipped drills are used on plaster and brisk walls, while star masonry drills are used often when mounting outdoor boxes and conduit straps.

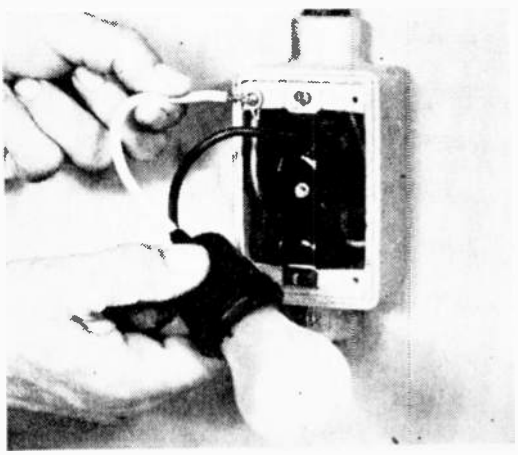
Chisels. One of the most urgent uses of a sharp wood chisel in electrical work is to make openings for outlet boxes in gypsum board walls.

The opening must be quite accurate, so the box will be held securely, with just enough clearance at top and bottom for the retainer screws. The chisels will, of course, be put to use almost at every stage of electrical work to cut away obstructions and for wedging out moldings and other purposes.

Other Materials. Aside from the cable, wires, switches, light fixtures and receptacles, installations call for boxes of one kind or another, each special for its purpose. Every connection is made inside a box, and the cables entering that receptacle must be securely anchored inside the box with connectors. Also, the cables are strapped close to the box for reinforcement.

Boxes are of steel, cast iron, aluminum, Bakelite and porcelain. They come in squares, Hex's, octagonals, round, and oblong. Some have "ears" with holes for surface mounting in plaster walls, others are intended to be held in place with straps, while still others have threaded holes which permit turning the box on metal conduit.

Junction boxes are usually octagonal, 3 or 4-in. size, with two threaded lugs on the inside for attaching the covers. Knockout or pryout openings on several sides and back permit entry of the cable from any direction while keeping the box otherwise intact. Switch boxes are narrow, rectangular shape, with built-in connectors.



Basic Electrical Supplies

For almost all electrical work, it is good to have on hand certain supplies that are frequently used.

- Friction or Plastic Electrical Tape
- Rubber Tape
- Plastic Solderless Connectors
- Fiber Cable Bushings
- Connectors for BX and Non-metallic Cable
- Steel Straps, for Conduit, Cable
- Wire Lugs Assortment
- Solder and Paste

Test light is useful to check if right fuse was pulled and to determine if wire is properly grounded.

Appliance wire.

Service entrance or combination, and service drop. Type SE.

Service drop. Type SD.

Underground service entrance, direct burial. Type USE.

Dry locations only. Smaller than No. 6. Type V.

General purpose for Direct Burial, Aerial, Conduit and Underground Duct Installations.

Pendant or portable extra hard usage in damp locations; type SO for oil resistance. Hard surface core.

Pendant or portable hard usage in damp locations; SJO for oil resistance. Junior hard surface core.

For use in pendant or portable applications in damp locations not subject to hard usage. All rubber.

What Wire

AS IN almost every field, the scientific achievements and industrial advances of recent years have produced many improvements in wires and cables that make some of the old materials obsolete and have considerably affected techniques used in the electrical trade. Further changes are occurring constantly in wires, wiring devices, tools and equipment.

New types of wire have simplified electrical installations in homes and thus reduced costs —though you'd hardly know it because rising labor charges and more rigid code requirements have more than made up for any possible saving in that direction.

Plastic Coatings. Vinyl-insulated wire is highly efficient, smooth, leak-proof, resistant to flame, moisture, rot, fungi, and acids. In fact, it is almost immune to the many ills that formerly affected wire and caused deterioration and troublesome damage. Yet, this new type of wire is actually much thinner and more flexible than before, so that more wires can fit into a smaller conduit, and the wires are more easily pulled through.

Non-metallic cables, with extra heavy vinyl coating can be used for indoor wiring circuits, and outdoors for yard lights, underground burial, embedded in plaster masonry, and almost everywhere including damp locations. Some of these cables come in a clear white color. They have a flat shape which not only assists in making bends inside walls, but also offers a good enough appearance to be used for surface wiring or receptacles.

Other cables have neoprene coatings as replacement for natural rubber which was affected by oil, grease, sunlight, and ozone.

Wire now comes imprinted with brand identification on the jacket, stating size of conductor, description of insulation material, whether vinyl, neoprene, fiberglass or other plastic. Thus, you can now tell at a glance the specifications of the wire and determine its limitations and the proper use.

Approved Wires. Whenever making a purchase of wire or cable, as with any other electrical materials, look for the Underwriters' Laboratory (UL) label.

There's no need to take anyone's word for it, as the "inspected" or "approved" label will be found either printed on the insulation or in decals or bracelet bands on all UL approved electric cords, BX cable, non-metallic

Use stranded wire on small appliances, larger-size wire for high-wattage units, and heavy for motored devices.

for the Job?

cable and single-wire conductors. Many cables are marked also as meeting REA requirements.

Armored Cable. Electrical codes in many communities require use of BX armored cable in certain installations. Sometimes this requirement specifies that BX be used only for concealed or behind-the-wall wiring in dry locations. Conduit wiring may be called for in all exposed or surface installations. BX cannot be used outdoors, underground, or in wet locations.

The cable has a spiral steel armor, which is quite flexible and offers good protection against being pierced by nails driven into walls. It cannot be attacked by rodents, has good fire resistance, and has little tendency to sag when properly supported with straps or staples. The steel cable also serves to maintain a continuous ground connection between electrical boxes.

BX consists of two or more plastic-coated copper conductors, wrapped tightly with heavy water-repellent paper, and a layer of cotton fabric insulation between the conductors. An uninsulated bonding wire between the paper wrapping and steel spiral gives added safety by providing low armor resistance and assures continuous ground connection. Only steel junction and outlet boxes should be used with BX cable.

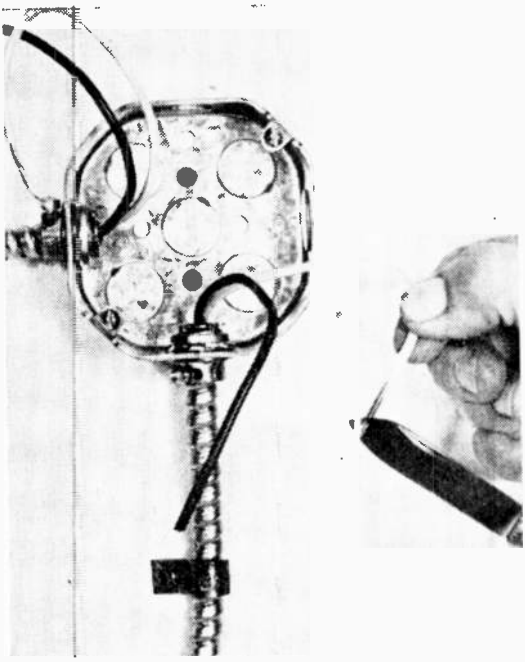
Lead Sheathed Cables. For underground installations without conduit, the lead sheathing assures utmost safety and longer service.

The cables, such as Tiger Brand *Amerclad*, have high neoprene content jackets which are extremely flexible, with excellent resistance to damage from stress, grease or oil, and water. The conductor insulation is permanently vulcanized in a lead sheath, providing a leak-proof density.

Non-Metallic Cable. Easiest to install and cheapest to buy, non-metallic sheathed cable is used for exposed or concealed installations indoors, in homes, barns and out-buildings, where permitted by local code. This cable is not intended for outdoor, or underground work.

Non-metallic cable consists of two or more plastic-insulated conductors which are wrapped in heavy paper, with an outer jacket of braided fiberglass that is resistant to moisture, rot, fire and acid vapors.

It is available in sizes from #8 to #14 wire, and comes with or without ground wire. A rip cord helps to strip the coating, though a small tubular cable ripper will do this easier. This cable can be quite easily damaged by



BX cable has a spiral steel armor that is flexible, and provides protection against its being pierced by nails.

stress, nails, or other mechanical conditions, so must be adequately supported with straps and protected by guard boards in certain locations.

Vinyl Covered Cable. Protected with a heavy outer jacket of polyvinyl plastic over a secondary leak-proof insulation of fiberglass, this dual-purpose cable can be used anywhere, indoors or out, even for underground and outdoor installations, where permitted by local code. The vinyl cover resists moisture, weather, flame, corrosion, fungi, oils, acids and alkalis, and even mechanical injury. It is available in several jacket colors.

The cable, somewhat flat in shape, is ideal for rewiring old work where it can be snaked behind walls, because of its excellent flexibility. In addition, it is attractive enough to be used for surface wiring along baseboards for adding receptacles and fixtures. The cable comes in white and gray color, in sizes from #10 to #14 gauge, and with or without a grounding wire.

TABLE 1: AMPERE CAPACITY OF CABLES

Wire Size	#14	#12	#10	#8	#6
Maximum Ampere Capacity.. ..	15	20	30	40	55

TABLE 2: CORD SELECTION

Appliance	Wire Size	Insulation
Lamps up to 800 watts	#18	plastic
Vacuum cleaner, percolator, etc., up to 1100 watts	#16	rubber type SV
Up to 1650 watts	#14	rubber type S
Saws, washers, refrigerators (major appliances)	#16	rubber type SJ
Toaster, broiler, iron (heater appliances)	#16	asbestos and rubber
Damp locations		rubber type S

Ways You Can Guard Against Electrical Shock

Outdoor ground contact can be made by driving a copper-coated steel pipe, 8 to 10 ft. long, into the ground and fastening heavy wire to it with clamp.

Protect yourself from the hazards of leaking current by providing a safe pathway for this current to travel

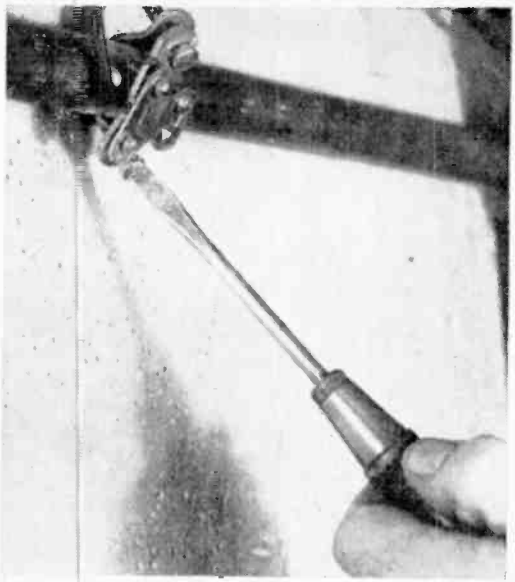
THE carefree way in which we handle electrical appliances and tools confirms their record of safety. But electricity packs a tremendous wallop when mishandled. Far too often we read of tragic accidents—a child electrocuted in the bathtub while tuning a radio, a woman shocked to death while using a washing machine, a homeowner killed by a small electric drill in the garage. And there's no counting the fortunately less-serious shocks and burns that occur in homes and shops.

These happen only when the basic protective devices become defective or the simple precautions ignored. Intensive efforts are being made by appliance manufacturers, trade associations and governmental bodies to eliminate any hazards.

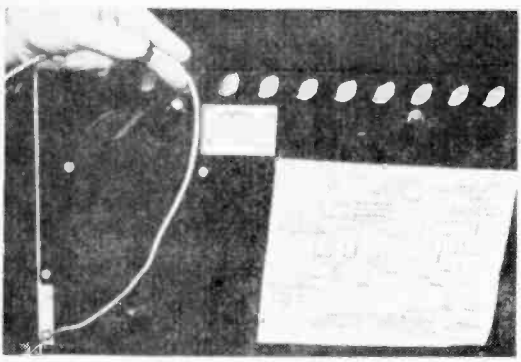
One of the most important steps is that of equipping all electric cords on tools and appliances with three-wire plugs for automatic grounding, and promoting the change-over of outlet receptacles to the grounding type.

All appliances, tools and electric equipment should be adequately grounded. Stationary equipment like a washing machine can have a simple grounding wire attached with a clamp to a water pipe. Portable tools and appliances should have the three-wire cord used in a special grounded receptacle. When extension cords are used with these tools, they should be the three-wire type.

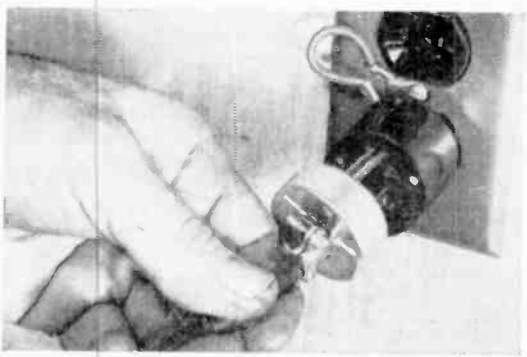
In addition, never place a radio or other electric appliance where it can be reached by anyone in a bathtub—if you must have a radio in the bathroom, use a battery-powered transistor model which is safe. Avoid using any electrical equipment in the sink while the cord is attached. Don't touch electrical equipment while your hands are wet or while standing on a damp concrete floor.



Use emery cloth to sand the pipe down to bare metal before attaching clamp that will ground appliances.



Be sure to scrape off any paint that would prevent insulated ground wire from making positive contact.



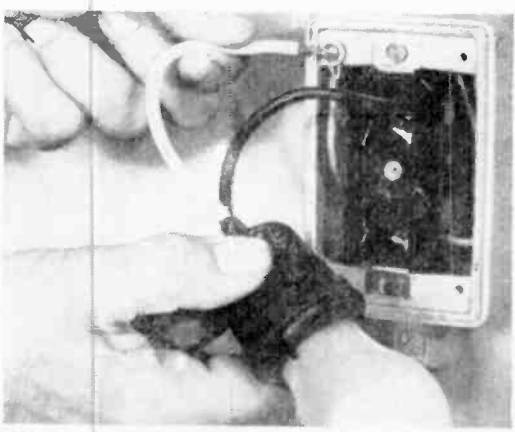
Effectiveness of pigtail attached to the cover depends on whether the receptacle box is properly grounded.

Never tinker with any fixture or appliance before pulling the cords or disconnecting the circuit. Always short out the condenser spark before making repair on a TV set, even after the cord is pulled. These safety rules are easy enough to remember and follow, may save you lots of pain and grief.

Cause of Shocks. An electrical shock sometimes is attributed to a short circuit. This theory is not correct; a short will blow a fuse and disconnect the current.

A shock occurs when current passes through part of the body. This happens when a person touches a "hot wire" (or any part of an appliance which has become "alive" because of a defective electrical connection) and at the same time is in contact with a ground.

As the human body can conduct electricity,



Use a test lamp to determine if wall box is grounded so screw plate can be used to ground appliance.

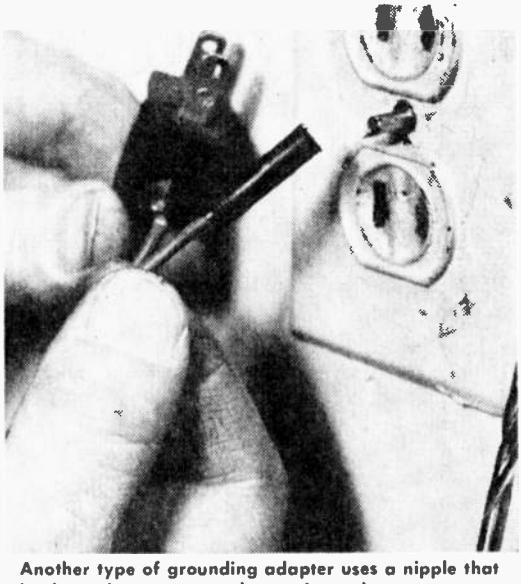
the current will go by the shortest route through to the ground to complete the circuit. Thus, if one finger touched the hot wire, and another finger of the same hand touched a water pipe, the shock would be felt only in that hand, causing a sharp tingling of the nerves and momentary paralysis.

But if the person were to touch a "live" appliance while standing on a wet concrete floor, the current would flow through the entire body and could be lethal. The severity of the shock depends on the line voltage, duration, and physical condition of the person.

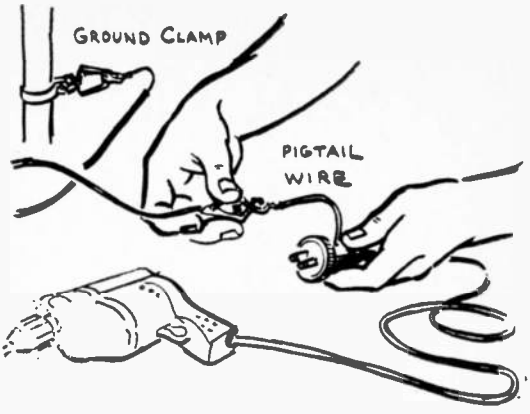
The condition of your skin also offers varying resistance to passage of the current. Thick, dry skin has greatest resistance, which accounts for the fact that many manual workers are hardly affected by shocks.

Electrical Defects. Normally, the electrical cord and inside terminals are adequately insulated so they do not come in contact with the metal frame of the tool or appliance. But if the insulators become damaged, or from some other cause the hot wire comes in contact with any part of the metal frame, the entire unit comes "alive," that is, it is charged with electricity.

A common spot where this occurs is the electric cord which becomes frayed at the point where it enters the tool body because of rubbing against the metal shell. (Good tools have rubber grommets at that point to protect the insulation, but the grommet has been known to fall out, thus permitting a hazard). The insulation may become cut sufficiently to expose a tiny bit of bare wire that touches the metal shell.



Another type of grounding adapter uses a nipple that is plugged onto a stem that reploces the cover screw.



One way to use the pigtail lead is to attach a separate wire with alligator clip to clamp on water pipe.

If you touch the machine while standing on a wood floor, there is no effect because the current will not pass through you. Thus a machine may be "hot" for years and no one know about it, or suffer any injury, because the machine is located where you are not in contact with a conductor to complete the circuit.

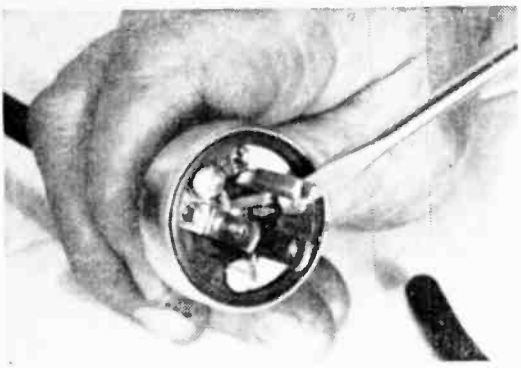
Then one day you may touch an electrical receptacle cover while holding that appliance, and get belted by a real shock because the current has passed through your body just as if you had touched a bare wire.

But none of this would happen if the appliance itself were grounded. In this case, if the bare wire touched the appliance shell, it would be like the two wires of the power line touching; there would be an immediate short circuit and the fuse would blow.

Precautions. Though not essential, it's a good safety precaution to stand on a rubber mat or a hardboard panel when changing fuses or working with appliances and power tools.

This rule applies to every kind of electric equipment, even those that might never be used near a conductor, such as a washing machine, dishwasher, electric wall oven, air conditioner, attic fan, space heater, toaster, mixer, hair dryer, even shaver. One installation that is particularly hazardous is the filter pump for swimming pools, where people walk around barefoot on wet ground and might touch the filtering machine.

This potential hazard is so serious that the National Electrical Code was amended in 1962 to require that circuits for swimming equipment and lighting must be grounded with an insulated conductor and that the armor of the cable may not be used for grounding.



Be sure ground wire is attached to the right terminal when replacing plugs so tool shell will not be "hot."

Polarized plug eliminates the chance of wrong wiring by having the ground terminal stamped on plate.

Grounding Appliances. A ground is a wire permanently connected from the body of a tool or appliance directly to a water pipe or other metal conductor which has a continuous run into the earth. It is comparatively easy to ground a stationary appliance like a washing machine by attaching a wire to a bolt on the appliance, then connecting it to a clamp on the pipe.

A water pipe makes the perfect grounding contact. Also suitable are receptacle boxes in circuits wired with BX armored cable, a steam pipe or radiator, a plumbing drain or sewer line.

Circuits connected with Romex and other insulated cables must be checked to be sure that they have a continuous grounding wire in addition to the electrical feed wires.

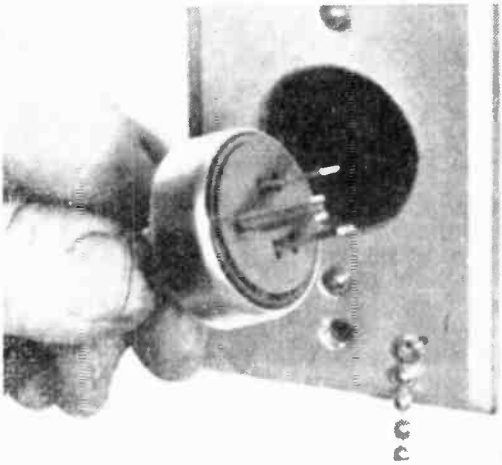
Attaching the Ground. Low-cost grounding clamps (less than 50¢) available at all hardware and plumbing supply stores, should be used to be sure of good, permanent connection. Before attaching the clamp, clean the pipe with sandpaper to remove any surface rust, until the metal is bright color.

Similarly, turn out a screw or bolt from the frame at the back of the machine. If there is any paint, scrape it off with a knife or chisel, then sand the metal bright. For the grounding cord, use stranded wire of sufficient size (#14 or #16) so it won't break. Insulated wire is preferable, but not essential.

Strip the insulation, wrap the wire around the appliance screw at one end and the ground clamp screw on the other, and tighten securely.

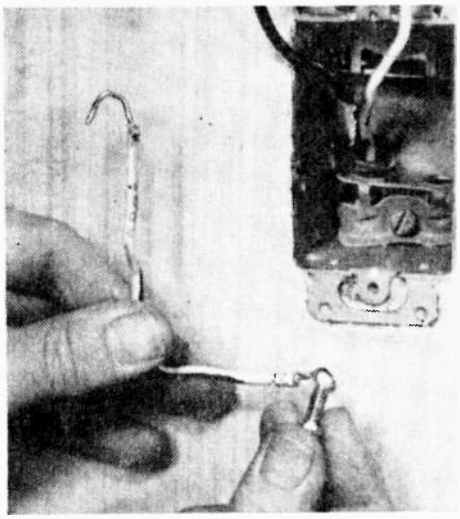
A neater and more dependable connection can be made with wire lugs, to which the wire is crimped with special wire pliers. These lugs slip over the terminal screw for sure, permanent contact.

If no water pipe is handy at the location, the ground wire can be attached to a steam pipe, a hot water heating line, or with a screw to the metal electric receptacle cover. At swimming pools, there must be available

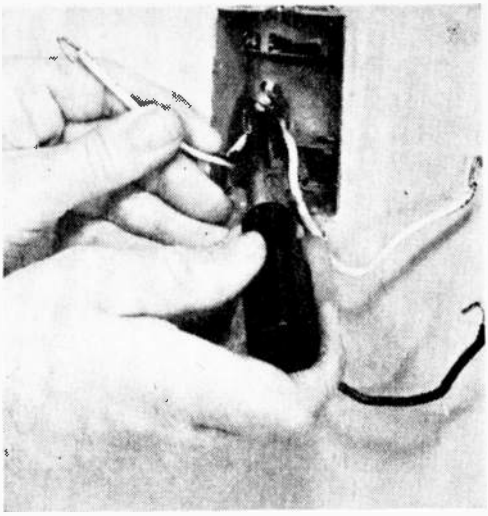


Appliances that are used outdoors can be safely grounded by installing a convenient all-weather outlet.

Extension cords can provide a continuous ground if outlet and tool plugs have three-prong receptacles.



Changeover to a polarized receptacle can be made by installing a short grounding wire with lug on one end.



Fasten the crimped wire lug to the inside of the box with a screw that is securely tightened.

The vast majority of accidents occur when protective devices have

a separate insulated grounding wire which is connected to an acceptable ground such as the water system piping.

That's all there is to this very effective and important safety measure, and it requires no further attention or servicing.

Check for Continuity. Don't take it for granted that there is proper ground continuity in older work, which relies on color coding. Test it with a trouble light consisting of a bulb socket and two short wire leads having stripped ends for probes.

Insert one probe into an electric receptacle (try both sides) and touch the other to the ground clamp. If the ground is good, the bulb will light. If the bulb does not light with either side of the receptacle, there is no ground.

On water pipe, the fault may lie with coating on the pipe or poor wire connection. If the contact is on an armored electric cable, lack of a ground indicates that the cable connections are broken at some spot and this should be checked through. With Romex and other insulated cable containing a third grounding wire, the test will prove whether there is continuity of ground.

Extra Ground Wire. Manufacturers of portable power tools have been trying for years to solve the problem of assured grounding. The portable drill, saw, and sander are most subject to trouble because the cords are continually flexed (sometimes the tool actually is lifted by the cord) so that the insulation becomes frayed or the wire strands break away from their terminal screws. Both these conditions are prime causes of the tool casing becoming "alive" with electricity.

Compounding the hazard is the fact that such tools are carried to the job, used in varying locations such as the garage, attic and even outdoors in damp weather.

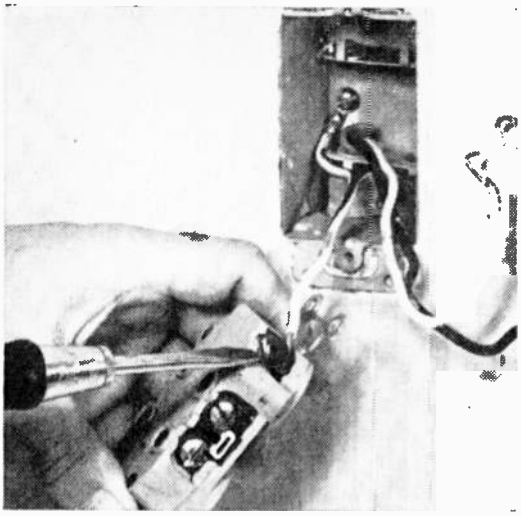
Formerly, such portable tools were supplied with a "pigtail" ground lead near the plug end of the cord for grounding on the receptacle cover. This lead had either a lug which could be fastened down with the receptacle cover screw, or a brass plug was used in conjunction with a small terminal nipple. In use, this required replacement of the receptacle cover screw with the nipple, so the pigtail could be plugged in.

The shortcomings of this system were that the thin pigtail wire tore off, or that the tool user simply ignored the grounding procedure. Another difficulty was the use of extension cords when working at a distance from the receptacle, which made the pigtail ground worthless.

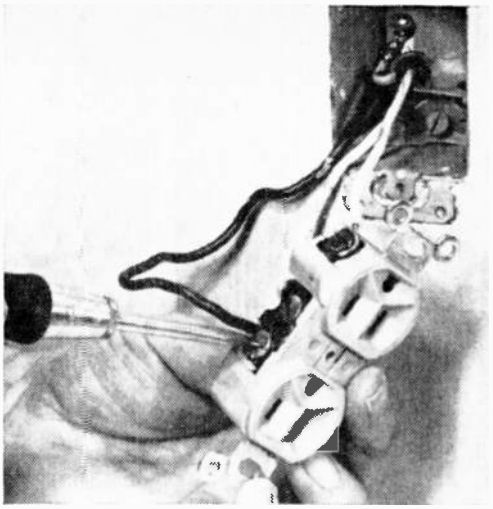
Now tool and appliance manufacturers use a new type of plug with three prongs; two are flat for the electrical leads, the other is round and centered above the others, to make the ground connection.

But this requires a special grounded receptacle, designed to take regular plugs in addition to the three-prong type. Until recently, these outlets were quite scarce in the home, so an adapter was supplied which has a short pigtail lead to be used in the old-type receptacles.

Three-Prong Receptacles. Now there is greater emphasis on installing these three-prong grounding receptacles, both in new work and in converting regular outlets to the new polarized grounding type. The cost is



Attach the other end of the short length of wire to the grounding terminal of the electrical receptacle.



Connect the other wires to the right terminals, then fold the wires inside the box and replace the plate.

become defective or the simple precautions are carelessly ignored

nominal, about 75¢ each, and they can be installed by anyone in just a few minutes.

The 1962 modifications of the National Electric Code for the first time makes mandatory the installation of these grounding type outlets. This means that various types of sheathed wire supplying these receptacles contain a separate grounding conductor.

So you see that this matter has received utmost attention, and from now on almost all the equipment you buy will have the three-wire cord with grounding plug, and it will be most convenient for you to have at least some of the necessary receptacles in your workshop, laundry room, kitchen, etc.

Installing the Receptacles. Buy duplex receptacles of the parallel blade type that take standard three-prong polarized plug caps. To make the changeover, first cut the current and remove the receptacle plate cover. Remove the two retainer screws inside at top and bottom, and pull out the receptacle with its wires. Disconnect both wires from their terminals.

Make a grounding lead of insulated #18 wire, about 6 in. long and stripped at both ends. Attach one end with a screw inside the electric box if it has an armored cable feed, or splice the wire to the grounding conductor in a sheathed cable. Then connect the other end of the lead wire to the terminal with a green-colored screw at the top of the receptacle, marked "ground." Fasten both feed wires to their correct terminals (black wire on the brass screw and white wire on the silver screw), and replace the receptacle in its box.

Extension Cord. The three-wire system is ideal for retaining a ground connection when using tools away from the receptacle. Just use a three-wire extension cord with the proper fittings, which are a rubber plug cap and a rubber cord connector.

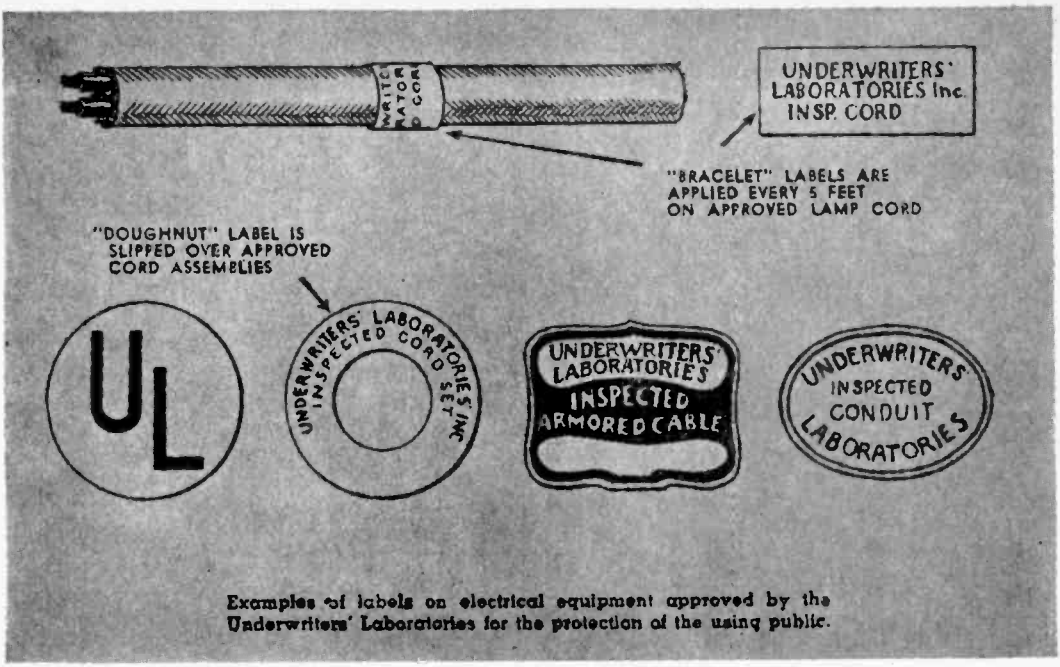
Thus not only the ground is retained, but also the polarity of the extension cord. The plug of the tool can go on only one way because of the position of the rounded ground prong.

When making up extension cords, make sure to use wire of the right size in relation to the length of the cord. For wire up to 25 ft., use #18 wire, for 25 to 50 ft., use #16 wire, for over 50 ft., use #14 wire.

Older Tools. There are millions of portable tools in use that do not have the three-wire cord, and are not equipped for use with the three-prong receptacles. To make a ground, attach a separate wire to the shell of the tool with a screw where possible, and fit an alligator spring clip to the other end of the wire for attaching to a nearby ground.

A better way, still, is to open the tool and replace the cord with a three-wire lead, attaching the ground wire to a part of the frame or shell. Be sure that it is well-insulated from the lead wires. Then the tool can be used with regular three-prong receptacle. This is also a good time to add a longer cord.

When working outdoors, there often is no available ground. You can overcome this by driving a metal rod deep into the ground. These are copper-covered steel rods, ½ in. or more in diameter, and 8 to 10 ft. long. Use with extra heavy wire, at least #8 gauge, that is attached to the rod with a special rust-resistant clamp.



Examples of labels on electrical equipment approved by the Underwriters' Laboratories for the protection of the using public.

It Pays to Be Code Conscious

By complying with these standards you can assure yourself of a system that is essentially free from hazard

IN ALL electrical work, the National Electrical Code is the guiding light for safe and sane—and legal—installations. The code spells out the methods of work, material to use, and is promulgated by specialists on the basis of long experience.

This code is issued by the National Board of Fire Underwriters, an organization of fire insurance companies and electrical manufacturers. In addition, the Underwriter's Laboratory tests and issues approval for the materials and devices used in electrical work. The well-known *U.L.*-Inspected label assures that the article meets with minimum approved standards, but does not necessarily indicate the quality of the product.

Violations of Code specifications can create serious hazards, may lead to cancellation of a fire insurance policy, and even serve to prevent payment of insurance in the event of loss.

Many municipalities have local regulations which supersede National Code specifications. For example, the code approves certain installations with non-metallic cable, while some cities require BX armored cable or thin-wall conduit. In New York City, non-metallic cable is simply banned and outlawed.

You can obtain a copy of the Code without charge from your utility company or Rural Electrification Administration, or by writing to the National Board of Fire Underwriters, 85 John St., New York 38, N. Y. A sample of some of the information contained in the code is shown in Tables 1 and 2.

Information in these chapters is intended to acquaint you with the workings of your home electric system, give you a better understanding of its limitations and suggest improvements, and to help you avoid abuses that create hazards.

Suggestions are given for proper maintenance, making repairs, and replacing defective devices to keep your system in good working order and save needless expense. For example, exposed wire strands or poor contact of cord plugs causes sparking or shorts which not only blow the fuses but also destroy the receptacle.

The bigger jobs of adding extra receptacles

TABLE 1: Sizes of Grounding Conductor

Rating or setting of automatic overcurrent device in circuit ahead of equipment, conduit, etc. not exceeding (amperes)	Copper Wire No.	Aluminum* Wire No.	Conduit or pipe (in.)	Electrical Metallic Tubing (in.)
20	16**	12	½	½
30	14	12	½	½
40	12	10	½	½
60	10	8	½	½
100	8	6	½	½
200	6	4	½	1
400	4	2	¾	1¼
600	2	0	¾	1¼
800	0	000	1	2
1000	00	000	1	2
1200	000	250MCM	1	2

* Refer to installation restrictions in code.
** Permissible only when part of an approved cable assembly.

or even installing a complete house wiring system can also be done by any homeowner who is handy with tools and takes the trouble to master the correct techniques.

But there are three things you must keep in mind before tackling any changes or installations. These are:

1—Find out whether local regulations restrict or prohibit such installations by the homeowner.

2—Make sure the work you do conforms in all respects with the National Electric Code.

3—Make sure you are thoroughly familiar with the specific job you are planning, before you start.

Permits and Inspections. Regulations regarding electrical work by individuals vary extensively in different communities. Most towns do not have any restrictions or require permits. Some large cities have strict regulations regarding this work, while others require only filing of a description of the work to be done, so that it can be checked to comply with the code.

In New York City, an electrical installation can be made only by a licensed electrician, who must file an application with sketch for a permit on every job, no matter how small. After an inspector checks the job, a certificate of approval is issued. But even in New York City, some repairs by the homeowner are permitted.

But just across the city line, in Nassau County, there are no restrictions on individual homeowner work. The utility companies, however, keep a watchful eye on this matter and help maintain conformance to the national code by inspecting the installation.

The city of Philadelphia allows the homeowner to make the installation provided an application is filed before that describes the nature of the installation.

Most Rural communities do not impose any controls except the REA cooperatives, which issue specifications for safe installations.

Inspection. To be sure of the coverage your fire insurance offers, any electrical installation should be inspected and certified as correctly wired. You may request this certification by the proper town agency, usually the building department, or by the utility company representative. This certification need not be official, if such service is lacking in your community; any formal statement by a person qualified as an authority by background or occupation will be sufficient if it says that he found the work in accordance with the code and that it does not create a hazard.

Now for some rules of your own:

1—Play it safe! Always shut off current before doing any electrical work, by pulling main or circuit fuse.

2—Know exactly what you're doing before you start. Make a diagram of any wiring changes.

3—Use only U.L. labeled materials.

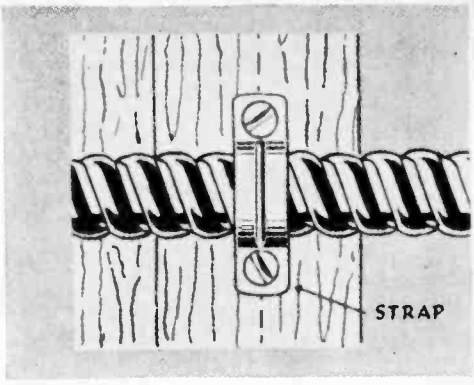
4—Comply with National Code standards and local regulations. No skimping, no shortcuts.

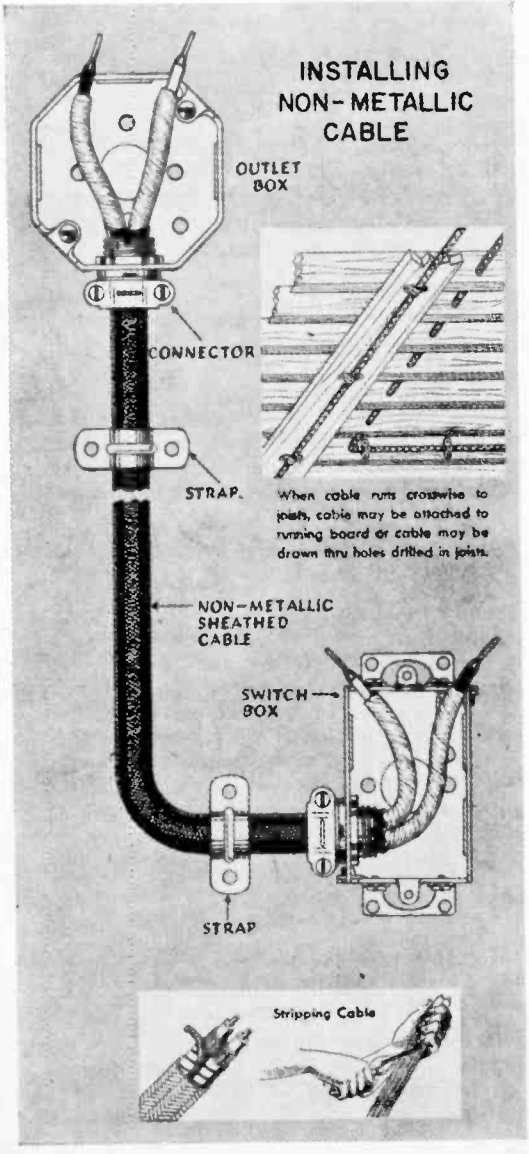
5—Always remember that electrical power which is of such great benefit can also be a great menace if not correctly used.

TABLE 2: Support of Rigid Non-Metallic Conduit

Conduit Size (in.)	Maximum Spacing Between Supports (ft.)
½	4
¾	4
1	5
1¼	5
1½	5
2	5

How to Make Connections





Each installation differs. But

EACH step of an electrical job must meet strict standards of workmanship. This refers to conforming with the codes established by government bodies, municipalities, and industrial organizations, which specify the kinds of wire to be used, the selection and placement of boxes, methods of grounding, types and spacing of supports for devices and cables.

Of equal importance in any electrical work is the technique. This means, simply, doing the job right so it will be trouble-free, long-lasting, and have as good an appearance as the circumstances warrant.

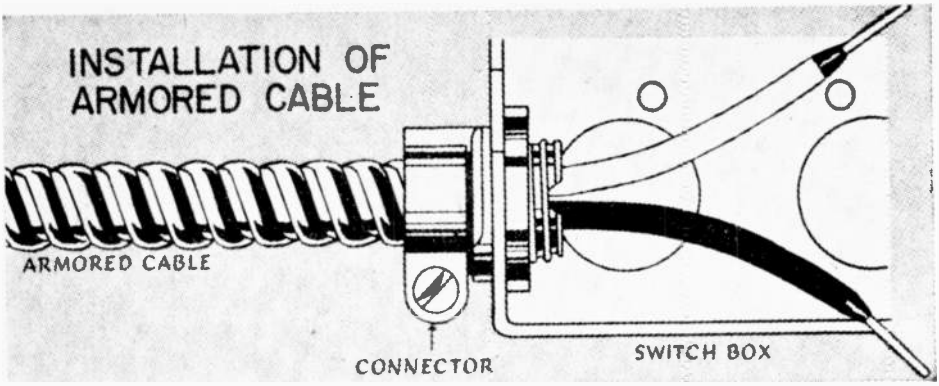
The homeowner who does only an occasional bit of wiring or electrical installation must be on the alert to be sure that every phase of his work is correct, missing no detail and avoiding any shortcuts that will result in an inadequate installation.

If protective bushings are needed at the ends of BX cable, be sure to put them in before going further. Where supporting straps are called for every 3 ft. don't try to skimp with wider spacing. Terminal connections must always be secure, so make sure they are really tight.

With all this, there's plenty of latitude to cope with every possible situation because each installation is somewhat different in location, encumbrances, and the twists and turns. That means using common sense together with tried-and-proven methods to solve individual problems.

Handling BX Cable. Armored cable is broken by making a shallow cut with a hacksaw, across one section of the metal spiral, then twisting to snip the armored covering.

Easiest way is when the BX is on a workbench where it can be held down, but this is not usually possible because the cable must be cut on location or when part may be inside a wall. In that case, the cable is either pulled so it is taut, or wrapped around one leg and held tightly against the knee so



these proven methods will be useful in most situations

you have a steady and rigid support.

Hold the hacksaw at an angle across the spiral. A few strokes of the blade will make a starting nick, then cut just enough to go part way through the metal. It's not necessary to cut all the way through. Twisting the cable armor will snap it off at the cutting place. Be careful never to cut deeply enough to damage the wire insulation.

When measuring for the cut, always allow for at least 8 in. of exposed wire to make splices and connections. This may require two cuts each time. The first includes cutting through the wires to separate lengths of the cable. The second cut is to remove enough of the armor to expose the inside wire for making the connections.

At the second cut, twist off the broken armor. The wires inside have a water-repellent paper wrapping with a bare stripper wire inside the wrapping. Pull this wire to the cut end of the BX and cut it near the end by bending it back over the armor. Then tear off the paper wrapping to expose the insulated wires.

Put a fiber protective bushing at once into the end of the spiral to protect the wire insulation from the sharp edges of the cut armor.

The cable now can be connected into a junction box, which is secured to a wall stud with nails or firmly attached in some other way to a solid support. The box has "knockout" openings on the sides and back. Select the point of entry for the cable, remove the knockout by driving a screwdriver into a corner until the round metal plate is pushed out and can be bent back and forth until it breaks off.

Anchoring the Cable. Some junction boxes have built-in cable clamps, others require separate connectors on each cable that goes into the box. With the built-in clamps, just insert the cable through the knockout opening and under the clamp, and tighten the screw that anchors the cable in place.

Most boxes, however, require use of separate connectors which are in two parts: a threaded bushing with set screw, and a locknut. Slip the fiber bushing part on the cable armor so the protector touches the front of the connector, and with the bond wire bent back underneath. Tighten the bushing screw, then bend the bond wire around the set screw. Push the wires and bushing into the box opening, then turn the locknut onto the threaded bushing. Turn the locknut as far as you can by hand, then give it a few taps with hammer and chisel or screwdriver to make it tight.

Armored cable must be supported with a strap no more than 12 in. from every junction, outlet or switch box, except for concealed runs behind walls where it would not be possible to fasten the straps.

Large staples can be used though straps, and cable clamps attached with screws give stronger support. Straps should be spaced no more than 4½ ft. apart to prevent sag and resist any pull on the cable. Avoid running any cable at hidden places where there is a possibility that nails will be driven through it.

Installing Non-metallic Cable. Strip the sheathing by pulling the built-in rip cord, or with a cable ripper. Allow at least 8 in. of wire for making splices or terminal connections. Fasten the cable at junction and receptacle boxes with a threaded connector and lock nut similar to the type used for armored cable except that there is a clamp across the cable instead of the set screw. When non-metallic cable includes a grounding cable, this must be protected from damage and included in the terminal connections.

This cable may be run through a series of holes in ceiling joists or wall studs, but requires supporting strips (not staples) every 3 ft. Where there is an open run, as across ceiling joists, a supporting board is required

to which the required straps can be attached.

In concealed installations of new work, cable is fastened with straps at least every 4½ ft., and within 12 in. of every junction or switch. This is not required for old work.

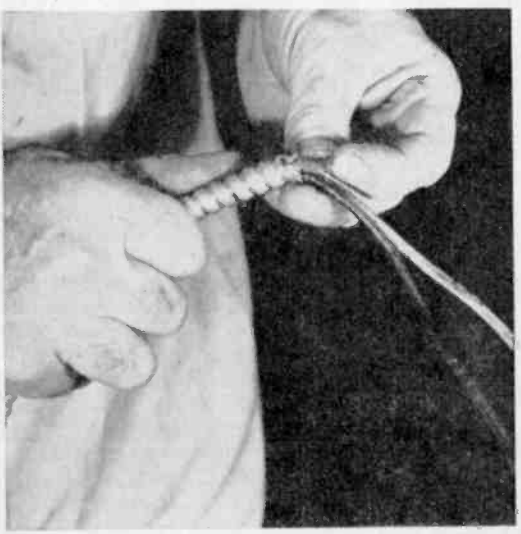
Splicing Wires. The essential first step in electrical work is to learn the right way to splice wires. Two or more cables may enter the same box, and the wires spliced together inside or connected to some device such as a receptacle or light fixture. The insulation is skinned for a distance of 1 to 1½ in. before or after the wires are put into the box. Always allow sufficient length of free wire so it can be conveniently handled.

Wires are skinned most quickly and easily with a wire stripper, or with a pocket knife. Make it a habit each time to scrape the exposed wire with a knife edge to remove any oxidation or bits of insulation.

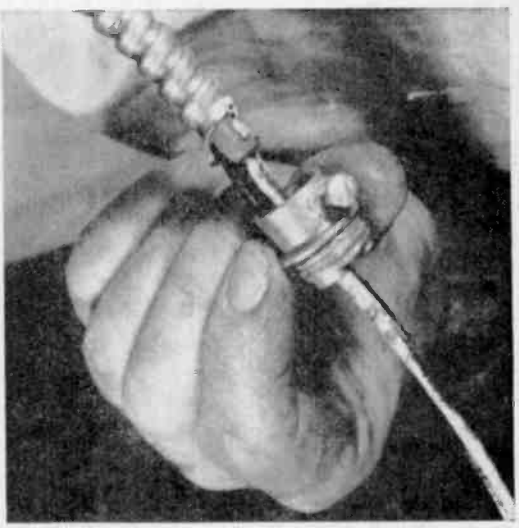
The stripper tool blades are bevelled so they cut the insulation properly at a neat taper all around, rather than straight across which would prevent mating the wires closely in a splice. Adjust the tool for the particular

If bench vise isn't handy, cut through armored cable by drawing it across your knee to get some tension.

Break the sheathing by twisting and bending where it was notched with hacksaw. Pull cord to split paper.



Protect wire insulation from jagged end of the cable by pushing a round fiber washer into the open end.



Connector slipped over cable armor and locked by tightening set screw, will hold the wire to junction box.

wire diameter that you are going to install.

The novice skinning insulation with a knife, usually makes the error of cutting through the insulation straight across, and all around. When stripping with a knife, cut through the covering at an angle, until enough of the insulation can be gripped with your fingers so it can be pulled all the way to the end of the wire. Then additional bevel cuts are made to clear the rest of the insulation neatly.

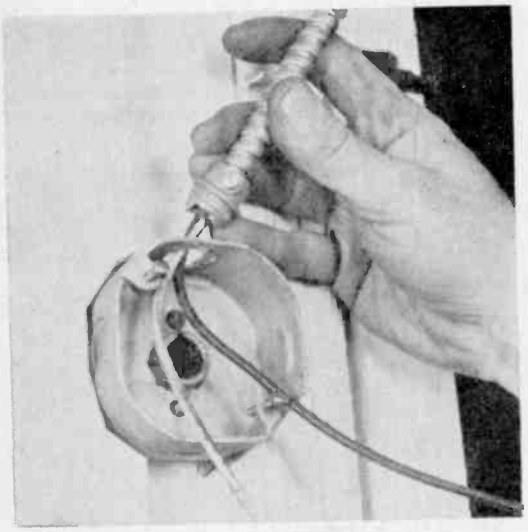
When two wires are spliced, the ends are brought together parallel, then twisted into a tight coil with pliers.

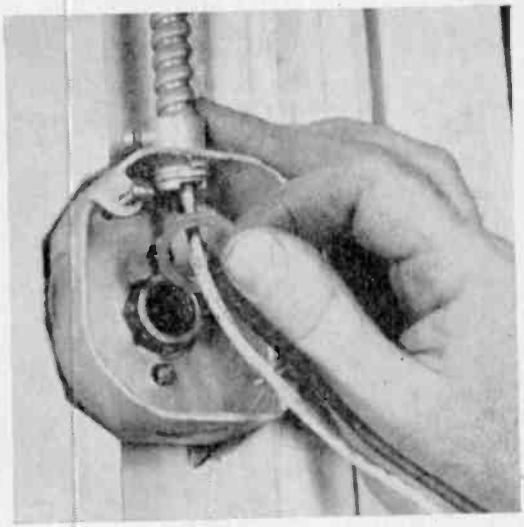
Solderless Connectors. A splice can be joined with a solderless connector. Make sure it is of the right size, for your wire.

These connectors are the same for sizes #14 to #18, while #12 and #10 wires take individual size connectors. Just screw on the connector all the way so it is tight. If the spring coil inside is loose or the connector fails to hold tightly, discard it and use another one.

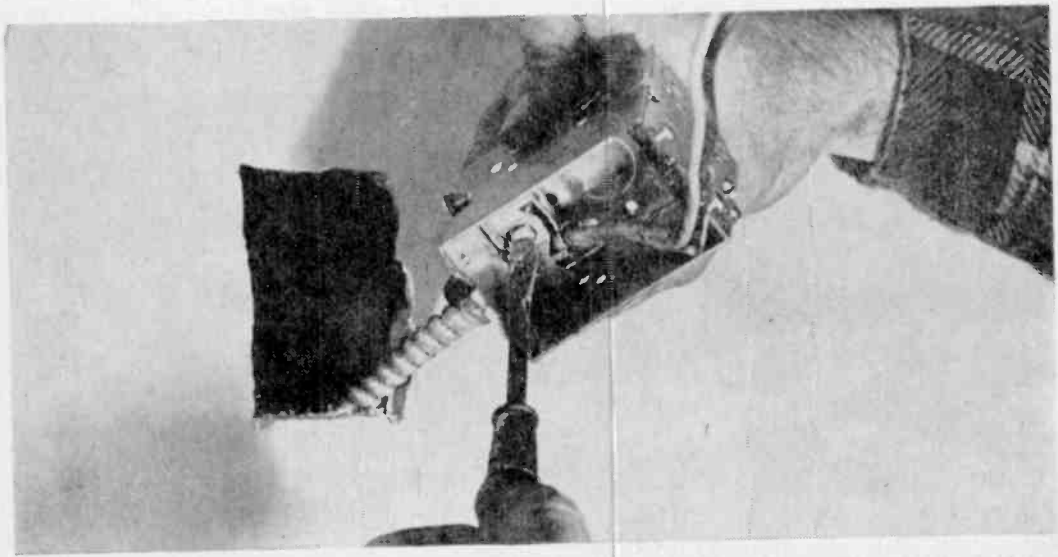
Some electricians prefer to tape up the connector for additional protection, so it won't loosen and fall off due to vibration.

Usual Procedure for securing a splice is to

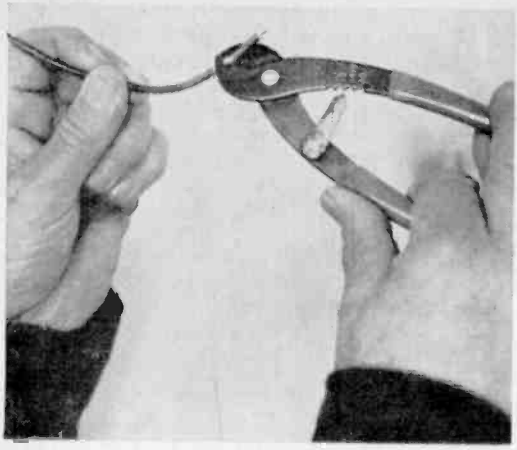




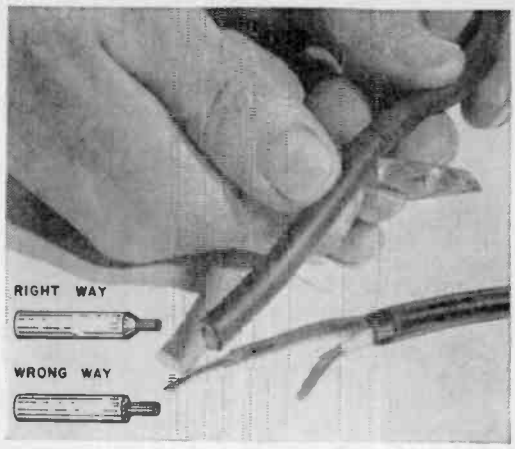
After knockout slug is removed, insert threaded end of connector into the box and fasten with a lock nut.



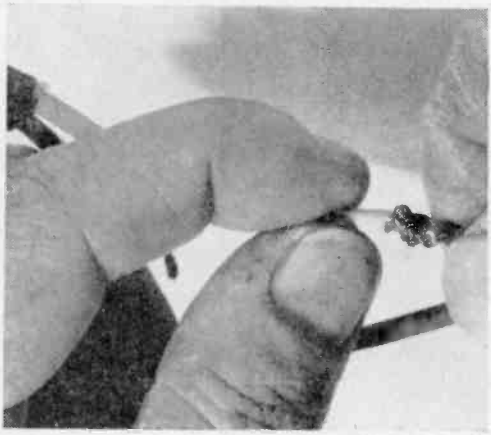
Some boxes have a built-in cable anchor, with a set screw that is tightened over the cable to hold it.



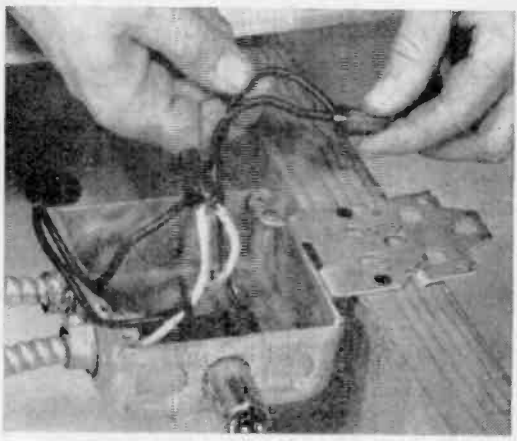
A wire stripper has a series of openings that can be used to cut into insulation without damaging the wire.



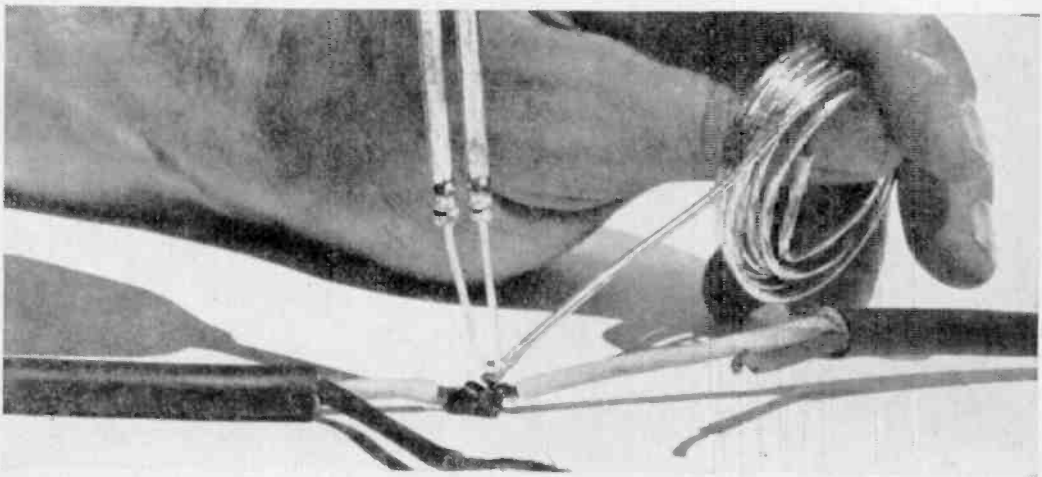
A pocket knife can be used to remove insulation by cutting it at a slant, just like sharpening a pencil.



If wire is made up of many strands, twist into a stiffer unit, then form a tight and solid joint with the ends.



Wire nut connectors are often used on house circuits because they are time savers and do not require soldering.



First coat wires with electrical soldering paste, then heat them so the solder can melt into every crevice.

solder the joint, either by dipping the twisted wire ends into a solder pot, or applying solder directly, after brushing on the flux or solder paste.

Direct soldering should be done with a quick heating soldering gun, heating the wires enough so that the solder flows into the coil. Use of a blow-torch calls for extreme vigilance to prevent a fire.

If it's necessary to use a torch, the small propane type like the BernzOmatic or Turner is handiest and most efficient. No matter which method you use, keep a can of water handy with a small brush and douse any scorched woodwork or insulation by brushing on water.

Tap Splices. When one wire is joined into another at right angles, so that the end of one wire is wrapped around a skinned section of another wire, that is a tap connection and should be made only inside a box, with the cable securely fastened into the box to prevent drag which can break the splice.

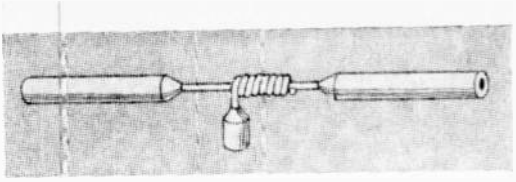
The wire ends should be at least 1½ in. long, and coiled tightly around the other wire for at least ½ in. Make sure both wire sections are cleaned bright. Solder the wires and cover with both rubber and friction tape.

Terminal Connections. When solid (unstranded) wire is to be attached to the terminal screws of an outlet, switch or any other device, there are two basic, and simple, methods of doing it right. Remember that in all cases, the wire is placed on the screw in the direction that the screw will turn for tightening, that is, clockwise. First loosen the screw as far as it goes (usually the screw end is peened so it won't turn completely out).

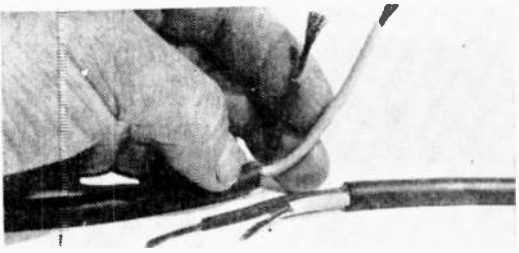
If there is ample length of bare wire, wind the wire around the screw in the right direction, so the insulated part of the wire just clears the position of the screw head. Make an almost complete circle of the screw post, then tighten the screw all the way. Finally, break off the remaining length of wire.

Another acceptable way it to cut the skinned end of the wire so there is just enough length to go around the screw. Form a loop on the end, place it on the terminal screw and close the loop tighter with the pliers so it forms an almost closed circle. Then tighten the screw.

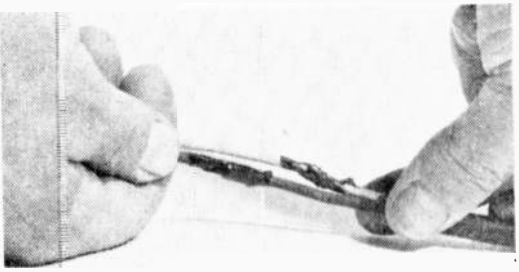
Either way, the wire should be centered closely around the screw so that none of the wire extends beyond the screw head. Also, there should be only a minimum exposed section of uninsulated wire, and no free end of wire dangling beyond the screw. All this means that the wire end is securely fastened and covered, with no chance of causing a short.



Use tap splice for connecting a wire on a continuous wire. There should be no pull on the tapped wire.

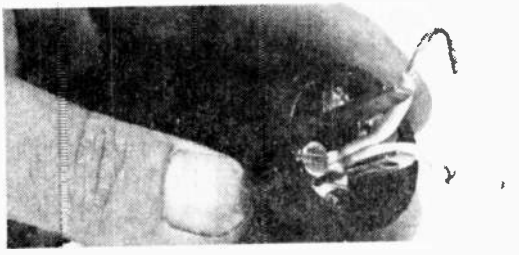


Way to eliminate a bulge at a joint is to cut one end longer than the other and stagger the spliced sections.



After each staggered spliced joint is wrapped, tape the two wires together to form a protective jacket.

Heavy-duty wire can be attached to this screw-type splicer, then connector covered with insulating tape.



A better connection can be made with fine strands of wire by soldering them together so they won't short.

WALL lamps are popular again. Everything from an old gas mantel fitted with bulbs, to ultra-modern Norwegian glass cones, dolls up the walls. Then there are the new swivel-type student lamps, and all shapes and styles in travel lamps, and others that are simply decorative, so it's hard to find a home today without one or more of the lamps.

They're practical and very attractive—except when installed with the lamp cord hanging down to the floor. The right way is to make the line connections with concealed wiring and set the fixture box into the wall. It is also safer because the lamp is more securely fastened to the wall box. It will be more convenient too, if the lamp is controlled from a wall switch near the door.

New Receptacles. Believe it or not, any homeowner will tell you that fully half his "convenience" receptacles are located where they can't be conveniently reached—behind a dresser, cabinet or piano. Many people have difficulty stooping to floor-level outlets, so the new trend in homes is to locate these much higher on the wall so they are convenient.

In some homes, one duplex receptacle is jammed with cords from a radio, clock, and a couple of lamps, while another outlet is not used because it is just beyond reach.

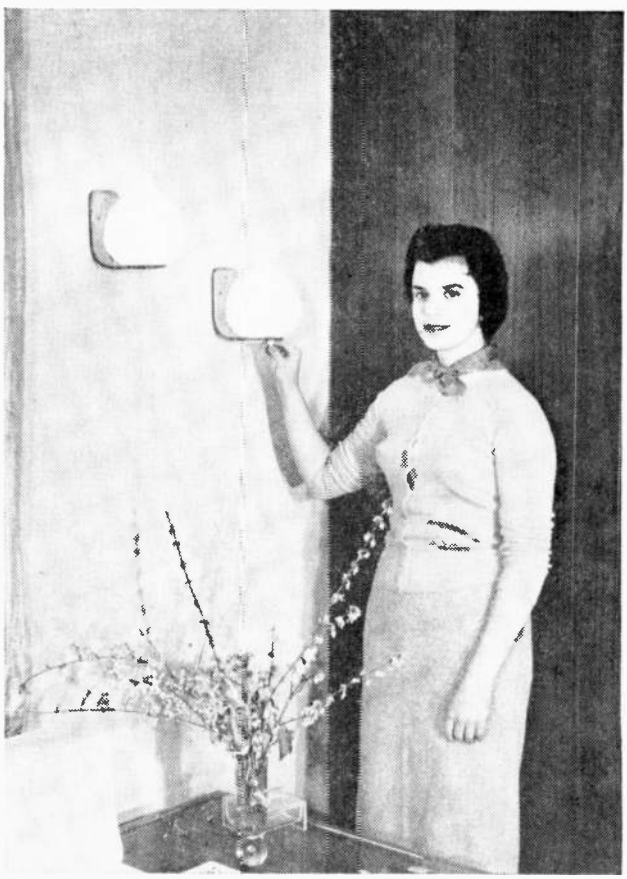
All these situations can be corrected by shifting the position of the outlet. But it makes more sense to just put in an additional receptacle at the desired location, connecting it to the unused one.

Breaking Into Wall. Installation of concealed wires in a room involves breaking small holes in the plaster, or gouging out a channel along the bottom of the wall to recess the cable. The amount of such plaster breaking depends mostly on the distance between the fixture and the nearest receptacle at which the connection is made. The electrical boxes on the wall or ceiling will be completely covered by the fixture plates.

The breaking and cutting of plaster isn't as messy as it sounds—if you go about the job in a workmanlike manner. That calls for moving furniture out of the way, covering the floor with one of the large plastic drop cloths,

Put Outlets Where You Need Them

Modern lighting techniques and use of more appliances means up-dating your present system to satisfy your family's needs



and keeping a cardboard carton handy to catch the plaster pieces so they don't scatter and break. The most important detail is to clean up as soon as possible so the plaster dust isn't tracked around the house.

The wall can be smoothly re-plastered, good as new so the breaks can't be detected.

A more valid objection to making small breaks in the wall for electrical wiring is that they affect the room decoration, as it is difficult to repaint the area to match the original part.

This problem does not arise if the room is scheduled for a repainting or papering, or if the location of the new wall lamp is above a couch or other long piece of furniture that will cover the area. A possible solution is to plan on repainting at least the one complete wall, as any slight difference in shade to the rest of the room will not easily be noticed.

Raising the Outlet. Suppose you want to place the new outlet just above the old one, but higher on the wall so it is above an obstructing cabinet, or is more convenient to reach. You'll need a steel outlet box (get the plain type, without mounting bracket), and a length of two-wire #14 cable to reach between the old outlet and the new location, plus at least 2 ft. of wire for stripping and clearance. Also, get a pair of metal box supports.

At the position of the new box, tap the wall to see if it is over a stud, and shift the position, if necessary, to avoid the obstruction.

Outline the template on the wall with a soft pencil, and drill ½-in. holes at the four positions indicated. Use a brace and bit, or carbide-tipped drill. These openings will allow entry of a fine-tooth keyhole saw or a hacksaw blade for cutting through the plaster. Wrap electrical tape around the end of the blade for hand grip. Apply pressure on the forward stroke of the blade only, to minimize chipping, and hold a small carton underneath to catch the dust.

The entrance holes allow cutting in both directions from the corners. Stay on the guide lines, or a little on the outside so the opening won't be too small, otherwise a lot of filing or chipping will be required. Plaster is rough on hacksaw blades so reverse the one you are using when the teeth wear down. Periodically position the box to make sure you are making the opening just large enough for the box.

Now go to the outlet box below. Disconnect the current by removing the fuse on that circuit. Loosen the screws and pull out the receptacle with its wires.

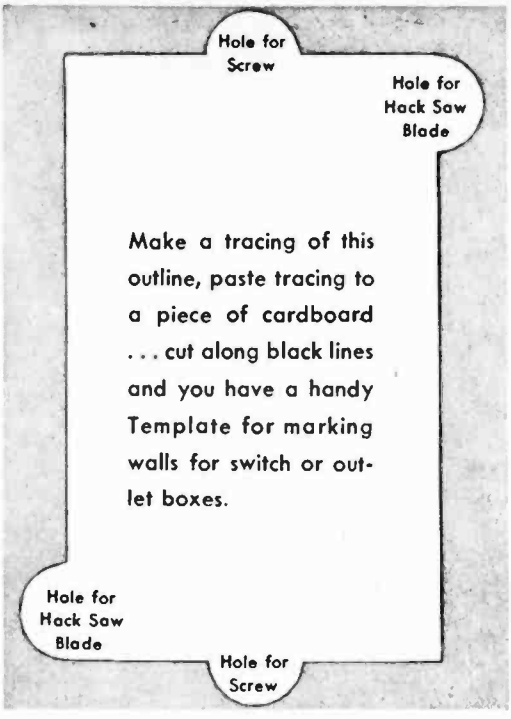
Use a chisel to cut a hole in the plaster at the desired height above the old receptacle. Make the opening large enough to reach in with your hand. Drop a weighted cord from the wall opening above to see that there is no obstruction that will interfere with the cable coming up. Pry out one of the top knockout covers in the lower box.

Use Armor Cable. Strip the covering or armor from the cable, at least 8 in. from each end, and also skin and scrape the wires for making the terminal connections. Feed the cable down from the top. Bend the top of the wire down over the hole or tie it with the string so it will not slip between the walls. If the box does not have cable clamps, tighten a connector on the end of the cable.

Put the cable into the top opening and carefully move it around until the wire slips into the knockout opening of the bottom box. On the inside of the box, either secure the cable in one of the built-in clamps, or turn a locknut on the connector. Now you can connect the cable wires to the old receptacle.

Drive out one of the knockout slugs in the new box and put a connector on the cable. Bring only the wires part way into the box, bending them sharply so they will not slide down. The armored cable is not connected to the box at this time to allow more flexibil-

You can end extension cord clutter and install new fixtures by putting outlets where you need them. There are several methods you can use to do the job; no special tools are needed for installation.



Outlets Where Needed

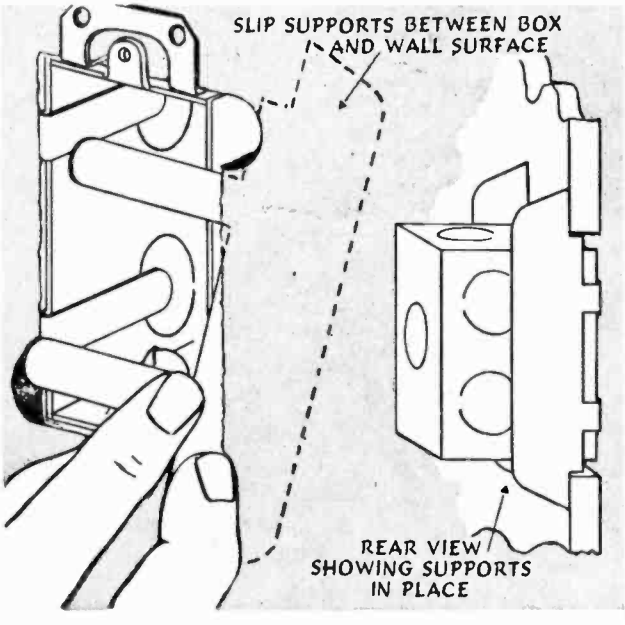
ity for inserting it into the wall opening. Hold the box at an angle with the wires inside so the lower part enters first, then push the box all the way so the thin screw plates are against the wall.

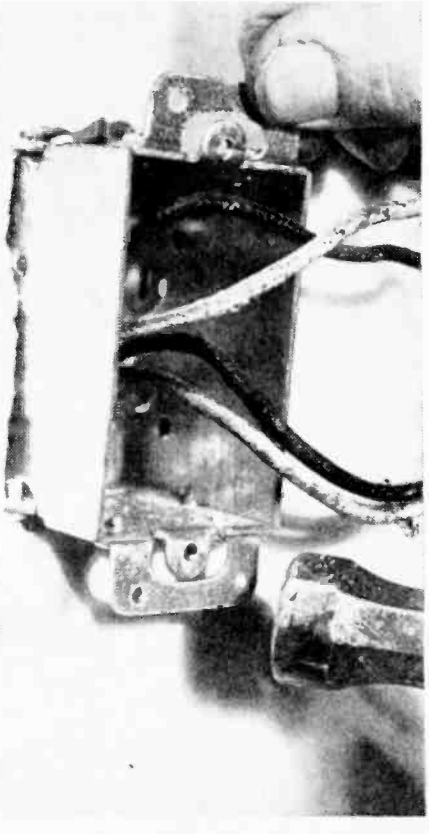
Secure the box with a metal support bracket on each side. The illustrations show how the support is inserted, by tilting it to clear the extension at one end, pushing it up far enough so the lower end can slip inside. Manipulate the bracket until it sets tightly against the inside surface of the wall, then bend the ears around the box.

Now you can pull in the wires to draw the cable through the hole and into the connector clamp. Tighten the clamp or locknut, on the cable connector.

Connections are made to the receptacle terminals, then the wires folded back out of the way so the receptacle can be pushed and locked in place.

Repairing the Wall. The hole made into the wall can be patched neatly by doing the work in several stages. Cut a backing piece of wire lath, or hardboard drilled with a number of ½-in. holes, and larger than the size





Allow enough of an opening around the receptacle box so brackets can be inserted without chipping plaster. Bend the metal tabs back with fingers.

of the opening. Tie a string at the center, then insert the backing sideways into the hole and pull on the string to center it so it presses against the back.

Mix up a batch of fast-setting plaster and apply over the lath and into the edges against the old plaster, leaving a rough surface that is not quite flush with the wall. Be sure to moisten the edge around the opening so the plaster will form a better bond.

When applying the plaster, press it firmly against the backing plate so the mixture goes through the openings. Hold the string taut for a few minutes until the plaster sets enough to hold in place. Allow to dry thoroughly, then use slow-setting plaster mixed with lime for the finish coat. When the patch begins to set, smooth it with a damp sponge, or wide paint brush, working back and forth lightly until it is free of gouges or streaks.

The edges around the new receptacle can be touched up with plaster, filling the small openings left by the hacksaw holes. This plastering also will help make the box more secure. The receptacle cover plate will hide the newly plastered area.

New Outlets. When a new outlet is wanted at a different location, the installation varies from the above. Connection is also made with a cable from an existing receptacle, but this time the cable must pass a number of wall studs along the way. There are two ways to make this modification.

One way is to break a small hole at both sides of each wall stud and cut a narrow groove in the plaster between these openings. By making a notch in the stud you can recess the cable even more. This way the cable can run behind the wall between the studs, and plastered into the grooves in front of the studs.

The thickness of the plaster determines whether it is necessary to notch the studs a bit for recessing the cable. The number of holes required will depend on the distance that the cable must go, but it is quite an effective method and the damage is not extensive particularly since these holes are made at the lower part of the wall. Careful replastering will completely eliminate any signs of the work.

Cable connections with the old and new outlets is done in the same manner as above. Because holes are made along side the studs, the new box can be attached directly to a stud with nails or screws. In this case, the knockout opening should be made at the bottom of the box, and the receptacle mounted above the line of the cable.

An Alternative is to remove the baseboard along the wall and make a channel in the plaster with a chisel. Lay the cable in this channel and the baseboard replaced as before. At locations of the boxes, a larger hole can be made to permit bringing the cable up through the back of the wall to the box position.

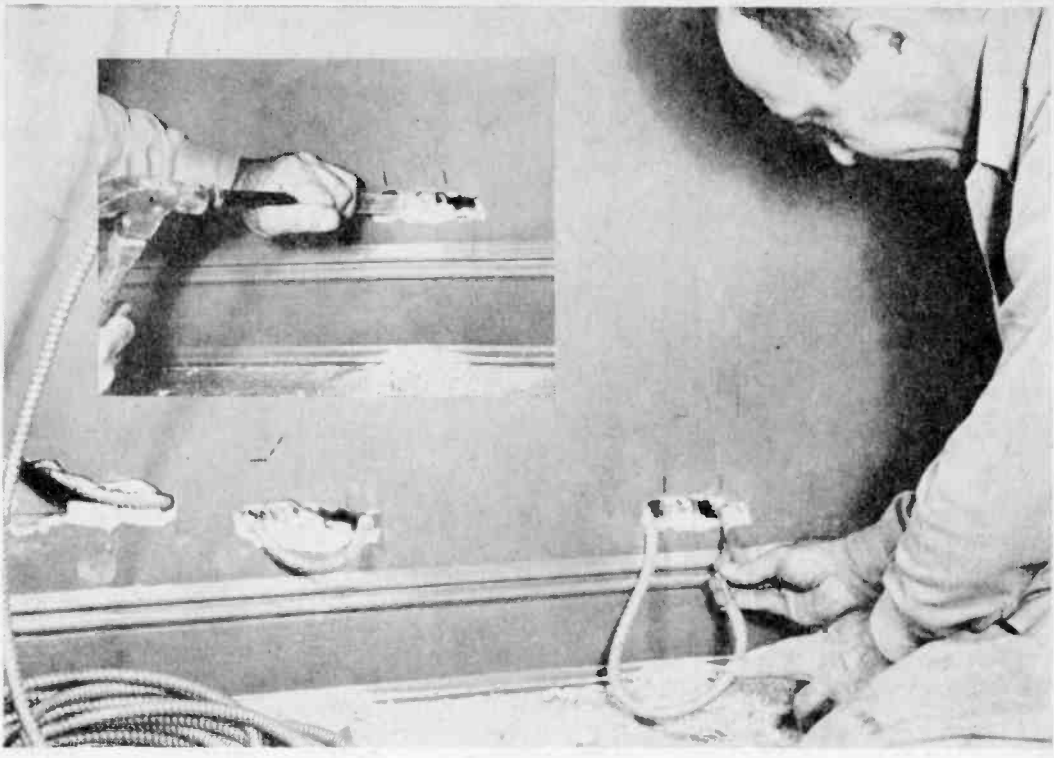
Removal of a baseboard, however, may be more complex than it appears, particularly when the adjacent baseboard overlaps the ends. Also, there is usually considerable chipping of plaster and paint. In this case these problems are minimized because repairs can be made easily by replacing the baseboards.

Back-to-Back Receptacles. One quick and easy way to double up on your electrical outlets is to extend them through the wall into adjacent rooms. Thus, for every outlet on an inside wall, you can have another in the next room, at a minimum of effort and no damage to the walls.

Connections are made either with a small jumper cable locked into the back knockout openings of both boxes, or better still, with two wire leads through a short pipe nipple joining the boxes.

Locate the exact position of the new receptacle in relation to the original one by careful measuring on both sides of the wall. Then mark the outline of the hole by tracing around the guide template. Drill and cut the hole, enlarging the opening a little more this time to be sure that the boxes are aligned.

Ceiling light fixture box has a long bar that's attached to rafters. Cable is clamped by tightening the fitting screw that compresses the armor jacket.



Mark the position of your wall studs, then cut a narrow groove through the plaster and notch wall member.

Outlets Where Needed

After pulling out the first receptacle, open knockout holes at the back of each box. A threaded nipple should span the space between them, with an extra ½ in. on each end for locknuts that will hold boxes together.

Once the nipple is installed in both boxes, just use short jumper wires, #14 gauge, between the outlet terminals. The new box will need no further fastening. Be sure to allow enough wire.

Ground Connection Important. In all receptacle installations be sure to retain the continuous ground. This is automatic with BX cable and steel boxes, but when nonmetallic cable is used, a third grounding wire should be connected to the box.

Also, keep in mind that most new appliances and tools, even of the smallest type for household use, will be coming through with the U-shaped ground plug that can be used only with receptacles designed for that purpose and connected to a ground wire. It is advisable to have these three-wire receptacles on all appliance circuits, and also one in every room in the house.

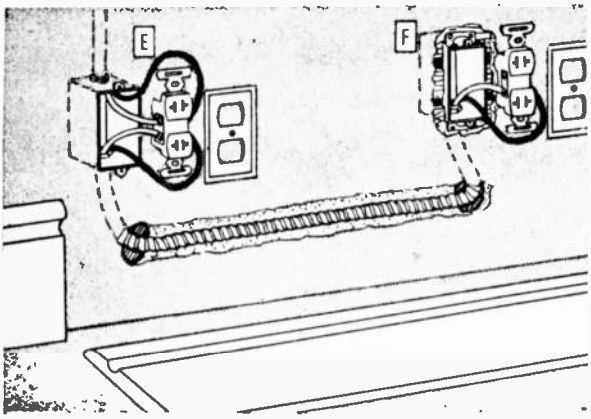
Wall Lamps. Wall lamps can be serviced with current from nearby receptacles. In some situations, there are receptacles that are of duplex type of which one of the outlets is controlled by a wall switch. If this is lacking, and a wall switch is desired, then the wall light sometimes can be connected directly to the switch. One hitch, though, is that this switch must be wired with a neutral lead wire, rather than just a switch leg from some fixture.

Installation of the wall bracket follows the same procedure as was used for a receptacle. That is, a steel box of the same type is placed into the wall at desired height (usually 66 to 70 in. above the floor) and connection made to the power feed from an outlet or switch.

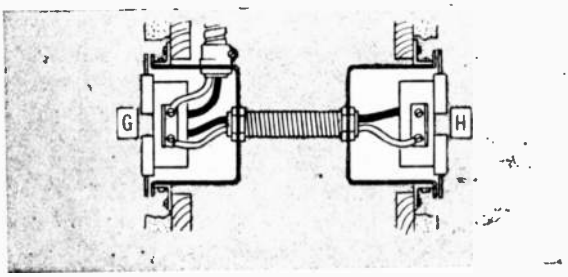
The wall light is supported by a metal strap which is fastened to the wall box with the two screws that go into the ears of the box. A nipple goes into a threaded hole in the strap, and the fixture is held with a cap nut on the nipple. The cable wires are spliced to the fixture leads with solderless connectors.

Connection to a wall switch is not difficult, if the switch is at the same stud line as the fixture, but will require additional wall openings if it is to be located at another part of the room.

Install the switch box at the selected place in the same manner as described for receptacle boxes. A cable goes from the switch to the original outlet box, and another cable from the outlet box to the light fixture.



Once cable is extended from the old outlet box (E) to the new one (F), fill damaged areas with plaster.



A short length of cable is all that's necesssary to connect old box (G) to new outlet (H) in same wall.

Connections are made this way: white wire from lamp to the receptacle, black wire from switch to receptacle. Splice the black wire from lamp to the white wire of the switch (paint or code the ends of this wire black for "hot lead" identification). These connections can be made with solderless connectors, or the spliced wires soldered together and wrapped with electrical tape. In any case, be sure the connections are secure and that all exposed wires are completely covered Carefully fold the wires into the outlet box. The switch will now control flow of current to the newly attached wall lamp.

Ceiling Fixtures. Various types of ceiling lamps are used throughout the house. New designs for brightening the kitchen are a great improvement over the old. A current favorite in living rooms and dens is the recessed "high-hat" spotlight for reading, over the piano, for the bridge table, and general lighting effects. In the dinette, a number of travel types are very effective.

Such lights can be installed with concealed wiring by one means or another. In one-story homes, the cables can be brought in most easily from above through the attic. In homes where this is not possible, the cables must be snaked up through the walls and inside the ceiling along the joists. Also, all ceiling lights should have separate switches, so that means extra work. You can even have a three-way switch for that light. It will take a bit of plaster breaking here and there but that can be patched and painted without difficulty.

Locate the spot for the ceiling lamp, select the best place for the wall switch, and also pick the power source from the most conveniently located receptacle.

In addition to the required length of cable, the box for the switch and other required supplies, you will need an octagonal box with a hanger strap, which is nailed across the joist. This strap has bends to go around the box.

Make Openings. Punch a hole in the ceiling where you want to locate the fixture. If you find a joist at that position, locate the lamp a few inches to the side of it. Remove some plaster under the joist, and cut a narrow slit in the ceiling so the strap can be put in. Hold a carton under the ceiling to catch the plaster dust, and dispose of this waste frequently so it doesn't pile up.

If the joists run counter to the direction the cable will take, make additional holes in the ceiling, one on each side of every joist, chopping away the plaster under the joist, until you reach the end wall. If the joists run the same way, only one hole at each end will be enough to snake the cable through.

At the corner, make a deep indentation so the BX can be recessed and covered with the plaster. Also, notch the corner joist sufficiently so you have an opening into the space between the walls.

Now run the cable down inside the wall through the ceiling corner opening. If the outlet box is directly below, punch a hole to reach above it for fitting in the cables from both the light fixture and the switch. Follow the procedure already mentioned for connecting terminals.

Connections. Next step is to fasten the fixture and connect the cables to the fixture. Snake the cable along the ceiling, under the joists, to the fixture. Put a staple or support bracket into the cable at each place where it crosses under a joist, and also at the corner where it drops down inside the wall.

Strip the cable wires and splice them to the fixture leads with solderless connectors. Each fixture has slightly different hanger equipment, for which instructions are usually given by the manufacturer.

Fixture attachment is made usually by turning a stud into a threaded strap, which is attached to the ceiling box with screws into the corner ears. Some fixtures are mounted with small screws into threaded holes of the box. The "pan" type fixtures use a threaded nipple through which the glass shade is pushed up flush against the fixture plate.

Surface-Wired Outlets

A convenient way to put outlets where you need them without the trouble of behind-the-wall installation

Plenty of convenience outlets are needed to provide current for the many appliances used to prepare meals.

HOW exasperating it is that so many electrical receptacles are located behind heavy furniture, or too far from the place where an appliance is to be used. Toaster, mixer, roaster and blender vie for the one or two available kitchen outlets; the electric blanket cord just won't reach the wall receptacle; alarm clocks can't be placed where they are most visible and convenient.

Long extension cords are frequently used, but there are serious objections to these: the trailing electric wires are unsightly and can be tripped over; the insulation tends to become frayed and may permit the wires to short. More important, such cords usually are of smaller gauge than the house wiring of that circuit, so that if high-wattage appliances like an iron, or portable tools are used the wires become overheated because of the increased resistance and create a fire hazard.

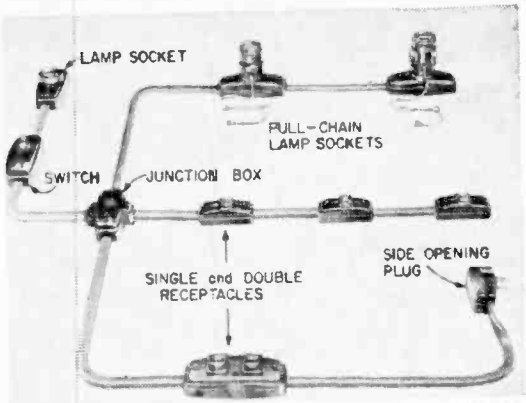
Types of Systems. Several companies have introduced flexible surface extension wiring systems providing an easy way to add new outlets, sockets and switches. The semi-rigid cables, covered with an extra-thick thermoplastic jacket, or a surface runway sheated in a plastic or metal duct meet the requirements of the electrical code and are UL approved.

With the General Electric surface extension wiring system, installation is greatly simplified by the special pressure-lock terminal connections, so no splicing of wires is necessary. The cable is cut to length, the insulation stripped from the ends of the wire for about 1 in. (exact length is shown by a guide on each of the devices), and the bare wires are inserted into the marked terminal openings where they are securely gripped by powerful spring action.

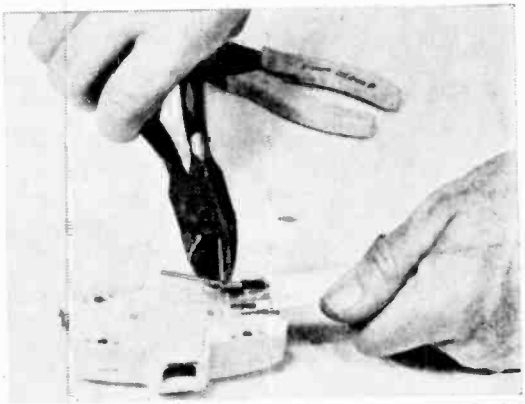
Another surface wiring system comes in short sections or "links" of rigid plastic-coated cable or duct, with the electrical outlets or cap plug already fitted into each link.

The plug-in link has an interesting feature in that the plug swivels so the cable may be placed horizontally, or in vertical position to reach the baseboard or other mounting sur-

Extra outlets, switches, lights, etc. can be quickly installed with channel ducts that have snap-on covers.



Typical arrangement of fixtures that can be used with surface cable. Entire group can be switch controlled.



Gage on back of fixture enables you to cut off the wiring to exact length so it can be pressure fitted.

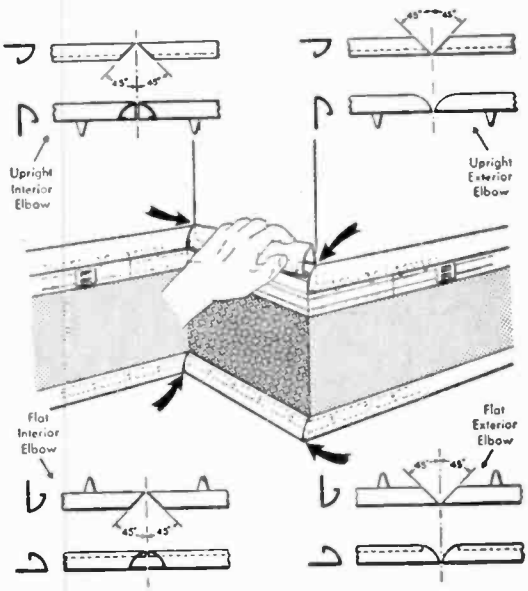
face. The cable is attached with screws to any wood surface, such as door frame.

Next are the plain continuation sections, which are sufficiently flexible to bend around corners. Finally, there are the links containing three outlets in each section.

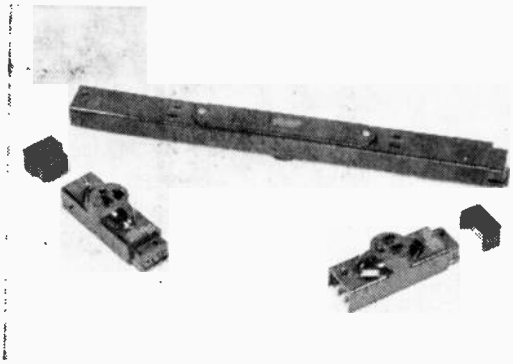
One Important Caution. Having a row of extra convenience outlets does not increase the capacity of your home electric system and should not be an invitation to overload the circuit by using several appliances simultaneously.

Actually, there's little likelihood of this in actual practice. Discretion should be exercised because you now will have more receptacles, but still the same single circuit that can carry just so much of a load and no more.

The extra outlets will be a great convenience as they will make it unnecessary to pull the plug from each appliance to make room for using another one—rather, several can be kept ready for use at all times without interference. Receptacles formerly hidden behind



PLUG-IN STRIP



Short lengths of Pierceway duct have receptacles with separate safety ground outlet for appliance and tools.

Surface-Wired Outlets

cabinets are now more accessible.

The major brands of similar surface extension wiring are: G.E., Sears Roebuck, Snapit Power Strip and Montgomery Ward.

Installation. One system includes single and double outlets, wall switches, lampholders with pull chain, and their connecting plug, which goes into a nearby outlet. The nearest possible receptacle should be used. This flexible cable can be shaped as needed to run it along the baseboard into corners, around doors and windows. Special nails are driven between the wires into the wood baseboard and door frame to hold it in place.

Where the first outlet is to go, cut the cable and strip the ends. Break open one of the terminal entry covers. Lock the wires into one end of the receptacle, which is then attached to the wall. A second knockout opening at the other side of the outlet permits continuing the cable to the next location for another receptacle. Thus there is a short run of cable between each device.

Provision is made for disconnecting the cable terminals when necessary by inserting a screwdriver into a covered opening, and pressing down on the locking spring to release the wires.

A peculiarity of this cable is that the wires can slide freely inside. Thus, when the cable is bent along its narrow edge, one of the wires becomes lengthened or shortened; watch out for this when you measure for cutting, otherwise the wire will not be of correct length.

It's best to make all necessary bends before the cable is cut, and retain that position until the wires are fitted into the terminals where they are secured.

The switches are a helpful feature, but remember that they are located directly in line with the outlets, so cannot be used to control an individual appliance unless it is at the end of the line. You can, however, use a switch to control the entire array of outlets by placing it in the line before the outlets. This is desirable to prevent children from playing with the appliances.

Surface Wire Ducts. The wider use of heavy electrical appliances, particularly window fans, air conditioners and space heaters, poses a need in many homes for more and better-located plug-in receptacles to eliminate overloaded electric cords.

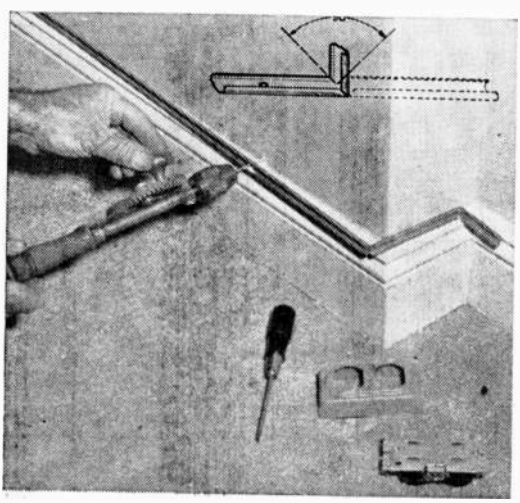
Generally, the use of these appliances requires more adequate home wiring in the form of heavier service wires and additional circuits. In fact, some air conditioners and heaters function efficiently only on individual circuits.

But in addition to this, there is the problem of how the wiring is to be brought to various locations in the home. New concealed wiring means breaking of plaster walls.

There is, however, a completely effective and inexpensive way to extend electrical outlets and light fixtures without damage to the walls or the room decoration. The surface runway system of the National Electric Co. (2 Gateway Center, Pittsburgh 22, Pa.) has metal ducts which consist of a flat metal channel into which the wires are laid.

Special fittings make it easy to connect the molding to present receptacles, switches, junction boxes and ceiling lamp canopies, and to join inside and outside corners. The metal channels are neatly covered with a snap-on molding.

Advantages. There are many important features to this surface raceway system. The molding can be installed so it won't detract from the appearance of the room. This



Cut the metal channel to length and make the necessary bends before drilling the holes for Rawplugs or screws.

is done by running the molding directly on top the baseboard; when painted to match, it will be hardly visible.

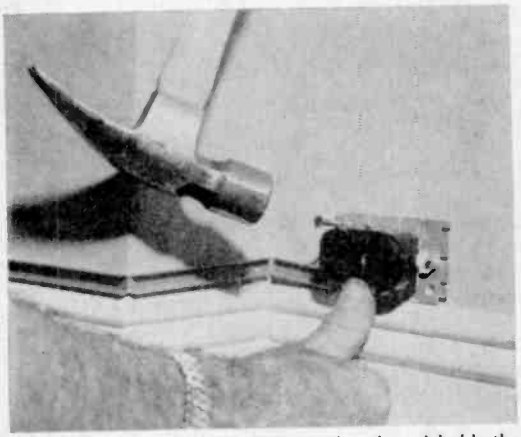
Another advantage is that it permits installations on masonry walls, such as in an enclosed porch built onto the house, for adding ceiling lights and outlets. Standard wiring would involve breaking through a finished wall from inside the house; with metal moldings the wiring can be run from an outlet near the floor to any required point.

There are a large variety of fittings available to meet almost any condition. Special elbow caps fit over the mitered molding at inside and outside corners; couplings connect the metal strips; adapters allow fitting the molding to any type receptacle or switch box. There is even a low-cost miter gage for exact cutting of the duct and molding with a hacksaw to fit corners.

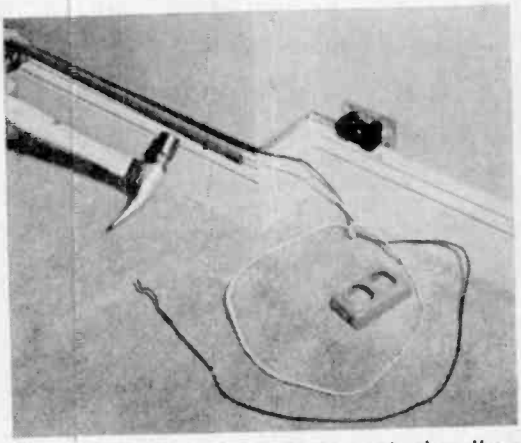
Where to Start. Installation is quite simple and speedy. Work starts at an outlet box where the cover is removed and the receptacle taken out, after the fuse is pulled on that circuit. The old receptacle is discarded for a new one with three twistouts. A special extension plate is fastened to the old wall box, the molding base is inserted under the tongue of this plate, at side or bottom as required.

Run the duct to the new outlet position and install the new outlet box, which is either recessed into the wall or fastened to the surface. At corners, miter the ducts by cutting into the flanges with a hacksaw and bending the back.

Now go back to the original outlet, connect the wires to the terminals as marked, and lay in the wires to connect with the new receptacle. Finish by snapping on the cap molding, starting at one end of each strip and pressing the molding toward the other end. The 90° elbows are snapped over the corner openings, and the molding is ready for painting to match the walls.



Drilled plate attached to wall over baseboard holds the surface receptacle. Plate can cover old outlet opening.

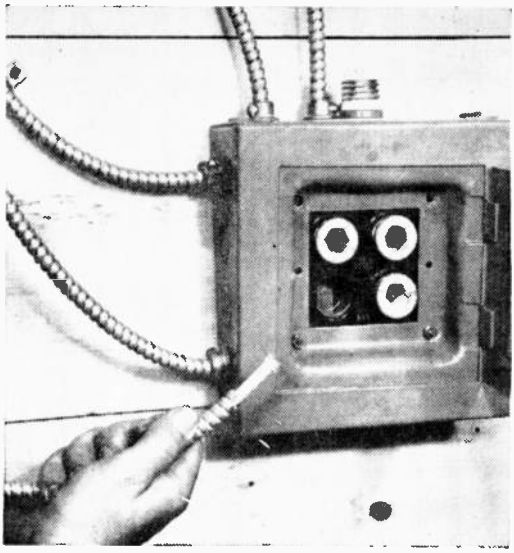


Wires are placed into duct and cover put in place. Use a third wire through the channels for a continuous ground.

Plate will cover the opening once wires are spliced. Corner cap snaps over the metal channel for a neat fit.

Lamp holder has a special plate to which surface fixture is attached. Paint channel to blend with ceiling.

Add extra circuits to your present system by installing a four-fuse sub-panel that's attached to main cabinet.



Adding a Circuit

Increased demand caused by more appliances can be supplied by tapping reserve power

IN MANY homes the electric service was planned for future expansion of the branch system and not all the circuits that could be used were installed. Where this is the case, you can tap off additional circuits to handle the load of newly purchased appliances.

A quick look at your main circuit panel will tell you whether there is reserve power that can be utilized. If there are any empty fuse sockets, that means that those terminals in the box are not in use, either because no wiring had been connected to those terminals, or there is a "dead" circuit that's been abandoned.

Also, look to see if there is a burned-out fuse in any of the sockets, because it is possible that an "empty" was covered that way. You can distinguish a burned fuse visually by the blackened color under the glass, and the fact that the thermal strip inside has parted or burned away.

Another way to check for unused circuits is to count the number of circuit cables entering the sides of the box (in addition to the power feed cable from the main switch) and compare with the number of fuses or circuit breakers.

You may find that the box has provision for 12 circuits, but only 10 cables enter the box. Unless they are already taken by three-wire circuits, two additional branches can be tapped. This is based on the assumption that the right size panel box was installed originally, conforming to local power company or REA requirements.

Parts of the System. Before coming to conclusions about the possibility of having additional circuits, you should know the arrangements and parts of the electric system. The service entrance is the power feed from the utility company which may come into your house through overhead wires, or through underground conduit in some cities.

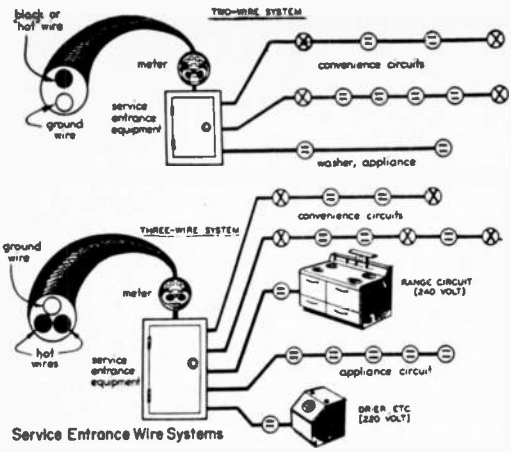
The utility company lines end at the meter. From there on, the system is part of the house. Wires from the meter may go through a separate main switch box which also contains a main fuse that is of the correct ampere rating for that service.

Then the power lines go into the circuit box, sometimes called the fuse panel, or cabinet. In modern installations, the main switch and fuse are part of the circuit box, so the separate switch and fuse box are eliminated. The circuit box has a number of fuse sockets or circuit breakers, each intended to serve an individual branch circuit.

A 60-amp. box has from four to six fuses, while a 100-amp. service has from eight to twelve fuses. Homes with electric ranges and electric water heater may have 150 or 200 amp. service, with up to 24 circuits.

Another factor determining the total number of branches is the "size" of the circuits, or rather the purpose for which they are used, whether for lights and small appliances, or for major appliances and heaters that draw considerably more wattage.

With these considerations in mind, you can tell whether there is room for putting extra circuits into the panel. If there is any doubt in your mind, get in touch with the utility company which has a record of the type of service installed at your house.



Service Entrance Wire Systems

Adding a Fuse Cabinet. The wiring in your home may have been badly planned to begin with, resulting in inefficient distribution of the power. There may be only one circuit in the kitchen where there are a number of appliances. In addition to the refrigerator, some of them simultaneously are in use like a toaster and skillet, while other circuits to the bedrooms are used only for a few lights. You could correct this to some extent by redistributing the load with an extra circuit if it is installed in conformity with National Code standards and local ordinances.

The new circuit won't add a bit to your total electric capacity, but can help prevent special overloaded situations. In the above case, a separate circuit for the refrigerator may make the present wiring in the kitchen more reliable, prevent blowing of fuses.

If there are just six fuse plugs, and all are in use, you will need an extra box for the additional branch. A small box for surface mounting, with two fuse plugs, should be purchased. This is called a sub-panel and costs about $5.

The switch panel and sub-panel should be close together and joined with a short pipe nipple through knockout holes at the sides. The wires run from the switch panel through the nipple to the fuse lugs and the circuit wires connected at the terminals.

Mounting the Box. The sub-panel box must be separately attached to the wall, or to the same board that holds the main panel. Pry out the knockouts in both boxes, get a pipe nipple to fit the opening and long enough so there is about ½ in. of thread on the inside of each box.

Usually, there is ample clearance inside the boxes, but check on this first to select the best knockout position in the main box so the nipple can be easily joined on the inside with a locknut. Remember to use bushings on the nipple threads. Avoid making any extra holes in the box beyond the ones needed for the actual connection. Strip the enamel on the box around the holes so there will be good ground contact for the nipple locknuts.

When the box is mounted, shut off the power by pulling the main fuse. This may be the blade type, held in copper spring catches, and can be gripped at the center and pulled out. As a safety measure, it's a good idea to stand on a rubber mat or wood plank and avoid touching anything with the other hand.

Use #12 wire for an appliance circuit. Measure the wire beforehand to correct length and strip the ends.

Making Connections. When the boxes are solidly joined with the nipple, slip the wires through. First connect them to the fuse lugs, then make the connection in the main box. The terminal connections are just as simple as any other, except that utmost care should be exercised to get the wires on the correct lugs. That is, the white wire on the common ground (neutral) side, and black wire on the "hot" side.

Also, avoid changing the wires of the existing circuits in the box, and be sure not to touch the service entrance wires if the main fuse is in the same box, as they would be "live" even though the fuse is pulled. Go over the terminal connections to make sure they are tight.

Replace the panel cover and turn the main switch back on. The fuse plugs in the new box now have current and are ready for connecting the new circuits. If you want to test them, just screw a light bulb into the sockets. Don't leave the sockets empty, but rather put in burned out fuses right away.

For connecting an appliance circuit use #12 cable. Make the outlet box installation first, working back toward the fuse box. This is the general practice in almost all electrical work. Connect the wires into the appliance outlet box, then run the cable back to the panel box. If possible, use a continuous run of cable without splices.

At the fuse box, with power shut off, bring the cable through a knockout opening, lock it in tightly with a connector, and make the connections to the terminal lugs. Replacing the fuse and turning on the main switch puts the circuit into service.

Snaking Wires. The big task in circuit wiring is getting the cable to the final location. That's easy enough when connecting an outlet in the basement laundry room for a washing machine, as the location is probably not far from the fuse box and there is no need for concealed wiring. Even appliance wiring for a kitchen is usually without complications because the cable is simply brought up through the basement ceiling behind wall cabinet or the sink.

But it's a different matter when bringing

wires to an upstairs bedroom for an air conditioner or to the living room or den where there can be no breaking of walls.

The basic technique is snaking wires through the walls, or wherever there is the slightest opening. Cables can be brought from the basement all the way to the attic for a cooling fan, by fishing it up along the plumbing soil stack.

A Fish Tape is the chief tool in the electricians' bag of tricks. Also known as a snake, it is used to find the trail and pull wires inside walls, through floors, along the joists, and through long runs of conduit.

This tape is a tempered flat steel wire, 1/16 x 1/8 in., comes in coils of 50, 75 and 100 ft. lengths, and is sold at electrical supply stores at $1.65 to $3.70 depending on length. Ordinary steel baling wire sometimes is a satisfactory substitute, though it lacks the springy temper and stiffness that straightens out the tape after it hits an obstruction.

Before using the tape, make a loop at the tip so the wire won't snag, and to form an eye for threading the cable wires. As the tempered steel may snap when bent, the end should be heated red hot with a torch or over a gas stove. Some tapes come with a knob at the end for use with a special "eye ball" ($1.15).

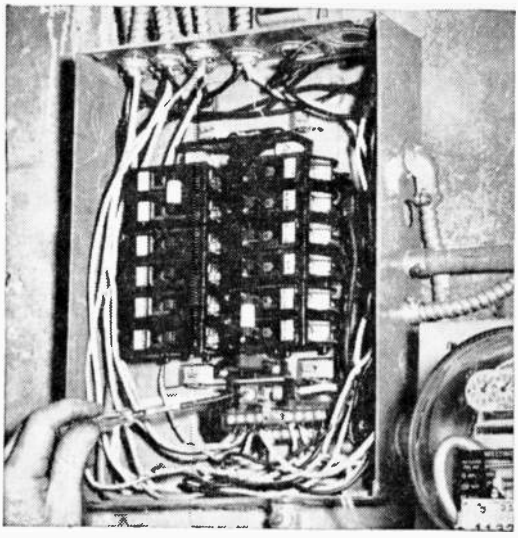
A drill bit extension is also valuable for drilling through from floor-to-floor, or where there is unusual thickness. A bit extension is 12, 18 or 24 in. long, with a square chuck at one end for clamping the bit shank. The other end is fitted into a standard drill brace.

Because the extension chuck is 5/8-in. dia. at its largest part, the bit used with it must be at least 1/16 in. larger to permit the extension to follow through in the hole. This extension is sold at hardware stores and the price varies from $1.75 to $4.80.

Fishing Tricks. Fishing for an opening inside walls is slow work and may exhaust your patience unless you know there's a good chance to get through. The "light test" gives encouragement to keep at it. For example, if you need to push the snake a long way between beams, place a drop lamp or flashlight at the far end of the run; a glimmer of light at your end is a sign that the way is clear.

When the tape is stuck because of a sharp bend in the wall or other obstruction, it sometimes can be brought in by sending a second tape from the other end to help pull it through. One of the wires is rotated while it is moved back and forth until both hooks catch, then one tape is pulled back carefully, bringing the other with it.

If the snake is blocked by a "cat" or header in the wall, the position of the obstruction is found by sticking a bit of electrical tape on the snake at the point where it enters the wall opening. Measuring the length from the marker to the end of the snake will show where to cut into the wall and notch out the header to clear the way.



Use utmost care when connecting wires to fuse lugs to be sure they are attached to the right terminal.

Snaking cable takes patience but

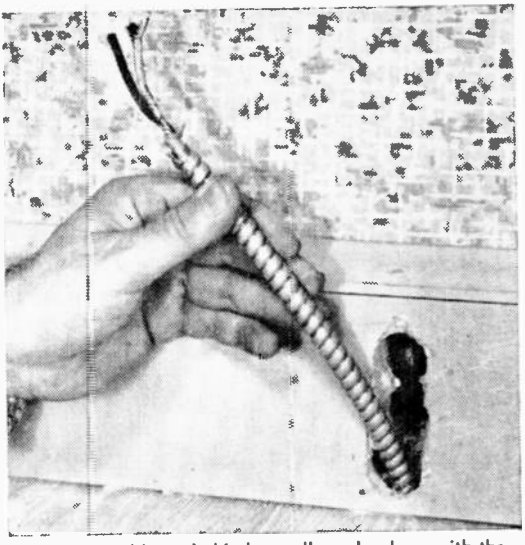
Make a Safe Tie. When the tape reaches its objective, it must pull the wire cable after it. There may be tough going around curves and through small openings, so the cable must be securely fastened.

Strip about 12 in. of armor off the cable to expose the wires. Both wires go part way through the tape hook or eye. Bend one wire back and wind it tightly around the other cable wires, then bend the others so they can be turned around the steel tape. Another way is to separate the cable wires, putting one through the tape hook from one side, the other wire from the opposite side. Then bend both wires back and wind them tightly around the pair of wires. For extra security, bind the tie with electrical tape.

Fishing Holes should be located, when possible, behind baseboards, moldings and inside closets. Small holes are punched in room walls and ceiling only as a last resort and then damage is minimized.

For example, if the wall is papered, the section of wallpaper is peeled back so it can cover the patch later. To do this, make several slits with a razor blade, then moisten the paper with a sponge until it softens and can be peeled back. Ceiling holes are easy to patch. The paint usually is white, or a light color that can be matched. At the very worst, painting of an entire ceiling is simple.

First place to consider snaking the fish tape is alongside the soil stack where an opening usually exists.



Bringing cable up behind a wall can be done with the least damage by drilling outlet holes in baseboard.

is not as difficult as you may have believed

Valuable "coverup" scheme is to place a new outlet at the location of a fishing hole. The opening is planned at a logical place for the outlet, which will be part of the new circuit wiring. This method helps also to simplify the installation, as the outlet serves as a splice box and thus a shorter stretch of the cable need be used from the circuit box.

The new outlet also offers opportunity to distribute the circuit for additional purposes. This outlet connection should meet the requirement that cable splice boxes be solidly mounted and always accessible.

Additional ways to bring cable across a room are under the floor and along the basement ceiling (in a one-story house), or between the floor beams, if they run in the right direction. In the first method, holes are drilled up from the basement through the floor plates at both receptacle locations. The cable then is run underneath between both points.

Running the cable across the floor joists is a bit more tricky, as this requires lifting a length of finish flooring, by slicing the tongue at both sides, with a 3-in. flooring chisel. A narrow strip of sub-floor can be cut with a portable saw to recess the cable.

Second Story Job. One way to get a new circuit cable to a second-story bedroom is to start from the top—that is, up in the attic alongside a vertical plumbing line, such as the vent stack. House framing and flooring do not fit closely at such installations, so there's a chance to snake all the way through to the basement. This takes patient fishing, but is frequently successful.

Once the tape gets through, pull the cable all the way up to the attic, then lower it inside the wall to the floor below through a hole in the top framing plate, and fish it out through the new outlet opening.

The standard procedure for bringing cable floor-to-floor is to drill inside the wall.

Directly below the second-floor opening, drill up from the basement into the first-floor plate. Now push a snake up from below, and send another down from the second floor.

This is a long-shot chance, but the tapes must stay within the narrow area between two studs and if one of them loops over, the other hook will slip under it and ride along until the ends meet and hook together.

If repeated efforts fail, the situation is solved by opening a hole for an extra outlet. A cable through the bottom hole is spliced inside the outlet box, from which a second cable is easily brought upstairs.

A chief obstacle may be a header in the wall frame. The choice then is to shift operations to the next stud, which may be clear, or to open a hole and notch the header.

An alternative method for reaching the upper floor, particularly for homes with metal lath or solid walls, is to bring the weatherproof wires outside the house, through rigid conduit. The conduit is passed outside a hole drilled in the exterior wall above the foundation sill, then bent in the upper story. Bending is done with a hickey. Conduit is available in 10 ft. lengths, and joined with couplings. The wall openings must be properly caulked and conduit securely strapped to the wall. Pull the wires through with a snake after the conduit is installed.

Low Voltage Remote Control Switches

They represent the ultimate in convenience and, perhaps, the greatest forward stride since T. Edison's pioneering

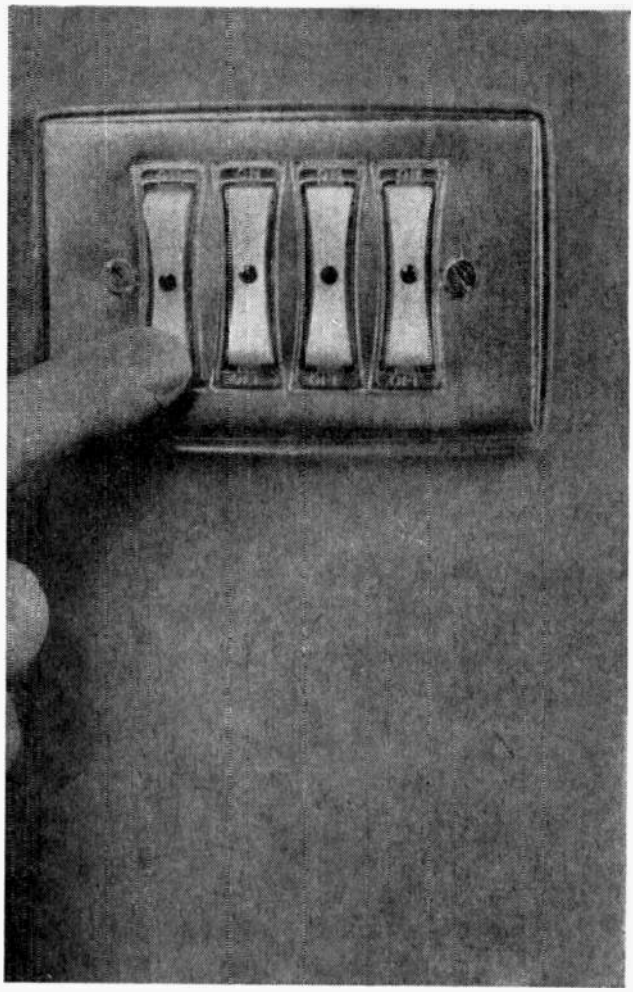


FIG. 1. Remcon high-fashion switch for use with firm's low-voltage equipment.

BY installing low-voltage remote-control switching, you equip your home with one of the latest developments in wiring and acquire absolute safety and convenience for better electrical living. Some home-owners are reluctant to tackle low-voltage switching, but it is really a simple thing to learn

Remote control is a system of wiring in which the *control* of the circuit is remote from the switch. This may be at the fixture or outlet. It in no way affects the conventional method of wiring so far as installation. circuitry or load calculation.

Low-voltage remote-control wiring systems use two circuits: the regular 120-volt circuit which feeds lamps and convenience outlets and low-voltage (24 volts in the GE* and Bryant Electric** systems; 6 volts in Amprobe Instrument Corporation's† Remcon) in a control circuit for the switches which actuate thermal or magnetic-control relays that complete the 120-volt circuits.

Let's consider the 6-volt thermal-relay system known as Remcon.

This method's greatest asset is simplicity of design. It consists of a relay to operate the fixture, connected by 3-conductor low-voltage wire to as many switches as desired. Figure 2 shows a simple way of demonstrating what happens in the Remcon method.

Low-voltage switching is, perhaps, the greatest stride forward in switching since Edison's pioneering. It makes practical for the first time adequate switching at low cost.

Application. The low-voltage wiring system is of particular value for the older home

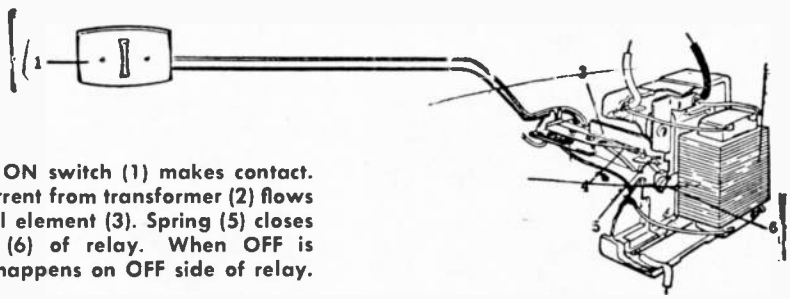
* *GE Wiring Device Department, 95 Hathaway Street, Providence, Rhode Island*

** *Bryant Electric Company, Box D, Bridgeport, Conn.*

† *Amprobe Instrument Corporation, 630 Merrick Road, Lynbrook, N. Y.*

FIG. 2. The switch that operates the light in a conventional hook-up is, in effect, moved to outlet box as at right above, eliminating need for clumsy armored cable.

Because Remcon relay which replaces conventional switch works on 6 volts, cable is replaced by light low-voltage wire that is connected to momentary contact switch.



When pressed, ON switch (1) makes contact. Low-voltage current from transformer (2) flows through thermal element (3). Spring (5) closes 120V contacts (6) of relay. When OFF is pressed, same happens on OFF side of relay.

because low-voltage wires can be installed with less mess and damage to the walls than can regular cable wiring. It simplifies the procedure for brightening up basement and attic rooms. It is thus a natural for the do-it-yourselfer because the wiring is safe to handle and install and complies with the National Electrical Code. (Check your load requirements.)

At present low-voltage switching is going mostly into luxury custom-built homes. But wider use is indicated as the cost of conventional layout with a limited number of switches may actually exceed that of complete low-voltage relay wiring.

While the low-voltage system involves extra cost for the relays and control switches, the total installation may be more economical because it does not involve handling and splicing of conventional cables and eliminates the expense of wall boxes, connectors, etc. Wiring for the switches may be done by the home-owner after the other electrical work is completed at considerable saving.

A good opportunity to get acquainted with low-voltage wiring presents itself in the often-neglected need for proper closet lighting. This is a good spot to try a simple installation. All needed material other than the wire comes in a package known as Remcon's RCL-2.

Closet installation of the RCL-2 is accomplished this way (Fig. 5). Box is mounted at closet fixture location and 12-volt line run to it. Knockout is broken out of box for insertion of relay later. A ¾-in. hole is drilled in door jamb for the switch. Two-conductor #18 wire is brought from door jamb and pulled through knockout in box. Two wires projecting from cylinder of relay

Low-Voltage Remote-Control Switches

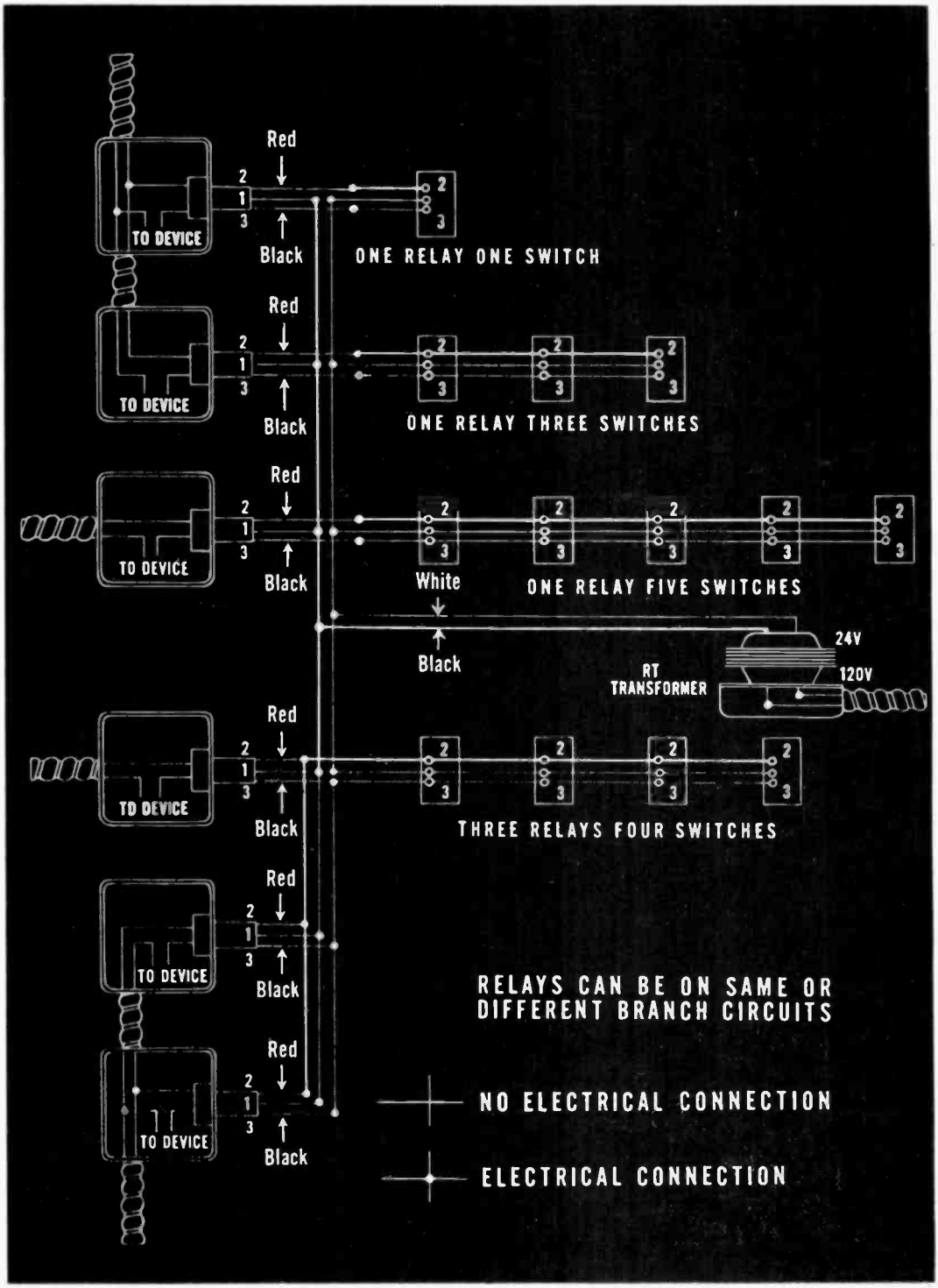


FIG. 3. Suggested relay and switch arrangements using Bryant equipment.

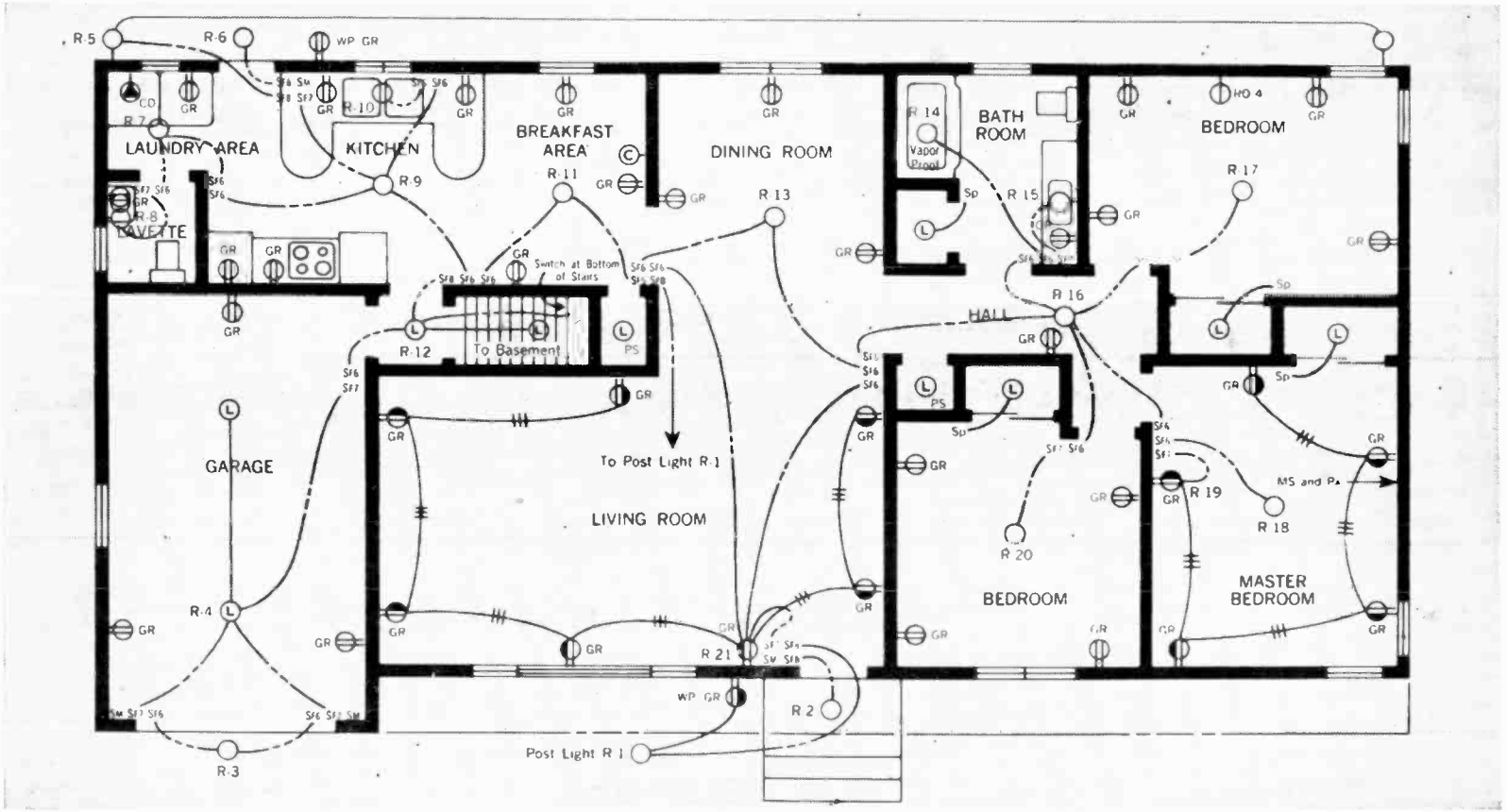


FIG. 3-B. Any portion of this layout can be used as a guide for a GE remote-control installation. A deluxe system, it permits turning ON room lights from every doorway. It also permits switch-controlled split outlets in living room and master bedroom, master-selector switch at master bed. It will also light grounds, selected rooms from bed.

Low-Voltage Remote-Control Switches

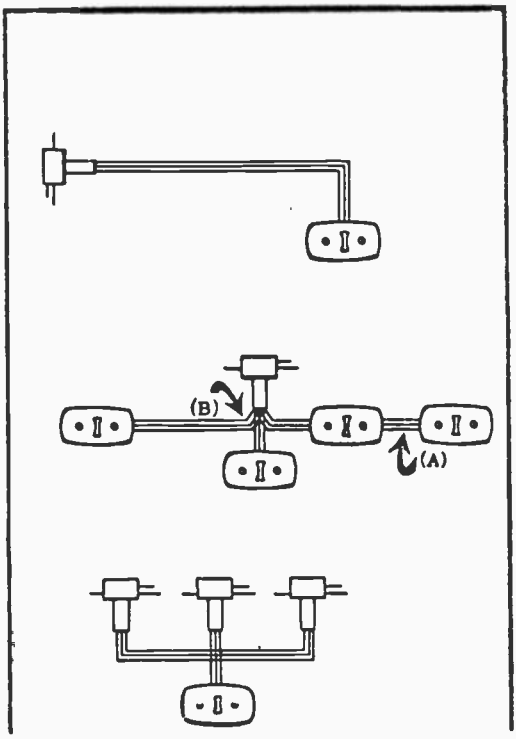
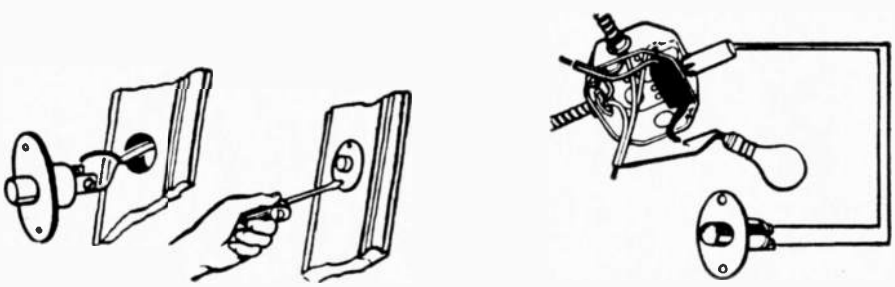


FIG. 4. At top right is the basic hook-up, one relay and one switch, easily installed by the home-owner. One relay can be operated by as many switches as you wish to install, center. You can have many switching points on one relay and you can add a switch to existing switches (A) or relay (B). You can control up to 5 relays from one switch.

FIG. 5. Box is mounted at closet fixture and 120-v. line run to it. Two-conductor #18 is strung from door jamb to box and connected to wires from cylinder of relay.



The two-conductor #18 wire is connected to switch which is then inserted in door jamb and secured with screws. Relay is then connected to 120-v. line as per diagram.

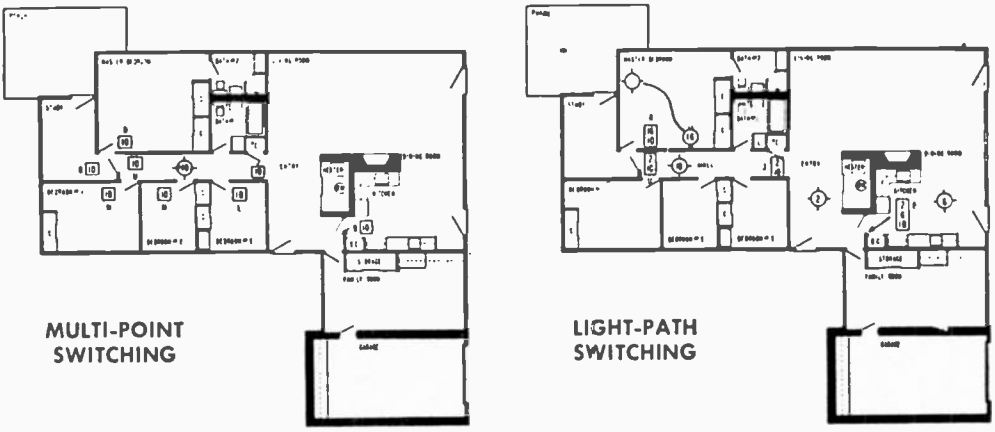
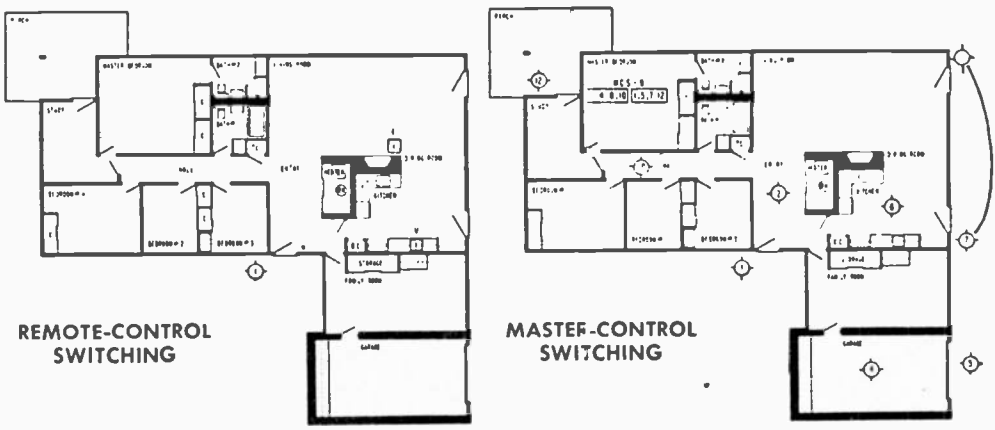


FIG. 6. An encircled 2 is relay # and position—controlled fixture; encircled 3 is same for convenience outlet. Numbers following A are relays operated from switch position, the letter.



are connected to the 2-conductor #18 and relay is inserted through knockout. The two-conductor #18 is connected to the switch and switch is inserted in ¾-in. hole and secured with screws. Relay is connected to the 120-volt line. That's all there is to it. No need to chop away part of the door jamb to install an outlet box. The ¾-in. hole holds the Remcon closet-light switch.

Aside from the closet-light installation, there are many other areas where a single relay may be involved. One that occurs is the post light in front of the house.

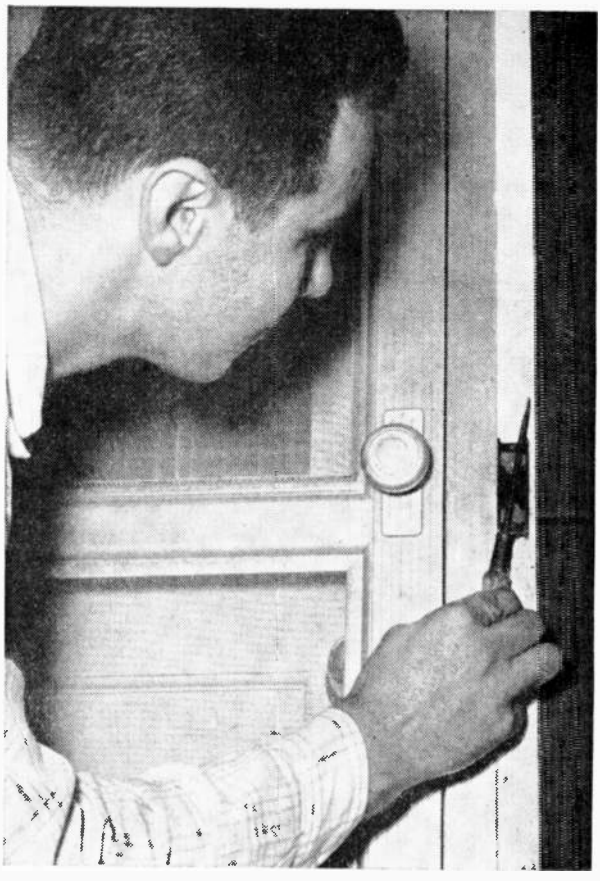
When such lights are installed after the home is completed, the work is simplified by using a low-voltage relay since it eliminates running a cable to the front door and cutting in a switch box. You only have to cut a hole large enough for the low-voltage switch and fasten it with two screws. If it's too difficult to pull the #18 wire through the wall, you can run it along the baseboard or bury it in the surface of a plaster wall.

Low-voltage remote-control switching permits you to control outside lights from your bedroom. It affords the convenience of light-path switching so you will never have to fumble around in a dark room or retrace your steps to turn lights off. You merely turn the lights on ahead of you and off as you depart.

A good switching and lighting installation in the home entails both science and art. Individual tastes, decor, color and need will all play a part in its development. But by keeping the basic goals in mind any homeowner can plan a low-voltage switching and lighting plan suited to his family's needs. Few home improvements can provide greater convenience, comfort and satisfaction with minimum investment.

DOOR BELLS

Fixing them is a simple matter and they can be converted readily to a paging system for every room in the entire house



IT TAKES so little effort to keep door bells and chimes in top condition that there's no reason to let them get out of order. Your door bell works on a low-voltage electric system so it is perfectly safe to make any necessary repairs, and there's no need for worry about great electric shocks. The bells work on either a bank of dry-cell batteries or get power from a transformer which is hooked into the house electric system and carries a safe 6 to 16 volts (Fig. 2).

Causes of Failure. Door bell trouble, in most instances, is caused by faulty push buttons or loose connections. The push button contacts tarnish or corrode due to dampness and general oxidation so they fail to make electrical contact.

It is possible to clean and sand the contact metal, but it's hardly worth while when a new button costs as little as $1 and will give service for many years. Continuous ringing of the bell indicates that a wire from the push button has become shorted. This calls for close examination of the line to discover the point of contact and taping up the wires.

Sometimes the bell itself may be defective, or the cause of trouble is a broken wire (Fig. 3), or the insulation is frayed sufficiently so it is shorted. A plastic-coated wire is less likely to short out. The power source, whether dry-cell batteries or low-voltage transformer, may be at fault. The diagram (Fig. 4) shows a typical doorbell hookup.

Test the Push Button. Remove the two small attachment screws and pull out the button with the wires attached. (If the button is the round type that's recessed into the door frame, carefully pry it out with a screwdriver at the edges.) Remove the two wires from the terminals, bending back the wires so they can't slip back into the hole and get lost.

Scrape the wires down to the bright metal, and cross them so they make contact. If the bell rings, that is proof that the button is faulty. Replace with a new one, which can be installed in just a couple of minutes.

Either wire goes on any terminal. Make sure that the wires are scraped clean, the terminal screws tightened all the way, and

FIG. 1: Converting from a bell or buzzer to chimes requires a larger transformer for higher voltage.

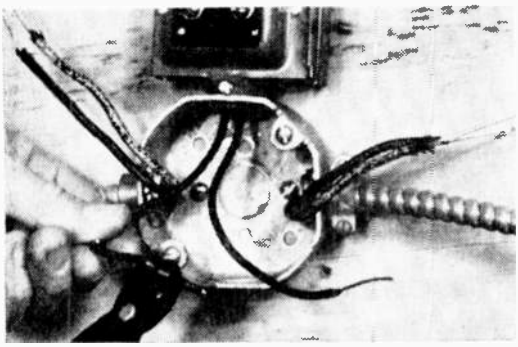


FIG. 2: Attach transformer to junction box by removing knockout and splicing leads to main line.

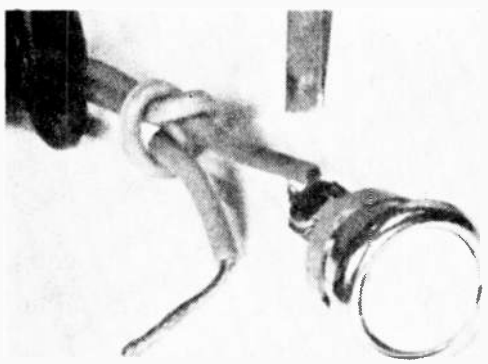


FIG. 3: Frayed or broken wires can cause continuous ringing, erratic operation, or complete failure.

the wires are reliably reconnected in place.

The round flush-type button (Fig. 3) is press-fitted back into the hole, or may be replaced with any type of surface button that is large enough to cover the ¾-in. hole in the door frame.

Check Bell or Chime. In many homes the bell is connected with two or more push buttons, such as at the side and front doors. Try the second button, and if the bell rings, power source and bell are okay. The trouble then lies with the wiring. If the bell does not ring, one way to test it further is with a pair of good 1½-volt dry cell batteries, fitted with a couple of short bell wire leads.

Or you can remove the bell and take it to the transformer where the two short wire leads from the bell are touched to the low-voltage terminal of the transformer. If the bell fails to function, replace it.

If the bell or chimes has three or more wires, for hookups from different doors, before removing any wires make sure to code each one so they can be replaced in the proper order. Best way to code the wires is to wrap a piece of masking tape around the insulation, and write the designation on the tape.

Is Power Source Okay? Door bells are powered either from a group of dry-cell batteries, or a low-voltage transformer. Batteries go "dead" after a period of time and must be replaced. Transformers rarely give any trouble except that they may not deliver enough current to handle additional accessories put into the line which need greater voltage, in which case a larger transformer should be substituted.

To test the batteries, cross the terminals with a short wire. If there is no spark, the batteries have definitely lost their charge and should be replaced with new ones.

You may decide at this point to change over to a transformer, which ranges in price from about $2.50 to $4. If you intend to install chimes now or later, you should put in a 16-volt transformer like the Edwards #992 which has an automatic thermal cutout that disconnects the current if there is a short in the wire.

The transformer has two leads that are connected to the house power source, usually at the fuse box, but the simplest installation is to plug it into any convenient receptacle by attaching a standard plug to the primary leads and drawing the bell wire from its low-voltage terminals.

Broken Wires. When the push button, bell, and power source all check out okay, the trouble then must be in the wires. These may be broken, a splice separated, or the insulation worn and shorted. Trace the wires where they are exposed examine and rework all splices, even when covered with tape. Al-

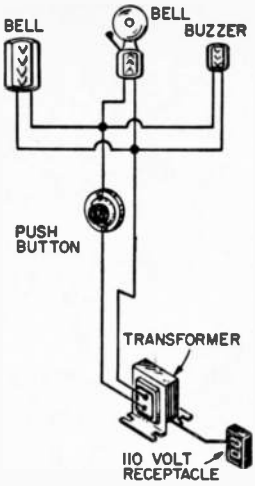


FIG. 4 EXTRA DOORBELL

FIG. 4: Wiring shown for extra bells. Install new bells where wanted, bring two wires from each bell, splicing into the push button and transformer lines for required hookup.

FIG. 5: Sick bell hookup. Pendant button rings call bell, brings response with sounding of chime or bell. Three wires can serve for double installation, connected to central bell and button location in kitchen.

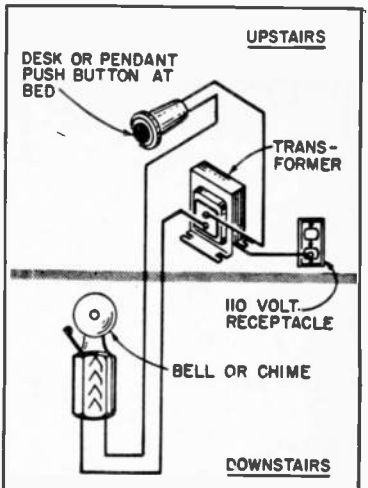


FIG. 5 SICK-BELL

A paging-system conversion will pay for itself in convenience

ways scrape the wires clean when splicing for good contact.

Test any run of concealed wiring with batteries at one end, a bell at the other. If current does not come through, best thing is to string a new wire. Cut the old wire at one end, tie the new bell-type wire securely to the end and pull the old wire through at the other exposed end. Splice the wires into circuit again.

Convert to Chimes. Replacing a door bell with chimes involves merely switching the wires from one to the other and putting the connections from the front and side doors to their proper terminals as before. But the chimes will draw higher voltage than the original bell transformer, which is only 6 or 10 volts, so it will be necessary to change to a 16- or 24-volt transformer.

Extra Door Bells. The single door bell or chime no longer fills the bill for the active modern family. Can mother hear the bell when she's busy in the laundry room, with the washer playing its own decibels? When the family is out in the backyard patio, can you hear if callers are at your front door?

Extra door bells are a primary necessity in today's home. And fortunately, they're so inexpensive and easy to put in, everywhere in the house and even outdoors. As the bells are wired in parallel, you can place a cutoff switch near any of them so they can be disconnected when desired, without affecting the function of any of the others.

A multiple bell installation consists merely of splicing new wire into the present circuit or chimes, or connecting the extension wire directly to the present bell terminals.

Bringing the wires to desired locations is simplified by the fact that no special boxes or other fittings are needed. The thin bell wire can be run along the baseboards, through from floor-to-floor inside closets, or attached behind cabinets.

It is possible that your present transformer may not be able to handle the longer run of wire and additional bells, in which case it is easy enough to substitute a heavier duty transformer, such as the Edwards #992, which delivers 10 watts at 16 volts and costs about $3.

Bell Paging System. Just think how helpful it would be to have a call bell in each room of the house as in Fig. 6.

When there's a phone call, just touch a push button so the person called will answer on their extension.

It works for other things as well. To wake the children and hurry them to school; summon the family for dinner, serve as a general paging system to keep in touch—without noisy and disturbing yells from various rooms in the house. For the sick child or aged person, it's so comforting to have a bedside call button available (Fig. 5).

Heart of the installation is a wire block (Fig. 6), purchased at any electrical or radio parts store, which is a plastic plate with two or more rows of terminal screws. Also get a sufficient quantity of plastic-coated bell wire or cable containing different colored wires.

Fasten this on the wall in an out-of-the-way but accessible position, such as in a closet. Draw a wire from the bell transformer and connect it to a terminal on one side of the wire block.

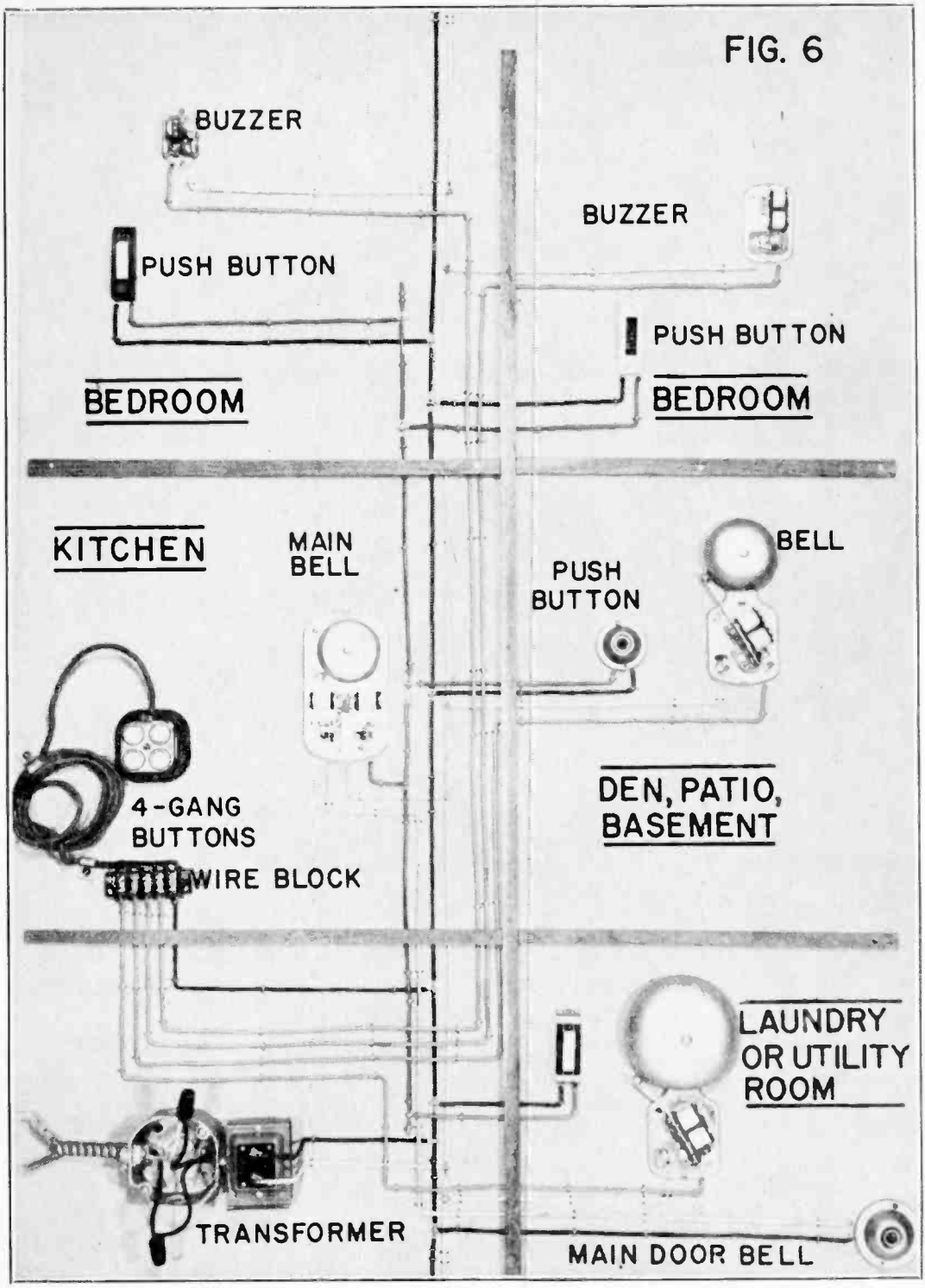


FIG. 6: The cost of a completely efficient paging system throughaut the house is relatively inexpensive. The materials you need will not cost very much and you can make the entire installation yourself. No permit or certificates are required, as the low-voltage installation is perfectly safe and legal.

Early warning might have prevented this. Alarm box can be mounted out of way in bedroom near regular receptacle. Heat sensitive detector, inset, set for 140°, can be positioned over likely trouble spots.

Fire Alarms

OF ALL the devices that go to make up the modern home, one of the most valuable is a fire-warning system. This appliance serves you every minute, alertly standing by to raise the alarm if there is danger to your family.

But very few homes now are equipped with a fire alarm system, because the householder either is not "sold" on the need for, or does not recognize the efficiency of such equipment. The lack of interest also may be due to the cost, or a reluctance to string electric wires through the house.

Neither of the latter reasons is valid; a good-quality home alarm system, such as that made by the Edwards Co., (90 Connecticut Ave., Norwalk, Conn.), can be bought for less than $25. The wiring need not be obtrusive and an electrician is not required to make an average installation in exposed locations.

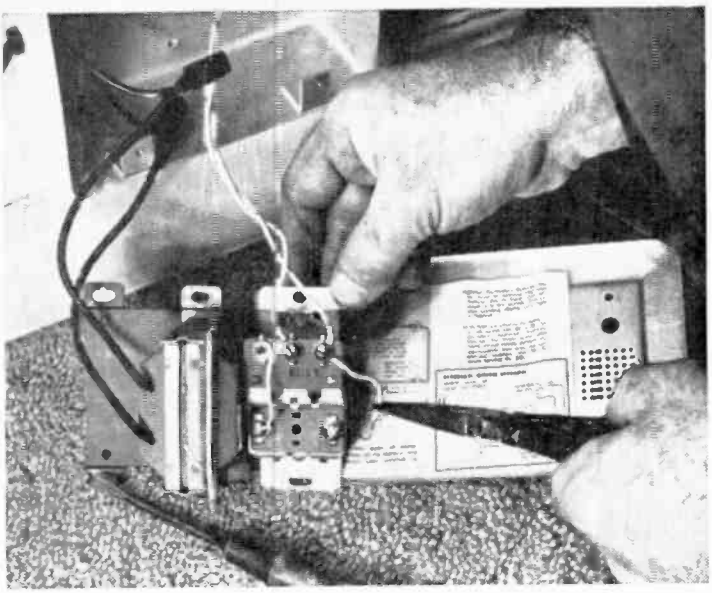
Admittedly, alarm systems for the home are less than 100% dependable, but certainly they provide a large measure of protection by covering specific hazards.

Open or Closed Circuit. There is some controversy whether an open-circuit or closed-circuit system is best.

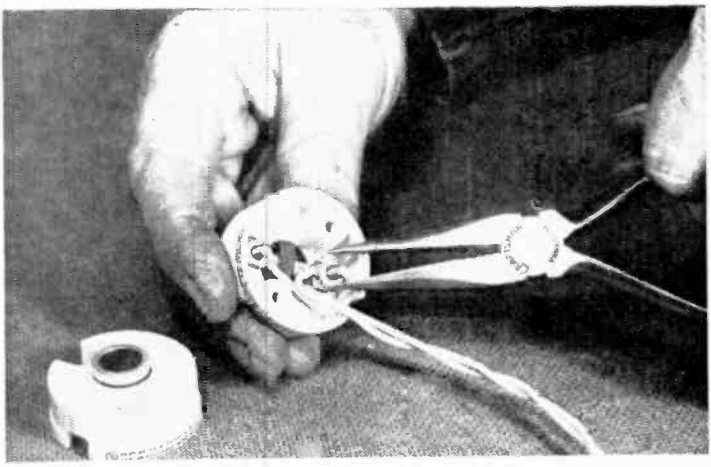
Evidence seems to favor the open circuit, which operates from a transfer off the main house current and has parallel wires linked to thermal detectors at strategic spots in the home. If heat rises to over 140 degs. (or other predetermined level) a switch in the detector closes and sends the current to ring an alarm bell.

These detector switches, costing $3.50 each, are of dependable quality with corrosion-proof contact points, and also can be tested easily to see if they are in working order. The detectors are 1½-in. diameter, and can be mounted flush with the ceiling so they are not noticeable.

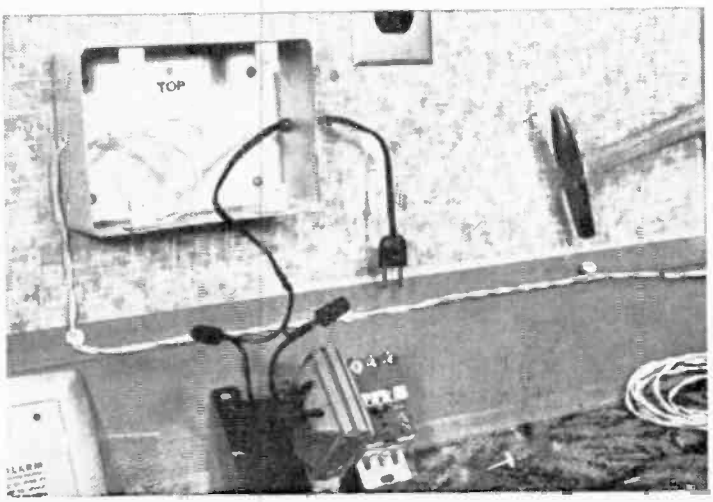
While there is a possibility that a fire would



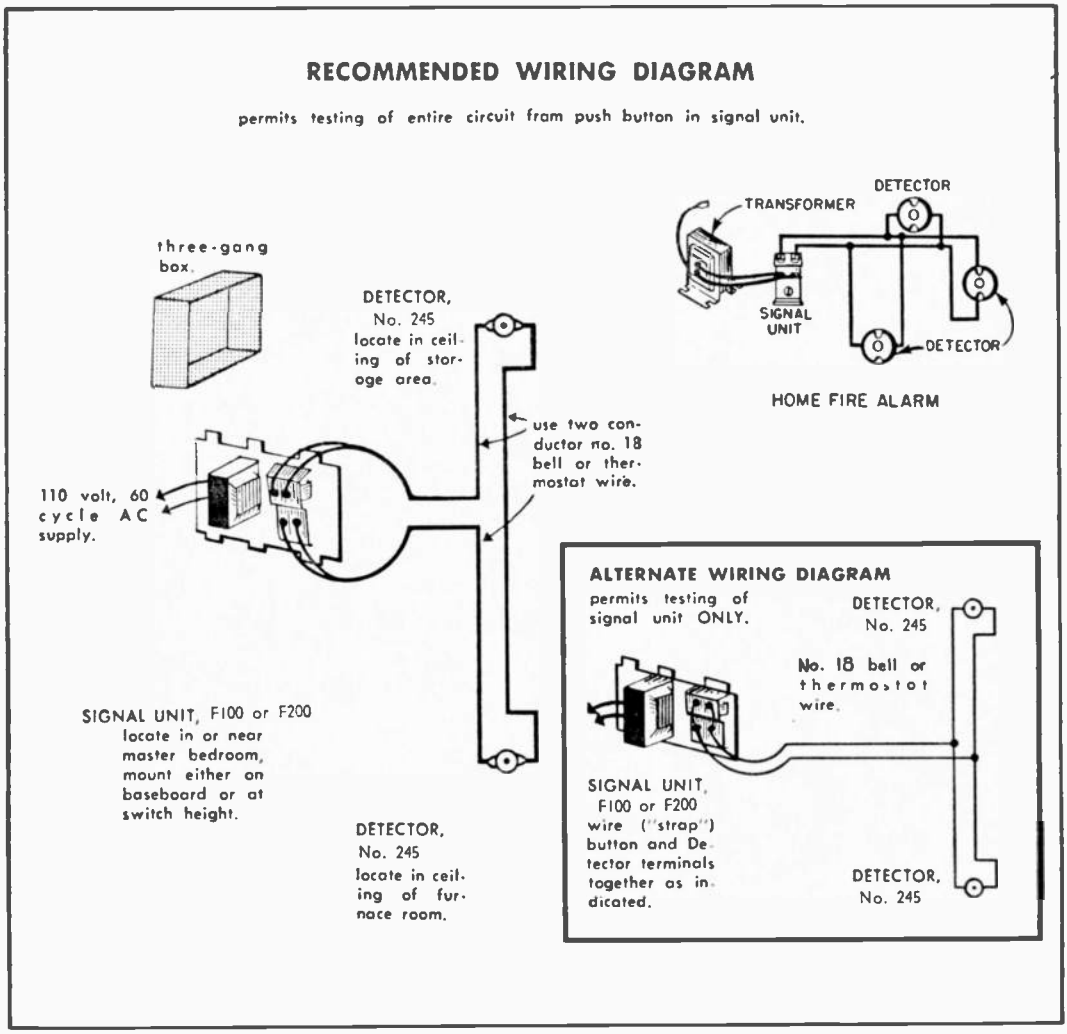
Tester button, transformer and alarm bell are all in one assembled unit. All terminals are clearly marked so the system can be hooked up with few connections and available tools.



Small detector is part of the low-voltage system. It is connected by attaching wire to the terminals, then surface mounted or set flush right into the plaster of the ceiling.



Plastic insulated wire leading from alarm to detectors can be held against baseboard with staples or large-head nails, or hole made in back and snaked between walls.



Fire Alarms

knock out the electric power, this is not likely to take place simultaneously so the alarm would function at least during the start of a fire—and that's all you need.

Reliance on dry-cell batteries as a secondary power source has been discounted, since batteries have limited "shelf life" and are likely to be neglected.

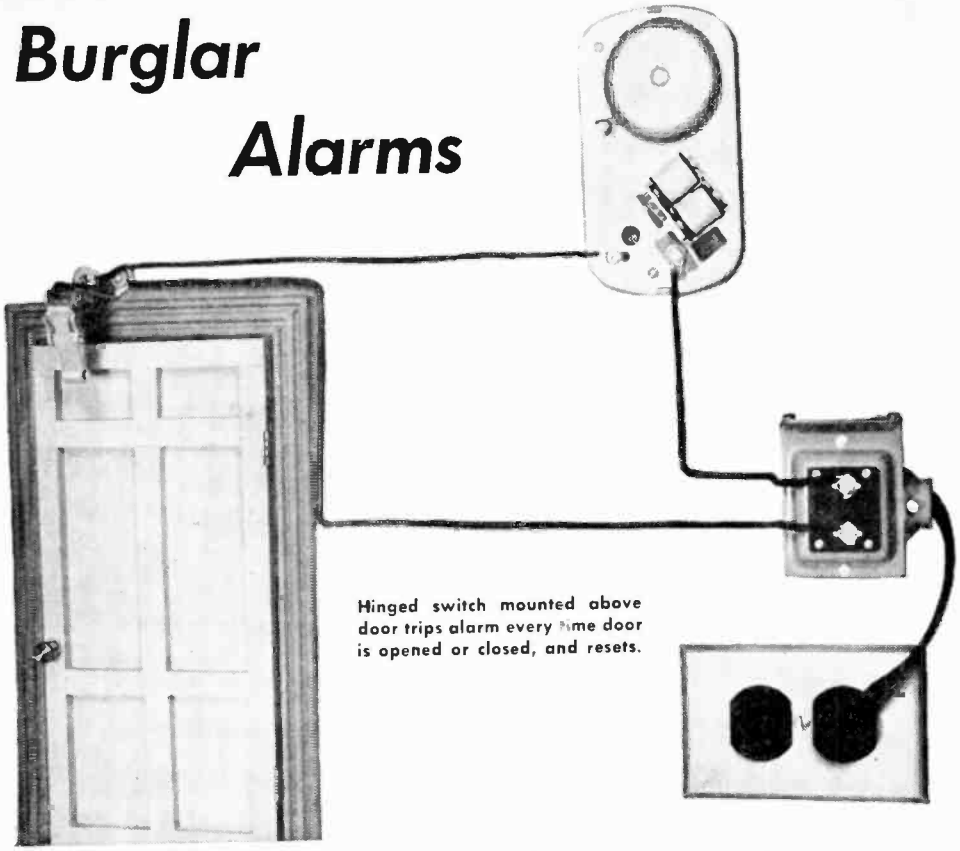
The installation of an open-circuit system is quite simple and can be done by the family handyman. The signal box has its own built-in transformer. Only low-voltage bell wire is used except for a short electric cord from the bell unit itself that is plugged into a nearby receptacle to activate the transformer.

Concealed Wiring. The chief problem is in placing the wires so they are not visible in the rooms. Fire detectors are located in the furnace room, laundry, kitchen, attic, and other strategic spots. The bell wire is run along ceiling joists in the basement, along a rafter in the attic, and up through closets when it goes from floor to floor. If a wire must go along a wall inside a room, it can be disguised by running it along the top of the baseboard, or under carpet.

In new homes, the small detectors can be located flush in the ceiling of each room. Each detector is rated to protect an area of 400 sq. ft. (20x20). In the kitchen, place the detector in the ceiling soffit, where the wire can be snaked through the hollow space inside. If you're going to have the house redecorated, install the detectors first in the ceilings.

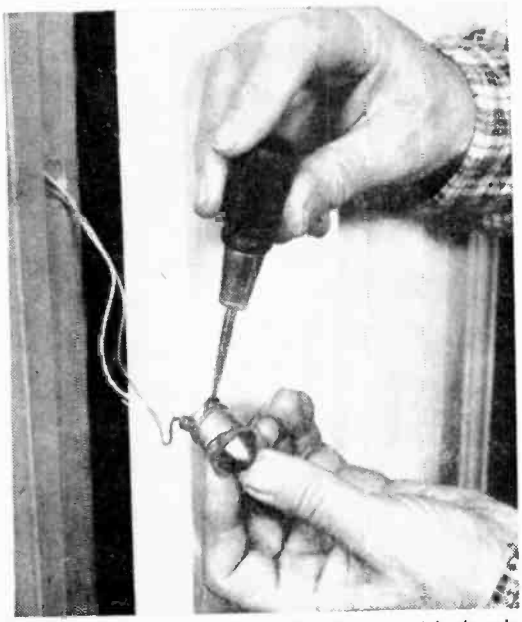
Get into the habit of testing the equipment at frequent periods. This is done by pushing the bell button to check if any wire is broken. Also, a 100-watt bulb held near the detector will sound the alarm. The tests do not affect functioning as detectors automatically reset.

Burglar Alarms



Hinged switch mounted above door trips alarm every time door is opened or closed, and resets.

Protective devices can be installed on doors and windows that guard against intruders



Open circuit type switch has a thin flange and is sharply beveled to permit ease in opening or closing window.

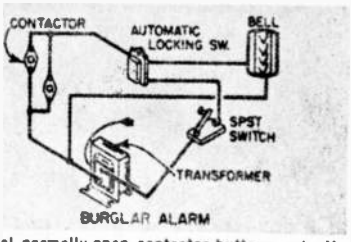
A BURGLAR alarm system in your home will do so much for the safety and ease of mind of your family, and protect your home even while you're out of town.

You can install a basic but efficient system, covering vulnerable windows and doors in a day or so at a cost of only $10 to $12 for all the materials, and without marring the walls with unsightly wire. A more elaborate and dependable system, one monitored by a relay which is like those used in stores and other commercial establishments, will cost about $25 for materials.

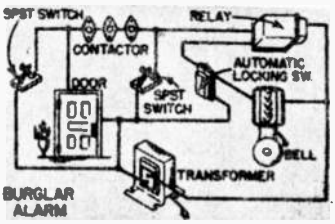
The low-voltage system works by means of hidden contactor switches set into door jambs and window sash. When a door or window is opened a bell or buzzer starts to ring. Sounding of the alarm usually is sufficient to scare away any intruder and puts you or your neighbors on guard.

Another value of the system is that it simplifies the nightly lock-up rounds. Like everyone else, you may have found some morning that a basement or side-entrance door had been left open all night by error.

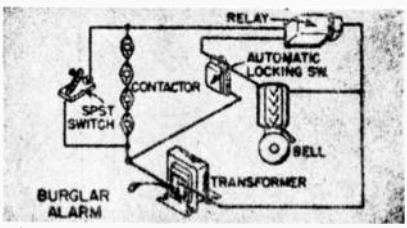
With the alarm switch turned on, you



Special normally-open contactor buttons, set off alarm when door or window is opened and automatic locking switch keeps bell going until reset. Switch disconnects system in daytime.



Selective arrangement of the closed-circuit system with relay permits disconnecting several of the alarm contactors at certain hours while others continue in operation.



Closed-circuit system with relay is better. Normally-closed contactors keep flow of current to relay. When current is interrupted, automatic locking switch is actuated, alarm rings.

Burglar Alarms

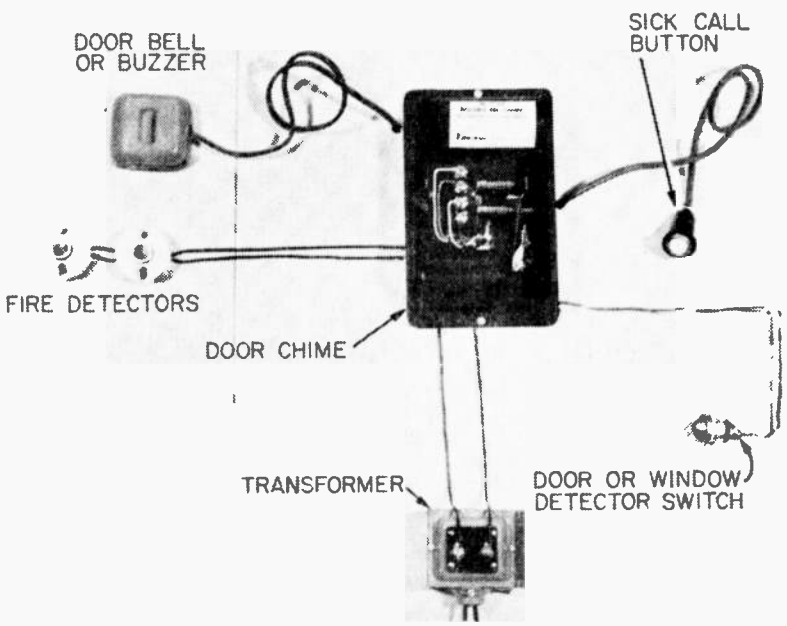
would know instantly that a door is not closed. And if a door is left unlocked, the alarm stands guard through the night. Also, during the daytime you can use it to keep control of children's comings and goings by knowing when any door is opened. A combination bell and buzzer like Edwards Buzabel #730 (Edwards Electric, 90 Connecticut Ave., Norwalk, Conn.) can be used for this, with a convenient switch for day and night use, or for complete cutoff when the alarm is not required.

Installation starts with drilling ¾-in. holes in the door jamb and window frame for small, round contactor switches with thin metal flanges which fit almost flush. These are called normally open switches—releasing the button makes the contact, ringing the bell.

This contactor is used in the systems shown in the diagrams. The contactors used in these installations are Edwards #44. In window frames, the sharply beveled sides of the switch button permit moving the sash.

Use ordinary plastic-coated bell wire (18 gauge) powered from dry-cell batteries or connected to the door-bell transformer, which delivers from 6 to 10 volts.

The wire is snaked up behind the door jamb to connect to the switch. At basement doors the wire can be stapled around the door frame and along the ceiling joists to the transformer. At upstairs doors, drill through the floor from the basement for the wire to come up directly behind the door frame. Where necessary, use a stiff wire to fish the conduc-



Paging and warning system can be wired into one circuit and worked from the power supplied by a single transformer.

tor wire inside the door frame and bring it out through the contactor hole.

For windows, the Edwards button switch is set at the sill or top of the frame and will make contact when the sash is raised or lowered. Another type of spring switch can be installed at the sides of the window so that the sash can remain open part way for ventilation without affecting the switch.

Positive Control. One problem in this circuit arrangement is that the alarm bell will ring only for the short time that the door is open. An improvement on the circuit would include a constant-ringing drop (sometimes called locking switch) connected directly to the transformer. When this is energized by an open door, it sets the alarm in constant operation until the control is reset or power switched off. This important device (Edwards #26) costs about $6.50.

Other protective devices are tension spring switches, for transoms and closets; pressure matting for floors or stair treads, and burglar traps which hold a cord stretched across an entry way near the floor so that anyone passing will pull the string and set off an alarm.

Electric eye burglar detectors are widely used in industry and homes, are highly effective. Anyone crossing a ray of light will break the circuit and set off the alarm.

It is best to have a shut-off switch conveniently located in the kitchen or bedroom so the alarm can be disconnected during the day. If you neglect to shut off the alarm during normal daytime door traffic, the frequent bell soundings defeat the purpose of the system.

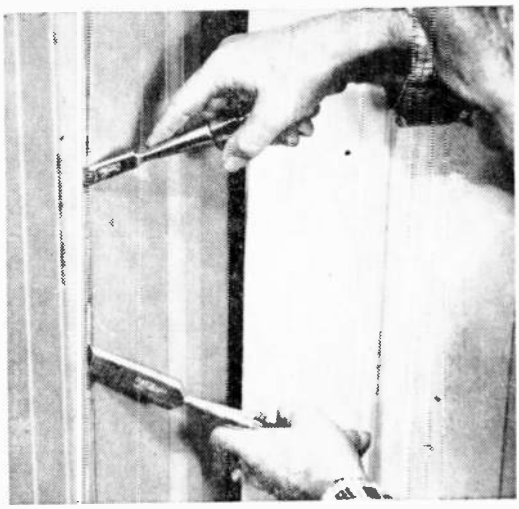
Other Systems. The basic system described is the normally open circuit connected directly to the power source. A more efficient, but also more costly and complicated system is the normally closed circuit including a relay which monitors the system with a tiny trickle of current running constantly through the wires at all times.

Thus when a door opens, the button *breaks* the contact, interrupts the circuit and sets off the alarm which rings constantly. In this system the #45 closed circuit contactor switches are used, together with a 12-volt relay.

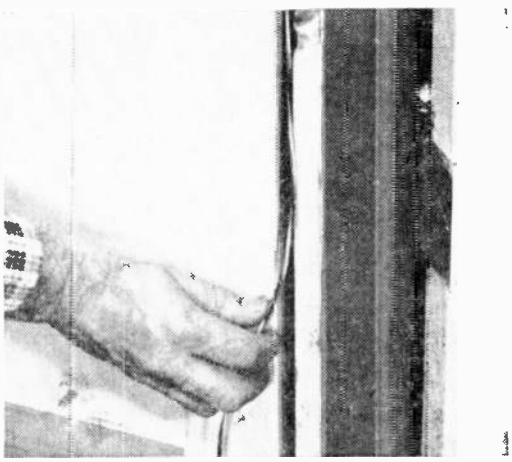
In either of the closed-circuit relay systems, it is possible to arrange for disconnecting certain alarm contactors while leaving others in operation at all times. This is shown, p. 85.

Another helpful device to guard against intruders that is far less complex is the door trip, a simple tripper switch that is placed above a door. A hinged lever extends below the top of the door and swings back each time the door is opened.

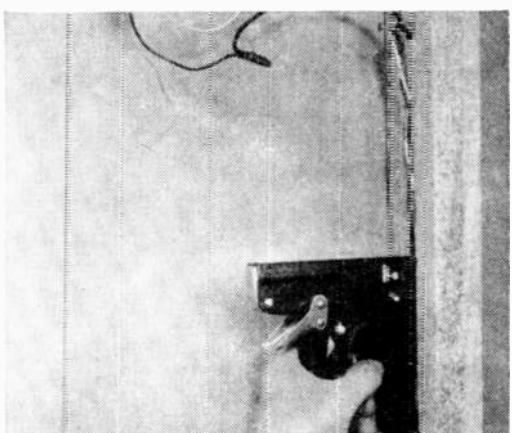
The alarm is sounded momentarily when the door is opened, or a constant ringing drop can be used with a nighttime control switch which is set, when the family retires. The hookup for the door trip system is on p. 65.



Wires can be concealed by carefully prying off the door or baseboard molding with a set of chisels.



Force the 18-gauge wire between frame and wall. Keep it fairly taut so molding can be nailed flush to frame.



Quickest way to attach wire to exposed frame members is with gun that has fasteners designed to hold wire.

Special Section

How to Pinpoint Appliance Trouble

THERE are several steps you should consider before deciding what to do when an appliance breaks down or fails to operate in a normal manner. Whenever you are faced with such a situation, check-out the following pre-service program before deciding how to proceed. You may need to go no further to clear up your trouble.

Make certain there is a problem. Have you read the operating instructions supplied with your appliance so well that you are sure you know how to operate it properly and are entirely aware of what the manufacturer claims it will do? If not, and they are still available, read the instructions carefully.

External Supply Failure. An appliance cannot operate (do its work) for anyone by simply standing in space. It must be connected to some source of energy, such as electricity, gas, or water.

A electrical appliance must have electricity so make certain that there is power to the appliance; that the fuse hasn't blown and that the plug hasn't pulled out of the socket.

A gas appliance must have gas. Make sure that the valve hasn't been shut off in the gas supply line.

An oil burner must have fuel. Be certain the tank isn't empty.

A water-using appliance must have the water turned on, an adequate supply of water, and the kind of water needed to do the job for which the appliance is designed.

Make certain that temperature of the water at its points of use is within the range recommended by the manufacturer. For example: Dishwashers require water temperature in the tub within a 140°-160° range, for each wash and rinse cycle.

You must be sure there is enough water available to operate the appliance. Both water pressure and condition of the supply are important factors and should be considered as a pair. These two control "flow rate" or gallons per minute (*gpm*). A low flow rate will not allow some appliances time to fill with enough water to do a good job.

Is Your Machine Worth Fixing? Minor damage such as broken handles, dials, knobs, cabinet dents, and scratches should be easy to fix. Individual damaged parts can be ordered and you can replace them.

In case of fire or flood: clean out the machine thoroughly and bake the electrical parts dry at a low temperature (180°) in your oven for several hours. Check all contacts for cleanliness and all insulation for damage. Make sure that all connections are tight and that all moving parts operate smoothly.

Make certain that the gear box, crankcase, and such are properly lubricated and free of water and other impurities. Clean all sand, soot, and carbon deposits from all electrical connections and terminals. Remove all rust and protect the surface with a proper finish. Replace any questionable parts.

The Smell of burning insulation is a warning to turn off or disconnect your machine promptly. Then remove the cover and/or electrical part to check for burned insulation and smoke smudges. Once you find the part, it can be removed and replaced. It is usually less costly to replace burned out electrical parts than to repair them. If the insulation is burned off a connecting wire, the parts connected to this wire must be checked for "shorts" or "grounds" (see article on electrical circuit tester, p. 70).

Listening will tell if there are any unusual squeaks, rattles, bangs, or if your machine is "dead"—assuming the switch is on.

If your appliance is inoperative, or partially so use a test light to check for a faulty

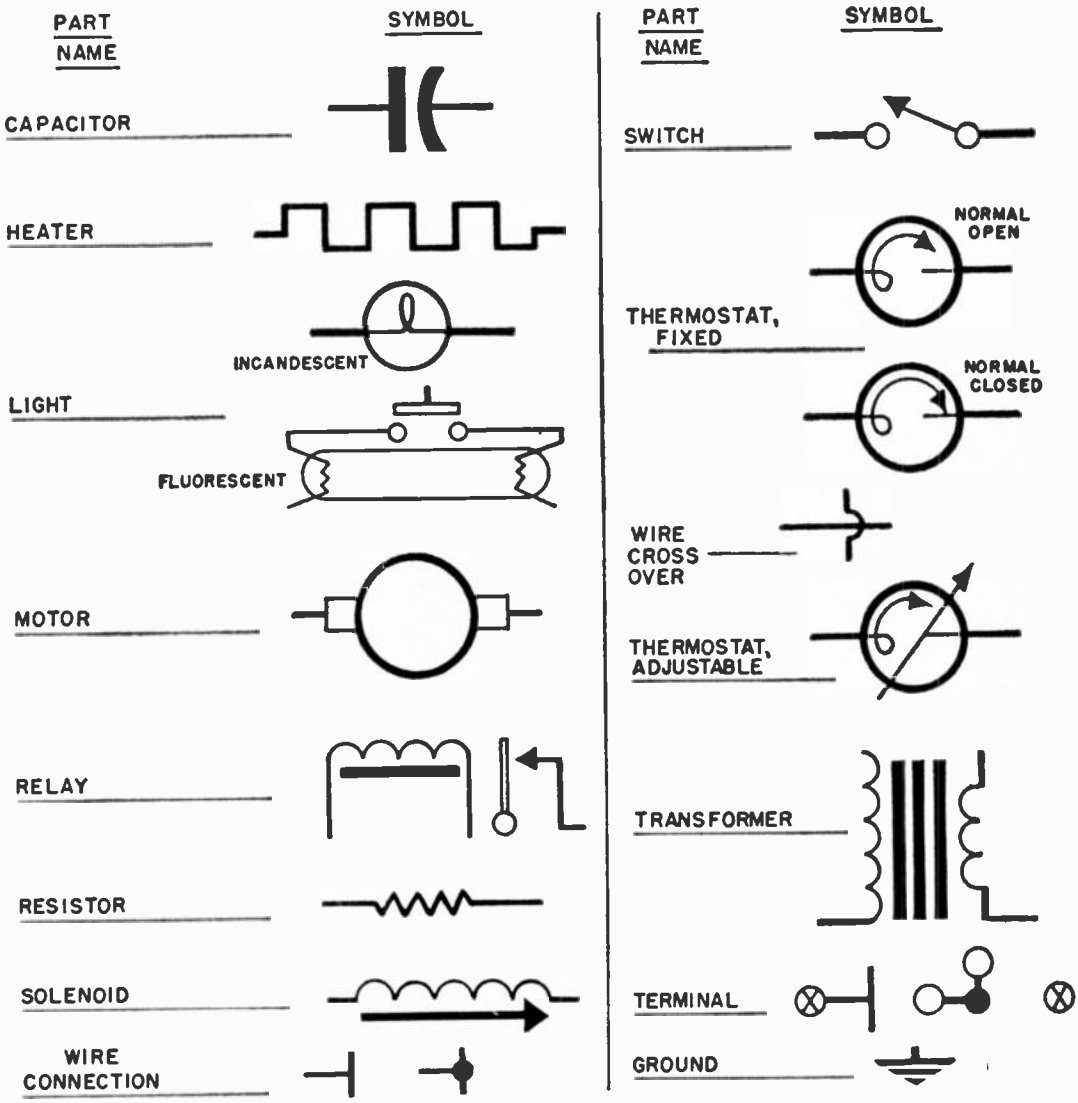
(Continued on page 111)

Appliance Wiring Diagrams

To troubleshoot most major appliances you must know these symbols

BEFORE trying to locate trouble in the electrical circuitry of an appliance you should know how to read a wiring diagram. This is the electrical map showing which parts are which and how they are connected to each other.

There are many signs and symbols with which you will need to become familiar before you will be able to understand a diagram and use it intelligently. The table below lists the symbols most commonly used. Study them carefully.



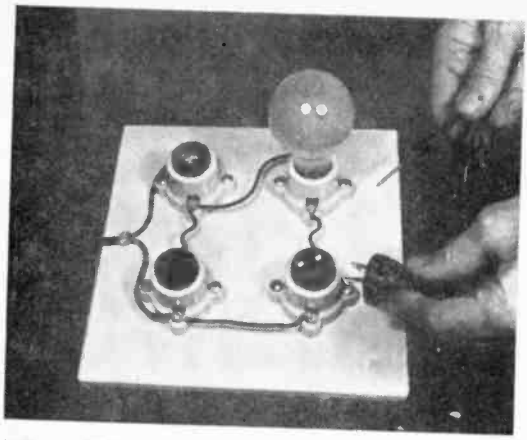


FIG. 1: With this handy tester you take the guess work out of restoring your appliance to working order.

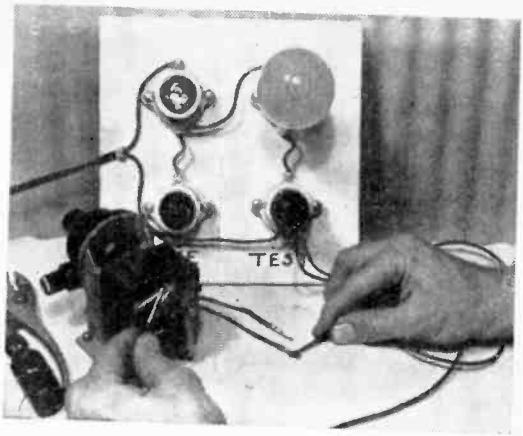


FIG. 3: Test for internal electrical leakage by running tester leads from bare metal to a lead terminal.

Special Section

Appliance Electrical Circuit Tester

Inexpensive check-out device will pay for itself many times over through repair bills you won't have to pay

HERE is an appliance circuit tester you can build for less than $3.50, even if you have to buy all the parts. With it you can test any appliance for grounds, circuit continuity or individual part operation.

Mount the parts as shown in Fig. 1 and connect as illustrated in the schematic diagram (Fig. 2). Complete the tester by making two sets of test leads and a jumper lead as shown in Fig. 2. Your appliance can be electrically checked out by plugging the test leads into the receptacle.

A fuse is located in this panel to protect the household one and to make it easier to change should it blow. A circuit breaker instead of a fuse is better.—G. MEYERINK.

FIG. 4: There must be continuity from the bare metal to the grounding terminal in the three-prong plug.

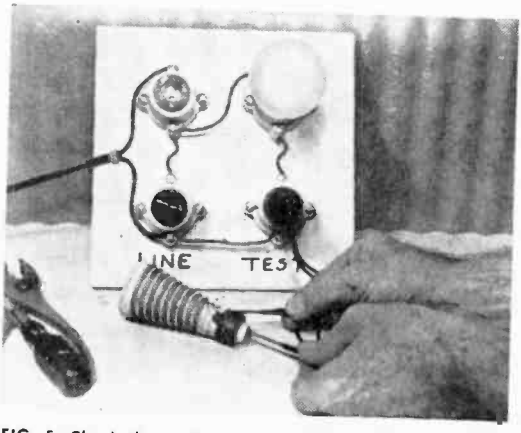


FIG. 5: Check the performance of individual components by running leads to positive and negative terminals.

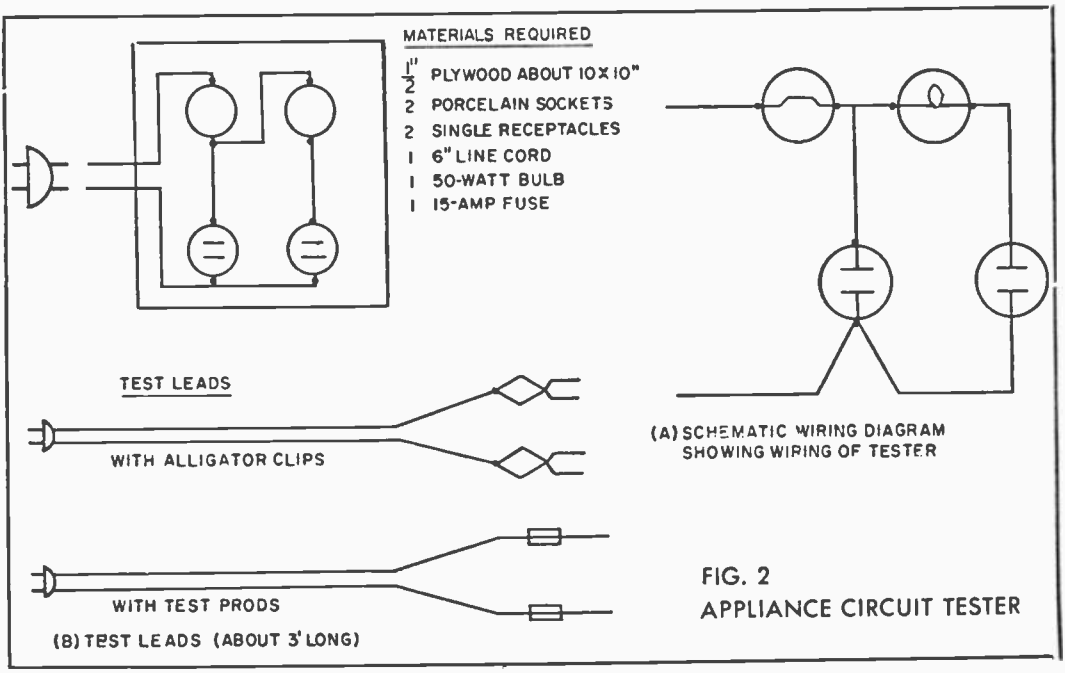


FIG. 2
APPLIANCE CIRCUIT TESTER

SPECIAL SECTION Appliance Troubleshooting

AUTOMATIC WASHERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No water fill	Water valves closed	Turn on valves
•	Hoses kinked	Unkink hoses
•	Screen in fill hose clogged	Clean out screen
•	No power to fill hose solenoids	Check circuit for continuity
•	Defective fill solenoid	Replace solenoid
•	Faulty water level control	Replace control
•	Machine not turned on	Check controls and power at outlet
•	Machine did not drain out last time used	See "Water will not drain . . ."
Incorrect fill or temperature	Faulty water level control	Replace control
•	Faulty thermal element in mixing valve	Replace valve (sometimes repair kits are available)
•	Hot water supply inadequate	Check temperature setting and capacity
•	Reversed hoses—hot water hose on cold water connection	Connect hoses correctly
No spray rinse	No water supply	Same as no water fill
•	Defective timer	Replace timer
Water will not shut off	Defective timer	Replace timer
•	Defective water level control	Replace control
•	Foreign particles in mix and fill valve	Clean out valve
	Defective valve	Replace valve
Water leakage	Inlet hoses loosely connected to valve	Tighten hose connection
•	Drain hoses not tight on pump	Tighten hose clamps
•	Broken hose	Replace hose
•	Leaky gasket	Replace gasket
	Cracked housing	Replace part
Water will not drain from machine	Kinked or clogged drain hose	Clear drain hose
•	Pump does not run	Readjust and tighten pump drive mechanism
•	Suds lock	Remove suds, add cold water
•	Faulty transfer valve	Replace valve
	Defective timer	Replace timer
	Loose belt	Adjust belt
Motor will not run	No power to machine	Check outlet
•	Door switch or other safety control in motor circuit	Check controls for operation and replace if defective
•	Faulty timer	Replace timer
•	Faulty water level control	Replace control
	Faulty motor	Repair or replace motor
No agitation	Motor failure	Repair or replace motor
•	Faulty timer contacts	Replace timer
•	Faulty transmission	Repair or replace
•	Defective control solenoids	Replace solenoids
•	Broken linkage	Replace or repair
	Faulty water level control	Replace control
Basket will not spin	Loose or broken belt	Tighten or replace belt
•	Inoperative door switch or other safety control	Check control for operation and replace if needed
•	Loose pulley	Tighten pulley
•	Grease on clutch	Clean with grease solvent
•	Defective control solenoid	Replace solenoid
•	Broken linkage	Replace or repair linkage
	Faulty water level switch	Replace switch
Slow spin	Belt or clutch slips	Adjust belt

continued on next page

Excessive vibration	Washer not level	Level machine by adjusting leg screws
•	Weak flooring	Reinforce floor
•	Unbalanced load	Redistribute load
•	Rubber cups not on feet	Install cups on feet
	Damaged snubber or suspension bolts	Replace snubber
Torn clothing	Improper bleach usage	Add bleach to water before loading clothes in tub or dilute bleach well before adding
•		
•	Broken agitator	Replace agitator
•	Defective basket	Replace basket
Machine will not shut off	Defective timer	Replace timer
•	Break in wiring	Repair wiring
Timer will not advance to next cycle	Defective timer motor	Replace timer motor
	Bound timer shaft or control knob	Clear knob away from panel
•	Faulty water level control	Replace control
No suds return (for machines with suds saver)	Faulty distributor valve	Replace valve or solenoid
•	Slipping belt	Tighten or replace belt
	Kinked hose	Straighten hose
•	Defective solenoid	Replace solenoid
	Faulty water level switch	Replace switch
•	Jammed pump	Remove pump and clean out
No recirculation of water during agitation	Jammed pump	Clean out pump
	Defective pump drive	Replace coupling or tighten belt
	Clogged hose	Clean out hose
•	Defective distribution valve	Clean out or replace valve or solenoid

NOTE: Timer does not advance during water fill period until the water level fill switch has been satisfied.

ELECTRIC DRYERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Will not run	No power	Check fuse and power supply
•	Loose wiring	Check terminals and wiring
•	Door switch	Make certain door closes properly to actuate switch
•		Replace switch
	Defective motor	Check motor
•	Defective timer	Replace timer
Runs but will not heat	Loose wiring	Check terminals and wiring
	Defective thermostat	Replace thermostat
•	Defective centrifugal switch at motor	Replace switch (check linkage to motor)
	Defective timer	Replace timer
•	Open heater element	Replace heater element
•	Heat switch set to "off"	Set switch for desired heat
Drum will not rotate, motor OK	Broken or slipping belt	Replace belt
	Jammed	Check for foreign article between drum and shroud
•		Replace defective bearing or bearing support which allows drum to sag and hit
•		Tighten pulley set screw
•	Loose pulley	
Clothes not drying but dryer runs and heats	Defective operating thermostat	Replace thermostat
	Fan loose on shaft; no air motion	Tighten set screw
	Clogged lint screen	Clean out
•	Leaky door seal; air leaks	Replace door seal
	Incorrect heat or timer selection	Reset timer and/or heat control
•	Clothes too wet when placed in machine	Wring out or extract water before placing in dryer
•		
Will not shut off	Defective timer	Replace timer
Blows fuses	Electrical ground	Check heater element for foreign object or sagging drum
•		Check wiring for bare spots touching the frame
•		
Motor runs when door is open	Defective door switch	Replace door switch
Bulbs do not light	Defective bulb	Replace bulb
	Loose wiring	Check and reconnect
•		
Timer fails to advance	Dial binds	Relocate on shaft
	Timer motor defective	Replace timer motor
•	Door switch open (some models)	Close door or replace door switch

FOOD WASTE DISPOSERS

PROBLEM	CAUSE	CORRECTIVE ACTION
Leaks at sink flange	Loose mounting screws	Tighten flange screws
Leaks at drain gasket	Loose flange Improper gasket	Tighten screws Replace
Leaks between body and chamber	Defective or poorly placed shredder basket	Replace
Leaks between chamber and sink flange	Loose mounting Defective gasket	Tighten nuts Replace
Abnormal noise and/or vibration	Undisposable matter in chamber Flange gasket or tailpipe gasket improperly placed Broken impeller vane Motor bearings may be damaged	Clean out chamber Replace Replace impeller Replace bearings
Erratic operation	Loose wiring, switch, motor, or power connection	Locate and reconnect
Slow grinding	Undisposable matter Damaged impeller Dull shredder Insufficient water flow	Remove Replace Replace Minimum 2 gal. per minute
Slow drain out	Partially clogged drain Clogged shredder teeth	Check plumbing Remove and clean
Jammed	Something stuck between impeller and shredder	Move impeller backwards until free
Won't stop	Defective switch Short in wiring Incorrect wiring	Replace Clear short and insulate Reconnect properly
Won't run	Overload protector has tripped Blown fuse Defective switch Burned-out motor winding Open or shorted wiring Inoperative centrifugal switch in motor	Wait for motor to cool, reset Replace Replace Replace stator Repair Replace
Cover doesn't control	Defective switch Broken guide tab Worn cover	Replace Replace housing Replace

COFFEE MAKERS

PROBLEM	CAUSE	CORRECTIVE ACTION
Coffee tastes bitter	Accumulated residue inside coffee maker	Clean with baking soda solution or other mild kitchen cleaner
Weak coffee	Insufficient grounds Control incorrectly set Starting percolator with hot water Pump valve stuck	Use more Reset control Use cold water to start Clean valve for free action or replace if damaged
Coffee boils	Incorrect thermostat setting Defective thermostat	Adjust thermostat setting Replace thermostat
Unit is slow in brewing coffee	Low line voltage	Check line voltage—if it is low, notify the power company
Does not operate at all	No voltage at outlet Defective power cord Defective pump heater element	Check fuse and replace if needed Repair or replace Replace heater element
Gets warm but does not percolate	Defective pump Defective thermostat Incorrect setting of thermostat	Replace pump Repair or replace thermostat Reset thermostat

ELECTRIC FRY PAN

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No heat	No power at outlet	Check fuse
•	Defective cord	Repair or replace cord
•	Open heater element	Replace unit
	Defective thermostat	Replace thermostat
	Poor wire connection	Clean and tighten
No heat control	Defective thermostat	Replace thermostat
Broken part	Accidents	Replace part
Shocks user	Grounded unit	Replace defective part
•	Wire touching frame	Locate and reinsulate or replace wire
Food sticks	Excessive cooking temperature	Use lower thermostat setting
•	Pan is not conditioned	Recondition pan by heating with high heat shortening alone
•		
Staining of aluminum	Reaction of food acids	Wash immediately after using
•	Reaction to harsh detergents	Use a mild soap for washing

PROBE CONTROL

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No heat	No power at outlet	Replace blown fuse
•	Defective cord	Repair or replace cord
•	Defective thermostat	Repair or replace thermostat
	Burned contact	Replace contact
	Open heater element	Replace unit
Won't shut off	Thermostat contact points stuck in closed position	Clean contact points on thermostat
•	Incorrect thermostat calibration	Recalibrate for definite off position

BLENDER

PROBLEM	CAUSE	CORRECTIVE ACTION
Motor won't run	Blown fuse	Replace fuse and check wiring
•	Defective line cord	Repair or replace line cord
•	Defective switch	Repair or replace switch
	Burned out motor	Replace armature or field coil
•	Frozen bearings	Free and lubricate
	Armature hitting due to worn bearing	Replace bearing
Motor runs but blade doesn't turn	Broken belt (G.E.)	Replace belt
	Incorrect placement of container	Relocate container on base
	Defective motor coupling	Replace motor coupling
Blade edges damaged	Using large solid ice cubes, bones or hitting a spoon	Replace blades
Runs at high speed only	Defective switch	Replace switch
	Open resistor	Replace resistor
	Defective section of field coil	Replace field coil
Container leaks	Cracked glass jar	Replace glass jar
	Poor seal between jar and bushing	Tighten bushing or replace seal
Abnormal noise	Bent cutter blade hitting jar or seal	Replace cutter blade
•	Motor fan blade hitting	Straighten fan blade
•	Loose coupling between motor and container	Reseat the container
		Replace the coupling unit if defective
	Loose cutter blade assembly	Tighten cap nut

TOASTER

PROBLEM	CAUSE	CORRECTIVE ACTION
Fails to heat	No power at outlet	Check house fuse
•	Defective cord	Repair or replace cord
•	Loose connection	Clean and tighten connection
•	Switch not making contact	Repair or replace switch
•	All elements burned out	Replace heater elements
	Hold down latch not locking	If bent, straighten to correct position
Toast will not stay down		If binding, clear bind to allow free operation
•	Bind in toast carriage	Clear cause of bind
•	Broken latch spring	Replace spring
	Toast carriage binds	Clear bind to allow free operation of carriage
Toast will not "pop up"	Release latch binds	Check latch bind and clear it
•	Broken power spring	Replace spring
•	Bind in slide rods	Clear and lubricate rods
Toast lifts slowly	Weak spring	Adjust or replace spring
•	Excessive spring tension	Adjust tension on lift spring
Toast lifts too rapidly	Dash pot not effective (where used)	Repair piston or washer in dash pot
•	Incorrect adjustment of timer mechanism	Adjust timer setting
Toast too light or too dark	Defective thermostat on timer	Replace defective parts
One side untoasted	Defective heater element	Replace defective heater element
Shocks user	Grounded wire	Locate ground and take corrective action

DEHUMIDIFIERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Unit does not run	No power to the unit	Check fuse, wiring and outlet
•	Defective motor starting relay	Replace relay
•	Humidistat set wrong	Adjust for desired humidity
•	Faulty humidistat	Replace humidistat
	Defective motor or compressor	Replace refrigerant unit
Unit turns off and on too frequently	Defective humidistat	Replace humidistat
•	Failure in refrigerant system	Call qualified serviceman
Unit runs but does not dehumidify	Abnormal conditions	Check operating conditions
•	Poor location and air circulation	Relocate with more clearance
•	Defective fan motor	Replace fan motor
	Refrigerant low in system	Call qualified serviceman
Unit runs but evaporator frosts	Abnormal conditions	Check operating conditions
•	Poor location and air circulation	Move unit
Fan not running	Defective fan motor	Replace fan motor
•	Jammed fan blade	Straighten fan blade
•	Motor relay defective	Replace motor relay
Noisy operation	Fan blade hitting	Straighten fan blade
•	Tubing hitting	Rebend tubing to clear object being hit
•	Loose cabinet, etc.	Tighten loose parts that might vibrate
Unit does not run	No power to unit	Check fuse, outlet, cord, and cord plug
•	Low voltage	Overloaded branch circuit
•		Incorrect wiring
•	Loose wiring	Incorrect voltage for machine's rating
•	Defective switch	Check all wiring connections
•	Defective motor overload protector	Replace switch
•	Defective fan motor	Replace protector
	Defective compressor	Replace fan motor
Fan runs but compressor does not	Defective compressor	Call qualified serviceman
•	Defective overload protector	Replace compressor
•	Motor capacitor defective	Replace overload protector
•	Thermostat set too warm	Replace capacitor
•	Thermostat defective	Reset thermostat
	Defrost thermostat defective	Replace thermostat
	Defective switch	Replace defrost thermostat
		Replace switch

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Compressor runs but fan does not	Defective switch	Replace switch
•	Fan speed control reactor defective	Replace reactor
•	Defective fan motor	Replace motor
•	Defective fan motor capacitor	Replace capacitor
	Fan blades or shaft binding	Straighten blades or free shaft
No cooling; both fan and compressor running	Clogged air passages	Clean filters. If coils are iced, allow to defrost
•		Clear any foreign obstructions from air passages
•	Compressor not pumping (coils will not be cool)	Call qualified serviceman
•		
Insufficient cooling, both fan and compressor running	Excessive load due to doors and windows being open; above normal temperature, etc.	Check room conditions
•	Partially clogged filters or air passages	Clean or replace filters
•		Clean air passages
	Incorrect air damper position	Check control's position and owner's manual for correct setting
•	Fan motor speed set too low	Check fan speed and adjust if a variable speed fan is used
•	Fan dirty, blades loaded with dust	Clean fan and blades; make certain fan blades are tight on shaft
•	Compressor not pumping at full capacity	Call qualified serviceman
•	Insulating seals out of place	Replace insulation

ROOM AIR CONDITIONERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Compressor stops and starts on short cycles	Trying to restart too soon after shut-off	Wait for unit to cool down before restarting after overload
•	Incorrect line voltage	Make certain line voltage is correct for unit
•	Thermostat set too warm	Reset thermostat
•	Defective defrost thermostat	Replace defrost thermostat
	Defective starting relay	Replace relay
•	Defective motor capacitor	Replace capacitor
•	Defective compressor motor	Call qualified serviceman
•	Slow fan	Set fan for higher speed if variable speed fan is used
Noisy operation	Parts are loose	Check unit and tighten screws
•		Clear tubing from areas where it may hit
•	Fan hitting	Clear and straighten blades
	Shipping bolts still tight	Loosen shipping bolts to allow compressor to float
•		
Blows fuses	Low line voltage	Check for voltage at outlet
•		Check circuit for abnormal load. Make certain that wiring is adequate and has tight connections
•	Improperly fused	Use 15-amp fuse for #14 wire circuit, 20-amp fuse for #12 wire circuit
•	Wiring or a part grounded or shorted	Locate ground or short and repair if possible; otherwise replace defective part
•	Defective motor starting relay	Replace relay
•	Defective compressor motor	Call qualified serviceman
Evaporator frosts up	Low outside air temperature	Turn off air conditioner
•	Thermostat set too cold	Reset thermostat
•	Clogged air filter or passageway	Clean or replace filter
		Clear passageway
•	Fan too slow	Check fan speed and set higher if variable speed fan is used
•	Defective compressor	Call qualified serviceman
Moisture drips into room	Inadequate seal	Reseal unit
•	Not enough slope from unit to outside	Reposition unit in window to provide correct slope
•	Abnormally high humidity	Wait for weather to change
•	Drains plugged	Clean out drain holes
•	Evaporator fins dirty	Vacuum evaporator and brush thoroughly

DRY and STEAM IRONS

PROBLEM	CAUSE	CORRECTIVE ACTION
No heat	No power at outlet	Check outlet for power
•	Defective cord or plug	Repair or replace
•	Broken lead in iron	Repair or replace lead
•	Loose connection	Clean and tighten
•	Loose thermostat control knob	Replace knob and tighten on shaft
•	Defective thermostat	Replace thermostat
•	Defective heater element	Replace heater if separate Replace soleplate assembly, if cast in
Insufficient heat	Low line voltage	Check voltage at outlet
•	Incorrect thermostat setting	Adjust and recalibrate thermostat
•	Defective thermostat	Replace thermostat
•	Loose connection	Clean and tighten connections
Excessive heat	Incorrect thermostat setting	Adjust and recalibrate thermostat
•	Defective thermostat	Replace thermostat
Blisters on soleplate	Excessive heat	After repair of control, replace or repair soleplate depending on its condition
•		
Water leakage	Careless filling	Allow spilled water to dry. Be more careful
•	Defective seam or tank weld	Replace tank
Water leakage	Inadequate tank sealer	Reseal with proper sealer
•	Damaged gasket	Replace gasket
No steam	No water in tank	Fill tank
•	Thermostat set too low	Set control higher
•	Valve in off position	Turn valve to correct position
•	Dirty or plugged valves or holes	Clean out
Spitting	Incorrect thermostat setting	Reset thermostat, usually too low
•	Excessive mineral deposit	Clean out
	Overfilling	Be more careful
Bad spray (spray irons)	Defective plunger	Replace
Iron stains clothes	Starch stuck on soleplate	Rub soleplate with damp cloth, then polish with dry cloth
•	Foreign matter (iron, lime) in water	Use distilled water
•	Sediment in tank	Clean tank. Use vinegar or lime
Tears clothes	Rough spot, nick, scratch or burr on soleplate	Remove with fine emery, then buff or polish area
•		
Shocks user	Electric circuit grounded to iron	Check 1. Cord and wiring for bare spot 2. Thermostat for insulation breakdown 3. Heater element for ground
•		
•		Repair or replace as indicated
Cord sparks	Loose connection	Clean and tighten
•	Broken wire	Repair or replace
Sticks to clothes	Dirty soleplate	Clean
•	Excessive starch in clothes	Iron at a lower temperature. Use less starch next time
•	Iron too hot for fabric being ironed	Lower thermostat setting

WAFFLE IRONS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No heat	No power at outlet	Replace fuse
•	Defective cord	Repair or replace cord
•	Open heater element	Replace heater element
	Broken hinge wire	Replace wire
	Defective thermostat	Replace thermostat
Blows fuses	Shorted cord	Replace cord
•	Shorted heater element	Replace heater element
•	Shorted wiring	Reinsulate wiring
Gets too hot (note #1.)	Check thermostat setting for maximum temperature of 520°F	Reset thermostat Replace thermostat
Waffles stick	Improperly seasoned grid	Operate for one-half hour with liberal amount of cooking oil on grids, no batter!
•	Insufficient shortening in batter	Add more cooking oil to batter
•	Operator error	a. opening griddle too soon b. too much sugar in batter
•		

Note #1. Handles will get hot with normal use but should not burn fingers. Feet should not burn or discolor table top.

DISHWASHERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Machine will not run at all	No power to machine	Check for power at outlet
•	Loose leads	Check and secure all leads
•	Door switch not operating	Check door adjustment and continuity through switch
•	Manual reset open	Push reset button
	Timer not operating	Check out timer
Does not make a complete cycle	No power to component	Check for power at component
•	Timer working erratically	Check operation against sequence chart on wiring diagram
•	Loose lead	Check and secure all leads
	Defective component	Check for proper operation
Water does not enter machine	Supply valves closed	Open valves
•	Open circuit in wiring	Check continuity
•	Timer not operating	Check out timer
•	Solenoid not operating	Check leads and operation
	Supply line restricted	Check for kinks and foreign matter in lines
Water does not drain from machine	Restricted lines	Check for kinks and foreign matter
•	Pump jammed	Remove foreign material
•	Motor not reversing (some impeller machines)	Check timer switching (pump should run counterclockwise for pump out)
Water leakage	Poor door seal	Adjust gasket, latch. Check level of machine
•	Splash at fill valve	Check alignment and tube end for burrs or deposits left by hard water
•	Split hose or loose clamps	Check condition of hose and clamps
•	Overfill (undercounter machines)	Check operation of pressure switch timer and inlet valve
•	Tub leaks	Repair with patch kit
Water leakage in gravity-drain type	Timer switch sticks in closed position	Replace timer
•	Leak in tub	Repair or replace tub
•	Drain plug leaks	Check "O" ring for damage or foreign particles. Clean or replace "O" ring
•	Drain plug sticks open	Clean lime or foreign matter from plug. Also clean inside of drain opening
•	Solenoid plunger sticking because of dirt or bent bracket	Remove plunger and coil and clean, straighten or replace bracket
Unsatisfactory drying	Low water temperature	Should be 140° in machine at last rinse
•	Heater element inoperative	Check electrical circuit, replace if defective
	Impatient user	Wait for end of cycle
Poor washability	Improper water level	Check flow, washer water pressure, and installation of drain
•	Improper water temperature	Check temp. in machine during last rinse (140°-160°)
•	Undesirable water conditions—(hardness or excess iron)	See about a water softener
•	Improper use of detergents	Change brands and vary amount used
•	Improper loading	Use proper procedure
•	Pump motor not operating (defective starting relay)	Check for restrictions; replace electrical circuit if necessary
•	Spray arm not turning	Clean under bearing, check clearance between arm and basket rails, etc.
•	Impeller loose or damaged	Tighten and/or replace
•	Detergent dispenser not dumping	Check solenoid, adjust linkage, avoid blocking cups
•	Loose or dirty filter screen	Refit screen to eliminate gaps; wash out well
•	Drain pump inefficient	See if water is being properly evacuated. Look for kinks, obstruction foreign matter and motor operation
•	Back siphoning from sink	Check installation drain loop and/or air gap
•	Incorrect timer function	Check timer against sequence chart
Abnormal noise (other than water hitting dishes or small item knocked loose)	Spray arm or impeller hitting	Check clearances
	Foreign matter in tub	Check for broken dish
	Loose parts	Check impeller and pump operation
	Low water level	Check for proper fill and water pressure
	Improper loading	Read owner's manual
	Machine not level and solid	Level and fasten

PORTABLE ELECTRIC HEATER

PROBLEM	CAUSE	CORRECTIVE ACTION
No Heat	No power to unit	Check fuse
•	Defective cord	Repair or replace cord
•	Switch off	Turn on switch
•	Defective thermostat	Replace thermostat
•	Thermostat set too low	Reset thermostat
•	Defective heater element	Replace heater element
Fan doesn't run (units having fan)	Defective connection to fan	Repair wiring
•	Burned out fan motor	Replace fan motor
•	Jammed fan blade	Straighten fan blade
•	Frozen motor bearing	Free armature and lubricate bearing
Won't shut off	Defective switch	Replace switch
•	Defective thermostat	Replace thermostat
•	Shorted wiring	Separate wires and reinsulate
Low heat	Defective heater element	Replace heater element
•	Incorrect thermostat setting	Reset thermostat
•	Line voltage is low	Notify power company
Shocks user	Defective wiring	Clear bare wire from frame and insulate it
•	Heater element sagging and touching reflector	Repair or replace heater element
Noisy	Fan blade hitting	Straighten fan blade or clear loose part or wire away from blade
•	Worn motor bearings	Replace motor bearings

POLISHERS AND SCRUBBERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Polisher will not run	Wall plug loose	Check that plug makes contact in outlet
•	Fuse in house circuit blown	Check fuse
•	Wall outlet defective	Check outlet with another appliance or lamp
•	Open circuit in cord	Check circuit in cord
•	Loose connection in appliance plug on cord	Check appliance plug for loose connection
•	Loose connection in plug at handle fork	Check handle plug for loose connection
•	Handle switch broken or loose	Check switch for loose connection and general operation
•	No voltage or low voltage	Check voltage at motor terminals. See that it is within 10% of voltage on nameplate of motor
•	Motor failure	See motor repair section
Excessive bearing	Armature not properly balanced	See motor repair section
•	Improper care	Check lubrication
Motor runs hot	Bearing trouble	Check alignment of bearing and lubricate
•	Failure of ventilation	Check ventilating openings and clean
•	Motor failure	See motor repair section
Motor smokes	Motor failure	See motor repair section
Motor is noisy	Unbalanced rotor	See motor repair section
•	Worn bearings	Check bearings; replace if necessary
•	Excessive end play	Check armature clearance
•	Worn gears or spindle bearings	Check gears and spindle bearings; replace if needed
•	Dirt in air gap	See motor repair section
Floor is sticky slippery or shows footprints after polishing	Inferior grade of wax may have been used	Use a good grade of liquid or paste wax
•	Too much wax	Use less wax
•	Wax may not have been rubbed well into floor and allowed to dry thoroughly	Allow wax to dry very thoroughly before polishing
Spots and streaks remain after scrubbing	Suds may have been dirty	Remove all dirty suds and water with "squeegee" or clean, dry absorbent rag
•	Dirty brushes	Clean brushes by washing in warm water and soap; then shake out, stand on bristles and let dry thoroughly before using again

continued on next page

Ruts and grooves cut in floor when sanding	Sandpaper disk may be too coarse Improper use of sanding attachments	Use a finer grade of sandpaper disk Floors should be sanded diagonally or across the grain of the floor
Excessive vibration (2-brush units)	One polishing brush may be worn	Replace polishing brushes as a *pair!*
Slow brush speed but motor OK (on belt driven units)	Worn or loose belt	Replace belt

ELECTRIC WATER HEATER

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No hot water	No power	Check fuse and replace it
•	Defective thermostat	Replace thermostat
•	Thermostat out of calibration	Replace heater elements
•	Defective heater elements	Recalibrate thermostat
	Defective wiring	Check all terminals and tighten if needed
Not enough hot water	Thermostat set too low	Reset thermostat to a higher temperature
•	Insufficient capacity for usage	Replace with larger capacity heater
•	Defective heater element	Replace heater element
•	Incorrect heater elements	Check elements for wattage and voltage against parts list
	Incorrect wiring	Check wiring against diagram
Water not hot enough	Thermostat set too low	Reset thermostat to a higher temperature
•	Incorrect heater elements	Replace heater elements
Water too hot	Thermostat set too high	Lower thermostat setting
•	Defective thermostat	Replace thermostat

FOOD MIXER

PROBLEM	CAUSE	CORRECTIVE ACTION
Motor does not run	No power at outlet	Check fuse in that circuit
•	Defective cord	Check cord for break
•	Worn brushes	Replace brushes
•	Open field coil	Replace coil
•	Open armature winding	Replace armature
	Defective governor contacts	Clean or replace contacts
Motor does not run and blows fuses	Frozen bearing	Free shaft in bearing and lubricate
•	Bent shaft, jamming armature	Straighten or replace shaft, clear jam
•	Shorted line condenser	Remove and replace
•	Defective armature or field coil	Replace defective part
	Shorted cord	Repair or replace cord
Motor runs, but beaters do not turn	Stripped beater gears	Replace beater gears
•		
Erratic operation and speed	Defective cord	Check cord for intermittent break and replace or repair
•	Worn motor brushes	Replace motor brushes
•	Loose connection	Repair connection
•	Defective speed control	Repair governor assembly
Slow speed or weak power	Incorrect speed setting for the work being done	Change speed control to correct setting
•	Too heavy a mix, beyond the power range of the mixer	Not a fault of the mixer being used
•		
Slow speed or weak power	Worn brushes	Replace brushes
	Defective speed control	Repair governor assembly

PORTABLE MIXER

PROBLEM	CAUSE	CORRECTIVE ACTION
Motor does not run	No power at outlet	Check fuse in that circuit
•	Defective cord	Check cord for breaks
•	Worn brushes	Replace brushes
•	Open field coil	Replace field coil
•	Open armature winding	Replace armature
•	Defective switch	Replace switch
Motor does not run and blows fuses	Frozen bearing	Free shaft in bearing and lubricate
•	Bent shaft, jamming armature	Straighten or replace shaft, clear jam
•	Defective armature or field coil	Replace defective part
•	Shorted cord	Repair or replace cord
Motor runs, beaters do not run	Stripped beater gears	Replace beater gears
Erratic operation and speed	Defective cord	Check cord for intermittent break and replace or repair
•	Worn motor brushes	Replace motor brushes
•	Loose connection	Repair connection
•	Defective switch contact	Replace switch
Slow Speed or weak power	Incorrect speed setting for the work being done	Change speed control to correct setting
•	Too heavy mix, beyond the power range of the mixer	Not a fault of the mixer being used
•	Worn brushes	Replace brushes
•	Bind in shaft	Clear bind
Motor runs hot	Bind in shaft	Clear bind
•	Shorted winding in armature	Replace armature
•	Shorted field coil	Replace field coil
Noisy	Armature hitting field	Replace worn bearing
•	Bent cooling fan blade	Straighten fan blade to clear
•	Dry gears or bearing	Lubricate as required
•	Bent beaters hitting each other	Replace or straighten beaters

ELECTRIC SHAVER

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Doesn't run	No power at outlet	Replace fuse
•	Defective cord	Replace card
•	Burned out motor	Replace motor
•	Switch not making contact	Bend switch contact arm
	Contact points burned	Replace contacts
	Shorted capacitor	Replace capacitor
Abnormal sparking	Worn brushes (Sunbeam)	Replace brushes, clean commutator
•	Dry bearing	Lubricate bearing
•	Defective capacitor	Replace capacitor
•	Defective suppressor resistance	Replace motor winding
•	Defective contact points	Replace contacts
	Improper timing	Re-time
	Shorted field winding	Replace motor winding
Slow speed	Dry motor bearing	Lubricate
•	Electrical defect	See "Abnormal sparking"
•	Binding or dry shaving head	Clean and lubricate
	Damaged shaving head	Replace head
Poor quality of shave	Shaver running slow	See section on this
	Worn shearing head	Replace head

ROTISSERIE OVEN

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No operation	No power at outlet	Check fuse
•	Defective cord	Repair or replace cord
•	Defective switch	Replace switch
•	Defective timer switch	Replace timer
Heats but motor does not run	Defective motor	Replace motor
	Stuck gearing	Clean gears
•	Defective motor switch	Replace motor switch
Motor runs but oven does not heat	Defective heater element	Replace heater
	Defective heater switch	Replace heater switch
Timer doesn't work but switches do	Defective timer mechanism	Replace timer
Spit motor noisy (Some noise is normal)	Load is unbalanced	Relocate meat on the spit
Incorrect heat	Defective thermostat	Replace thermostat
•	Thermostat off calibration	Recalibrate thermostat

HAND MASSAGER

PROBLEM	CAUSE	CORRECTIVE ACTION
Does not run	No power at outlet	Check fuse
•	Defective cord	Repair or replace cord
•	Defective switch	Replace switch
•	Open field coil	Replace field coil
	Open armature	Replace armature
	Worn brushes	Replace brushes
Speed is slow	Worn brushes	Replace brushes
•	Worn bearings	Replace bearings
•	Dry bearings	Lubricate with light oil
Erratic operation	Defective cord	Repair or replace cord
•	Loose connection	Repair connection
•	Worn brushes	Replace brushes
Noisy	Armature hitting field core	Worn bearings—replace with new ones
Excessive sparking at commutator	Worn brushes	Replace with new ones
	Dirty commutator	Clean commutator

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Will not run	No power	Check fuse and power supply
•	Broken wire or loose terminal	Check terminals and wiring for continuity
•	Door switch	Make certain door closes properly to actuate switch
•		Replace switch
•	Inoperative motor	Check motor thermal protector
•		Check motor centrifugal switch
•		Check motor wiring
•	Defective timer or timer circuit	Check timer wiring
•		Replace timer motor or timer switch as needed
Motor runs but main burner will not ignite	Heat switch set wrong	Correct switch setting
	Defective timer or timer circuit	Check timer wiring
•		Replace timer motor or switch as needed
•	Defective centrifugal switch in motor	Clean switch or replace it as needed
•	Gas supply valve closed	Open gas supply valve
•	Inoperative solenoid coil	Test coil for open circuit and the voltage to it
•		Replace defective coil
•	Defective thermostat	Check thermostat for operation
•		Replace if needed
Motor runs but drum does not turn	Broken or slipping belt	Replace belt
	Loose pulley	Tighten pulley on shaft
	Drum jammed or bearing frozen	Check for foreign object and clear it
•		Clean or replace bearing
Clothes not drying but dryer runs and heats	Defective operating thermostat	Test thermostat; replace if defective
	Fan or its pulley loose on shaft	Tighten set screw
	Incorrect heat or timer setting	Reset timer
•	Clothes too wet when placed in machine	Wring out or extract water from clothes before placing in dryer
•	Clogged lint screen or duct (little air motion)	Clean out lint screen and duct
•		
Will not shut off	Defective timer	Replace timer motor or switches as needed
Motor runs when door is open	Defective door switch	Replace door switch
Timer fails to advance	Dial binds	Relocate dial on shaft
•	Timer motor defective	Replace timer motor
•	Door switch open	Close door more tightly or replace door switch
Pilot burner goes out	Insufficient gas supply	Low gas pressure
		Clogged pilot filter
•		Partially closed gas valve
•	Carbon deposit on thermocouple tube	Clean tube and check pilot burner for proper combustion
•	Improperly adjusted pilot flame	Adjust pilot flame until faint yellow tip begins to appear
•	Faulty ignition or reset valve or thermocouple	Replace defective part
•		You may need professional help here!
Pilot burner does not light	No gas to the burner	Gas shut-off valve closed; open it
	Defective safety thermostat	Test thermostat; replace if defective
•	Gear switch set for "air"	Reset controls
Main burner does not light but pilot is OK	Insufficient gas supply	Partially closed shut-off valve or low gas pressure
•	Defective safety thermostat	Test thermostat. Replace if defective
•	Incorrect air supply	Adjust air shutter
	Main valve solenoid defective	Replace solenoid
Main burner cycles rapidly	Loose connection	Check wiring and terminals; tighten
	Defective timer	Replace timer
	Defective operating thermostat	Replace thermostat
•	Safety thermostat cycling due to restricted air flow	Clean out lint and other obstructions
•		
Main burner goes out	Insufficient gas supply	Partially closed gas shut-off valve or low gas pressure
•	Incorrect primary air adjustment	Adjust air shutter for clean bright blue flame
•	Loose connection in wiring	Tighten all terminals

GAS RANGES

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Baked goods burn bottom	Oven flame too soft	Increase primary air at air shutter
•	Dark utensils	Use bright utensils
•	Improper circulation	Use bright utensils
•	Utensil too large for amount of batter used	Use smaller utensil
•	Baffle improperly positioned, smothering flame	Reposition baffle
•	Flue blocked	Open flue
Baked goods burn on one side	Utensil in direct line of heat circulation	Allow 1½ in. at sides and 1 in. front and back
•	Range or utensil not level	Level range. Replace warped or dented utensils
•		
Baked goods burn on top	Oven flame too hard	Decrease primary air
•	Baffle upside down	Properly position baffle
•	Flue blocked	Open flue
Baked goods crack open	Oven too hot	Check calibration—use lower temperature
•	Batter too stiff	Check recipe
Baked goods soggy	Oven not hot enough	Check calibration—use higher temperature
•	Improper ingredients or failing to remove promptly from pan	Check recipe
•		
Pilot outage	Draft	Check location in respect to open doors, windows, fans, etc. Relocate range or baffle air from striking pilot
•		
•		
•	Loose oven door	Check door fit at top; tighten springs
•	Improper pilot adjustment	Readjust to proper flame. Minimum tinge of yellow on steady flame
•	Improper burner adjustment	Readjust main burner so that its ignition will not extinguish pilot. May be too much air or gas
•		
•	Splatters from broiler put pilot light out	Lower food slightly
•	Oven pilot will not light	Check safety valve and thermocouple
•	Clogged filter	Clean or replace
Fuses blowing	Metal part of light socket touching frame	Make certain bulb and socket are tight and clear from flame
•		
•	Short in wiring	Trace wiring and clear short
Top burner won't light	Pilot light out	See pilot outage
•	Excessive air in gas mix	Adjust air shutter
•	Burner not in its proper position	Reposition burner
•	Incorrect height of pilot flame	Adjust to satisfactory flame
•	Pilot incorrectly positioned	Reposition pilot
Yellow tips on gas flame. Smoky flame	Too much gas in proportion to air	Adjust air shutter. Clean air shutter
•	Burner dirty	Clean burner thoroughly
Flames lift from burner	Excessive primary air	Adjust air shutter
•		
Clogged burner. Carbon forms on utensils	Food spilled on burner	Clean burner
•	Incorrect air gas ratio	Adjust air shutter
Gas odor	Leak	Locate and correct
•	Pilot flame impinging on burner casting	Relocate pilot so flame doesn't touch
•	Oven burners out of adjustment	Reduce air to burner
Condensation or sweating in oven	Oven not preheated with door open	Open door during preheat
•	Oven door doesn't seal at top	Adjust oven door
•	Clogged oven vent	Clear vent
•	Temperature setting too high	Operate oven at lower temperature
•	Heat control not properly calibrated	Recalibrate oven control
Oven heat control doesn't lower flame	Improper by-pass adjustment	Adjust by-pass to lowest possible flame
•	Foreign matter in heat control	Clear out control
•	Defective control or capillary tube	Replace control
Porcelain crazing	Utensil being used is too large for burner	Use large burners for large-bottomed pans
•	Cleaning with moist cloth when hot	Wait until stove is cool before wiping

REFRIGERATORS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Refrigerator does not freeze properly. Turns on and off automatically, some frost on evaporator but ice cubes do not form in trays	Dial set improperly Defective thermostat	Reset dial Replace thermostat
Unit runs continuously, liquids in main storage compartment freeze	Dial set improperly Defective thermostat	Reset dial Replace thermostat
Unit will not run at all	Blown fuse Defective cord or plug No power at wall outlet	Replace fuse Repair or replace Plug refrigerator into another circuit; check outlet with lamp
Unit will not run, no hum, but light in compartment operates	Defective thermostat, relay or motor	Replace defective part
Compressor will not operate	Defective relay	Replace relay
Feeble, erratic starting, with motor taking too long to reach full speed	Defective relay	Tapping relay housing with screwdriver handle may cause motor to start temporarily
Same as above with intermittent hum from motor	Poor circuit due to burned or pitted contacts in relay	File burned and pitted contacts in open relay; readjust for good contact, or replace relay
Unit runs too long at a time	Dial set improperly Clogged or dirty condenser Vertical condenser placed too close to wall for proper air circulation	Reset dial Clean Allow more space between refrigerator and wall
Evaporator frosts up too quickly, requires frequent defrosting; unit runs more often than necessary	Leaking door gasket	Replace damaged gasket and/or tighten door catch
Motor noisy, does not run with usual speed and power, or fails to start even after new relay has been installed	Defective motor or compressor	Call serviceman; new unit required
Refrigerator runs continuously, but little refrigeration produced	Low gas supply	Call serviceman; new unit required
Refrigerator turns on and off and freezer compartment works okay; refrigerator compartment is warm (double-door refrigerator)	Faulty valve prevents cooling coil for main area from receiving sufficient refrigerant	Call serviceman
Rattling sound when unit shuts off	Tubing leading from unit to evaporator vibrating against cabinet	Do not bend tubing; insert piece of rubber between tubing and cabinet
Water in bottom of automatic-defrosting refrigerator	Obstruction in drain tube running from tray under evaporator down back wall to tray mounted close to unit	Run piece of fine wire down tube to clear it

VACUUM CLEANERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Motor will not run	No power	Check outlet for power
	Defect in cord	Check cord plug for damaged prongs and cord for a break
	Defective switch	Replace
	Worn carbon brushes in motor	Replace with new brushes
	Jammed fan	Free fan. If bent or damaged, replace it
	Frozen motor bearings	Clean and lubricate. If too worn, replace
	Open or shorted motor winding	Repair or replace defective part
	Poor contact of cord plug at wall outlet	Check plug prongs, wire connections, and outlet

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Motor starts and stops while cleaner is being used	Intermittent break in cord	Shake cord to locate break
•	Loose connection in cleaner	Check all wire connections
•	Defective switch	Replace switch
	Loose connection within motor	Check motor and tighten connection
	A short in the wiring (will blow fuses)	Check wiring and insulate the bare spot
Motor running too slow, no power	Misaligned or tight motor bearings	Realign bearings
•	Something caught on fan or armature	Remove the foreign object
•	Burnt out armature or field coils or poor brush contact in motor	Repair or replace defective part
Motor running too fast	Fan loose on shaft and not turning with armature	Check its balance
•	Shorted field coils	Replace both
•	Overfilled dust bag	Replace if disposable, otherwise thoroughly clean
Motor sparking	Dirty commutator (oil and/or dirt)	Clean with strip of 2/0 sandpaper
•	Worn brushes	Replace both brushes
•	Incorrect brush seating or commutator	Check for correct seating; allow to run free
•	Open wire in armature	Replace or rewind armature
Motor noisy	Foreign matter in motor	Clean out
•	Fan damaged	Replace fan
•	Armature hitting	Realign armature
	Worn bearings	Replace bearings
Poor dust pickup	Worn or damaged attachments	Check attachments for cracks causing leakage and replace as needed
•	Leaky hose	Check hose for air leaks and repair or replace hose
•	Clogged hose	Blow or push obstruction out of hose
•	Overfilled dust bag	Replace or clean out dust bag
•	Clogged exhaust port	Clear out obstructions
•	Defective motor and fan assembly	See motor checkout items
Poor pickup and cleaning (upright models, in addition to previous problems)	Broken belt	Replace belt
•	Stuck agitator brush	Clean bearings free of dirt
	Incorrect nozzle adjustment for carpet nap	Adjust nozzle for correct contact to carpeting
Dust leakage into room	Holes in dust bag	Replace dust bag
•	Incorrectly installed dust bag	Install per your owner's manual instructions
•	Defective or leaky sealing gasket	Replace gasket
•	Old and dirty dust bag (for machines using cloth bag)	Replace dust bag

FANS, AIR MOVERS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Won't run but fan is free to turn	No power	Check for connection at outlet
•	Break in cord	Check fuse for fan's circuit
•	Defective switch	Repair or replace cord
	Defective motor	Repair switch
		Repair or replace motor
Fan won't turn	Blades hitting grille	Straighten grille and blades
•	Armature hitting stator within motor	Usually due to worn bearings, rust or foreign matter within motor. Must be cleaned and worn bearings replaced
•	Armature frozen in bearings. Lack of lubrication	Free armature and lubricate
•	Misalignment of bearings	Realign bearings
Runs in one speed only (models with 2-speed switch or other speed control)	Defective switch	Replace switch
•	Defective speed control	Replace speed control
	Poor connection	Check and tighten switch terminals
Runs slow	Bearings dry, gummy or misaligned	Clean, relubricate and realign bearings
•	Defective speed control	Replace speed control
Noisy	Fan blades hitting	Clear obstruction and straighten blades
•	Fan blades bent	Straighten blades
•	Worn bearings	Replace bearings. In some instances this may not be practical and motor housing must then be replaced

APPLIANCE TROUBLESHOOTING PUMPS

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Motor will not run	No power to system	Check fuse, break in wiring, power failure
•	Defective pressure switch	Operate switch manually until replacement is made
•	Motor overload protector is out	Allow motor to cool off
•		Check for jammed impeller by turning the shaft by hand
•	Defective motor wiring	Repair motor
Motor hums but does not run	Line voltage may be low	Check power source for correct voltage
•		Check motor voltage with its name plate rating
•	Overload condition in pump	Check wiring for correct size Bearing may have seized
•		Foreign matter may have jammed impeller
•	Defective motor starting capacitor	Replace capacitor
Thermal overload protector functions too often	Overloaded pump	Check pump for jammed impeller, seized shaft or misalignment
•	Frequent short cycling overheats motor	Incorrect usage of pump Suspect waterlogged tank and add air
•	Low line voltage	Check voltage (see above) and wiring
•	High surrounding temperature	Check ventilation. Shade from sun
•	Faulty overload protector	Replace protector
Pump is noisy (Some noise resulting from ejector water flow is normal)	Bearing may be worn	Replace bearing
	Impeller may be misaligned	Realign shaft and impeller
	Pump may not be mounted rigidly	Mount pump and piping securely
	Pump may be pulling extreme vacuum	Clear abstruction in the suction lines
•		Check water table; you may need a deep well pump
Pump operates but loses prime	Air leak in the suction line	Check entire suction side for air leakage: pipes, fittings, air volume control
•	Water may draw down below foot valve	Have well checked for clogged screen or low water-table
•	Gas in well	Call in a well expert

SHALLOW WELL PUMPS with vacuum gage

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No vacuum reading and no water delivery	No prime at pump	Prime pump
•	Leaky seal	Replace seal
•	Leak in suction line	Plug suction line at various places to isolate leak, then repair as needed
•	Defective air volume control	Replace control. Check by plugging hole in suction line
•	Plugged or sticky check valve or screen (when valve is between gauge and pump)	Clean out valve and its screen
Maximum vacuum reading steady at approx. 28 in. but little or no water delivery	Water level too low for pump to lift (over 25 ft.)	Change to deep well pump
	Well point screen is clogged, preventing water from entering	Have new well point and screen installed in well
•	Foot valve stuck closed	Repair or replace foot valve
Gage hand climbs steadily then drops suddenly to zero	Leak in the suction line at some point below normal water level allows air to be sucked into the pipe	Call in a well man. Water-table may have dropped and/or well screen may be partially clogged
•	Insufficient water	
Gage hand rises to required height; when pump stops, it recedes slowly instead of dropping at once	Leak in suction line	Check fittings at pump. Call in well expert having the special tools. New well casings may be needed

Where to Obtain Replacement Parts

SOME time or other, when you are repairing an appliance, a new part will be needed. There is no one book, or other generally available source, that lists all the parts needed for the repair of all appliances, so your first check would normally be the local authorized dealer handling the particular appliance. If you don't know who he is, look him up in your classified directory.

Dealers, however, cannot possibly stock all parts that might be needed for all the models, past and present, of the brands they carry. Their inventory cost and that of the warehouse space needed would be prohibitive. Instead, they maintain a small stock of the parts most likely to need replacing.

The progressive dealer will have a parts list and catalog on hand from which you can obtain the correct manufacturer's number of the needed part. If he has that part in stock, you're in luck. If not, you may have to order it. How soon you get it depends on the dealer, the post office, the distributor and/or factory. Two weeks should be sufficient. If delivery takes longer than that, someone has "goofed."

If You Have No Dealer, you may order directly from the factory. Chances are, however, that you will not have a parts list for your appliance and will not know what to order, short of sending the old part back and saying that you want one like it. This is done quite frequently, so don't hesitate to try it if you feel there is no other way.

Here is an alternate, direct-order method to try first. List your appliance by name, model number, and serial number. Then describe the part by its location in the machine, by the job it does, and state its condition. If the factory representative is puzzled as to what you mean, he will at least know which parts catalog to send so that you can then order by the correct part number.

If you know the name and address of the national or regional distributor for your faulty appliance, you can contact him instead of the manufacturer. Better yet, if you should happen to live within practical traveling distance to his headquarters, you could make your request for the part in person, at the service department's parts desk.

If your appliance is a "house" brand of a national mail order house such as Sears or Wards, write to the company's service department as you would a manufacturer. You can also order the part through one of the branch stores, but do not expect to pick it up on direct call unless it is a normally stocked replacement.

Independent Supply Sources are often the quickest means of obtaining the part you want. The trick is to know who they are, where they are located, what appliance lines they specialize in, and which ones will sell directly to you—the consumer. You may find several in your local classified directory listed under the name of the appliance, or "electric repair service," "appliance repairs," etc. In smaller communities, these suppliers will seldom have many parts, but will be able to get them quickly from larger firms who will sell only to servicemen.

While most of the larger firms with big stocks of appliance parts will not sell to the consumer, there are some very welcome exceptions. Among them are these three Chicago firms that will handle mail orders as small as $1 plus shipping cost:

Washers, Dryers, Vacuum Cleaners
Midwest Appliance Parts Co. (M. Meiman)
3647 W. Fullerton Ave., Chicago 47, Ill.
Tel. BR 8-1300.

Washer-Dryer Parts Only
Clarke Appliance Parts Co.
(Kenneth Clarke)
4872 N. Milwaukee Ave., Chicago 30, Ill.
Tel. PA 5-1111.

All Small Appliances
C. W. Smith Co.
5459 W. Lake St., Chicago 44, Ill.
Tel. CO 1-7855.

Electra-Craft, Inc.
348 W. 42nd St., New York 36, N. Y.
Tel. LO 3-2885

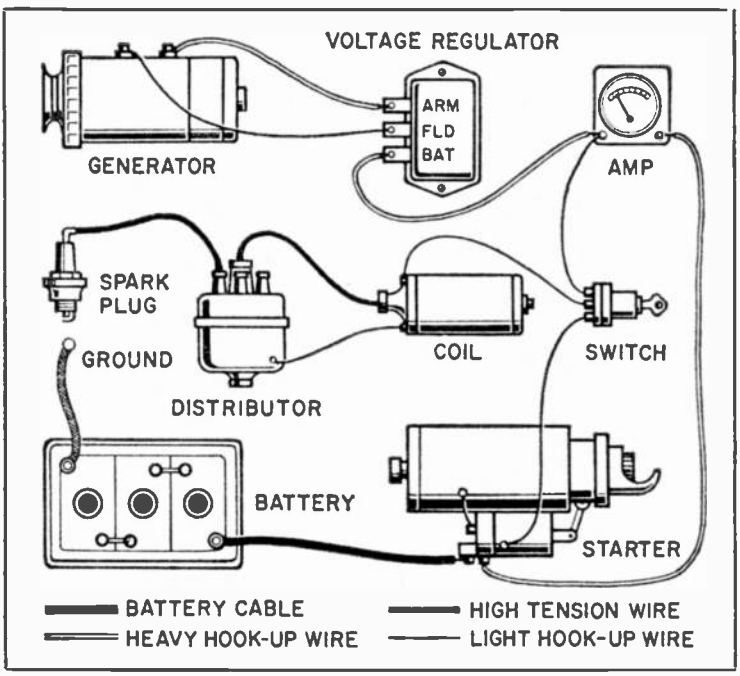
Reading Electric Co., Inc.
308 Canal, New York 13, N. Y.
Tel BE 3-7800

For most expedient and accurate handling, be sure to state the make, model, and year of your appliance and any other descriptive information possible that will make identification more positive.

If you know the cost of the part, include a check or money order with your order, whether addressed to dealer, distributor, manufacturer, or mail order firm. If not, you must be prepared to accept the part COD. Shipping parts that way is the most practical for factories to handle individual orders. Extra paper work and bookkeeping involved in separate billing and collection are costly.

YOUR CAR'S ELECTRICAL SYSTEM

By MORT SCHULTZ



Suspect the wires and electrical connections if your car is still hard to start and rough running even when you know it is in proper tune. Here is the how and why of the checks you can and should be able to do yourself

A DAMAGED wire or cable, corroded battery connection, poor ground or faulty switch can quickly turn your smooth running, powerful automobile into a 3498 lb. weakling. Easy-to-find and fix electrical system troubles can even put you completely out of operation if you don't know what to look for and how to make simple repairs.

This article deals with the wiring that makes your car go. It assumes that all parts of the ignition system (distributer, spark plugs, and coil), fuel system (carburetor, fuel pump, filter and fuel lines), and that the engine itself (compression, valve and spark timing), battery, and charging system (generator or alternator, and voltage regulator) are in good working condition and functioning as they should.

With all of these systems working right, your car's wiring system can still make it hard to start, ragged running and much more of a gas hog than it should be.

Plain dirt or corrosion between a cable or wire terminal and its connection is a common reason for high resistance and poor performance. A quick, off-the-cuff try for a fast cure is to disconnect the suspected wires or cables one at a time, clean the connections and replace them.

Start with the primary wiring circuit (Fig. 1). These are the wires that carry the current to fire the spark plugs and make your engine run.

Do a careful job of cleaning each terminal end, holding bolt and nut and contact surface. Use a wire brush, fine emery paper, or steel wool to remove hard dirt, paint, corrosion. A cloth dampened with gasoline or cleaning fluid will help remove oil and grease deposits. Don't forget the connections on the braided copper ground strap between the engine or transmission and the frame of the car.

When you complete a careful job of terminal cleaning, chances are that your car will have even better connections than it did when it was brand new. There will be no paint under terminals or bits of insulation trapped in electrical connections as there often are on newly built cars.

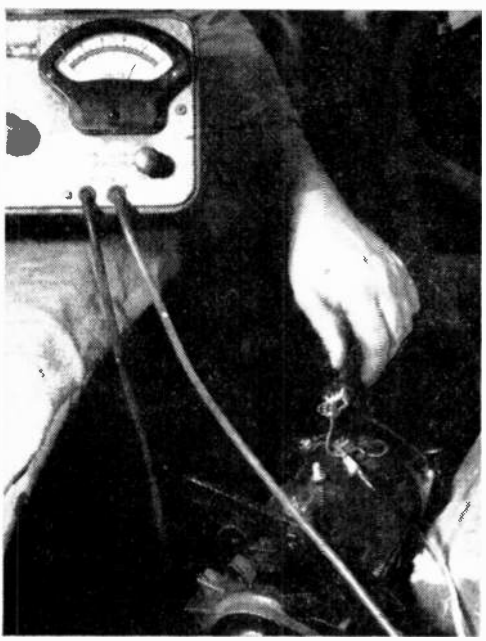
Make this kind of cleaning and inspection a part of your tune up procedure and you will go a long way toward having a smooth-running trouble-free car.

While you clean terminals and connections, check each wire carefully for frayed insulation, cracks, and kinks. Such visible defects often point to internal faults which could cause high resistance or no continuity between one end of the wire and the other.

If a wire looks bad, you can test it with a voltmeter (perhaps you can borrow one from a hi-fi enthusiast friend or the service station where you trade regularly if you don't have one of your own). If you can't get a voltmeter, you can still check wires for continuity and high resistance with a home-made tester.

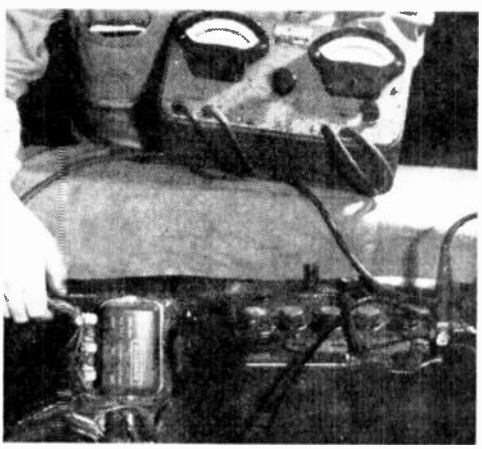
For testing hot circuits, use a bulb like the ones in the tail lights or parking lights of your car. Solder a length of auto hookup wire to the side of the bulb and attach an alligator or spade clip to the other end. To test a circuit, simply attach the clip to the terminal at one end of the wire to be tested and turn on the switch. If the bulb lights when you touch it to ground, that end of the wire is getting juice. If the bulb seems to be just as bright when clipped to the terminal at the other end of the wire, then chances are there is no high resistance in the line.

Using a voltmeter start to check overall circuit condition by hooking one lead to the ARM (armature) terminal of the voltage regulator (Fig. 2) and the other end to a clean ground. Make sure leads are connected with correct polarity. Most US

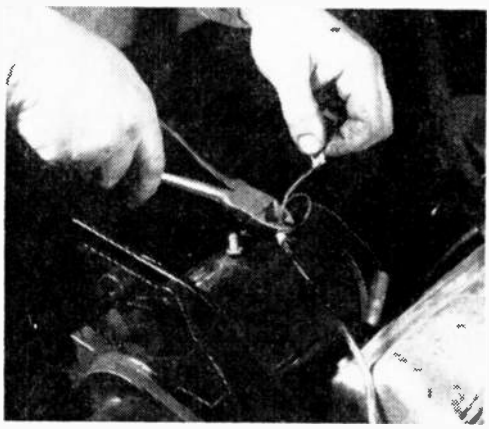


2: Test generator ground wire by connecting voltmeter hot lead to hot battery post (+ lug on U.S. cars) and ground lead to wire. Meter reads 12V.

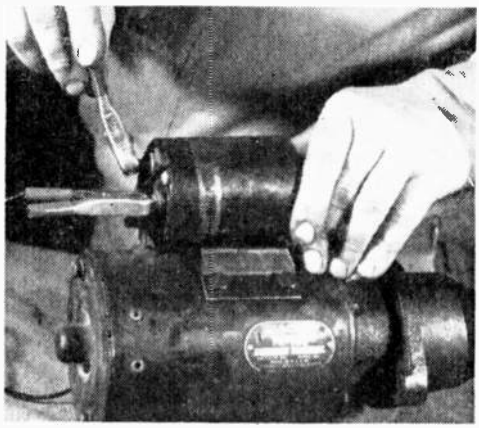
3: Spot high resistance in charging circuit by connecting hot voltmeter lead to ARM (armature) terminal on voltage regulator and ground lead to ground.



cars have negative (−) grounds, most British cars have positive (+) grounds. If in doubt check to see which terminal on the battery is connected to ground or check the owner's handbook. (If you have an alternator equipped car make this test on the FLD [field] terminal of the regulator.) Remove the heavy wire from the center of the coil tower so the engine will not start when cranked, turn on the switch and crank the engine for 30 seconds. The voltmeter should read at least 9.0V. on 12V. cars, 4.5 on 6V. systems, and remain constant throughout the whole 30-second cranking period.



4: Easy cure for high resistance wire is to cut off original end and replace wire with a new line. For a neat job, tape new wire outside old harness.



5: Test starter switch by jumping battery contact and control terminals. If starter spins when key or push button is operated then switch is all right.

Lower readings or 0.2 voltage drop indicate high resistance in the cables. To find the trouble follow this step-by-step testing pattern:

1. Start at the generator (or alternator). The three wires here are the ground, the field, and the battery wire. Most cars tell which is which. If not check your owner's handbook for a wiring diagram. By checking all three, you test the condition of the wiring system between the generator (or alternator) and the battery.

2. Disconnect ground wire. Connect the hot lead of the voltmeter to the ungrounded battery terminal and the ground lead to the generator ground wire. Turn on the ignition switch. The reading should be 9.0 (12V.) or 4.5 (6V.). A lower reading means excessive resistance. Reconnect the wire to the generator if it is OK.

3. Remove field wire and repeat the test with the hot lead from the voltmeter on the hot terminal of the battery and the ground lead attached to the field wire. You should get the same reading as before. Reconnect this wire if it checks out.

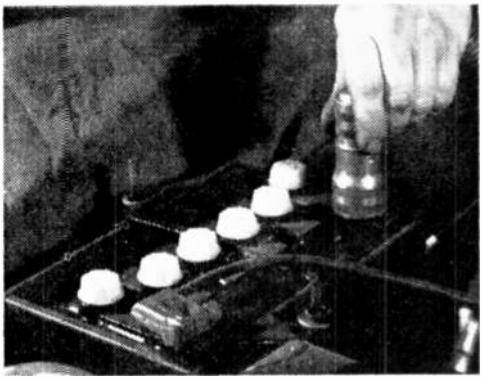
4. Last, remove battery wire from the generator. Now switch the voltmeter leads connecting the hot lead from the meter to the generator wire and the ground lead to a clean ground on the engine. Again the readings should be 9.0 or 4.5.

5. The quick fix for a high resistance line is to replace it. Simply cut off the terminal end of the old line at the generator (Fig. 4) and run a new line to the same terminal at the regulator. Field (FLD), battery (BAT) and ground (GRD) are usually indicated on the regulator or the color code of the wires is the same. Next cut off the other end of the wire at the regulator. Run a new wire of the same size as the old one from the generator or alternator to the regulator. Tie it to the outside of the wiring harness with electrician's tape for a neat job.

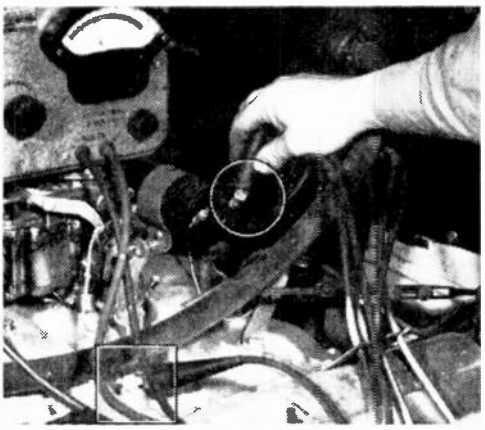
6. Check the heavy cables from the battery to the starter switch or starter relay with voltmeter ground lead to ground. Voltages should read 9.0 or 4.5 on 12 and 6V. systems. Before replacing cables check out the starter switch by using a jumper cable to bypass it. Check the wiring dia-

gram in your owner's handbook, car's workshop manual or a Chilton or Motor Repair Manual from your library. If the starter operates vigorously when you jump the switch or relay, but not when you don't, then replace the switch or relay.

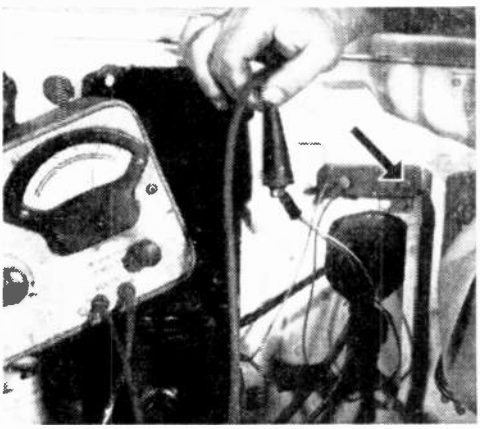
The next test *is the* primary ignition circuit. Again, do it by the numbers. Make a quick overall test of the system by connecting the ground lead from the voltmeter to ground and the hot lead to coil's battery side (usually marked BATT). Both 6- and 12V. systems should check out at 4.5 volts because 12V cars have a resistor to cut



7: Battery cleaning tool combines inside wire brush (in use for cleaning battery lugs and outside brush (covered) for cleaning inside terminals. Cost $2.



6: Primary ignition circuit is tested with voltmeter ground lead to ground (box) and hot lead (circle) to battery side of coil. Meter reads 5.5V. for 12V. car.



8: Check ignition switch by removing wire from resistor (arrow). Note meter reading is back to 9V. for this 12V. car. A 6V. system should read about 4.5V.

voltage in half.

High resistance may be in the wiring or in the ignition switch. Check the wire with the voltmeter connected between ground and the hot lead at the ammeter. High resistance means you need to replace the wire. A proper reading (4.5V.) points to a faulty ignition switch.

Check the switch by turning on all the accessories that operate off it (radio, heater, dash lights) and see if the switch heats up more than the surrounding area. A hot switch is overloaded and needs replacing.

The last wiring check is on the high tension leads to the spark plugs. One way to spot electrical leaks is to run the engine in a pitch dark garage with the hood raised. Little flashes of light around these wires mean faulty insulation. The cure is replacement. Be sure to get the right kind of high tension lead wire for your car. Many late model cars use special wire with carbon conductors. These must be handled carefully to avoid breaking the fragile conductor. Even yanking the wire to remove it from the spark plug can break the conductor and cause rough running, so be gentle in your cleaning, checking, and tune-up work where spark plug leads are handled.

Of course, make sure these connections are clean and tight when you check out the wiring. Adding a flashlight battery to your bulb and wire tester lets you make a quick check on these or any other wires for continuity. If the bulb lights when you touch the test clip to the bulb, but does not when you make contact through the length of wire you want to check, then you know the wire is broken. A noticeably dimmer bulb points to high resistance.

Curing Nine Types of Alternator Ailments

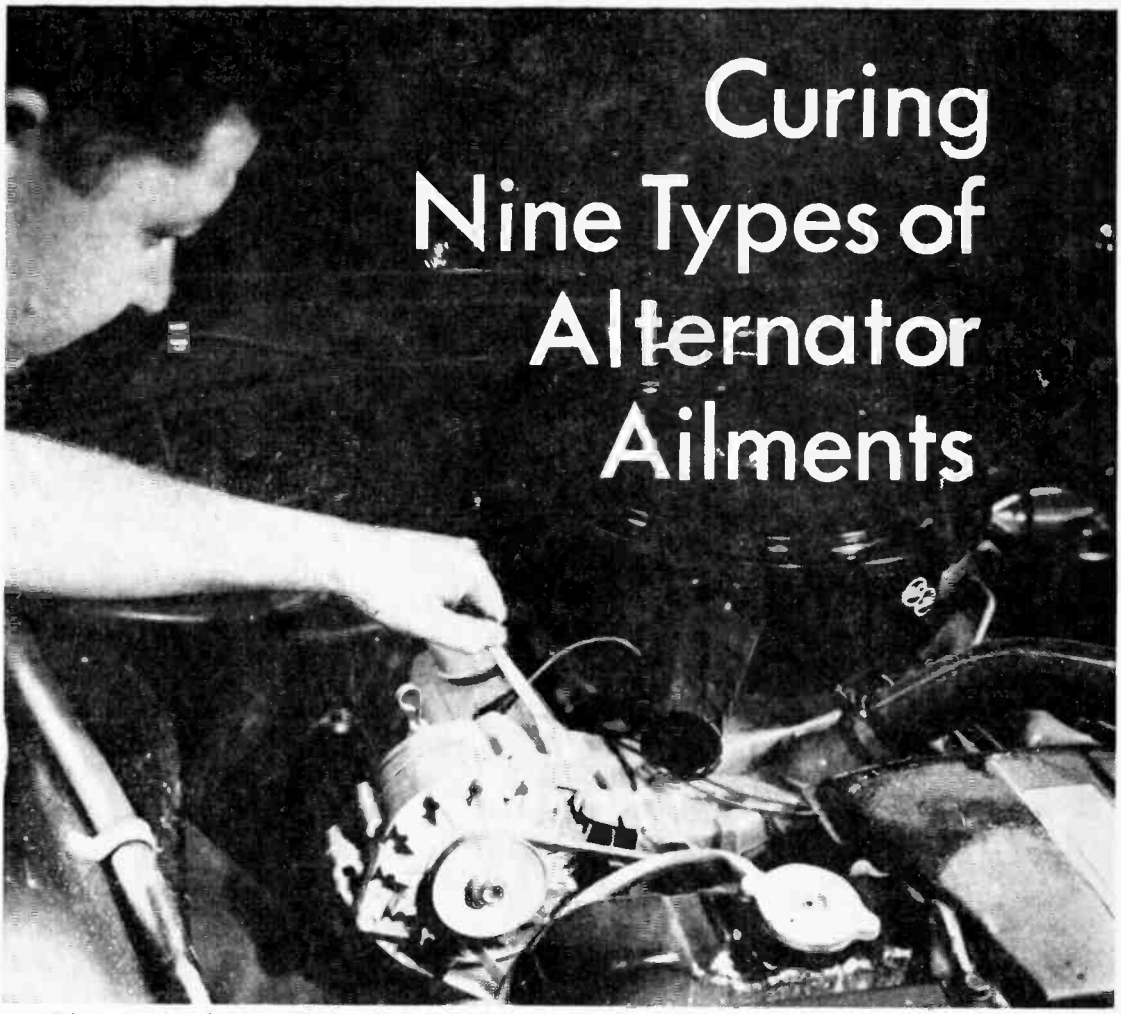


FIG. 1: A noisy alternator can be silenced by tightening the mounting bolts and securing the drive pulley.

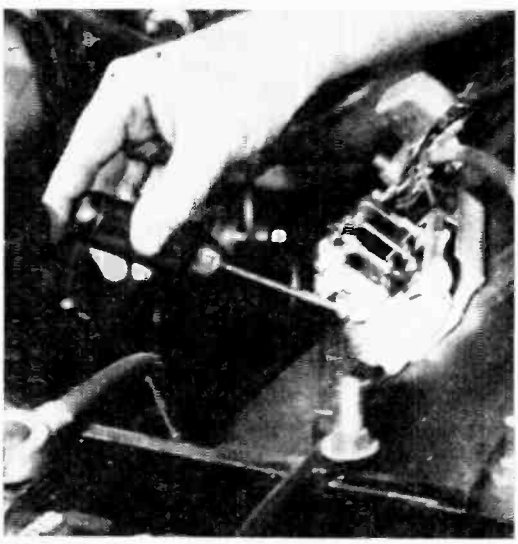


FIG. 2: Set regulator points with a screwdriver or by bending the tang with insulated needle-nose pliers.

FIG. 3: Brushes do not carry a very heavy load. When they wear it's usually caused by excess lubrication.

Cause of the malfunction does not have to be in the generator, but can be in another part of the system

By HOWARD STEVEN

YOU don't have to look with puzzlement at the alternating generator, which may now be part of your car's charging system, should trouble rear its head. Actually, the alternator is no harder to troubleshoot and repair than its predecessor, the dc generator. In many cases, it can be a lot easier.

To save yourself time and money, it is best to tackle the easy troubleshooting tasks first should any of the malfunctions listed below occur. Many times the trouble can be cured by simply tightening a connection (Fig. 1) or adjusting a fan belt. Seldom will you have to replace an entire alternator, since the unit breaks into two parts, both of which can be replaced.

One factor to keep in mind when working on an alternator is to guard against reversing polarity. Reverse the polarity of the alternator or the battery for even an instant and you've got a burnt out wiring harness, and stand the chance of burning out the diodes. To prevent accidental grounding use insulated tools whenever you're working in the general area.

No Charge. If this happens, the ammeter troublelight on your dash will glow red when the engine idles or when it is accelerating. Another consequence of an alternator failing to charge is a dead battery.

Look to the fan belt first to determine if it is broken. If so, replace it. Also check belt tightness, since a loose belt could prevent the alternator from charging. Adjust the fan belt to the specifications outlined in your car's manual (usually about ¾ in. of free play).

If the fan belt checks out, inspect the regulator next. Make sure all connections at the regulator are tight. If this fails to uncover the problem, check the regulator for burned or pitted points (Fig 2). If you find them, don't try to salvage the unit by filing the points. It won't work and you may eventually ruin the alternator. Replace the regulator with a like unit.

If the alternator still fails to charge, look to that unit itself. First, however, clean, check and tighten all connections including those to the ignition switch, the ballast resistor, the voltage regulator, and the con-

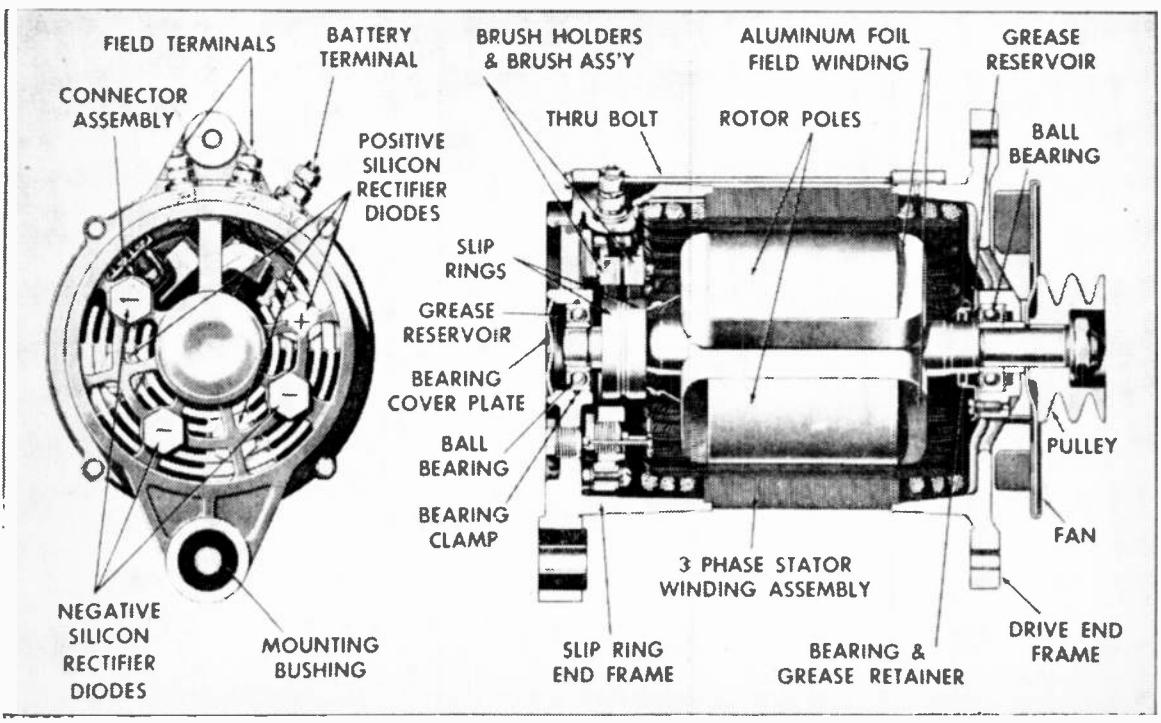


FIG. 4: There are usually six rectifiers in an alternator. Check them for negative and positive readings.

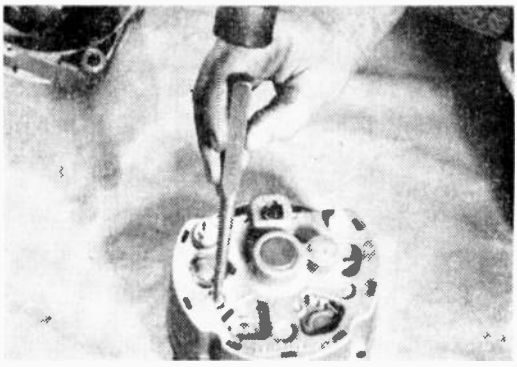


FIG. 5: Faulty rectifiers have to be punched from their seat. Use rosin-core solder to attach the replacements.

Curing Alternator Ailments

ducting surfaces of the fuse and holder.

Now unscrew the brushes from the unit, if possible, and inspect them for wear. If worn, they should be replaced.

In some cars, such as Chrysler products, the brushes can be removed from the alternator with the unit on the car. This is done by unscrewing external cap screws to which the brushes are attached. In other cars, such as with this Pontiac, the unit must be removed from the car and broken open to reach the brushes, which can then be unscrewed as shown in Fig. 3. Major parts of the unit consist of rotor and stator (see page 95).

Make Circuit Tests. Rectifier testing is usually done with a special meter (Fig. 4), although you can use an ammeter calibrated in 1-amp units. Simply touch each rectifier with the probe. The meter should read at least 1¾ amps. If not, the rectifier is the cause of the trouble; replace it (Fig. 5).

Next inspect the stator windings carefully for breaks. To be absolutely sure, you should test from the stator leads to the stator core with a 110-volt test lamp or other suitable tester. If the lamp lights, the stator is grounded and should be replaced.

Finally, test the field windings in the rotor part of the alternator. This is done with an ammeter hooked to the alternator battery output terminal while turning the rotor shaft by hand. The correct field current draw should be recorded on the meter. This reading differs from car to car, and you should consult the service manual for your vehicle.

Low Charging Rate. This trouble is indicated by an ammeter light that flickers on and off at low engine speed and idle, and by a rundown battery.

Look at the fan belt first and make sure it's properly adjusted. Then check the battery terminals where high resistance could be causing the trouble. Remove the cables and clean the terminals and posts. Make sure the ground cable is clean and tight.

Finally, check at the alternator for loose connections. If the trouble is still occurring, replace the brushes since poor contact between brushes and slip rings is a major reason for the malfunction. As a final solution, remove the alternator from the car and check the stator. Open windings will cause an unsteady low charging rate.

Low Voltage Output. If the ammeter trouble-light flicks on and off at all speeds and you have a rundown battery, which indicates a low voltage output, check the regulator first.

To do this, hook the negative lead of a voltmeter to the battery's negative post and the positive lead to the battery's positive post. Connect a jumper wire from the ignition terminal to the field terminal on the regulator. Start the engine. The voltmeter should read about 14.3 to 15.0 volts for a 12-volt charging system and 7.0 to 7.5 volts for a 6-volt charging system. If not, the regulator is faulty.

The trouble could be a low regulator setting, so try adjusting the points first (Fig. 2). If this doesn't increase the voltage output, get a new regulator.

If the regulator checks out, go to the alternator and tighten all connections. The trouble could also be with a shorted rectifier or grounded stator.

Too Much Charging. This will show up in the form of acid salts on the battery top and the use of an excessive amount of water by the battery. The trouble here can only be in the regulator, so test the unit. If the regulator is set too high, adjust the points. If this does not cure the trouble, don't scrap the regulator unit yet.

First remove the unit and clean its mounting surface. A poorly grounded regulator

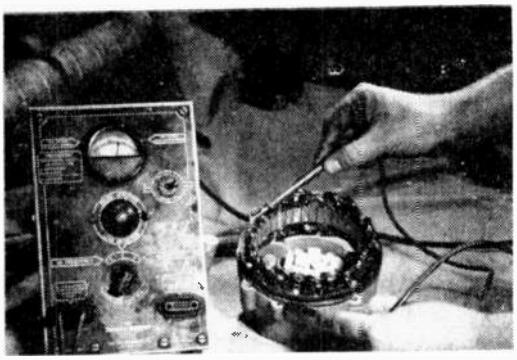


FIG. 6: Check for a grounded condition in the alternator shell by touching stator winding assembly and case.

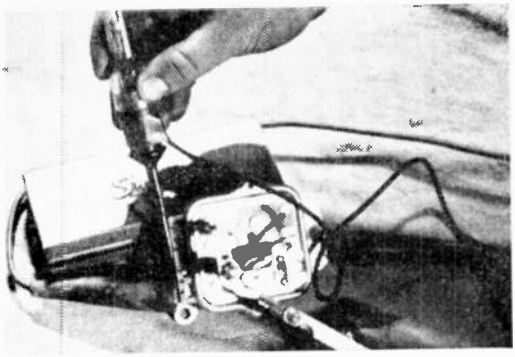


FIG. 7: Test regulator air gap with a gauge and trouble-light. Lamp should dim when armature is pressed down.

could be causing the problem. If not, the trouble is either that the regulator points are stuck or there are open windings in the unit. Either way, replace the regulator.

Oxidized Regulator Points. If the battery is using too much water or a lot of acid salts are showing up on the battery top, it could also mean that the regulator points are oxidized. The cause could be a loose or dirty ground connection, so clean the mounting surface and tighten all attaching belts.

Now, test the regulator. If the meter shows a high voltage setting, adjust the points.

Finally, check and adjust the regulator air gap to specification shown in Table 1, or as called for in your car's manual. To do this, connect a test lamp between the regulator ignition and field terminals. Insert the proper wire gauge (usually one of .048 in.). Press the armature plate down. The contacts should open and the test lamp should dim.

Now, insert a larger wire gauge in the same position (usually one of .052-in. gauge). Depress the armature plate. The upper contact should be closed and the test lamp should remain lighted.

If the air gap doesn't check out, adjust it by bending the upper contact support until you get the right opening and test readings.

Another cause of oxidized points could be shorted field windings in the rotor pole. In this case, the rotor will have to be replaced.

Burned Regulator Points. Again, excessive use of water by the battery and acid salts on battery are an indication of this condition. The trouble is probably a regulator set too high or shorted field windings in the rotor pole. In the former case, adjust the points—in the latter case, replace the rotor.

Noisy Alternator. An alternator that raises havoc is one that is either loose on its mountings or one that has internal troubles. First check the mounting bolts and make sure the alternator is tightly connected. The drive pulley could also be causing the noise, so tighten that as well.

If this fails to uncover the cause of the racket, remove the unit from the car and break it open. Inspect the rotor fan blades. If they are bent, replace the rotor. Now, test each rectifier for shorts. If this doesn't uncover the problem, the trouble is a sprung rotor shaft, worn shaft bearings, or open or shorted windings in the stator, and a rubbing rotor pole.

In the event of a sprung rotor shaft, replace the rotor. If you believe the problem is caused by worn shaft bearings, you can have them replaced as well. If however, the stator windings are shorted and the rotor poles are rubbing, you will have to replace the entire alternator.

Points Stuck Closed. If the battery keeps running down, it indicates that the regulator points are stuck closed. This was probably caused by a poor ground connection between the alternator and the regulator. The only course is to replace the regulator and make sure the new unit is properly grounded so the trouble doesn't happen again.

TABLE 1: SETTINGS FOR ALTERNATOR VOLTAGE REGULATOR

MAKE	AIR GAP	POINT GAP
Buick	.057	.014
Cadillac	.057	.014
Oldsmobile	.060	.014
Chevy	.057	.014
Chrysler	.048-.052	.015
Dodge	.048-.052	.015
Plymouth	.048-.052	.015
Valiant	.057	.015
Ford	.045-.052	.010-.015
Lincoln	.045-.052	.010-.015
Mercury	.045-.052	.010-.015
Rambler	Sealed Assembly	

SUPER FLOOR LAMP

For working under the hood, it beats an awkward, hard-to-hang trouble light.

You can't buy one, but you can make it for approximately $2. It has a wide variety of uses around the home, garage and workshop

ONCE you have this adjustable light stand you'll wonder how you ever got along without it because it has so many uses around the house. For example:

- As a portable shop light, you can quickly have adequate illumination at any shop tool.
- Raised to its 9-ft. height and with an outdoor floodlight bulb in it, the stand makes an excellent backyard light for late cookouts or working outdoors after dark.
- For working under the hood of your car which is a dark spot in any garage even during the day.
- As an adjustable height support for photo backdrops or slide projector screens.
- If photography is your hobby, this stand will easily support two or three clamp-on spot or floodlights.
- For illuminating temporary drawing table or hobby work bench.

The standard is made from short lengths of scrap electrical conduit which you can pick up for about a dollar at your local electrical contractor's shop. Since thinwall conduit can not be threaded, the heavier rigid conduit, threaded on one end, is used at the bottom of the standard to fit into the pipe floor flange as in the drawing. The rigid conduit also adds weight and rigidity at the base of the stand.

First make the stand base by cutting two 2 x 4's to shape as in the drawing, and half lap them to form a cross. If you don't have a jig saw or bandsaw to cut the 1-in. clearance on the underside of the base pieces, nail blocks on the ends of the 2x4's as indicated in the alternate method. Then fasten a 1-in. pipe floor flange to the crossed 2 x 4's with #14 x 1-in. *fh* screws.

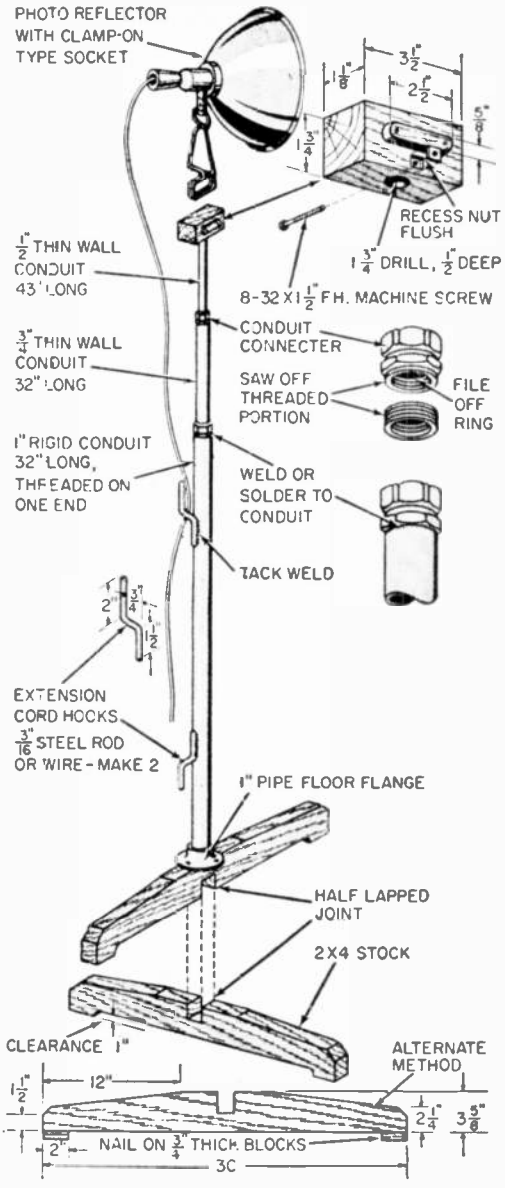
Height adjustment is achieved by using

The portable light stand supplies plentiful illumination for any shop tool. Photo reflector puts light on work, no glare in eyes.

three pieces of ½-, ¾- and 1-in. conduit, which telescope into one another, and may be locked at the desired height adjustment with standard conduit friction connectors. Be sure to get conduit connectors made of steel rather than the die-cast type because they are to be welded, brazed or soldered to the ends of the conduit.

First, hacksaw off the threaded portion of the connectors. Then, using a rat-tail file, file down the conduit stop ring inside the connectors so that the conduit will slide through. Now tack weld, braze or solder the ½-in. connector to the end of the ¾-in. thinwall conduit and the ¾-in. connector to the end of the 1-in. rigid conduit. If you are soldering the connectors in place, use a propane torch—a soldering gun or iron will not supply enough heat to raise the conduit to soldering temperature. Make the wire hooks as shown and weld or solder them to the 1-in. conduit to hold the extension cord.

A block of wood drilled to fit over the top end of the ½-in. conduit and fastened



Construction details of the super floor lamp which can be built for $2. It has many uses.

with a screw as in the drawing, provides a clamping surface to attach a spring-clamp type of photo reflector-light socket. The light fixture can then be easily and quickly removed when the stand is to be used as an adjustable prop to support something.—ART YOUNGQUIST

Battery Powered Floodlight

Aside from batteries, it will cost you about $10 to construct from a few surplus materials

LIGHTWEIGHT, the light is ideal for color or black and white—no clumsy plugs, cords.

By Victor W. Kondra

BAKELITE cover protects flood. The on-off switch can be on cord or on battery case.

A BATTERY-POWERED floodlight is probably the single most valuable asset to any camera bug. Why? Primarily because it will allow him to take light anywhere. He can have a self-contained light source in a helicopter, on the back of a speeding motorcycle or in a submarine. Those examples are pretty far-out but do get the idea across.

A battery-powered floodlight is presently being used by many professional news and motion-picture photographers. No longer attached to an extension cord or wall plug, you can move around easily, indoors or out. The adaptability of this unit is unlimited when used in conjunction with stationary floodlights.

The battery-powered floodlight described in this article produces 250 watts on 32 volts of wet-cell battery power. It is completely portable, weighs less than 8 lbs. and will operate for two hours without recharging.

If you think two hours isn't long enough, look at it this way. Still camera exposures are usually around 1/50th of a second. If you turned the unit on for 5 seconds at a time for each exposure, you would be able to take approximately 1440 exposures.

Eight millimeter film exposes at 12 feet per minute. Consequently 50 feet of film will take 4 minutes and 10 seconds to expose. You still have 115 minutes of light left.

Construction of the unit is simple. There are no resistors or condensers and no special soldering, wiring or mounting is required. It is merely a matter of buying the various components and assembling them with nothing more than a screwdriver, pliers and an electric drill.

The big expense is batteries. It will take twenty-one 1.5 volt nickel-cadmium wet cells. (Or 24, 1.3 volt.) Batteries cost approximately $1.50 each. I found that prices varied in different stores.

Tape the batteries into two or three packs and then wire them together in series to produce 32 volts.

Any sturdy fiberboard, wood or metal container with a hinged lid, approximately 8x6x10 in. will make a good carrying case for the batteries. When you put the batteries inside the case be sure to block them in place so they won't rattle around. Attach a 5-ft. strap to the sides of the case with wood screws or bolts to make a carrying strap. The lid of the case should open at the top to make charging the batteries convenient.

I used jack plugs as connectors for the case and lamp cord. As the photo shows, I drilled two holes in the case and mounted the female receptacles by means of the nut fasteners that come with them. They are mounted in the lid with enough slack wire to allow the top to open freely.

The male plugs are attached to a 4-ft. lamp cord. The lamp cord has an on-off switch mounted about mid-way on the line. (Switch can easily be mounted on the lid of the case for convenience.)

The free end of the lamp cord is attached to the lamp socket. The lamp socket must be first installed in the Bakelite housing.

The housing I refer to is a surplus military signalling lamp. There are several varieties on the market. The one in the photographs is made of Bakelite and is approximately 8 in. in diameter. It has a metal fixture on the underside which is perfect for the camera mounting bracket. Some of them come with fiber cases, attached cords and sockets with an on-off switch. Complete they sell for about $4.50. The one I purchased was not complete and sold for $1.50. If you can buy one complete, you will only need to screw in the bulb and attach the cord to the battery case.

Your local camera store can supply you with the bulb listed in the Bill of Materials. I listed another supplier just in case he won't order it for you.

The bracket for mounting the camera and floodlight is made from ⅛ in. aluminum strap, approx. 10x2x⅛ in. The drawing shows a bend of 90° at the 6-in. point. A standard camera mounting screw can be used or a ½ in. long by ¼-in.-20 bolt will work.

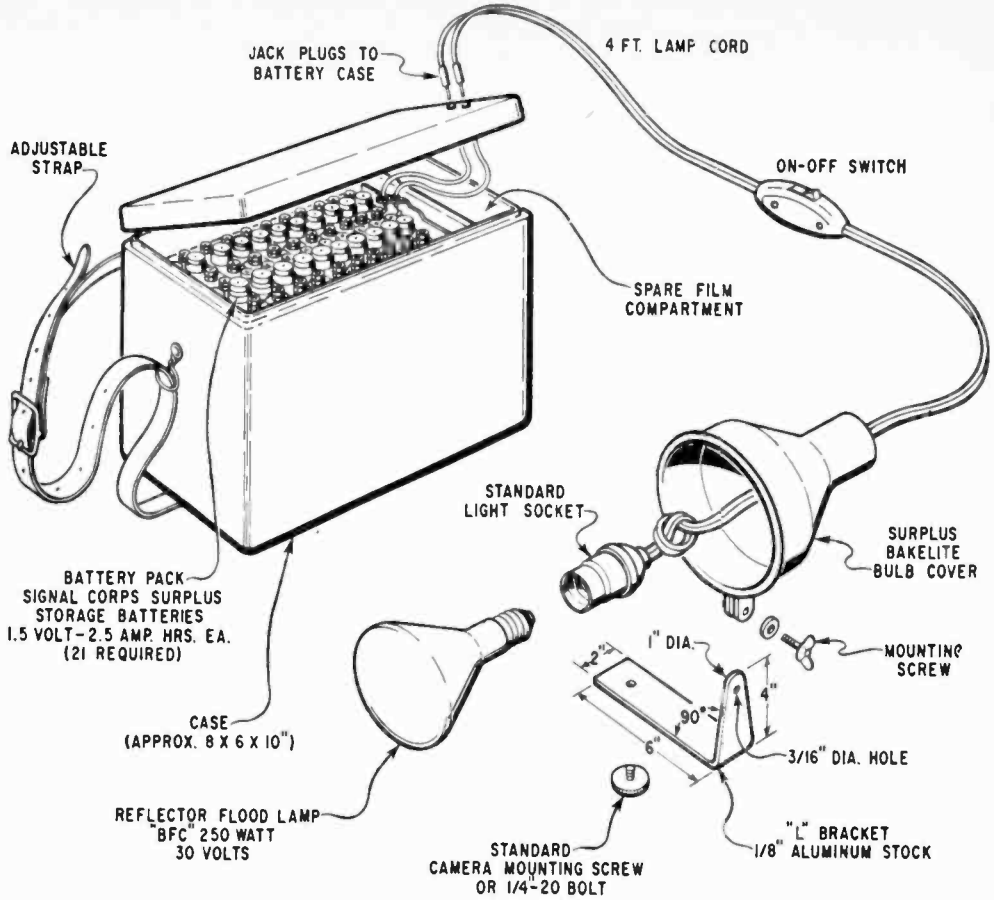
Using the Light. Now that you have the unit assembled here are some tips on using it. Always use the highest film speed available. This is especially true for color film. Black and white film, ASA 200 or better, will give excellent results.

The term 3400° Kelvin refers to the type of color film for which this light is balanced. To simplify this, always use tungsten or type "A" color with this unit. Then your colors will balance perfectly. Please note the separate chart for use as an exposure guide. Always remember that an exposure meter is far better and more precise than any ready-made guide. Use yours.

Exposure Recommendations For Floodlight

Still Photographs ASA	Distance	Black & White or Color Shutter	f-Opening
200	10′	1/50	f 2.5
200	6′	1/50	f 4
100	10′	1/50	f 2
100	6′	1/50	f 2.8
Motion Pictures ASA	**Distance**	**Black & White or Color Frames per second**	**f-Opening**
200	10′	16	f 4
200	6′	16	f 5.6
100	10′	16	f 2.8
100	6′	16	f 4
12	10′	16	f 0.95
12	6′	16	f 1.4

Note: These exposure recommendations are meant to be used only as guides. The best exposures and times will be determined more accurately after tests are made.



Battery-Powered Floodlight

Recharging the unit is done seven batteries at a time with a 12-volt auto battery charger. It takes an hour to charge each section.

Keep the batteries charged, the water level correct and your battery-powered floodlight will give you many years of trouble-free service.

MATERIALS LIST

No. Req.	Size and Description	Source
1	Box or case, large enough for battery pack. (8"x6"x10") $1.00	C & H Surplus Sales 2176 E. Colorado Blvd. Pasadena. Calif.
1	Lamp-cord, on-off switch and two male and female plugs. $1.00.	C & H Surplus Sales
21	Batteries, nickel-cadmium, wet cells, 1.5 volts each. $1.50 each.	C & H Surplus Sales
1	Signal Corps Surplus signalling light, head made of Bakelite. $1.50-$4.50.	Airborne Sales 8501 Stellar Dr. Culver City, Calif.
1	"BFC" reflector flood lamp, 250 watts, 30 volts. (GE-250R-FL) 3400° Kelvin. $3.25 each.	Harwood Company 1141 W. Valley Blvd. Alhambra, Calif.
1	"L"shaped mounting bracket. Scrap aluminum, 2"x10"x1/8".	
1	Standard lamp socket. $.30.	

RECHARGING with 12-v. trickle charger. It takes a half hour to recharge each section.

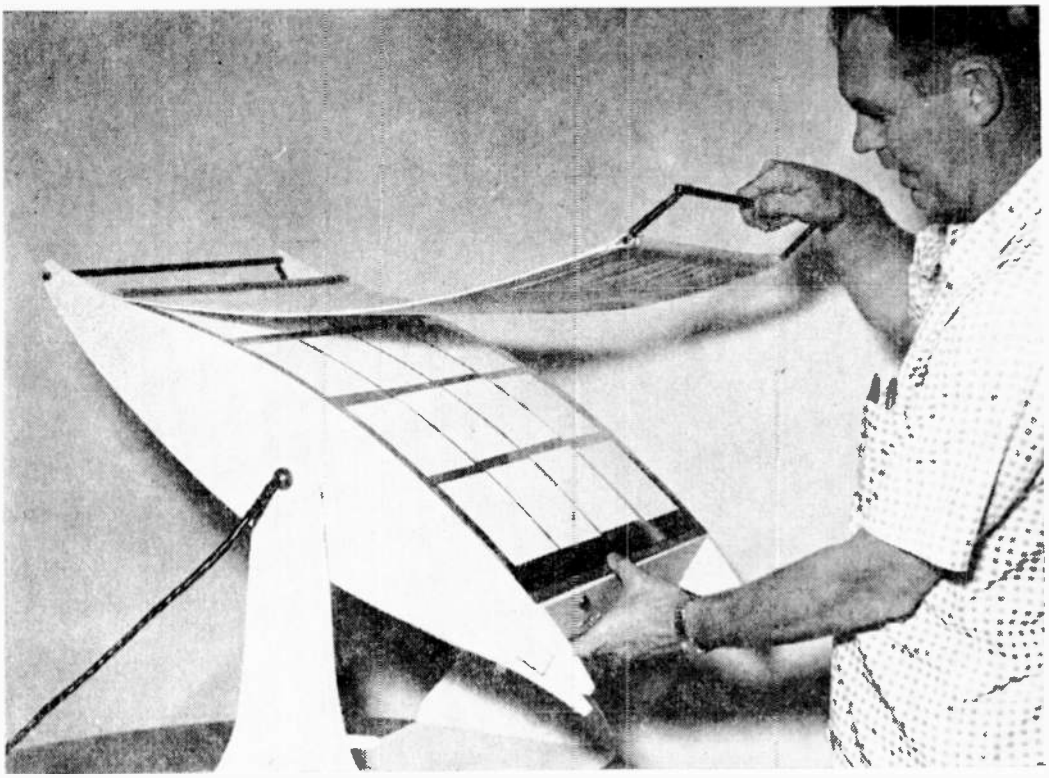


FIG. 1. Coiled springs tension canvas apron of the deluxe, big-capacity print dryer.

PHOTO PRINT DRYER

Built for a few dollars, this darkroom gem compares favorably with commercially-produced models costing upwards of 40 bucks

MOUNTED on its own stand, this print dryer loads easily without lifting. Standard 18x24-in. chrome ferrotype plates are used, and will take four 8x10 prints to a side at each loading. Dual heating elements permits the two sides of the dryer to be used independently for drying small batches of prints and internal heat reflector plates distribute the heat for quick and even drying on both sides.

The body of the dryer is cut from ½-in. plywood to the dimensions shown in the drawings. The frame is assembled with flathead wood screws and glue. Locate and mount the stop block, shown in Fig. 3, which prevents the dryer from being rotated more than 360° and permits it to be locked for carrying. Also drill the mounting holes for the switches and pilot lights.

The side panels are insulated with sheets of ⅛-in. asbestos cut to form the supports for the reflector plates. Only the center portions are mounted at this time, using small nails.

The stand is cut from ¾-in. plywood. A 22-in. length of ⅜-in. pipe serves as the pivot for the drier. Both ends are threaded to take a nut and a hole is cut 5 in. from one end for the power cord exit inside the dryer (Fig. 7.) Large washers space the dryer inside the stand, and the nuts on the pipe support are adjusted to provide enough friction to prevent the dryer from "free-wheeling."

The heat reflectors shown are old 18x24-in. chrome ferrotype plates. If these are not available, use 28-gauge galvanized iron. Notch the plates for the wires and switches. The plates are held in place by the outer portion of the asbestos insulating panels.

The heating elements consist of two standard 600-watt replacement elements connected together for each side of the dryer. Stretch each element to a length of about 80-in. before installing it on the supports. Later, if you find the drying time too long, the heat may be

Photo Print Dryer

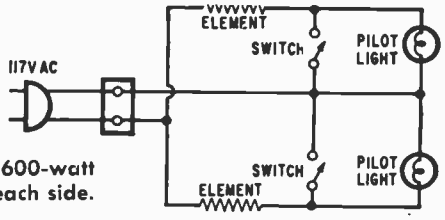


FIG. 2. Wiring diagram. Two 600-watt replacement elements are on each side.

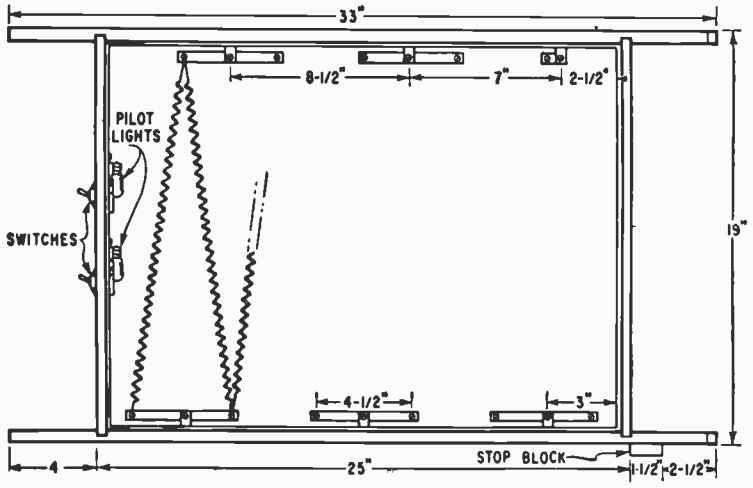


FIG. 3. Frame plan. Stop block prevents rotation of more than 360°.

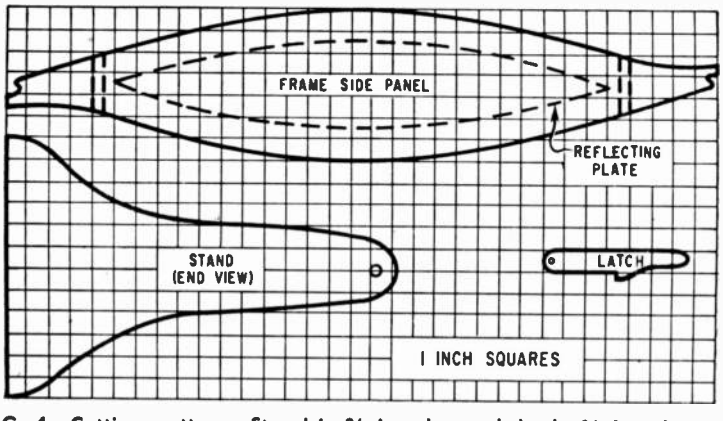


FIG. 4. Cutting pattern. Stand is ¾-in. plywood, body ½-in. plywood.

increased by cutting off several inches of the element and stretching the remainder to fill the gap. The supports are strips of ⅛-in. hard asbestos mounted on angle brackets.

The sheet metal covers which support the ferrotype plates are 28-gauge galvanized iron.

Attach them to the frame with small flat-head wood screws counter-sunk flush with the surface.

The aprons are cut from white duck and measure 19x26 in. plus material for hems on three sides and a loop on one end. The fixed end of each apron is anchored by a wood strip and screws. A pair of 2½-in. coil springs and two lengths of ⅜-in. tubing make up the tensioning mechanism.

The latch, Fig. 6, which locks the dryer in position for carrying or storage, is cut from ¼-in. plywood. A handle completes the carrying equipment.

FIG. 5. Attaching heating element to supports. Stretch to 80 in. before installing.

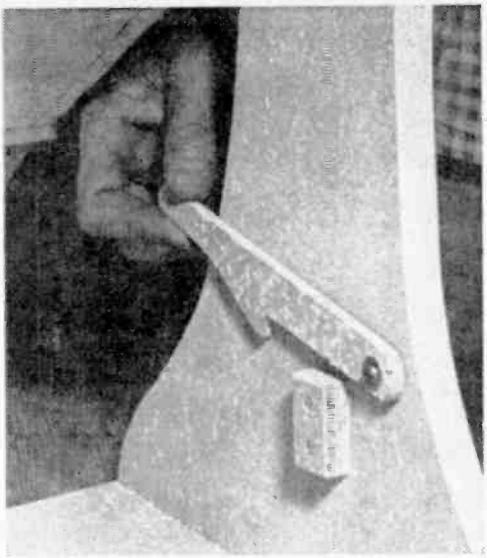


FIG. 6. Simple latch serves to lock dryer upright when it's transported or stored.

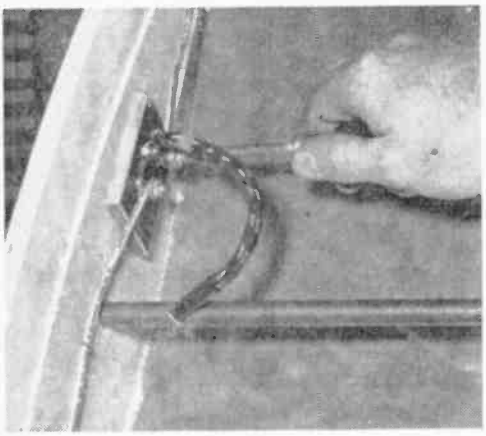


FIG. 7. Power cord enters through pipe pivot, distributes power from a terminal block.

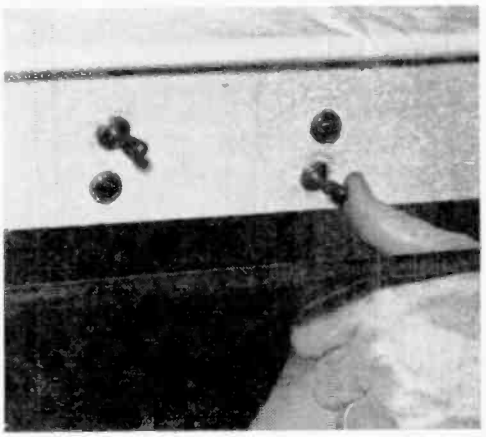


FIG. 8. Switches control elements. Two pilot lights show when on. Note tensioned apron.

MATERIAL LIST

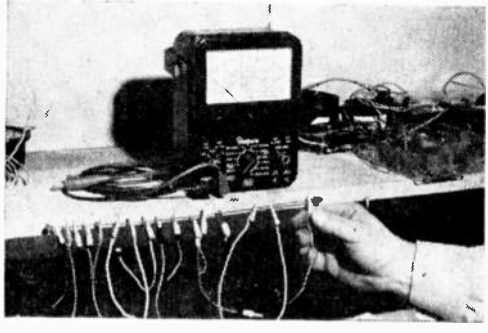
No. Req.	Size and Description
2	18 x 24" used chrome ferrotype plates (or 28-gauge galvanized iron)
2	18 x 25¼" sheets 28-gauge galvanized iron
1	20 x 38" piece ½" plywood for frame members
1	20 x 38" piece ⅛" hard-pressed asbestos for insulation and heating element supports
1	30 x 24" piece ¾" plywood for stand
7½ ft.	⅜" O.D. steel tubing for canvas tensioner
22 in.	⅜" I.D. pipe for pivot
1	60"-wide piece white duck 40" long for aprons
4	2½" coil springs
6 in.	¾" aluminum angle for heating element supports
2	12-v pilot lamp assemblies
2	switches
15 ft.	heater cord with plug
1	handle
	#3 fh wood screws, ½", for mounting drier cover
	#9 fh wood screws, 1½", for assembling plywood parts
4	600-w replacement heating elements

FIG. 9. As evident, dryer presents trim appearance and it is easily moved and stored.

QUICK CONNECTIONS

IF you've ever had to make a quick electrical connection you'll know how irksome it can be to heat up the soldering iron, or maybe you can't use a solder connection at all.

With clip leads this problem is eliminated. Hooking a test instrument *probe* into a circuit to leave hands free becomes simple, as does temporarily connecting resistors, capacitors and potentiometers, and it saves socket pins, terminal strips, and pigtails from unnecessary damage.



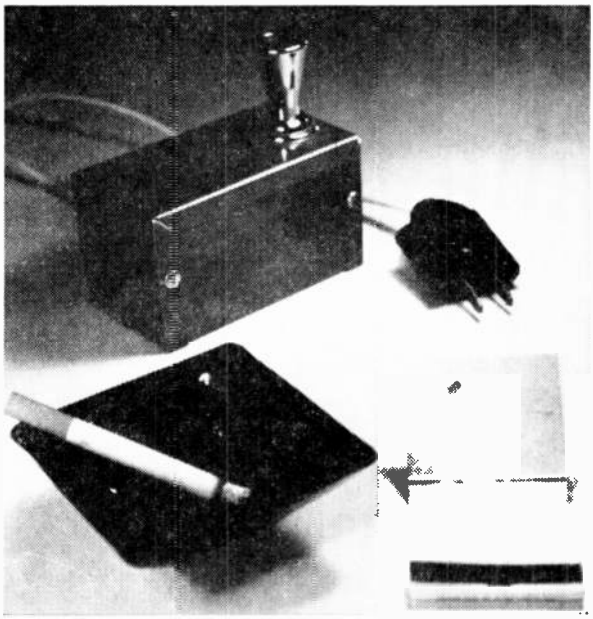
CLIP LEADS to a piece of wire strung between screws or nails to keep them handy.

These and a multitude of other uses can be found for insulated 8- to 12-in. clip leads and they can be made up from alligator clips such as Lafayette MS-569 or MS-570 and thermoplastic hookup wire (Lafayette WR-227) or bought ready made (MS-479). For special purposes battery boxes and snaps can be wired up with clip leads making battery connections simple and reliable.

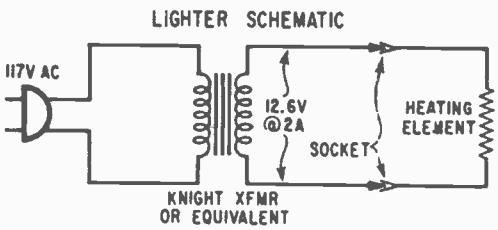
For transistor work Mueller Micro-Gator clips #34 and insulators to fit, at 6 and 7¢ respectively, are excellent, affording a firm grip on small diameter pigtails and easy access to tight places on printed circuit boards. The clips also make excellent heat sinks for transistor soldering.

To keep your clip leads handy and ready for use, string a piece of #16 bus wire or any other heavy wire tightly between two screws or nails and clip the leads to it.—BRICE WARD

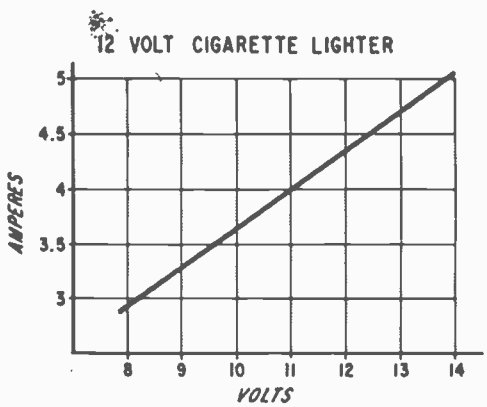
"Electrical Matches"



HOUSED properly, unit makes attractive table piece.



SWITCH, fuses, indicator can be added.



RELATIONSHIP of current and voltage.

SMOKERS who occasionally run out of matches while working in the shop should try this project. A car lighter and a filament transformer make an excellent "electrical match." Easily constructed in one evening, the "match" requires only three parts plus a small box. Housed in an attractive holder, it even makes a unique addition to a living-room end table, as evident in the photo above.

Available in most auto parts stores, the lighter requires about 4.5 amps at 12 volts; however, a transformer with a 12.6 volt winding at 2 amps will work quite well for intermittent duty. I used a Knight (Allied Radio) unit—it gets warm only after 5 or 6 uses in quick succession.

The parts can be mounted in any small box; a 4 x 2¼ x 2¼ Bud Minibox handles the job nicely. If you have a high-current supply (ac/dc) in the lab, just hook up the lighter directly whenever you need it. Though it isn't vital, a switch, indicator, and fuses can be added. I used a fused-plug for protection.

Although the "electrical match" is initially a bit more expensive than the paper variety, it is far more convenient than trying to light up your stogey using a large soldering iron!—ROBERT K. RE

Add to Your Know-how

(Continued from page 10)
good intentions don't buy many porterhouse steaks. (Not that there are many things that good intentions do buy.)

A course that gives you real know-how in practical electricity can call for 10 or 12 hours of study every week for one or two years. It can cost anywhere from $100 to $300 or even more, depending on the school, the course, and the materials that are included. Clipping a coupon is a waste of time unless you're willing to make this kind of investment for a worthwhile skill—or for a pretty strong nudge into a higher income bracket.

But if you *are* willing, start looking around. Answer some ads, and check out the quality and content of various courses. Some schools automatically send Lesson 1 as part of the sales package when you send in a coupon. Others will send an early lesson and a typical advanced lesson if you ask for them. Which you should certainly do, by all means.

When you get the lessons, look them over with this in mind:

1. In most courses dealing with electricity, simple book-learning isn't likely to get the job done. The course should include plenty of do-it projects, and maybe a kit or two.

2. The print, the pictures, and the language should all be as clear as a spinster's intentions.

3. *Most* of the tests will probably be of the true-or-false and multiple-choice type. But when *some* of them call for "in-your-own-words" answers, or diagrams, or completed projects, you know for sure that the lessons will be evaluated and graded by an experienced and extremely well-qualified instructor.

If you can't get a lesson or two to look at, examine the sales literature for the "accreditation" seal. The one that counts most is the restrained lamp-in-a-schoolhouse symbol of the National Home Study Council. The NHSC is a self-policing organization that carries a big stick and keeps a close, strict, and continuing watch on all its member schools. When you see the seal, you know that a school's courses, faculty, advertising, tuition policies and student relationships have been approved by hard-to-please experts.

But in any case, before you put the enrollment coupon in the mail, read it as carefully as you'd read any other contract—because that's what it is. Most schools ask for a small deposit payment when you first sign up, plus the first of the weekly or monthly payments. If you enroll, get a couple of lessons, and then decide you'd just as soon spend your evenings down at the bowling alley, you won't get this money back. *Legally*, you're probably tied up for the whole course, but few schools will hold you to the contract this strictly. The farther you've gone into the course, though, the less likely you are to get loose without paying at least a settlement on the full amount.

And to be sure you get exactly the course you want, check with all the top schools, not just one. Following is a list of some of the leading schools, showing some of the courses they offer in electricity and basic electronics.—JESS MORRISON

ADVANCE TRADES SCHOOL, 5944 N. Newark Ave., Chicago 31, Ill.—Electrical service and appliance repair.

AMERICAN SCHOOL, Drexel Ave. at 58th St., Chicago 37, Ill.—Electrical technician course.

AMERICAN TECHNICAL SOCIETY, 850 East 58th St., Chicago 37, Ill.—Electricity; basic electronics.

CHRISTY TRADES SCHOOL, 3214 W. Lawrence Ave., Chicago 25, Ill.—Electrical appliance repair.

COYNE ELECTRICAL SCHOOL, 1501 W. Congress Parkway, Chicago 7, Ill.—Electricity; basic electronics.

INDUSTRIAL TRAINING INSTITUTE, 2150 Lawrence Ave., Chicago 25, Ill.—Electricity; basic electronics.

INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton 15, Pa.—Electrical appliance servicing; practical electrician; electric motor repairman.

NATIONAL RADIO INSTITUTE, 3939 Wisconsin Ave., N. W., Washington, D. C.—Electrical appliance servicing.

NATIONAL TECHNICAL SCHOOLS, 4000 S. Figueroa St., Los Angeles, 37, Calif.—Basic electronics; home appliance technician's course.

RCA INSTITUTES INC., 350 West 4th St., New York 14, N. Y.—Electronic fundamentals; introduction to electronics.

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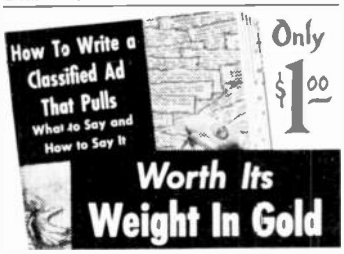

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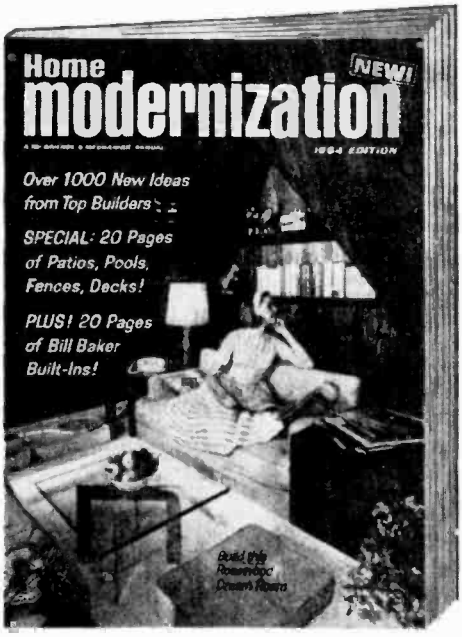

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Pinpoint Appliance Trouble

(Continued from page 68)

circuit. Follow the electrical supply circuit until you come to a point where the light doesn't work. This indicates that there's probably something wrong between that point and the one tested just before.

Rattles and similar noises are usually due to something loose that is vibrating or swinging out of place and hitting another part of the machine. You will have to listen and look for the offending part.

It may only be necessary to tighten some screws. However, the noise may be caused by a worn bearing which would have to be replaced. This is usually a special tool job!

Squeaks are that source of noise made by two surfaces rubbing each other or friction. It may be caused by two loose pieces of metal, which can be tightened. Lack of lubrication has a characteristic sound. Proper use of grease or oil will often remedy such noises. Another cause of noise could be a slipping belt, which usually requires a tension adjustment.

Looking Carefully will often reveal a great deal about the condition of your machine. The broken control knobs previously mentioned might be binding against the escutcheon to prevent proper operation.

The door lid on many appliances operates a switch to shut off the machine while it is open. If the door is not closed tightly the machine will not start. A slight push to secure the latch may be all that is needed; however, a simple hinge or latch adjustment may be required.

A loose drive belt can be tightened; all machines have an adjustment for that. On some there is automatic tension adjustment; on others it is manual. This is usually evidenced by slow or erratic operating speed.

Keep all appliances clean. An abnormal collection of dust and dirt in a machine will certainly affect its performance. For instance, lint in your dryer can be a hazard; dust on your refrigerator coils will cause it to run too much.

A panel bulb or indicator light may be burned out. Your owner's manual may point out that it should be considered a "safety light," such as with freezers, and that as long as it was lighted everything was fine. So check it before you look further.

Water leakage is self evident. Once the source of a leak is located, replace the hose or tighten the clamp. Pump or tub leaks will require replacement of the part or a patch. Check with your manufacturer on recommended patching procedure.

Who Does the Job? If, after having satisfied yourself that the trouble is not of a simple and observable nature, you still wish to continue further toward finding it yourself, you must answer some questions: Do you have the equipment to continue? Tools? Ability? Parts?

If you reach a "yes" decision, restudy the owner's manual for that appliance, supplied by the manufacturer.

Locate the wiring diagram, usually found on the access panel of appliances which are complex enough to require such information. Follow the steps outlined in the troubleshooting chart for the particular appliance (see contents page) until the failure is located.

Decide—again and finally—are you still going ahead with the job yourself? If you have gone this far to find out what the trouble is, you probably can. At the same time, some troubles way within the machine require special tools and equipment.

Among items needing particular tools, equipment, and test apparatus are refrigerator compressor or evaporator, gear case assembly on a washer, bearings, an electric motor or coil needing rewinding, thermostats, timers, and burner assemblies. This is the area where it is cheaper and safer for you to ask for professional help!

Hammer Strips Wire

Devices for stripping insulation from lamp cord and other wires are available but a common tool that serves the same purpose is a claw hammer. With a sharp knife first cut *part way* through the insulation at the point where it is to be removed. Press it into the claw of the hammer, then pull gently. The insulation will come off in one piece.

Stripping Without Cutting

When you strip flexible wire with a knife, like you would sharpen a pencil, you probably will sever some of the wire strands too. If you should cut a fifth of the strands of a No. 18 wire the allowable capacity is immediately reduced from 5 to 4 amps. It will safely carry only 460 watts instead of the normal 575.

Here are two *safe* methods of stripping by hand without cutting. 1) Hold the knife blade *parallel* with the wire and cut a gash in the insulation. Pull and peel the latter back as you'd peel a banana, then snip it off. 2) Grasp the end of the rubber insulation with pliers and pull to stretch it about 1½ inches. Cut off the stretched portion and the remainder will snap back to cleanly expose the wire.

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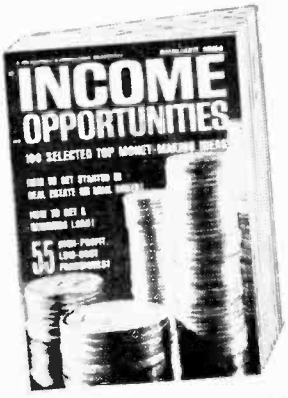

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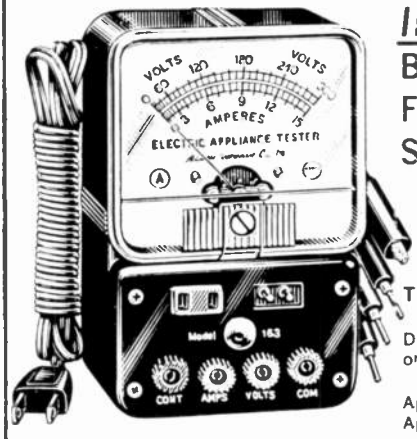

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The model 163 will test all motors—single phase, multi-phase, universal, squirrel cage, induction; in fact every type from fractional H.P. to 2 H.P.

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Profits That Lie Hidden in America's Mountain of Broken Electrical Appliances

By **J. M. Smith** *President, National Radio Institute*

And I mean profits for you — no matter who you are, where you live, or what you are doing now. Do you realize that there are over 400 million electrical appliances in the homes of America today? So it's no wonder that men who know how to service them properly are making $3 to $5 an hour — in spare time or full time! I'd like to send you a Free Book telling how you can quickly and easily get into this profitable field.

THE COMING OF THE AUTO created a multi-million dollar service industry, the auto repair business. Now the same thing is happening in the electrical appliance field. But with this important difference: anybody with a few simple tools can get started in appliance repair work. No big investment or expensive equipment is needed.

The appliance repair business is booming — because the *sale* of appliances is booming. One thing naturally follows the other. In addition to the 400,000,000 appliances *already* sold, this year alone will see sales of 76 million *new* appliances. For example, 4,750,000 new coffee makers, almost 2,000,000 new room air conditioners, 1,425,000 new clothes dryers. A nice steady income awaits the man who can service appliances like these. And I want to tell you why that man can be *you* — even if you don't know a volt from an ampere now.

A Few Examples of What I Mean

Now here's a report from Earl Reid, of Thompson, Ohio: "In one month I took in approximately $648 of which $510 was clear. I work only part time." And, to take a big jump out to California, here's one from J. G. Stinson, of Long Beach: "I have opened up a small repair shop. At present I am operating the shop on a spare time basis — but the way business is growing it will be a very short time before I will devote my full time to it."

Don't worry about how little you may now know about repair work. What John D. Pettis, of Bradley, Illinois wrote to me is this: "I had practically no knowledge of any kind of repair work. Now I am busy almost all my spare time and my day off — and have more and more repair work coming in all along. I have my shop in my basement."

We Tell You Everything You Need to Know

If you'd like to get started in this fascinating, profitable, rapidly growing field — let us give you the home training you need. Here's an excellent opportunity to build up "a business of your own" without big investment — open up an appliance repair shop, become independent. Or you may prefer to keep your present job, turn your spare time into extra money.

You can handle this work anywhere — in a corner of your basement or garage, even on your kitchen table. No technical experience, or higher education is necessary. We'll train you at home, in your spare time, using methods proven successful for over 45 years. We start from scratch — *tell* you in plain English, and *show* you in clear pictures — everything you need to know. And, you will be glad to know, your training will cost you less than 20¢ a day.

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