

A Job Analysis of the Electrical  
Wireman's Trade for Teaching  
Purposes.

by

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### Acknowledgment.

The work of this thesis has extended over a period of years. I have gleaned, from many of my friends and associates, much of this material. Particularly am I indebted to the members of the faculty of the Lathrop Trade School in Kansas City, Missouri where much of this work was tried out in actual class work. I must, also, acknowledge additional help from members of the Electrical Unions in Kansas City, and in Owensboro, Kentucky where the final work of this thesis was completed.

C.F.C.



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## Method of Approach.

The method pursued in compiling the material used in this study differs from most masters theses in education as found in the library in the University of Kansas. There is no controlled experiment in which a method of teaching has been measured. There are no statistical data on the basis of which evaluations may be made. The material has been gathered from many sources by observation and consultation with those in the trade. The author has had many years experience as an electrician and as an electrical contractor working in the field of power and light wiring besides ten years experience as an electrical instructor in a large trade school. All of the practices shown in this study are common to the trade and have been in use for many years. The thing that has been lacking, however, is an organized method of dealing with the teaching content of the trade.

As in many trades the Electrician's trade can be classified into separate groups or blocks with respect to the material used. The first step, then, was to divide the work into these natural blocks. Each block was then further examined by asking the following question: What must an Electrician know and be able

to do in order to handle the material used and do the ordinary jobs of the trade? In setting down these "Do" jobs it was found that certain basic operations were done over and over again. It was then decided to analyze these "Do" jobs from this standpoint of fundamental operations. For example, the threading of pipe, here is a job that is done many times in a days work and on different kinds and sizes of pipe. It is not a different job for each kind, and size of pipe, for the same fundamental operations are found in each job, and when these are once learned, will serve whenever a pipe is to be threaded. The same thing is true for the various operations that are found in this block. Some blocks of the trade were found to contain many operations while others had only a few.

There has been no attempt to find a "best" way of doing an operation as the nature and environment of the job often dictated the method of approach. It was thought best to give only one or two methods that were found in common practice and let the learner develop his own "best" way from his own experience.

The idea of the Job Sheet and Trade Analysis sprang from necessity. The teacher had to do something to organize his work in some fashion. This analysis of the electrician's trade is an attempt to find out what an electrician needs to know, and be able to do, to work at the trade, and to include classified jobs and other devices that would make for steady progress on the part of the student.

The Need for a Job Analysis in Teaching a Trade.

The passage of the Smith-Hughes Act in 1917, after many years work on the part of its supporters, was the beginning of the organized effort to expand the secondary curricula to the extent that it would more adequately take care of the great majority of students who do not go to college. The classification of teachers under this act calls for persons who are expert at their trades and who have earned their living doing the kind of work they are going to teach. The teachers, then, for these trade and vocational classes, are drawn from the ranks of labor. They were workmen first and teachers second. Perhaps the greatest job that the new teacher in this work finds, is to organize his teaching material. It is one thing to know the trade well but quite another thing to teach it. There was at that time no well worked out courses of study; no text books that covered the work from a teaching viewpoint. Even, today, thirteen years after the passage of this bill, there are few books that attempt to cover the work, and these in only a few of the most popular trades.

This same technique was followed on the "Know" side of the trade. Only those things that were necessary to know, in order to do the job, were included.

In arranging the classified jobs, so that the learner would encounter the easier ones first, it was found difficult to keep the jobs personal. It was not desirable to have every one doing the same job in the same way, yet it was very desirable to have the same difficulty. This was finally solved by showing a standard work booth, such as is used in many shops teaching the electrical trade. The plan of work was shown on the drawing but no dimensions were given. These dimensions were to be placed on the drawing either by the student or by the instructor. When these dimensions were varied the job was varied in appearance but not in its difficulty. This also had the advantage of allowing the student to accommodate his job to his material and working space.

Various questions have been placed on the Operation Sheets to stimulate thinking on the part of the student and are in no sense examination questions.

A device, called a Checking Sheet, has been included at the beginning of each Block of work. This is to

cause the student to think his way thru his job, before he does it, by causing him to check on the sheet the various steps in the order of their doing. In other words the student must check the thing that he will do first, the thing that he will do second, and so, until he has thought thru the entire job.

The workman, who has learned to think thru his work before he starts it, has a very valuable asset. This checking sheet is devised to encourage this practice.

OPERATION SHEET

GENERAL DIRECTIONS FOR ALL JOBS.

PLANNING AND MAKING A BILL OF MATERIAL

1. Locate the outlets on the walls and ceilings and plan various ways of getting around corners or obstructions. Try to figure out the best way to bring in the feeders, in other words, try to get a mental picture of the completed job. Be sure that you understand everything on the plan before you start.

MAKING A BILL OF MATERIAL

2. From the plans estimate, by measuring, the amount of metal raceway and wire needed. Start at some convenient spot on the plans and figure all the fittings, boxes, switches, knobs, tubes or what ever is needed to make a complete job.

List these materials in the place provided for them on the job sheet and the price for each item along with the trade number. Such items as solder, tape, nails, screws, toggle bolts, paste, and other such small materials when used in very small amounts, should be lumped under one sum.

Lighting fixtures of any type should be considered separately. The wiring job and the fixture job are two distinct jobs and require two permits from the city electrician.

DRAWING THE CIRCUIT

3. On the back of each job plan is a general plan to be used for drawing the wiring connections.

Make all outlets in the same place on this plan as they are on the other side. DO NOT DRAW THE RACEWAY, SHOW ONLY THE WIRES AND THEIR PROPER CONNECTIONS.

Have this drawing OK'd by the Instructor before connecting the wires.



### Gleat Work.

While Gleat Work is more or less obsolete in some places an electrician still finds use for the operations learned in the doing of this block of work. Gleat Work has considerable value for the beginning student. The knowledge gained in learning the switch connections will carry over into all of the future work. The work habits gained in doing the work so that it will pass inspection will also carry over into future jobs.

Information Sheet.

Cleat Work

While Cleat Work is very seldom used now in the wiring of buildings, it was one of the earliest forms of electrical construction. The first cleats were made of wood and the wires were nailed or tacked to the surface of the ceilings or walls. Due to the faulty insulation on the wires and the presence of moisture in the wood fires sometimes resulted so that these wooden cleats were replaced by those made of glass or porcelain. These cleats were practically the same shape and size as those you will find in the shop today.

Since these cleats are made of glass, or porcelain, they can be cracked or broken by rough handling. Screws should be used in place of nails and the screws pulled down evenly so that the pressure will be the same on both ends of the cleat. Any electrical catalog will show many kinds and sizes of cleats.

CHECKING SHEET

CLEAT WORK

1. Place in the column at the right the numbers showing when these operations will be performed; that is, which of these operations will be done first, which will be done second, and so on.

JOBS

	1	2	3	4	5	6	7	8	9	10
Drawing the wiring plan. Planning and making a bill of material. Installing cleats.										
Making a dead end. Tapping a circuit. Making a turn.										
Installing a snap switch. Soldering with an iron. Soldering with a blowtorch.										
Taping Making joints										

GRADES: Job 1--- Job 2--- Job 3--- Job 4--- Job 5---

Job 6--- Job 7--- Job 8--- Job 9--- Job 10---

AVERAGE GRADE -----

TOTAL TIME FOR ALL JOBS -----

DATE BEGAN -----

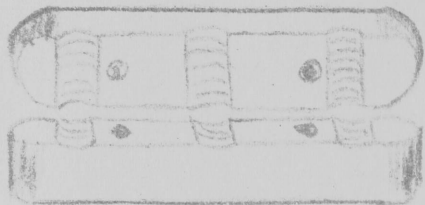
DATE FINISHED -----

### OPERATION SHEET

### CLEAT WORK IN OPEN WIRING

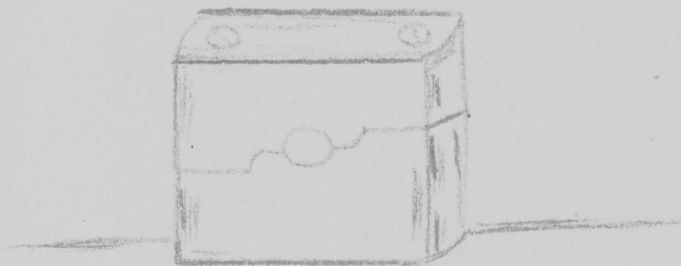
#### INSTALLING CLEATS

1. Examine the cleats to see if they are in good condition and are pairs. Fasten them to the surface with nails or screws. Screws are much better than nails as there is less chance to break them. For ordinary cleats use a #6 screw two inches long. For use over plastered surface the screw should be at least three inches long.



Regular two or three wire cleat.

2. For wires larger than #8 use one wire cleat.



#### QUESTIONS

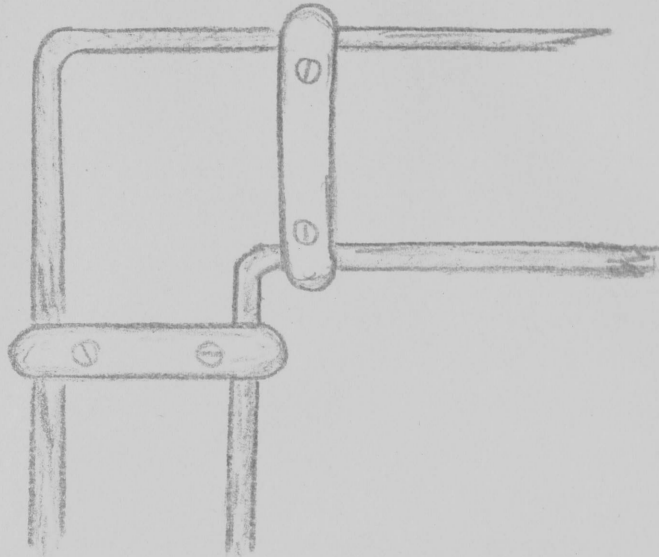
1. May duplex wires be used in cleats?
2. What is the maximum distance between cleats?

## OPERATION SHEET

### CLEAT WORK IN OPEN WIRING

#### MAKING A TURN

1. It takes two cleats to make a turn. Space them close together as shown in the picture. Make a square turn with the outside wire in a neat manner.



In making a long straight run put on the first cleat and then go to the end of the run and put up the last cleat. Smooth out the wires by sliding a knob over them and then pull the wires tight. Put the supporting cleats at the proper intervals along the run.

#### QUESTIONS

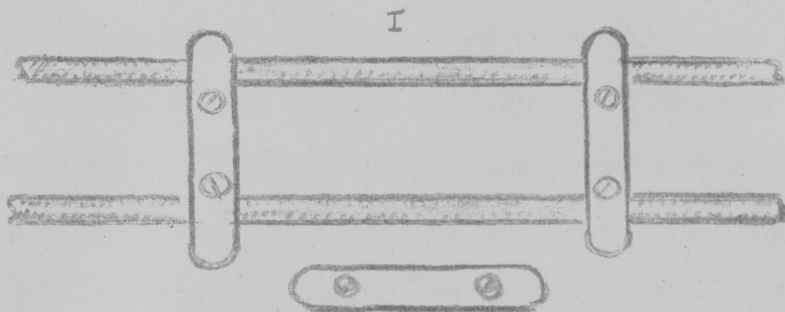
1. In making a long run why not put up the cleats as they come?

## OPERATION SHEET

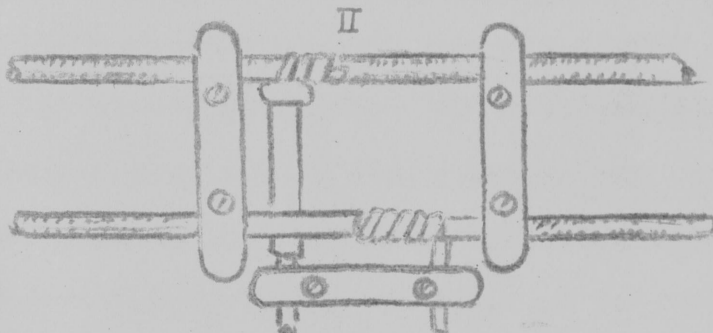
## CLEAT WORK IN OPEN WIRING

## TAPPING A CIRCUIT

1. Run the branch circuit up to the place where it is to tap the main circuit.. It takes three pairs of cleats to make a tap. Put one pair on the tapping branch about one inch from the main branch. Put the other two on the main circuit on each side of where the wires will tap.



2. Make scrapes on the wires about one inch long. Arrange the tapping circuit as shown in fig.2 being careful that the cross tube is under the main circuit wire and next to the surface wired over.



3. Make the joints by twisting the branch circuit onto the main circuit.

## QUESTIONS.

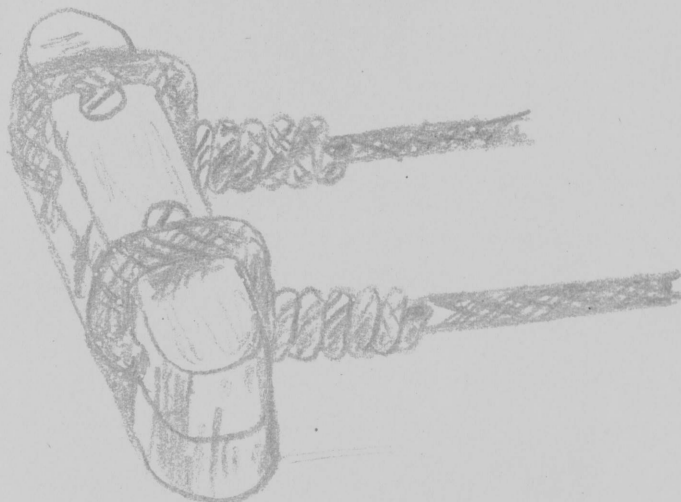
1. Why does it take three cleats to make a tap?
2. Why should the cross tube be placed underneath the wire crossed?

## OPERATION SHEET

## CLEAT WORK IN OPEN WIRING

## MAKING A DEAD END.

1. Install a pair of cleats near the end of the run. Pull the wires tight and then screw top part of cleat down tight.
2. Place short end of wire over top part of cleat and make five or six turns about the wire.



## QUESTIONS

1. Why should care be taken in dead ending a run in this manner?
2. How can the run be finished at a receptacle or a rosette?

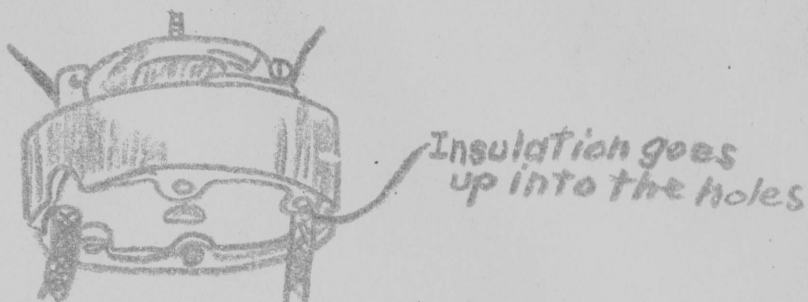


## OPERATION SHEET

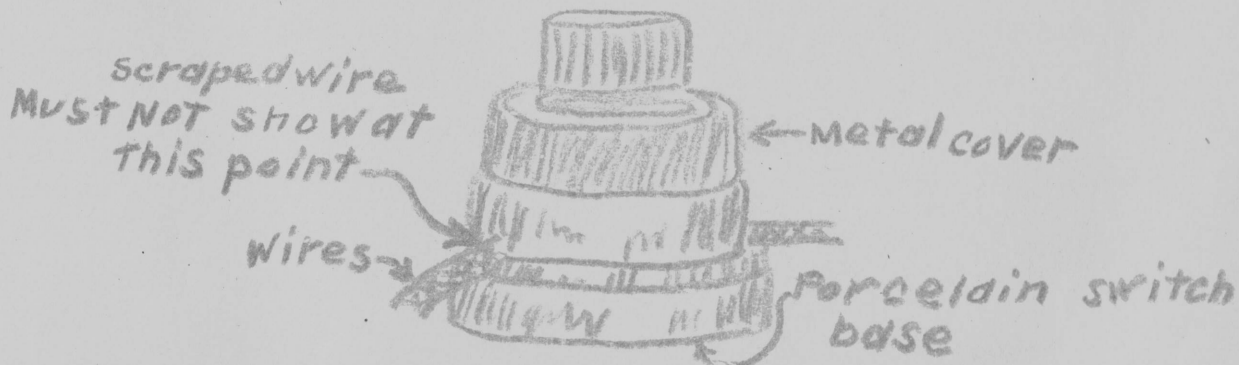
## CLEAT WORK IN OPEN WIRING

## INSTALLING A SNAP SWITCH

1. Make the proper scrapes on the wires and pass them thru the base of the switch, but do not make the connections. Put the switch base underneath and fit the wires into the slots. Put in the screws and draw them tight, alternating from one to the other so as not to crack the switch.



2. Pull the wires tight and pass them around the binding screws in the way that the screw turns when it is tightened. Cut the wires so that there will be no sharp ends to interfere with the workings of the switch arm or to ground on the cover.

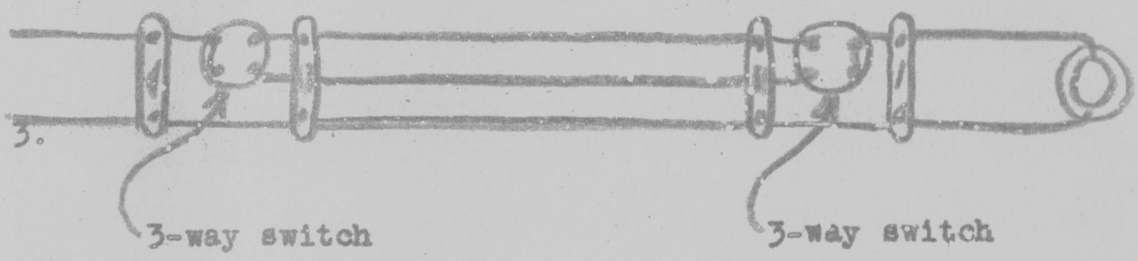
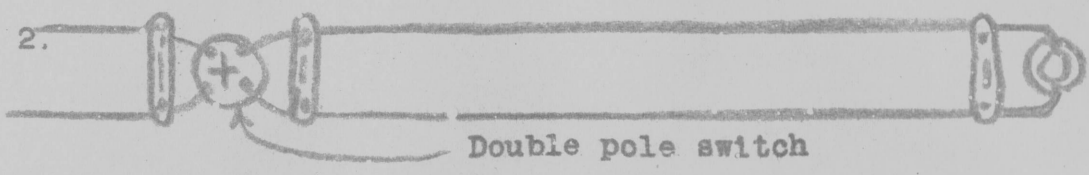
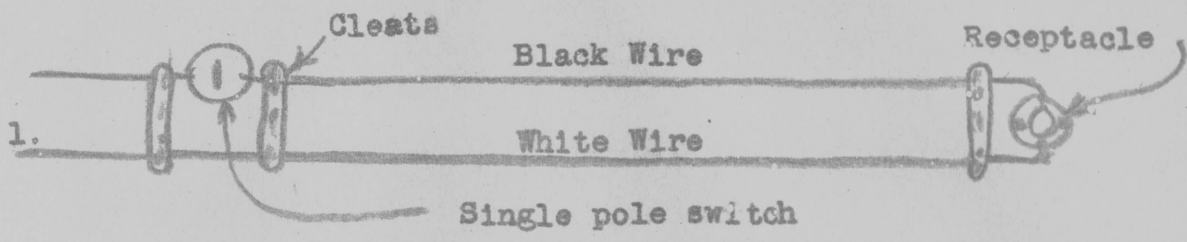


## QUESTIONS

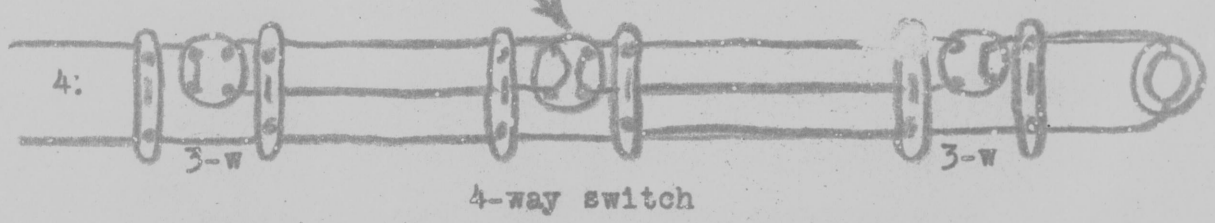
1. What is the switch base needed for?
2. What may be substituted for a regular base?
3. Where should the scrape be made on the wires?
4. What is an Indicating Switch?
5. How do you tell the size of a switch?



JOB SHEET  
CLEAT WORK



Note: Wires are crossed under the switch

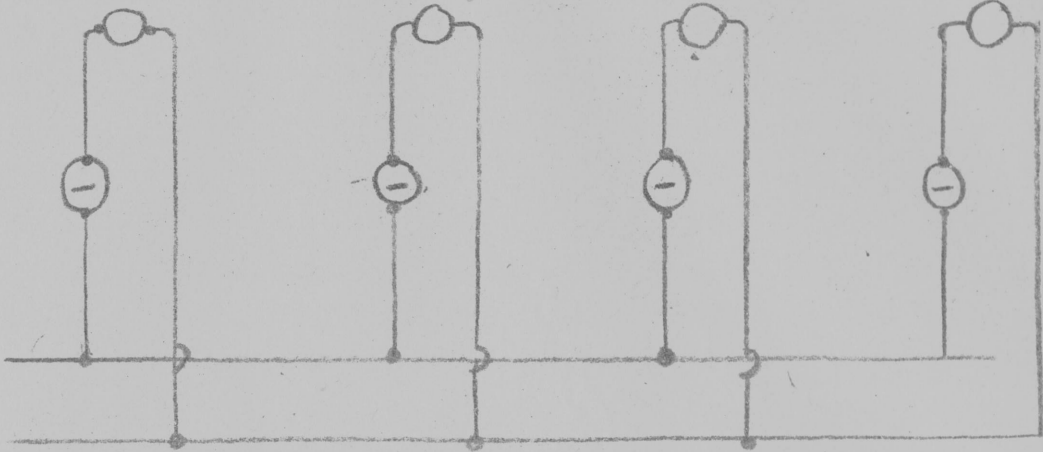


Grades Job 1---Job 2---Job 3---Job 4----- Average grade-----

Total time for all jobs-----.

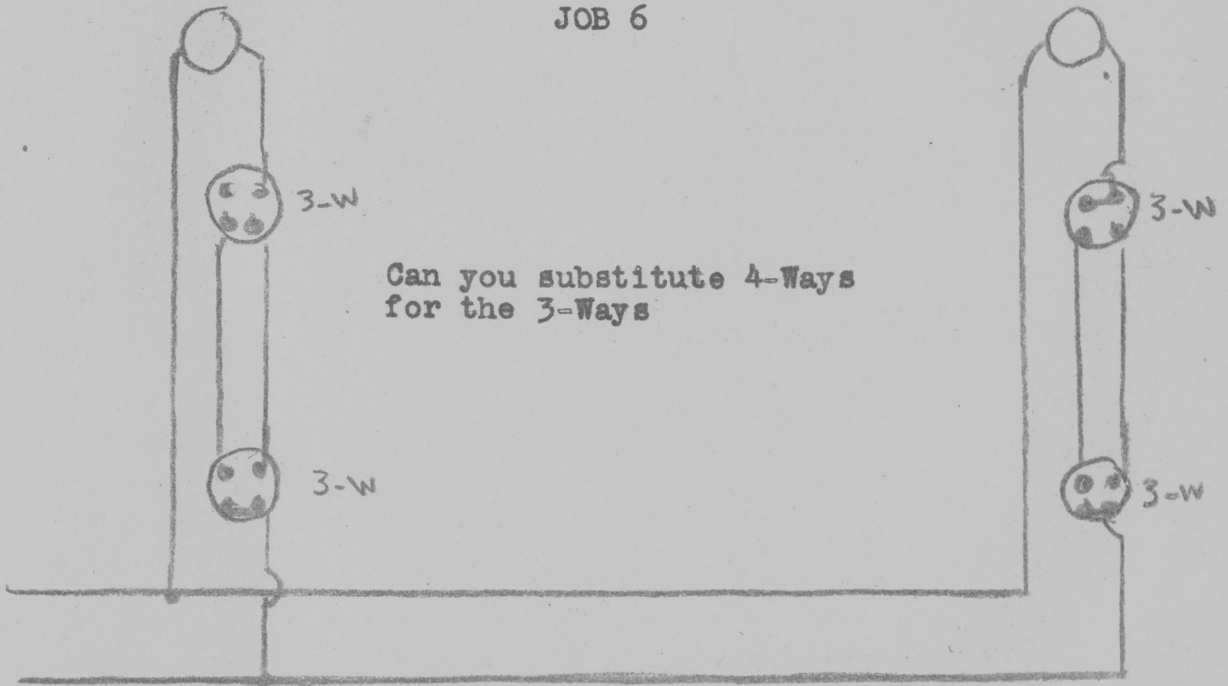
JOB SHEET  
CLEAT WORK

JOB 5



Each light controlled from a single pole switch.  
 Draw in the cleats in the proper positions. Show cross  
 tubes.  
 Label the wires as to their color.

JOB 6



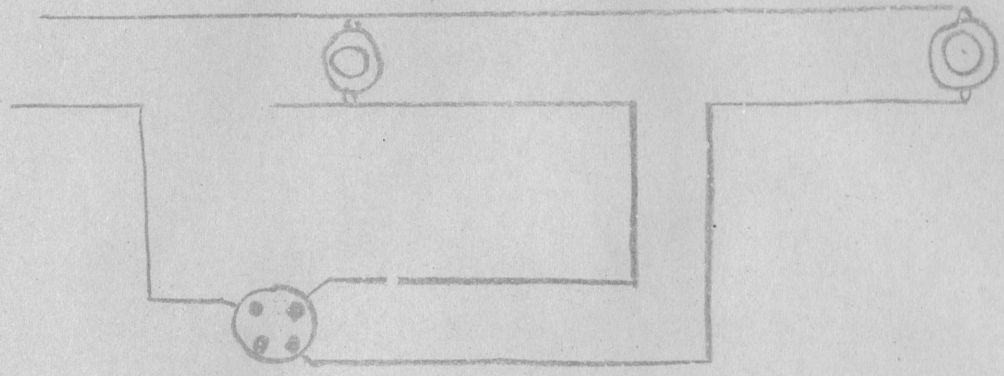
Can you substitute 4-Ways  
 for the 3-Ways

Each light controlled from two places.  
 Draw in the cleats and tubes in their proper positions.  
 Label the wires as to their colors.  
 Draw in the correct switch arms in the switches.

Time for JOB 5 ----- Time for JOB 6 ----- Total-----

JOB SHEET  
CLEAT WORK  
JOB 7

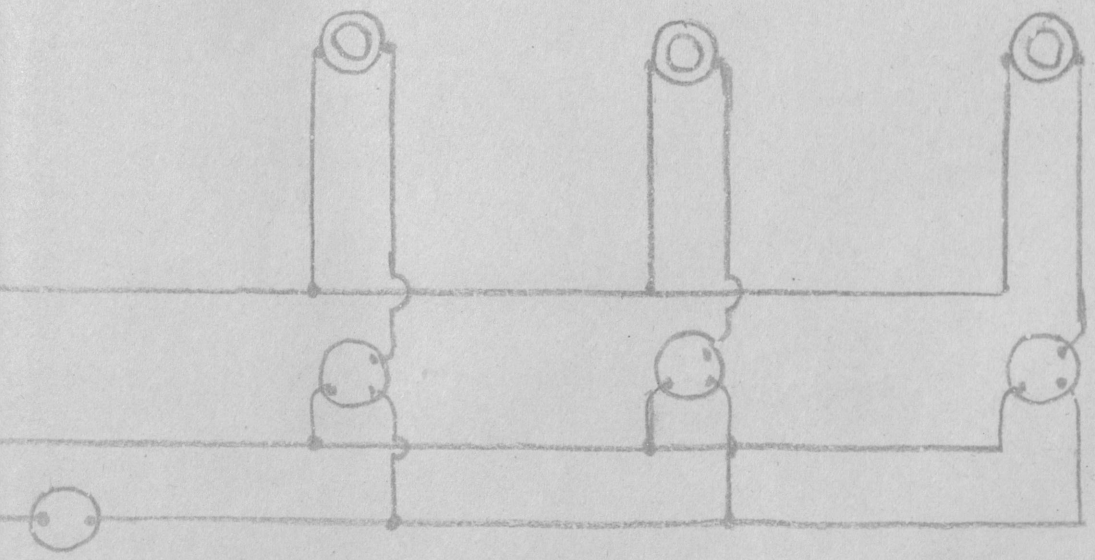
To show the operation of a 2 circuit electrolier switch



Draw in the cleats and tubes in their proper positions.  
Label the wires as to their colors.

JOB 8

To show the operation of a Master Switch



Draw in the cleats and tubes in their proper positions.  
Label the wires as to their colors.

Draw in the correct switch arms in the switches

Time for Job 7 ---- Time for Job 8 ---- Total -----

Construction Sheet

Cleat Work.

1. Show where to place the cleats in going around a large wooden beam.
2. How would you go around a steel beam?
3. Show how to pass thru a floor.
4. Show how to change from conduit to cleats.
5. Show how to pass thru a brick wall.
6. Show how to take a run down a brick wall.
7. How would you run you wires in an elevator shaft?
8. What is the price of the following :

500- 3 wire cleats

500ft # 14 wire RC

2 gross 2"x6 flat head wood screws

100- 3" porcelain tubes

1 roll of rubber tape

1 roll of friction tape

1-lb of wire solder

15- cleat receptacles.

INFORMATION SHEET

WIREMOLD

Wiremold is a product of the American Wiremold Company of Hartford, Connecticut. It is a molding made in two pieces but assembled at the factory as one piece and is so handled on the job. Wires must be fished into Wiremold the same as in conduit. All the general rules that apply to metal raceways apply to this molding.

Wiremold now comes in two sizes, the #500 size that will hold three #14 wires, and the #700 size that will hold four #14 wires. Fittings that belong to the #500 size all have a catalog number beginning with 5, like 518 Elbow, while those fittings that go with the #700 size have numbers that begin with 7, like 718 Elbow. Then there are the fittings that will fit either the #500 size or the #700 size; these fittings all begin with the number 57, like 5718 Elbow. This makes it easy for the workman to order the right fittings for the job in hand.

Wiremold is furnished in the standard ten foot lengths and comes 100 feet in a cardboard box. It is a neutral brown in color that will harmonize with most decorations.

Wiremold requires no special tools for assembly and only takes a hacksaw, screw driver and Wiremold bender for installation.

Wiremold is designed for use in finished buildings where the existing outlets are not sufficient or where they are not located in the proper places. Wiremold may not be concealed, it must be run entirely on the surface. It may not be run in wet or damp places as it is not water proof. It must not be run out of doors for the same reason.

## CHECKING SHEET

## WIREMOLD

1. Check at the left the operations needed to do the job.
2. Place in the column at the right numbers showing when these operations will be performed, that is, which operation will be done first, which will be done second, and so on.

OPERATIONS	ORDER OF DOING					
	Job 1.	Job 2.	Job 3.	Job 4.	Job 5.	Job 6.
Cutting Coupling Coupling to base plates						
Installing clips Bending Soldering with an iron Soldering with a blow-torch						
Taping Putting in the wires Testing for shorts and grounds						
Planning and making a bill of material Making joints Drawing the wiring plan						



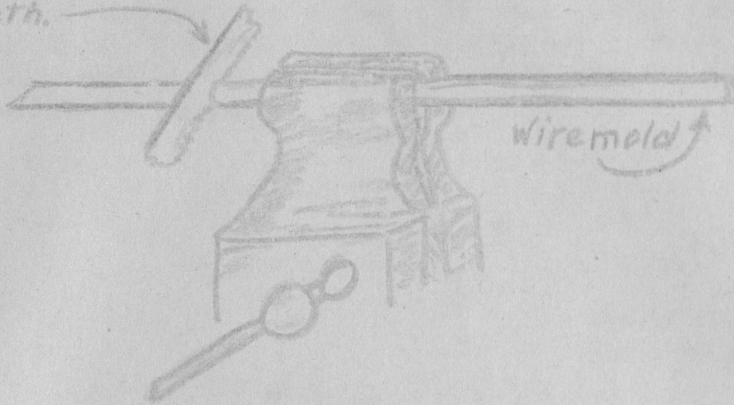
## OPERATION SHEET

## WIREMOLD

## CUTTING

1. Place the wiremold in a vise or between a couple of nails and saw on the mark with a fine toothed hacksaw. The molding should be held fairly rigid while cutting or you are liable to break the blade of the saw.

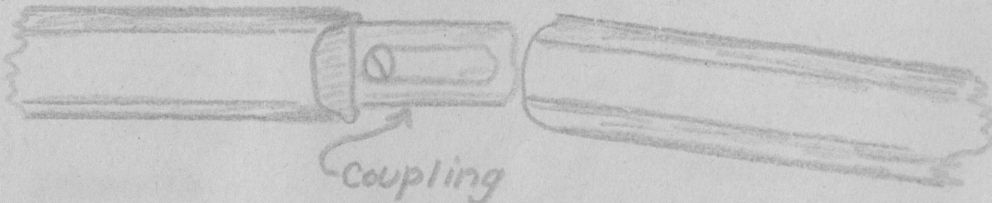
Hacksaw about  
32 teeth.



OPERATION NO. 37.

## COUPLING

1. Wiremold is furnished with one coupling per length much the same as rigid conduit. To couple two lengths, slip the coupling out of its groove until the screw hole is visible and drive in the screw. Push the wiremold to be coupled over the coupling and tap with a hammer until a good fit is obtained.



Note: Coupling must be on the outside of the base.

## QUESTIONS

1. Why not put the coupling on the Inside of the base?

## OPERATION SHEET

## WIREMOLD

## BENDING

1. Place the wiremold in a regular wiremold bender as shown in figure 1.

Apply the pressure close to the bend as shown in figure 2. so that the wiremold will bend in the right place.

Either external or internal bends may be made by simply reversing the wiremold in the bender.

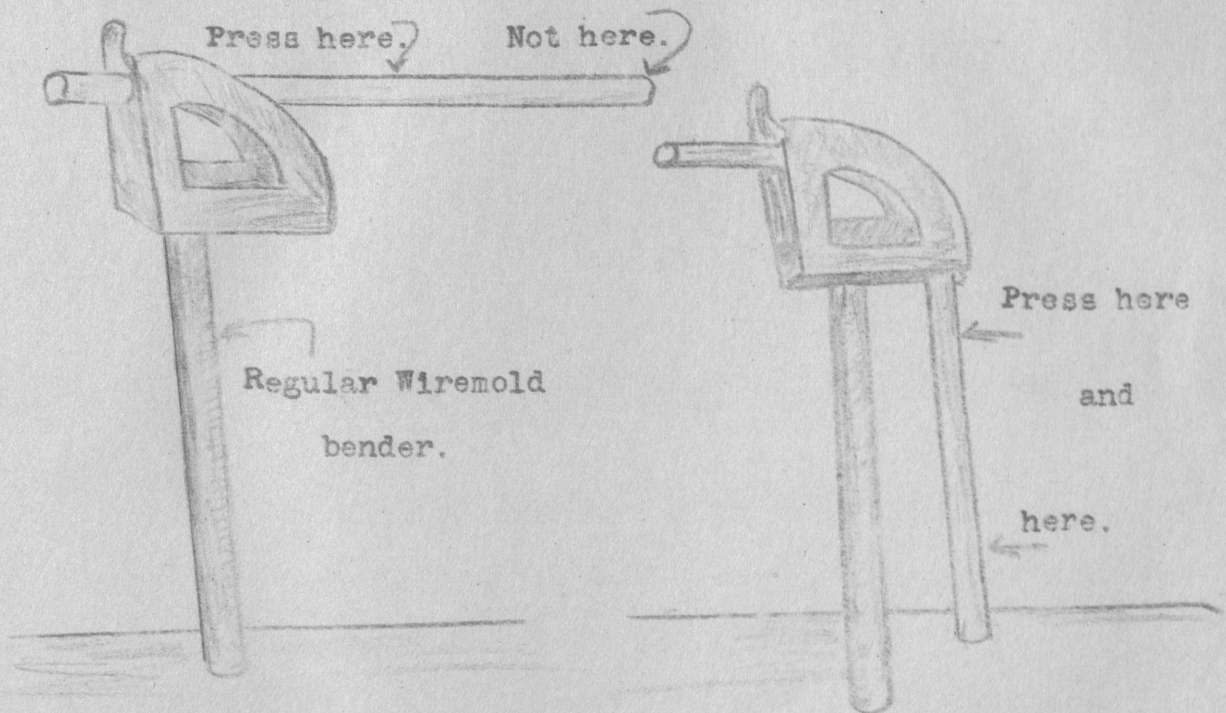


Fig. 1.

Fig. 2.

## Questions.

1. Why should a regular wiremold bender be used?
2. When should ells be used in place of bends?
3. If the wiremold kinks in bending what should be done ?

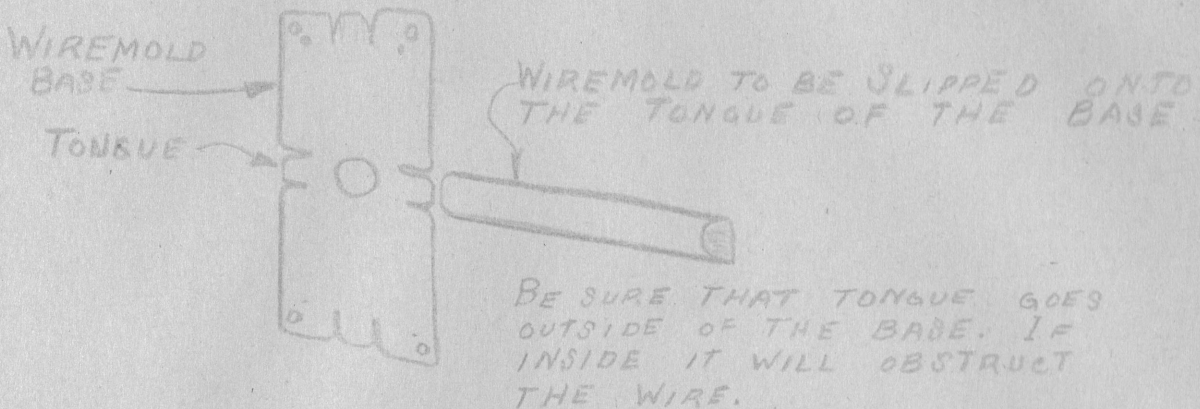


## OPERATION SHEET

## WIREMOLD

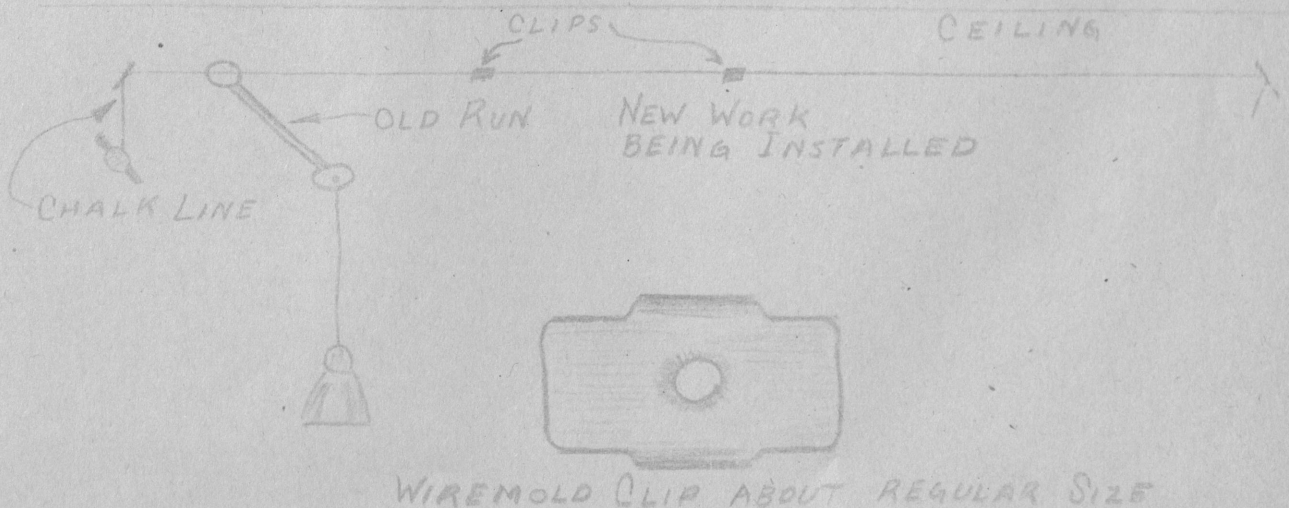
## COUPLING TO BASE PLATES

1. Ribbed tongues are provided on all fittings in such a manner that they will fit into the end of the molding. The coupling is done by slipping the end of the molding over base plate either before or after the plate is fastened to surface wired over.



## INSTALLING CLIPS

1. Lay out the run of molding with a chalk line snapped thru the centers of the outlets. Screw the clips in the exact center of the chalk line about every four feet. The molding may then be laid upon these clips and struck smartly with a hammer. The molding snaps into the clips and is held quite securely.



## INFORMATION SHEET

## METAL MOLDING

Metal Molding is made by the National Metal Molding Company of Pittsburgh, Pennsylvania. It is made from Sheradized steel and comes in two sizes, a small size known as #222 and a larger size known as #333. This larger size is the one most generally used. It will take four #14 wires while the small size will take only two.

Metal Molding is used for all kinds of surface wiring. It does away with unsightly exposed wires and makes a more uniform and safer job.

It is used generally in finished buildings where the present wiring is not adequate or for changing the locations of lights or putting them on switches. An inspection of show windows will show a number of present day applications.

Metal Molding comes in lengths 8'4" long and is made up into bundles of 100 feet of complete molding. The company provides fittings for almost every conceivable need which makes a neat, safe, and inexpensive method of bringing the wires where they are needed.

Metal molding must be used for exposed work only and must never be concealed. It cannot be used in wet or damp places, as it is not water proof, nor can it be used out of doors for the same reason.

## INFORMATION SHEET

## NATIONAL ELECTRICAL CODE

## METAL MOLDING - WIREMOLD

No joints in the wires are allowed in metal raceways except in the boxes or fittings.

Metal raceways such as Wiremold and Metal Molding should not be run in wet or damp places as these moldings are not water-proof.

These moldings may be run thru wooden partitions if there are no joints in the moldings, that is, there must be none in the partitions.

To go down a wall and thru a floor with molding it is necessary to change over to conduit at the floor. This is done generally just above the base-board and the conduit must extend thru the ceiling. A special fitting may be had for this purpose in either molding.

All Metal Raceways must be able to carry a current and so must be continuous from fitting to fitting; that is, there must be no gaps any where in the molding.

All Metal Raceways must be grounded with some approved grounding device.

In alternating currents used in metal raceways, all the wires of the circuit must be run in the same raceway. If one wire only is run in a metal raceway there may be excessive heating of the raceway or inductive drop difficulties.

## QUESTIONS

1. Why are no joints allowed in wires which are placed in raceways?
2. Why is conduit used instead of moulding in going thru the floor or ceiling?
3. Why do raceways heat if only one wire of a circuit is run thru it?

CHECKING SHEET  
FOR  
METAL MOLDING & WIREMOLD

1. Check at the left the operations needed to do the job.
2. Place in the column at the right numbers showing when these operations will be performed, that is, which operation will be done first, which will be done second and so on.

GRADES... WIREMOLD.

Job 1...Job2...Job3...Job4...Job5...Job6...Job7...Job8...

Job9...Job10...

Total time for all jobs..... Date began .....

Date finished.....

OPERATIONS	ORDER OF DOING									
	1	2	3	4	5	6	7	8	9	10
Cutting Slotting and Punching Coupling and Fitting										
Bending and mitering a turn Installing a snap switch box Soldering with an iron										
Soldering with a blow-torch Taping Putting in the wires										
Testing for shorts and grounds Planning and making a bill of material. Making joints										

Grades Metal Molding

Job1....Job2....Job3....Job4....Job5....Job6....Job7....

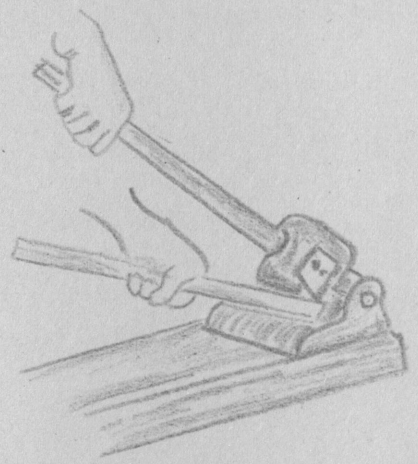
Job8....Job9....Job10....

Date began....Date finished.... Total time.....

OPERATION SHEET  
METAL MOLDING  
CUTTING.

1. To cut with a hack saw, place the molding in a vise, or in some other manner hold the molding rigid. Use a fine toothed saw and cut squarely thru the molding. The cap and the base may be cut at the same time if desired.

2. To cut with a regular molding cutter, place the cap or base in the cutter so that the mark on the molding will be on the proper side of the cutting knife. Press down hard on the cutting handle.



QUESTIONS.

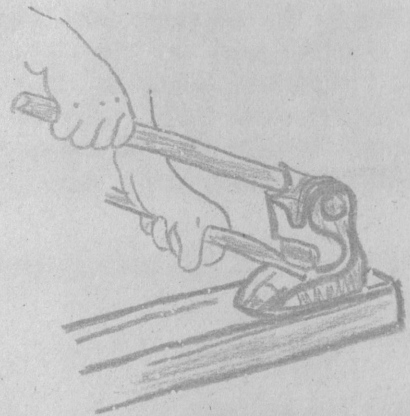
1. Will this cutter cut both the cap and the base at the same time?
2. What other methods may be used to cut metal molding?



OPERATION SHEET  
METAL MOLDING  
SLOTTING OR PUNCHING

1. When molding is cut it is generally necessary to provide slots for the screws on the fittings and also slots for the supporting screws. Hold the molding in the punch as shown and push down hard on the handle.

If the punch changes the shape of the molding, straighten with a few taps of the hammer.



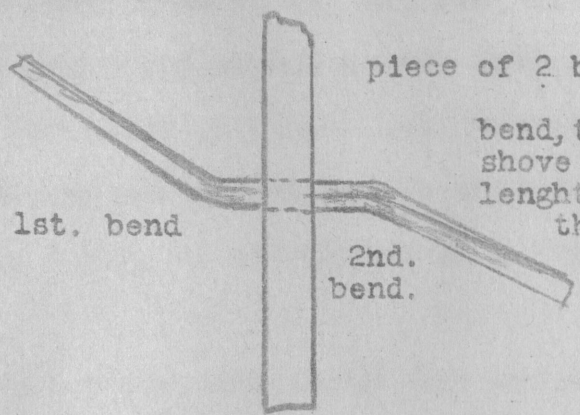
QUESTIONS

1. Is the punch used for the cap as well as the base?

OPERATION SHEET

METAL MOLDING  
BENDING AND MITERING A TURN.

1. To bend, place the base and the cap together and either bend over a form or make a bending tool by boring a hole in a piece of 2 by 4. Slip the molding thru the hole and bend, being sure to keep the base and cap together while bending.



After making the 1st. bend, turn the molding over and shove thru the hole the desired length of the offset and bend the 2nd. bend.

MITERING.

1. The inside bend is made by cutting a 90 degree notch out of the base as in fig. 1. The outside bend is made by sawing a straight cut in the base fig. 2. Be careful not to saw thru the base when making this cut.



Fig. 1.

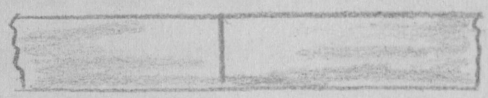
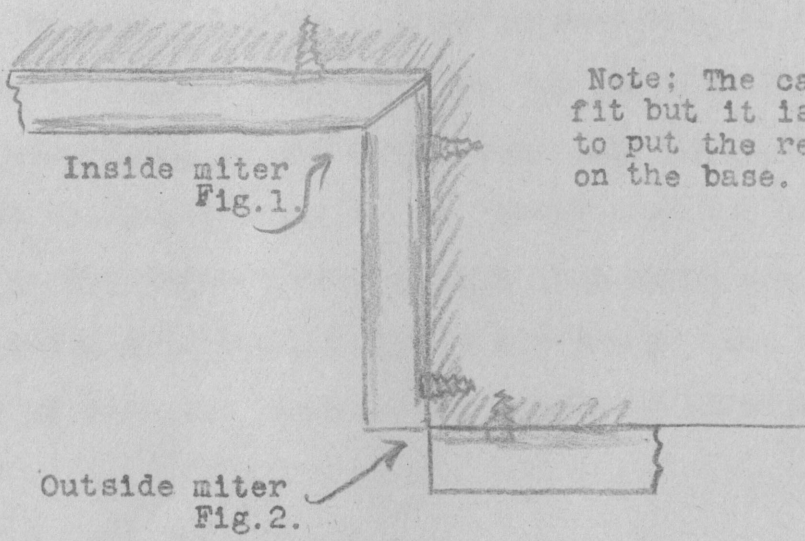


Fig. 2.



Note; The cap can be cut to fit but it is generally better to put the regular ell covers on the base.

Questions.

1. Why must the base and capping be put together before bending?

## OPERATION SHEET

## METAL MOLDING

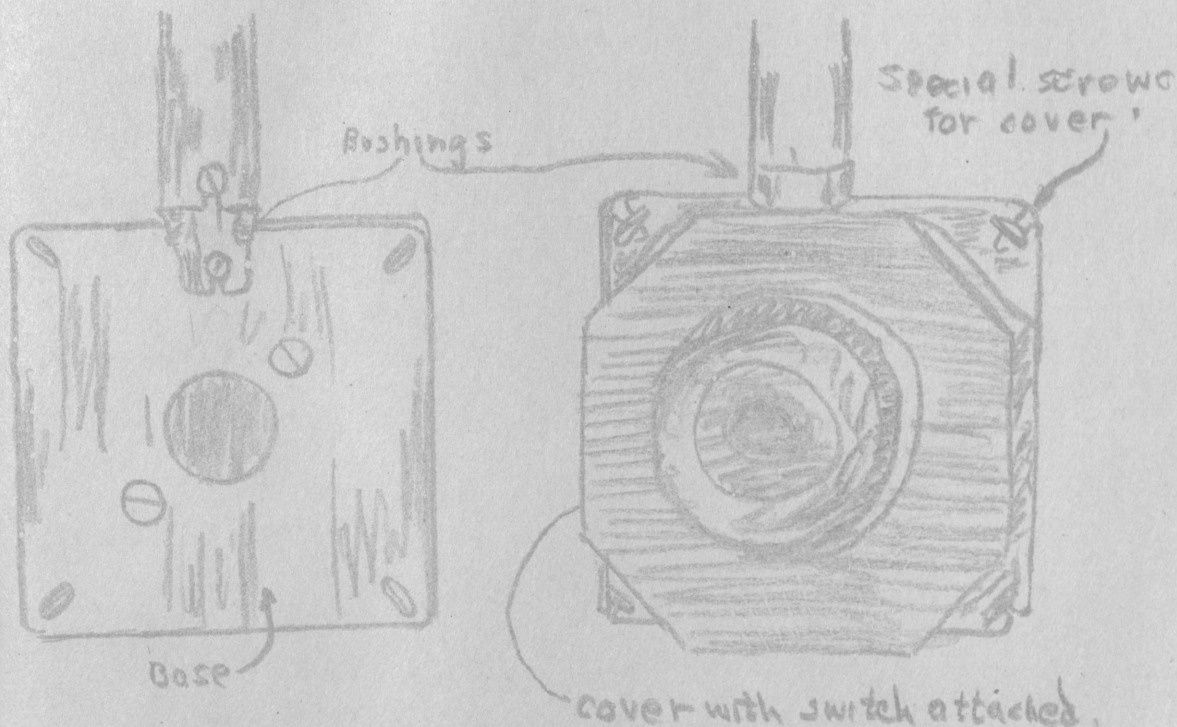
## INSTALLING A SNAP SWITCH BOX.

1. Select type of box to be used. Connect the box to the molding and fasten to the surface of the wall.

Put on the top. Scrape the wires and pull them well up into the holes in the switch so that there will be no bare wire showing at the base to touch on the metal of the box.

Fasten the wires under the binding screws and clip off the ends so that they will not touch on the switch cover.

Fasten the switch to the cover with the screws provided.



## QUESTIONS

1. Could you attach a rosette or receptacle to the cover?

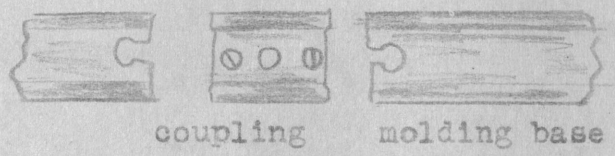


OPERATION SHEET

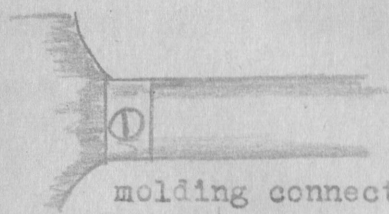
METAL MOLDING

COUPLING AND CONNECTING TO FITTINGS.

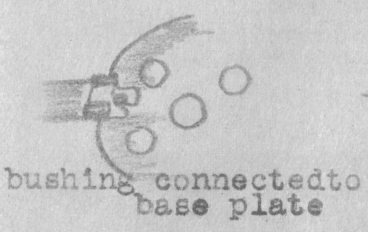
1. Loosen the screws on the coupling and slip the molding in place. Tighten the screws being careful not to strip the threads or try to remove them entirely as they are made so that they will not come off.



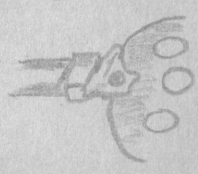
coupling      bushing cap      molding base



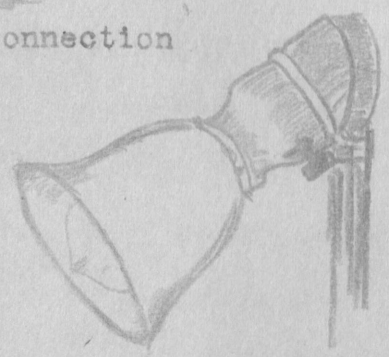
molding connected to fitting, no bushing needed



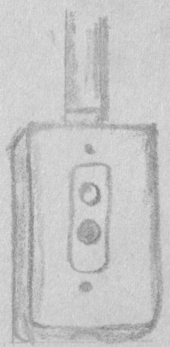
bushing connected to base plate



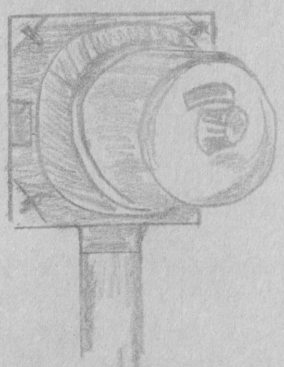
tee connection



showing use of angle fitting.



flush switch outlet box



snap switch outlet box with switch mounted.

Questions.

1. What is the purpose of the bushings?
2. Why are couplings needed?

CONSTRUCTION SHEET

METAL MOLDING  
and  
WIREMOLD

Draw a picture and give the catalog number of the fittings used in the questions listed below.

1. Show how to pass thru floors.
2. Show how to pass thru walls.
3. Show how to change to armored cable.
4. Show how to change to rigid conduit.
5. Show how to tap from concealed outlet box.
6. Show how to install a "through run".
7. Show how to enter a flush cabinet.
8. Show how to enter a surface cabinet.
9. Show how to change to cleat work.
10. Show how to change from large size to small size molding.

INFORMATION SHEET

CONDUIT

The function of rigid conduit is to provide a path, or raceway, for the wires that will protect them, and yet be arranged in such a manner that the wires may be drawn from the conduit at any time without disturbing the wall or ceilings. If any trouble occurs in the system and a fire starts, the trouble will be inside the pipe and no damage to the building is likely to occur.

Rigid conduit provides the safest, although the most expensive method, of any of the wiring systems in use. Conduit is a standard size pipe made for the electrical trade for electrical purposes only. It is very smooth on the inside, being coated with an enamel paint so that the wire will pull thru easily. Conduit comes in the same sizes as regular pipe, the same as the plumber or steam fitter uses so that the ordinary cutting and threading tools are used.

Conduit may be had in either of two finishes, galvanized or black. Fittings may be had in either cast iron or pressed steel, and in either finish galvanized or black. The galvanized finish is used in wet or damp places or for all out of doors uses. The black finish is used inside or where the conduit is not exposed to moisture.

QUESTIONS.

1. Why is not ordinary plumbers pipe used for electrical purposes?
2. What kind of conduit should be used in a boiler room?

INFORMATION SHEET  
 CONDUIT SIZES FOR WIRE AND CABLE AS ADOPTED  
 BY THE NATIONAL FIRE PROTECTION ASSOCIATION.

SIZE OF WIRE	SIZE OF CONDUIT IN INCHES.			
	1 wire	2 wires	3 wires	4 wires
14	1/2	1/2	1/2	3/4
12	1/2	1/2	3/4	3/4
10	1/2	3/4	3/4	1
8	1/2	1	1	1
6	1/2	1-1/4	1-1/4	1-1/4
5	3/4	1-1/4	1-1/4	1-1/4
4	3/4	1-1/4	1-1/4	1-1/2
3	3/4	1-1/4	1-1/4	1-1/2
2	3/4	1-1/2	1-1/2	1-1/2
1	3/4	1-1/2	1-1/2	2
0	1	1-1/2	2	2
00	1	2	2	2-1/2

QUESTIONS.

1. When may more wires than those above specified be carried in a conduit?
2. What size conduit will carry 15 no. #14<sup>c</sup> wires?

CHECKING SHEET

CONDUIT

1. Place in the column at the right numbers showing when these operations will be performed; that is, which of these operations will be done first, which will be done second, and so on.

	Job 1	Job 2	Job 3	Job 4	Job 5	Job 6	Job 7	Job 8	Job 9	Job 10
Planning and making a bill of material.										
Cutting.										
Reaming and threading.										
Running thread.										
Bending.										
Throwing an offset.										
Installing.										
Soldering with an iron.										
Soldering with a blowtorch.										
Taping										
Putting in the wires										
Testing for shorts and grounds										
Making joints										
Drawing the wiring plan										

GRADES: Job 1---- Job 2---- Job 3---- Job 4---- Job 5----

Job6---Job7---Job8---Job9---Job10---

AVERAGE GRADE -----

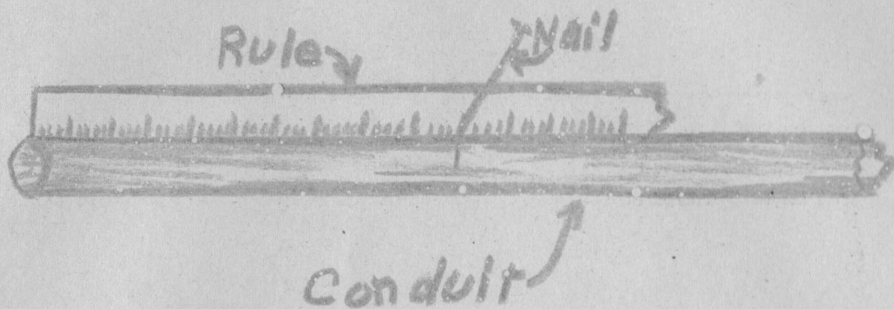
TOTAL TIME FOR ALL JOBS -----

## OPERATION SHEET

## RIGID CONDUIT

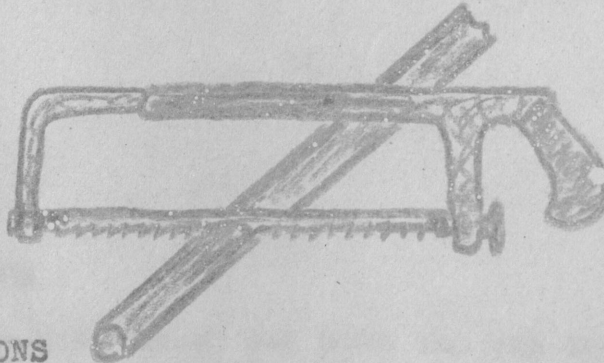
## CUTTING

1. With a sharp nail, knife or chalk, mark the conduit at the place it is to be cut. Place the conduit in a pipe vise and clamp snugly so that the pipe will not move when you start to cut. If you tighten too tight you may dent the conduit.



To cut with a hack saw, first inspect the saw to see if the blade is loose or the teeth badly broken. The blade should be strained rather tightly in the frame. 24 teeth to the inch is about right for the blade as a coarse blade will have its teeth knocked out when sawing pipe.

Saw right thru the mark, taking pains to have a square cut, sawing with a firm forward cutting movement. If you twist the blade during the stroke you may snap the blade.



## QUESTIONS

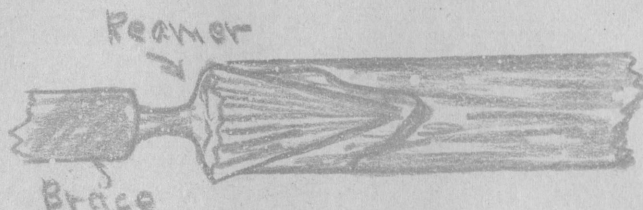
1. Which way should the teeth point when placed in a hack saw frame?
2. What is the advantage of a flexible back blade?
3. How can you tell a flexible back blade when you see it?
4. If the blade is loose, what is liable to happen?



## OPERATION SHEET

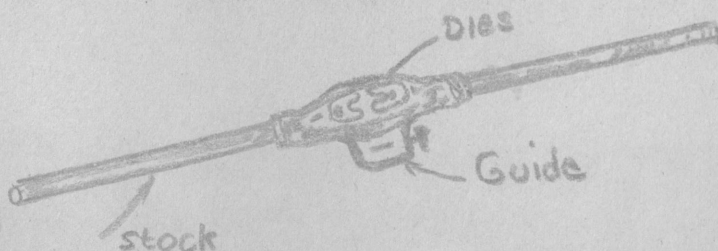
## RIGID CONDUIT REAMING AND THREADING

1. After sawing it will be noticed that the inside of the cut will have a sharp edge that is liable to scrape the insulation from the wire when it is drawn thru. Take a burring reamer and ream the inside until it is smooth. If the reamer is placed in a brace 8 or 9 turns will generally be enough.



## 2. THREADING

see that the size of the die is the same as the pipe; also note if the guide is the same size as the die. If every thing seems to be O K put a little lard cutting oil on the pipe and run the dies on it until the dies engages the pipe. Turn the stock slowly to the right, pushing hard against the conduit until the dies start to cut. From time to time put a little oil on the pipe as you cut. Cut until the end of the pipe comes thru the dies about three or four threads. Rock the stock back and forth a few times and then unscrew. Take the stock off and rap the pipe smartly a few times with the handle of the stock to knock off any chips that might stick to the pipe and also to knock out the shavings from the inside of the die.



## QUESTIONS

1. What does the mark "R" on the die mean?
2. What will happen if no oil is used?
3. Why not use ordinary oil?
4. Why should the dies be run over old threads?
5. How may pipe burrs be removed without a reamer?

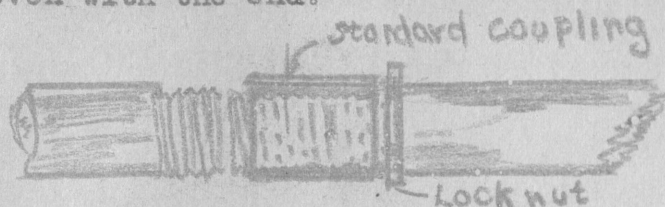


## OPERATION SHEET

## RIGID CONDUIT

## MAKING A RUNNING THREAD ON A PIPE

1. Thread one piece of the pipe in the regular manner and ream it. Thread the other piece to be connected to it about  $1/4$  inch longer than the standard coupling to be used. Ream this pipe. Run a regular lock-nut on this longer thread then run on the coupling until it is even with the end.



2. Put the two pieces of pipe together and unscrew the coupling off of the other pipe. If the pipe to be connected is held straight the coupling will screw on to it. Run the coupling on until the joint between the pipes is about in the middle of the coupling. Run the lock-nut up against the coupling and tighten.



Finished Job.

## QUESTIONS

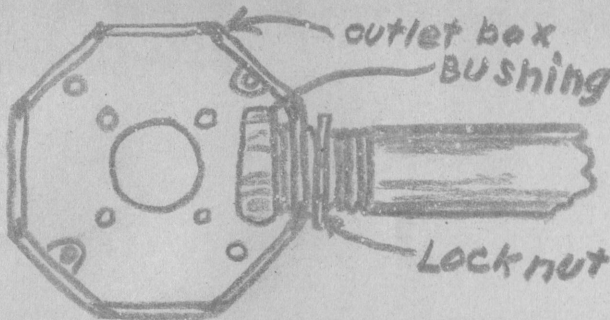
1. What is this kind of a coupling for?
2. What does a Plumber use for this same job in his work?
3. What is the lock-nut for?

## OPERATION SHEET

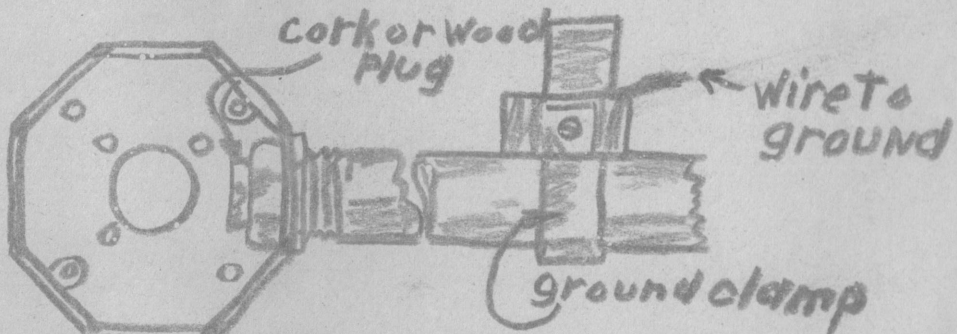
### RIGID CONDUIT

#### INSTALLING

1. After locating all outlets try to figure out the most direct way of running your pipe to avoid as many turns or bends as you can. By looking thru each length of conduit determine if there is any obstruction. Make the necessary bends. Place a locknut on the pipe and put the pipe in the box outlet then screw a bushing on the end of the pipe and tighten both the bushing and the locknut so that there will be a good connection between the box and pipe.



2. Fasten the conduit to the material being wired over with pipe straps or other approved holding devices. When supports are notched to allow the pipe to go in a large size nail is all that is needed to hold the pipe in place.



#### QUESTIONS

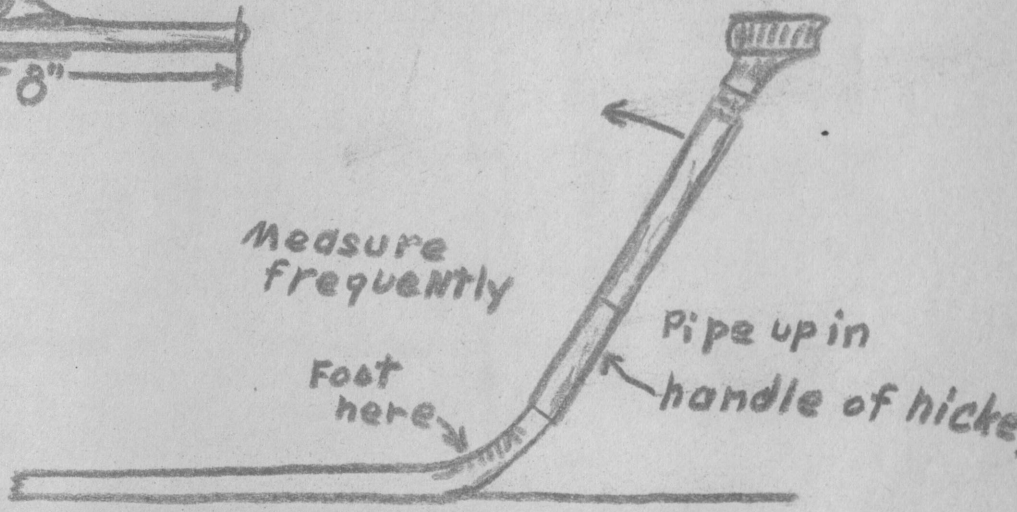
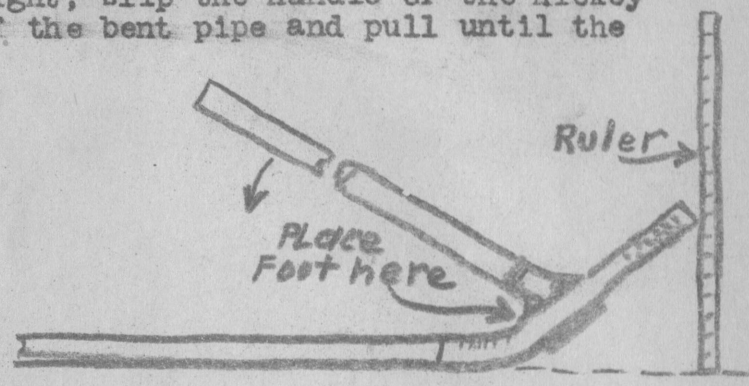
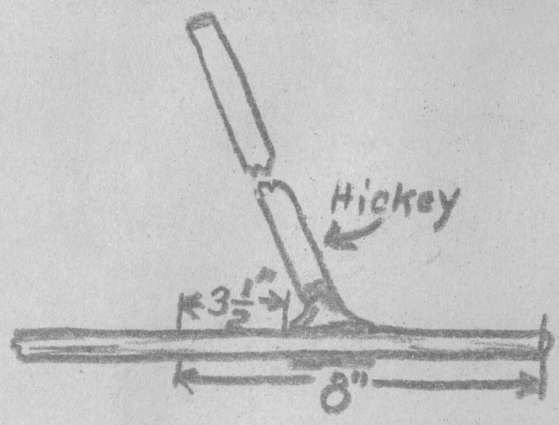
1. What is the difference between conduit and ordinary pipe?
2. How can you keep the dirt out of the pipe after it is installed?
3. Where should the conduit system be grounded?
4. How many right angle bends are allowed in each run of pipe?
5. May conduit be buried in the ground?
6. Why must there be a good electrical connection between the boxes and the conduits?
7. What kind of holding devices can be used for holding the conduit in position?

### OPERATION SHEET

#### RIGID CONDUIT

TO BEND A RIGHT ANGLE ELBOW OF ANY GIVEN LENGTH.

1. Mark off on the pipe the length of the bend. Move the bending hickey about 3-1/2" from this mark towards the end of the pipe. Put the foot up tight against the hickey and bend. As the pipe comes up measure it to see if it is likely to be right. If it seems to be a little long, slip the hickey farther up toward the end. If the bend looks short, slip the hickey down and bend. When the bend is nearly straight, slip the handle of the hickey over the straight end of the bent pipe and pull until the bend is finished.



#### QUESTIONS

1. What is the radius of the smallest bend that may be made on 1/2 inch pipe?
2. How many bends may a pipe have between outlets?



### OPERATION SHEET

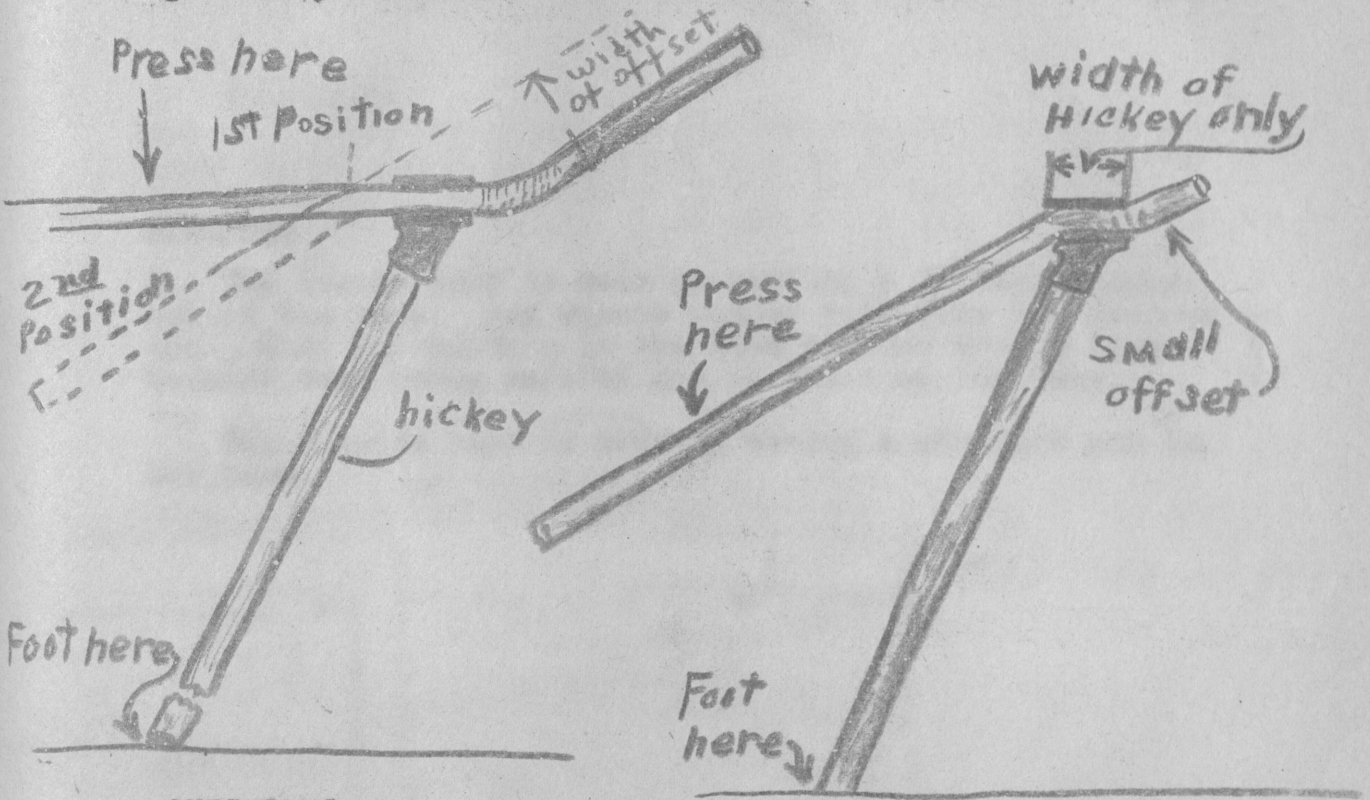
### RIGID CONDUIT

### THROWING AN OFFSET.

1. Mark on the pipe the place where the offset is to be and make the bend in the regular manner.

2. Slip the hickey along the pipe to about where the next bend is to be made. Place the hickey handle on the floor and hold it from slipping with the foot. Grasp the pipe tightly with both hands and bend down until the pipe has the shape needed. Be sure that the pipe does not twist in the hands or the pipe will not lay flat.

Small offsets on the extreme ends of the pipe are generally made with the handle of the hickey on the floor.



### QUESTIONS

1. When are standard elbows used in preference to offsets?
2. How would offsets be made in large pipes?

## Construction Sheet

## Conduit.

1. Draw a picture of each of the following condulets: LL..LB..FSC..LR..FS..C..A..B.
2. Draw a picture of a conduit entrance naming the parts.
3. What materials are needed for a 4 circuit entrance?
4. Draw a picture of a 3 wire pothead.
5. Show how you would support 3 no. #4 wires in a conduit run of 100 ft. in an elevator shaft?
6. What would it cost to buy the following materials from a dealer in your town?
  - 100 ft. of  $\frac{1}{2}$ " conduit.
  - 10- 8E boxes.
  - 50-  $\frac{1}{2}$ " locknuts.
  - 5- FSC  $\frac{1}{2}$ " condulets
  - 10lbs of  $\frac{1}{2}$ " pipe straps.
  - 1 8" by 12" by 4" panel box  $\frac{1}{2}$ " KO.

Information Sheet.

Flexible Metallic Conduit.

(Greenfield)

Flexible metallic conduit called Greenfield, by those in the trade, is a flexible metallic pipe like a hose. It is used in places where rigid conduit cannot be employed such as in walls or ceilings of finished buildings. It is sometimes used in long runs of rigid pipe where the expansion of the pipe due to changes of temperature require a flexible joint.

The electrician finds it convenient to use when wiring around machinery where the nature of the work calls for flexible connections. It is not waterproof so that it may not be used in wet places.

Flexible Metallic Conduit comes in the regular conduit sizes and may be had in rolls of 250 ft. or less. It is much more expensive than the rigid conduit so the electrician uses it only when nothing else will do.

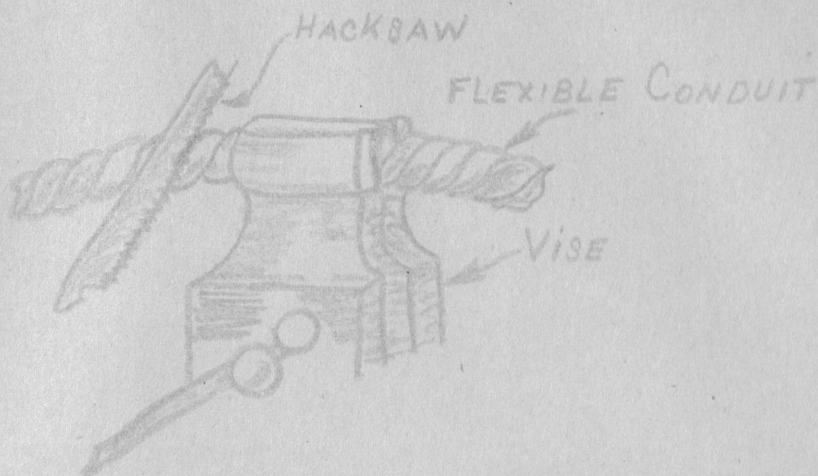
## OPERATION SHEET

## FLEXIBLE CONDUIT (GREENFIELD)

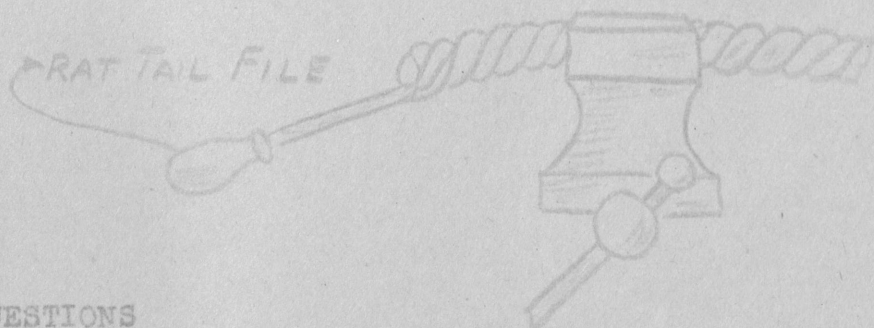
## CUTTING AND REAMING

1. Place the conduit in a vise, being careful not to crush it, and cut with a fine toothed hack saw close up to the vise.

It is generally best to cut thru the middle of one of the spirals as the saw is not so likely to catch and break.



2. Ream or file the burr that is left with a three cornered or rat tail file. If the end of the spiral bends down it must be bent back out of the way of the wire.



## QUESTIONS

1. Can a regular reamer be used to clean the burr from the flexible conduit?
2. What is the radius of the smallest bend that may be made?

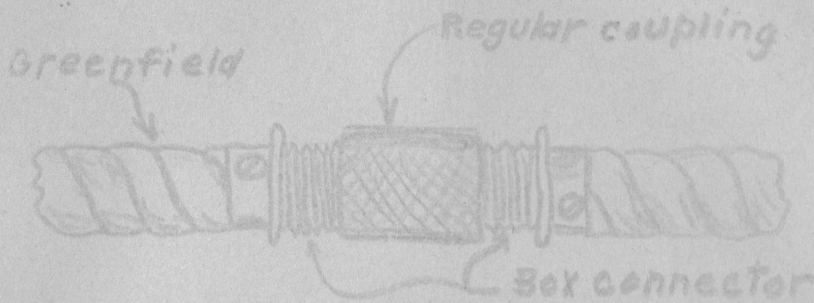


OPERATION SHEET

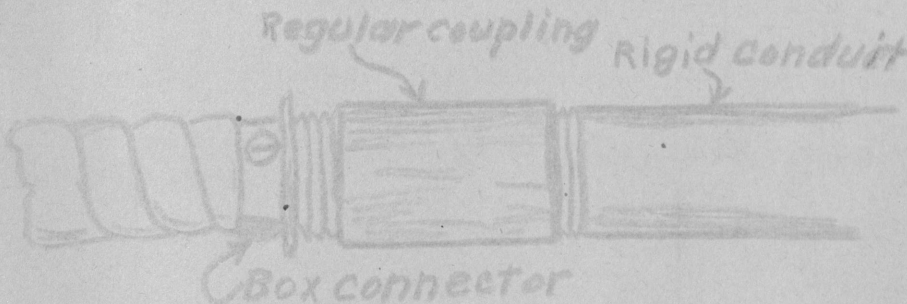
FLEXIBLE CONDUIT (GREENFIELD)

COUPLING FLEXIBLE CONDUIT

1. Screw two regular Greenfield box connectors together with a standard pipe coupling. Push the ends of the Greenfield in the ends of the connectors as far as they will go and tighten up the set screws.



2. To connect a piece of Greenfield to rigid conduit, screw a connector on a regular coupling and then on the rigid conduit. Push the flexible conduit on the connector and tighten up the set screw.



QUESTIONS

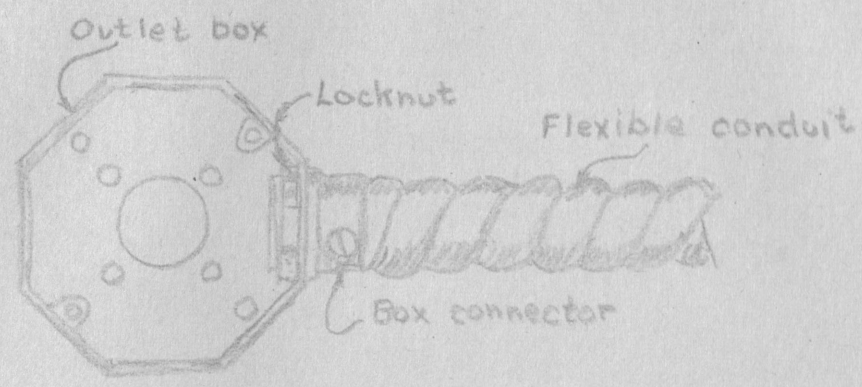
1. What other methods are there for connecting two pieces of flexible conduit together?
2. Where is flexible conduit used?
3. What are the regular sizes that are the most used?
4. May flexible conduit be used in wet or damp places? Why?

OPERATION SHEET

FLEXIBLE CONDUIT (GREENFIELD)

INSTALLING AND CONNECTING TO BOXES

1. Flexible conduit is used in the wiring of old buildings and so must be fished thru the walls and ceilings. When run parallel to the joists the flexible conduit may lay loose upon ceiling. When run across the joists bore holes and run the conduit thru them. When making turns let them be as large as possible so that the wire will fish thru easily. Fasten the conduit well at the turns so that when the wire is fished thru the pull will not kink the conduit or pull it out of the box.



CONNECTING TO BOXES

2. Put a regular connector on the Green field and tighten set screw securely. Then push the connector thru the desired knock-out in the box. Place the lock-nut on and tighten securely against the box so that there will be no looseness.

QUESTIONS

1. Why should flexible conduit be tightly connected to the box?

## INFORMATION SHEET

## ARMORED CABLE (BX)

Armored Cable, or BX, is a flexible steel conduit with the wires placed in such a manner that they can not be withdrawn from the cable. It is made by serving a wrapping of metal around the wires in such a manner that the cable may be easily bent and yet protect the wires from mechanical injury. The different manufacturers have each a special way of serving the armor around the conductors.

Armored cable is generally used in the wiring of old buildings where rigid iron conduit can not be used. It has its advantages here because it can be pulled around short bends and obstruction in the wall and ceilings.

The ordinary armored cable is not water proof. For places where a water proof cable must be used the wire first has a lead sheath put on it which is absolutely water proof, and then the steel cable is put on. This cable is called BXL and looks about the same as the regular BX.

Armored Cable comes in various wire sizes and may be had in one, two, and three conductors.

CHECKING SHEET  
ARMORED CABLE (BX)

1. Place in the column at the right numbers showing when these operations will be performed; that is, which of these operations will be done first, which one will be done second, and so on.

	Job 1	Job 2	Job 3	Job 4	Job 5
Planning and making a bill of material. Cutting. Installing.					
Stripping armor from cable. Soldering with an iron. Soldering with a blowtorch.					
Taping. Testing for shorts and grounds. Making joints.					
Drawing the wiring plan. Fishing in side walls. Fishing in ceilings.					

GRADES: Job 1---- Job 2---- Job 3---- Job 4---- Job 5----

AVERAGE GRADE -----

TOTAL TIME FOR ALL JOBS -----

DATE BEGAN -----

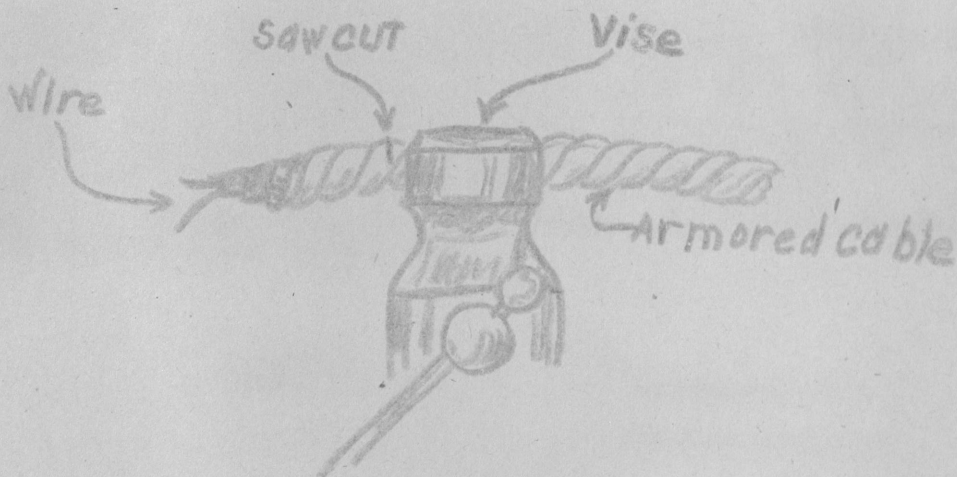
DATE FINISHED -----



OPERATION SHEET  
ARMORED CABLE (BX)

CUTTING

1. Place the cable in a vise being careful not to crush it. Start in the middle of a spiral and saw thru the cable with a fine toothed hack saw.
2. Measure back on the BX about seven or eight inches. Take the saw and cut thru the spiral at right angles to the twist, being very careful not to saw into the wire. Bend the BX back and forth so that it will break and then pull or strip the armour from the end. This will leave wire enough for the connections.



QUESTIONS

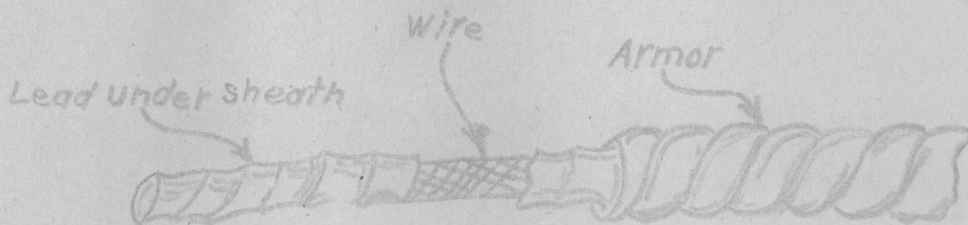
1. How much BX should be allowed for the connecting ends?
2. May BX be run in wet or damp places?

OPERATION SHEET

ARMORED CABLE (BX)

STRIPPING THE ARMOR FROM BXL

1. BXL is the name of the armored cable made to be used in wet or damp places; it is the same as the regular BX except there is a sheath of lead under the armor. Cut the armor in the usual way and strip off the outer coat. The lead under the coat may be bent sharply once or twice and it will break off at the bend. Pull the lead sheath from the wire.



QUESTIONS

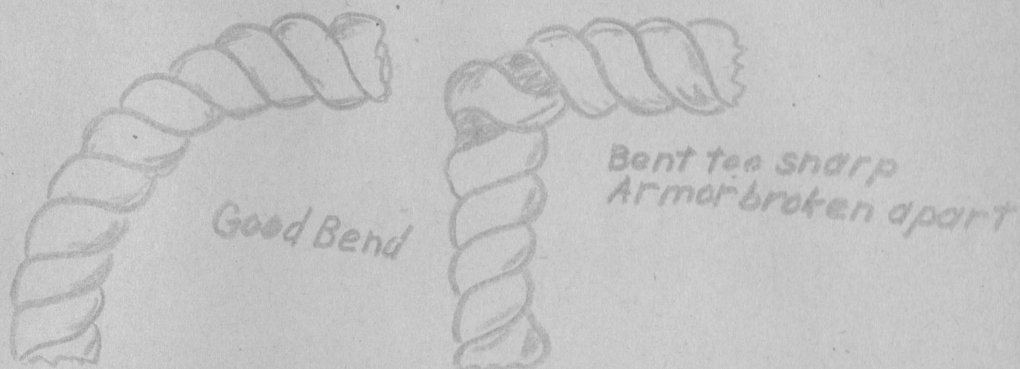
1. What kind of cable should be used outside?
2. Would BXL be all right to bury in the ground?
3. How is the surface of the armor coated?

## OPERATION SHEET

## ARMORED CABLE (BX)

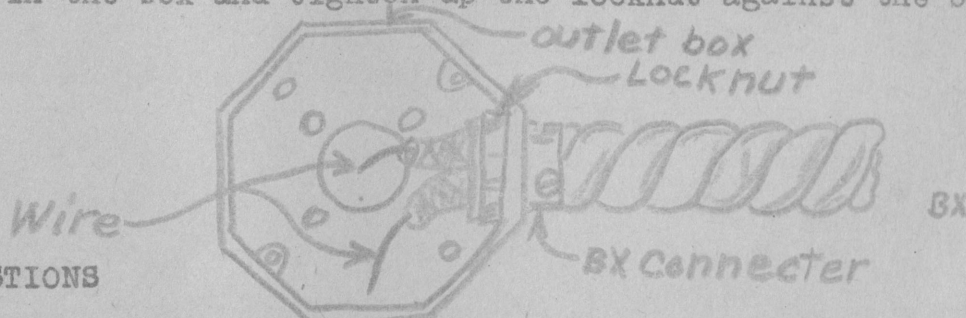
## INSTALLING AND CONNECTING TO BOXES

1. Armored cable may be used in the wiring of old or new buildings. In old buildings it must be fished thru the walls or ceilings and need not be supported when fished parallel to the joists. When run across the joists, bore holes and pull the BX thru them. In making turns be careful not to bend the cable too sharp or it is liable to pull apart and expose the wire. If the cable is broken in a place the whole length must be replaced. When used in new work pipe straps or nails bent over may be used to hold the cable in place.



## CONNECTING TO BOXES

2. Put a regular BX connector on the cable and tighten the set screw. Put the connector thru the desired knock-out in the box and tighten up the locknut against the box.



## QUESTIONS

1. If your circuit was placed in a damp place, what kind of cable would you use?
2. How may joints be made in armored cable?
3. Why is a bushing required in a BX connector?
4. What other kind of connectors are there besides the straight ones?
5. What is BXL?



## Construction Sheet

### Armored Cable.

1. Show how to pass thru a brick wall.
2. Show how to pass thru a floor
3. How would you change to rigid conduit.
4. How many condulets be used with armored cable?
5. List the material needed to put a light in a garage that is 50 ft from the house. A switch at the house and in the garage. Cable to be laid in the ground.
6. What is the cost of the above material? List each item separately.
7. A store is now wired in conduit and you are called in to wire up a sign on the outside of building. The sign has 2-100 watt lamps in it. What would you do first, second and so on.

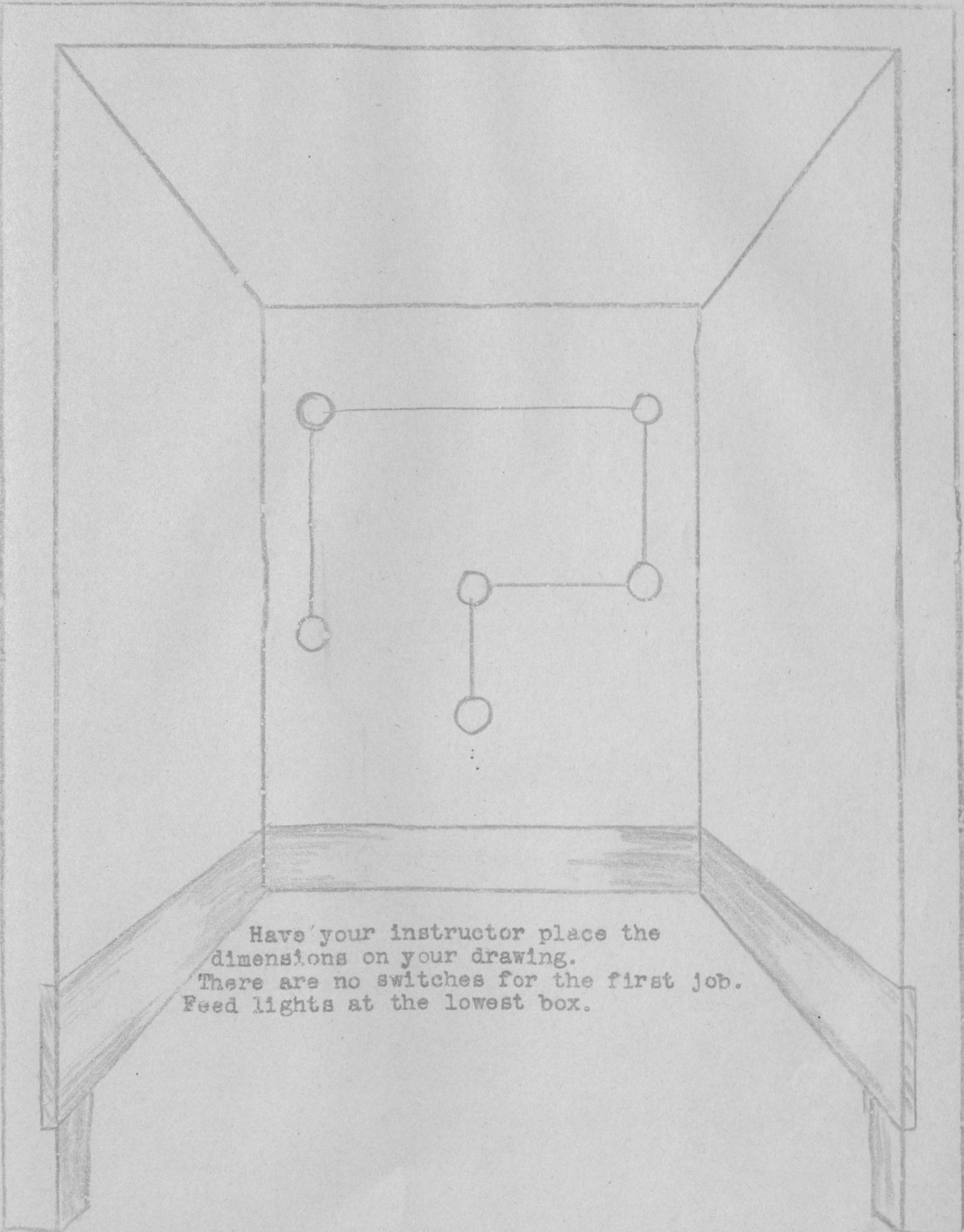
### A Block of Ten Jobs.

The following ten jobs are designed to lead the student from the easier to the more difficult operations and switch connections. The student or instructor should place the necessary dimensions on the drawings before starting the work. The back of each sheet should be used for making the wiring hook-up and a list of the materials used on the job.

These jobs may be used as guides for the work in any of the Blocks. By varying the dimensions the student or instructor may change the appearance of the work but not the difficulty.

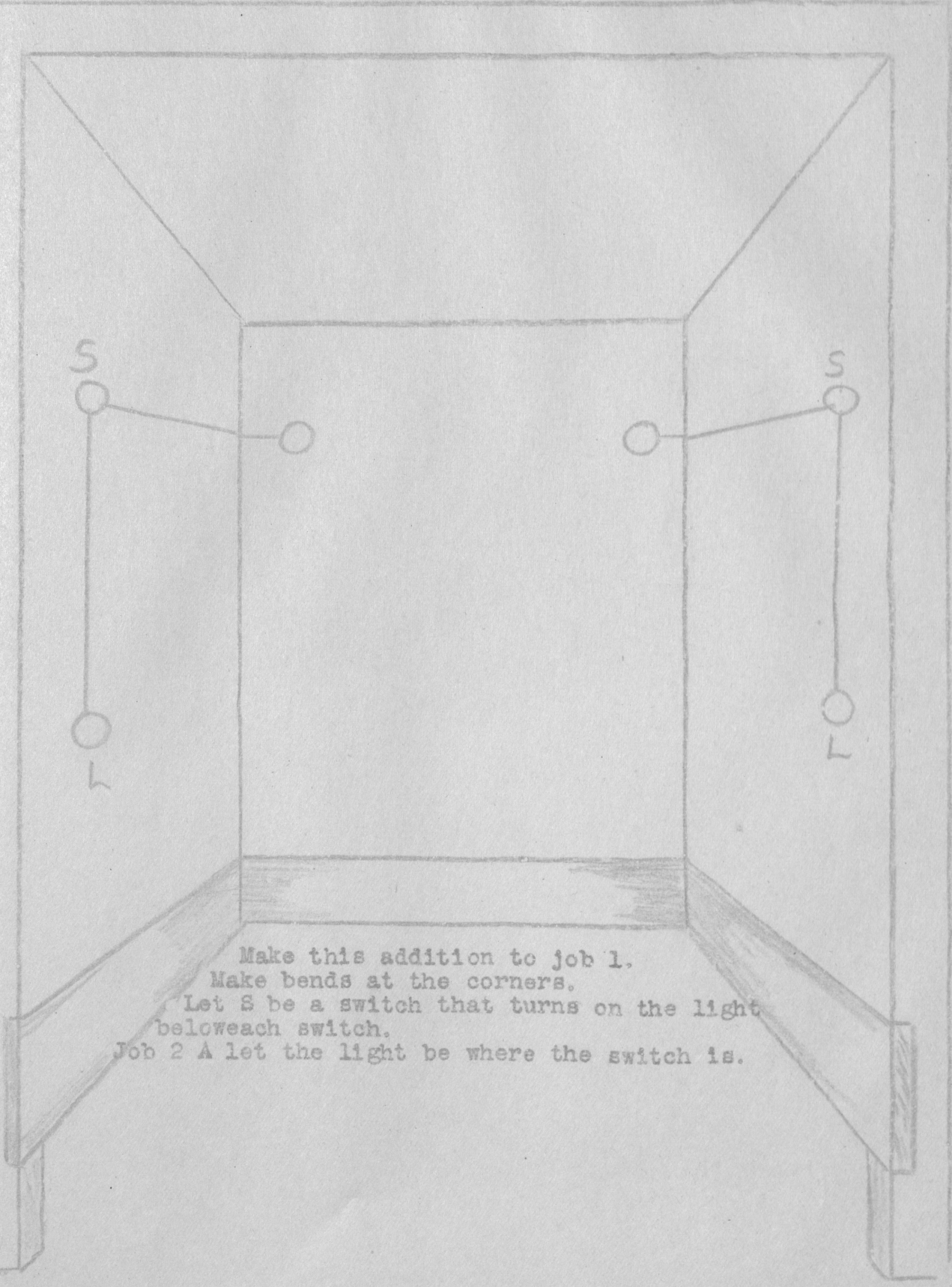
At the completion of each Block of work it is desirable to let the student, under the direction of the instructor, draw a test job that will incorporate the various difficulties that the student has encountered in his work. If possible the work should be of such size that it will be necessary to do this test job outside of the regular booth.

Job 1



Have your instructor place the dimensions on your drawing.  
There are no switches for the first job.  
Feed lights at the lowest box.

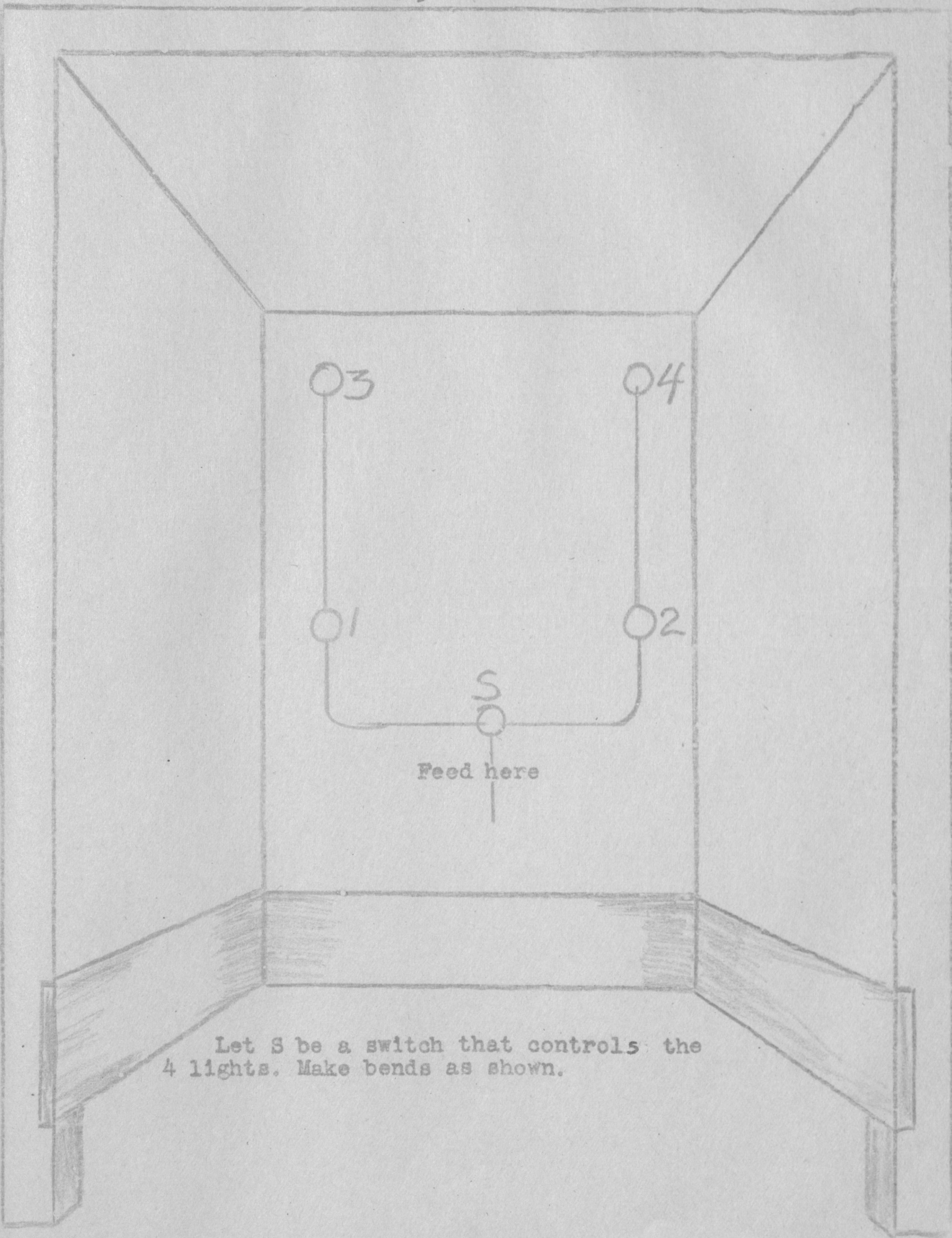
Job 2



Make this addition to job 1.  
Make bends at the corners.  
Let S be a switch that turns on the light  
below each switch.  
Job 2 A let the light be where the switch is.

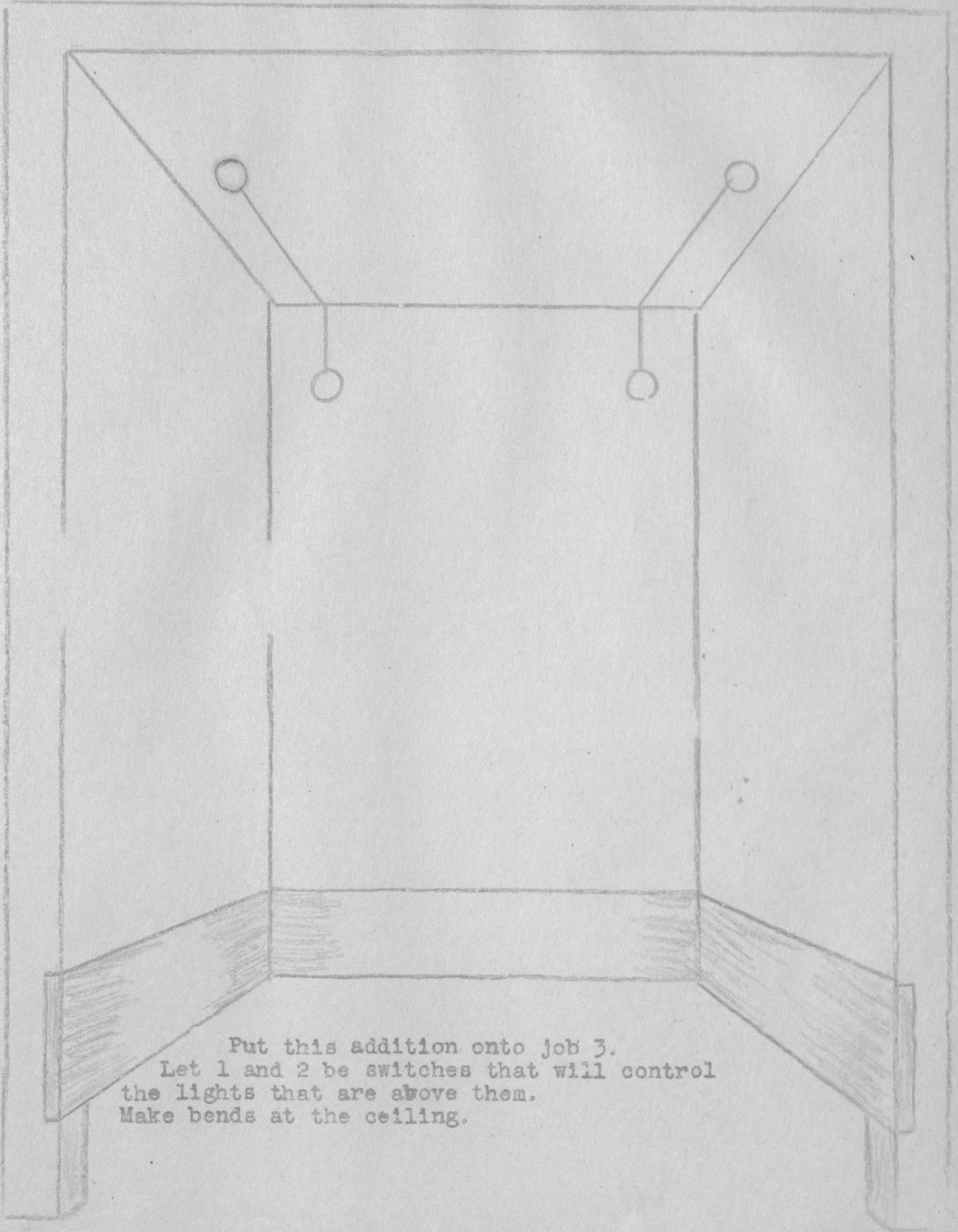


Job 3



Let S be a switch that controls the 4 lights. Make bends as shown.

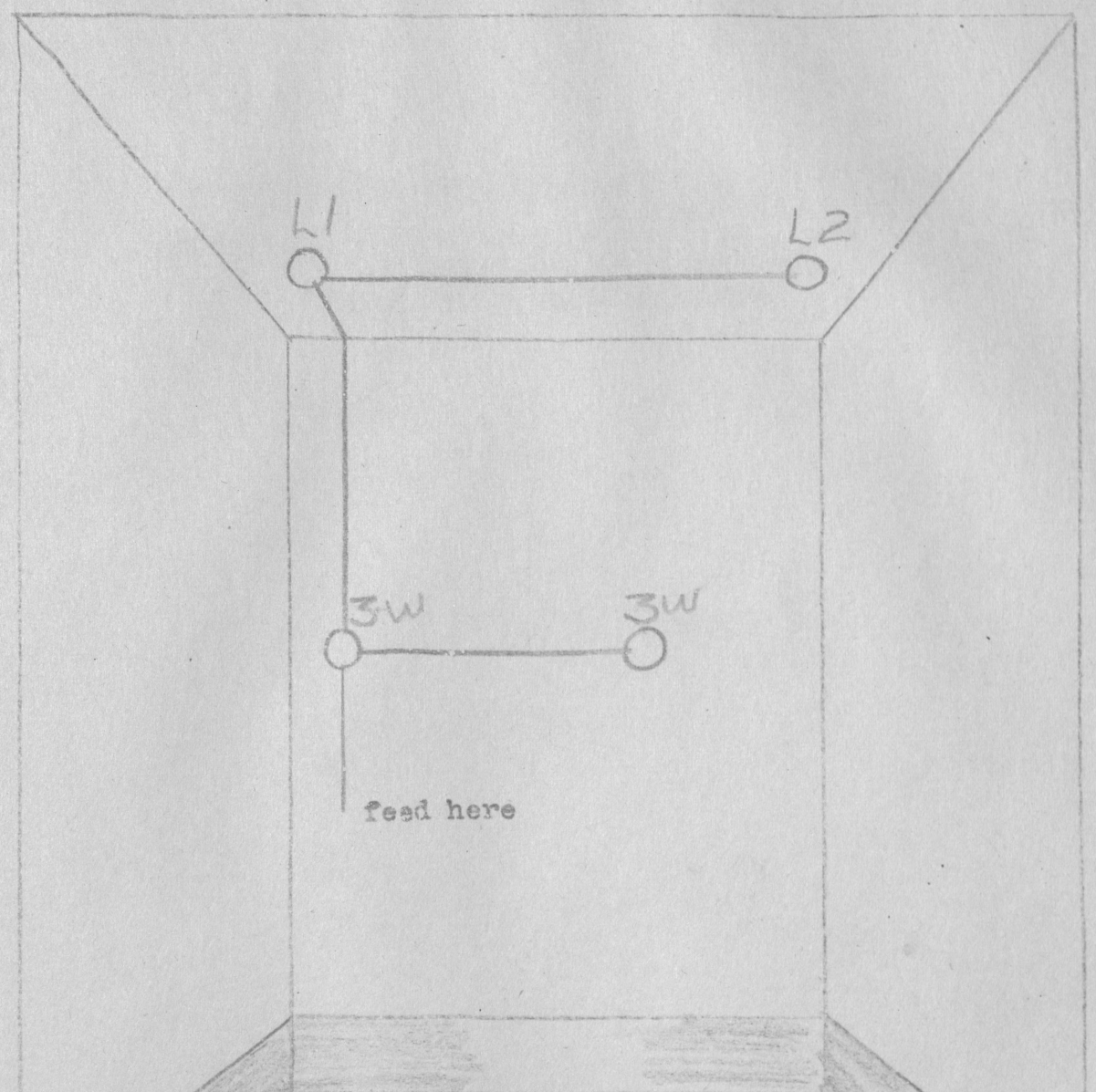
## Job 4



Put this addition onto job 3.  
Let 1 and 2 be switches that will control  
the lights that are above them.  
Make bends at the ceiling.



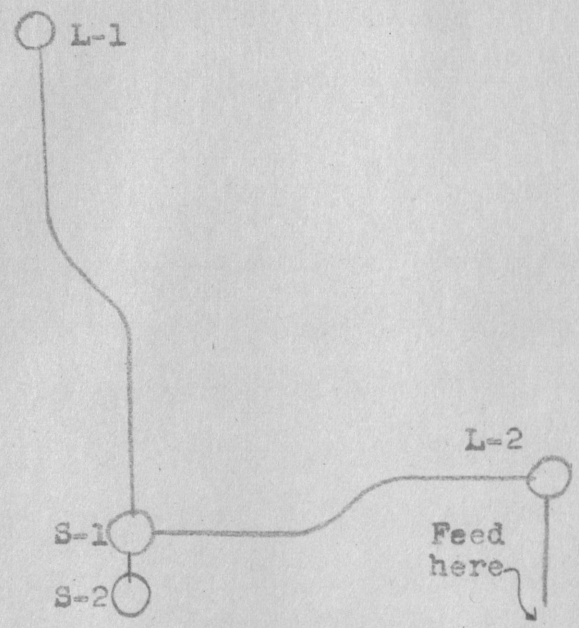
Job 5



The switches marked 3-W control both lights on the ceiling. You must be able to turn the lights on from one switch and then turn them off from the other. Let the feed be as shown.

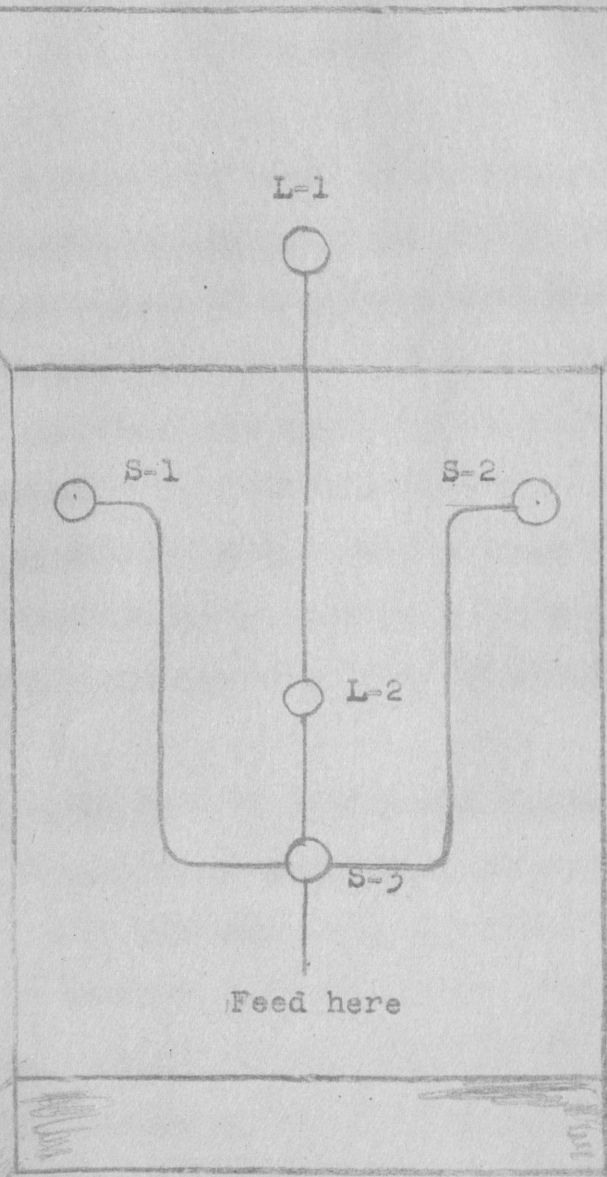
Job 5 A Change the connections so that S1 will control L2 and S2 will control L1. Could the same switches be used?

Job 6



Make the offsets where shown.  
Let S-1 control L-1 and S-2 control L-2.  
Next change the connections so that S-1 will  
control L-2 and S-2 will control L-1.

Job 7



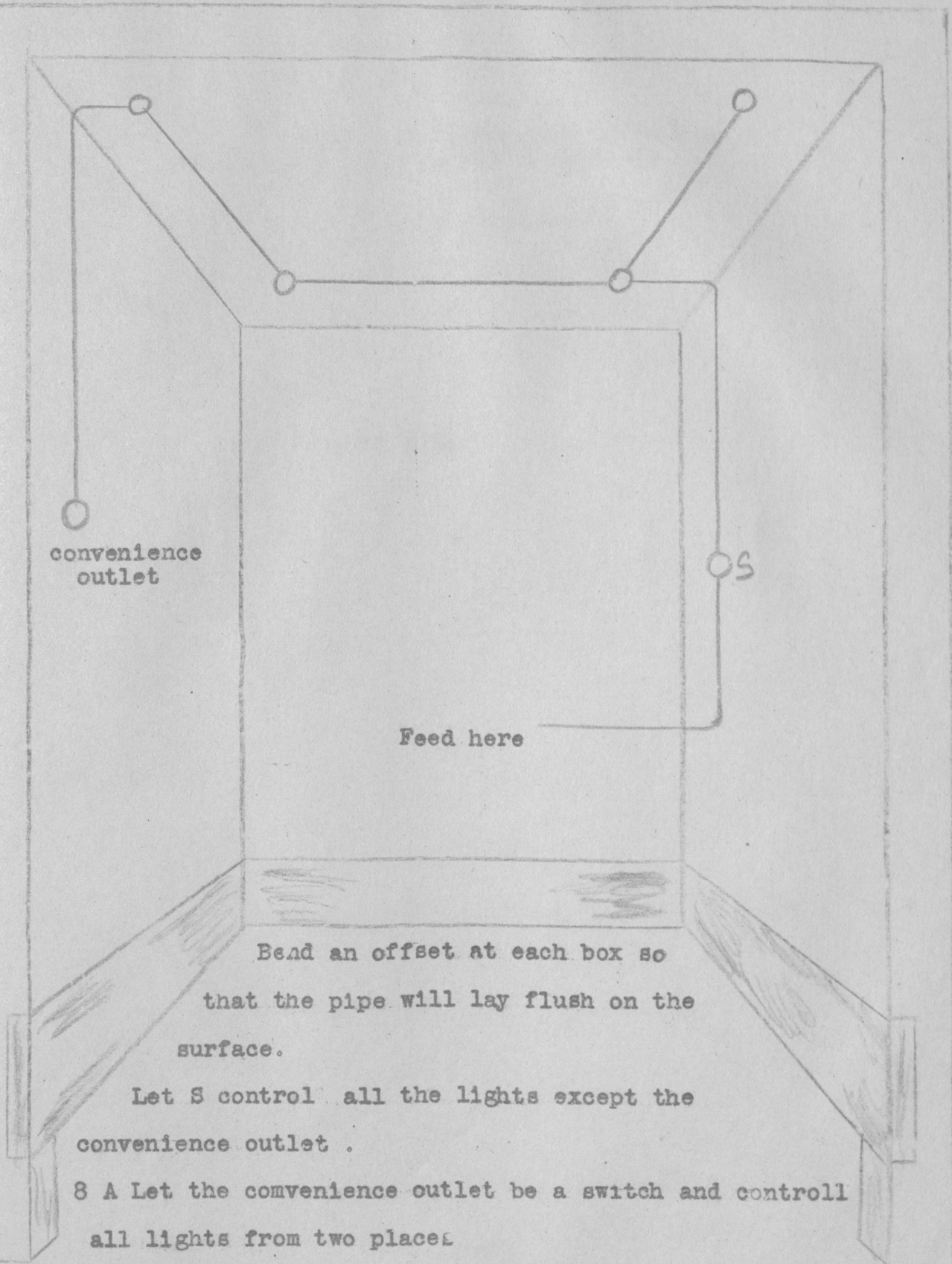
Feed here

Control L-1 and L-2 from three places .  
Bend one of the switch legs from a single piece of conduit.

7A Make L-2 a Master switch.



Job 8



convenience outlet

Feed here

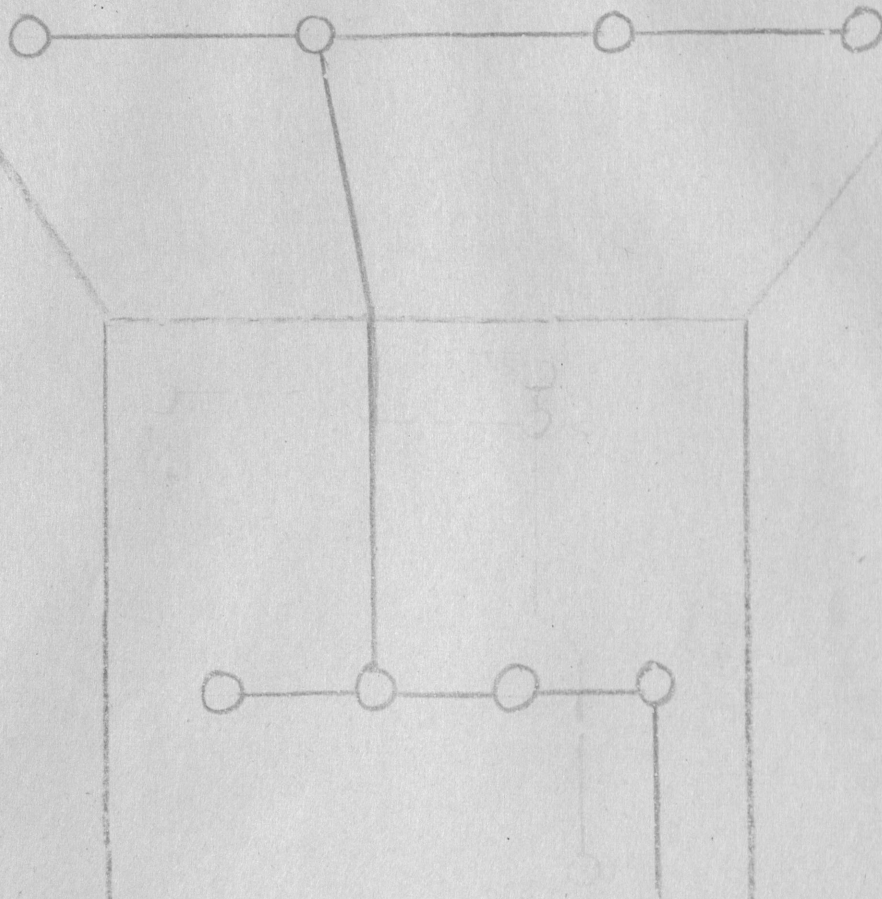
S

Bend an offset at each box so that the pipe will lay flush on the surface.

Let S control all the lights except the convenience outlet .

8 A Let the convenience outlet be a switch and controll all lights from two places

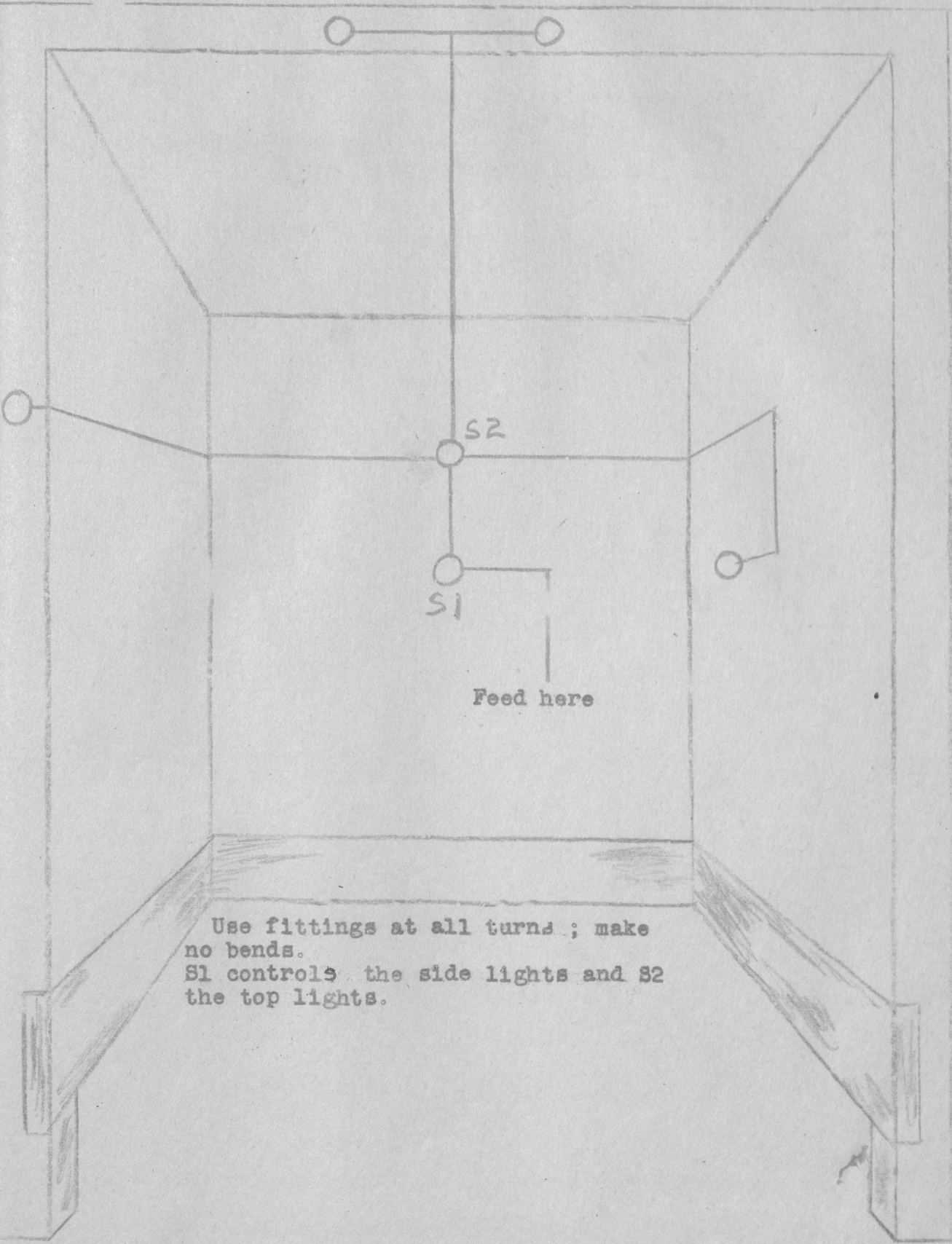
## Job 9



These ceiling lights are to be controlled from four places. Use the standard system and then the Hot wire system of switch connections.

Make offsets at the boxes

Job 10



Use fittings at all turns ; make  
no bends.  
S1 controls the side lights and S2  
the top lights.



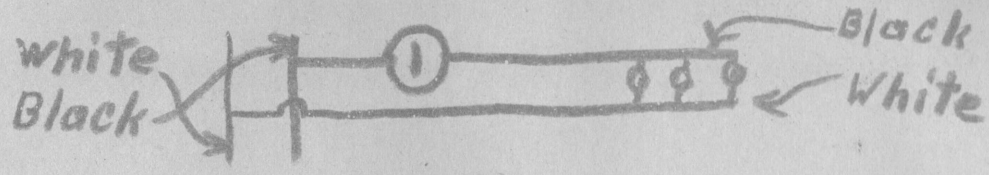
QUESTIONS ON THE "CODE".

1. How must wires be marked?
2. How are screws in sockets marked?
3. What is the smallest conduit allowed in buildings?
4. What is the smallest wire used for an entrance?
5. What is the smallest wire used for a ground?
6. What is the maximum distance between supports in cleat wiring?
7. How many circuits should a 5 room house have? A 9 room house?
8. How do you determine the number of rooms in a house?
9. How many watts to the circuit for residences?
10. In knob and tube work what kind of box is used in the basement?
11. How must joints be made?
12. How shall ground connections be made to water pipes?
13. What are service wires?
14. How should the ground wire be run down a wall in Knob and Tube work?
15. What kinds of buildings must be wired in iron conduit?
16. Where must all buildings be wired in conduit?
17. How must a ground be made when no water pipe is available?
18. What is the rule about loom at outlets?
19. What kind of wire should be used out doors?
20. What kind of wire should run to an out door sign?
21. May armored cable be laid in plaster?
22. What size job requires a 3 wire meter? (110-220)
23. How would you run wires under ground?
24. How many #14 wires are allowed in a 1/2" conduit?
25. Explain the difference between an attic and a roof space.
26. Why must metal raceways be continuous from outlet to outlet?

1. What is the boundary of the City Fire District?
2. Why should an Electrician know the extent of the Fire District?
3. How must all buildings be wired inside of the Fire District?
4. What is the new rule concerning Knob and Tube work?
5. How many circuits should a house of 7 rooms have?
6. What must an Electrician do before he may start to wire a building?
7. What must you do to obtain an Electrician's License?
8. What must be done before a house is connected up by the Light Company?
9. What about a house outside of the city limits, who inspects it?
10. Must all electrical work have a Permit?
11. With what would you wire a four apartment building?
12. A house wired with knob and tubes is now in the Fire District; how would you run an extension in the attic?

INFORMATION SHEET  
SWITCH CONNECTIONS  
SINGLE POLE.

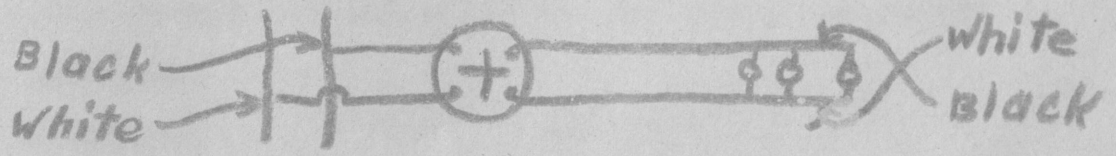
The single pole switch gets its name from the fact that it only disconnects one side of the line or pole. The connections are like this:



The feed wire for all switches must be the black wire. This is the hot or ungrounded wire. The WHITE wire must feed the 1 lights. This is the grounded side of the line. The WHITE wire is run to the shell of the socket and the BLACK wire to the center of the socket; this arrangement makes it nearly impossible for a person to receive a shock when the switch is off as all the wires that go to the socket are of ground potential.

DOUBLE POLE

The double pole switch opens up both sides of the line like this:




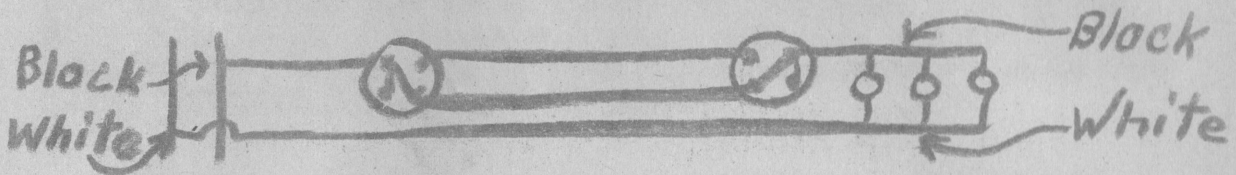
It is used in places where it must be absolutely certain that the line is dead when the switch is off.

INFORMATION SHEET  
SWITCH CONNECTIONS

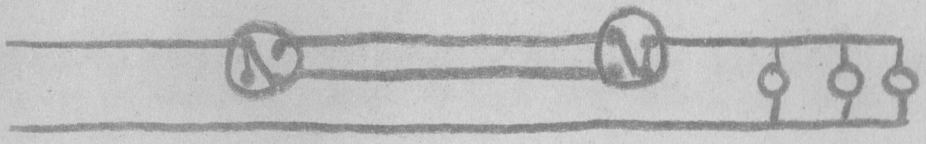
3-Way

The 3-way gets its name, perhaps, from the fact that three wires run from it. It is generally used when lights must be controlled from more than one place. It is really nothing more than a single pole switch with 2 switch wires like this:

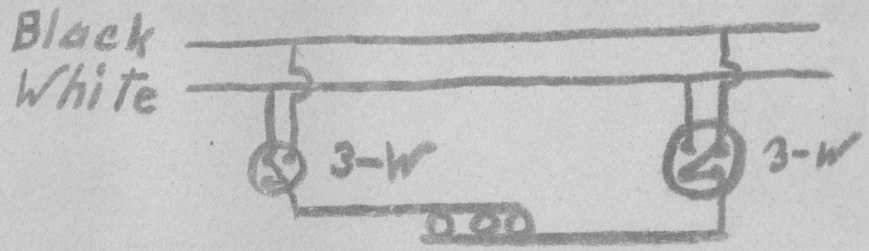
 3-Ways generally operate in pairs. The STANDARD system of connecting is like this:



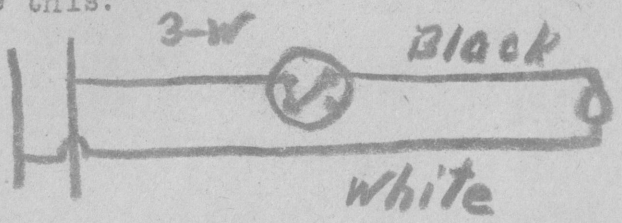
In this position the lights are on but by turning one of the switch arms breaks the circuit and the lights are off.



There is another system of connecting 3-ways which is known as the CARTER system. The CARTER system requires that both sides of the line be brought into the switch in the same manner as the double pole. The connections are like this:



When necessary the 3-way may be used as a single pole switch like this:

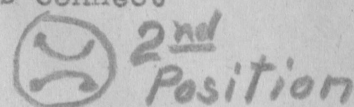
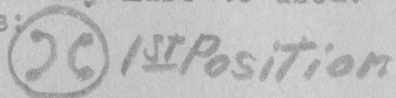




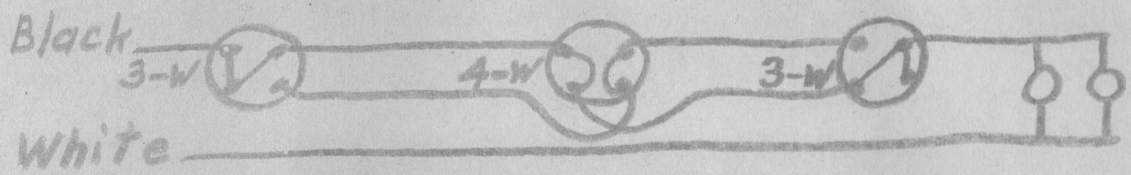
INFORMATION SHEET  
SWITCH CONNECTIONS

4-Way

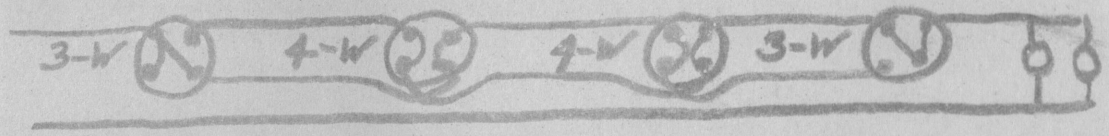
When lights are to be controlled from more than two places a 4-way must be used. The switch arms connect like this:



The switch arms are insulated one from another and are always in contact with the wires no matter which way the arms are turned.

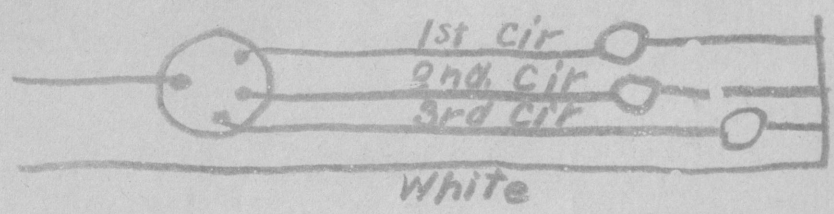


Any number of points of control may be added simply by putting in more 4-ways in the line like this:



ELECTROLIER

This is a single pole that does the work of two or more ordinary single pole switches. The wiring for an electrolier is just the same as if the same number of single pole switches were being connected. Below is a type of 3 circuit electrolier which controls three lights or groups of lights.



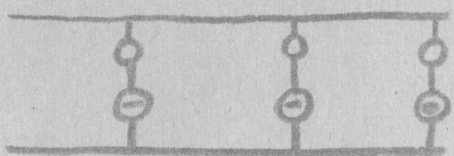


INFORMATION SHEET

SWITCH CONNECTIONS

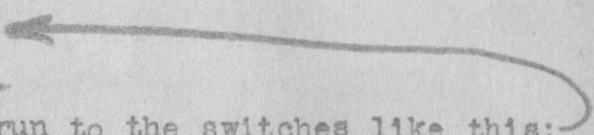
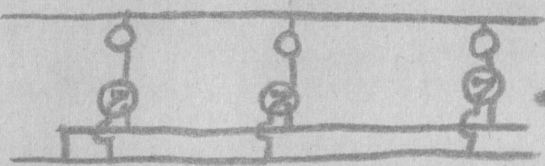
MASTER SWITCH

A Master Switch so controls the lights that they may be turned on from one point, the master switch. When this switch is on the lights cannot be turned off from their individual switches. This Master control is used for emergencies only, such as burglar alarms and in cases of fire. It is placed in some convenient spot such as the main bedroom.



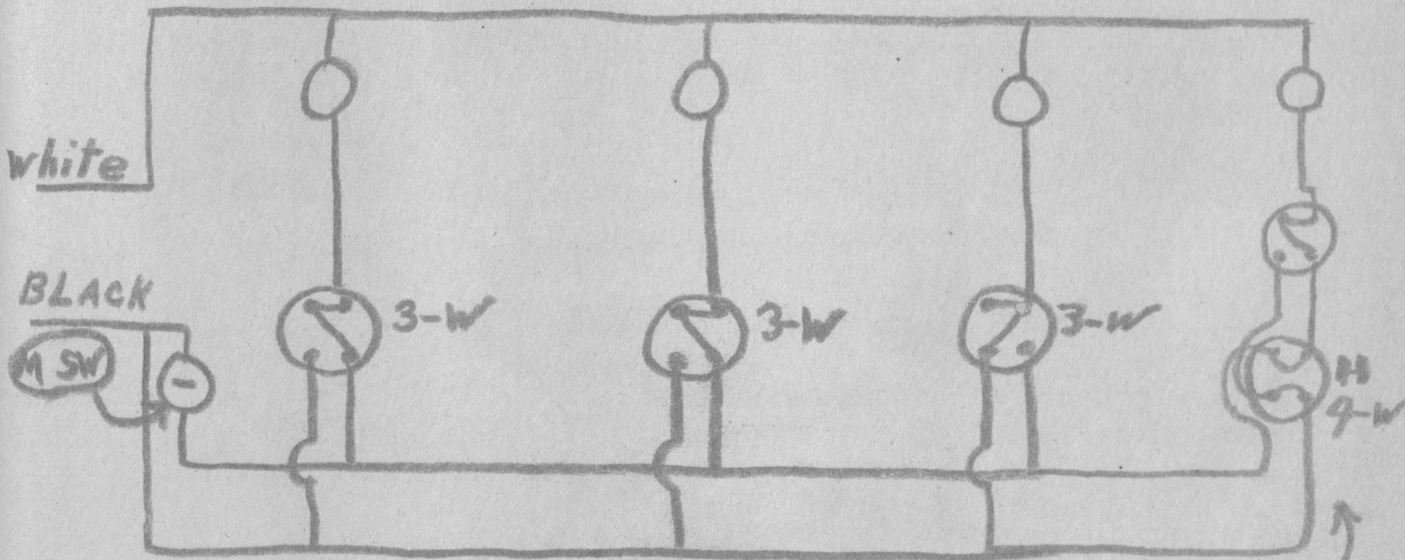
This is the regular way of controlling three lights.

Now substitute for the single poles 3-ways like this:



Suppose we have another feed run to the switches like this:

It would be impossible to turn off the lights. But if this last wire fed thru a switch (the master switch) it would not interfere with the regular operation of the individual switches.



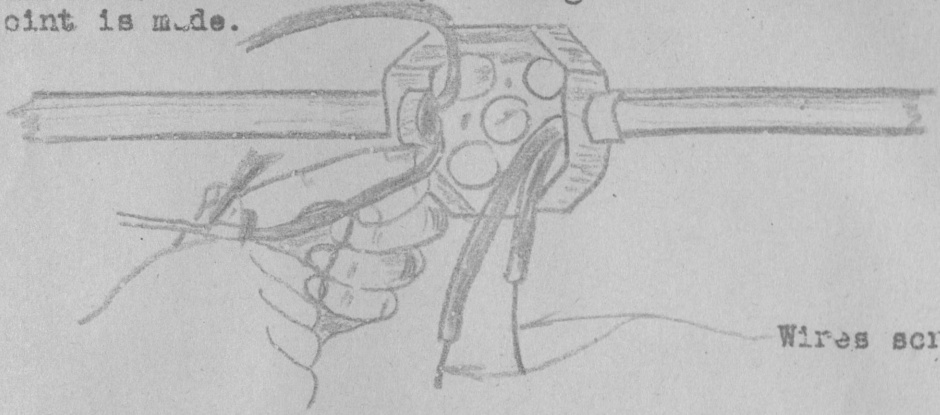
When a light is controlled from two or more places the switch fed by the Master switch must be a 4-way.

OPERATION SHEET

MAKING JOINTS

PIGTAIL JOINT

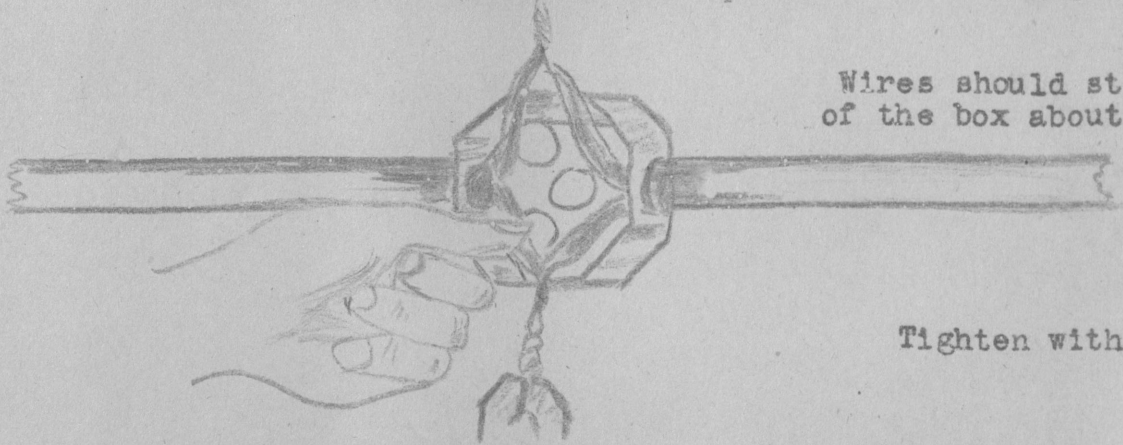
1. Scrape the wires about two inches, being careful not to nick the wires in doing so. Cut the insulation off in the same manner as if you were sharpening a pencil. Never cut the insulation at right angles to the wire as this is liable to nick the wire, causing it to break when the joint is made.



Wires scraped

2. Scrape the wires clean of all rubber so that a good contact is made and so that the solder will stick. Cross the wires to be joined and twist them tightly, first with the fingers and then with the pliers.

Cut off the ends until the splice is about an inch long.



Wires should stick out of the box about 6 inches

Tighten with pliers

This is the type of joint that is used most in all metal raceways. Enough insulation should be left on the wires so that they may be pulled out of the box about six inches.

QUESTIONS

1: When is it undesirable to use this type of a joint?

## OPERATION SHEET

## PUTTING WIRES IN METAL RACEWAYS

1. For short runs of all types of metal raceways the wires are generally pushed into the conduits.

Make a small bend on the wires so that they will not catch on the coupling or joints in the raceways; see that there are no kinks in the wires and push them thru.

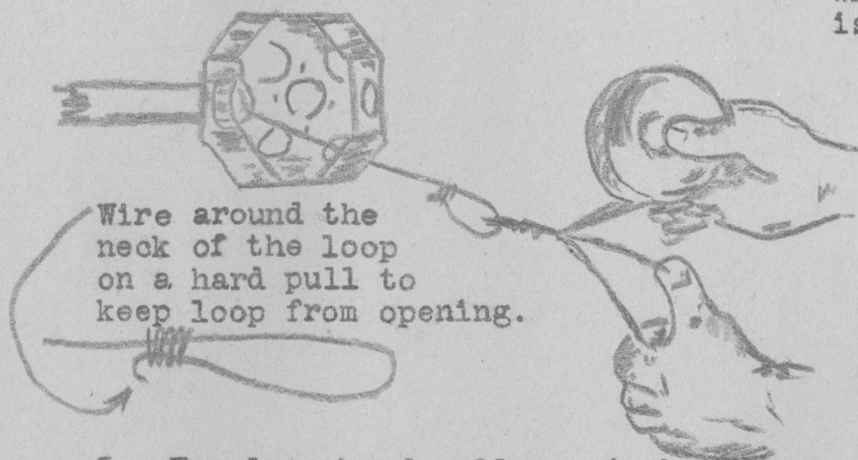
2. For long runs with turns the wires must be pulled or fished thru. For this purpose a steel tape is used.

To make a hook on the end of the steel tape heat it in the flame of a blow torch until it is red hot and bend to the desired shape. Push the tape thru the raceway until enough of it is out of the run so that the wires may be fastened to it easily.

3. Scrape the ends of the wires about three inches long and fasten them tightly to the fish tape so that there will be little possibility of their pulling loose. (Where more than three wires are to be pulled in it is a good idea to serve the joint with tape so that there will be no chance for the tape or joint to catch on the couplings in the raceway.)

4. While a helper pulls the fish tape at one end, push the wires in at the other, keeping them straight and without kinks so that the wires will pull easily.

Wrap tape when pull is long and hard.



5. For long hard pulls or in hot places where the wire becomes sticky, rub the wire as it goes into the conduit, in soap stone.

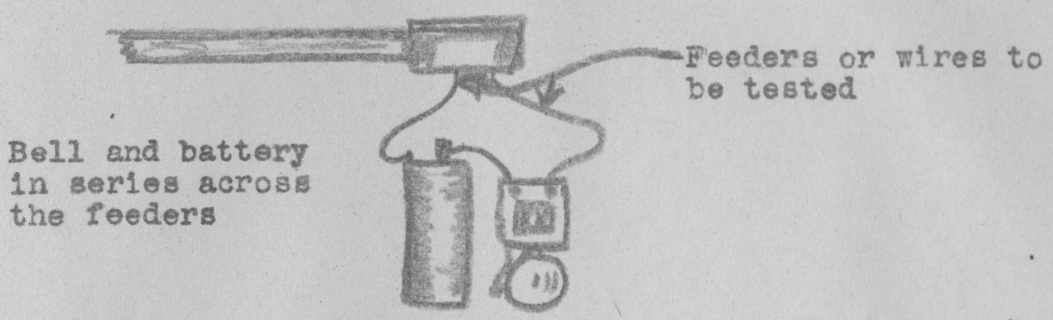


### OPERATION SHEET

### TESTING FOR SHORTS AND GROUNDS

#### SHORT CIRCUITS.

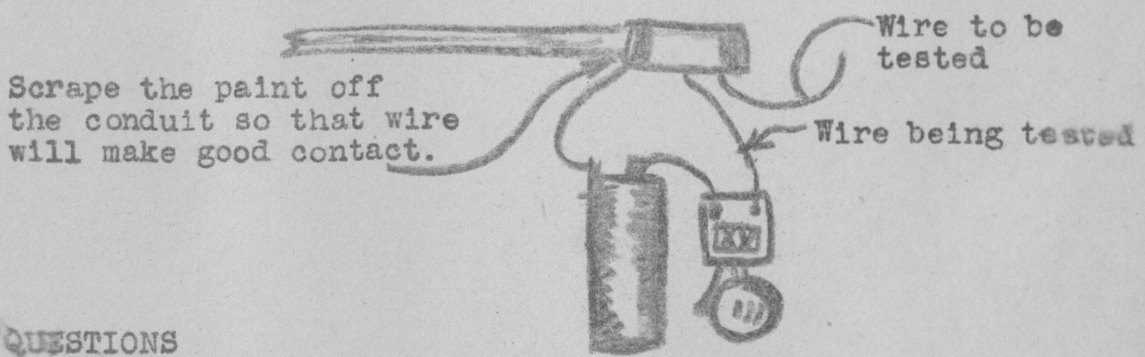
1. Put a bell and battery test set in series across the feeders; if all the load is turned off and the bell does not ring, then there is no "short" on the line. If the bell does ring that means that there is some path for the current to flow thru that is not desired. Inspect all joints and connections on the line until the test can be made and the bell does not ring.



#### TEST FOR GROUNDS

2. Connect one end of the wire of the test set to one wire of the run to be tested. Connect the other wire from the test set to the metal raceway. If the bell RINGS, then there is some place on that wire where the insulation is off and it is touching the metal of the raceway. The wire must then be inspected until the bad place is found. If the bell does NOT ring, then that wire is free from grounds.

Test each wire in the raceway in the same manner as described above.



#### QUESTIONS

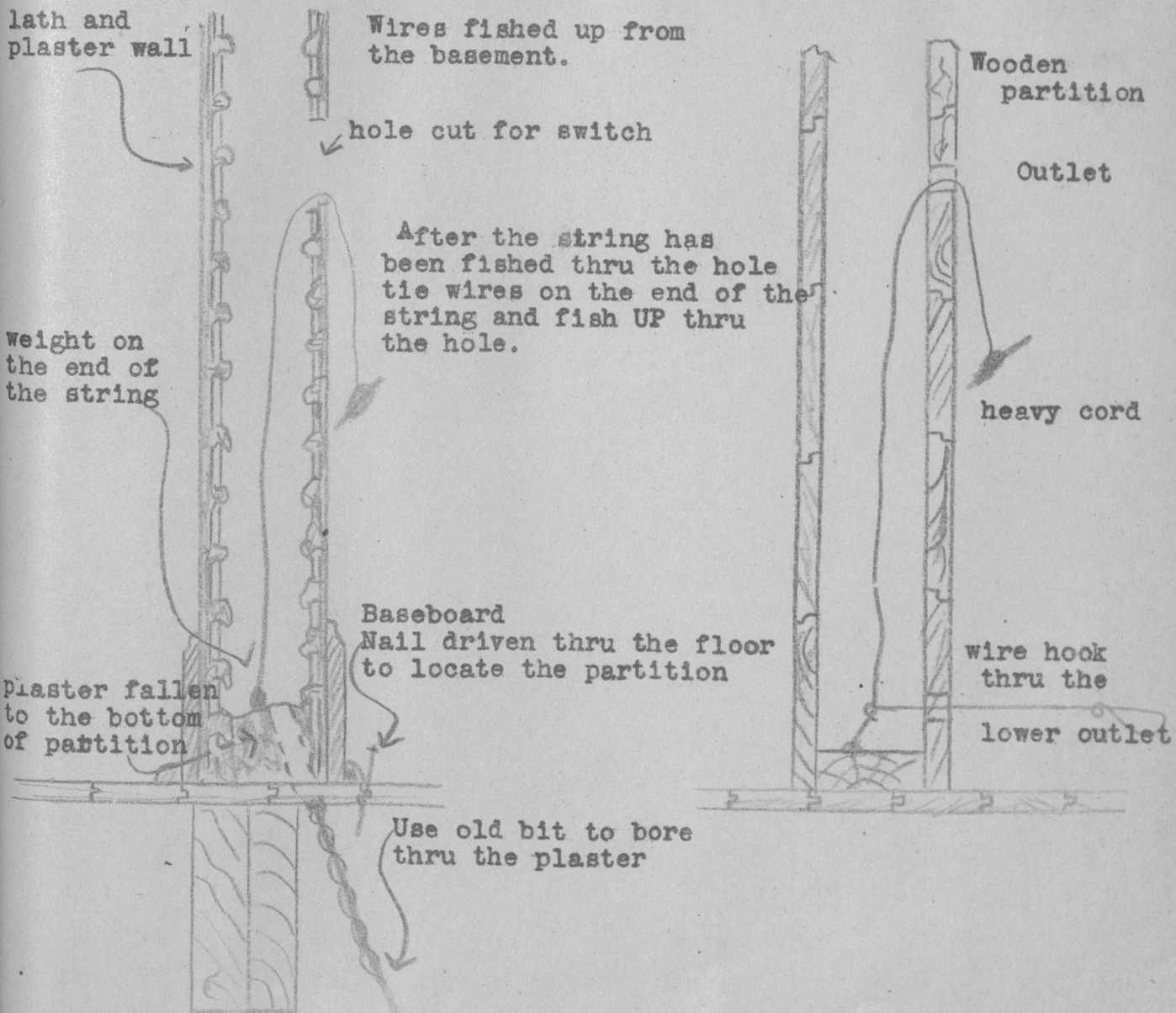
1. Why is it dangerous to have a wire touching on the raceway?

# OPERATION SHEET

## FISHING IN SIDE WALLS

1. Bore a hole in the wall about an inch in diameter at the desired outlet. With a bent wire feel around in the partition as much as possible for any obstructions.

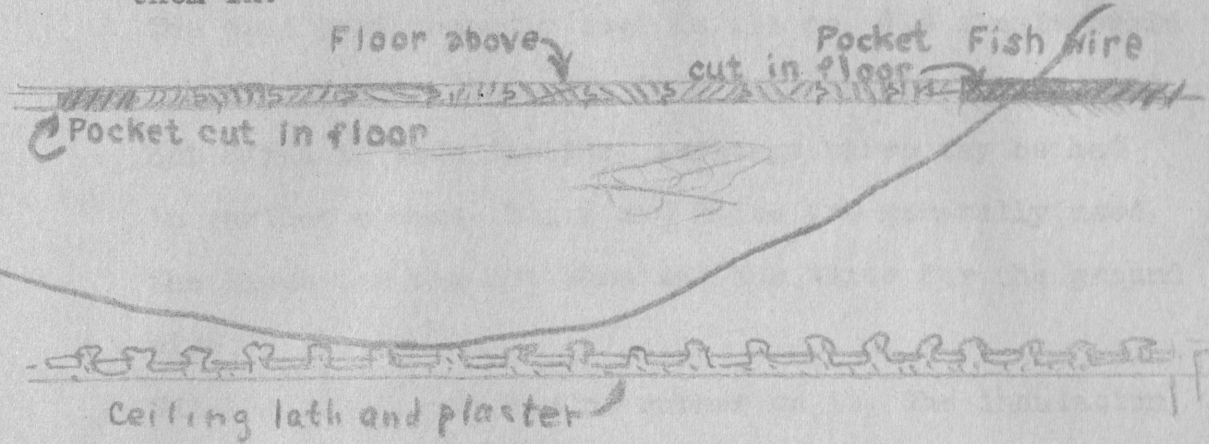
If the wires are to be fished up from the floor, drop a weighted string down thru the hole until it stops. Hold the string at the edge of the hole and then pull it out to see if the weight fell clear to the bottom of the partition. This is done by holding the marked string against the wall and seeing how far down the weight falls. If no obstructions are encountered, drop the weight down the hole again and fish the string out of the hole at the bottom. For fishing use a piece of #14 scraped about 3 inches on the end and made into a small hook.



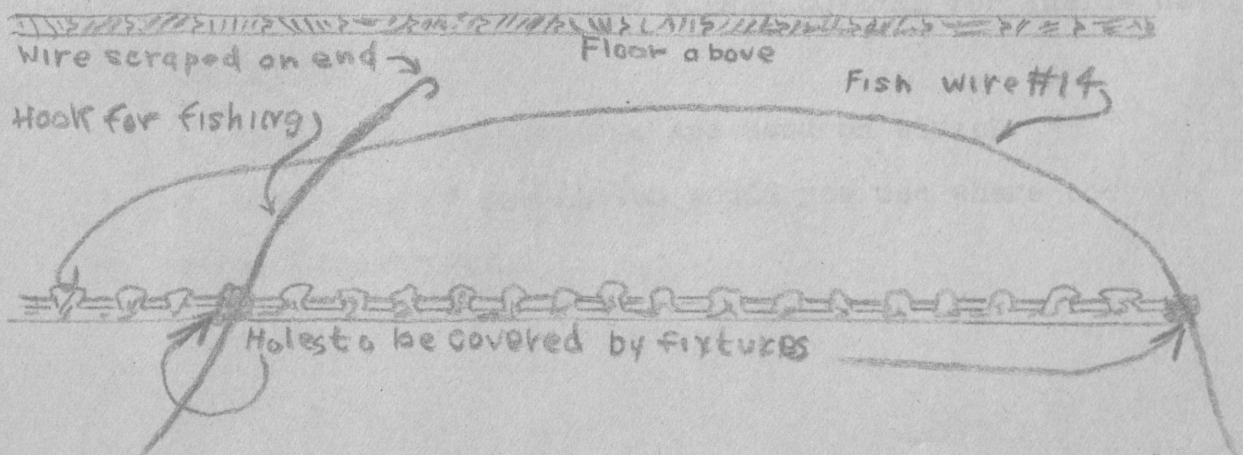


OPERATION SHEET  
FISHING IN CEILINGS

1. (In the floor above the ceiling)  
Pockets must be cut out of the floor so that the wires may be fished out. Smooth out a piece of #14 long enough to go from one hole to the other. Bend it over on the end so that it will not catch on the rough ceiling and push it thru the hole in the direction that you wish it to go. As you push the wire in jiggle it back and forth so that it will not hang up against any obstruction and curl up in the floor space. When you think that the wire should be at the other floor hole go over and pull it out. Fasten the wires to be fished thru on the other end of the fish wire and pull them in.



2. (In the ceiling from below)  
No holes should be cut in the ceiling unless they can be covered by the electrical fittings. Great care must be taken so that the ceiling is not marred or dirtied by the workmen. Smooth out the fish wire as in paragraph 1 and follow the same operations in pushing the wire thru. To fish the wire out at the other end make a small hook on the scraped end of a piece of #14 about 18" long. Try to bend and manipulate this hooked wire in such a fashion that it will cover all the space between the floor joists in trying to hook on the fish wire.



INFORMATION SHEET

WIRE

For our use the insulation on wires is of two kinds: RUBBER COVERED and WEATHER PROOF.

Rubber covered wires are used for all inside work.

First is the copper conductor, then a layer of rubber, then one, two, or three layers of cloth called braids.

The wire most commonly used is the no. #14 single braid rubber covered. Since the Code requires the ground and hot wires to have distinct markings wires may be had in various colors. Black and White are generally used, the Black for the hot wire and the White for the ground wire.

WEATHER PROOF wire has no rubber on it. The insulation is made up of braids that are impregnated with a kind of tar solution that will stand the weather better than rubber. This type of wire has not the insulating qualities that the rubber covered has so it may not be used where the wires are close together and must depend upon their coverings for insulation. WEATHER PROOF is used for out of doors work and RUBBER COVERED for inside use.

QUESTIONS

1. What other insulations are used on wires?
2. What type of insulation would you use where the wires became hot?

INFORMATION SHEET

WIRE

Wires may be divided, as to the conductor, whether SOLID or STRANDED.

Most all of the small wires are solid although the larger sizes may be had solid when specified. Large solid wire can not be drawn thru the conduit as it is so stiff it will not pass around the bends.

In STRANDED wire the conductor is made up of many small wires. This is done to make the wire easily handled and flexible so that it can be pulled thru the conduit without stripping the insulation from the wire. If a wire must be very flexible it is made up of strands of very fine wire. The battery cable on an automobile is an example of this type of wire. This finely stranded wire is also used where the cable must stand repeated bending without breaking. The wires connecting the brushes to the leads on motors and generators are samples of this practice.

QUESTIONS.

1. What kind of conductor would you expect to find in the following wire sizes: 14, 32, 4, 8, 22, 6.
2. Where would large solid wire likely to be used indoors?

INFORMATION SHEET.

WIRE

SIZE.

Wire comes in sizes according to numbers. The large sizes of wire have the small numbers, while the small sizes of wire have the large numbers. An 00 wire is about 1/3 of an inch in diameter while a size 40 is about the size of a hair. For house wiring, the most common wire used, and the smallest allowed by the Code, is No. 14.

The commercial sizes of rubber covered wires that are used for house wiring are as follows: 14, 12, 10, 8, 6, 5, 4, 3, 2, 1, 0, 00, 000, 0000. When larger sizes than 0000 are required the wires are ordered according to their sizes in circular mills. A mil is 1/1000 of an inch and a circular mil is a circle 1/1000 of an inch in diameter.

Since there are different gauges for measuring wire it is necessary to specify the gauge used. For electrical purposes the Brown and Sharpe gauge is used; generally written B.S. Example: #14B.S.

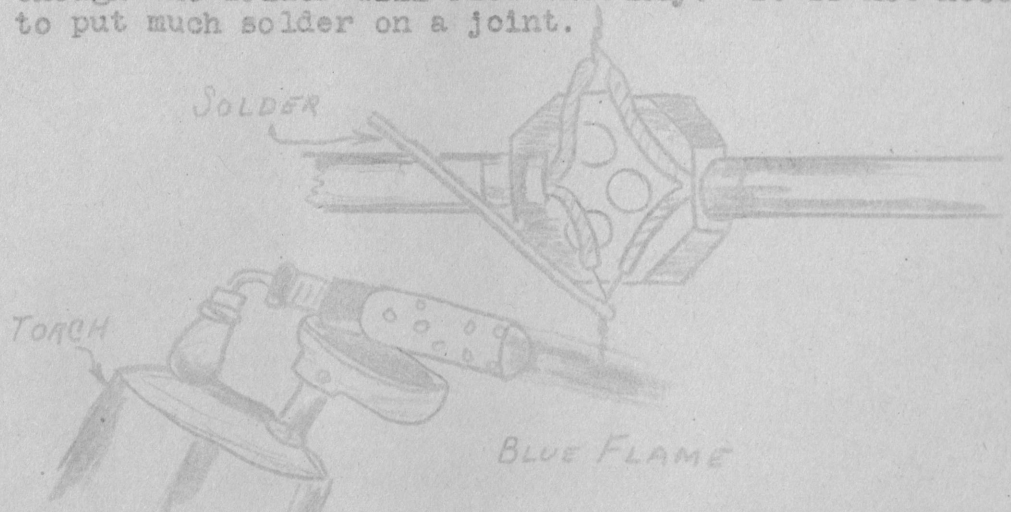
### OPERATION SHEET

#### SOLDERING WITH A BLOW TORCH

1. Fill the torch about three-fourths full of gasoline. Pump in enough air so that the gasoline will come out in a good stream when the torch is turned on. Hold the hand over the end of the torch and let the gas run until the little cup is nearly filled. Turn off the gas and light. The idea is to get the neck of the torch good and hot so that the raw liquid gasoline will be turned to a vapor, which, when mixed with the air, will burn with a hot blue flame. See that there is nothing near that is liable to catch fire while the torch is generating. Protect the blaze from any drafts that might tend to blow the generating flame from the neck of the torch, as this neck must be HOT before the torch will act properly.

When the gasoline has burned out in the cup, turn on and light; the flame should be blue with little or no yellow in it. If the flame is yellow it will smoke the joint and make it hard to solder.

Put some paste on the joint and hold the torch in such a position that the end of the blaze will play on the joint and not burn the insulation of the wire. Hold the flame on the joint until the soldering paste has stopped sputtering, then move the flame a little to one side and put the solder on the joint and NOT IN THE FLAME. If the joint is hot enough the solder will flow smoothly. It is not necessary to put much solder on a joint.



#### SUGGESTIONS

If the torch is nearly empty, shake it a little so that the gas will splash up on the wick on the inside. A nearly empty torch must be held quite level or it will go out. Why?

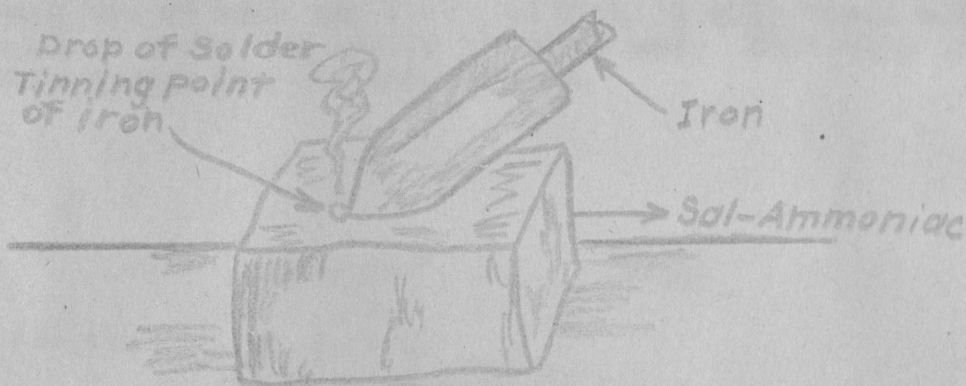


OPERATION SHEET

SOLDERING WITH AN IRON

TINNING SOLDERING IRON

1. Before the iron can be used it must be put in shape to solder; this is called tinning the iron. Heat the iron until it will melt solder, then with an old file clean off the scale from the point of the iron only. Do this quickly and then rub the point on a block of sal-ammoniac along with a drop of solder. This solder will run and cover the point of the iron, "tinning" it. This whole operation should be done speedily so as not to allow the iron to cool. If still hot the iron is now ready to use.

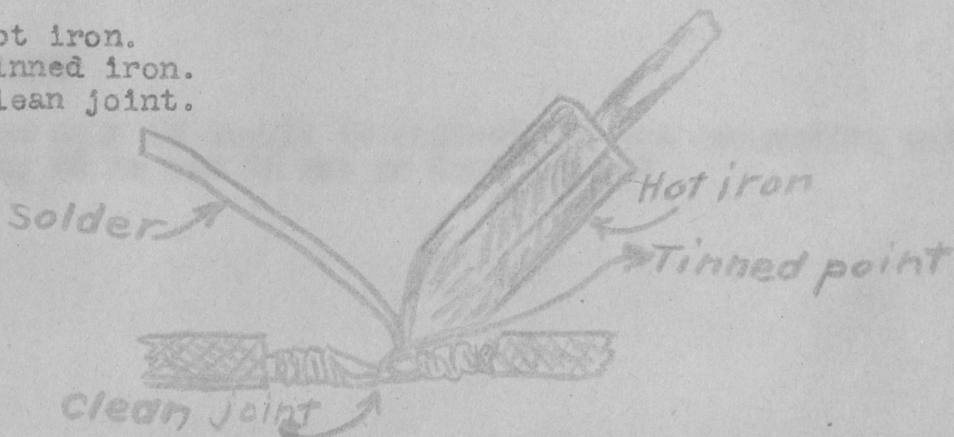


SOLDERING

1. Rub a little soldering paste on the joint to be soldered. Place the point of the tinned iron about midway on the joint. Place the end of the solder against the iron and melt a small drop. DO NOT PUT MORE SOLDER ON UNTIL THAT DROP FLOWS FREELY ALONG THE JOINT. When this occurs a little more solder may be added. Leave the iron on the joint until the solder runs freely and covers the joint.

These things are necessary for good soldering.

1. A hot iron.
2. A tinned iron.
3. A clean joint.



OPERATION SHEET

TAPING JOINTS

1. The Code requires all joints to be taped with with an insulation equal to that on the wire. For rubber covered wire, it is necessary to serve a layer of rubber tape on first, then a layer of friction tape.

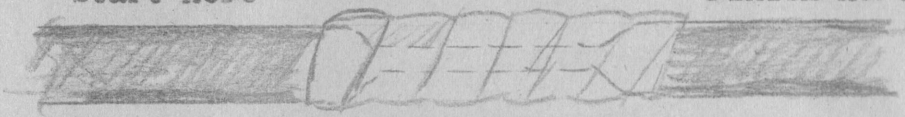
Tear off a piece of rubber tape about 2 inches long for the ordinary joint of an inch and a half.

Tear off a piece of friction tape about 7 inches long as it takes two hands to serve the tape on the friction is held in the lips while the rubber tape is put on the joint.

Begin back on the insulation about 1/4 inch and serve the rubber tape on, stretching it tight and so wrapping that it will cover the insulation on the other side of the joint about 1/4 inch.

Start here

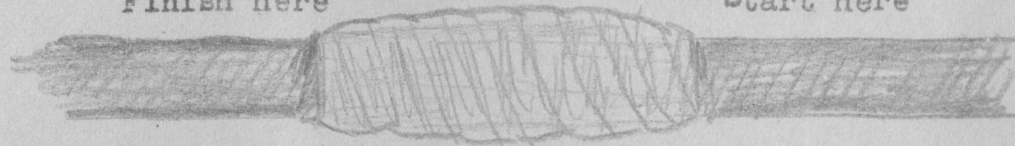
finish here.



2. Hold the rubber tape tight with one hand to keep it from unwrapping, then place the friction tape on this end and serve back on the joint making tight wraps, especially at the ends, so that the tape will not come loose.

Finish here

Start here



Questions.

1. How is weatherproof wire taped on joints out of doors?
2. Where is the weakest place on the insulation of a taped joint?

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