



another MRL Handbook...

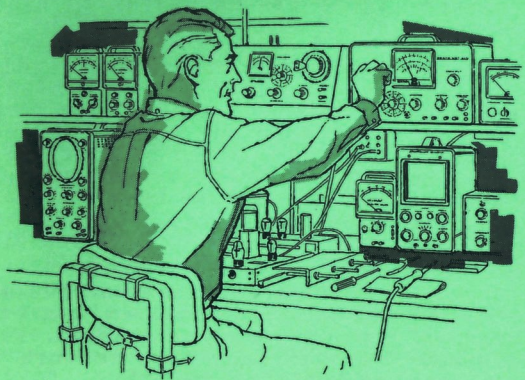
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TIPS



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by

Elmer G. Osterhoudt

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FOREWORD

The Radio workbench is usually taken for granted - whether in the Radio store or in the home. Usually some boards are thrown together - and that is it. It may be just a makeshift - put there by some other operator.

This Handbook strives to lay out, in simple terms, a real good Radio workbench. Changing, or just patching up the old one, takes a lot of time. In a short period - you can construct one that has most of the good features from the start, instead of waiting for years to doctor up the present one. You need not go into all the complicated mortising and glueing jobs that makes for a first class piece of furniture. All construction is for practical use only.

We haven't stressed complicated test equipment - you may put that in later - to your heart's desire. What we have shown, in this respect - are simple testers that you will use over and over again - even tho you may be a Radio service contractor on a large scale.

The matter of proper storage of parts has been gone over. If you don't take care of this matter - soon you won't have room

for the bench or anything else.

We then take up the machine table - which is a Radio man's dream - nothing else. Yes, it may be used by the Auto mechanic or any other, as well as the home dabbler. Many practical kinks have been added.

This HB is written from only a practical standpoint. I've been in Radio most of my life, and I am no kid, either. Radio is in my blood, altho I've never made much money at it. Radio servicing is not a big money business.

The HB helps the small dealer get started - but many of the ideas can be useful to experienced dealers. Many of the ideas have helped us stay in business, long after others had given up. In one district - 7 closed up. In another location, our competitor sold out to us 5 times in 5 years - altho he continued to cut prices on us. We could go on and on - but we hope you can use many of these little ideas in your business to push you along, and fill up the bank book.

Everything changes. The mechanically inclined man can usually improve on most ideas. We offer you many here to work on - so let's get going!

Opportunities

HOME SHOP OPPORTUNITIES.

While this Handbook is slanted toward the home Radio-TV workshop - many of the ideas may be incorporated into the commercial shop. It just depends on how much you want to apply yourself.

Electronic servicing is a terrific business for the novice as well as the first-class technician. Enough is paid out each year for Radio-TV servicing to build over 200 big Empire State buildings. A good commercial TV-Radio shop may gross \$30,000 per year in receipts. If the owner is a good manager - he may net \$7500 per year. A home shop will not do any near this amount - but there is a greater percentage of net profit due to low overhead. Besides Radio, TV, there are recorders, Hi-Fi, color TV, citizen bands, marine, FM, municipal circuits, inter-coms, electrical parts and appliances, and what not, to repair. In our Los Angeles' store, we even repaired baby buggies! People are always looking for some "fellow who can fix anything" - and they usually land at the nearest Radio shop, or home mechanic to do the job.

The most successful home shop operator is one who has a steady outside job. We greatly subscribe to this. In this way, the Radio-TV business is mostly "gravy." In a commercial shop there are always many obstacles to a good net profit. If he goes on the rocks - he has nothing to fall back on. Also, in a home shop he seldom gets into complicated hiring problems. This makes him more independent and allows him freedom to go and come as he pleases.

THE BIG ONES STARTED SMALL.

You've probably heard of many large concerns that started in a garage, attic or basement. The Sierra Electronics started in a garage in 1942, with \$400 - and in 1958, sold the U.S. Navy a

transmitter for 2 million bucks. Ampex tape machine builders was a one-man shop that now has over 1500 employees. Varian started at Stanford Univ. in 1938, but is now the largest builder of Klystron tubes. Eimac (Eitel and McCullough) started in 1934, in San Francisco, in just a vacant butcher shop - and have grown to be the largest manufacturer of transmitting tubes. Lenkurt began in San Francisco in 1945, with 18 people, and now claim to be the biggest independent electronic manufacturer of carrier systems on the coast. Even our photographer, who makes negatives for this Handbook, said he wished he was back in his garage again, instead of the many complications of a big business. One could go on forever with big successes that were started on a shoestring in a home workshop. At least, everyone has to start somewhere, and this is the best place to do it. In his home shop the operator may take his time without outside interference he may get from a closer contact with the public.

YOU MAY INVENT.

The home workshop may be the means to an invention - if the operator is inclined along this line. Inventors usually watch people work - and try to get up something to save time - which is the basis for most inventions we now have. In his shop, he may take his time and not have prying eyes looking over his shoulder as in a store. Along this line, we may put over a good point. In a store (we had for 11 years) we found many people just dropped in to idle around, while they waited for a bus or street car. In view of my desire to chat - very little work was done until after 6 pm, after everyone had gone home to watch TV. In a home shop you get very few visitors, so have a lot of time to

Handling Customers

work and experiment. While the commercial shop is usually the money-maker - it is an open door to salesmen and ones looking for donations, etc. This takes up a lot of time - and some cash!

A few may go into Electronic writing - where a home workshop is a "must." Space forbids the discussion of many opportunities in this field.

HANDLING CALLS.

If you drift into a small commercial one-man shop, you may require all work to be brought in and picked up. You can afford to charge a little less this way - which advertises you. You cannot do the amount of business of shops having outside calls, but you won't have the problems, either. Many one-man shops find it a good idea to install a "tube secretary" - which takes calls on a tape rig when he is out on calls or at night. This usually runs about \$12.50 per month. It will pay for itself if you miss many calls.

If you employ a service man - he may handle 8-10 calls per day - when 4 out of 5 sets may be repaired in the home. Often 75% of TV trouble is tubes, so you make some off your tube sales. Usually the cost of the service man about balances the charge for the service call. However, service charges must be figured for each shop - consistent with overhead and wages of the technician you are hiring. If you're making the calls yourself - you will reap this extra profit.

Licenses. The average small town requires a license for a home business. A good idea is to work until they "catch" you! Hi. There may be laws against putting up a sign, so this must be looked into. Sales taxes must be collected for parts sold, but not for labor, as most states still have this "temporary" law.

CUSTOMERS BY MAIL.

Local mail soliciting is often very lucrative. It is best to have a separate entrance to your shop. Advertise that you have very little overhead- and can do jobs reasonably - and they'll soon find a way in. A phone number is essential for someone to take calls when you're absent.

Small hand mimeo-type duplicators work very good for local mail work. Postcards seem to work as good as anything for a quick get-up. By using small type, like a Varityper, etc., you can get a lot on a postal. It may be good to contact someone with a machine to make your stencils. But a local printer can do a much better job. Nothing is worse than a sloppy card as it hints that your work is the same. The cards may be printed up and a member of the family can address them from the local phone book at will. Almost everyone in the book has something to do with TV or Radio - or has something to be repaired. As for postal permits, to save 1/2¢ on a card, it's better to pay the full price and address them at will, as your work and needs progress. There's one point - try to have some good special deal on each card, as a free checkup or even a tube test may help. Here is where Ur ingenuity will come in. But don't be discouraged if the first card doesn't pull- maybe the next one will go over big. At least, you are making a contact - and the more of these the better, and they'll soon know that you are out to supply their needs.

ESTIMATES.

Altho we all dislike them - it seems almost everyone expects an estimate before starting his job - and it is the bugaboo of all Radio men. The customer expects you to give him a clear, concise price - after a few tests. A way

Shop Planning

we found was to give two estimates. One, at say \$5, would get the set operating. One for \$10 would overhaul it. I was always self-conscious about charging - but I found most of them took the higher priced job when I could replace most small condensers, hot resistors, clean up the set, etc. This \$5-10 depends on the size of the set and is given just as an illustration of a proportional charge. Usually a midget set can't be worked on for less than the present value of the set. In figuring the final charge to the customer - try to knock off 50¢ from the estimated price and you'll find you can't buy advertising like this for any price. As you will find, it is almost impossible to "diagnose" a Radio or TV at first pop - altho the customer may think it should be easy. Also, when a part is replaced - you may find another one out - just like they do you in a garage when they take down your engine. Often the fellow who leaves his set without an estimate may come out better than the one who expects an "expert" guess! Some of the large chains charge exorbitant prices - and a customer should get an estimate in writing, and a stipulation that if it goes over that he will be notified. A big chain can get by with this easier than a small fellow who comes in direct contact with his customer. Most customers feel the little fellow tries harder to please than an order clerk in a big place, with nothing to worry about except his pay check getting out on time. Usually a customer will come back again and again if treated right. Also - don't gloat on the first customer - he is an advertising expense - it is the repeater that makes continual money for the shop. Any time you can do some little thing for free - you have made a steady customer of him.

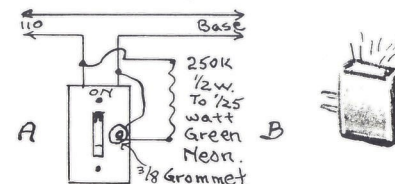
Drug store tube testers may

sell a lot of tubes, but they do not give free information, service or prattle. Ironically, the customer usually pays as much for his tubes. You might sneak in a tube now and then for a test if your tester doesn't test a certain tube. Hi.

SHOP PLANNING.

Needless to say, we require a dry and comfortable room to work in. Some form of air conditioning is imperative, but place it so it is not directed toward you or it will give you colds.

IMPORTANT. Put all base plugs on a wall switch, with a neon lamp, or red light for pilot indicator. When you leave the room



1. Pilot Lights for Base Plugs.

- you will be sure all electrical outlets are not working. We have had many close calls from fire - that makes one shudder. As an example - I've returned from demonstrations at midnight, and found a hot soldering iron running - over a wooden bench. A rat could easily knock the iron off the soldering rack. Shorts may occur, especially if you have some set hooked up that uses the cheap dime store cords we are now getting. Do you realize how close those hi-potential 110 leads are - and what little material separates them? Diagram shows different methods of using pilots for the switch plate. (A) shows green neon and resistor across the wall switch, that is green when switch is off. (B) is a neon nite lite that plugs into a wall receptacle. When plugs R off - neon is also off.

Shop Layout

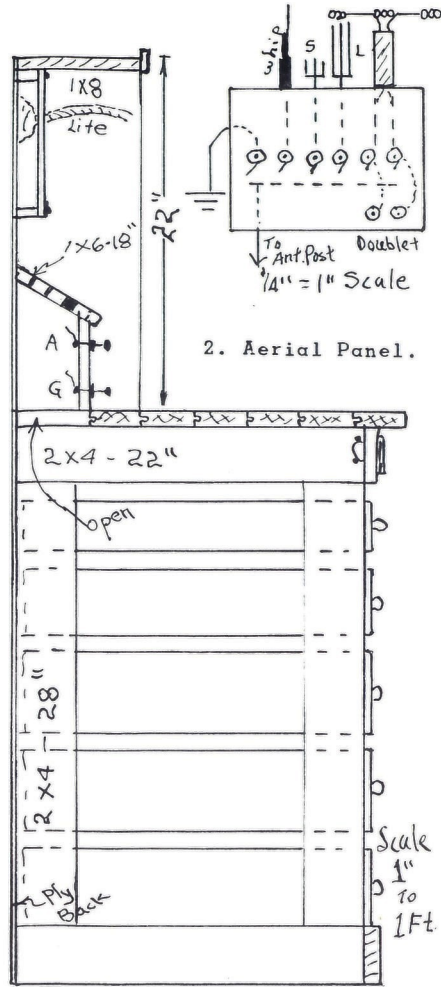
We also have a DPST knife sw. on our test panel. A red lite, or neon is wired in the circuit. Whenever we leave - we always look to see if the red lite is off. Be sure you take care of these precautions.

Don't forget the legs and feet - as these old varicose veins and "rheumatiz" show up later. If you have a cement floor, put some felt paper over it and rubber tile it. We have put down felt paper and then floored it over with 1x4 wooden flooring. This makes a real nice floor to work on. A rubber hall runner is also good to have in front of the bench. As a substitute, one can use a large piece of strawboard, and renew it when bad.

All we "lazy bones" will never forget a high stool, we can hang on while working. Makes life a lot more pleasant- and is always better than hanging on a bar stool! Also a nice desk and chair we can use for concentrating and puttering up the books. Don't forget the Radio library shelves - you can find plenty of books.

As for lighting, its hard to beat the old inside frosted lamp - with an opaque reflector for good lighting for the eyes. Once we installed a modern fluorescent desk lamp that made us many headaches. In Los Angeles, we had opal shades, over regular frosted lamps - over the bench. Both servicemen got terrible headaches as a result. We replaced them with goosenecks and metal shades - and overcame it. A filament lite is still best as it is steady. A fluorescent, or neon goes on and off 60 times a second - altho we don't notice it - it raises heck with eyes.

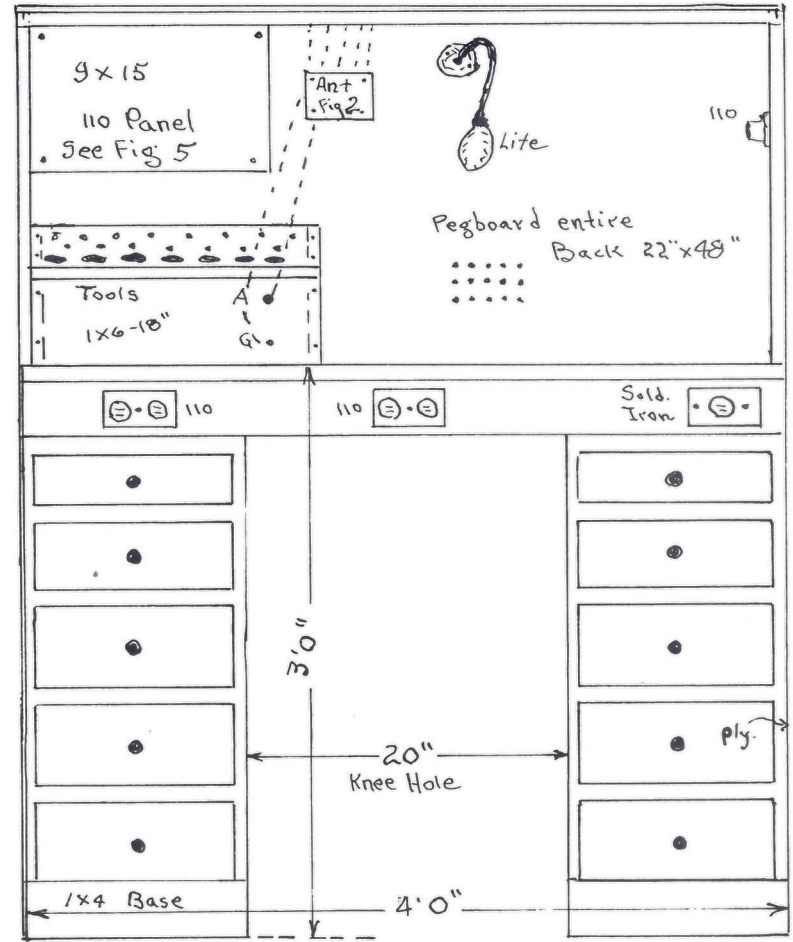
Around the bench you'll need "galloping" lites. Several goosenecks with 60 w. lamps, with metal shades, serve the purpose well. Some shops use sliding lites on a wire, but we believe flexible goosenecks are best.



2. Aerial Panel. Scale 1/4" = 1"

Another fixture, that is handy around the shop, is a table with castors, to hold large Radio or TV sets. You can save yourself from lugging them around. A 2 ft. wide bench seems to be about standard as you require a lot of space to place sets and test equipment - let alone your tools. Make it about 36" high. Some shops use circular benches, with a table in the middle to

Bench Layout



4. Bench front View. 1" = 1'

hold plans, notes, etc. about the job. However, benches around a square room serve as well. We used to make our benches with 2x4 framing and covered over with Masonite may go over this if you want a real nice top. Place a shelf about 22 inches above the bench top to hold portable testers. Nail a little protective strip in front so they won't be

jerked off. Years ago, we made test panels above the bench, but we believe portable testers work better. Portable speakers may be put into boxes. Also dry, or mercury batts. may be made up in portable boxes. Also an adjustable DC power supply. AC filament transformers may be mounted in boxes, and plugged in at will. We believe that portability is a

Building the Bench

good idea for all these units, just like your tube tester, signal generator, scope, etc.

BUILDING THE BENCH.

As you can see - the top and bottom of the bench are made up separately - the upper setting on the bench top. This makes it more handy in moving - or making major changes around the shop.

The cutting lengths of the 2x4 pieces for the ends are given. There are 4 sets of these- there being two for the center knee holes. Toenail them together with 8 d. box nails - in several directions to make them rigid. Put a square on the ends and nail braces diagonally across to keep them square.

Space the center frames 20" apart for the knee hole. A 1x4 apron may be nailed across the front, at the top edge to space the four sections. Nail another temporary piece across the back, along with a diagonal brace at the front and back to keep them in a square position.

Next, nail on the 1x4 flooring - with 4 or 6 d. box nails - and leave the first piece overhang about 2½". Knock off the tongue with a plane. Pull the flooring up good and tight with a nail set. Run the flooring back to about 5" from the back. Leave this space open for catching the tools that may drop thru the tool holder.

When the top is nailed on- cut a piece of plywood 3x4 ft. and nail it to the back. Keep the legs square when nailing. Plywood may also be nailed to the ends and inside the knee hole to keep it rigid. If you wish, you may now fit a piece of tempered Masonite over the flooring - for a real FB bench top.

Drawers may be built later - at your convenience. The top ones are used principally for additional tools. You never have enough drawer space - so take

advantage of it here. Most of you know how to make drawers, so no need to go into it here. Use plywood fronts - and let them overlap on the 2x4 legs. Try to use as flat drawer pulls as possible- even the metal disappearing ones are excellent - so they don't catch on your clothes.

The upper section is easy to make. Use 1x8's as shown. Nail Pegboard to the back as you will find lots of uses for all these holes. It isn't much more expensive than plywood. Be sure to square it up good before nailing with small shingle nails.

THE TOOL RACK.

We found the tool holder to pay for itself many times. You get so you put them back into the same holes - so you always know where to find them. If you lose a tool - it will be in the top drawer. It is easy to build.

Just cut (2) 1x6's - 18" long. Cut the ends on a 45 degree angle. Screw on the front and top to the end pieces - as you may want to change something now and then. Drill a series of 3/4" holes near the front for large screw drivers, pliers, etc. Now, a series of 1/4" holes at the back for smaller tools.

The Aerial and ground posts are made of (2) 8-32 RH machine screws - with the heads protruding for alligator clips. Both of these leads go to the Aerial panel shown in Fig. 2.

Note that the entire underneath of the bench top is open. This makes it easier to run various 110 leads, etc. around. On the 110 circuit - use #14 house-wire, held in place by split knobs for insulation and fire prevention. A couple of 110 wall receptacles may be mounted in the front as shown. Also one for the soldering iron plug. Other 110 wall sockets may be placed around as desired - like the one at the upper right for your test

The Aerial Panel

equipment. Note, from the 110 panel - all 110 lines to lights, machines, etc. go thru the panel for fire prevention.

THE AERIAL PANEL.

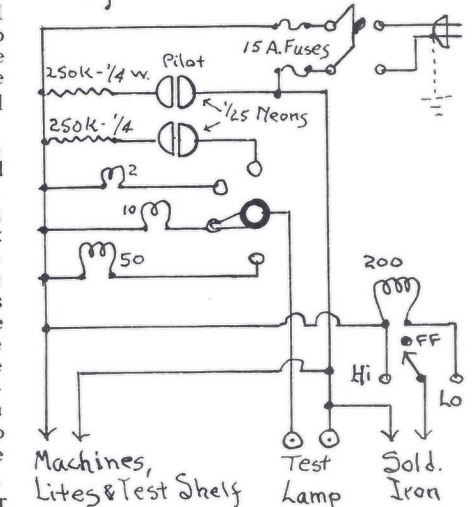
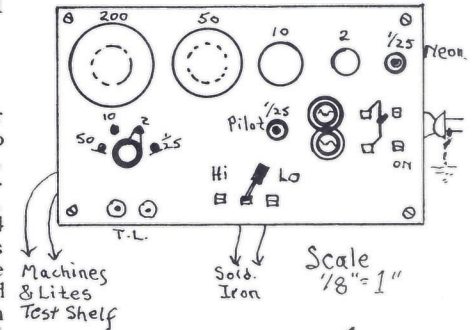
In Fig. 2, you will note our Aerial arrangements. In Radio experimenting and service work, you'll always be in need of different types of Aerial pickups. Our panel is laid out on a 3x4 piece of Compo., preferably as the layout shows. One could use a switch lever - but you would be defeating your purpose. Often you require several Aerials all hooked up together, so it is so much better to use SPST toggle switches for convenience. Note that all switches are connected to the common lead to A post.

In this arrangement, you can throw the first switch in and use the ground for an Aerial. Next may be a whip Aerial. Then a short Aerial and a big one. At the right are separate connections to a doublet - in case you want to try different directions of reception. However, on the latter- you may drop down to the two phone tip jacks and use the doublet as a doublet for short-wave work. You may also throw in the long Aerial switch and also the ground switch and get some lightning protection. However, for the latter, it is much safer to put a lightning arrester as your long Aerial leadin comes in the house. Also a large #8 Aluminum wire, or bunched #14 wires - all running directly to a good ground rod. Also, note that if you throw all toggle switches on - you ground all Aerials at once.

As for the grounds - hook up all you can - the more the merrier. Use water pipes, ground rods, plumbing, heating, etc. Bring all ground connections to the post on the tool rack.

DX requires a good ground!

BUILDING THE 110 PANEL.



5. 110 Panel.

Going back to our Radio service days - the first panel we built was our 110 panel. Panels were in vogue in those days. Now it seems so many instruments are used portable - because they have to be so flexible in operation. When we tore down our 6 panels - the only one we kept was the 110 panel - which we still use.

For several years - in the 20's - a 110 test lamp, AC-DC voltmeter, ohmmeter and some form of simple tube tester were

Building the 110 Panel

the only equipment necessary to test most sets.

Our panel is 9x15 - and may be of Bakelite - but Compo. is OK if you don't lacquer it. We are so afraid of arcing - that you can't use lacquer around your 110 controls and keep them safe. We have put all our 110 controls on this panel - with the simplest of wiring. The panel may be bolted out from the Pegboard. In fact, a good idea is to put the screw heads at the back - then a nut on the front. Then another nut to hold it out - and then the final nut on the outside. In this way you may remove the panel anytime you wish to make a change of some sort. Feed the 3 sets of 110 external leads to 3 2-lug tie points on the rear of panel. Solder these leads to the 3 sets of 110 and feed them thru pegboard down to underneath the bench top. As you can see, one set goes to the machines, lamps, etc.; another goes to the soldering iron; and the third set goes to your 110 wall receptacle. You will find these tie points will help a lot in case you wish to "pull" the panel. The 6 connections will be all that are necessary to unsolder.

As the 200 watt lamp is so big - we'll put it in the upper left corner. This is the lamp that goes in series with your soldering iron, with the outlet in the right side of bench top.

For the standard 110 volt, medium screw base sockets - you may use wall sockets. Drill the holes so they will protrude thru - but mount them from the rear. Use washers of rubber or fibre to keep from breaking the socket during use. Do the same with the fuse blocks, or sockets if you want to use them. Run the common (hot) wire across the top as shown in diagram. Wire it up with #14 housewire for safety.

Now you will have a series of resistances, controlled by the 4-point lever switch. First is the 50 watt lamp; then the 10-

watter; 2 watts or so; and finally, the 1/25th watt neon. These, and the lead to switch center run to the phone tip jack below - to the test lamp leads.

You will note that the DPST entrance switch is at the right. Dismantle it from its base and mount it directly to panel, and use lugs to come out the back. When this switch is open - all leads to lites, machines, soldering iron, board, etc. are all off. Note there is a 1/25th watt neon, in series with a 250K x 1/2 watt resistor across the line. This will light when the board is on. As the neon is reddish - it will serve as a pilot. All you have to worry about are the lites and plugs in your room if you leave the shop.

To the left of this switch are (2) 15 amp. fuses mounted as we described above. You will find, in most cases, your board fuses will blow before your house fuses do - altho latter are usually 15 ampere also.

When mounting your switch lever - put the points 1/2" apart so they won't arc across. Put a soldering lug under each switch point.

When mounting the 2 neon lites - drill 3/8" holes, to hold 3/8" rubber grommets. You will find the 1/25th watt neons fit snugly into these holes. They may easily be removed at will.

Use phone tip jacks for the test lamp connections - but put them 1 1/2" apart so you won't get shocks when plugging in tips.

These neons do not draw enough current to turn your meter, so there is no cost in operation.

Mount the bottom SPDT knife switch as shown - using lugs at the back.

USING THE 110 PANEL.

IMPORTANT! Before hooking up the bench, be sure to make this test. Rig up a 110 v. lamp and socket, with appropriate leads.

Testing with the 110 Panel

Push one lead into the wall base receptacle and touch the other to the switch plate. If you get a lite - that is the "hot" side of the line. If you don't - try the other connection and switch plate ground. If still no light, then the plate isn't grounded. Grounding is required on all new construction, but some of the older houses didn't ground them. With no lites so far - then hook one lead to your ground and do it all over again. When you find the side of the 110 that lights, then chalk it for "hot."

Now, you are ready to hook up your board. Fish out the lead that goes to the top post of Ur entrance switch, which is "hot." Line this up with the "hot" side of your line - and you are ready to take off.

After plug is inserted correctly, plug in the lamps, 15 A, fuses, and we assume you already have your 2 neons in circuit. Now, for a final checkup, take your portable test lamp again and touch it to the right phone tip terminal of TL and to your ground post on tool rack. If it doesn't light - then you have the 110 poled right. You can see the consequences if it is poled wrong. Suppose you are working on a metal chassis, that goes to the ground directly, or thru the 110. You may touch the right terminal of TL to it. If correct - it won't make any difference. If you touch it to the left one, you'll light one of the lights, whichever the switch is on, and nothing will happen. If poled wrong - and you touched it to the right jack, it would blow a fuse - and you might have some fireworks! We have been thru all this - so passing it along to you. As long as you have a test lamp in series, on your switch, no problem will exist.

There are hundreds of tests U can make on this simple board. Space won't permit going into all of them. As you use it - you will find out a lot more.

THE SOLDERING IRON CIRCUIT.

As you can see, throwing the switch over to the left puts the soldering iron directly on the 110. This is for heating it up to start work, or if you want to do some real hot soldering on a chassis, etc. We prefer a 100 watt iron, or gun, of some sort for best operation. In this case - a 200 watt lamp seems to be about right in series. After the iron is hot, we switch it over to the right - on LO - when the 200 watt lamp goes in series. This will give you ample heat for most soldering. It will also make your iron last longer. We've used an American Beauty iron since 1924 - they seem to never burn out if you treat them OK.

When you want the iron off - just pull the switch out and leave it. As an additional precaution, we pull out the plug below the bench top. When cold, and not in use, we put the iron out of the way. The 200 watt lamp will last for years. It also cuts down current on your light bill! Note the 200 watt lamp is placed up high. Our's happens to be down low - and we keep bumping our heads on it - but have never hit it hard enough to put the lamp out of commission.

OTHER SOLDERING IRON CIRCUITS.

As the 200 watt lamp lets two amps. thru at 110 volts - you'll find many uses for this circuit. Rig up an attachment plug to go into the soldering iron receptacle, with 2 3-ft. leads on it. If you are working on electrical appliances - and not sure of Ur connections - you can put it on LO to try it out. Then, as you get up your nerve (?) you can put her on full. This also works for small motors up to 1/3rd HP. Some motors will start slowly on LO, and then you can go ahead with your full 110 without blowing a fuse. Testing various motor connections, as commutators,

Large Lamp Tests

brushes, shorts, fields, etc. works good on the LO.

If you'd like to test out a power transformer, or filament transformer - you can hook the primary to the LO, and get almost the same readings on the secondaries as you would with straight 110 - and still be safe (instead of half-safe!) Hi.

Toasters, heaters, waffle iron combinations, flatirons, or in fact, any of the electrical heater types, may be tested on the LO before you get into trouble with a short.

CAREFUL!

Watch your circuit - as it is directly across the 110 on HI, so don't "mess" with it, or you will have plenty of fireworks!

NOW FOR THE TEST LAMPS.

There is no end to the tests you can make on this circuit. Note the two Neons are in series with a 250K x ¼ watt resistor for protection. A neon won't use any juice, nor will it ever burn out, as far as we know. The top one is for the pilot for the whole board. The lower one is for testing, and lined up with the lever switch to pass only 1/25th watt of current.

For the 50-watter, we prefer a clear mill-type lamp, with circular filament, as it stands a lot more abuse. If it is not the clear type, you can't see the different degrees of color on the filament. The 50-watter was our standard test lamp for many years, and needless to say, it passes ½ amp. It can be used for all kinds of appliance testing, shorts, open circuits, cord tests of various types, etc. For instance, before throwing away a lamp globe or fuse, put it on the 50 watter to see if it is really burned out. Many times it is a loose connection in your socket. It is very good for working with various appliances.

The 50-watter may be used for "burning off" filings from your variable condensers. These filings often stick between plates by electro-static action, etc. Place a heavy rag in a vise and gently place the condenser frame between the jaws. You might use some gloves if you don't like to get "nipped." Hook a lead to the stator and one to the rotor. Rotate the shaft and you can see the filings burn off. If you detect a shorted plate - gently bend it a little until it is cleared up. Usually, after a condenser goes thru this burning test - it is much better for any type of RF tuning circuit.

THE 10 WATT TEST LAMP.

If you wish, you may substitute a 25 watt clear, but the results will be a little different. A 10 watt clear lamp, with medium, or Edison type standard base, can usually be purchased where they sell lamps. It used to be called an S-14 clear sign lamp. It is useful in testing transformers, chokes, etc. - just so the resistance isn't too high to carry the current. For instance, in series with the hi-voltage winding of a standard power transformer - you shouldn't get a glow. On the 110 winding, it will glow about half. On the 5 or 6.3 v. windings, it will light up. Put by shorting the leads, while testing, you may note a slight difference in the light's brilliancy.

Experiment. Put a 200 watt lamp in series with the 10-watt lamp. The 200 won't light, but the 10 will. If you measure the resistance of the 200 watt filament - it will be practically zero. The 10-watter will run 75 or so ohms. This shows the 200 watt needs the full current but the 10 watt is getting the full current - and lights. In other words, the 10 won't pass enough current to light the 200 watter.

Small Lamp Tests

THE SMALLEST LAMP TESTS.

For the 1 or 2 watt, you may have to go to 7 watts, if you can't find one smaller. But, just so it works on 110 is OK. We have found the smaller lites in clear types quite often. The sockets may be candelabra, bayonet, or other types, so you'll have to match them up. A clear sewing machine lamp will run around 7 watts. You might get an outdoor Xmas tree lamp, for 110, that is clear. Some have tint on the outside - that may be washed off with lacquer thinner. The main thing, you must be able to see the filament glow. Our Xmas tree lamp showed 150 ohms DC resistance. Our's wouldn't light on over 5,000 ohms on a 50-watt bleeder voltage divider.

We have obtained clear 110 v. lamps for our grinder - but, due to vibration, they didn't last a long time. However, they would be OK for your tester here.

The smaller lamps are much more sensitive to variations in resistance than the 10-watter. Appliance heater resistances will show up good with the tiny lamps. They test transformers and chokes much better, also. Don't try a high resistance audio transformer on a test lamp as the Resistance is too high.

TESTING WITH THE NEON LAMP.

The neon is useful in testing all kinds of resistors for continuity. Because it is not critical in brilliancy - you can't judge the ohmmage. but, it can do a lot of things for you. With the 250K resistor in series, as we have on the board - we ran it up to over 50 megs. (50,000,000) ohms and it still glowed. We drew a thin pencil mark, which didn't register. But, a heavy one several inches in length lit it up good. Be sure, when you test a resistor, that there is no condenser, or other part, across it

or you won't get the right reading. Also, be sure your fingers don't short the resistor - as they will also make it glow. Be sure your test leads are well insulated, or it will register. Use clips on your leads and keep your fingers away from them.

Referring to testing an audio transformer above - you can test them with this neon. It shows up good for the primary or secondary. But, you'll also notice it may show a leakage between primary and secondary - but very faintly. Most transformers are wound and then impregnated with a wax - so the leakage may be due to this.

Because AC goes across a condenser - you will find any type will glow the neon. DC doesn't go thru a condenser, so we always test them with DC. When DC is put across a condenser, and it glows intermittently, it shows leakage. A glow now and then is OK, but one that glows rapidly shows too much leakage. One that glows continually is shorted. The intermittent glow is caused by the condenser charging and discharging. When the latter occurs, it creates a "pulse" and reverses the current and the neon glows for an instant.

TEST LEADS.

You never get thru making up test leads of various combinations. For the test board you'll need a red and a black test prod wire about 4 ft. long. Put insulated solderless phone tips on the top end, and tape the pair about 2" from the end. On the other ends fasten insulated solderless phone tips again. All leads to be hung on a nail near the bench. Make it a big one as you're going to need plenty.

Another set of leads may be made with two insulated solderless phone tips and running to 2 banana plugs. Latter will fit into alligator clips and solder-

Bench Accessories

less phone tips. By having different fittings handy - you can make a number of combinations.

An attachment plug on one end, and insulated alligator clips on the other make another good combination for 110.

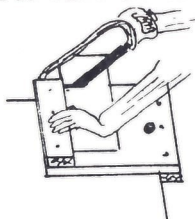
For quick testing, we rig up a lot of 6" leads of test prod wire, and place a tiny alligator clip on each end and hang them on a nail for safe keeping. We find them very useful in all kinds of bench hookups - usually called "haywiring a circuit." In a few minutes you can run a very quick test on many simple circuits you care to test out.

BENCH ACCESSORIES.

Bench Yardstick. We often find one handy. Tack it on the front edge of your bench for measuring wire, panels, coil forms, bolts or anything else.

Rubber Drainboard Mat. Place one on top of your bench when U handle sets, chassis, cabinets, etc. that may get scratched up. The dust and grit drops down in the holes. If without this, use folded newspapers or strawboard.

Bench Hook (6). Take a piece of 1x12 - 10" long and 3/4" in thickness. Screw a cleat on one end; fasten another on the opposite side on the other end. Drill

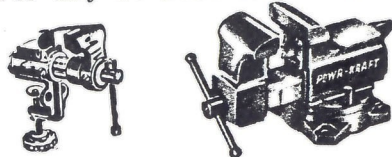


6. Bench Hook.

a hole so it can hang up on the end of the bench. This is a very handy rig for holding panels, tubing, plywood, etc. instead of marring up your bench. Saw with a hacksaw so work won't splinter off. The bench hook may save some of your fingers. I used to get

my thumb in my father's mitrebox - when sawing small pieces. Hi. This may also be used to plane against - instead of a bench stop on the end.

Small Vise (7). While we use a large machinist's vise, on our machine table, most of the time, we find this one handy. For temporary work, screw it on the overhang, under the gooseneck lite. It is handy for small work as setting phone tips, fine filing, forming, etc. Often tiny units may be held in it while

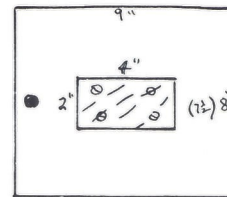


7. Small Clamp-on Vise and large Machinists' Vise.

assembling, dismantling or soldering, leaving the hand free to man the soldering iron, etc.

Soldering Iron Rack. Needless to say, you need a good, substantial soldering iron holder. We put ours on a piece of 1x6 - 8" long. To make it fireproof - we shod it with tin. On top of this, mount the heavy wire holder. If you wish to be safer - mount a piece of tin on the back board where the hot tip may come in contact. Always think of fire - not to say burns, when working with an iron. A fellow, at the Naval base, during the War, laid his iron down. Another fellow used it, and reversed it on him. Automatically he picked it up by the hot end - which isn't to be done in the best of families!

Emery Board (8). We use a pc. of 1x8 - 9" long, with a piece of emery cloth tacked on it. On the under side, we screw a 1" piece of wood 2x4" long. This is to hold the board in a vise. Put a hole in one end so it may also be hung up on the end of bench. When truing up the ends of coil forms, etc. - we rotate them on



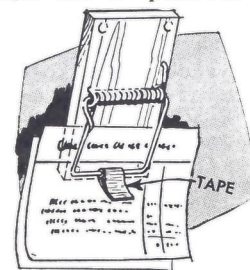
8. Emery Board.

the board for a fine finish. The outside burr edges are then taken off with our emery wheel. Inside burrs are trimmed off with a sharp pocket knife.

Paper Holder (9). After you've caught all the mice - put the mousetrap to further use. Mount it on the backboard. Use a pc. of adhesive tape for a "puller."

9. Paper & Note Holder.

Popular Mechanics



It will hold circuits, notes, and memos, when working on sets. Some use it for girl's telephone numbers!

Soldering Iron Cleaner (10). Get a small tin lid and drill a #6 hole in its center. Take a flathead wood screw and fit a washer under its head. Get a wad of steel wool and push the screw and washer down thru it and the lid - into the bench top, near the end of the iron. Drive two small nails thru the lid to keep it steady. Take a small stick, as used on all-day suckers (as you use for applying soldering paste

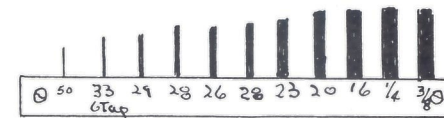


10. Soldering Iron Cleaner.

Bench Accessories

to your work), and put a generous supply of paste on the steel wool. Now, when your iron is hot - you can occasionally pull the end across the wool and keep it clean and tinned at the same time. We use it all the time - and couldn't be without it. Occasionally wipe the end of the iron off with a cloth - and again be careful with fire.

Drill Holder (11). Most metal drill holders are expensive. And

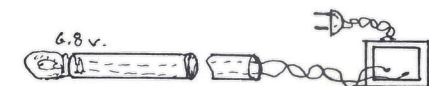


11. Drill Holder.

they put the drills so close together that they are hard to put back, etc. We prefer a 1" wooden strip - with holes the size of each drill - and every 3/4" along its edge. Below the drill, mark the number and any pertinent facts as for "6-32 tap" - "4-40 tap" - "#2 rivets" - etc. If you have an extra hole - fill it up with a match. Your drills will always go back "home" where you can find them later. Needless to say - the holder should be made so it can be easily removed.

Drill Gauge. This is very good for a Radio man to have. It will check sizes of drills as well as giving decimal equivalents. Also many show drill sizes for taps.

Bench Probing Lite (12). For sneaking around in dark corners, a dial lite may be mounted on the end of a 6" piece of 3/8" by 1/2" bakelite tubing. Lite will fit snugly in the end. Run two flexible leads out to a 6.3 volt filament transformer and you now have a permanent lite. No bother with dead batteries. No current



12. Small Probing Light.

Storage of Parts

will be drawn by the primary if not in use. It'll get you into small dark places.

Dentist's Mirror. Well, it's about the same as they use. Fasten a piece of Mirror $\frac{1}{2}$ " square, at a 45 degree angle, on the end of a stick. You can realize how handy it is for looking under Ur wiring- you can't see otherwise. Often it prevents tearing out a lot of wiring to check a connection that is "buried."

Good DC Supply. If you have a signal generator, or other form of tester, working off 110- just hook a lead off the plus and one off the chassis. Run them to red and black insulated phone tip jacks, mounted on the front of the instrument. It will be a very good source of DC supply. If you wish - you may cut it down with an 0-500K volume control in series with the plus lead.

Small Boxes. Always have a good supply of small boxes near the bench. When you take down a set - put all parts into the box - it saves time. I used to have a store across the street from a washing machine repairman. When he took down a machine - all the parts were piled in a heap under each machine, on the floor. At least, he kept them segregated in little piles in the room! Hi.

Phone Hook. Take good care of those phones- by mounting a wire coat hook on the backboard. Just right for holding headphones.

Cement Dispensers. We drill a hole in the lid of a vaseline, or other small bottle, and force a brush down thru it. It is then soldered, or sealed in some way, to the lid. It is very useful for brushing on Light Coil Cement or Heavy Cement. We use a bottle for each - and always are kept handy on the bench.

You ingenious Experimenters can always come up with a lot more ideas. There is nothing like experience to save time in the future. Keep working at it!

STORAGE OF PARTS.

This is a problem that becomes all the more important as time goes on. Most of us - in the Radio field - are just outright "pack rats." We are always accumulating. And, during my Radio life - I've been tickled pink, hundreds of times, that this is so. One is always finding something that will fit onto something else - and complete a unit of some sort. During the War, when our metals were entirely cut off, we made hundreds of variable condensers, brackets, connections, and what not, from old Radio scrap metals - that - well, we don't know why we never threw them away! Guess that was the reason. While we had certain priorities in our business, we couldn't get metals of various sorts. At the same time, the government had hoarded thousands of tons of the same stuff - with no apparent reason for doing so, as they had first priorities in their favor. As you know, these were later dumped for 10¢ on the dollar as so much junk.

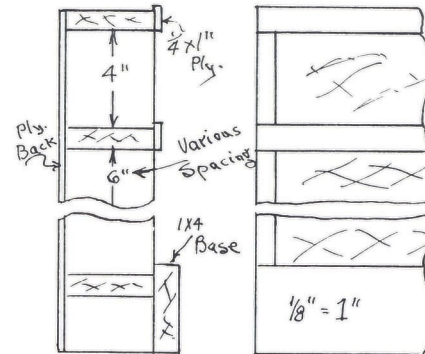
On entering the Radio shop, at the Naval base, we were told to start making up a "back log." This is what they call an accumulation of hardware, parts, and other plain junk! Every day we dug into our back log.

So - here are a few hints as to your storage problems. First, we built up units, a long time ago, in our store. They were 2 ft. wide and 6 ft. high. Some were just plain shelves - with various spacings. Others contained drawers. Some were combinations. After each of our moves, we could adjust them into any position to fit the premises. A nail was slanted into each one to keep them in place. The drawer type contained 4 drawers across by 10 high - 40 in each section. Each drawer can be divided into several compartments. If you are going into the business - and U

Storage of Parts

have plenty of time - it is a good idea to start building up units like this. They can be used for general mechanical storage, no matter what you're in.

Hardware Shelves (13). One unit of most importance to us is

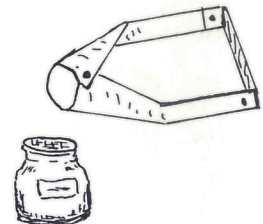
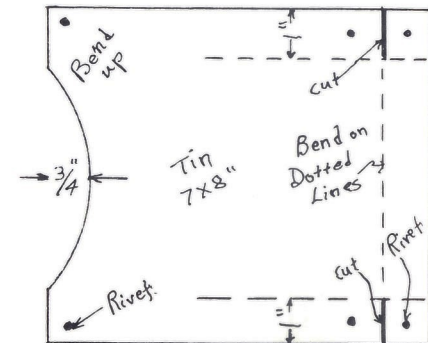


13. Cutaway Showing Parts Shelves. End and Front Views. $\frac{1}{8}$ - 1"

our hardware and small parts shelves. It is 2 ft. wide and 6 ft. high. Shelves are all 1x4 - as well as the ends. It is made sturdy with plywood on the back, all squared up. Top bunch of shelves are 4" apart - to take the 3x3 mayonnaise jars. As you go down - you can gradually accommodate the pint mason jars for larger parts. On the front edge of each shelf, is a small strip that sticks up $\frac{1}{4}$ ". This is very important - as jars will almost automatically slip back on the shelf. In case of a jar, or earthquake, they won't fall off. Nothing is more disgusting than have hundreds of tiny parts mixed up with fine bits of glass all over the floor! Then, put a nice label on the front of each bottle. We put roundhead screws on one shelf; flatheads on the next one; binding heads; one for nuts; washers; and so on. You may not have them filled now - but over the years, you will.

DON'T fall for this one! Now and then, some ingenious writer comes up with the idea of screwing a jar lid under a shelf. So, when you put the jar back, you have to screw it in - which is very unhandy itself. See how much more convenient our shelves are. Also, here is the catch - if you happen to get it cross-threaded, or drop it - you have a "pie" as the printers say. And, Mamma doesn't like those naughty words that may be forthcoming!

Sorting Tray (14). Using a box to sort parts, as we did for many years, and then transferring them back into jars - almost always spills some on the bench - which is annoying. Make this little tin tray and it will pay for itself many times. Pick out what you want - and then pour the balance back - real neat!



14. Sorting Tray.

The Shop Machine Table

OTHER STORAGE METHODS.

Coffee Cans. You can go over to these for larger parts.

Milk Cartons. At the Naval base, a friend of mine concocted the idea of cutting off milk cartons just the height to go in a drawer. Most of us "kids" used a lot of milk at noon, so it was easy to collect them. Use grease pencil to mark them in the back.

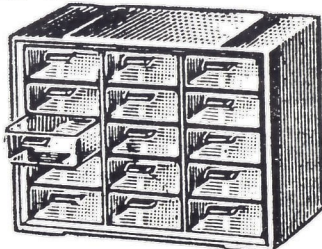
Old Shower Curtain Clips. One fellow comes up with a neat idea for their use. Spring them apart and push ends thru washers, lugs, nuts, wrench sockets, or what not. They may be hung up in some handy place - so everyone, who comes in will say "what's that?"

Typewriter Ribbon Boxes. Not so ingenious - but handy for Ur tiny parts, cotter pins, etc. A small roll of friction tape will go in them and keep it useable.

Pin Cushion. We use a piece of Balsa wood for pins and sharp punches, and quite handy. Screw it down next to coil winder.

Plastic Cases (15). These are now being sold at very reasonable prices - thanks to the many plastic molding presses. They usually have adjustable divisions in the drawers. Also, a slot for a card label on the front. It is a very quick way to arrange for storing small parts, and very neat for the shop. Besides the front label - we use a grease pencil to mark each section in the rear.

15.
Plastic
Parts
Drawers.



THE MACHINE TABLE.

We always found it much better to use a separate table for machines. The workbench is no place for vibrations, sawdust and metal dust. Besides, the bench is usually crowded for room.

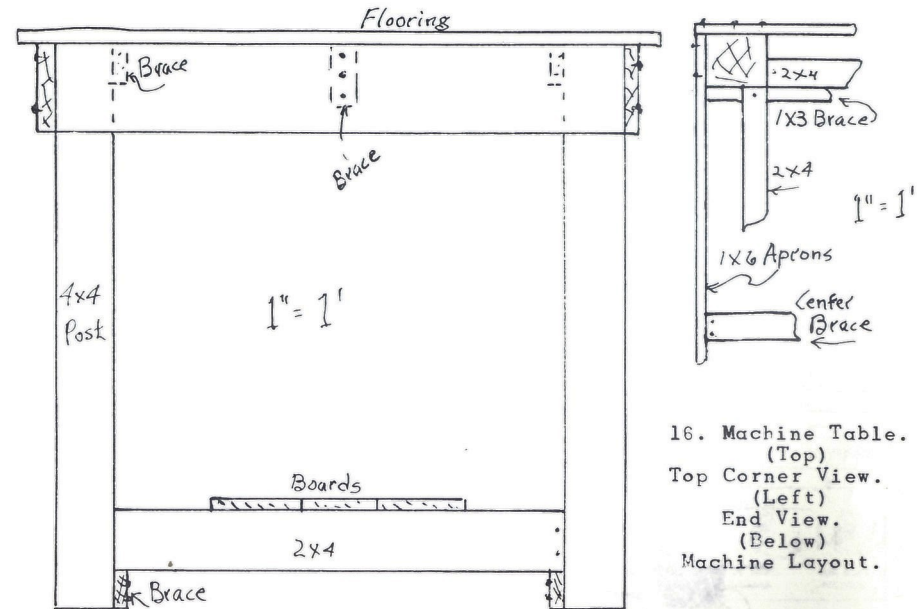
Machines may be bought on such good terms now, that one can afford to get good ones. Over a period, they will always pay for themselves. It is better to wait until you can purchase a good, substantial machine, rather than getting a makeshift and have to dispose of it later. There are many contraptions, on the market that aren't worth dragging home, and are far from practical, regardless of what the advertisers say. Buy a machine; not a toy!

A suggest size for a top is about 3x5 ft. and 36" high. We have laid out a good arrangement here, that we have used in the past. As the drill press stands upright - keep it at one corner, so you can swing material around in it. The saw is on an opposite corner - for the same reason. Grinders, etc. are placed so they won't interfere with use of the saw table. A good machinist's vise should be set on another of the corners - so material may be swung around in it without any interference. Other machines may be added - or a larger table made to fit your desired.

Size of the table depends a lot on your room, and how many machines you wish to use. But the construction is the same. Get (4) 4x4 posts 35" long. Cut 2 pcs. of 1x5 - 3 ft. long, and nail them at the top of the two sets of posts. Then, up 6" from the bottom, cut (2) 2x4's to fit in between the posts. Toenail these in, making them flush with the back of the posts. Make two sets of these for the ends.

Now, cut (2) 1x6's - 5 ft. long and nail the two end sections together, at the top. Fit 2 more 2x4's lengthwise - 6" high, same as for the ends. Now, cut (4)

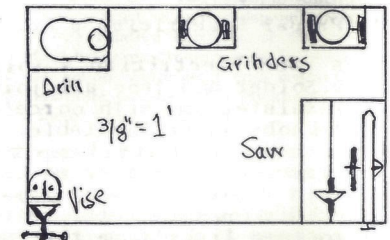
The Shop Machine Table



16. Machine Table.
(Top)
Top Corner View.
(Left)
End View.
(Below)
Machine Layout.

1x3 braces, to fit inside the posts, from top of one down to the bottom of the other - underneath the 2x4 crosspieces. Then, square it up good before permanent nailing. Boards may now be nailed lengthwise, from the 2x4 cross pieces - but about 6" back from the inside of posts. This is to give you more foot room under the table. The boards are for storage of material. Run a 2x4 the full length of the center and nail from the end aprons for stability.

Now, after leaving 1" overhang - start nailing 1x4 flooring crosswise on the table. Draw 'em up tight with #4 box nails. You may set your saw table on its corner - and allow for holes for sawdust to fall thru. What may be better, is to lay the flooring; mount the saw; then keyhole saw your holes. The tongue and grooved flooring should stay in place. Make a 2" drawer, under the saw to catch the dust. Cut



the slot thru the 1x6 apron. It will collect 95% of the dust, altho many don't believe it. We use it all the time.

After mounting the saw, build a removable box around it so you can get to it for oiling or any overhauling. After using the saw - dump the dust on your flowers, and you can detect any spark, that may have ignited the dust, especially after sawing wood and Bakelite, in that order.

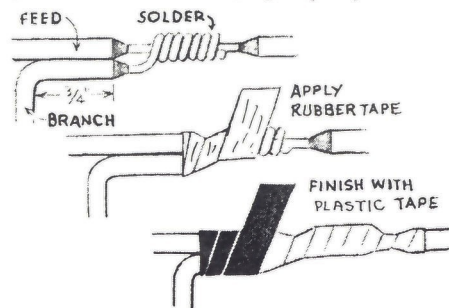
Positions of machines may be arranged to suit your shop. Try to save steps here and there.

Shop Machine Operation

ELECTRICAL CONNECTIONS.

If you can pick up some old-style push-button wall switches, with plates, they work fine for each machine. If not, the toggle type is OK. In case you want to shut off a machine quickly - the push-type is best. Mount a switch for each machine by drilling thru the 1x6 apron. This is much better than fumbling around with an electric light socket.

Wire all electrical work with #14 housewire. Fig. (17) shows



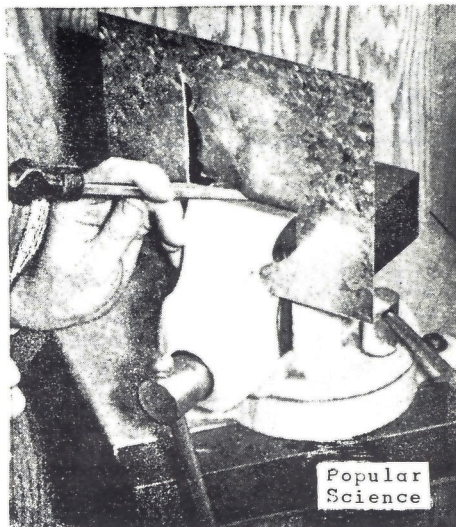
17. Proper Electrician's Splice.

how a good Electrician's splice looks. Solder and tape all joints and insulate them with porcelain split-knobs under the table. Try to place a 60 watt lamp over each machine for better work. We prefer a regular 60 watt frosted globe. Rig up some metal reflector to keep light from the eyes. Needless to say, all electrical switches and lites go to the entrance switch on the board.

THE MACHINIST'S VISE (18).

A good vise, with 3" jaws, is one of the most useful helps around the shop. Many have removable jaws and swivel joints with base locks. Our vise has additional jaws that grip pipe.

Do not use a pipe on the handle to expand the pressure - you will break the vise. They are made for certain limitations. Oil it lightly, but frequently. It should last you a lifetime.



18. Shearing with a Vise.

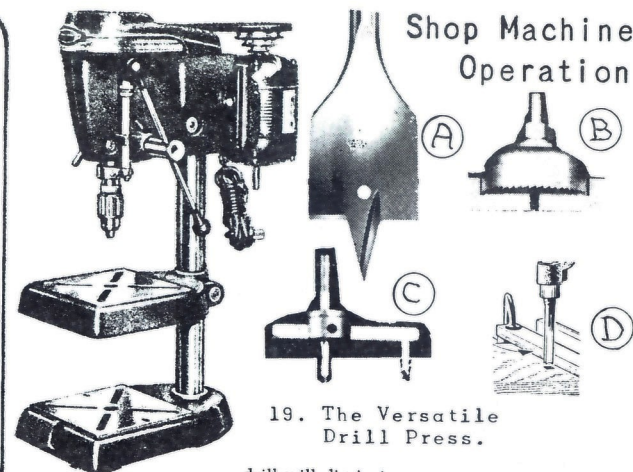
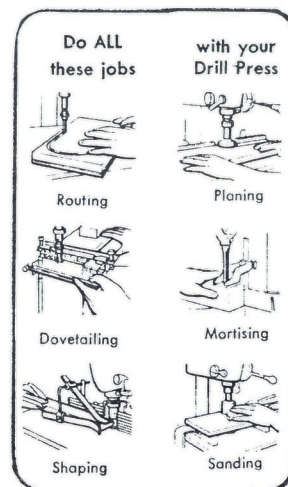
Picture shows how it is used for shearing square holes, for power transformers, or straight edges, with a cold chisel. Always work close to the edge of the vise for best results.

Brackets may be bent between the jaws. Holes may be drilled before or after bending, as you wish. A bending jig may be made with two pins spaced in a block of metal. Place block in the vise and bend rods between the pins.

Always protect your work with wooden blocks between the jaws, especially when holding wood, Compo. or other soft material, so it won't be marred. When you drill this material, in the vise always have a wooden backing to drill into. With care, you can slowly come up on a plastic tube without breaking it - in case you want to saw or work it.

THE DRILL PRESS (19).

Buy a good drill press as it is the most versatile machine you can get, and you'll need it always. A small, cheap machine will give you "sloppy" operation



19. The Versatile Drill Press.

- due to loose bearings, poor adjustments and inability to do heavier, more accurate work when you require it.

We have one like Fig. 19. It has a 3-pulley combination, but we use only the slow one. It uses a 1/3rd HP. induction motor. It takes up to 1/2" drill shank, which covers the field. We'd like one that raises the table by a gear, but they are hard to get. Mount press substantially, preferably on the corner of the table.

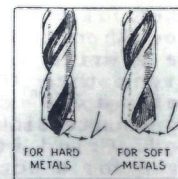
A few drill kinks may help. Make drill holder (Fig. 11). Fine drills may often be made from nails, by cutting off the heads. If too small for the chuck, wrap fine sandpaper around them, with grit toward bit. If drilling in wood, soak them in lacquer thinner to remove pitch, etc. that may make heat and remove temper. Keep drills sharp - it pays. The size of drill may be marked on the shank with masking tape. Most used drills are for #6 hole. For a loose fit, use #22; #27 for a tight fit; #33 for a 6-32 tap.

Grinding Drills for Soft Metal

Drills used for steel and other hard metals are generally ground so that the cutting edge tends to dig into the work. This method of grinding is correct for hard metals, but when holes are drilled in copper, aluminum and other soft metals, the

drill will dig in to such an extent that it will either stall or break. In most cases drills can be made to cut soft metals smoothly by grinding away the actual cutting edge so that it scrapes

rather than cuts. The extent to which this scraping must be carried depends entirely on the relative hardness of the metal. Hard brass may require very little scraping action while lead will require the maximum possible. The thickness is also a factor to be considered.

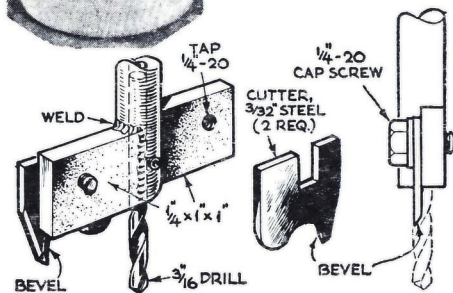


There are various ways to make large holes. A wood expansive bit should be used with a brace, as press goes too fast. The flat bit (A) is available in various sizes - at reasonable prices. It does a real good job on Compo. panels, plywood, etc. Be sure U clamp a piece of hardwood for a backing, so bit won't crawl. (B) is a continuous circular hole cutter that is obtainable in a number of sizes. It usually requires a 1/4" starter hole. (C) is a groove fly-cutter that usually has its own center bit. But we find no substitute for a large drill bit for holes under 1" for a clean hole. For metal panels, a 2-pc. screw chassis punch is preferred in sizes 3/4" - 1" - 1-3/16" - and should be stocked.

Shop Machine Operation



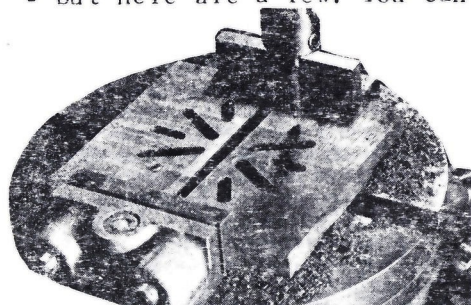
20. Fly-cutter Bit makes Wheels.



Reamers may also be required at times, for enlarging holes a little. When knocking off burrs, use a drill size several times larger than the hole. We also prefer a 3/8" drill bit for making countersinks on metal or on wood. Grind it to the correct angle for a screw head, 50 deg.

Fig. 20 shows how a fly-cutter may be rigged up to make small wheels - or Radio knobs.

A routing big (D) or Fig. 21, sure gives you a lot for your money. There isn't space here to go into all of its possibilities - but here are a few. You can



21. Routing Speaker Grilles.

make grooves, like dado heads on a saw. Another if for raised letters or similar work. It may be used for outlining curved edges. Speaker grilles are easy to make this way. The main thing is

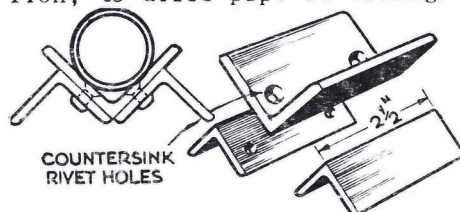
to have a sturdy guage. If you are making circles - just rig up a center pin guage.

Another drill press use is to get a flexible extension shaft. You know the many possibilities of this rig - for small work. It is better to throw your motor over to the fast pulleys.

Polishing the inside of holes, is another use. Take a drill and wrap steel wool around it. Or, you may mount a typewriter eraser on a shaft and put a satin-finish on aluminum panels.

A drill depth guage is usually built on most presses, and it works very good. A collar and a setscrew may be fastened to the drill for getting depth.

Make a jig (Fig. 22) of angle iron, to drill pipe or tubing.



22. Jig for Drilling Tubing.

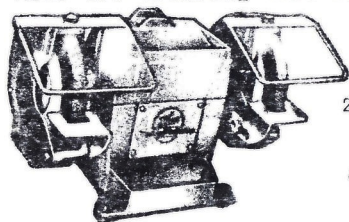
It holds it solidly and helps to protect those fingers.

Fig. 23 shows a drill press



23. Drill Press Vise.

vise. It clamps, or lays on top of the press table. It holds rods, etc. in upright position. Also for drilling fine work.



24. Bench Grinder & Buffer.

Shop Machine Operation

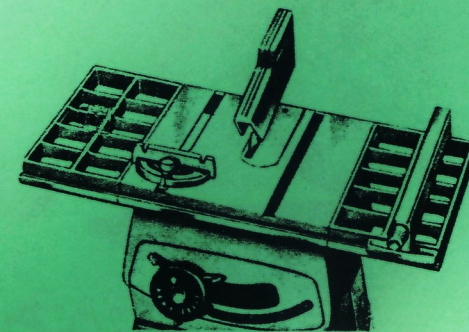
THE BENCH GRINDER (24).

Grinders are not too expensive but are a "must" for any shop. They are usually 1/4 HP. and ball-bearing. Most of them have eye guards. Be sure to use them, tho you have glasses as the metal specks will nick them. The use of goggles is much preferred. Never stand directly over your wheel - always to one side, in case the wheel shatters. Ours came with a 7 1/2 watt lamp, that kept burning out from vibrations - so hang a 60 watt, with reflector, from the ceiling. We prefer a fine wheel and a wire scratch wheel on the other end. If you can afford it, and have the room, get another grinder. Place a coarse wheel on one end and a fine one on the other. Then for the other grinder - use a scratch wheel and a cloth buffer on it. The scratch wheel is for removing rust, dirt, etc. Touch knobs to the scratch wheel, with the engravings, and it'll clean them out FB. It will also put a satin finish on Aluminum. The buffer is for polishing knobs, etc. A piece of polishing Rouge, held against it, will greatly improve the luster.

THE CIRCULAR SAW (25)

There is no end to the usefulness of a circular saw table. The one shown can be purchased, with motor for less than \$100. We got our first saw in 1925 - and we've sure given it a beating since! Hi. It doesn't have all the refinements they do now.

The one shown has a large table - which is very essential - as no need for someone to hold up the end on large pieces. It may be tilted as shown. Check up your fence (guage) and table with a square to see if they are square. Also check your "push" guage to see if it is square with your saw blade - or you're in trouble. Test the shaft to see if it wobbles - and take up any excess play.



25. The Circular Saw Table.

Keep the saw and motor oiled, once a month, with #10 oil. Be sure to use a guard over the saw at all times to protect Ur eyes. On your "V" belts - measure them with a cord and replace at an Auto supply store - cheaper than a machine supplier. Write the number down near your saw for a later replacement.

Read back on page 19, and Fig. 16 about the sawdust catcher.

SAW BLADES AND THEIR USES.

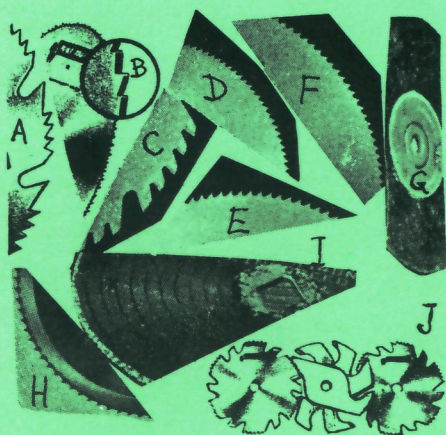
Usually a combination rip and cross cut blade (A) comes with a new saw. Use it only for ripping as it is no good for cross-cuts, except rough, thick pieces. Buy a cross-cutting blade (B) for wood, Compo., etc.

Blades may run from \$1.50, for the disposable, up to \$80 for the finest carbide-tipped. But, for the regular shop - you can stay within \$10 - and even do better with the Catalog houses. Cheaper carbide-tipped blades (C) may be obtained and will last 25 times as long before sharpening as regulars.

The thin rim blade (D) is for fine veneer work, etc. Feed it slowly - only for thin work.

The plastic-cutting blade (E) is hollow-ground, and may have a tiny bit of set. It smooths as it cuts.

We use a metal-cutting blade



26. A Variety of Saw Blades.

(F) for soft metals, Bakelite, fibre, etc. It does not require a set - and teeth will break if you try - so we found out! But, after a short run - it must be re-sharpened with a hard file, especially after Bakelite use.

The Carborundum disc (G) is much better - altho it takes a larger bite, it gives a smooth finish. They are also made of Aluminum oxide for metals and Silicon carbide, etc. for softer materials. As this kind of wheel may shatter - be sure to use the guard. Use it outside as it makes lots of dust. Tie a handkerchief over your nose for the dust.

Disposable blades (H) are sold in a big variety. They go a long time before throwing them away.

Flex wheels (I) are thin discs that look like cardboard. They

are coated with glass fibre, resins, or hard abrasives. They will cut pipe, concrete, stone, etc. that will defeat a hacksaw. They won't shatter, but use a handkerchief for the dust. They run around \$2 each. Uses printed on each disc. #24 grit is for grinding; #36 for finishing. Use end flanges for protection of the discs to make them last.

Grooving blades are very expensive, so the dado head (J) is much preferred as they are adjustable and cheap. They are used for making all kinds of grooves. Molding blades may also be used.

OTHER USEFUL EQUIPMENT.

One can go on and on, when it comes to adding new equipment. A few things, that may be added, are a metal bending brake, different types of chassis punches, welders, jig saws, innumerable pieces of test equipment, etc. It all depends on how far you desire to go - and how much you'd like to earn from their use.

We hope you've found a lot of useful hints that will help to make your workshop more enjoyable. It is a pleasure to do things right - as well as to do them quicker. The above suggestions have resulted from years of practical experience in a Radio shop. As there is something new every day - you may find many of the suggestions may be improved. Everyone's experience in a specific line - when blended together - makes a very interesting batch of brew.

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