

Everyday Mechanics

"It Tells You How to Make and How to Do Things"

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No. 3

WANTED—A TITLE FOR THE READER

WHAT shall we call ourselves—you and I who delve into the mysteries of science solely for the love of it?

Are we junior engineers, amateur craftsmen or handicrafters, scientists, everyday mechanics, model makers, or—what are we?

I want some ingenious and serious reader to give me a name for members of our craft—a name typical of our work which is constructive and of serious import. Our real object, whether we are given credit for it or not, is the advancement of science to which the progress of the world is indebted.

The term "amateur" is little understood in this country. The commonly accepted definition, which relegates the title to dabblers, triflers, jacks-of-all-trades, "nuts," is a direct result of the careless ignorance or lack of culture permitted to develop during the last generation by those intrusted with the education of our youth. The latest edition of Webster's New International Dictionary gives just the same definition as former editions: "Amateur. One who cultivates or is attached to a particular pursuit, study or science, from taste, without pursuing it professionally."

That definition is clear, is it not? If it were not for the fact that people at large have failed to treat themselves to a decent share of the common education available through the medium of the nearest dictionary, we could call ourselves "amateur scientists," or amateur this or that, and still retain the measure of dignity and respect that is coming to us. However, in view of the disrepute into which the term has fallen, we must shun it.

Now we face the task of *originating* or *coining* a title that fits us—a title that we can hammer into the heads of the public until they know what we mean, and will take our title at its true valuation without having to adulterate it with a measure of ridicule. In England, the "Model Maker" is an accepted institution, and he is

held in the respect he deserves; in Germany the "Physicist," both amateur and professional, is held in affectionate awe. In the United States we have three classes: "Great Inventors," "Nut Inventors," and "Experimenters." The third class invariably finds himself in one or the other of the remaining two classes. The distinction is drawn solely by the money the experimenter makes out of his idea. If he puts across a good deal he is a great inventor; if he does not, he is either a "nut" (if he grows old) or else he is still merely an "experimenter"—wasting his time with his fool machinery.

The fact of the matter is that the most brilliant engineers of the present day have graduated from the ranks of the despised amateur mechanics; in fact, I do not know of any other manner in which a man could develop his inventive and analytical faculties. All of the education in the world could not make his mind greater in breadth than that of his instructor, if it were not for experimental and research work through which he is enabled to ferret out better ways of doing a certain thing or by means of which he is enabled to improve the quality or lessen the cost of production of a commodity, or, perhaps is shown the light of a brand new discovery which may in time have some bearing upon the lives of every civilized being on earth.

My contention is that there is no nobler or more important work in the world than that of what I shall call "race cultivation" for want of a better term. We are put here to do our little bit, each one of us, to make the world a more habitable, cheerful, and pleasant place to live in. If we are sufficiently broad-minded to recognize and admit this fact, then each of us should contribute his share to the general scientific improvement of conditions as they are. Perhaps we may merely discover some little kink to make Mother's work lighter in the household—a new wrinkle for the sink or an improvement in the arrangement of the kitchen shelves; perhaps our tastes may run to electricity or radio—we make some little discovery and pass it on, the next fellow uses it in his work, and finally the germ of the idea comes out in some great invention *that the original inventor could never have developed*, owing to lack of facilities, education, or resources.

Do you get the point? This little magazine that my collaborators and I are building for you is the official organ, *the mouthpiece*, of that vast army of amateur physicists who are working for the betterment and the cultivation of the human race. The members of this army may be men or women, young and old, in all walks of life.

Their one requisite is an ambition, yes, a determination, *to make and do something* in this old world of ours.

I have thought deeply on the subject, and I have consulted many minds. Now I want *your* ideas. Shall we be merely dabblers in the eyes of the uninitiated or can we coin for ourselves a title that is typical of our work and of which we need not be ashamed? Can we be the creators of a new science—the science of *EVERYDAY HANDICRAFT*—the science which encourages and teaches personal cultivation in every walk of life? Can we call ourselves Everyday Handicrafters, and possibly form a society somewhat similar in character but of infinitely broader scope than the famous "Society of Model Engineers" in London? Write me and tell me what you think of it. You have been my inspiration and guide before. I have put my every problem up to you, *my readers*, and you have found the answer. Think this over. You see what I am driving at. Then give me your advice and suggestions.

Sincerely,

A handwritten signature in cursive script that reads "Thomas Starley Curtis". The signature is written in dark ink and is positioned above the typed name of the editor.

YOUR EDITOR.

HOW TO BUILD A MOTOR SLED

PART I. CONSTRUCTION OF THE BODY AND RUNNERS

BY WM. P. LANGREICH, OF THE LABORATORY STAFF

ONE day, a few weeks ago, a member of the Laboratory Staff, who is about as serious minded as any other experimenter, happened to see a pretty little gasoline engine on display at one of the many automobile salesrooms in New York City.

When we discovered that a deposit had been paid on it, and that arrangements were made for its shipment to the Experiment Station, someone suggested a private lighting plant, another a motor boat, a third a cycle car, and the fourth a motor sled. The last suggestion was developed first, in order to have the sled completed before the snow begins to melt. Those of our readers who hesitate at buying a motor because of the relatively short time during the year it can be used to drive a motor sled, may rest assured that EVERYDAY MECHANICS will find a use for it as long as there is a drop of gasoline in the can at the station.

The body of the sled is built of wood, and readers who consider themselves capable of doing so, may cover the top and sides with galvanized sheet iron or sheet tin, according to our instructions. Begin by cutting the floor to dimensions given in Fig. 2. The total length of this is 10 ft.

6 in., and the width at the widest point is 28 in. Except where otherwise specified, stock should be $\frac{3}{8}$ in. thick. The floor is built up of four 8 in. boards, 10 ft. 6 in. long. Place two of these next to each other so that the ends are flush and then nail strips across the bottom so that the curved line *BC* (Fig. 2) may be drawn. This is done as may be suggested by the illustration. Using an outer edge of the two boards as the line *BD*, lay off on it the dimensions given. That is, from the point *B*, measure 28 in. and erect a perpendicular. Then measure 26 in., and draw another perpendicular line, and so on. On these perpendiculars lay off the distances given showing one-half the width of the body at the various points. The curved line *BE* can now be made by driving a nail at *F*, which is on the first perpendicular line from the bow, 11 $\frac{1}{4}$ in. (one half the width) from the "working edge" (*BD*) of the two planks. By placing a slender stick on the outside of the nail and bringing the ends down so that the stick bends and its edge crosses the points *B* and *E*, the curve *BFE* can be drawn by running a pencil or crayon along the inside edge of the stick. In a like manner, by driving brads at *G*

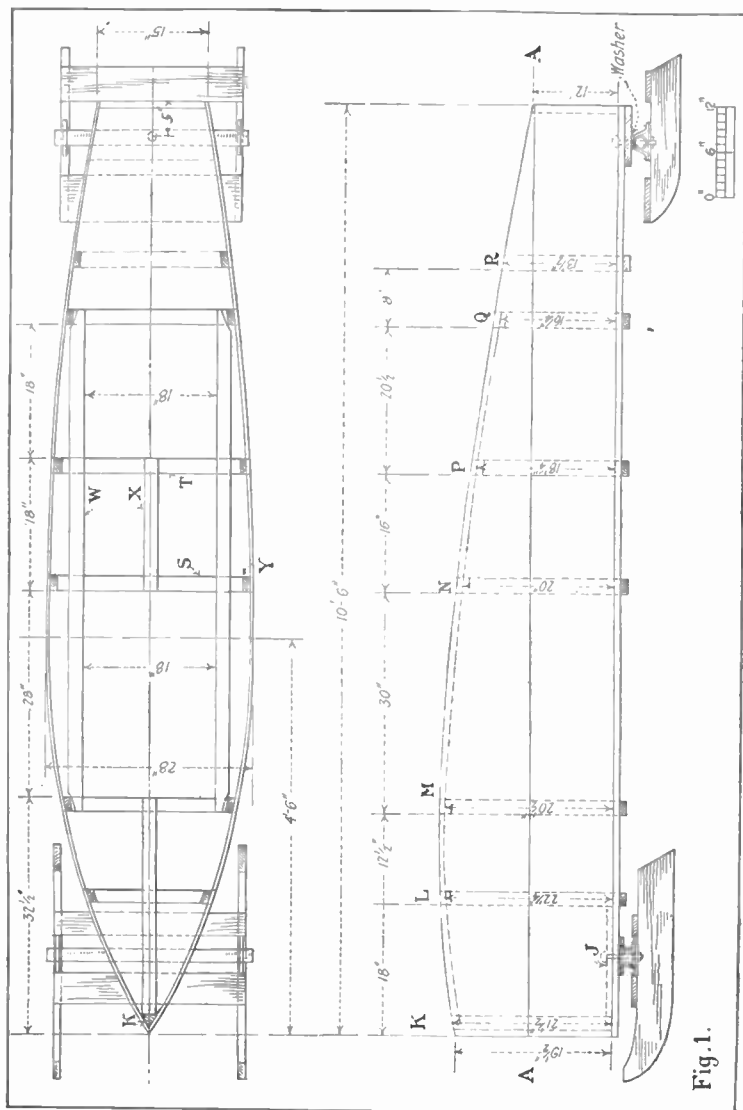
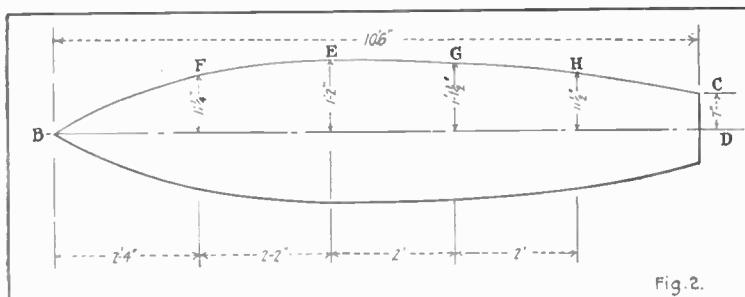
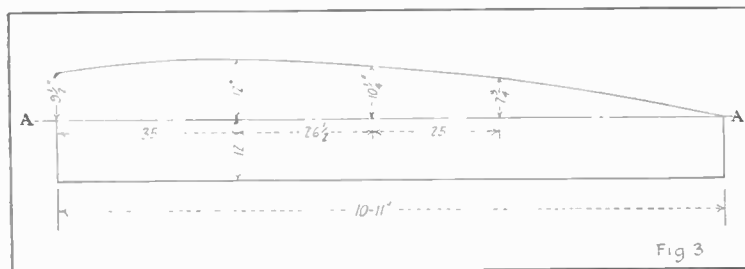


Fig. 1.

Dimensions for construction of the body



How the floor of the body is laid out



Dimensions of the sides

and *H*, the curve *EC* can be made.

This, then, lays out one half of the floor. Take the strips off and nail each of the boards to another eight-inch board of the same length. In this way, with a draw-knife and spoke-shave, both halves may be cut at the same time, and the two edges will have the same curve. Lay the four boards down in the positions in which they are to be assembled. At 18 in. from the bow draw a line across the four boards and nail a one by two strip across them on the *stern*

side of the line. Do the same at 12½ in. from that line and 30 in., 16 in., 20½ in. and 8 in. from each succeeding line. Across the stern end fasten an 8 in. board to facilitate the pivot arrangement for steering. Our floor is now complete, and the next step is to cut and fasten the uprights similar to *Y*, in Figs. 1 and 4. All of these but the one at the bow (*K*) are cut of one by two stock. The dimensions given in Fig. 1 are for the lengths in the middle, but both ends are not cut square. The upper one is cut at an angle

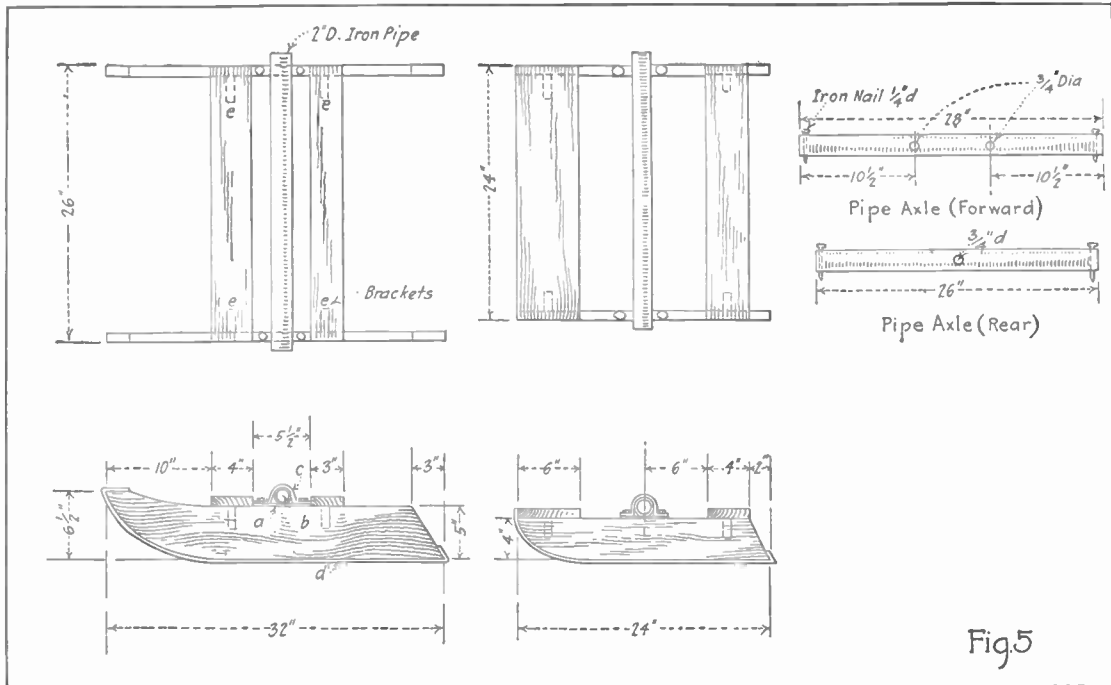


Fig.5

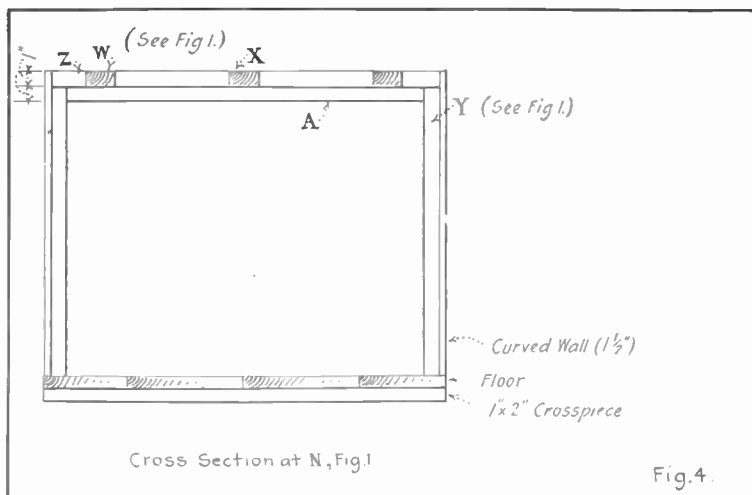
To the cutting edge of the runners are fastened strips of triangular steel rod or ribbon

equal to that made by the upper edges of the sides (if they were of straight lines instead of curves) to the floor. These angles can be approximated by referring to the drawings. The uprights are fastened over the ends of the strip under the floor and are almost parallel to and about $\frac{1}{2}$ in. in from the edge of the floor. The upright at the bow (*K*, Fig. 1) is cut from a triangular stick 2 in. x 2 in. x 2 in., and also fastened $\frac{1}{2}$ in. back from each edge. Nail a one by two stick between each pair of uprights except the last (*L*, Fig. 1) as shown by *A*, Fig. 4. At the stern nail a board, 12 in. by 14 in., to form the back or "tail-end" wall.

We are now ready for the sides of the body. Each of these need two $\frac{1}{2}$ -in. whitewood boards, 12 in. wide. If the instructions for cutting the curved edges of the floor were carefully followed, the length of a side should be about 10 ft. 11 in. It would be well, however, to measure along the curve of the floor to determine the length, allowing an extra inch for the joint at the bow. The lower boards can be cut to the proper length and are ready, but the upper pair require the laying out of a curve in a manner similar to the way the floor was laid out. For dimensions and details see Fig. 3. When the ends of the four have been beveled on the *inside* of the forward end to make

a neat joint, they are ready to be nailed into place. Notice how this is done in Fig. 1. The edge of the lower board rests on the edge of the floor left for this purpose, and nails are driven through the board into the upright strips. The upper boards are rested upon the lower and also nailed in place. Use long nails to enable "clenching," for the bend in the boards will have a tendency to draw the nails. Description of the top is given in a later chapter, as access to the interior is necessary to arrange for the seating, steering and installation of the motor. At the bow fasten a triangular board (*J*) to reinforce the floor where the runners will be strapped.

The drawings of the runners (Fig. 5) give dimensions and details necessary for their construction. They are not fastened to the floor of the sled, but strapped to a pivot arrangement utilizing 2-in. iron pipe for the "axle." In Fig. 5, *A* is an iron strap upon which the pipe *B* bears. This is held in place by the iron strap, *c*. The pipe *B* is secured to the floor in a similar manner, but to insure solidity two stone bolts are used to keep it in the middle. To prevent the runners from slipping off the "axle," drill $\frac{1}{4}$ -in. holes near the ends of the pipe to hold long iron nails which have been bent to avoid their loss. The rear runners are strapped to an "axle" in the



A cross section of the body showing method of assembling

same manner, but only one bolt in the middle is employed to secure them to the sled. This acts, at the same time, as a pivot for steering. Between the rear axle and the sled employ washers enough to insure easy steering.

To prevent "folding" of the runners, use 2-in. brackets, as shown at *E*. The steel ribbon (*D*) fastened to the runners may be obtained at any blacksmith shop. Secure this with screws, carefully countersinking all heads.

(To be continued.)

BLACK ANT EXTERMINATOR

To exterminate black ants, sprinkle a few leaves of green wormwood in the place they infest; for red ants use powdered

borax or cloves.—EMMA F. MURKAY.

BURNING STEEL

Get a piece of fine watch spring and dip it into melted sulphur. Having attached it to a slip of card or wood, ignite the sulphur and plunge the steel into a bottle of oxygen. It will burn rapidly, emitting a most dazzling light.

A nut that has worn too large to stay on can be made to do temporary service by hammering one side of the nut until the round hole is slightly oval. In this way the nut will hold on two sides and will keep the part in place until a nut of the right size can be obtained.

CONSTRUCTION OF A ONE-HALF HORSEPOWER GASOLINE ENGINE

By WM. C. HOUGHTON, M.E.

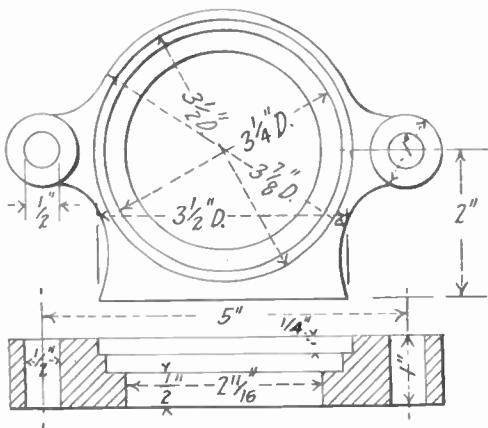
PART II

WHEN the castings are received from the foundry they should be carefully checked up and compared with the patterns to see that none are missing. Next inspect every part, looking especially for blow holes and similar defects, remembering that the foundry men will replace a defective casting, but will not pay for any work that may have been wasted on them. The castings should be "snagged," that is, all fins, gates, etc., chiseled or filed off and any rough places smoothed. This is supposed to be done at the foundry, but usually is very imperfectly done. There will also be some places where burnt sand sticks to castings, especially in corners. The end of an old file will remove it, if industriously used.

Actual construction may well begin with the cylinder. In this engine, the cylinder is made of a piece of drawn steel tubing which is supposed to be smooth enough inside to be used as it is and also to be round and straight. As a matter of fact, it is rarely so, but is more or less scratched, sometimes quite deeply as well as being somewhat rusty and perhaps slightly out of round. In

this case it must be *lapped*. A piece of hard wood, maple, beech or other close grained wood 10 or 11 inches long is put in the lathe and turned to 27-16 in. diameter. A piece of No. 1½ emery cloth is cut just large enough to wrap around the wood, with butted, not lapped ends, drawn tight and securely tacked in place. Small tacks should be used and slightly countersunk. The lap is then liberally oiled, preferably with lard oil, the tube slipped on, and ground out with lathe running about 200 or 300 r.p.m. Oil must be supplied from time to time as required, never allowing the lap to run dry. A second piece of emery cloth may be required if the tube is deeply scored. A better job may be done with a lead lap supplied with emery powder and oil. It is made by casting lead around a wooden core, turning to size and charging with emery and oil. Details of this process cannot be given here, but may be obtained from some friendly machinist who is familiar with it. Lapping should be continued until the inside of the tube is entirely free of scratches, etc. Care should be taken to roll the tube

Front Cylinder Collar (Make One)



Standard $\frac{1}{2}$ Pipe Thds.

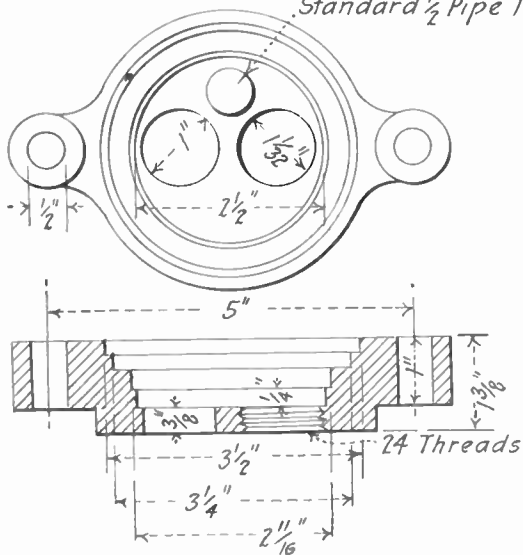


Fig. 9. Details of front and back cylinder collars

continuously, and also to slide it back and forth endwise to prevent uneven grinding. The successful working of the engine depends upon how carefully the work is done, more than on any one other part of the work.

A somewhat larger piece of hard wood, say $3\frac{1}{2}$ in. diameter and 12 in. long may now be put in the lathe. It is best to turn a plug at the tailstock end to fit the taper hole in the lathe spindle, or to fit the cup chuck if the lathe is provided with one. The work is then reversed, the plug driven into spindle of lathe, back center brought up, and turned to $3\frac{1}{4}$ in. diameter, *i. e.*, just small enough so that the *water jacket* tube may be driven on tightly. The ends of the tube should be squared up with a sharp side tool, making it $3\frac{1}{2}$ in. long. If outside of tube is rough or out of round a light cut may be taken to true up about $\frac{5}{16}$ in. near each end. The jacket may then be removed, taking care not to bruise the ends. The wooden arbor is next to be turned down to $2\frac{1}{2}$ in. diameter, a tight fit for the cylinder tube. The ends of the cylinder are to be squared up and $2\frac{3}{8}$ in. at one end and $\frac{1}{2}$ in. at the other turned to $2\frac{11}{16}$ diameter, and finished very smoothly. A slight taper may be given with the dead smooth file used in finishing. This will make the cylinder go in the col-

lars easily and at the same time fit tightly. The water jacket should have two holes laid out and drilled $\frac{27}{64}$ in. in diameter and tapped $\frac{1}{8}$ in. standard pipe thread, for the water pipes. The cylinder has one hole drilled near the front end, $\frac{1}{4}$ diameter and tapped 24 threads. The thin walls make it necessary to use a fine thread. If preferred, the hole may be left without threads, and a brass collar tapped to fit the thread of a standard sight-feed oil cup, soldered on.

The Cylinder Collars may be taken up next, the front one first. Punch the centers of the lugs, taking care to get them exactly 5 in. apart. Drill $\frac{1}{2}$ in. Clamp the back collar to this, spot through and drill corresponding holes in it. Also drill half-inch holes in a piece of bar steel say 6 in. long and $\frac{3}{4}$ in. wide, using the cylinder collar as a jig. The exact center between the holes is next to be punched. This piece is to be used as a jig in locating the collars to be bored. Put short pieces of $\frac{1}{2}$ in. steel rod through holes in jig and collar. Put a piece of newspaper on the face plate, the collar next, and bring up the back center of lathe, with point in punched center of jig. Screw up center to hold in place, clamp collar temporarily, remove jig and bolt collar to face plate with two half-inch bolts. This is a somewhat tedious process, but necessary unless the

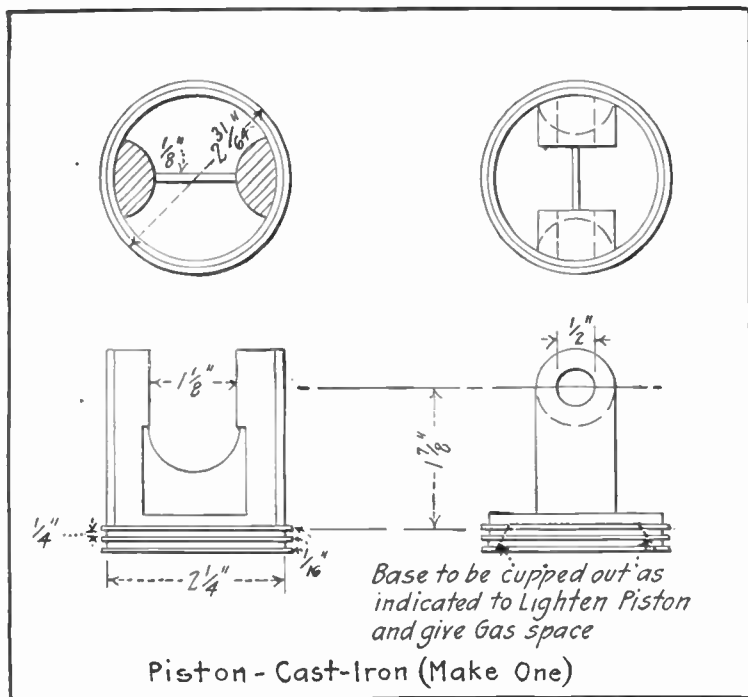


Fig. 10. Details of piston

builder has had experience with other methods of centering. The back collar should be bolted on and bored first. In boring the front one, a piece of $\frac{1}{4}$ -in. board may be put between collar and face plate. This is to prevent cutting the face when boring for the cylinder. Bore both collars as per drawings. The parts where the cylinder and water jacket go in should be fitted to the same, rather than going by the drawings. The fit must be water tight.

A slight variation in the depth of the shoulders will not seriously matter.

The boring completes the work on the front collar. The back collar must be turned smooth on the inside of the head which is combined with it. The front face must also be trued up all over. The casting is next reversed on the face plate and a light cut taken over the back of the head. The lugs may be faced off at the same time. It is then taken off

and the centers of the three holes, for inlet valve, exhaust valve and spark plug laid out. The first two are both on the center line between the holes in the lugs and are each $11/16$ in. from the center. It is well to scribe the circles of these holes and lay out the spark plug hole in the middle of the remaining space above them. Bolt the head to face plate again with inlet valve hole centered. This may be done by bringing up the tail stock of lathe with a sharp center, or better by a center indicator if one is available. Drill a $1/2$ in. or $3/4$ in. hole and bore out to 1 in., which should be accurate. Shift the casting to center the exhaust valve hole, drill and bore in the same manner, to $1\ 1/32$ in. diameter. Set gears to 24 threads, and with a very sharp internal threading tool chase out the full thread. *Very* light cuts must be taken or the cast iron will crumble.

Again shift casting to spark plug hole, drill $1/2$ in. and bore out until $1/2$ in. standard pipe tap will enter. Tap to fit standard spark plug, which should screw in until flush on inside of head. A smaller size spark plug is sometimes used on motor cycle engines, and may well be fitted to this engine if it is obtainable.

The Piston may next be taken up. It consists of two parts beside the two rings. The outer shell is a piece of steel tubing and may be put on the wooden arbor

which is turned down for the purpose, and the ends squared up to proper length. The outside should be smoothly finished and an easy fit in the cylinder. A smooth file will probably do the work, but if much oversize, a light lathe cut should first be taken. It should be two or three thousandths of an inch smaller than the cylinder. A word here in regard to piston rings. While the amateur will be able to make them if sufficient time and care is used with proper methods, it does not pay to do so. They can be purchased at 25 or 30 cents each, and if this is to be done, they should be obtained before the piston is machined. The grooves may then be fitted to them.

The piston casting should first be center punched and drilled, one center being in the boss at the base and the other in the bridge that is cast between the jaws. A quarter inch hole is also drilled near the edge of the boss and a stud driven in. This is for driving the work, and should be long enough to go in the face plate slot. The outside of the jaw portion is to be turned to fit the shell, with an eighth-inch shoulder at the back end. The ring grooves are then cut in to match the rings. A parting tool may be used to rough them and then the sides finished smoothly and to an exact, but not tight, fit for the rings. The depth should

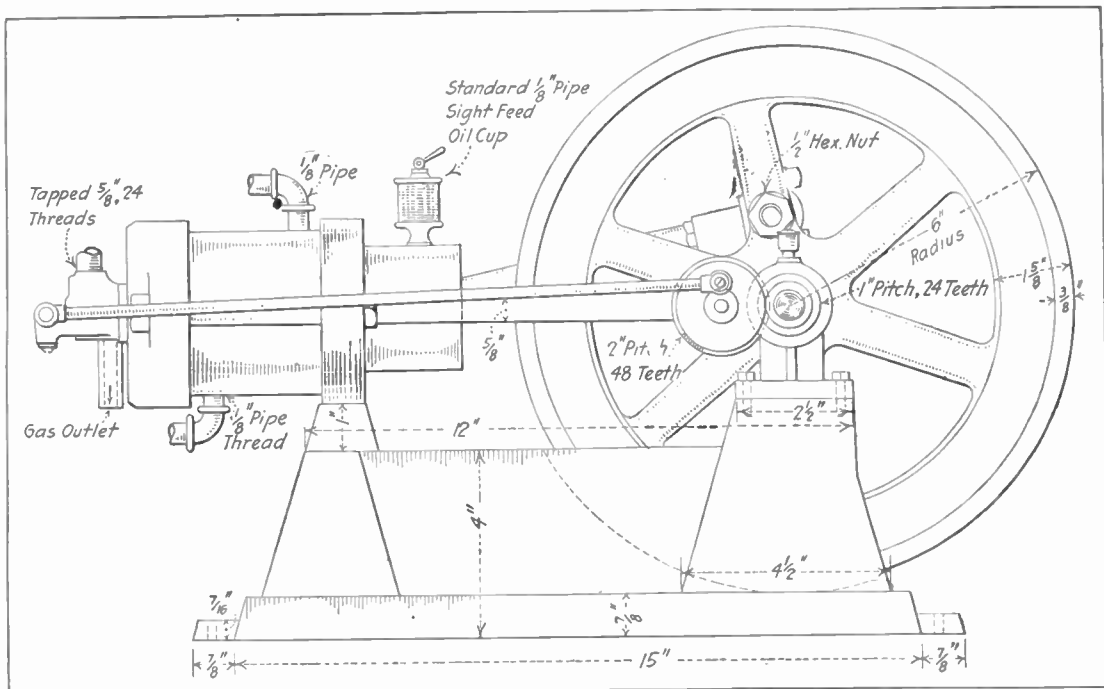


Fig. 11. Side view of assembled engine

be very slightly more than the greatest thickness of the rings. The outside of the casting should be an easy fit in the cylinder, say 8 or 10 thousandths small. The casting may now be reversed in the lathe, the stud removed, (driving by a face plate stud) and the base hollowed out as indicated. A small center may be left until the rest is done and then broken out.

If preferred the shell may be driven on and the whole held in a chuck for this process. The piston must now be clamped on the angle plate, base down and lined up by the bosses. The center should be $1\frac{7}{8}$ in. above the top of first ring groove, as indicated in drawing. Remember to put newspaper under work and also between the angle plate and the face plate, to prevent slipping. Spot the center, drill to $\frac{3}{8}$ in. or $7/16$ in. and bore to $31/64$ in. or until the end of a $\frac{1}{2}$ in. reamer will enter. Running lathe very slowly, put reamer through, taking care to keep it snugly against the back center. The shell of the bridge between the bosses may now be sawed out and a counterbore prepared for facing the inside of the same. This is simply a piece of $\frac{1}{2}$ in. cold rolled steel rod with a slot $\frac{1}{8}$ in. x $\frac{5}{8}$ in. drilled and filed through about $\frac{5}{8}$ in. from one end. A steel cutter is then prepared to fit in the slot, where it is held by a 10-24 screw tapped into the

end of the rod. The cutter may be made by grinding up a piece of an old flat file. One edge at least is to be ground straight and each end backed off for right hand cutting, leaving $\frac{1}{2}$ in. in the middle square for the set screw to bear on. It should be about $1\frac{1}{4}$ in. long. The steel rod is held in a drill chuck in the tail-stock, which is then brought up until rod enters the hole in the piston. The cutter is then inserted, screw set up, and one boss faced off. Reverse cutter and face opposite boss taking care to leave them of equal thickness, and the space between them $1\frac{1}{8}$ in. to fit the connecting rod. The piston may then be drilled and tapped for the screws that hold it in place. A piston pin is to be cut from $\frac{1}{2}$ in. cold rolled steel, the ends slightly rounded and finished to $2\frac{5}{11}$ in. in length. It should fit the hole in the piston rather tightly, and is held in place by the shell. Oil hole should be drilled in shell, and counter-sunk as indicated in drawing. A small brass tube leading to the oil hole in connecting rod is to be driven in when engine is assembled.

The Connecting Rod is built up of three separate pieces of bronze and a length of steel rod. The piston pin end may be first taken in hand. Hold in lathe chuck by the large end, center carefully, drill $7/16$ in. and bore true, large enough to let the end of the $\frac{1}{2}$

in. reamer enter. A spiral fluted reamer should be used for this purpose, or if a straight one it should have the sharp edges touched on the oilstone. If this is neglected, it will "chatter" and "grab," perhaps ruining the work. Ream at slow speed, then face off the casting. Remove from chuck, drive on an arbor and face off second side, leaving boss $1\frac{1}{8}$ in. thick. The casting is next to be bolted to the angle plate through the half inch hole, centered up by the long boss, which must be truly aligned by the use of a square on the face plate. Face off end of boss, center and drill $\frac{3}{8}$ in. in diameter 1 in. deep. Bore out to tapping diameter, which should be $\frac{7}{16}$ in., if a $\frac{1}{2}$ in. 24 thread tap is at hand. A standard 13 thread may be used, in which case the drilled hole is to be barely trued up. Tap out hole in the lathe, holding tap with a wrench resting on the tool post and feeding up with tailstock screw. The back gears should be used for drive, and the clutch or belt shipper only partly thrown over to avoid breaking the tap when it bottoms. It only remains to drill and countersink the oil hole as per drawing. This may well be deferred, however, until the rod is assembled.

The crank pin end, if cast in one piece, may be machined in much the same way. Hold in chuck, preferably a three jawed one, and drill the crank pin boss

$\frac{3}{8}$ in. diameter. Remove from chuck, lay out centers of bosses on each side for bolt holes. Drill half way through each boss with a quarter inch drill, from the top (outer) end. Finish with a No. 9 drill, and tap out $\frac{1}{4}$ in. 20 thread. Lay out the center line across the casting and cut apart with a thin saw. File the cut surfaces square and true, taking off, however, as little stock as possible. Put together with two $\frac{1}{4}$ in. cap screws which may well be slotted for a screw driver, however. This makes assembling a little more convenient. The split casting is now to be put back in the chuck, bored out, and a $\frac{3}{4}$ in. reamer put through. Face off front of boss, drive on arbor and face off the other side to 1 in. thickness. Mount on angle plate, drill, bore and tap in exactly the same way the piston pin end was done. The oil hole, which may be left until rod is assembled, is drilled to meet the inner end of tapped hole in boss, and another from the lower corner of the same hole, to the crank pin hole. The space between the steel rod and the brass may be loosely packed with cotton waste or felt to serve as an oil reservoir.

The steel rod is a piece of $\frac{5}{8}$ hexagon cold rolled steel cut $8\frac{1}{2}$ in. long centered, and $\frac{7}{8}$ in. at each end turned down to $\frac{1}{2}$ in. round. These ends may be partly threaded in the lathe, and finished with a die. Use 24 thread

if one is available. If not, finish in lathe, but leave large enough to screw in the bronze ends rather stiffly. The tailstock of the lathe is then set over and the rod turned tapering toward each end from the $\frac{3}{4}$ in. hexagonal portion left in the middle. Quarter inch hex collars are left at each end. The rod may next be screwed together. When set up tight, the crank pin hole and that in the piston end should be exactly parallel. Test by putting arbors on steel rods in the two holes and sighting for alignment. If they do not come exactly right, turn one shoulder of the steel rod back a trifle further. An idea of the amount to be taken off may be obtained in this way. The screw is 24 pitch. If the rod does not align nearer than 45 degrees, cut shoulder back .005 inch, that is $\frac{1}{8}$ of $\frac{1}{24}$ in., the pitch of the screw. If the difference is 90 degrees, .010 in. should be taken off. When perfectly aligned, the oil holes may be drilled, both in the upper side of the rod.

It may be well to put in a few words here in regard to the angle plate referred to in the description of the above operation.

No particular dimensions are required, but the following sizes will be found very convenient. Back 4 in. x 5 in., shelf $2\frac{1}{4}$ in. x 4 in. Back to have slots or holes which should be suitable for the face plate of the lathe on which it is to be used. The back and the

top of the shelf should be planed exactly at right angles. A half inch hole should be drilled in the shelf $\frac{5}{8}$ in. from the middle of the front edge. A steel bolt should be made $\frac{1}{2}$ in. diameter, 3 in. long with $\frac{3}{4}$ in. threaded; a bushing should also be made $1\frac{5}{16}$ in. long $\frac{1}{2}$ in. hole, and $\frac{3}{4}$ in. outside diameter for use in mounting the crank pin end of connecting rod, main bearings, etc.

The next instalment will take up the bed plate, bearings, side rods, main bearings, fly wheels and shaft.

(To be continued.)

FOR THE MOTORIST

If the tail-lamp glass breaks while you are on the road, buy some red tissue paper at a stationery or toy store, and either tie it around the lamp with a string or fit it into the frame which held the glass. This will answer very well temporarily, as there is no head draft on the lamp. Better still, if you can get a sheet of waxed paper such as is used to wrap around butter, grease and color it with red ink or dye and fasten on the lamp with a wire. This will do for head and dash-lamps, too—without coloring it, of course. If none of the pieces of glass are lost, you can sometimes make it hold together by means of adhesive plaster.

Contributed by F. H. SWEET.

THE ACTION OF THE AUDION DETECTOR*

BY MILTON B. SLEEPER

THERE has been much misunderstanding concerning the action of the Audion Detector, that it is necessary, before taking up the problems of its use, to describe the action taking place within the tube. It is unfortunate that so many infringements on the original patents of Dr. Lee de Forest have been brought out. With every infringement has come a new theory of action, until

show the principle involved in the *relay action* of this detector.

The Edison Effect, or one-way conductivity between a hot and cold electrode, was discovered by Thomas A. Edison in 1882. This effect was later investigated by Elster and Geitel, Sir William Preece, and Fleming. Fleming used the action as a rectifier for low frequency currents, but also applied it to the measurement of

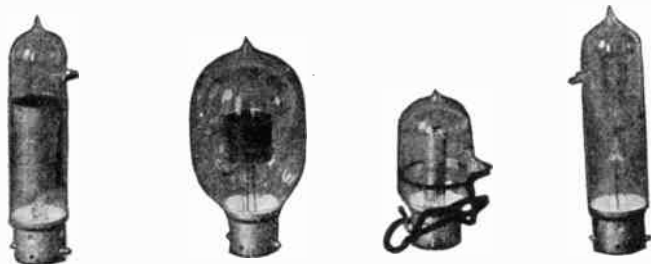


Fig. 1. A carbon filament and plate sealed in highly evacuated tubes were used by Fleming

at the present time, no authentic statement of the principle upon which the Audion works is available for the experimenters. From the information which follows, anyone can demonstrate for himself the phenomena taking place within the evacuated tube. The directions given in Part III, for operating the Audion also

high frequency currents. No attempt was made to use the rectifying action for commercial radio work, however, until after the discovery of the Audion detector by Dr. Lee de Forest, in 1906.

The first application of the evacuated tube to the detection of Hertzian waves was by Zehnder, recorded in "The Electrician," 1890. His tube had, in addition to the usual platinum electrodes, a pair of electrodes at right

* This is the first of a series of articles on the audion. Later ones will describe the various uses to which this unique device may be put.

angles, the ends of which were very close together. When a battery of 400 volts is connected in series with a high resistance and the tube, the potential can be adusted until a glow appears in the tube. If, however, a small discharge occurs between the transverse electrodes, the rarified gas in the tube becomes a conductor, and a much heavier discharge takes place in the tube. This is the real "trigger-action," although the term has been rather indefinitely applied to the operation of various types of tubes. This is also called a relay action, since a small amount of current controls a much larger quantity. Zehnder used his trigger-tube to make manifest, by the bright glowing, the presence of small sparks across the transverse electrodes.

J. A. Fleming described in the "Proceedings of the Royal Society of London," 1890, experiments which he carried on with a carbon filament and plate sealed in a highly evacuated tube, Fig. 1. Under ordinary conditions, no current can be passed from the filament to the plate. If the air is sufficiently exhausted even an induction coil will not discharge through the space. As was the case in Zehnder's trigger-tube, however, a current will flow when there is a glow in the tube, or, in Fleming's valve, the ionization is caused by the heated filament. Even a single cell will

send a current between the filament and plate if the negative pole is connected to the end of the filament which is joined to the negative side of the lighting battery. This device is, as Fleming calls it, an electrical valve, because it has a unilateral conductivity, and allows the current to pass through the vacuous space in only one direction, that is, from the filament to the plate. To demonstrate this phenomenon, he has connected a galvanometer in series with the secondary of a spark coil and the two elements of the valve. Ordinarily, the galvanometer would not be deflected by the alternating current from the secondary of a spark coil. However, the unilateral, or one way conductance in the tube, when the filament is lighted, allows the current to pass in only one direction, and the needle of the galvanometer is accordingly deflected by the pulsating, direct current. The current across the filament and plate does not vary with the impressed voltage in the circuit, but increases to a maximum, when the space is said to be saturated. The conductivity also rises to a maximum, and then decreases. The rectification, or unilateral conduction of the alternating current across the two enclosed elements *is dependent upon the temperature of the plate*; that is, the cooler the plate, the more marked is the pre-

ponderance of one-half of the cycle of the alternating current.

When used as a wireless detector, the valve is connected as in Fig. 2. The filament is of tungsten or carbon, while the plate or cylinder is of copper gauze or sheet. Usually a grounded copper gauze cover is put over the bulb to carry away any static charges which may collect on the glass, and decrease the sensitivity of the detector. The negative terminal of the filament is connected to the potentiometer and phones. It should be noted that the small fixed condenser in shunt with the phones is used only to increase the signal strength by discharging into the phones, as is the case with a crystal detector, and can be omitted without greatly effecting the results.

In 1908 the diagram in Fig 2 was used, for it was found that a current through the phones and tuner to the grid, greatly improved the original results, but it changed the action to that of the Audion detector, patented in 1906. If, in this circuit, a galvanometer is inserted in place of the phones, it shows a continual deflection which is decreased by the incoming signals, as is the case with the Audion detector.

The operating characteristics—the unilateral conduction of the incoming current across the vacuous space, the dependance of the rectification upon the temperature of the plate, the circuit used, and

the sensitivity of the valve, which, is no greater than a good crystal detector, should be kept in mind when comparing the action of the Fleming Valve with Dr. Lee de Forest's Audion Detector.

In 1900, Dr. de Forest found that heated gases, or gases immediately surrounding heated electrodes, are in a highly sensitive state which can be upset by the most minute electrical charges. Dr. de Forest believed that a wireless detector could be made, using this

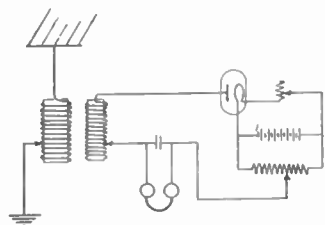


Fig. 2. Wiring diagram when valve is used as wireless detector

sensitive, heated gas. He made the first detector operating on the action of thermions from a heated electrode in 1903. The same action took place in the electric arc, but it was too noisy. Experiments were also made with a mercury vapor tube, and incandescent lamps. The first bulb detector ever used in commercial work was brought out by Dr. de Forest in 1905. It consisted of a tantalum filament and platinum plate, operated by a lighting battery, and a high-voltage battery to break

down the resistance in the bulb, a feature not included in Fleming's original patents.

The grid was added in 1906. This was first outside the bulb, but louder signals were obtained with the grid inside, as it is now used. Since then, every Audion, no matter what the name, has the essential features of the original—heated filament, grid, plate, and high-voltage battery. The grid is used in every form of detector, amplifier, and oscillator. This feature makes it unfair to call any of these types *valves*, for no valve or rectifier action is involved.

It is unnecessary to discuss the numerous infringements on the de Forest Audion, as it is so evident that they cannot, because of their construction, work on any principle different from that of the original Audion, whether of the bulb or tube type. The first distinctive characteristic is the use of a grid in addition to the filament and plate. It is upon this addition that the Audion action depends.

Fig. 3 gives the circuit of the Audion, and illustrates the phenomenon which takes place in the bulb or tube. The negative ions, or "thermions," given off by the heated filament, pass through the grid to the plate. The high-voltage, or "B" battery, connected to the filament and plate, with the negative side joined to the filament, supplies the potential neces-

sary to break down the resistance across the vacuum. It is ordinarily supposed that the negative ions carry a current from filament to plate, and allow the current to flow in one direction only, as in the Fleming valve, but the alternating current impressed upon the antenna is not rectified, as will be shown. As a matter of fact, a current is continually flowing through the phones, but when the high frequency current is conducted to the grid, the amount of current carried by the electrically charged ions is varied, as the ions are scattered, retarded, or repelled by the charge on the grid. This action is remarkably forceful, for a unit charge on the grid will divert ten to one hundred unit charges which would normally pass during that time from cathode to anode in the telephone circuit. This is a *relay action*, for a slight current from the antenna circuit controls a much larger current through the phone.

The absence of any *valve action* is shown by the fact that the Audion circuit includes a stopping condenser connected to the grid, which, if used in the plate circuit of the valve—there is nothing in the valve to correspond to the grid of the Audion—*prevents all rectification*. Moreover, a galvanometer in the grid circuit shows no deflection, for the stopping condenser prevents any rectification.

The rectification of the Fleming

valve depends upon the low temperature of the plate, but experiments by the De Forest Company show that the Audion action is unaffected even though the three elements, plate, grid, and filament, are heated to incandescence. This alone shows that there is no similarity between the Audion action and valve action. Moreover, the different methods of connection, and the signal intensity, which is many times greater than with the valve, makes it evident that the principles involved in the two instruments must be entirely different.

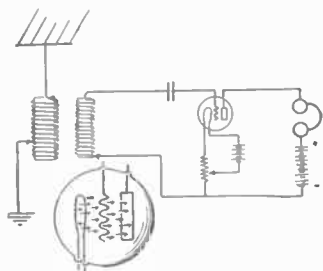


Fig. 3. Audion circuit, illustrating action in bulb

There are three other uses of the de Forest Audion, to which the Fleming valve cannot be put—that is, the reception of undamped waves, the generation of undamped oscillations for wireless telephony and telegraphy, and the amplification of the most minute currents and signals. It is the de Forest Amplifier which

has made possible the transcontinental telephone.

The use of the Audion as a detector for radio signals, and the other applications just mentioned, will be taken up in the series of articles to follow.

CLEANING FLUID FOR MIRRORS, ETC.

Take a soft sponge, wash it well in clean water, and squeeze as dry as possible; dip it into some spirits of wine and rub over the glass; then have some powdered blue tied up in a rag, dust it over your glass, and rub it lightly and quickly with a soft cloth; afterward finish with a silk handkerchief.

Contributed by H. G. FRANK.

BANANA OIL.

Banana oil or turpentine can be used effectively for pasting tin-foil on transmitting condensers.

Contributed by H. G. FRANK.

NOVEL METHOD FOR HEATING WATER

Recently an electrician, who had an all-important job on hand, needed some hot water in a jiffy.

Being without necessary means, he connected up an electric soldering iron and stuck the point of the iron in the water, which became heated instantly and without injury to the iron.

Contributed by H. G. FRANK.

CONSTRUCTION OF A MODEL SUBMARINE WITH WIRELESS CONTROL

PART VI. THE DECK, SUPERSTRUCTURE, CONNING TOWER, AND WIRELESS AERIAL EQUIPMENT

BY THE LABORATORY STAFF

READERS who have followed this series from the beginning will recall that the hull is built up of a number of planks of wood worked down to shape by means of a drawknife. The

structure at points occupied by the hatches through which access is gained to the interior of the hull, thus exposing the various devices which control and propel the vessel. Fig. 4 gives the de-

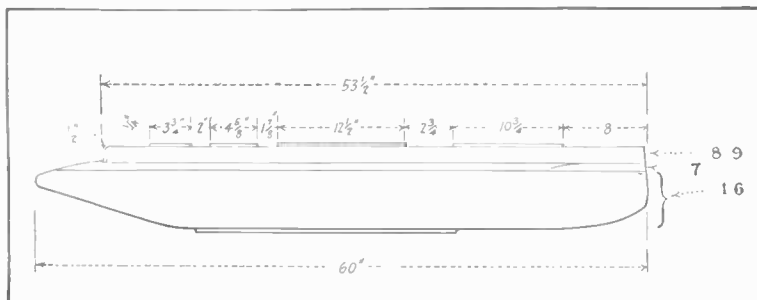


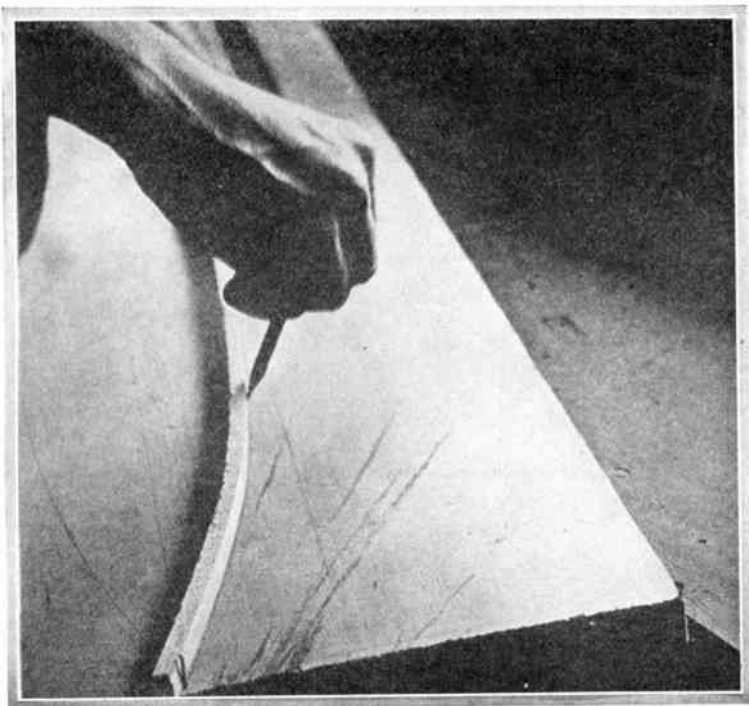
Fig. 1. Profile of hull and dimensions of hatches

deck follows this general scheme and Fig. 1 gives a good idea of the proportions. From this drawing the reader will note that the deck constitutes the No. 7 plank while the superstructure is composed of planks Nos. 8 and 9. Full dimensions and details of the deck and superstructure are given in Fig. 2.

For the sake of clearness, enlarged details are given in Figs. 3, 4 and 5. The first mentioned shows sections through the super-

tail of the conning tower and periscope housing. Fig. 5 covers the wireless masts, aerial spreaders, insulators, and the lead-in insulator, and also the two periscopes, which are really the only features in the entire craft that are not working devices.

The photographs give an idea of how the deck was marked off and worked out in the shop. The long and graceful curve can best be made by means of a thin strip of wood which will stand the re-



How the curves are laid out on the planks

quired degree of bending. A small brad here and there will hold it in place while the pencil is used.

In working down the deck and superstructure, the drawknife was freely used to rough out the design and the finishing touches given with a spokeshave, which tool incorporates all of the desirable features of a plane with the flexibility of the drawknife. First coarse and then fine sandpaper finished the job.

The conning tower and periscope housing were roughed out with the drawknife and finished to the desired shape by grinding on a sandpaper wheel. This tool is made by securing a sheet of medium sandpaper to a large disc of wood on the spindle of the grinder. It is one of the most useful of all of our special rigs for quickly and neatly finishing woodwork to peculiar shapes.

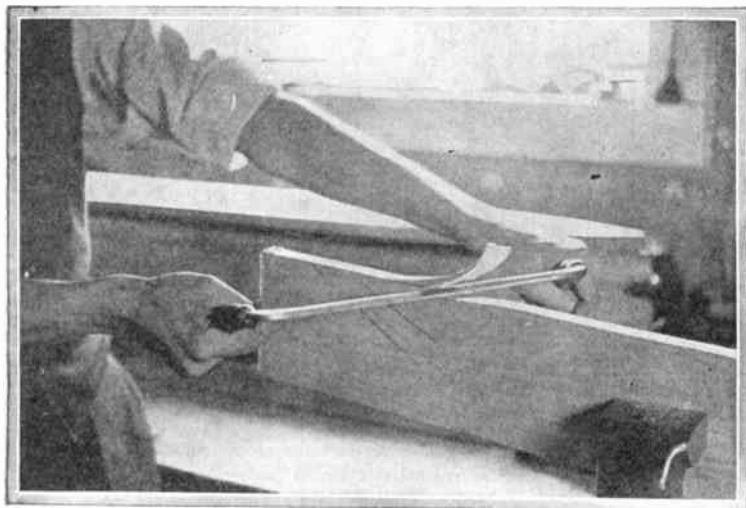
The hatches covering the openings in the superstructure are of

thin wood screwed to the deck with a gasket of rubber packing between. A metallic hatch would be neater and better, but the wooden ones appear to answer the purpose.

The deck proper is secured to the hull by means of a series of

offers the careful and ingenious workman an opportunity to exercise his skill, however, in a manner which may be productive of the most gratifying results.

The masts are pieces of $\frac{3}{8}$ in. dowel rod worked down in the lathe to a graceful taper. We



Cutting to the curve with a draw-knife

round head brass screws. A rubber gasket the entire length of the hull makes the joint watertight and this arrangement makes it possible to remove the entire deck and superstructure for demonstration or extensive repairs when necessary.

THE WIRELESS RIGGING

The rigging of the wireless aerial is an interesting but somewhat delicate piece of work. It

secured a nice color and finish on our masts by rubbing them with a cloth dipped in coal tar and then cleaning practically all of the tar off. This stained the wood a rich brown and after we had given it a coat of spar varnish, the effect was quite remarkable. Right here, perhaps we might let the reader in on a little joke on us. The coal tar finish was not premeditated! Coal tar

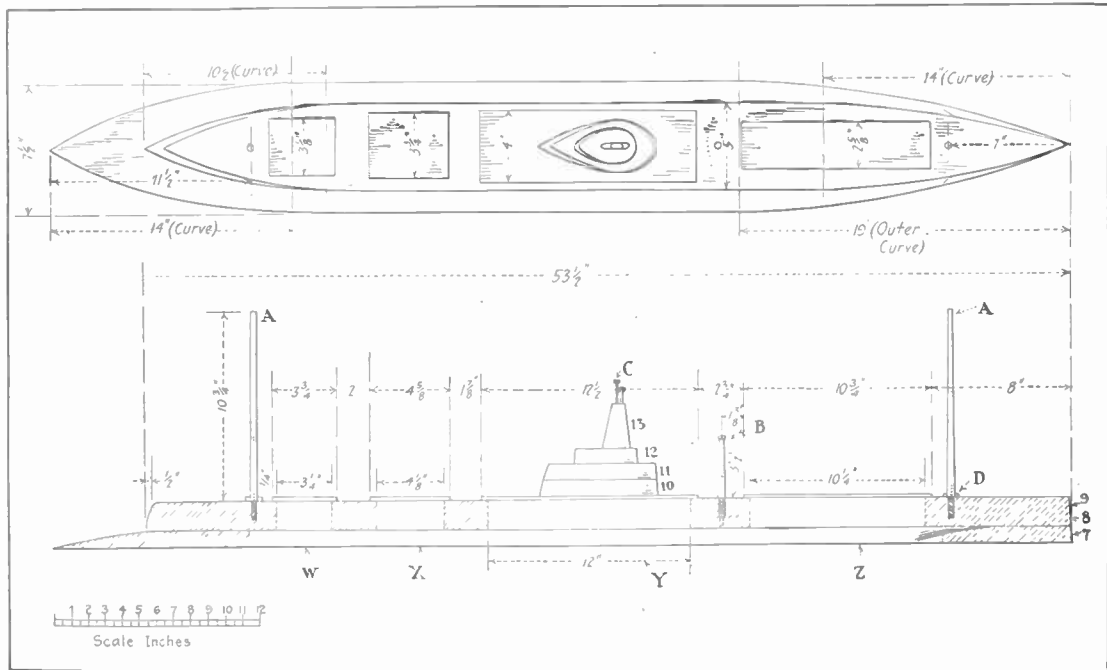


Fig. 2. Assembled superstructure with dimensions of hatch openings

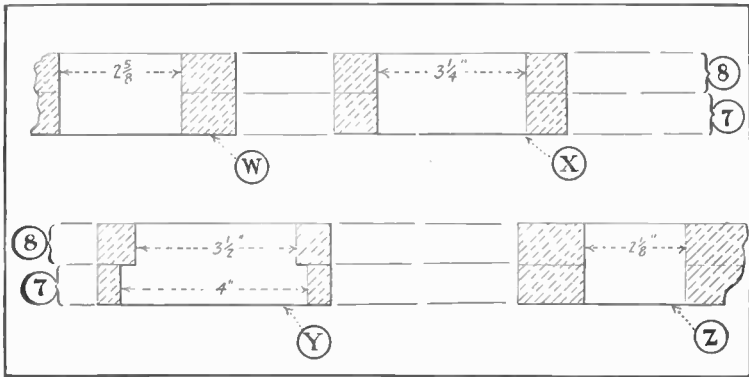


Fig. 3. Cross sections of various hatches looking from bow to stern

bears a most annoying resemblance to that all-around compound asphaltum. The latter dries quickly and as hard as varnish with a glossy black. When our masts were painted we (whisper) thought we were using asphaltum! But when the coat was not dry after several hours of patient waiting we found we had taken our compound out of the coal tar crock. In desperation we wiped the sticky mass off of our little masts and, behold, a beautiful chestnut brown wood was the result. So you see we do the same stunts that you do once in a while.

The guys for the masts are of strong linen thread well worked through beeswax. The spreaders are made from lengths of 3/16 in. dowel, turned to the shape indicated in Fig. 5. The insulators for the antenna were turned from the same size of rod

while the eyes in the insulators are bent from a piece of soft galvanized iron wire passed right through the insulator. The aerial suspension is of the same linen thread used for the guys. This gives sufficient insulation so that the fact that the "insulators" themselves are for appearances' sake only is of small consequence.

The aerial is of two bare copper wires tightly stretched. The lead-in is brought from near the forward end of the aerial to the lead-in insulator in the superstructure. This latter is a piece of the 3/8 in. dowel with a hole through its center. We had no drill long enough to pass through and did not want to solder an extension to a drill for this one job, so we drilled from both ends, holding the dowel in the chuck in each case and the drill chuck in the tailstock. The turning was

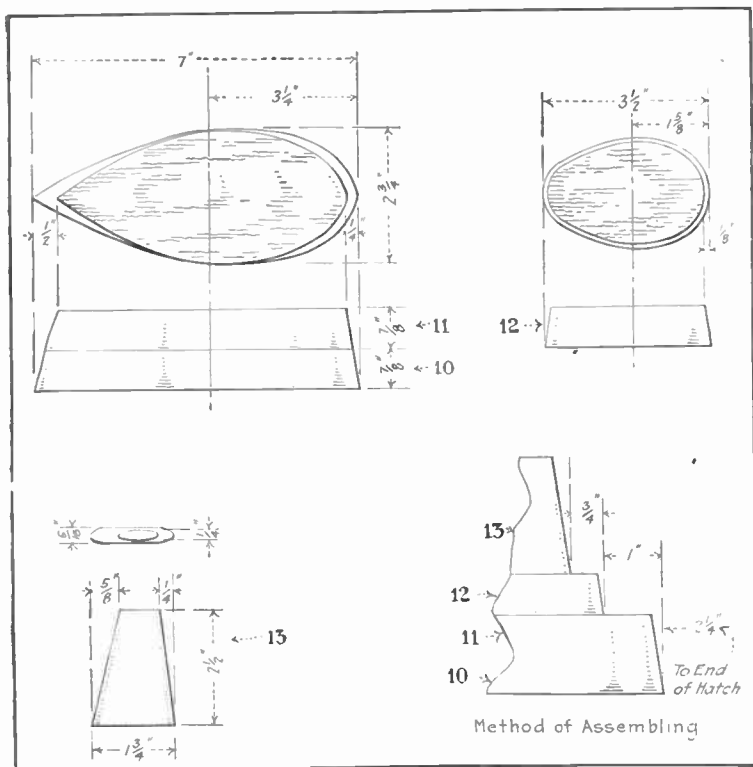


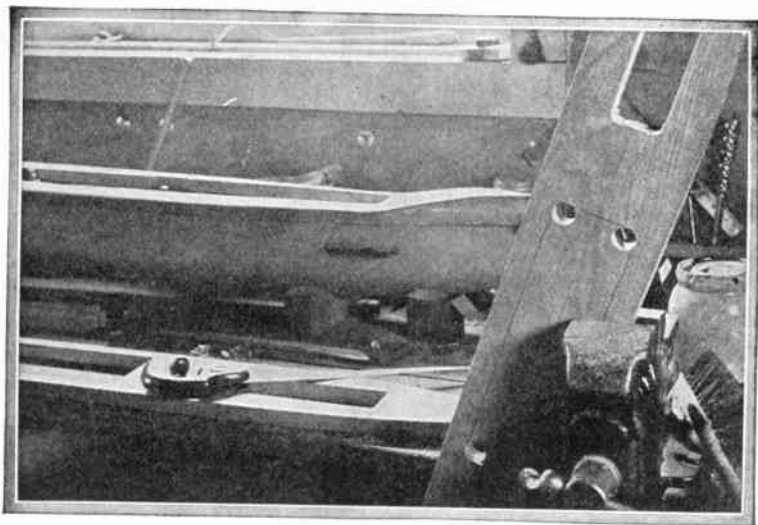
Fig. 4. The conning tower

done after the hole was in, so that one end could be used for a center.

The aerial lead-in is enclosed in a piece of very small rubber tubing after it enters the deck and from that point it goes to one side of the coherer. The other side of the coherer is connected with the lead keel outside the hull.

CONCLUDING REMARKS

For some time we have promised you a description of the automatic torpedo which propels itself away from the boat and fires a charge out of its head at a predetermined point. This promise has called forth such a storm of protest from the parents of many of our readers that we feel compelled to forego the descrip-



How the openings are cut through the planks

tion in the columns of the magazine. It must be admitted that the explosive torpedo is a dangerous toy in the hands of one who is inclined to be careless or negligent, for the little wad of wax in the end could readily put one's eye out. In view of all this, we shall not describe the torpedo as originally planned and will merely suggest here that a dummy be used in the tube and fired by means of the compressed air. To readers who feel that they are safe in handling the explosive torpedo and who can assure the Editor that they are sufficiently matured mechanics to operate such a device, we will forward drawings and a description of the mechanism on receipt

of a stamped, self-addressed envelope enclosed with the request to The Laboratory Staff, *Everyday Mechanics*, 33 West 42nd Street, New York City. There is no other charge for this and we trust our readers will understand our situation in refraining from publishing this data.

THE TRANSMITTER

The controlling transmitter may be a small spark coil of the ignition variety or preferably of the true wireless type. A single wire extending into the air four or five feet is ample for the transmitting antenna, where the distance is but a few hundred feet.

We have obtained best results when we used a condenser in the oscillating circuit in conjunction

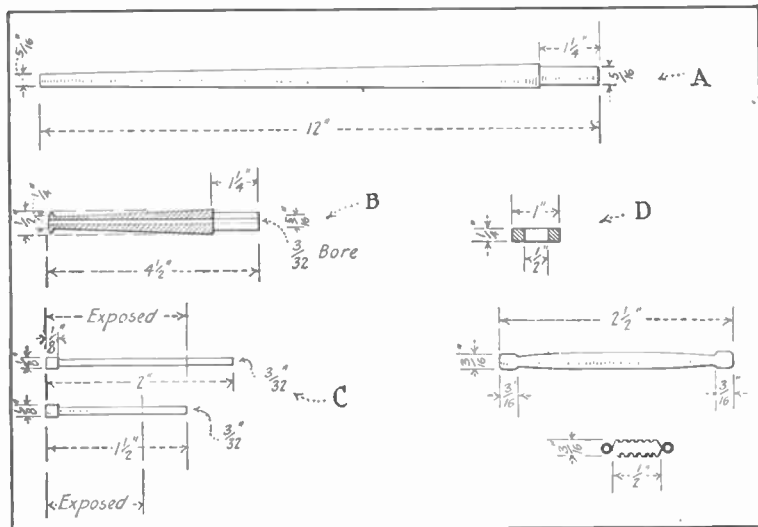


Fig. 5. The masts, lead-in, periscope, insulators and washers

with a simple open spark gap. No helix or other tuning appliance was used. The condenser was shunted across the coil secondary and the gap across the condenser. One side of the gap went to ground and the other to the wire forming the aerial. This arrangement with a one-inch wireless coil has given us reliable control at a distance of three hundred feet.

SELECTIVE CONTROL

Selective control is possible, but not desirable in a model as small as this. By increasing the hull length to perhaps eight feet, a selective controller may readily be applied in order that the vessel may be made to respond to any

direction at will without having to go through a prescribed series of evolutions. If sufficient interest is manifested in such a control, an article will be published later giving the construction details.

In concluding this series, we will merely remind the reader that the Technical Adviser is at his service and anything that has not been made clear in the articles will be supplemented by explanations in The Technical Adviser section of the magazine.

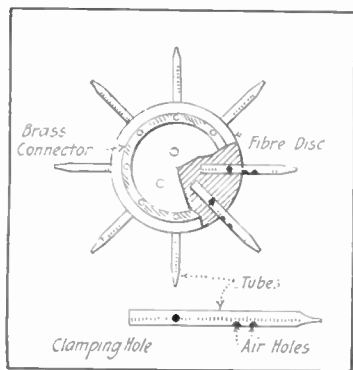
To prevent cracking the celluloid in the window of your car front, cover it with paper before you roll up the curtain.

A TURBINE ROTARY GAP

BY THOS. W. BENSON

A ROTARY gap of unique design is described here, and should be of interest to every experimenter in radiotelegraphy.

Referring to the illustration, the hub of the rotating electrodes consists of a disk of fibre 3 in. in diameter and $\frac{3}{4}$ in. thick.



The electrodes are made of copper tubing

Three equally spaced holes are drilled near the center to pass the screws used to clamp the wheel to the motor shaft. To mount the electrodes, eight equally spaced holes are drilled radially around the disk; these holes are 1 in. deep and $\frac{1}{4}$ in. in diameter.

The electrodes proper consist of $2\frac{1}{4}$ in. lengths of copper tubing $\frac{1}{2}$ in. outside diameter. One

end of each of these tubes is pressed flat in a vise, leaving a thin, narrow slit. Half way down the length of the tube two or three large holes are drilled at right angles to the plane of the flattened end.

The tubes are then slipped into the holes around the edge of the fibre disk and, after adjusting them carefully, so that all extend the same distance, they are fastened into place by drilling holes through the disk and tubes, in which are placed short bolts. A length of stranded cable is then soldered to the heads of these bolts to connect them all together.

If properly assembled with all the holes in the sides of the tubes facing the direction of rotation of the wheel, the principle will be easily understood.

As the wheel is driven at high speed, air will enter the holes in the sides of the tubes and, due to centrifugal action, will flow out the slits at the ends of the tubes. The air blast so formed will aid in quenching the spark, and enable it to be shortened to an appreciable extent with a decrease in damping in the circuit.

The stationary electrodes may also be made of tubing with one end flattened. Any hook-up may be used.

The gap being light, it will start quickly, run quietly, stop suddenly, and cut down the deceleration.

SOME PRACTICAL WARNINGS

When leaving a car standing on an asphalted street, look about carefully to see if any repairs are being made to the surface. It is very possible, in such a case, that the workmen may be using a petroleum heating apparatus that is used to soften the asphalt, and as such men are not infrequently both ignorant and careless, the tires and paint of the car may be ruined. It is also possible that a slight leakage of gasoline may be ignited and the complete destruction of the car follow. It has often happened. The heat generated by these heaters is very intense, and the air blast throws it ahead a considerable distance.

In taking the car up a sloping way leading over the sidewalk, for instance, or over any considerable obstruction, it is well to strike the high place at an angle, if possible, so that one front wheel will roll up and then the other, and the same with the rear wheels. In this way, whatever jolt there is will be divided up into four comparatively slight shocks instead of being concentrated into two as the two pairs of wheels strike the bump.

The same principle applies, of course, to crossing thank-you-ma'ams in country roads. If a thank-you-ma'am is taken at an angle the car will go over with a twisting roll, like a boat taking a sea on the quarter, and the jolt will be less unpleasant to the occupants of the car and less racking on the machine itself. In passing over a high obstruction of any kind, great care should be taken that there is sufficient clearance for the lower parts of the car to get safely over. A narrow ridge in a road, for instance, may be high enough, when the front wheels have passed over and the rear wheels have not, to catch the fly-wheel, or the pan, or the differential case, whereas, if the obstruction were wide enough for the car to stand with all four wheels upon it, there would be an ample clearance in running up one side and down the other.

Contributed by F. H. SWEET.

TO CLEAN AND TIGHTEN CANE-SEAT CHAIRS

Turn up the chair bottom, and with hot water and a sponge wash the cane-work so that it may be thoroughly soaked. Should it be dirty, use a little soap. Let it dry in the air and it will be as tight and firm as when new, provided the cane was not broken.

Contributed by H. G. FRANK.

Everyday Chemistry

HOW TO DETECT HYPO IN FINISHING PHOTOS

By A. D. CURTIS

ALL photographers realize the importance of removing every trace of hypo (hyposulphite of soda) from their negatives and prints. Usually they wash their negatives for a length of time in running water, and then "trust to luck" that all the hypo has been removed. But photography is a science, and luck and science are not close friends. Here is a method by which the faintest trace of sodium hyposulphite may be detected.

Place a small quantity of the suspected "bath" in a test-tube, and add a few drops of hydrochloric acid.

Into this mixture now drop two or three pieces of zinc.

Now, if there is any hypo in the suspected water, the sulphur of the chemical will desert the sodium and unite with the hydrogen evolved by the zinc and acid, forming hydrogen sulphide. By holding a strip of filter paper wet with a solution of lead acetate and water in the mouth of the test-tube, a very minute quantity of hydrogen sulphide will betray its presence by giving the filter-paper the characteristic brown-black hue of lead sulphide.

PURIFYING BEESWAX

Melt the wax, slowly bringing it to the boiling point. At the same time beat a fresh egg and add it to the boiling wax, stirring continually until the egg is thoroughly cooked. Pour the mixture through cheesecloth, and the egg and impurities will be separated from the pure wax.

Contributed by V. CARUSO.

To collect quicksilver which has fallen on the floor, pour a little water over the surface of the quicksilver and collect it with a piece of stiff paper.—V. CARUSO.

HAND CLEANSER

A very good hand cleanser to remove asphaltum, ink or any heavy dirt or grease without injuring the skin, is to slice one cake of naphtha soap into two quarts of boiling water. Add one box soap powder and allow to cool. Then add one medium sized cigar box full of white or beach sand with one pound of lard.—

EMMA F. MURRAY.

THE WOODWORKER

PART IV

BY RALPH F. WINDOES

Instructor of Manual Training, Davenport High School, Davenport, Ia.

TOOLS are classified according to their use and character, *i.e.*, "measuring and marking tools" alone, "edge tools," etc. Although each group is usually dependent upon the others to complete a given work, we will con-

sider, in this installment, the measuring and marking tools alone.

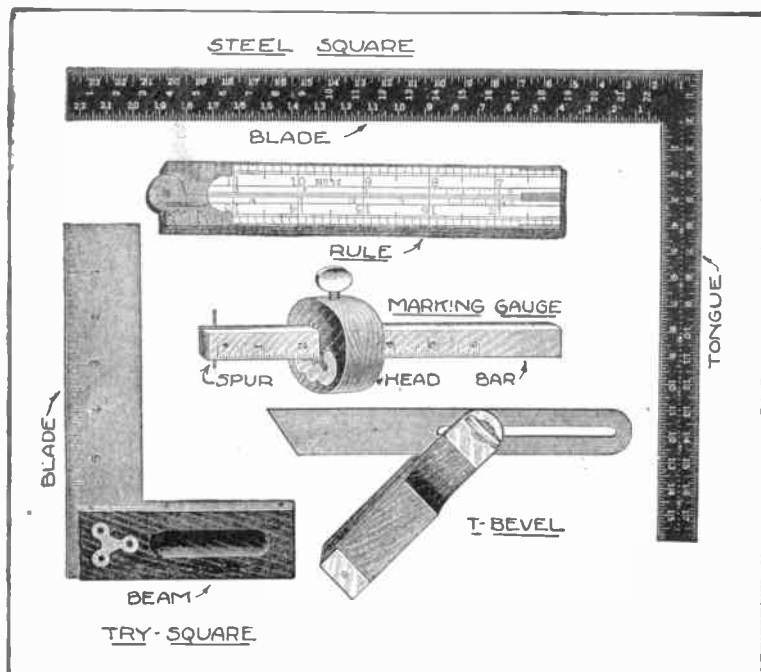


Fig. 14. Measuring and marking tools

tools." "edge tools," etc. Although each group is usually dependent upon the others to complete a given work, we will con-

Fig. 14 illustrates the common measuring and marking tools found in the cabinet-maker's kit. the steel square, the try-square,

the T-bevel, the rule, and the marking gauge.

THE RULE

The 2-foot rule may be of the four-fold carpenter's type, as illustrated, or of the two-fold

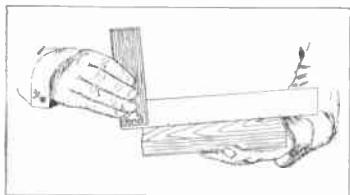


Fig. 16. Testing for straightness with the grain

bench type, which is better for cabinet work. It is used for measuring and "thumb gauging," which will be considered in a future chapter. When measuring, the rule should be tipped on edge, Fig. 15, and the measurements taken off exact with the

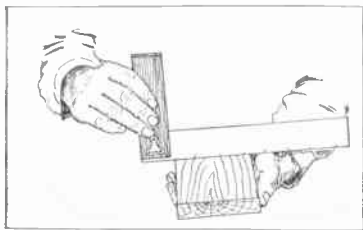


Fig. 17. Testing across the grain

point of a knife. For *very accurate* measurements, do not use the extreme end of the rule, but start the dimension in an inch or two from the end. When laying

off a series of dimensions, do not move the rule from one to the next, but prick them off as it stands in one position.

THE STEEL SQUARE

The steel square, in cabinet making, is used to square lines and test ends on wide pieces, and to test for straightness on long ones. Its special uses will come up later.

THE TRY-SQUARE

The try-square is, perhaps, the most useful laying-out and test-

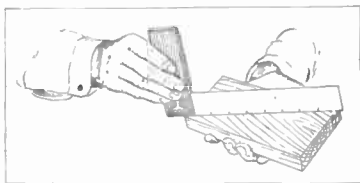


Fig. 18. Testing for wind in the surface

ing tool in the kit. Its duties are many, but only those of testing will now be explained in detail.

If we are planning one surface of a rough piece of stock, our one aim is to get the surface perfectly *flat*. By that, we mean perfectly straight across the grain, perfectly straight with the grain, and perfectly straight on the diagonals, or "out of wind," as it is called.

How we *plane* the surface will come up later, but how we *test* it

will now be given. It is assumed that we have a small piece of stock, say $\frac{3}{4}$ in. x 4 in. x 8 in. The position illustrated in Fig. 16 is correct when testing for straightness *with the grain*. Looking *toward the light* with the eye on

lar to the surface. In a similar manner, test it for straightness *across the grain*, sliding the square from end to end, Fig. 17, and on the diagonals, Fig. 18. This latter test is known as the "test for wind," and should be

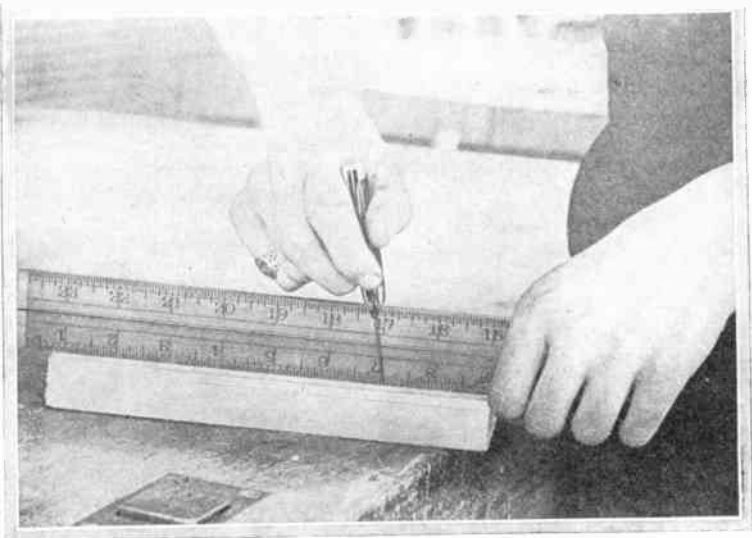


Fig. 15. When measuring, the rule should be tipped on edge

a level with the surface of the board, we should find the straight edge of the square touching the surface *evenly*. If it is touching in spots, or the ends of the board drop out from under, then it will be necessary to plane a trifle more. Test the entire width by sliding the square from edge to edge, keeping it constantly parallel to the edges, and perpendicu-

made on both diagonals. If the piece is too long for this test, the steel square can be used in this manner. If too long for the steel square, "winding sticks" can be employed, as explained in a future lesson.

If this surface checks up accurately, an edge is planed at right angles to it. This edge should be straight as to length,

testing as before, and *square* with the finished face. Fig. 19. The inside face of the beam is always held against the face first planed,

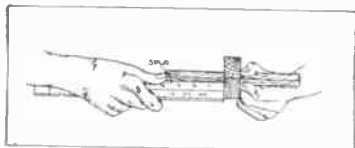


Fig. 20. Set the gauge with the rule when testing an edge for squareness.

THE T-BEVEL

The T-bevel is used in a manner similar to the try-square. The blade is adjustable for various angles. When testing an edge it is held exactly as the try-square is held, but its greatest use is found in laying out processes.

THE MARKING GAUGE

Gauging is a difficult process for beginners, yet, in reality, it

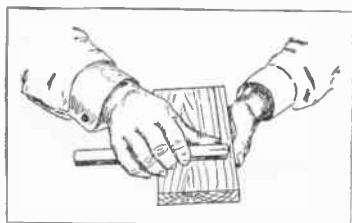


Fig. 21. Gauge for width

is one of the most simple if approached in a careful manner. Examine the gauge before setting

it. The spur should be filed rather sharp to a wedge point parallel with the head. It should project out from the bar about $\frac{1}{8}$ in.

The scale on the gauge, although in rare cases it will be found accurate, is unreliable, and the gauge should be set with the rule. Place the end of the rule against the head, and run the head out until the edge of the spur splits the mark of the desired dimension. Tighten the screw and test again with the rule. Fig. 20, as sometimes the

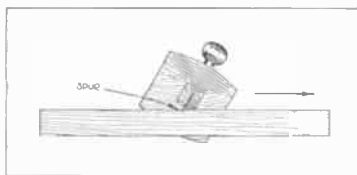


Fig. 22. The lower corner of the bar should rest on the surface of the stock evenly

dimension is accidentally changed when tightening.

Holding the board in the left hand, place the head of the gauge, held in the right, against the edge already planed. Start from the end nearest you and push the gauge ahead, holding the thumb opposite the spur. Fig. 21, *dragging the point*. The lower corner of the bar should rest flat on the surface of the wood, Fig. 22.

Push *in* and *ahead* at the same time, using considerable force, and gauging slowly and carefully. Watch the point, and if you find

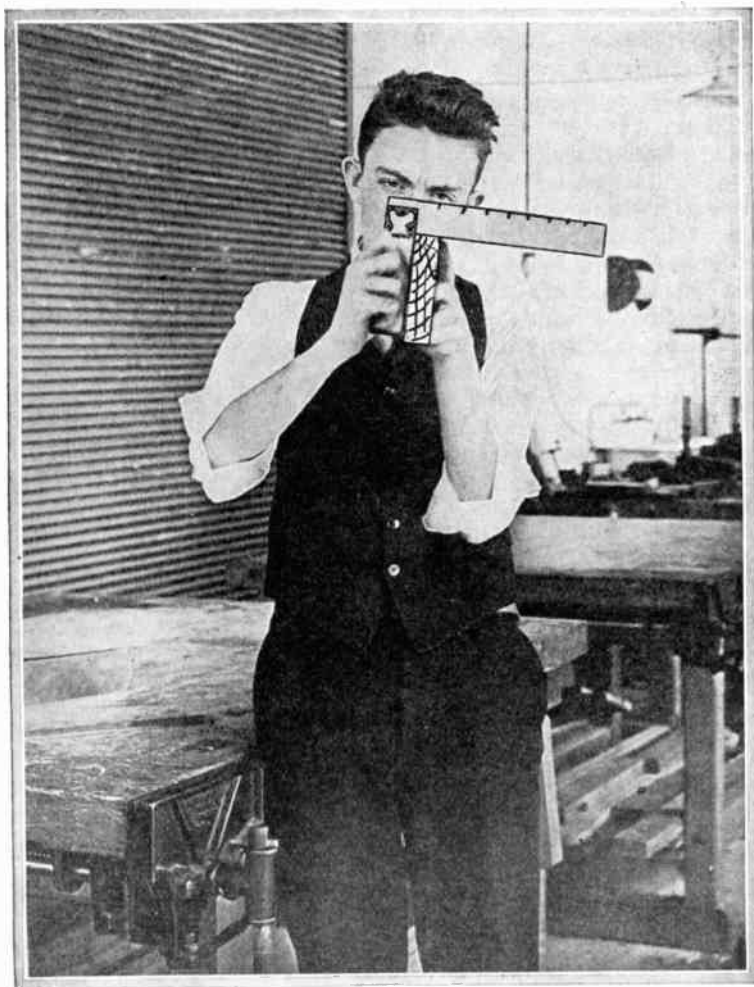


Fig. 19. Testing the "square" edge

it deviating from a straight line.
stop and find the trouble.

If a deep cut is desired, go over
the line a number of times rather

than endeavor to secure great depth at once.

TO THE BEGINNER

This lesson presents no construction, but its explanations must be clearly understood. It is suggested that the measuring and marking tools be placed on the bench top, and given a trial. For example, secure a board of small dimensions, and test its surfaces for straightness with the grain, across the grain, for "wind," and square edges. Repeat with a large piece, using the steel square. Set the gauge for $\frac{1}{2}$ in., and gauge a line around the piece. Set it over to 1 in., $1\frac{1}{2}$ in., etc., and gauge a series of lines. Success in gauging is due entirely to carefulness and practice.

In the next chapter, the use of these tools in connection with planing will be given.

(To be continued.)

SCULLERY PAINT WORK.

When cleaning scullery paint work, which naturally becomes very greasy from gas fumes, use a clean rag soaked in paraffin. It will not only remove all the grease and dirt, but revive the color. It is much better than scrubbing with soap, and the labor is lessened materially.

Contributed by MARY F. SCOTT.

A NEW USE FOR SHOE-STRINGS

Consider the humble shoe-string. Its uses are varied, yet

how many think of using it for any other purpose than to lace their boots or perhaps tie up a parcel.

But here is a new use. If you have a small rubber tube, electric light cord, or anything of a similar nature that you wish to cover with a flexible woven covering, get a shoe-string. But it must be one of the tubular woven kind. First cut off the metal tips on each end of the string and spread open the fabric. Now, in the case of an electric light cord, all that is needed is to *push* the hollow string into it. Pushing the string opens the weave, while pulling closes it down tight.

In covering a rubber tube a tight-fitting wire must be inserted into one end of it to serve as a guide, the shoe string to be pushed on this guide. The results are very gratifying.

Contributed by FRANK L. MATTER.

HOLDING ONE CHUCK WITHIN ANOTHER

Having some hexagonal stock to machine, and finding that the only chuck to fit the lathe was a four-jawed one, the idea was suggested to hold a dividing head chuck in the lathe chuck. This was a three-jawed universal chuck, and the work was centered fairly accurately.

Contributed by C. H. ANDERSON.

DESIGN AND CONSTRUCTION OF AN ALTERNATING CURRENT GENERATOR

$\frac{3}{4}$ KILOWATT OUTPUT, SINGLE PHASE, 110 VOLTS,
7 AMPERES, 1,800 R. P. M.

PART II

BY A. E. WATSON, E.E.

Professor of Electrical Engineering in Brown University

THE largest lathe job will be the boring out of the field, and for this the same sort of fixtures and tools are needed as for boring out an engine cylinder. If the lathe is sufficiently large, *i. e.*, has a swing over the carriage of $6\frac{1}{4}$ in. or more, the assembled field magnet and base may be mounted in an easy manner, the progression of the tool, or the "feed," being the same as for ordinary turning. Any smaller lathe must have at least the full $6\frac{1}{4}$ in. clearance over the bed, and then the dynamo must be fastened to the ways, and a boring tool with a traveling head employed. The seats for the pedestals are to be finished to the same diameter, it being more important to have these seats smooth and true than the face of the poles. The finished diameter is to be $5\frac{1}{8}$ in.

Castings for the pedestals are to be chucked, bored and reamed to $1\frac{1}{8}$ in. in diameter. They are then to be driven on an arbor and the bottoms turned off to the diameter of the field just bored.

As the circle is not complete, ordinary calipering will be impossible, so an indirect, though accurate, substitute measuring will be needed. To do this, some pulley or other casting or even a disc of wood may be turned in the lathe until it just fits the field bore, then with the same setting of the tool the final chip may be taken from the pedestals. One internal edge is to be finished, the one against which the shoulder of the bearing lining rests, and if this operation was not possible during the first chucking, some special provision must now be made. It may be accurately, though awkwardly, accomplished by mounting the casting part way on one end of a piece of 1 $\frac{1}{2}$ in. shafting, the latter supported close to the casting in the three-armed back-rest, the other end in the lathe chuck. By this means the casting runs reasonably true, and the desired access is secured to the surface to be machined. In addition, any irregularity in the outer lip of the casting can readily be removed at this set-

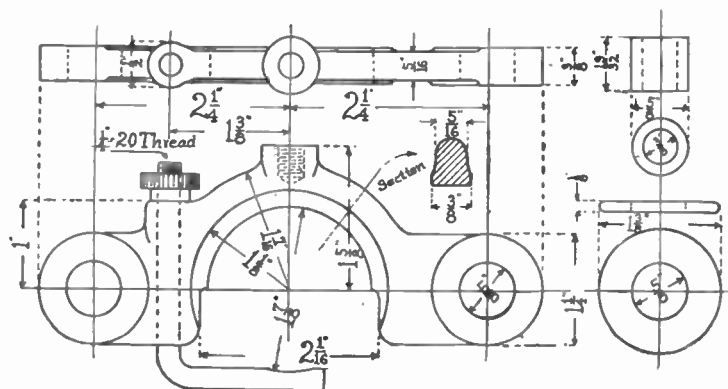


Fig. 7. Brush holder, yoke and insulation

plate. At this one setting the three central surfaces should be machined, the $1\frac{3}{8}$ -in. semicircle and the two adjacent belts, therefore, bringing the two latter exactly parallel to each other. While it is not imperative to machine the faces at the ends against which the insulation is to rest, it can be done. Certain projecting parts of the casting may prevent the tool from reaching the very inner edge of these faces, but by "pumping" the lathe in short strokes, or by use of a file, the metal can be removed. Reversing the castings permits the other side of these faces to be reached.

The bearing linings are made of the best procurable bronze, and can have the central holes cored to within $1/16$ in. of the finished dimensions, $\frac{7}{8}$ in. They are to be chucked, bored and reamed,

then put on an arbor and turned to fit the reamed holes in the pedestals. A fit that will permit ready removal by hand, rather than a drive fit, is desirable. The gash for the oiling ring is to be cut across the upper portion, and the oil-grooves provided. This latter operation, though highly important, is not particularly easy, one good method being to make a hooked tool from an old file, and to take the cut on the pulling stroke rather than pushing, as with a chisel; quite a number of cuts or scrapings being needed to secure the desired depth. The sharp edge of metal at the junction of the gash and grooves should be cut away, leaving a sort of pocket into which the oil, as it is left on the shaft by the slowly running ring, will pass and then follow along the whole length to be lubricated.

This type of bearing has been proved to be the most reliable and cheapest ever devised, but its success is largely dependent upon the consideration of this free flow. To prevent the bearing-lining from rotating a blind set-screw is to be used as shown, care being taken to see that there is no possibility of the end reaching the shaft. Oil covers are of brass, and for appearances' sake, can well be polished. The oil ring must be exactly round, and for this reason a piece of brass pipe may not always be suitable, and even if round in the beginning, it may readily get bent in the operation of cutting. A casting long enough for both rings can be obtained, chucked, smoothly bored to fit some available arbor, and the outside turned in a lathe. The half rounding of the outer edges can best be done with a hand tool. After making the rings and seeing that they will fit with the indicated freedom in their places, it will be well to lay them aside until the machine can be regarded as finished. A good many trials will be necessary, involving putting in and taking out the armature, and until these preliminaries are over the presence of the oil-rings will be a nuisance.

A diversion from working in purely metal parts will be found in making the four field spools. While it is easy to make them poorly, it is not difficult, by follow-

ing simple directions, to make quite perfect ones. Perhaps, however, the builder is an experienced winder, and may decide to do the winding on a form and to hold the coils with tape, as is now so largely done in commercial machines. Spools are very neat, and for beginners are really to be recommended. Eight pieces of fiber about $4\frac{3}{4}$ in. square and $\frac{1}{8}$ in. thick are to be provided, also four pieces of thin tinned sheet iron, such as is used for "tin" cans, about $2\frac{1}{8}$ in. x $8\frac{1}{8}$ in. Wrap a piece of paper of the thickness of a postal card around the cylindrical portion of one of the pole pieces, wrap a strip of tin over it, tightly bind it with string or wire, and solder the overlapping edge. After removing the string, the superfluous solder may be removed with a coarse file. If all the pole pieces are properly alike, the sample one will suffice for forming the rest of the tin tubes, the thickness of paper giving all the freedom required. A piece of $\frac{7}{8}$ -in. wood 5 in. or 6 in. square is to be fastened to a face plate, the front turned true, and the fiber pieces can be attached one at a time by screws through the corners, then the central hole cut to fit the tin tubes, a recess being made for a short distance, and then the outside circle cut. The recess is for receiving the overturned edge of the thin metal, and should have its corner rounded. The outside

edges should also be rounded, but this operation will readily come in for a final operation.

For the next step the builder has the choice of patronizing a tinsmith, but care must be taken to see that there is no reduction of diameter at the very ends. As some sort of an arbor will be required when winding the spools, it can as well be anticipated at this time and made in a manner to permit forming the spools, then changed to hold the spool during the winding.

A chunk of wood from which can be turned a cylinder about 6 in. long and $4\frac{1}{2}$ in. in diameter is needed. If of hard stock, the lathe centers will hold sufficiently without special provisions, but if of soft wood, it is well to bore a hole through the block and to drive in an iron or steel arbor. One end can now be turned to such a diameter as will permit a tin tube to be slipped on and to overhang about $\frac{1}{8}$ in. A clamp consisting of two blocks of wood is next needed, both to hold the tube securely on the arbor and to give the right spacing between the fiber flanges. The two pieces can be held together by means of two long flat-head wood screws or slender bolts, then attached to the wooden face plate, the central hole bored out to about $2\frac{9}{16}$ in. in diameter, and then trued off on the face to the required thickness of $1\frac{9}{16}$ in. Fig. 9 represents a spool in the process of

making, one of the rims having been turned over, and ready for the other. The projecting rim is seen at which is to be "spun" over while running in the lathe. A very smooth and hardened hand tool with rounded edges is to be employed, pressed with considerable force at various angles

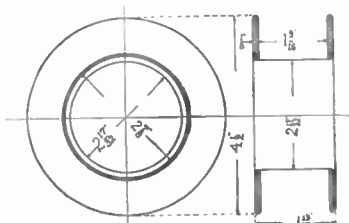


Fig. 8. Spool for field winding

against the edge of the metal. Or a lathe tool can be put bottom upwards in the tool-post, and gradually forced against the metal. By giving the tool several settings at different angles the desired result can safely be attained. The use of oil on the tool will prevent scratching and roughening. After thus turning over the metal at one end of each spool the wooden arbor can be cut a little shorter and then the other ends similarly treated. The space block should have such a thickness as to let the overall length of spool be slightly less than the space on the field cores.

The arbor on which the spools were formed is also to be used during their winding, and for this

second purpose the shoulder is to be turned back an inch or two further, explaining why so long a piece of wood was required. A washer, or ring, is to be made from a piece of $\frac{7}{8}$ -in. board having a hole to fit the neck of the arbor, the outside being about the same size as the spool flanges. This is to be crowded against the empty spool and held there by a short piece of $\frac{1}{2}$ -in. dowel pin pressed through a hole in the arbor. By boring the hole closer than its actual marking and flattening one side of the pin, a secure fit for the wooden ring can be insured.

COLLECTOR RINGS AND TERMINAL CONNECTIONS

The hub for the collector ring structure consists of a cast iron cylinder with a thin flange near one end. The casting is to be chucked, bored and reamed to a diameter of $1\frac{1}{8}$ in., or such other size as has been decided upon for that portion of the shaft. It is then to be mounted upon an arbor, the outside turned, and cut with a 16-per-inch thread for a short distance at one end. A nut, also of cast iron, is to be made, as shown with the rest of the structure in Fig. 10, and two holes drilled for fitting some available spanner wrench. Three fiber washers, of diameters indicated in "A," are to be provided, all closely fitting on to the cast iron shell. Flange "A" is to have two

$\frac{3}{8}$ -in. holes to match those similarly drilled in the cast iron flange; flange "B" is to have but one such hole, while "C" is to have none. Two other washers, also of $\frac{1}{4}$ -in. fiber, with dimensions as shown at "D" are required, only one of which, however, is to have the small hole. The collector rings themselves are to be as shown in "E." Though represented in the drawing as made of brass or bronze, which material is entirely proper, they can quite successfully be made of cast iron, as has been demonstrated in the case of alternating current generators of very large size. The operation of cast iron with a carbon or graphite brush has shown good electrical conductivity combined with extremely small wear.

Of course it is desirable that the rings have their sides quite parallel, and as an assistance for one of the machine operations, the castings may preferably have two of the interior projections rather than the single one shown; and one is to be sawed off after this temporary use. Chuck the castings of the rings, and turn off the side adjoining these projections, remove from the lathe, drill and tap the holes in the projections. By use of screws either from the front or the back, attach the rings to the face plate of the lathe, bore out the inner surface until a tight drive fit is made for the fiber rings "D," and

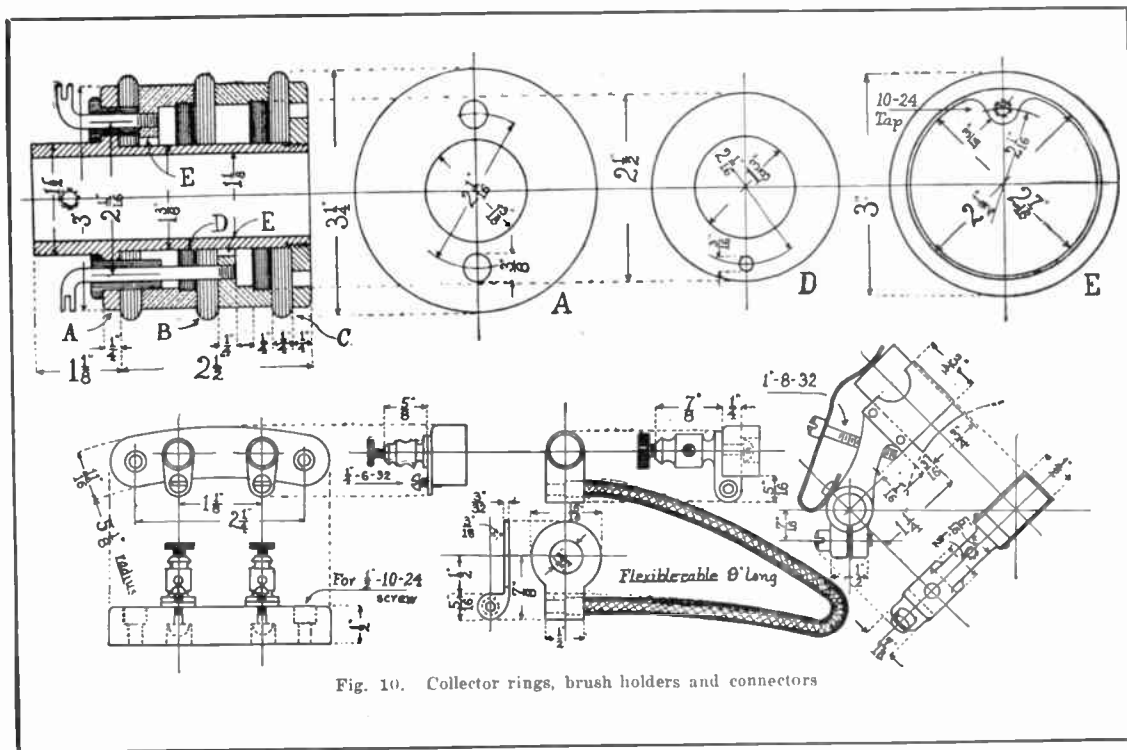


Fig. 10. Collector rings, brush holders and connectors

turn the outside to approximately the indicated diameter and thickness. Finally the interior projections can be removed from each of the rings.

Now by assembling these various parts, the small holes in the projections can be used to guide the drill for properly locating the holes in the washers "A" and "B" and in the cast iron flange, then enlarged to the indicated size. Two connectors, one long and one short, are to be made of 3/16-in. diameter brass rod, threaded at one end, bent and slotted at the other, as shown, are for making the actual conjunction between the armature winding and the collector rings. They are to be securely separated from the cast iron flange by use of fiber or hard rubber tubes or bushings. After assembling the structure a light chip may be taken from the rings; they may also be polished, but preferably not with the aid of emery cloth. Especially if the rings have been made of bronze or copper will the use of emery be objectionable, for the abrasive will become embedded in the soft metal and grind the brushes at too great a rate. As with commutators, fine sandpaper is the most appropriate material. A set screw or a key may be provided for finally securing the collector ring structure in place on the shaft, not on account of the requirements of ordinary running;

but at the sudden start of the machine there is tendency for the rings to slip, and further, when truing the rings in a lathe, or when otherwise working around the machine, there is quite as much reason for fastening the rings as the pulley.

Three terminal blocks secured to the rim of the field magnet will be found serviceable. These can be made of hard wood or fiber, and the dimensions are so clearly shown in the drawings as to require little explanation. It might be mentioned that provisions are taken for preventing the binding posts from the aggravating habit of loosening by soldering the two small ones belonging to the field winding to small brass strips that by virtue of the machine screws cannot swing, while the larger ones, to which the flexible cables are attached, are made of castings that overlap the edge of the blocks, serving at the same time as cable lugs. Other ends of cables are soldered to ordinary terminals that loosely fit the brush holder spindles. In the absence of a piece of suitable flexible conductor, of course it will be sufficient to use a solid wire, the required movement even with¹ direct current working being small, and with the alternator none at all.

The brush holders are made for holding the carbon in an edge-wise manner, and once set should

require very infrequent attention. To drill the central holes that fit the spindles, the castings should be firmly clamped, for otherwise the holes will be made at some undesirable slant. The hubs and edges of the other ends can well be turned off in a lathe, then the sheet copper rectangle that has been formed over a piece of $\frac{1}{2}$ in. x 1 in. bar, say the shank or a lathe tool, is to be pinned and solder-sweated, the required spac-

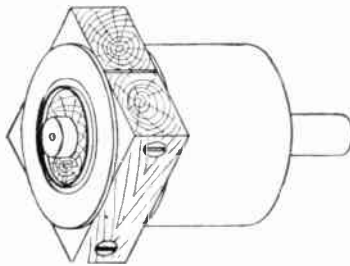


Fig. 9. Arbor and clamp for forming spools

ing being secured by use of a piece of $\frac{1}{2}$ in. x $\frac{3}{4}$ in. bar or stick of wood. Sheet brass about $\frac{1}{32}$ in. thick will be satisfactory for the pressure springs, but the strips should be somewhat wider in the center than at the ends.

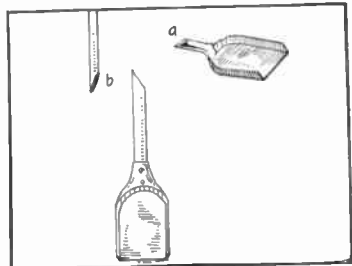
(To be continued.)

REPLACING THE BROKEN STOVE SHOVEL HANDLE

The handle of the stove shovel usually breaks off right above the scoop. Although the cost of

a new shovel is slight the handle of the new one will shortly be doing the same trick.

The broken handle may be easily and quickly replaced by a piece of a broomstick cut off at the end as shown at *b* and



Replace the broken handle with a length of broomstick

fastened on with rivets or screws.

This not only forms a substantial handle, but fits the hands nicely and may be made of any length to suit one's needs.

Contributed by T. H. LINTHICUM.

A HANDY MATCH SCRATCHER

A handy match scratcher for the man who smokes can be made by sewing or pinning a piece of emery cloth to the lining of the coat or vest or where it may be most convenient. As an aid to lighting "smokes" in a stiff wind, perhaps the emery cloth might well be placed inside the hatband.

Contributed by FRANK L. MATTER.

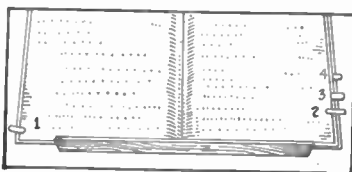
PRACTICAL MECHANICS FOR EVERYDAY MEN

CLIPS AS MUSIC PAGE TURNERS

In playing sheet music it often happens that several pages will be turned over at the same time, resulting in confusion and delay.

This can be quickly remedied by the use of a few wire paper clips. On the first page fasten a clip near the bottom, leaving about a half-inch of it projecting. The next pages are treated in the same manner, but with the clip placed about an inch higher on each succeeding page.

The ends of the clips can be



Place each succeeding clip one inch higher

easily caught with the finger and the page quickly turned.

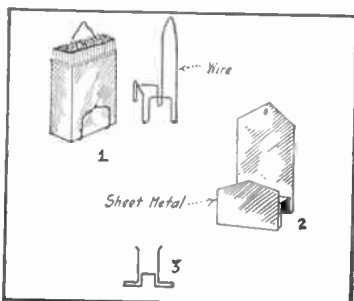
Contributed by FRANK L. MATTER.

HOME-MADE MATCHBOX HOLDERS

There are numerous matchbox holders on the market, but some of us derive a certain pleasure and satisfaction from making

such things with our own hands.

Figs. 1 and 2 are designed to hang in a convenient place on the wall, while the style as



Three types of matchbox holders

shown in Fig. 3 is for use on the table, desk or bureau.

These holders may be made of spring wire or sheet metal.

Contributed by T. H. LINTHICUM.

To clean jewelry successfully, and avoid scratches or marks of any kind when it is finished, wash the article in hot soapsuds in which a little ammonia has been dissolved. Shake off the water and lay it in a small box of fine sawdust to dry.—MARY F. SCOTT.

HOME-MADE FLOOR STAIN.

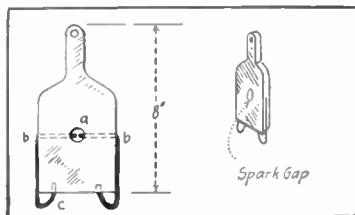
Have the floors very clean if you want to stain them darker. This is the first step in applying dark walnut polish. You can make it yourself by grinding up a pound of dark umber in oil, mixing a sufficient quantity of this in boiled linseed oil, enough to give it color, and not thicken the oil too much, or any more than is necessary. Try this on a piece of wood until you get the shade desired. Add or subtract the umber to regulate the shade. Rub this into the floor until it ceases to come off, putting on a second coat if necessary. If you want a shiny finish, use a good shellac to finish off.

Contributed by MARY F. SCOTT.

in its liquid state, but as it cools the latter will begin to solidify. Repeating the operation several times and at frequent intervals will unfailingly seal the bottle. Contributed by MARY F. SCOTT.

AN AUTOMOBILIST'S PADDLE

This device indicates whether or not a cylinder is firing. From



The paddle is a simple affair

HOW TO SEAL BOTTLES.

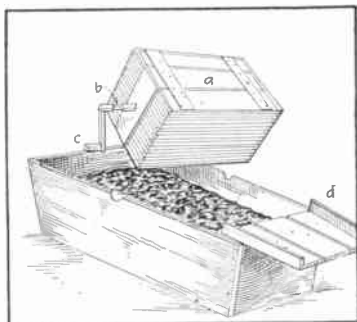
Fill the sterilized bottle to overflowing with boiling liquid and carefully press in the hot cork. Too much pressure will crack the bottle, and it is best to allow enough of the liquid to overflow so that the cork goes well into the neck of the bottle. With not less than a $\frac{1}{2}$ in. of the cork projecting from the bottle, invert and immerse the neck below this line in melted paraffin and repeat until the space between the cork and the neck of the bottle as well as the pores in the cork are well filled. The hot bottle will at first keep the wax

a board $\frac{3}{4}$ -in. thick cut a paddle like the one pictured about $3\frac{1}{2}$ in. wide. Bore an $\frac{1}{8}$ -in. hole from edge to edge (*bb*) and a 1-in. hole at *a*. The heavy black lines represent $\frac{1}{8}$ -in. steel wire. Cut and bend two pieces so that they will make loops at *c* and nearly touch at *a*. If one loop is made to touch the top of a spark plug and the other loop makes contact with the head of the motor or some steel near the plug, a blue spark will jump across the gap at *a*. If this does not happen the cylinder is not firing. Contributed by CHAS. W. STROUT.

A HOME-MADE VEGETABLE WASHER

The illustration shows a simple device constructed for the purpose of washing root or tubercous vegetables when preparing them for the market.

The arrangement consists of a



Vegetables are put in the crate

standard bushel onion crate which swings in a water trough. The crate is provided with a hinged lid, *A*, a shaft, *B*, and a crank, *C*.

The roots to be washed are poured into the crate a half-bushel at a time, and the crank is turned slowly, revolving the crate in the water until the vegetables are free of soil when they are emptied upon the drain-board, *D*, and then raked off into baskets.

This device is especially appreciated in frosty weather, as it does away with the necessity

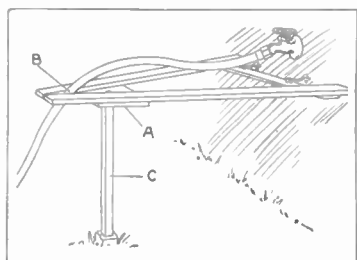
of putting the hands in cold water.

Contributed by T. H. LINTHICUM.

SUPPORT FOR THE GARDEN HOSE

A handy device, designed to keep the garden hose from dragging over flowers that are planted immediately below the faucet, can be easily made from a few strips of wood and two ordinary screen-door hooks.

Select two wooden strips about $\frac{3}{4}$ in. by $1\frac{1}{2}$ in. in diameter and long enough to hold the base *C* out beyond the flower-beds when they are placed in the V-shaped position shown. The spread ends of the V should be about 2 ft. apart, and connected by an or-



This support is easily removed

inary lath nailed on about 2 in. from the ends. The other ends are connected by a board, *A*, about 4 in. wide and placed far enough back to allow the hose to pass easily through the triangular opening as shown at *B*.

In the center of this board drill a $\frac{3}{8}$ in. hole.

Now make the strip *C* of 1-in. stuff long enough to hold the support above the plants. A shoulder should be cut in each end to form a $\frac{3}{8}$ -in. pin, one end to fit into the board *A*, while the other fits into a hole in the top of a stake set into the ground, as shown.

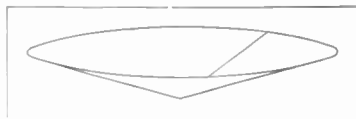
The support is held against the house by two hooks screwed into the lath and hooking into screw-eyes on the wall.

Contributed by FRANK L. MATTER.

SHEET-METAL BIRD BATH

To make a bird bath with the least amount of expense and time procure a sheet of tin or other metal. Mark off on it a circle about 24 in. in diameter, and cut it to this shape. Make two marks on the edge of this circular piece about 5 in. apart. Draw a straight line from each of these marks to the center of the circle. Cut along these two lines and remove the wedge-shaped piece between them. Now, by drawing together these two straight edges of the circular piece and soldering them into a water-tight seam, it will assume the shape of a shallow funnel, about 3 in. deep, as shown. After testing it for leaks give it a good coat of tar or paint on both sides and set it aside to

dry. When it is thoroughly dry select a suitable spot on the lawn and dig a hole of the proper diameter and about 5 in. deep in the center. Next put in dry sand and shape the bottom of



This is the sheet metal bath

the hole with it as nearly like the tin bath as possible. Now press the tin bath down into the sand and work it around until it rests firmly at all points. Test it with water to be sure that it is level and it will be ready for the birds.

Contributed by FRANK L. MATTER.

TO KEEP OUT FLIES

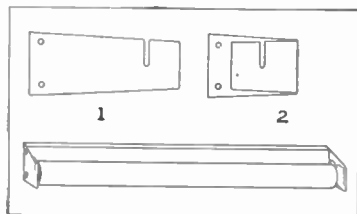
Get a few yards of fine book muslin and make into bags of various sizes. Through the hem at the open end pass a fine tape. After the dishes are removed from the table slip one of these bags over and tie the bag securely. This method not only keeps flies from settling, but prevents dust from collecting. Boil the bags to keep them sweet and clean, and you will find they are far more hygienic than the wire covers generally used.

Contributed by MARY F. SCOTT.

ROLLER FOR TOWEL

To make a simple roller and brackets for a roller towel, first make the roller itself out of a piece of curtain-pole of the proper length to contain the towel. Into the exact center of each end drive a large-headed tenpenny nail. The nails should not be driven entirely in, but should protrude about $\frac{3}{16}$ in.

Now, take two pieces of sheet iron or brass 4 in. long by 2 in.



Tin ends hold the roller in place

wide at one end; they should be tapered down to about $1\frac{1}{2}$ in. at the other end. At $\frac{3}{4}$ in. from this smaller end cut a slot as shown in Fig. 1, while at the other end two screw holes should be drilled. From the smaller end measure $1\frac{1}{2}$ in. and bend as shown in Fig. 2. These plates must not be bent in the same direction.

Now, take a piece of wood $\frac{3}{4}$ in. thick by 2 in. wide and about $\frac{1}{2}$ in. long than the roller.

The two plates should now be screwed to the ends of this board, taking care that the slots

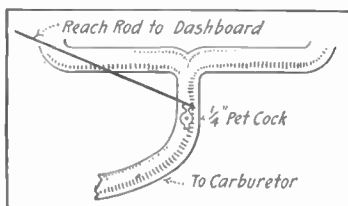
face each other and open upward. Drop the nails on the ends of the roller into the slots and it is all ready to screw on the wall.

(Contributed by FRANK L. MATTER.)

GASOLINE SAVING KINK,

The following "stunt" was tried on several cars, and resulted in the saving of from 15 to 30 per cent. in the gasoline bills.

A $\frac{1}{4}$ -in. pet cock was put in the manifold at the point indicated in the drawing, with a reach-rod running to the dashboard for regulation. This acts



A reach rod to the dash-board regulates the cock

as an extra air inlet, but does not cause back-firing. Another result was the keeping down of carbon deposits.

Contributed by J. R. O'NEILL.

RANGE BLACKING

A range will keep black longer if you wash it with soap and water before applying the blacking.

A Chat With the Editor

SUB-SEA FREIGHT AND PASSENGER TRANSPORTS.

THE achievement of the submarine transport *Deutschland* has been the inspiration for a second submersible model in the Laboratory. This model, the EM2, is rapidly nearing completion, and unless some unforeseen contingency arises, the first article of the new series will appear in the next number.

The EM2 will be nearly eight feet in length, with a beam of $11\frac{3}{4}$ inches. Her driving battery is a standard automobile lighting battery of 80 ampere-hours capacity at 6 volts. The control battery is of 4 volts, 40 ampere-hours capacity. The model will submerge while at rest by means of water ballast, which may be expelled either by radio or automatically by means of compressed air.

The control will be of the radiodynamic type and *selective*. That is, the vessel will respond to any one of some ten different controls at will without having first gone through the other nine evolutions. The control system is being fully covered by patents in the name of the Editor of EVERYDAY, but permission will be given to any reader to construct the model incorporating the selective control for his own use providing he does not manufacture the device for resale.

The EM2 is the natural result of a tremendous demand for other and more ambitious models along the lines of the first one described in EVERYDAY. Probably no single series of articles has ever created such a profound sensation in the history of "how-to-make" literature. There is ample evidence to show that the remarkable growth of this magazine's circulation from ten to fifty thousand copies in six issues has been due in large measure to this one series. At the New York Electrical Show, the model was viewed by thousands of visitors and the verbal requests for a second design were of hourly occurrence.

The EM2 is the answer. She is adapted to actual work day in and day out for purposes of demonstration, showing the principles of submarine construction and operation and also of wireless control. As an adjunct of a "Preparedness" exhibit, the model would cause a sensation. It is perhaps costly to build, but it is intended for serious work, and will surely repay the capable model maker who puts his time and money into it.

A word to interested readers who have been disappointed in failing to obtain back numbers containing the former Submarine series may not be amiss. Previous editions have been sold out, and we may expect the same results with the new series. Therefore, unless you are a subscriber, perhaps you had better practice safety first by asking your newsdealer to reserve your copy each month.

ELECTRICAL EQUIPMENT OF THE MOTOR CAR

How to Understand It

THAT is the title of a new series of articles from the able pen of Wm. C. Houghton, whose contributions to the field of practical literature have done much to show the "why and wherefore" of things electrical and mechanical. Professor Houghton will treat of the subject in a straightforward, "everyday" manner. His object will be to show the owner or driver of a motor car the innermost details of the electrical systems in use on all present-day cars, with a view to aiding the everyday man in *preventing* breakdowns as well as repairing them when they occur.

There is nothing mysterious or puzzling in the starting, lighting, or ignition system of the motor car. It is a concrete application of well-known electrical principles from start to finish. The mystery is solely in the mind of the user who, through a lack of knowledge of the fundamental principles involved, conjures all manner of problems that do not exist in reality. The object of Professor Houghton's series will be to lay bare these principles in an understandable manner.

The author is one of the pioneer motorists of the country and a man peculiarly well fitted to handle such a series. He built his first car, an electric, long before there was any such thing as a differential. Recognizing the necessity for such a device, and being without facilities for constructing it, he placed an electric motor in mechanical connection with each rear wheel, in order that a solid rear axle might not be necessary. Since those early days, he has driven and studied nearly every form and make of car of standard usage in the market. He has specialized in the study of ignition, lighting and starting systems, and knows their fundamentals from the standpoint of designer, engineer, and user.

Coupled with these natural advantages, Professor Houghton's work for many years past makes him master of the art of imparting his knowledge to the lay mind. He is a teacher of manual training and the electrical and mechanical branches of science. His

pupils today occupy positions of great responsibility in silent tribute to his ability in this direction.

Therefore, in presenting the opening chapter of this new and important series, we do so with a feeling of confidence, not only in the soundness of the author's knowledge of his subject but also in his ability to impart this knowledge in a form that will make it of peculiar benefit to the everyday man who drives his own car, to the professional chauffeur, and to the garage owner who may wish to use the articles as a means of interesting and authoritative education among his employees.

THE EDITOR.

THE TECHNICAL ADVISER

The object of this department is to answer the questions of readers who may experience difficulty in the construction or use of apparatus described in the magazine. The columns are free to all readers whether they are subscribers or not, and questions pertaining to matters electrical or mechanical will be answered in the order in which they are received. If the reader cannot wait for an answer to be published he may secure an immediate answer by mail at a cost of 25 cents for each question.

In order to insure prompt attention, readers should adhere closely to the following rules which have been formulated with a view to expediting the handling of the mass of correspondence. Questions should be written on one side of the paper, enclosed in an envelope addressed to The Technical Adviser, care of Everyday Mechanics, Æolian Hall, New York City. The letter should state plainly whether answer is to be published or sent by mail; in the latter case the fee of 25 cents per question should be enclosed in coin, one-cent stamps, check or money-order. The envelope enclosing questions should not contain matter intended for any other department of the magazine.

48. **P. C., Bridgeport, Conn.**, asks for the title of a book on the Brown and Sharpe or Gridley automatics. **Ans.**—We cannot find any book on this subject. The rapidity with which improvements are brought out, makes it impractical to write a book on these machines. However, by writing to Brown and Sharpe Mfg. Co., Providence, R. I., and to the National-Acme Mfg. Co., Windsor, Vt., you can get the literature which they publish on their automatics. The experience which you have had will be helpful, for there is a certain amount of similarity between the different makes.

49. **C. Le B., New York City**, wants to know if a spark coil can be used in place of a transformer for the high frequency coil described in the July issue of EVERYDAY. **Ans.**—A spark coil can be used with the high frequency apparatus, but the spark will not be as long or heavy as the transformer.

50. **C. J. B., Paducah, Tex.**, does not know what type of coil to use for an Audion amplifier

Ans.—The most efficient type of coil is wound with two wires, side by side, of 10,000 turns, No. 36 s.s. on an iron wire core 3 in. long and $\frac{1}{2}$ in diam. One of these windings is used as the primary, and the other as the secondary, to couple the Audion circuit to the amplifier. The primary winding is connected in place of the phones; one side of the secondary is connected to the grid, and the other to the filament. A 2 mf. telephone condenser is connected in place of the tiny condenser used in the grid side of the Audion hook-up.

51. **T. P., New York City**, asks (1) about the generation of infra-red rays. **Ans.**—(1) This is an interesting question, and on a subject which is not often attempted by others than research workers. The infra-red end of the spectrum is of a frequency below that to which the eye can respond. It does, however, affect the senses by causing a feeling of warmth, for the infra-red rays are the heating rays.

The apparatus used is simple.

An arc or gas-filled electric light is placed in the projector. The light is emitted through a narrow slit, and is focussed by a lens on the prism. For this work a rock-salt prism is used. This does not impede the long wave length rays, as glass does, and it is less dispersive, giving a narrow band on the screen. A thermopile is moved over the different parts of the band. The slightest heating of the thermopile generates a current through a galvanometer, which, in turn, indicates the heat from the spectrum by the deflection of the ray of light reflected from the galvanometer mirror. At a point as far beyond the red rays as the red is from the green, the greatest amount of heat is indicated. The rays are not visible, but the indication of the galvanometer shows the presence of rays at this point. These, then, are the infra-red rays.

(2) How can I make a standard inductance of 1 millihenry. Ans.—(2) It is not practical to construct such a standard. The slight changes that will be made, in spite of the most exact directions, will make such a standard useless. The best suggestion we can make is that you write to the General Radio Co., Cambridge, Mass. They can supply an inductance of this size for \$17.

(3) The formula used for the compound in the multi-audiophone, or the patent number. Ans.—(3) The formula you want has not been disclosed, nor can we give you the number of the patent. You can, however, get a copy of the patent by writing to the Patent Office at Washington. Simply give a description of the instrument and its use.

52. E. L. K., U.S.S. Azalea,

has asked for several formulas which are given here.

Luminous Paint—By weight. 100 parts, strontium carbonate, 30 parts sulphur, 2 parts sodium carbonate, 0.5 parts sodium chloride, and 0.2 parts manganese sulphate. The chemicals are mixed thoroughly and heated for one hour at a temperature of about 2,370° F. This gives a deep yellow light. When the paint is put on the name-plate it should be exposed to strong sunlight for a few hours.

Brass Polish—By volume, levigated emery powder 100 parts, anhydrous sodium carbonate 5 parts, tallow soap 20 parts, water 100 parts.

Heat Resisting Enamel—Thin one part of sodium water glass with two parts of water, by volume. This solution can be colored black by adding lamp black, or white by adding varium sulphate until the mixture is sufficiently thick.

Varnish Remover—Mix 4 oz. benzol, 3 oz. fusel oil, and 1 oz. alcohol; this will remove varnish, lacquer, tar and paint.

53. W. T. M., Columbus, O., wants to remove an iodine stain from a varnished birds-eye maple bureau. Ans.—This is rather a difficult question to answer, since we do not want to recommend anything which will injure the wood. We suggest, however, that you rub the spot with a little potassium iodine, to which a few drops of glycerine have been added. Then take a clean cloth with this mixture and a little oil on it. The second application should dissolve and remove the stain.

54. H. S., Enterprise, Ore., is making the audion receptor described in the October number of EVERYDAY, but he cannot

make the knobs because he has no lathe. There are several radio companies advertising in *EVERYDAY* which will supply these knobs. Their catalogues are interesting, and contain many articles of value in just this kind of work.

55. **V. B., Wilkesburg, Pa.**, wants to know (1) what he should use for the casing. *Ans.*—A glass jar is the most satisfactory container for storage cells. Several jars can be put in a wooden box, with packing around the jars to protect them.

(2) What is the electrolyte for this battery? *Ans.*—The electrolyte is made of 25 per cent. sulphuric acid and 75 per cent. water. Pour the acid into the water when mixing. A further discussion of home-made cells was given in the *Technical Adviser* for November; perhaps this will help you.

(3) Can I get the first of the series of articles on the Model Submarine? *Ans.*—(3) We cannot supply back numbers previous to the May issue.

56. **H. P., Kent, O.**, asks where he can buy a heterodyne receiving set for wireless work. *Ans.*—The heterodyne receptor is manufactured by the National Electric Signalling Co., Bush Terminal Bldg., Brooklyn, N. Y. If you write them they will give you prices on the apparatus.

57. **R. E. Tulsa, Okla.**, wants to know (1) the natural wave-length of an aerial 50 ft. long, 40 ft. and 30 ft. high, 6 wires, with a lead and ground 40 ft. long. *Ans.*—(1) A calculation of this kind is at best only approximate; the conditions, which are bound to vary, effect the wave-length to

such an extent that *no tables or calculations can be made accurate*. The closest calculation we can make gives a wave-length of 200 meters, but this may vary 15 per cent.

(2) Should a galena detector be short circuited when sending? *Ans.*—(2) It is best to disconnect the detector when transmitting. The switch should be separate from the antenna switch, preferably operated by a relay. A simple contact arranged on the antenna switch can be made to operate the relay.

(3) Is it possible to tune 200 meters with the loose coupler, described in the September issue, without a condenser in the ground? *Ans.*—(3) No condenser is needed in the ground circuit of this loose coupler unless an aerial with a wave-length of over 200 meters is used with the set. With a large antenna a condenser is necessary.

(4) Does a small fixed condenser across the phones increase the receiving range? *Ans.*—(4) A shunt condenser, if of the right capacity, will increase the signal strength. Moreover, it will raise the tone of the signals, if the capacity is properly adjusted. Four sheets of tinfoil 2 in. x 3 in., pressed tightly between very thin sheets of paraffin paper, gives about the right capacity.

(5) Does a variable condenser in shunt to a two-slide coil increase the range or wave-length? *Ans.*—(5) A condenser across the detector circuit usually increases the signal strength, because it increases the resonance effect. It also increases the wave-length of the circuit.

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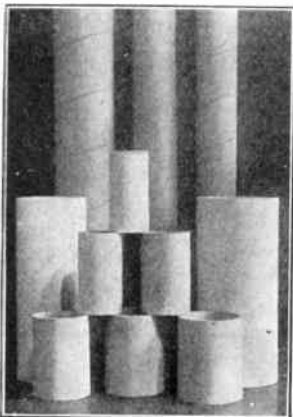
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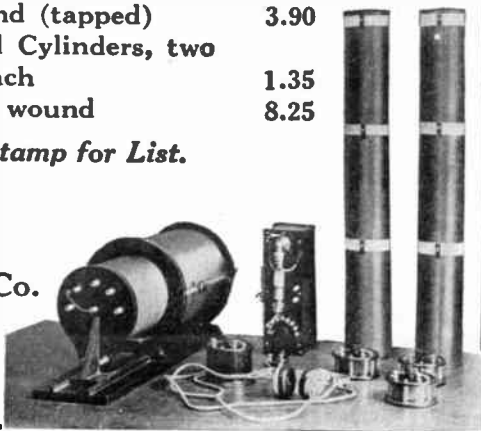
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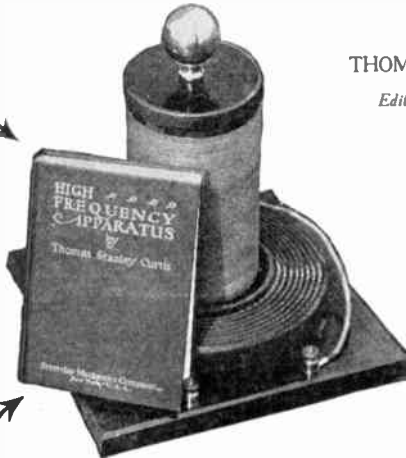
High Frequency Apparatus

Its Construction and Practical Application

By

THOMAS STANLEY CURTIS

Editor of "Everyday Mechanics"



The most comprehensive and thorough work on this interesting subject ever produced. The book is essentially practical in its treatment and it constitutes an accurate record of the researches of its author over a period of several years during which time dozens of coils were built and experimented with.

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