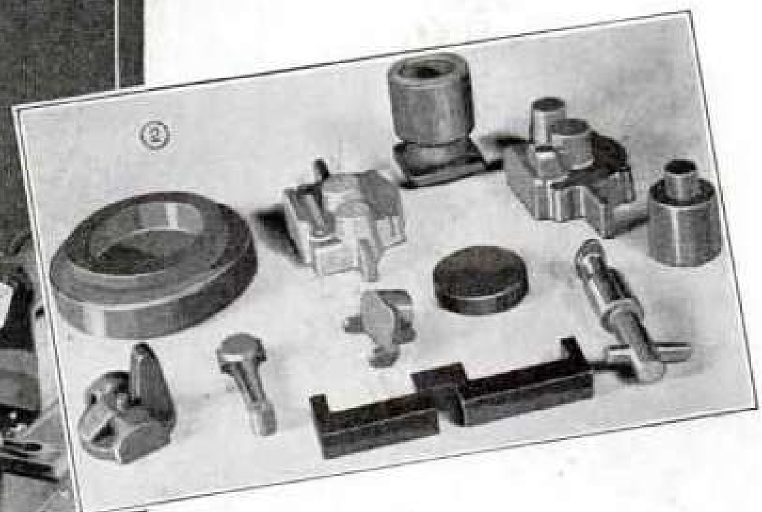


MIDGET

By E. C. Wittick

Part I—Making the Patterns

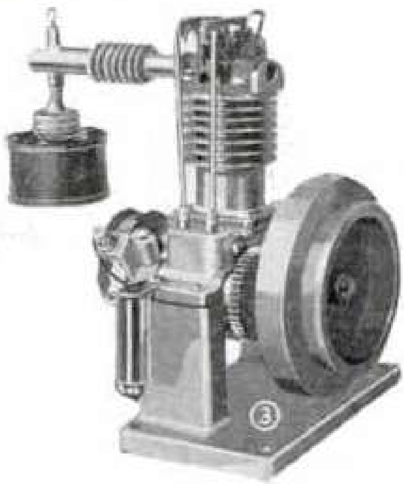
SPECIALLY designed for construction in the home workshop, this tiny engine, which will develop about 1/8 hp. at maximum speed, is really built "from the ground up." Being of the four-cycle type the engine is very easy to start, as in Fig. 4, and runs smoothly at high speeds. As a project in machine work, its construction would not be considered difficult, and it offers you not only excellent practice on your lathe but a try at pattern making as well. Now the patterns for the engine parts are not of the type that would be made by a manufacturer aiming to conserve metal, but they are designed for ease of construction and a liberal allowance of metal on the castings for finishing. The main thing to remember about pattern making is that certain projecting parts of the pattern must have "draft," that is, they must be tapered slightly so that the molder can draw the pattern from the sand mold easily. Also, certain patterns, the cylinder for example, must be made in two parts, or "parted," as it is termed. This is also done to facilitate the work of the foundry. Dimensions given for all the patterns allow for the normal shrinkage of the metal, so you don't have to lay out the work with a shrinkage rule.

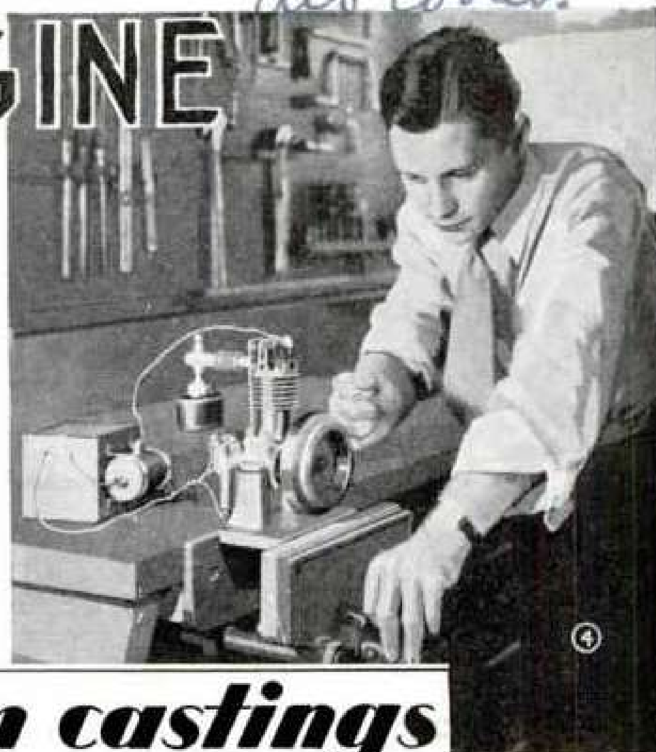
Work begins with the cylinder pattern—a very simple wood-lathe job as you will see from Figs. 1 and 5. Notice especially the upper-right and the lower-left details in Fig. 5, showing beveled edges on the two parts of the pattern stock. These bevels can be run on the jointer and each of the two pieces faced on one side to form a perfect flat joint. Registering holes for short dowel pins are bored in the halves and the dowels are fitted and glued into only one of the two parts. Then the two pieces are screwed together and turned down to the dimensions indicated, after which the ends are sawed off and the whole thing smoothed up. The projection at each end is a core print and should be finished with black shellac, which is made by adding lamp black to orange shellac. The molder will insert the proper core when he makes up the mold.

Now the connecting rod, Fig. 6. The pattern is made of mahogany. One good way to make this pattern is to use a base piece of 1/8-in. stock and then fit turned disks to form bosses for the wrist-pin and big-end bearings. Notice especially the location of the parting line and how the webbed center section is formed. The right-angle corners in the webbed section

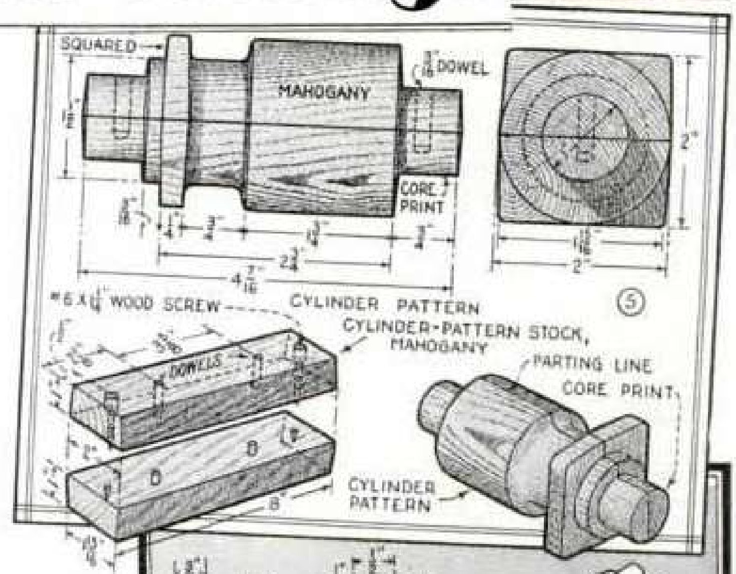
Refer ing. & S. N. air cooled.

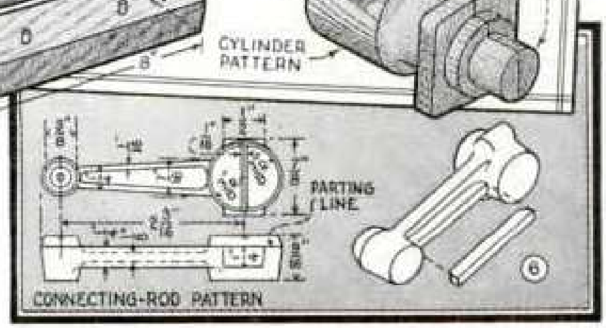
GAS ENGINE





turned from castings

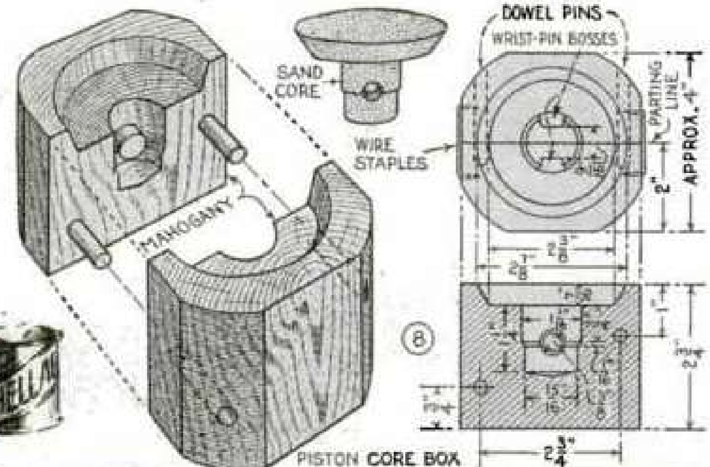


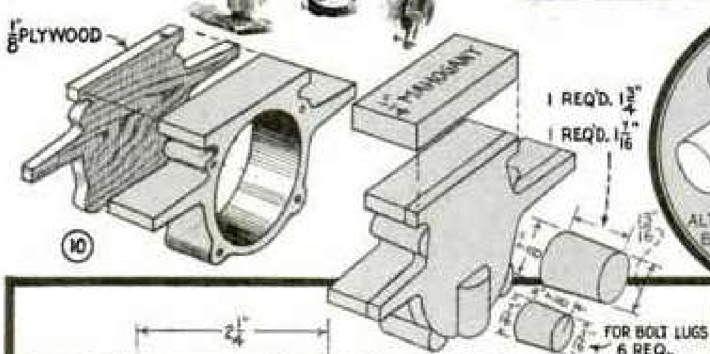


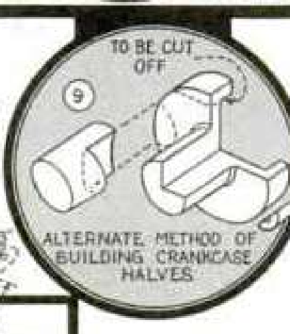
must be rounded with wax fillets. This can be done by softening a piece of beeswax and then pressing this into the corners, rounding it neatly with your finger. Bolt lugs are glued on and carved to shape with a knife.

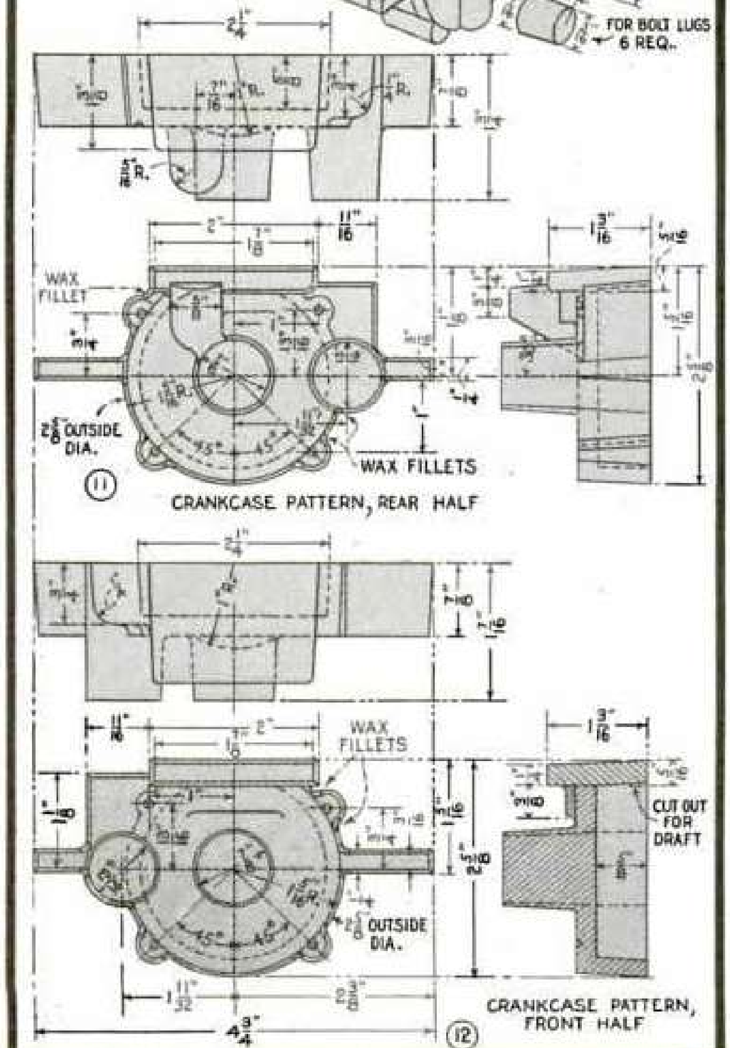
The piston pattern, Fig. 13, is merely another wood-lathe job, but the piston core box shown in Fig. 8 is a trifle more intricate. Here the blocks are doweled as shown and fastened together with heavy wire staples, then the whole is mounted on the faceplate and counterbored as in the sectional view. Bosses for the wrist-pin bearings are turned separately and glued in place.

There are two ways of making the crankcase patterns, one method being shown in Fig. 9. First, the cup-shaped pieces for the main body and bearings are turned out and then the other projecting parts are turned separately and fastened on with glue or metallic cement, the latter being very good for this purpose. The pieces that form supports can be cut from a strip about 1 ft. long, planed to exact size. The flat pieces that form the cylinder seat when the castings are bolted together can be made the same way. Lugs for bolts, which hold the two halves together, may be made as a split turning by gluing two strips together with a piece of paper between. Then turn down to cylindrical form, split the turning apart, and after cutting to length, glue the pieces to the pattern. Now another way of making the same thing, shown in Fig. 10. This is done by sawing the main body of the pattern





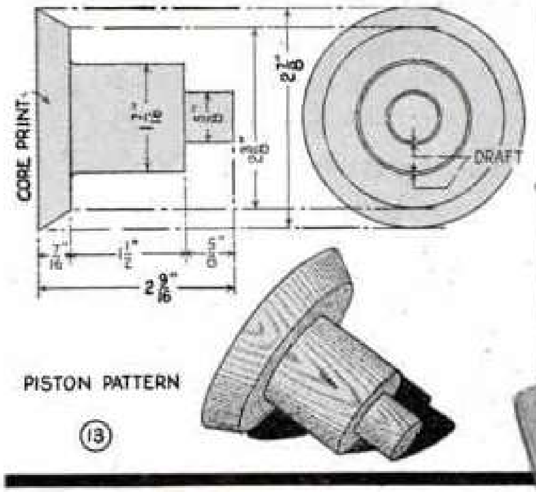




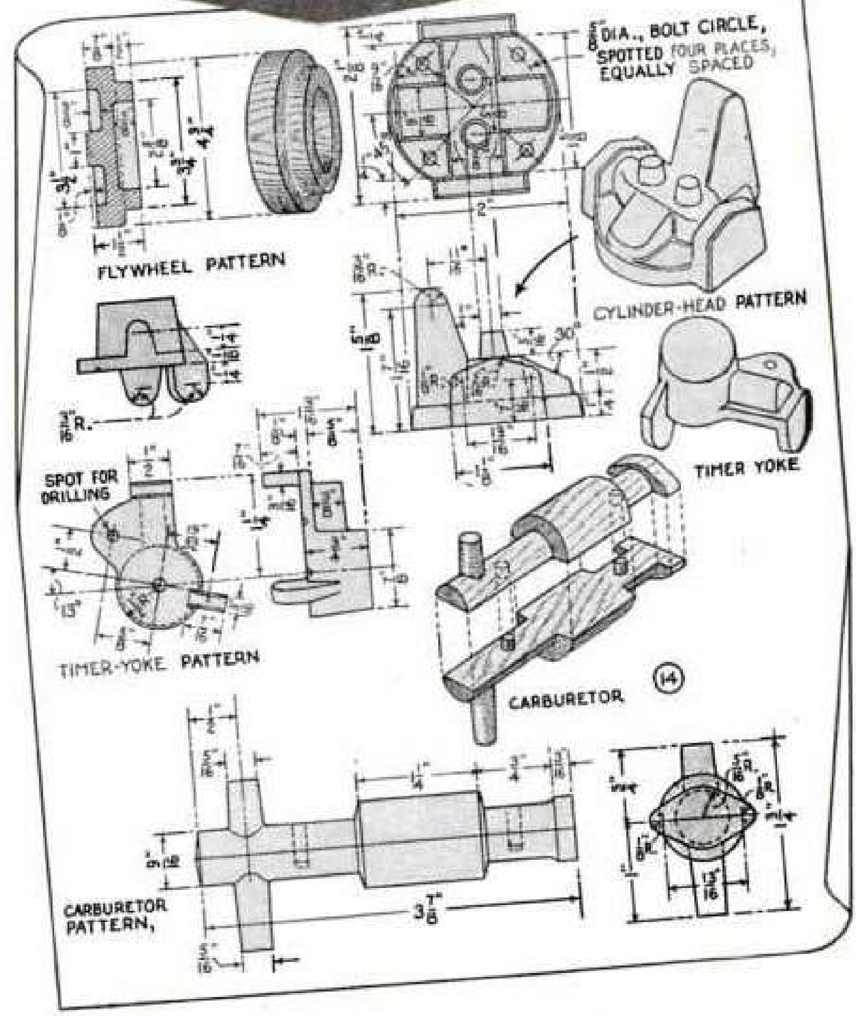
from 3/4-in. stock, the outer contour including the supports and bolt lugs. You can use a scroll saw, setting the blade at a slight angle to cut the draft inside and out. Then a piece of 1/8-in. plywood is cemented to one side and cut to the same contour. Some smoothing up will be necessary. Figs. 11 and 12 give the details and dimensions of both halves.

In Fig. 14, the flywheel pattern is another comparatively simple lathe job, the carburetor pattern is very similar to that made for the cylinder, but the cylinder head and timer yoke involve some gluing and handwork. Taking the cylinder head first, you turn a disk to form the main body, then glue on small parts forming flanges, valve-stem guides, rocker-arm support and spark-plug seat. The timer-yoke pattern is made in the same way. The body is turned to size in the wood lathe and the projecting parts glued on. However, notice particularly that the draft on this pattern runs each way from the main flat surface.

Now a few important details applying to all the patterns for this job. It is essential that each pattern be finished smooth all over, otherwise the molder will have trouble getting it out of the sand. This means careful sanding,

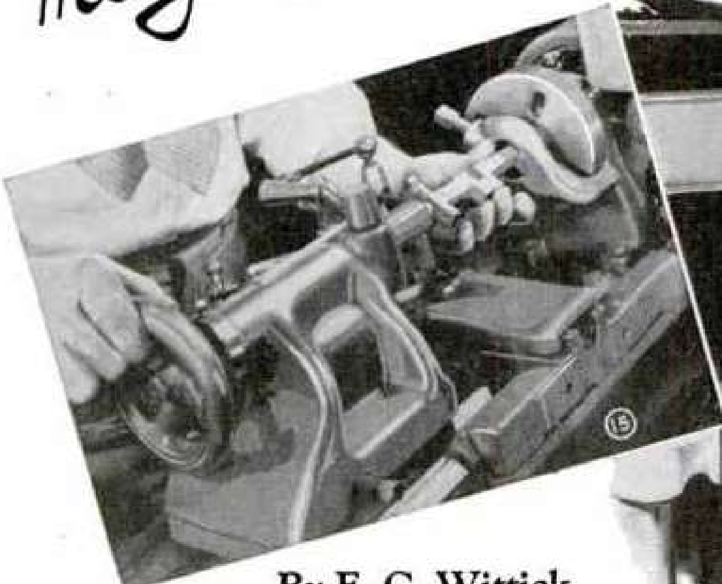


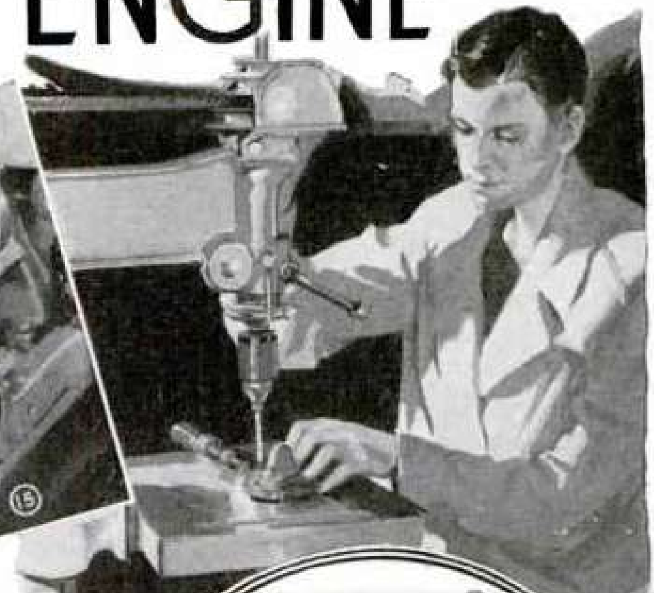
wax fillets in all corners where two parts join, and two coats of orange shellac applied as in Fig. 7. Don't forget that the core prints on the cylinder and piston patterns must be coated with black shellac. Where gluing is specified you can use either waterproof casein glue or metallic cement. Where dowels are used in the parted patterns remember that they serve only as locating or guide pins. They are glued into only one of the halves and the projecting ends are tapered slightly so that the halves will come apart easily. You will see from the drawings that wherever possible, holes to be drilled are spotted on the pattern. This is done with a short-beveled prick punch. The castings will then come back to you with the holes spotted all ready for drilling. The complete set of castings, and the steel crankshaft blank, are shown in Fig. 2. The finished engine is shown in Fig. 3. When you take the patterns to the foundry, specify soft, grey iron for the cylinder, cylinder head and flywheel; bronze for the connecting rod, timer yoke, and carburetor. The crankcase is cast in aluminum. Mahogany or selected white pine is the best wood to use for small patterns of this type. To make good patterns you must have good wood, of a grade suitable for pattern making. This is especially true of pine. Though the latter wood can be used, selected mahogany is always to be recommended for small patterns because of its durability, resistance to both shrinkage and expansion after working, and the ease with which it may be finished.

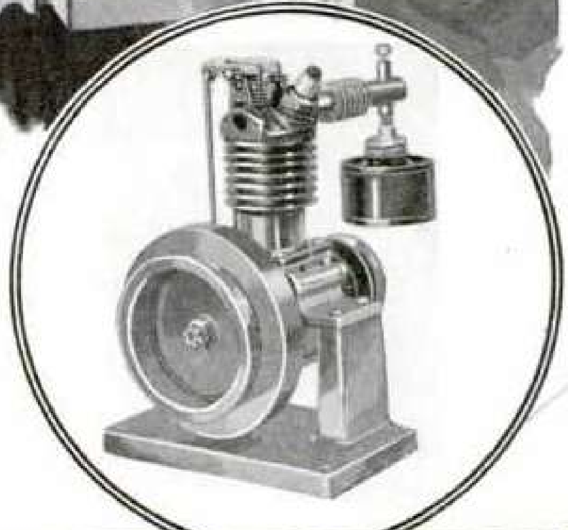


(To be continued)

Midget GAS ENGINE





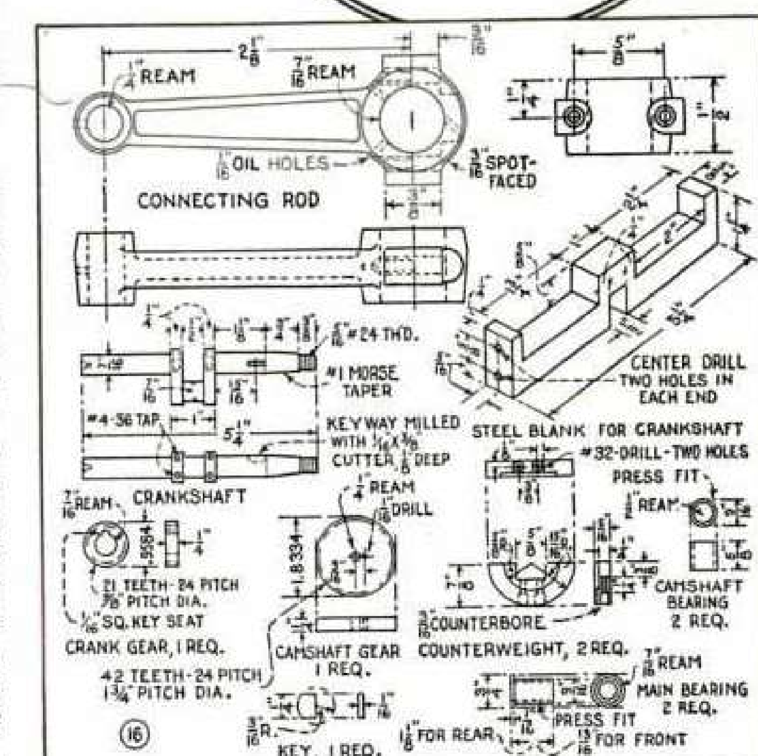


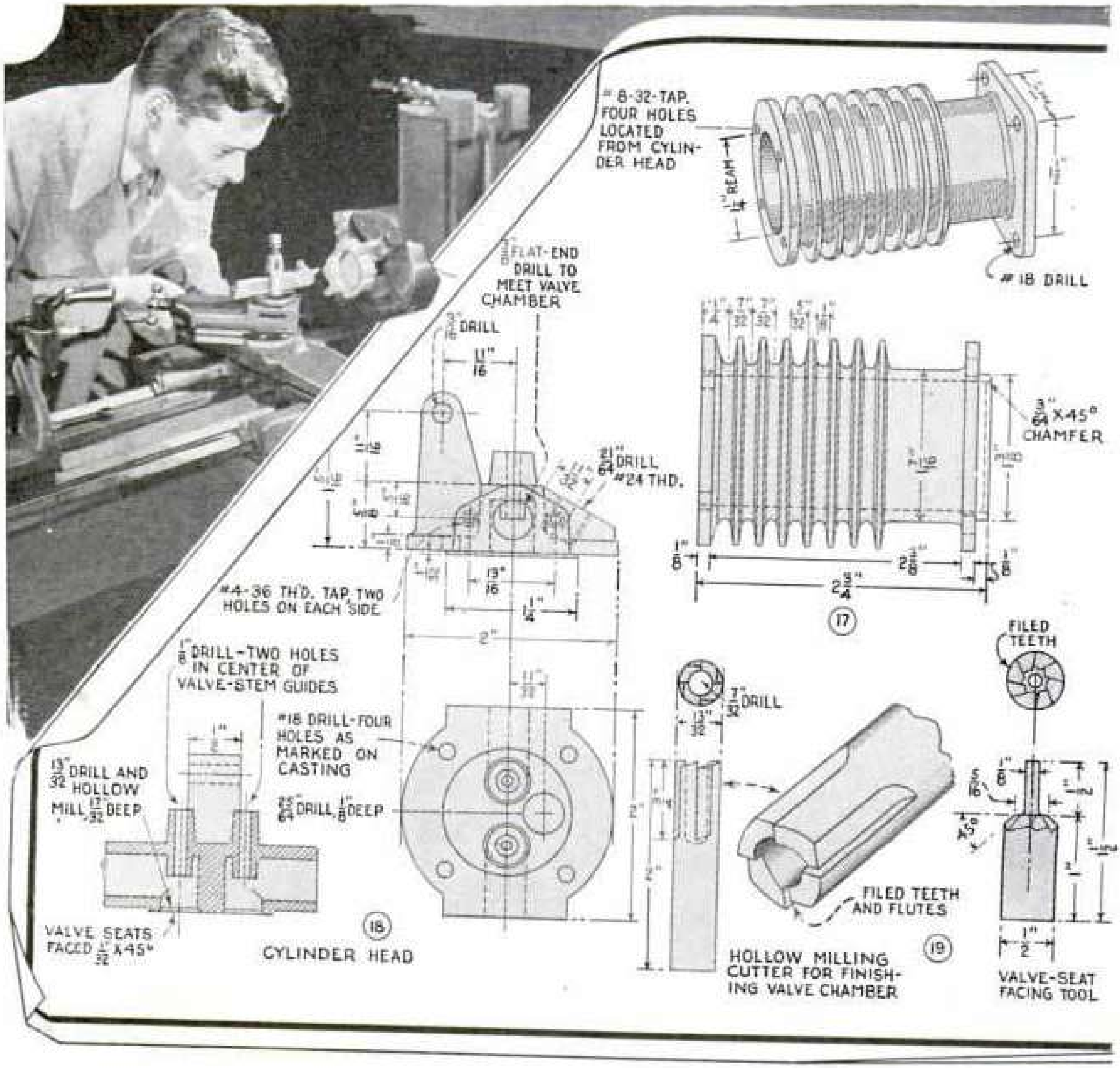
By E. C. Wittick

Part II—Machining the Castings

BEFORE you do any machining on the set of castings, it's a good idea to check the lathe centers for accurate setting, clean the chuck of all excess grease and chips, and see that the lathe tools are ground and shaped properly for the work. Be especially particular to see that your drills are properly ground. This means that the cutting edges of each bit must measure the correct angle, otherwise you are apt to have trouble doing the precision drilling necessary on this job.

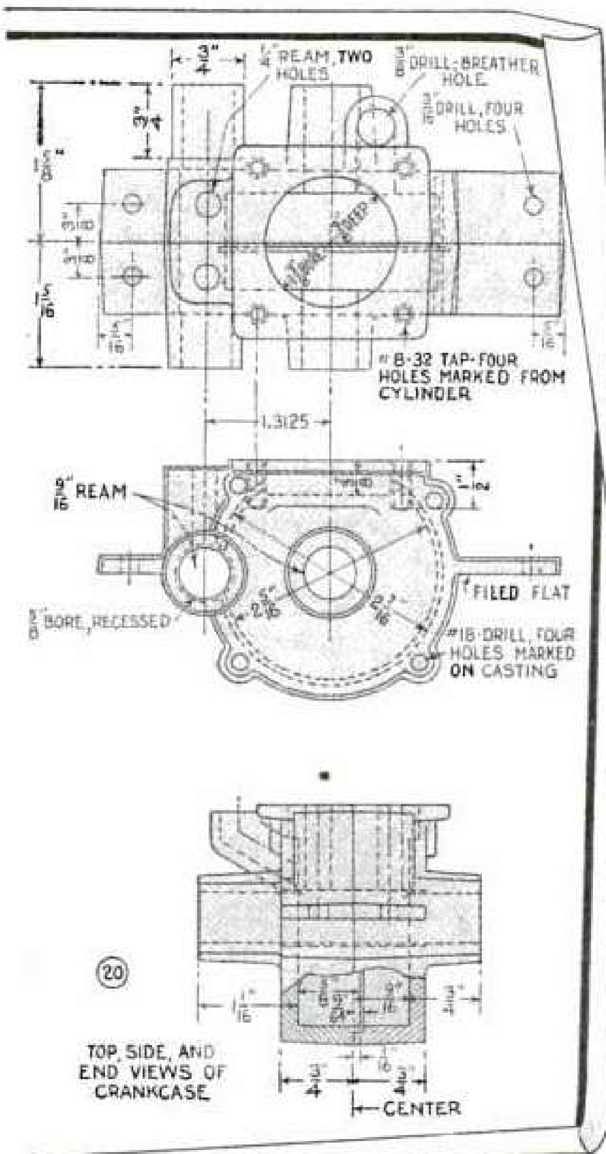
Although you can begin with most any part, it's best to start with the cylinder casting, finish dimensions of which are shown in Fig. 17. Chuck this with the flanged end out for the boring and lower-end facing operations. Keep in mind that the first roughing cut must, in all cases, be deep enough to get under the scale on the surface of the casting, but make certain to allow sufficient stock under the roughing cut for finishing. The cylinder bore is brought to final dimensions with an expanding reamer. The best way of machining the outside of the cylinder barrel and the cool-





ing flanges is to mount the casting on a mandrel. Otherwise you can finish half the length of the barrel before re-chucking after the boring operation. Then with the work reversed and re-chucked you finish the balance of the flanges and face the top end ready for the head. In any case the first method is the surest, as it avoids the possibility of error in re-chucking. Special care must be taken in chucking the cylinder-head casting, Fig. 18, for the facing operation. The important thing is to get the casting properly centered. After the head has been faced off and fitted to the cylinder, drill one 1/8-in. hole in the center of each valve stem guide. Then, in the lathe, drill 1/4 in. deep, following each of these 1/8 in. holes in from the faced side with a 13/32-in. drill, and finish the guides with the hollow mill shown in Fig. 19. Finish the valve seats next with the facing tool shown in the drawing. Next the flanges for the carburetor and exhaust should be finished, by center-drilling the location for the holes before they are drilled out and turning the head between centers in the lathe. Then drill out the exhaust, intake, and rocker-arm pin holes. Do not neglect to file or mill flat the sides of the rocker-arm support. Drill the screw holes as spotted and mark the location of registering holes in the cylinder top from these.

Machining the crankcase halves is about the most ticklish job of all, for here you have the problem of producing identical work on two separate parts. First you chuck each half and finish the face, then drill and ream holes for the main bearings. Be especially particular with the

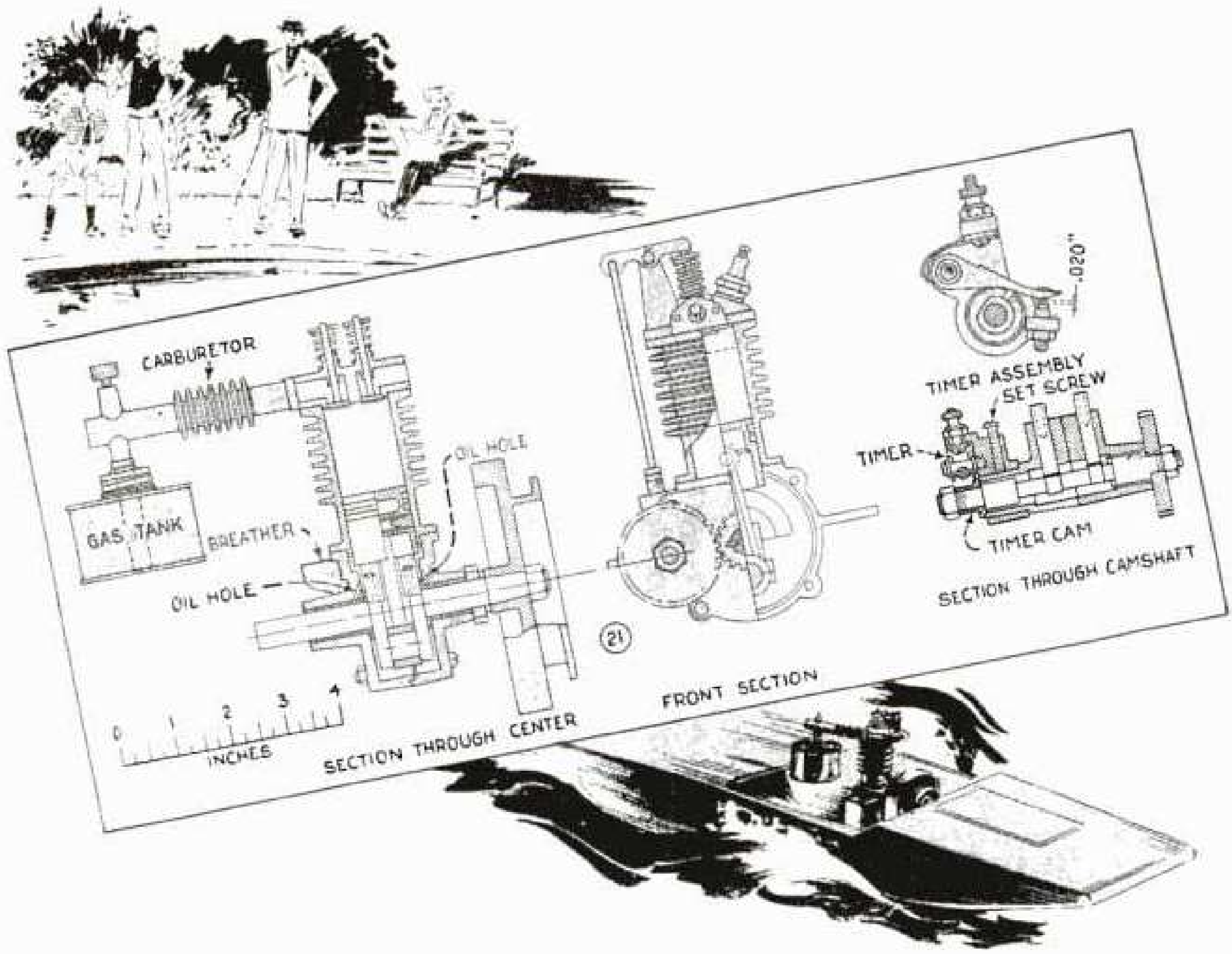


(20) TOP, SIDE, AND END VIEWS OF CRANKCASE

flanged joint between the halves, for when the latter are placed together the main-bearing holes must register exactly. Now, to finish the holes for camshaft bearings, the halves are set up on the faceplate separately with a locating pin passing through the main-bearing holes and bolted to the faceplate. To assure absolute accuracy the locating pin should be machined to a snug, slip fit in the main-bearing hole. Now, one thing to look out for: Notice in the details, Fig. 20, that the camshaft-bearing holes break into the inside of the crankcase. Because of this, each half is counterbored with a ⅝-in. drill, the counterbore being started on the inside of each half. This precaution avoids trouble with the reamer when you finish the holes.

When the camshaft-bearing holes are finished, the two halves of the crankcase should be placed together, and two short 9/16-in. mandrels inserted in the holes to line the pieces up. Then the holding-bolt holes are drilled, where spotted on the casting. The bolts are put in, and 9/16 by 5-in. mandrels are substituted for the shorter ones previously used. With this setup made you're ready to finish the job. The cylinder may now be set in place and the holes for the cylinder-base screws marked, drilled and tapped. Holes for the tappets and for bolts holding the engine on its base should be drilled at this time. The breather hole is made by first drilling from the top, ¼ in. deep vertically, and finished by drilling through on a slant with a 3/32-in. drill. Then the case is reversed and the 3/32-in hole is followed from the inside to meet the first hole.

The piston casting, Fig. 22, can be finished very nicely by first chucking it with the top end against the chuck face and truing up the skirt inside. Be careful when you true the bottom edge, to make allowance for facing the top end. Then the piston is re-chucked, turning it end for end, for finishing and cutting in the ring grooves. This is a rather fussy job, as you will note the piston is tapered, that is, it is .003 in. smaller at the top end. Although details are given in Fig. 22, you can save a lot of trouble by purchasing the rings ready-made. The wristpin, of course, must be made to suit.

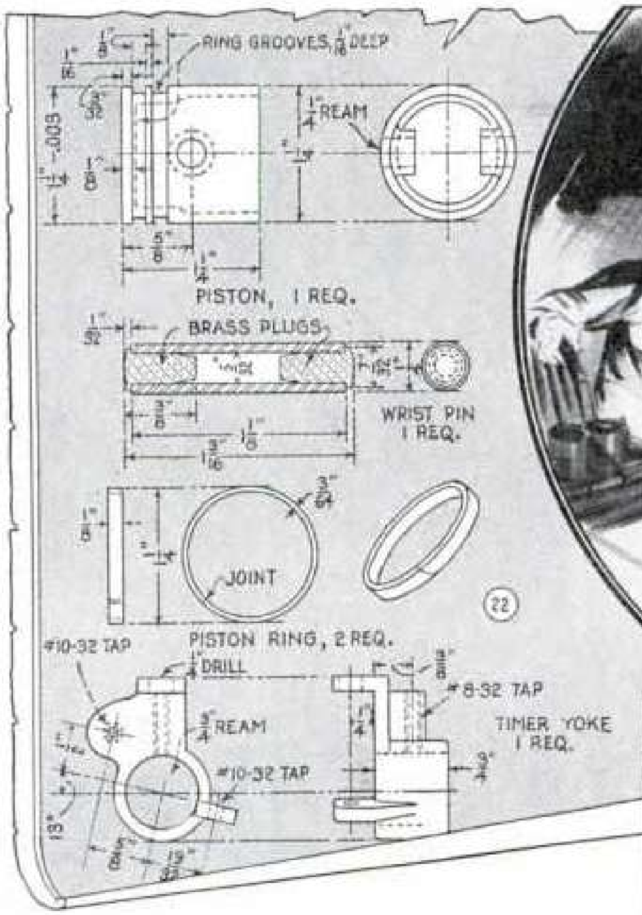


Now go back to Fig. 16 for details on the connecting rod and crankshaft. Because of its small size, the former is comparatively easy to finish up. At the big end, you first drill and tap for cap screws, then saw off the cap, which is fitted to the rod by filing or milling the meeting faces flat. The cap is then screwed to the rod. This done, you're ready to drill and ream the holes for the crank and wrist pin. Mount the rod on a mandrel to finish the sides of the bearings.

The crankshaft is made from a piece of flat, mild steel. The stock is 5¼ in. long and should be cut away by milling to the shape shown in Fig. 16. Then when the main and offset centers are located, mount in the lathe as in Fig. 15. Rough-turn the main journals, and finish-turn the crank pin. Cut off the projections with the offset centers and finish the main journals, then turn the taper and thread the front end. The keyway may be cut at this time. Counterweights are made from a steel disk which is finished true on a ⅝-in. mandrel, then split, paired and filed or milled to fit the crankshaft. The screw holes should be laid out in the bottom of the square notch, drilled from that side and counterbored from the opposite side. When this is done the crankshaft should be marked through these holes and drilled and tapped. Bearings are made from a piece of bearing bronze mounted in the lathe chuck. Cut off each bearing as finished and press into place in the crankcase. After the bearings are in place drill 1/16-in. oil holes from the inside of the crankcase into the main bearings as shown in the assembly drawing, Fig. 21.

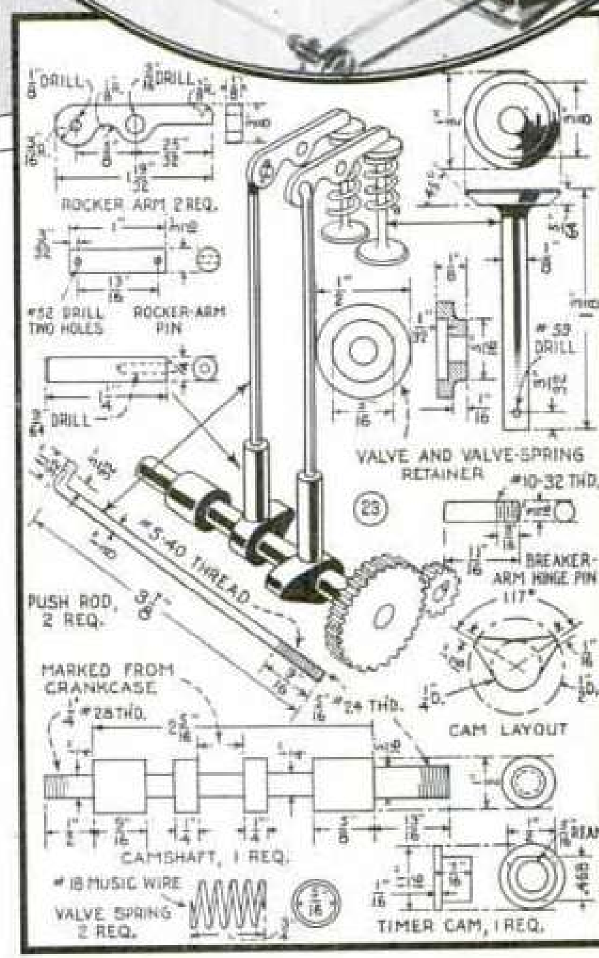
Next, the flywheel, Fig. 25. Rough-turn the casting on the outer side, then finish the inside, including the tapered hole. Mount on a tapered mandrel and finish the outer side. This procedure will give a true running wheel. The mandrel should be made just before the tapered end of the crankshaft is turned so that the same setup can be used. To make duplicate setups the mandrel must be made the same length as the crankshaft.

The camshaft involves some hand work. After turning out the blank as in Fig. 23, you have to lay out and file the cams to



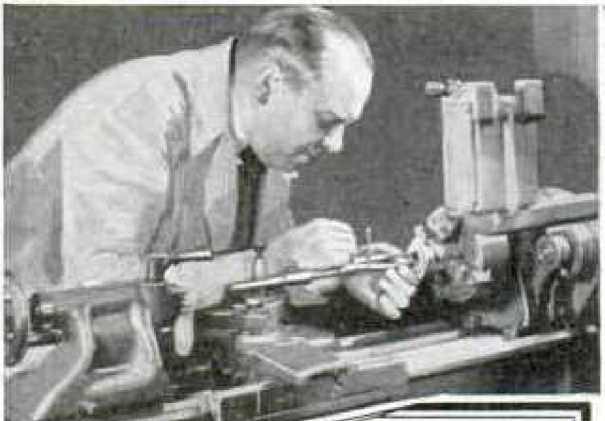
shape. Or you can make them by the cut-and-try method, the engine being assembled. With limited equipment, this may be the more accurate. However, the filing of the cams must be left until the valves, tappets, rocker arms, springs and push rods are made and fitted. Details on these parts you'll find in Fig. 23, with the timing gears detailed further in Fig. 16. This leaves only the timer yoke, Fig. 22, and the carburetor, Fig. 24, to complete the parts. Purchase of the valves and timing gears ready-made will save time.

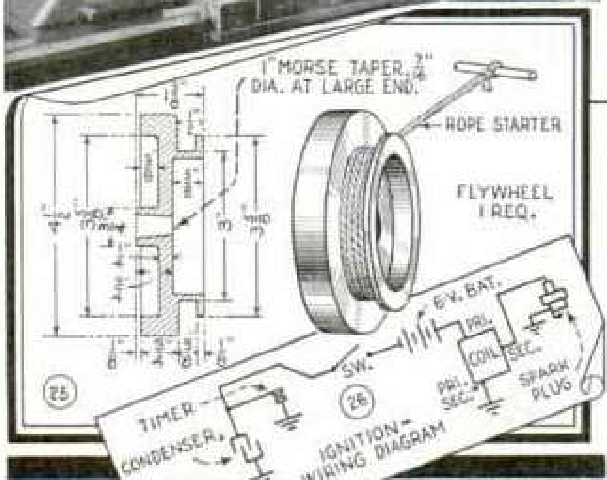
To make and fit the camshaft you proceed as follows: File the exhaust cam to the shape shown in the drawing. The camshaft may be held between the lathe centers to do this, using the lathe merely as a vise. With the engine assembled, time this cam so that the exhaust valve begins to open about 30° before bottom dead center and closes on top dead center. Set the piston at the center of the intake stroke, which begins at 5° past top dead center and ends at 10° past bottom dead center, and mark through the tappet hole to locate the peak of the intake cam. Then file the cam to the shape shown. Both cams may have to be dressed a little one way

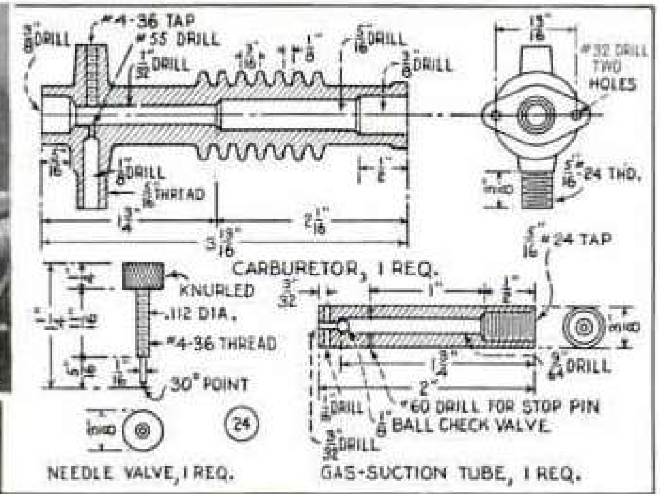


or the other to obtain the correct opening and closing points of the valves.

Assemble the engine in this order: Mount the piston on the connecting rod, put the rings on the piston, mount the connecting rod on the crankshaft, and assemble the crankshaft and crankcase parts.







Put on the cylinder and cylinder head, on which the valves, rocker arms and push rods have been assembled. Key the crank and camshaft gears, then insert the camshaft. Adjust the tappets to .002-in. clearance and time the valves. Put on the timer cam and place so that the flat is on top when the intake valve is at its closing point. Assemble the timer and set so that the points break at about 10° before the piston reaches the top dead center. The gap at the points should be from .018 to .020 in. The exact firing point is important and can be best found by experiment. Then put on the flywheel. If there is a slight gap between the crankshaft gear and the flywheel hub it should be filled in with a washer. Lastly, mount the carburetor, to which the gas tank and fuel suction pipe have been attached. Put in the spark plug.

Now the engine is ready for a running test. Mount it on a block of wood and clamp this in a vise. Wire up the ignition system as in Fig. 26. Put about a tablespoonful of oil in the crankcase, and fill the gas tank with high-test gasoline. Close the needle valve tightly and then open it about one-sixteenth of a turn, choke by placing a finger over the end of the carburetor and turn the flywheel a few times to draw gas up the fuel pipe into the cylinder. Wrap a stout cord around the cranking groove of the flywheel, switch on the ignition and pull the cord. If the engine fails to start, the spark timing and needle valve may need some adjustment. Normally, the engine should run at a speed of about 3,600 revolutions per minute.

Add oil to the supply in the crankcase from time to time when the engine is running. Oil in the proportion of one teaspoonful per two ounces of gasoline may be added to the gasoline in the tank for the breaking-in period. A half-hour run with a load, such as pressing a stick against the inside rim of the flywheel, will serve to break the engine in. The breeze of an electric fan will help keep the engine cool during the running-in period.

Rubber Hose on Carpenter's Bar Avoids Marring Surfaces

When using a carpenter's bar to pull large nails and spikes in places where it is necessary to protect the surrounding surfaces, a short piece of hose split along one side and slipped over the end of the bar as shown will do the trick. The hose can be moved up on the bar out of the way or removed when it is not needed.