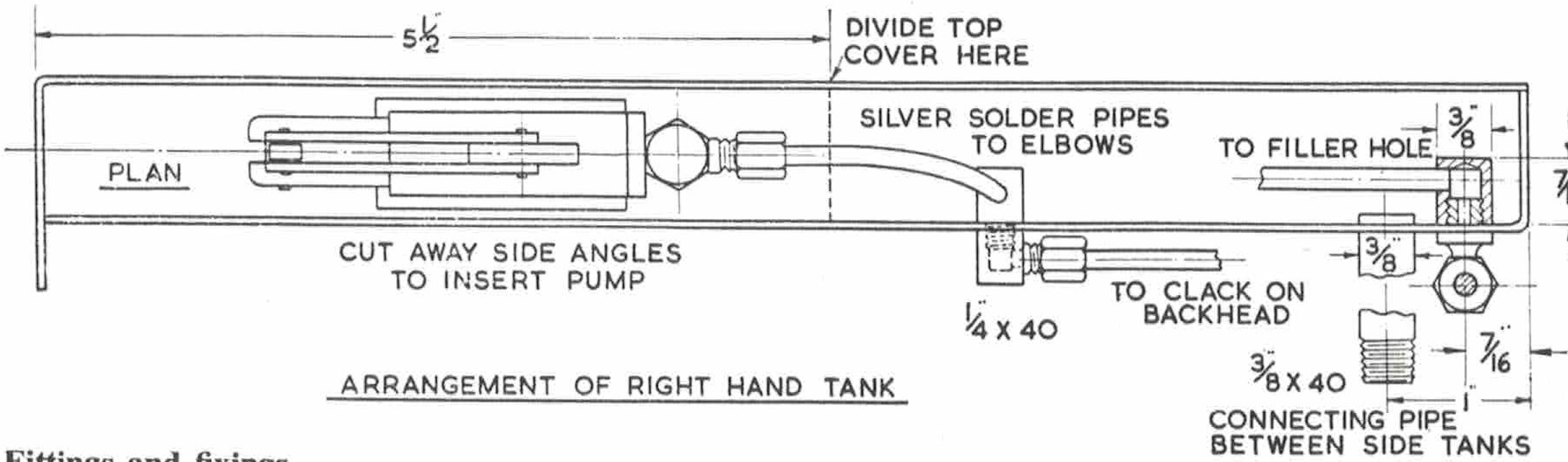


ARRANGEMENT OF RIGHT HAND TANK

**Fittings and fixings**

TO render the "works" of the engine readily get-at-able in case of emergency, the tanks can be removed instantly by taking out two screws and disconnecting the water-pipe unions. Take a look at the part section and you'll see how. Chuck a piece of ⅜ in. brass rod, face the end turn ¼ in. to 5/32 in. dia. screw 5/32 in. x 40, and part off at ⅝ in. from shoulder; make four. At 1½ in. from each end of the tank bottom, drill a No. 21 hole, put the screwed bit through, and fit a brass nut on it inside the tank. Set the tanks in position, and mark on the running-boards the exact position where the supports or spacers rest. I did mine the lazy way (trust Curly for taking the easy road!) simply smeared the bottom of each spacer with blue marking, put the tanks in place, lifted them up again, and there on the running-boards, were blue circles denoting the exact spots required! A No. 21 hole was drilled in the middle of each, the tanks replaced, and the drill put through the holes from underneath, making countersinks on the bottom of each spacer. The countersinks were drilled No. 30, tapped 5/32 in. x 40, and setscrews made to suit from ¼ in. hexagon road. The screws hold the tanks firmly in place under any conditions, but instantly release them when removed. It saves a lot of fiddling under the running-board!

The only fitting in the left-hand tank, apart from the connecting pipe, is the union for the pipe connecting the tank to the crosshead pump. Chuck a piece of ⅜ in. hexagon rod, face, centre deeply, turn and screw ¼ in. length ¼ in. x 40, part off ⅜ in. from shoulder, reverse in chuck, repeat turning and screwing, and drill through with No. 40 drill. Make a nut to suit. Drill a ¼ in. hole ⅜ in. above the bottom of the tank at 5/16 in. from the front end, poke the union screw through it with the countersunk end outside, screw the nut on the inside, and solder it as well, to make sure the so-and-so won't come loose when you are screwing on the union nut with the pump pipe attached. Little things are sent to try us, but we can avoid many with a little foresight!

The right-hand tank holds plenty beside water. Set the handle of the emergency pump (which has already been made and used for testing the boiler) in a vertical position, and locate the pump as shown, with the handle under the middle of the filler. The angles at the top of the tank at each side will have to be cut away sufficiently to allow the pump to be inserted. It is secured to the tank bottom by four ⅛ in. or 5 B.A. screws put through No. 30 holes drilled in the bottom, into tapped holes in the baseplate of the pump.

At ⅝ in. from the tank bottom, and 3⅝ in. from the back end ("mike" measurements not necessary!) drill a ¼ in. hole in the inner side. In this fit an elbow with a ⅛ in. pipe and union attached, as shown. Chuck a bit of ⅜ in. rod, face, centre, and drill No. 40 for 7/16 in. depth. Turn down 3/16 in. length to 3/16 in. dia. and screw 3/16 in. x 40. Part off at 7/16 in. from shoulder, and drill a No. 31 hole in the side. In this, silversolder a 2½ in. length of ⅛ in. pipe with a ¼ in. x 40 union nut and cone on the end. Push the screw through from inside the tank, and connect the union nut to the union screw on the pump valve-box. Chuck the ⅜ in. rod again, centre and drill 5/32 in. to 5/16 in. depth, tap 3/16 in. x 40, part off at a full ⅜ in. from the end, drill a 5/32 in. hole in the side and silversolder a ¼ in. x 40 union nipple in it. This is screwed on to the projecting end of the elbow outside the tank. When the tank is erected, a ⅛ in. pipe, with union nut and cone on each end, connects it to the clackbox on the backhead.

At 7/16 in. from the back end of the tank, and 1⅛ in. from the top, drill another ¼ in. hole, and in that one fit the bypass valve. Make another socket like that just described, but instead of a union nipple, drill a No. 31 hole in the side and silversolder a 7½ in. length of ⅛ in. copper tube into it. Hold the socket against the hole on the inside of the tank, and screw the spigot of the bypass valve into it. It must stand vertically when tight. The tube should be stiff enough to need no support inside the tank (it's O.K. on my own engine) but if it sags, solder a brass clip to it and the tank side, to keep the end in sight through the filler hole. Keep it clear of the pump handle.

Chuck a 1 in. length of ¼ in. brass rod, face, centre deeply, screw ¼ in. of the outside to ¼ in. x 40, reverse in chuck, repeat screwing, centre deeply and drill through No. 40. Drill a No. 23 hole in the side, and silversolder a 2 in. length of 5/32 in. pipe in it. Fit a ¼ in. x 40 union nut and cone on the other end. Screw this on to the union on the crosshead pump. The front end of the double union is connected to the right-hand clack on the boiler barrel, by a 5/32 in. pipe with union nuts and cones at each end. The back one is connected to the bottom of the bypass valve by a ⅛ in. pipe similarly furnished. I guess by this time *Mona* builders can make union nuts and cones in the dark! I make mine a dozen or more at a time when piping up a locomotive, so I don't waste time by having to go to the lathe every time I need one or two. Tip—attach the pipes to the tank unions first, then mount the tanks, after which, couple up to the boiler clacks and unions, and Bob's your uncle. The solitary union on the left-hand tank is connected to the union under the crosshead pump by a 5/32 in. pipe. Be careful to avoid kinking the pipe when bending it. I thread a piece of lead wire through any pipe needing a sharp bend; this entirely prevents kinking or crushing, and is melted out after bending.

The two tanks are connected by a ⅜ in. thin pipe just above the frame behind the boiler. You can either solder a short piece of plain pipe into each tank, and connect them by a slip-on rubber tube—in which case it doesn't matter about lining them up exactly—or screw the ends and connect them by a long nut with a thin locknut at one end, exactly as a plumber or gasfitter does. He calls it a connector, I did mine like that, making the nut from a ¾ in. length of 7/16 in. hexagon brass rod. One pipe was screwed ¾ in. length, the other 3/16 in. only. The locknut and the long merchant were screwed on the longer threaded pipe, and after erecting the tanks, the nut was screwed off the long thread on to the shorter one as far as it would go, then the locknut run up to it and tightened to keep it there.

**Rear tank and bunker**

Injectors won't work if the feedwater gets too warm, and as the water in the side tanks picks up radiated heat from the boiler, a supply is carried in the bunker, which keeps cold, and the injector draws its supply from that. The sides and back of the bunker are made from a single sheet of 18 or 20-gauge brass measuring 15¾ in. x 4 in. Mark out as shown, and bend at 4¾ in. from each end, leaving the overall width 6⅛ in. to match up with the tank sides.

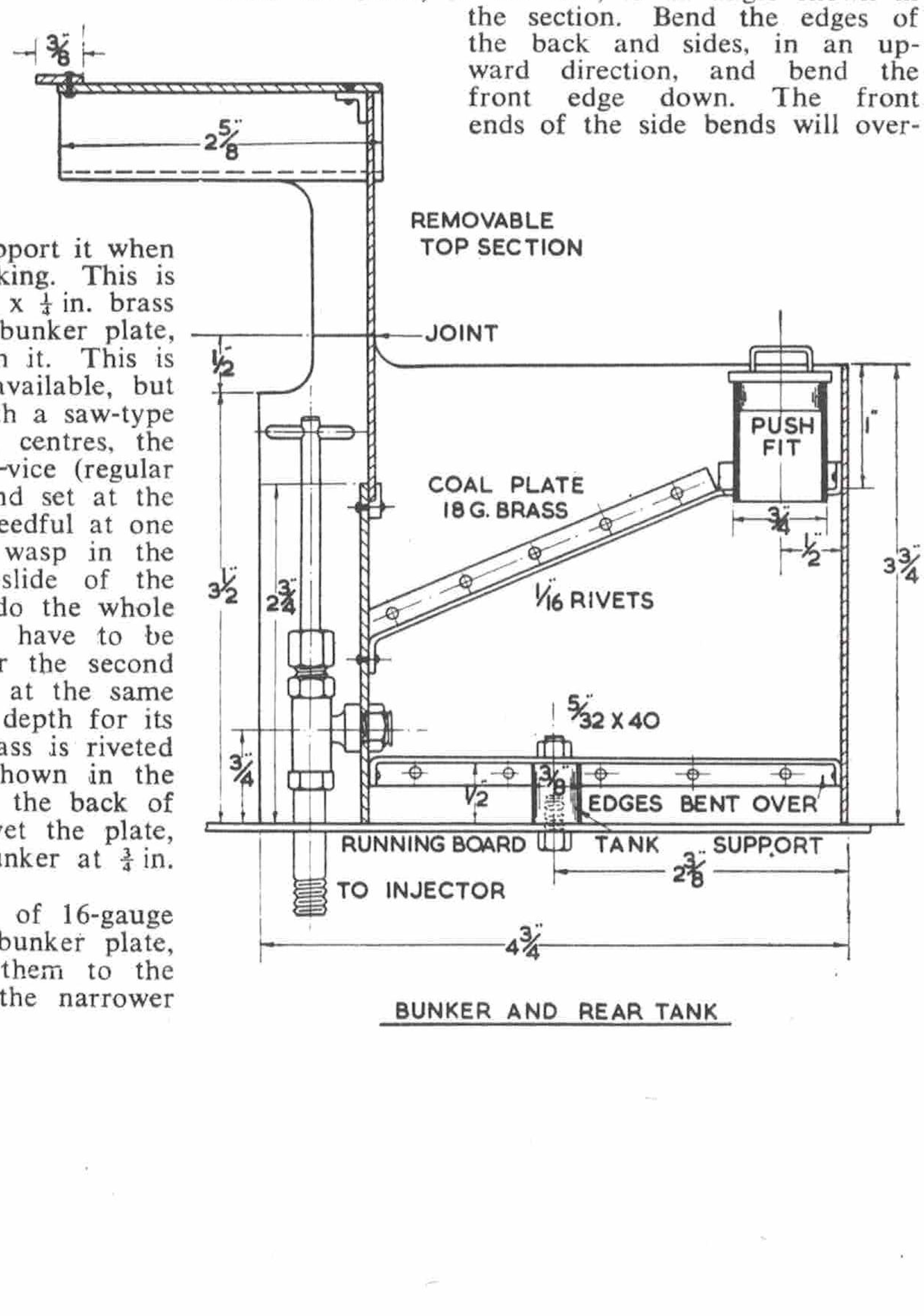
First fit the bunker plate, which is a piece of the same kind of material, 6⅛ in. long and 2¾ in. wide. To save fixing pieces of angle to each side, bend over the shorter ends to a full ¼ in. so that it will fit between the bunker sides. As the back of the cab must be made to take off so that the driver can get at the handles and the firehole, provision must be made to support it when in position while the engine isn't working. This is easily done by cutting a piece of ⅛ in. x ¼ in. brass to the same length as the top of the bunker plate, and milling a ⅛ in. x 1/16 in. rebate in it. This is easy enough if a milling-machine is available, but if not, it can be done in the lathe with a saw-type cutter mounted on a spindle between centres, the piece of rod being held in a machine-vice (regular or improvised) on the lathe saddle, and set at the right height for the cutter to do the needful at one fell swoop. But look out for the wasp in the jampot—the movement of the cross-slide of the average small lathe isn't sufficient to do the whole length at one cut, so two bites will have to be taken. When resetting the work for the second half of the cut, make sure that it is at the same height, so that the rebate is the same depth for its full length. The rebated length of brass is riveted to the top of the bunker plate as shown in the drawings, forming a groove to receive the back of the cab when in position. Finally rivet the plate, flanges inward, to the sides of the bunker at ¾ in. from the front end.

Failing milling facilities, cut a strip of 16-gauge brass ¼ in. wide, same length as the bunker plate, and another strip ⅛ in. wide. Rivet them to the top edge of the bunker plate, with the narrower one next to it as shown in the drawing.

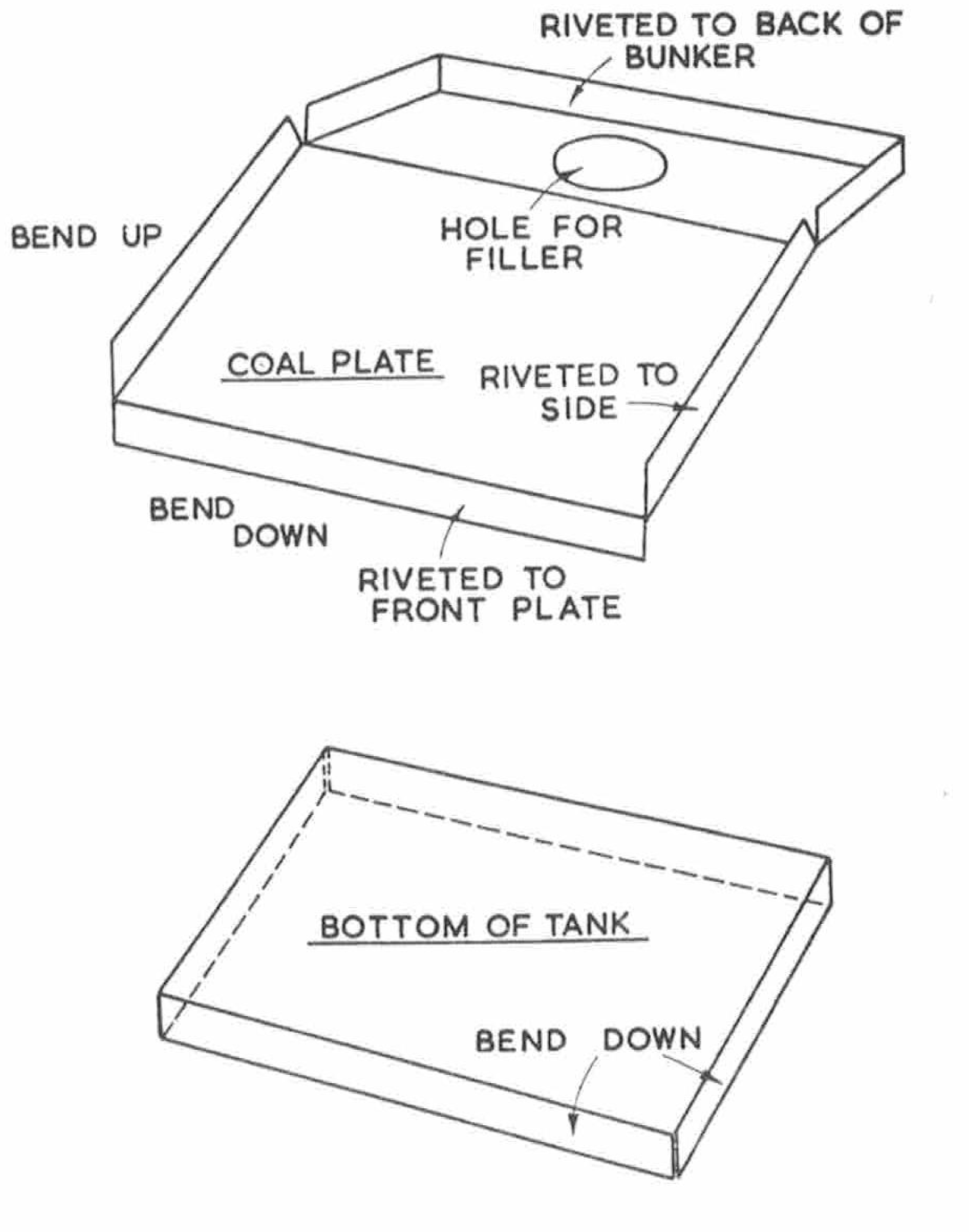
To save riveting bits of angle all around the tank bottom, make it like a tray, as shown in the perspective sketch. Mark out a rectangle on a piece of 18-gauge sheet brass, 6⅛ in. x 3¾ in. and add an extra ¼ in. all around for the flanges. Snip out ¼ in. from each corner, so that the flanges won't overlap when bent, then bend them in the bench vice. The result should fit nicely in the bunker, see section. Set it ½ in. from the bottom, use 1/16 in. rivets for fixing, and solder the joints right around to prevent water leakage.

Before fitting the coal plate, fit the supports or spacers for keeping the bunker and tank in position. These are the same as those under the side tanks, but only ½ in. long, see section. Drill the holes for the spigots at 2⅜ in. from the back end, and ½ in. from the sides. After fitting, screw up the nuts tightly, and solder over them. The position of the holes in the running-board for the screws holding them down, is ascertained in the same way as those for the side tank fixings. Note—the back of the bunker butts up against the ends of the frames, but two slots will have to be filed in the front plate, to clear the tops of the frames when the bunker is in position.

As the shape of the coal plate, which forms the top of the tank, is rather tricky, I have included a perspective sketch of it. On a piece of 18-gauge brass sheet, mark a rectangle 6⅛ in. x 4 in. Add ¼ in. all around for flanges, then at 1 in. from one of the long sides, draw a line right across. Cut a snip at each side where this line crosses the flanges, then bend the sheet, on the line, to an angle shown in the section. Bend the edges of the back and sides, in an upward direction, and bend the front edge down. The front ends of the side bends will over-




BUNKER AND REAR TANK




HOW TO BEND FLANGES OF BUNKER PLATES

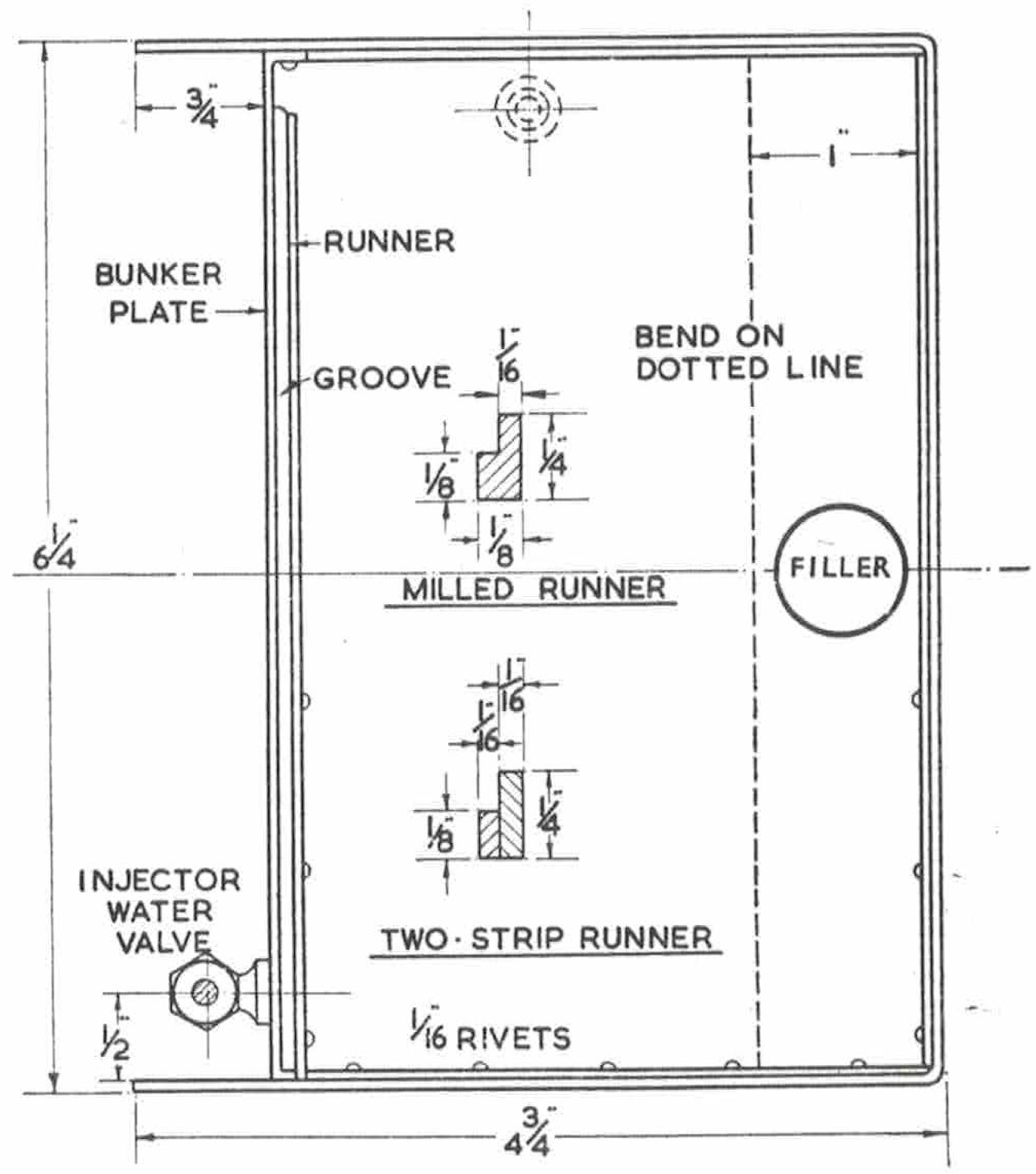
hang the front bend, so snip them off flush, as shown in the sketch. Drill a ¾ in. hole in the middle of the horizontal part, for the filler. In the bunker plate, ½ in. from side and ¾ in. from bottom, drill a ¼ in. hole, and fit the injector water-valve in it, with a nut inside, same as the bypass valve. The coal plate can then be inserted, the horizontal part at the back being 1 in. below the top edge, and the front about 1½ in. from the bottom. Rivet it in as shown, fit a 1 in. length of ¾ in. brass tube in for the filler, and solder the joints to make them all water-tight. Drill a ⅜ in. hole in the running-board to let the stem of the injector water-valve pass through, and the bunker can then be erected, using 5/32 in. screws through the running-board into the spacers in the same way as the side tanks were erected. The filler lid is turned from a bit of ¾ in. round rod, and needs no hinge; it just pushes in.

**Cab**

The front of the cab is cut from 18 or 20-gauge brass or steel (which does quite well, as there is no water in contact with it) to dimensions shown. Drill the window holes under size, and finish with a reamer or file, to have them perfectly circular. The window frames are rings of thin brass, riveted to the inside of the cab front by 1/32 in. rivets, or bits of domestic pins, with a disc of mica or perspex put between ring and cab front. Rivet a piece of ¼ in. x 1/16 in. angle to each side as shown. The cab front is fitted flush with the front edges of the cab sides, and secured by three 1/16 in. or 10 B.A. screws running through No. 51 holes drilled in the front edges, into tapped holes in the angles.

The back of the cab, and the upper parts of the rear side sheets, are made in one piece. Cut it from the same kind of material as used for the front, then bend the side extensions at right angles, so that the central section goes down between the sides of the bunker and rests in the groove of the runner, while the sides come flush with and rest on the raised part of the sides of the bunker. The result should be as shown in the drawing showing the bunker and rear tank, the upper part of each side lining up with the piece on the bunker, to complete the outline of the cab side. No fixing is required, as the back half of the cab roof is permanently attached to the cab back; this will have a flange which rests on the front half of the roof, and supports it. The whole lot is removed by simply lifting it off, and replaced just as easily. The windows are fitted with ring frames and mica or perspex "glasses", same as the front section. The rectangular windows in the cab sides are similarly treated.

The roof is made in two pieces, from the same material as used for front and back of the cab, each measuring 7 in. x 2⅝ in. Bend to the radius of the upper edge of front and back, and turn up the shorter edges to form the rain deflectors. These can be seen plainly in the photograph in the October issue. Each section is attached to the front and back by pieces of angle as shown. The front section of the roof should be screwed to the angles, but the back can be permanently fixed as mentioned above. A strip of metal ⅜ in. wide, is riveted along the front edge of the back section, with 3/16 in. of it overhanging, so that it rests on the back edge of the front section of the roof when the back of the cab is in position.




PLAN OF BUNKER AND REAR TANK

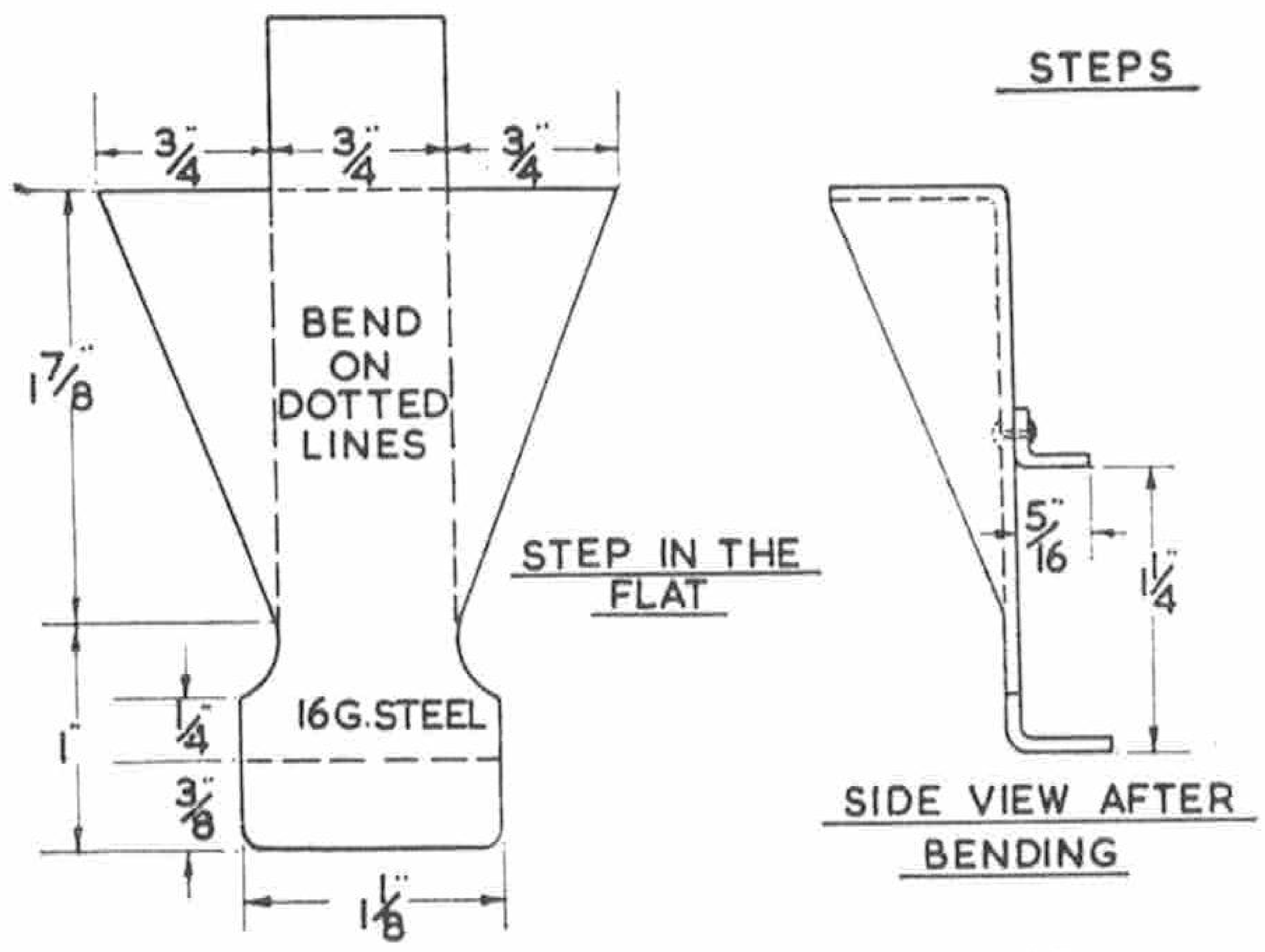
ONCE the cab and tanks are fixed, only a few blobs and gadgets are needed to complete the 3½ in. gauge engine. I'll just run through the essentials, and after that any builder can doll her up to their heart's content. The footplate between the bunker and the boiler is just a piece of 16-gauge steel cut to fit. There is no need to fix it permanently; if a little bit of ¼ in. × 1/16 in. angle is riveted along each side at 2⅞ in. apart, so that they fit between the frames and prevent the footplate sliding sideways, same will stay put but is instantly removable.

In the photograph in the October issue you'll notice that the edges of the cab sides have a beading. This is merely a strip of metal (tin will do, it keeps bright and looks like steel) about 5/32 in. wide, bent to the shape of the curved part of the cab-side and soldered on. At the lower edge it projects about ¼ in. and is rounded off. The vertical handrail pillars run from this to the running-board. They are pieces of 3/32 in. silver-steel cut to fit, with a nut on each end. The upper one is soldered to the underside of the projecting bit of beading, and the pillar should project about ⅛ in. below the lower one, and enter a No. 41 hole drilled in the running-board to receive it, the nut just resting on the running-board. The beading on the rear cab-sides must be made in two pieces, as otherwise the back of the cab couldn't be lifted off for driving.

The steps can be cast, or made from 16-gauge metal. I've seen little engines with the steps knocked all shapes and bent backwards, but this won't happen to *Mona's* if made as shown. Just cut out and bend as indicated, then braze the top corners. For the upper step, bend a bit of metal ¾ in. long to an angle as shown, and rivet it to the front of the step at 1¼ in. above the bottom treadplate. Braze it as well if steel. When this assembly is attached to the underside of the running-board by three screws, just below the cab opening, it would puzzle anybody to accidentally knock it back.

**Couplings and brake pipes**

To make the screw-coupling shackles, cut four pieces of 3/32 in. wire (nickel-bronze, alias German silver, will be found easiest to work) each about 2¾ in. long. File away ⅜ in. of each end to about

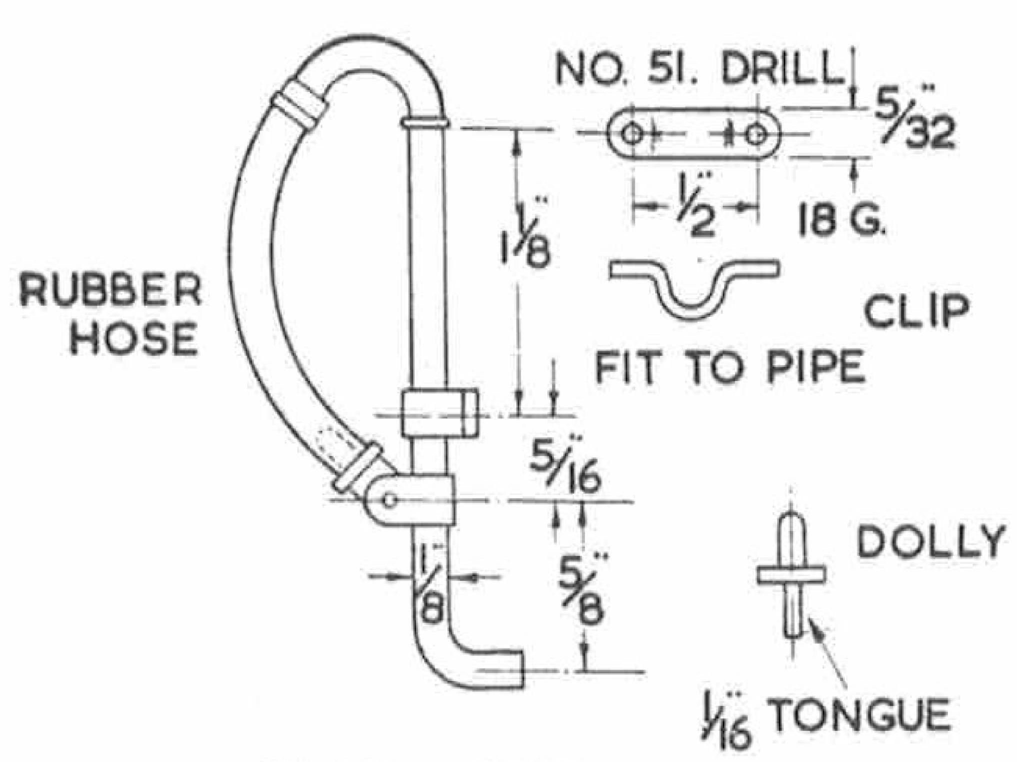



half-thickness, and bend into a loop with a small pair of roundnose pliers. Silversolder the joints, and don't worry if the eyes get blocked up, as they probably will. Just put a No. 44 drill through. Trim up the eyes if required, then bend to shape shown.

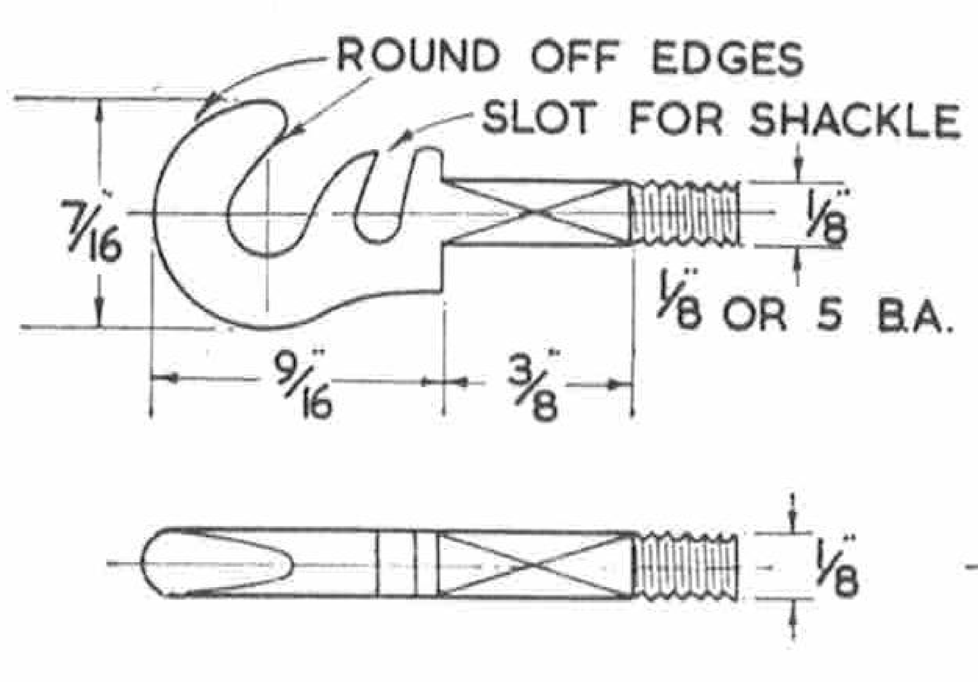
The swivels are turned up from 3/16 in. round rod Chuck in three-jaw, face off and turn a full 3/32 in. to fit the eyes in the shackles easily. Part off at a bare ⅛ in. from shoulder, reverse in chuck and repeat operation on the other end. Drill a No. 48 hole through the middle of each, and tap two of them 3/32 in. or 7 B.A. The shackles can be sprung over the end pivots with a little judicious wangling.

On carriages and wagons, the screw has right and left-hand threads, but on locomotives the usual practice is to screw one end right-hand, and leave the other plain, just pushing it through the hole in the swivel and burring over the end. Chuck a bit of ⅛ in. rod and turn 7/16 in. length to 3/32 in. diameter screwing it to match the tapped swivel. Part off at ⅜ in. from shoulder, reverse in chuck and turn ¼ in. of the other end to an easy fit in the plain hole in the swivel. In the middle on the ⅛ in. part screw a ⅝ in. length of 1/16 in. silver-steel with a 3/16 in. ball on the other end. Turn the ball from 3/16 in. rod. It doesn't matter about it being truly circular, as the full-size coupling-weights are only rough stamping.

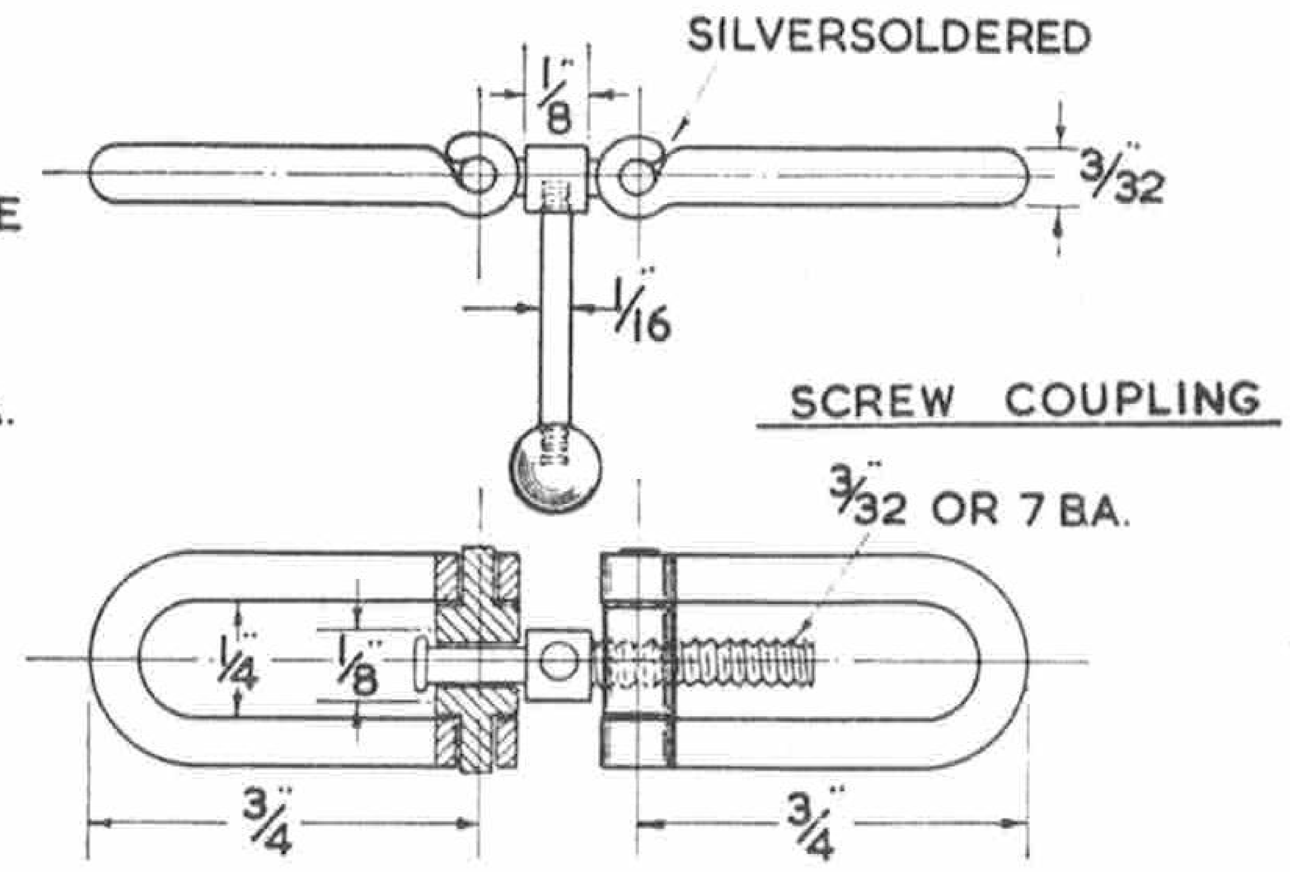
The drawhooks are sawn and filed from ⅛ in. steel; offcuts left over from the frames do fine. The stem is filed to fit easily in the square hole in the buffer beam, the end being rounded off and screwed ⅛ in. or 5 B.A. Be sure to round off any sharp edges which might tend to cut the link of a



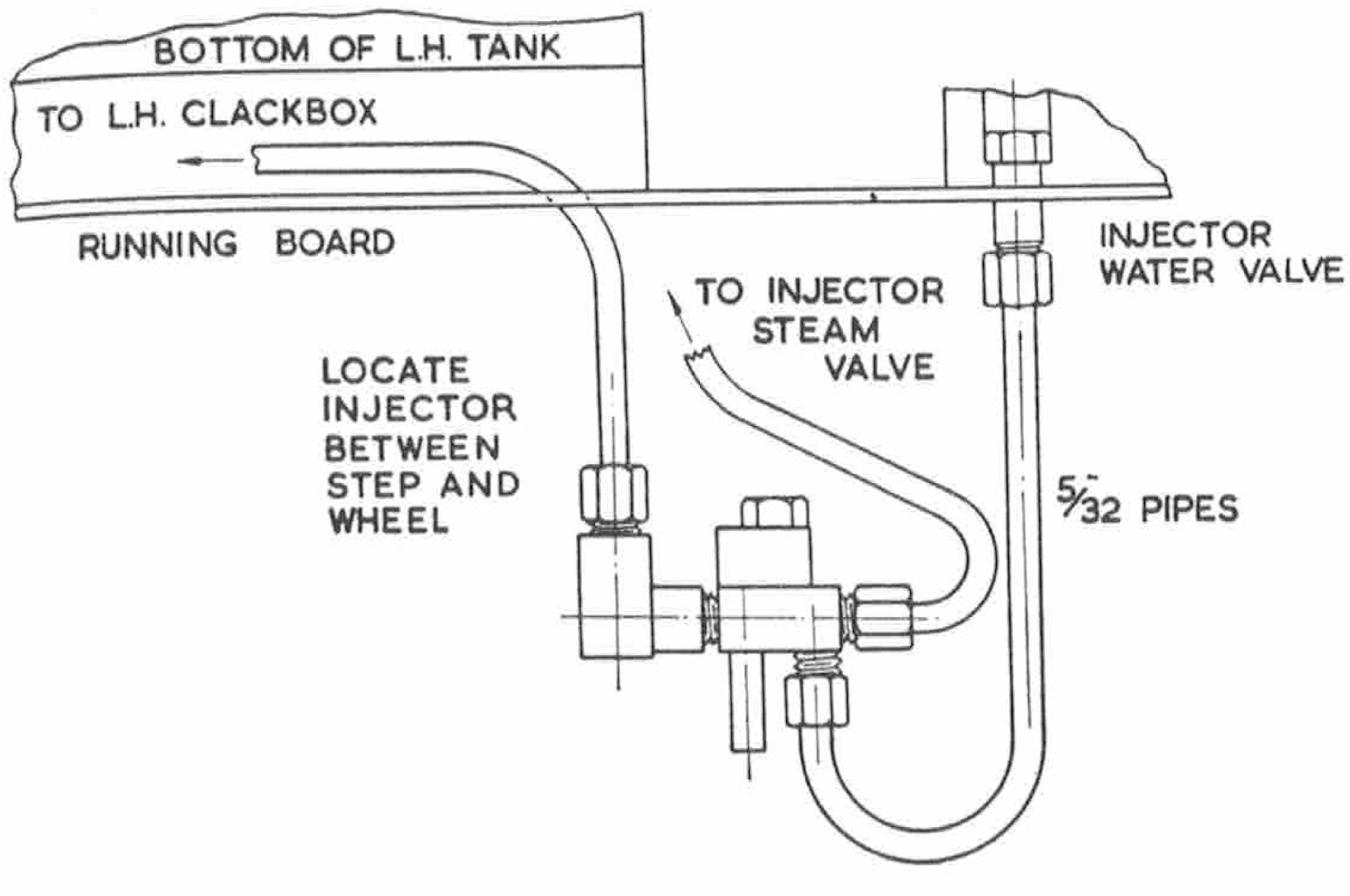

BRAKE PIPE




DRAWHOOK




SCREW COUPLING




HOW TO ERECT INJECTOR

coupling attached to the hook. The stems are pushed through the holes in the beams and secured by a nut and washer, with a spring wound up from 19-gauge steel wire between the beam and washer. The shackle with the plain swivel is placed in the slot. On my own engine I drilled holes in the hooks and countersunk them, instead of slotting them for the coupling; and before bending the shackles, the pieces of 3/32 in. wire were pushed through the holes in the hooks and the loops formed and silversoldered, thus making the shackles a permanent fixture in the hooks. It looks nice, but is rather more tricky than making them separate.

The brake pipes aren't pipes at all, but pieces of ⅛ in. copper wire bent to shape and shown. Before bending the swan-neck, turn down about 3/16 in. of the end of the wire, so that a piece of 5/32 in. rubber tube will slip on. Solder on a little ring of thin copper wire to form the collar (this makes it look pretty) and 1⅛ in. below that, solder on a little clip for attaching the stand-pipe to the buffer beam. The dolly, or dummy coupling, is turned from a bit of ¼ in. rod to the shape of a baby's dummy teat, but instead of a ring, the bit below the flange is filed to a flat tongue, and has a No. 56 hole drilled through it. This is attached to the pipe by a little clip as shown, the snipped-off end of a domestic pin being used as a rivet, or a 12 B.A. screw and nut, just as you fancy. Fit a piece of rubber tube as shown, for a hose, and attach the whole bag of tricks to the buffer-beam about ½ in. to the left of the drawhook, by two 1/16 in. screws.

**How to fit the injector**

The injector is supported just behind the bottom of the left-hand step by an inverted swan-neck of 5/32 in. copper tube with a union nut and cone at each end, as shown. The steam end is connected to the valve on the boiler by a 5/32 in. pipe with a union nut and cone at the top end, but at the injector end fit a collar 3/32 in. thick, to bear on the end of the steam cone when the union nut is tight.

The check valve on the injector is connected to the left-hand clackbox on the boiler barrel by a long 5/32 in. pipe with union nuts and cones at each end. It runs through a hole in the running-board and through the space between the bottom of the tank and the running-board, emerging at the front end of the tank and turning upwards to join the clackbox. Get the exact length of pipe required, by first running a piece of wire between the two union screws; saves muckle waste, ye ken! As the injector weighs less than an ounce, the three pipes provide ample support, and the gadget is instantly detachable for cleaning as required. The wee cones fur up just like full-size.

**Handrail knobs.**

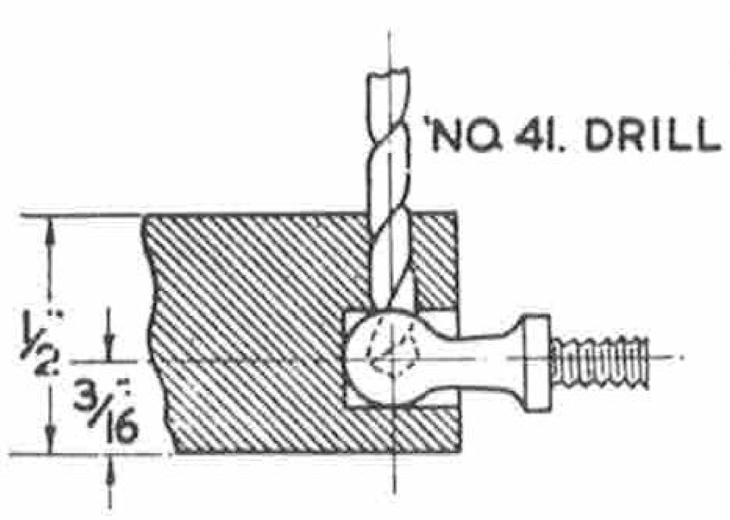
While our advertisers sell these at a cheap rate, some folk prefer to make their own, and here is a quick way of doing it. File the edge or a piece of cast steel of 9/16 in. × ¼ in. section, to the contour shown in the sketch, and harden and temper it to pale yellow. Clamp it under the slide-rest tool-holder with the cutting edge at centre-height. Put a piece of 3/16 in. nickel-bronze in the chuck with about ⅝ in. projecting, and carefully run the form tool up to it. If you get the right speed and feed (a trial-and-error job) the tool will cut the knob to correct shape. I part mine off with a parting-tool set upside-down in another tool-holder on the cross-slide, but anybody who can't manage that wheeze can saw off each knob as formed, with a fine-toothed hacksaw. The shanks are screwed 8 B.A.

To drill the ball ends truly, drill a 3/16 in. hole in the end of a piece of ½ in. square rod, about 3/16 in. from one of the facets. At right angles to this, drill a No. 41 hole through the thicker side as shown, to meet the first hole at such a position that a drill put down it, will cut through the centre of the ball. You can measure this from an actual knob. Then all that remains is to put each knob in the hole and drill straight through it, as illustrated. The knobs are screwed direct into the boiler shell and smokebox, with a smear of plumbers' jointing on the threads where they enter the boiler, and the handrails, of 3/32 in. nickle-bronze or rustless steel wire, can then be cut to length and pushed through the holes. That finishes the 3½ in. gauge engine, except for painting.

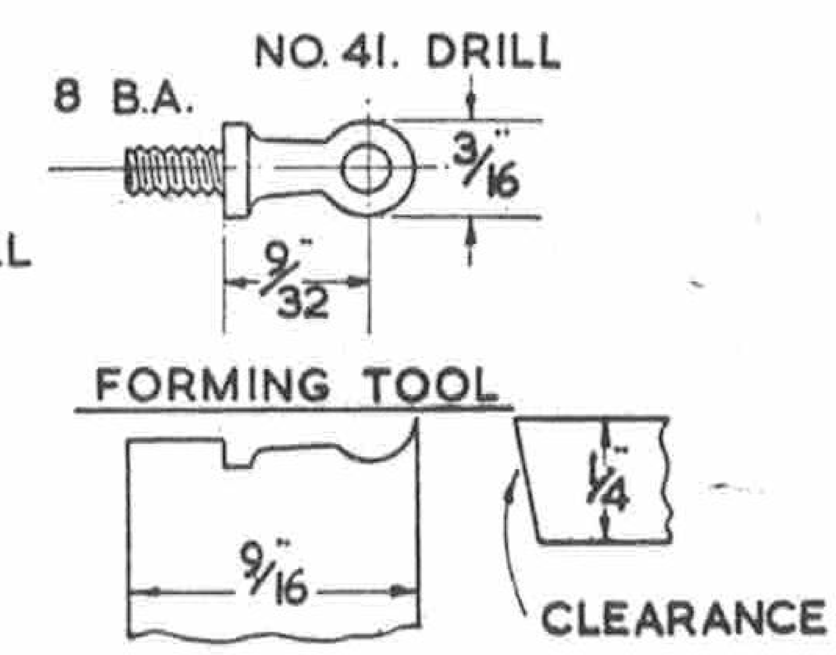
**How to finish off the 1¾ in. engine**

As far as the actual machining, fitting, etc., are concerned, the work on the smaller edition of *Mona* is pretty much the same as that described for the larger one, so repetition is only waste of space. If I briefly run through the differences in construction, builder of the baby should have no difficulty in completing it, if they haven't already managed it for themselves by aid of the 3½ in. notes.

To kick off with the boiler fittings, the dome is a dummy, turned from a casting or from solid, and attached by a 3/32 in. countersunk screw fitting a




JIG FOR DRILLING HANDRAIL KNOBS




HANDRAIL KNOB

tapped hole in the bush plug, as shown. The safety-valve is made as described for the 3½ in. size but to the dimensions given here.

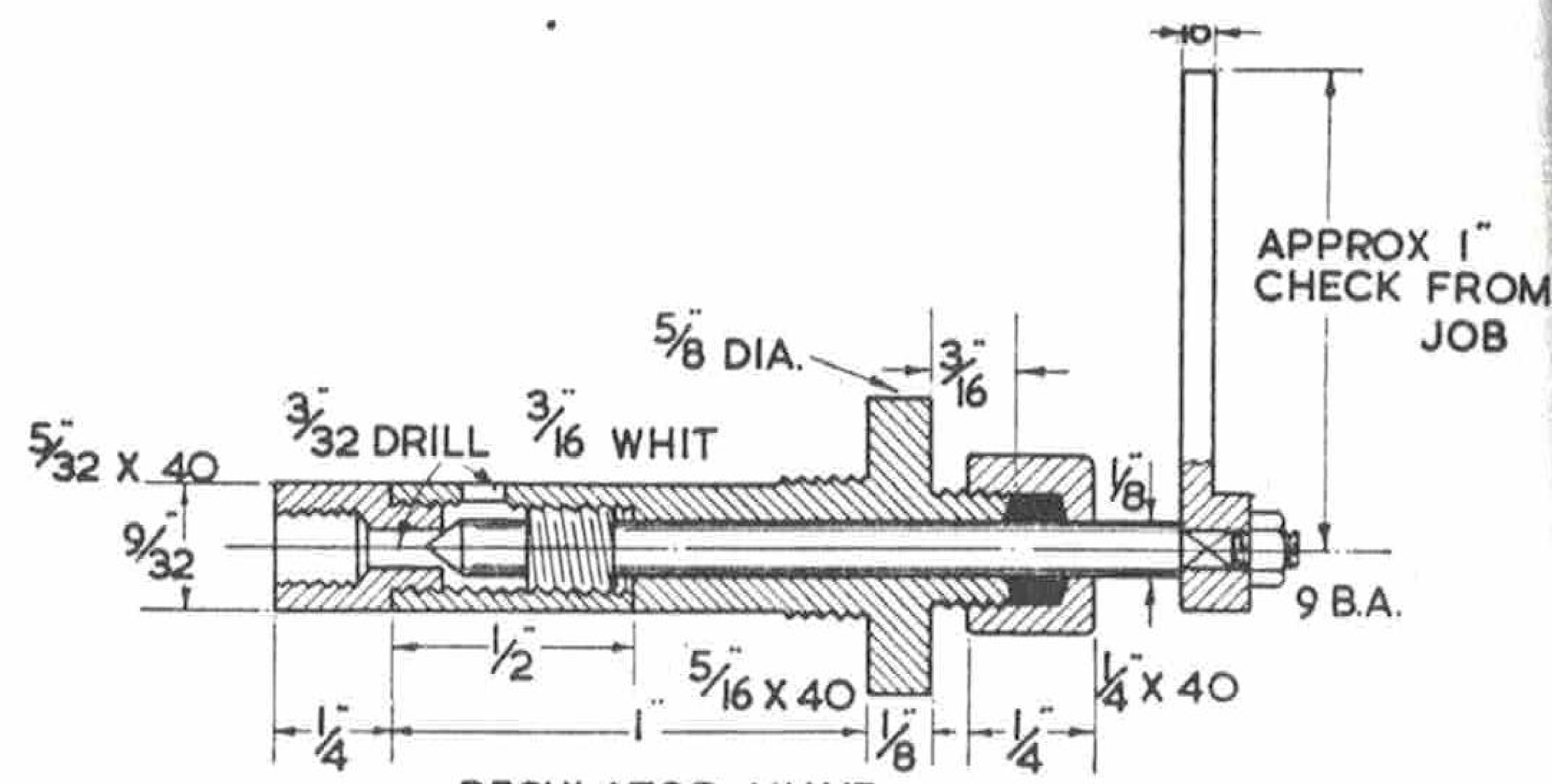
The regulator is a glorified screwdown valve. Chuck a piece of ⅝ in. round rod, face, centre, and drill No. 30 to 1⅜ in. depth. Open out to ½ in. depth with No. 21 drill, and tap 3/16 in. Whitworth. Turn down 1 in. length to 5/16 in. diameter and further reduce 13/16 in. length to 9/32 in. diameter. Screw the remaining bit 5/16 in. × 40. Part off at 5/16 in. from shoulder, reverse in chuck, turn 3/16 in. of the end to ¼ in. diameter and screw ¼ in. × 40. Make a gland nut to suit from 5/16 in. hexagon rod.

Chuck a piece of 5/16 in. rod, face, centre, and drill to a bare ½ in. depth with 3/32 in. drill. Open out to 5/32 in. depth with No. 30 drill and tap 5/32 in. × 40. Turn down ½ in. length to 9/32 in. diameter and part off at ⅝ in. from the end. Reverse in chuck and turn ⅛ in. full length to 3/16 in. diameter screwing 3/16 in. Whitworth. Skim the end true. The valve pin is a 1⅞ in. length of ⅛ in. rustless steel or bronze rod. Turn ⅛ in. of one end to 5/64 in. diameter and screw 9 B.A. File the next 3/32 in. square. Turn a blunt cone point on the other end.

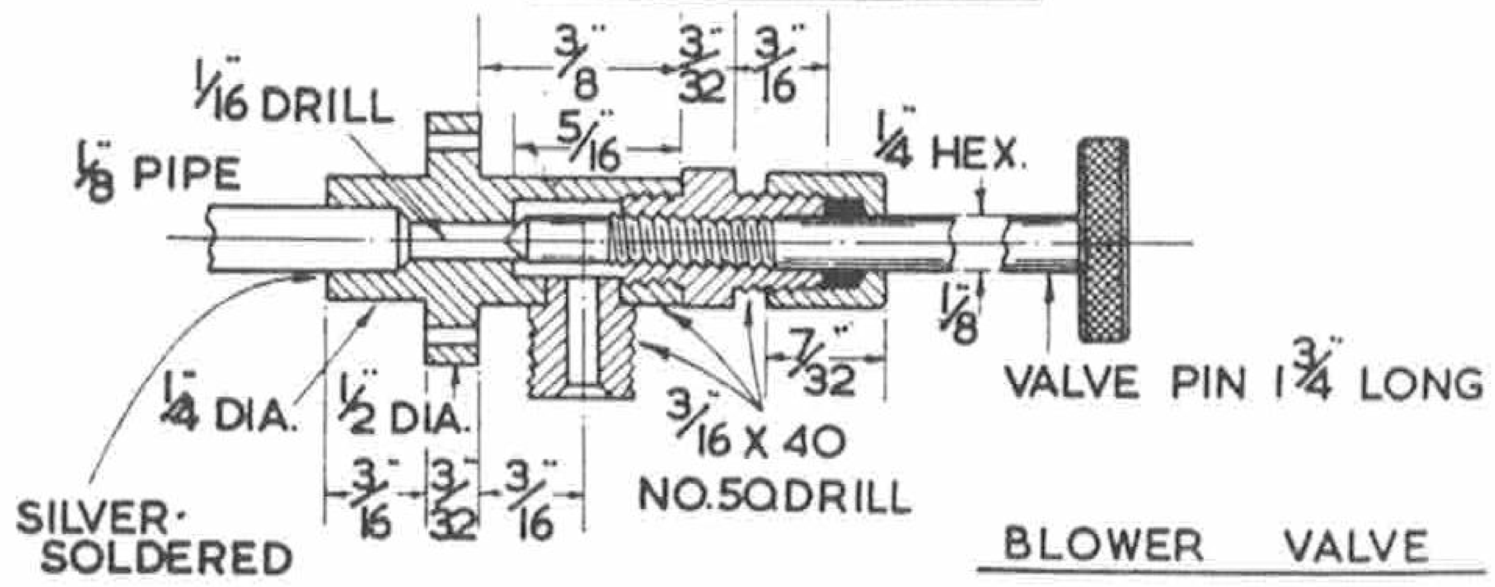
At ⅛ in. from the end of the cone, drive on a collar 3/16 in. long and screw the outside of it 3/16 in. Whitworth. Silver-solder the collar to the rod if not absolutely tight. Screw this into the tapped hole in the regulator body, long end first as shown, then screw in the valve seating. Drill a 9/32 in. hole in the backhead at ⅜ in. from the top, tap it 5/16 in. × 40, and screw the regulator body in tightly. Mark on the flange, which is the top; a centrepop will do. Remove regulator, and drill a 3/32 in. hole in the regulator barrel in line with the centrepop, and just past the end of the valve seating as shown. This lets steam into the regulator body, and if drilled as described, it will be on top of the barrel, thus ensuring dry steam, when the regulator is permanently fitted.

Cut a piece of 5/32 in. pipe a little over 5 in. long, and put a few 5/32 in. × 40 threads on each end. Screw one end into the regulator—don't forget the plumbers' dope—put another taste on the threads close to the flange, and screw the regulator home in the backhead, the pipe going through a ¼ in. × 40 tapped hole in the front plate of the boiler. Pack the gland with graphited yarn, and fit a handle as described for the larger engine, but make it to dimensions shown, the handle being long enough to work through a slot in the cab roof.

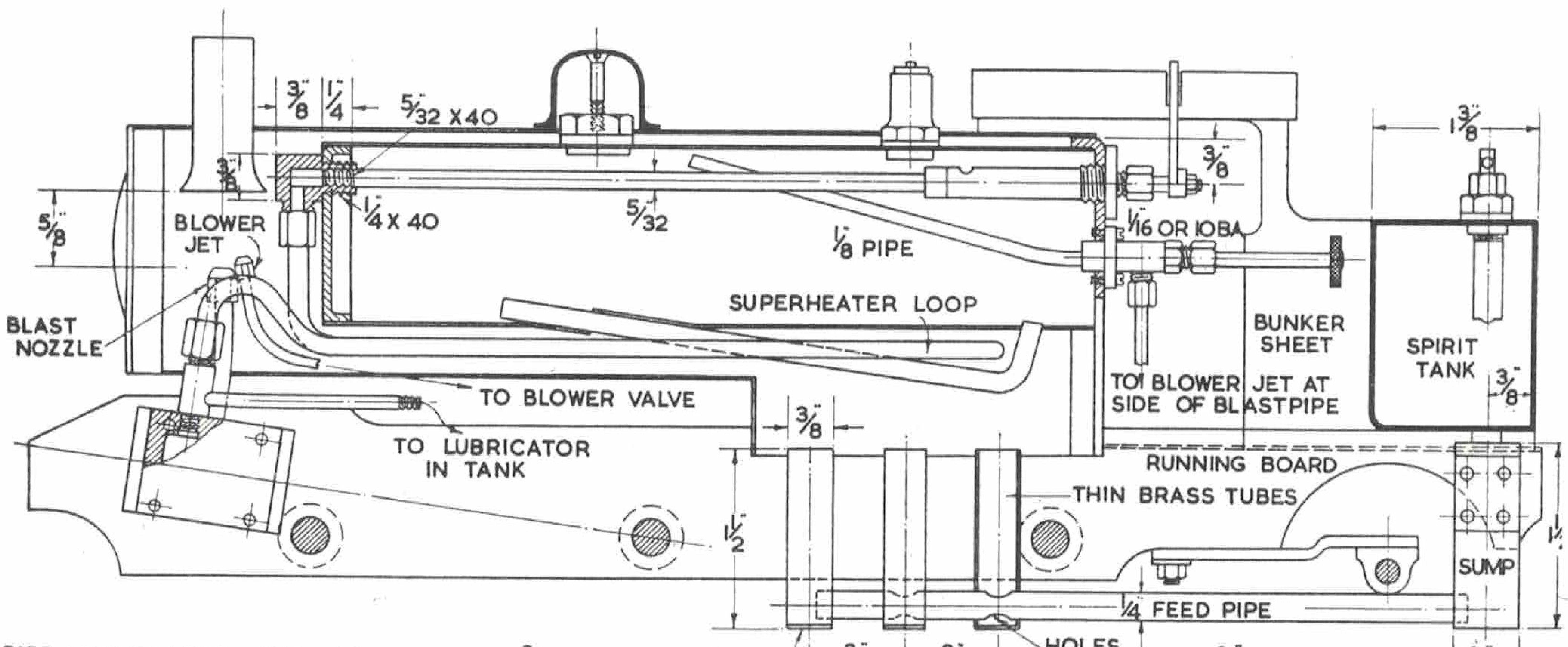
For the superheater elbow, chuck the ⅜ in. rod, face, centre, and drill No. 30 to ½ in. depth. Tap the end 5/32 in. × 40. Turn ¼ in. length to ¼ in. diameter, screw ¼ in. × 40 and part off at ⅜ in. from shoulder. Drill a 5/32 in. hole in the side and silversolder a ¼ in. × 40 union nipple into it. Anoint threads with plumbers' dope and screw the elbow on to the steam pipe, until the threads outside engage with the tapped hole, and the lot locks solid. The superheater itself is just a 14 in. length of 5/32 in. copper tube with union nuts and cones on both ends. One end is attached to the elbow, then the main part is looped under the boiler barrel as shown, and the other end is bent into a swan-neck for attachment to the steam-chest union.



REGULATOR VALVE



BLOWER VALVE



PIPE CONNECTIONS AND SPIRIT LAMP 1¾G. ENGINE

The blower valve is attached to backhead by a flange. Chuck a bit of ½ in. rod, face, centre and drill to ¾ in. depth with 1/16 in. drill. Open out and bottom to 5/16 in. depth with 5/32 in. drill and D-bit, and tap 3/16 in. × 40. Turn ⅜ in. length to ¼ in. diameter and part off at a bare 5/16 in. from shoulder. Reverse in chuck, turn 3/16 in. length to ¼ in. diameter open out the hole to ⅛ in. depth with No. 31 drill, drill three No. 51 screw-holes in the flange, drill a No. 30 hole halfway along the barrel, fit a 3/16 in. × 40 union nipple into it, fit a 3½ in. length of ⅛ in. pipe into the end, and silver-solder both pipe and nipple. Sounds like a Raymond Glendenning broadcast, doesn't it? The rest of the valve is finished off like those described for the bigger engine, but to sizes shown. Drill a ¼ in. hole in the middle of the backhead, bend the pipe so that it will hit the top of the boiler inside to get dry steam, and attach the flange by three 1/16 in. brass screws with a 1/64 in. Hallite washer between flange and backhead. The valve handle projects into the bunker to make it get-at-able, the cab roof being fixed. A ⅛ in. pipe goes from the union, under the backhead, through the casing of the boiler, and terminates in a weeny nozzle like a union nut with a No. 70 hole in it under the chimney liner.

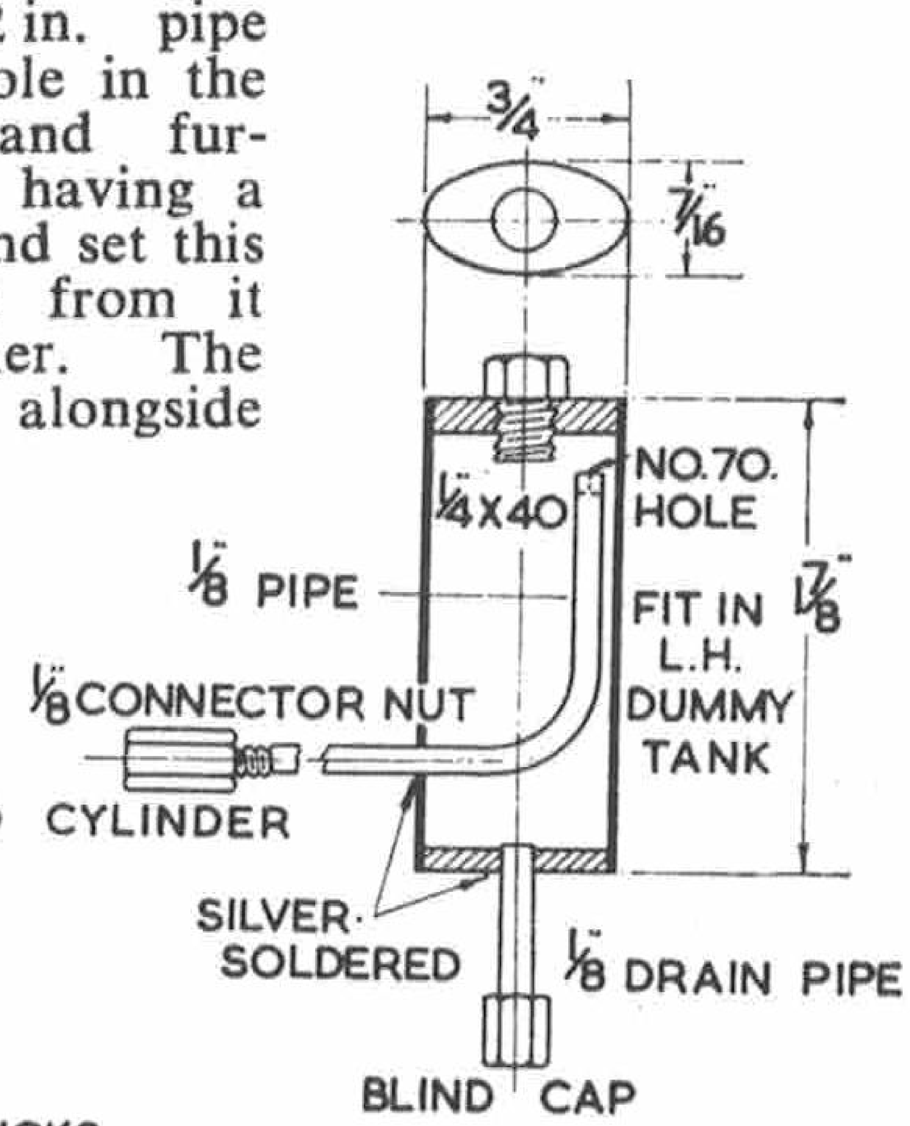
About three-quarters up the backhead, drill a 5/32 in. hole, tap it 3/16 in. × 40 and in it fit a water-level test valve, made as shown in the section which needs no detailing out.

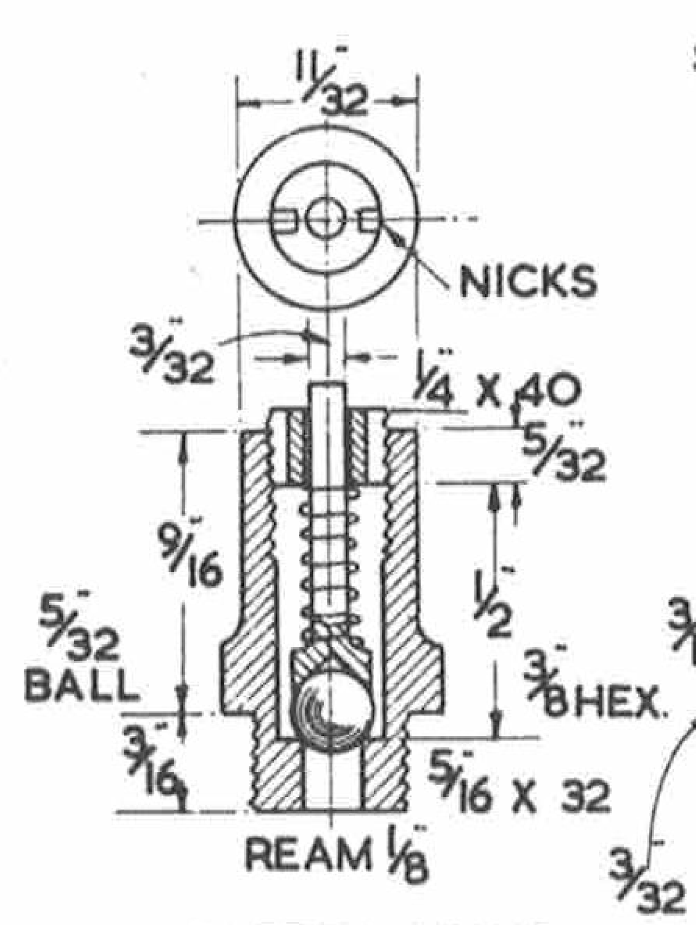
**How to erect boiler and superstructure**

In the top of the steam chest drill a No. 21 hole and tap it 3/16 in. × 40. Chuck a piece of ¼ in. rod, face, centre deeply, put about 3/16 in. length of ¼ in. × 40 thread on it, part off at ⅜ in. from the end, reverse in chuck, turn ⅛ in. length to 3/16 in. diameter and screw 3/16 in. × 40. Centre and put a 3/32 in. drill right through. Drill a No. 32 hole in the side, and in that, silver-solder a 2 in. length of ⅛ in. copper tube with a few ⅛ in. or 5 B.A. threads on the end. Screw this into the steam chest with the tube pointing backwards. Tip—take off the steam chest for this, and make sure there are no chips in it before replacing.

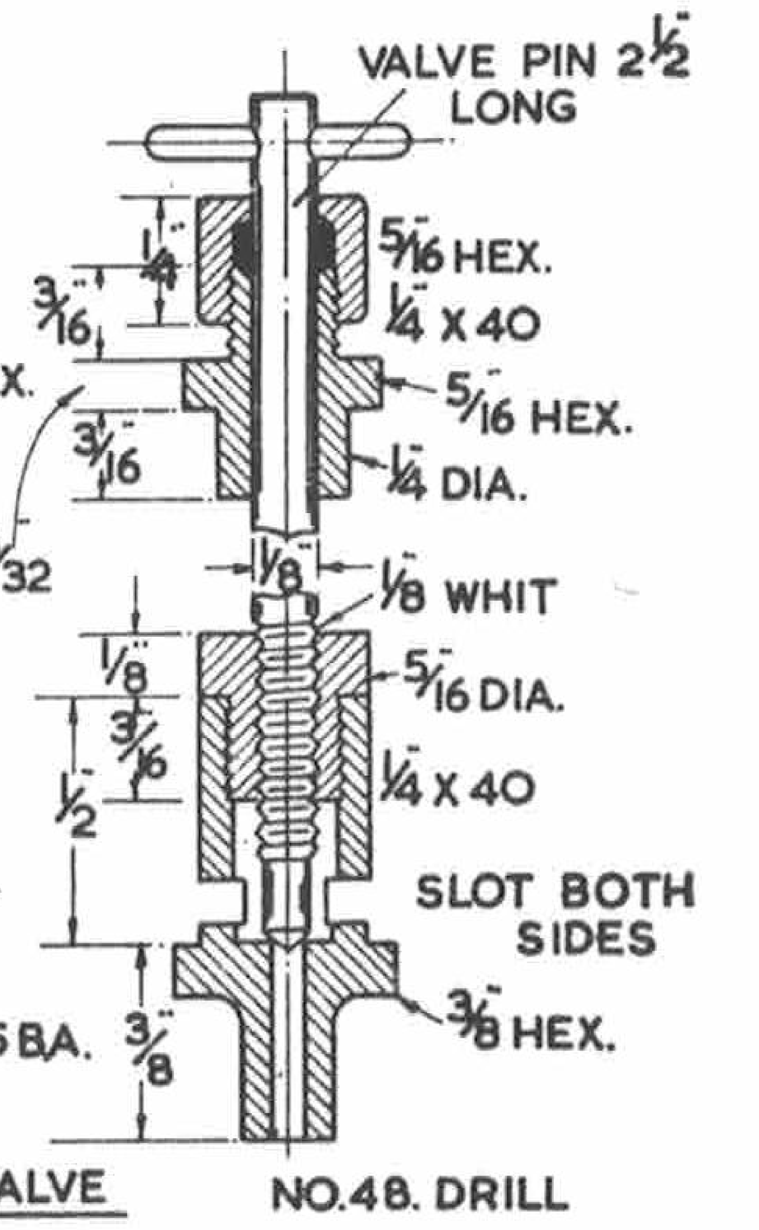
The front end of the boiler rests on a saddle made and fitted as for the larger engine, but to half the size. Fit it to the frames so that the bottom of the curve in which the boiler rests, is 3/16 in. above the top of frames, and fix with a couple of screws at each side. If not already done, drill the holes in the bottom of the boiler casing to allow the pipes to pass, then set the boiler on the frames. The front end is attached to the saddle by two 9 B.A. screws at each side, put through the flanges. See that the boiler shell is parallel to the top of the frame, then fix the firebox end with two 3/32 in. or 7 B.A. screws through frame and firebox casing at each side. No expansion brackets are needed. Put the screws through No. 41 clearing holes, with nuts inside. Couple up the superheater to the fitting on the steam chest; fit the blastpipe, which is just a piece of 5/32 in. pipe screwed into the hole in the cylinder casting and furnished with a cap having a No. 48 hole in it, and set this so that the steam from it blows up the liner. The blower nozzle is set alongside it as shown.

LUBRICATOR

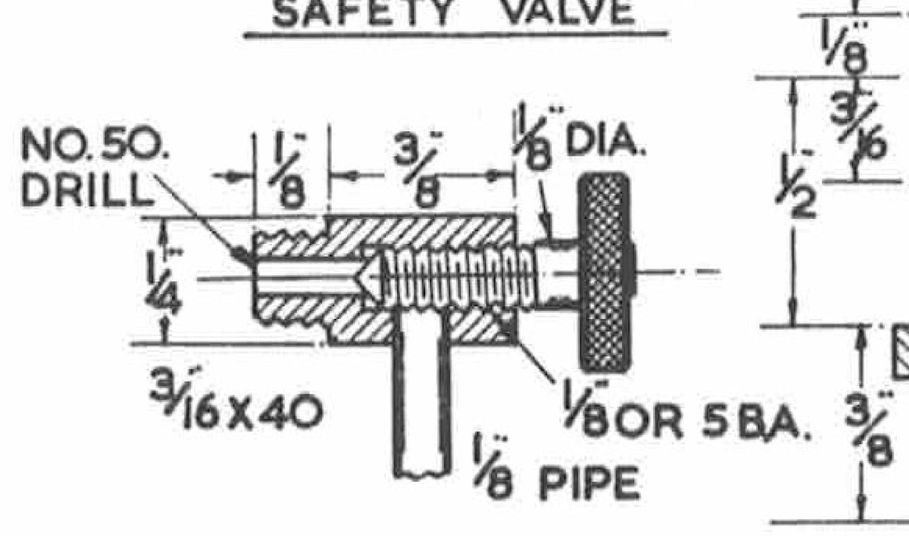



SAFETY VALVE

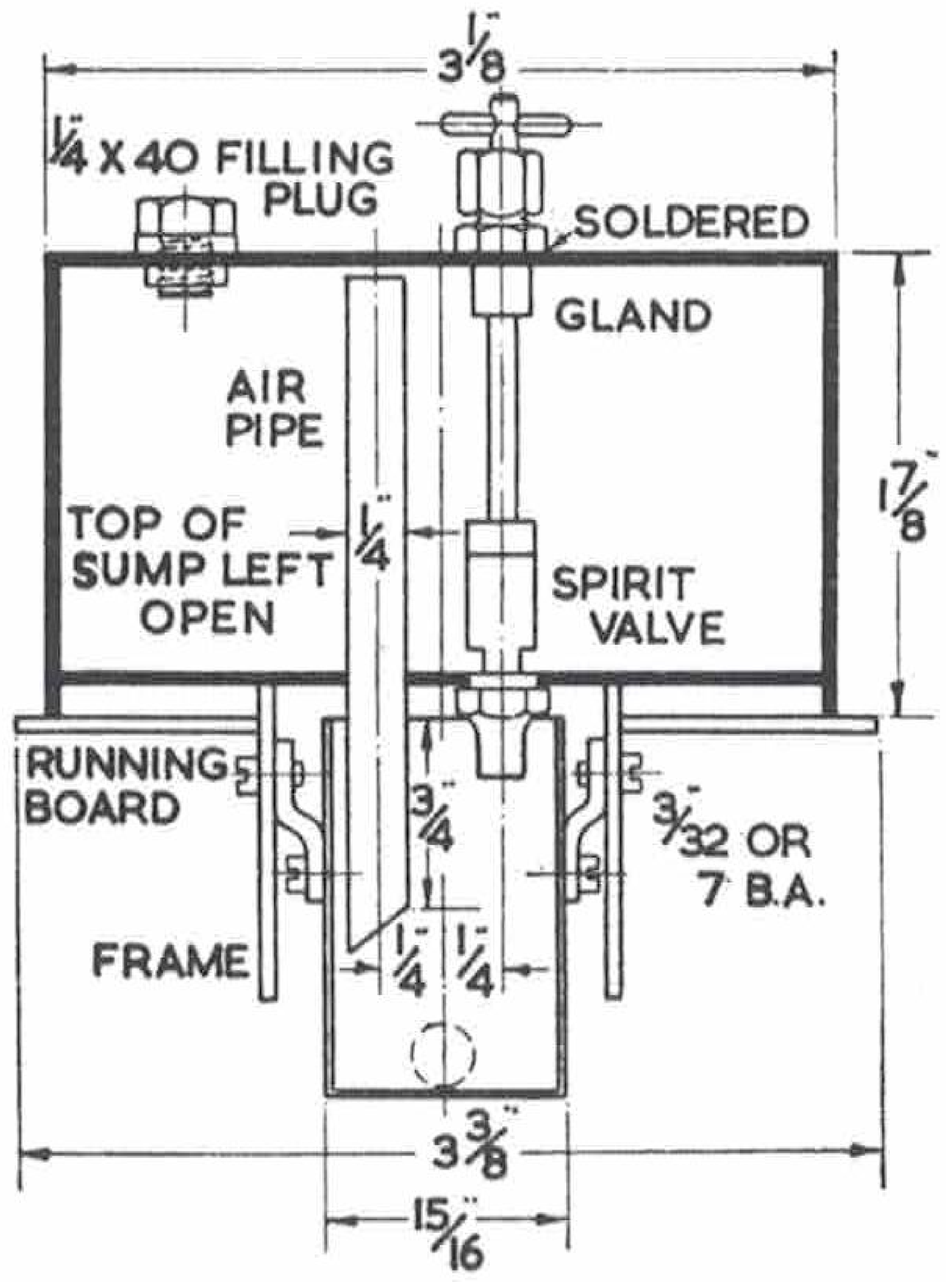



SPIRIT VALVE AND GLAND




WATER LEVEL TEST VALVE

SPIRIT TANK AND SUMP




The side tanks are dummies, and can be made from 22-gauge sheet steel, or stout tin would do quite well. Make them half the size of the 3½ in. tanks, and only the outside sheet, top, and front end are needed. The whole doings can be cut from a single piece, and the end and top formed by bending, in the same manner as the steps described in the first paragraph. Rivet a piece of $\frac{1}{4}$ in. × 1/16 in. angle along the bottom of each, and attach them to the running-boards by three 3/32 in. screws put through No. 41 holes in the running-boards into tapped holes in the angles.

The lubricator is fitted inside the left-hand tank, at the front end. It is made from a $1\frac{7}{8}$ in. length of $\frac{5}{8}$ in. thin brass or copper tube which must be squeezed oval to fit in the tank. The top is $\frac{1}{8}$ in. thick, and is tapped $\frac{1}{4}$ in. × 40 for a filling plug. A $\frac{3}{4}$ in. length of $\frac{1}{8}$ in. pipe is fitted in the bottom; this goes through a hole in the running-board when the lubricator is erected, and has a blind cap screwed on the bottom end, so that condensate water can be drained off before refilling. Drill a No. 32 hole near the bottom as shown, and fit a 3 in. length of $\frac{1}{8}$ in. pipe in it (see section) the top of this being plugged, and a No. 70 hole drilled in the plug. Silversolder all the joints, then put it in the tank before fitting same for keeps. Drill a hole in the top of the tank to let the filling-plug through. Cut the pipe level with the one coming from the steam-chest fitting, and screw it $\frac{1}{8}$ in. or 5 B.A. Join the ends with a long nut, same as plumbers and gasfitters join their pipes.

**Boiler and Superstructure Erection (continued)**

THE sides and back of the bunker are cut from the same material as the dummy tanks, but the back part of the bunker has a piece of 22-gauge brass or tin cut to fit between sides, and bent at right angles to form the bottom, soldered into it as shown. This forms the spirit tank, and another piece of metal is cut to fit over the top, and soldered all round so that it is airtight. If it isn't, the automatic spirit feed won't work, and the burners will flood. To make the spirit valve, chuck a bit of $\frac{3}{8}$ in. hexagon rod in three-jaw, face, centre and drill to 1 in. depth with No. 48 drill. Open out and bottom to $\frac{1}{2}$ in. depth with 7/32 in. drill and D-bit, tap $\frac{1}{4}$ in × 40, turn $\frac{1}{2}$ in. length to 5/16 in. diameter and part of at $\frac{1}{8}$ in. from shoulder, reverse in chuck and turn the other end as shown. File a slot close to the bottom at each side, with a thin flat file. Chuck a bit of 5/16 in. round rod, face, centre and drill No. 40 for $\frac{3}{8}$ in. depth. Turn 3/16 in. length to $\frac{1}{4}$ in. diameter and screw $\frac{1}{4}$ in. × 40. Part off at $\frac{1}{8}$ in. from shoulder, reverse in chuck and put a $\frac{1}{8}$ in. tap through. Screw this bit into the valve body as shown.

The gland is made in the same way as the other glands, and needs no detailing. The valve pin is a $2\frac{1}{2}$ in. length of $\frac{1}{8}$ in. rustless steel or bronze, one end being turned to a point, and screwed $\frac{1}{8}$ in. for $\frac{5}{8}$ in. length. The other end is cross-drilled No. 52 and a piece of 1/16 in. steel wire squeezed in it for a handle. At $\frac{1}{4}$ in. off centre of the top of the spirit tank, $\frac{3}{8}$ in. from the back, drill a $\frac{1}{4}$ in. hole and carry right on right through the tank bottom, so that the two holes will line up. Solder the gland fitting into the top one, and open the bottom one to 5/16 in. and solder the valve into that, then put the pin in and pack the gland. At $\frac{1}{2}$ in. to the left drill a $\frac{1}{4}$ in. hole, and in that, solder a piece of $\frac{1}{4}$ in. thin tube with the end bevelled off as shown. This should stand out far enough to dip $\frac{3}{4}$ in. into the sump as shown.

The sump can be made from tin, in the same way as the tank for the mechanical lubricator, but the joints need only to be soldered. Fit a bracket made from 16-gauge metal at each side as shown, and solder over the screws to prevent leakage. Drill a $\frac{1}{4}$ in. hole in the front. The burner tube is a $5\frac{1}{4}$ in. length of very thin $\frac{1}{4}$ in. tube, with three wick tubes on it. These are $1\frac{1}{2}$ in. lengths of $\frac{3}{8}$ in. thin tube, plugged at bottom and drilled $\frac{1}{4}$ in. to let the feed tube pass through. Only one hole is needed in the front one, but the others are drilled right through, and the feed tube is cross-drilled as shown, to let spirit flow to the wicks. The whole bag of tricks is silversoldered, and then the end of the feed pipe is soldered into the sump, and erected by screwing through the frames into the brackets as shown in the cross-section. Fit a $\frac{1}{4}$ in. × 40 filling plug in the top of the tank. Use asbestos string for wicks.

The action is simple. Screw down the spirit valve to close it, then fill the tank about three-parts up with spirit. See that the filling plug is closed airtight (put a jointing washer between flange and bush) then open the spirit valve. Spirit will flow from this into the sump until it covers the end of the air pipe and prevents any more air going in. The spirit will then stop flowing until the end of the air pipe is uncovered again by the level falling in the sump as the burners use it.

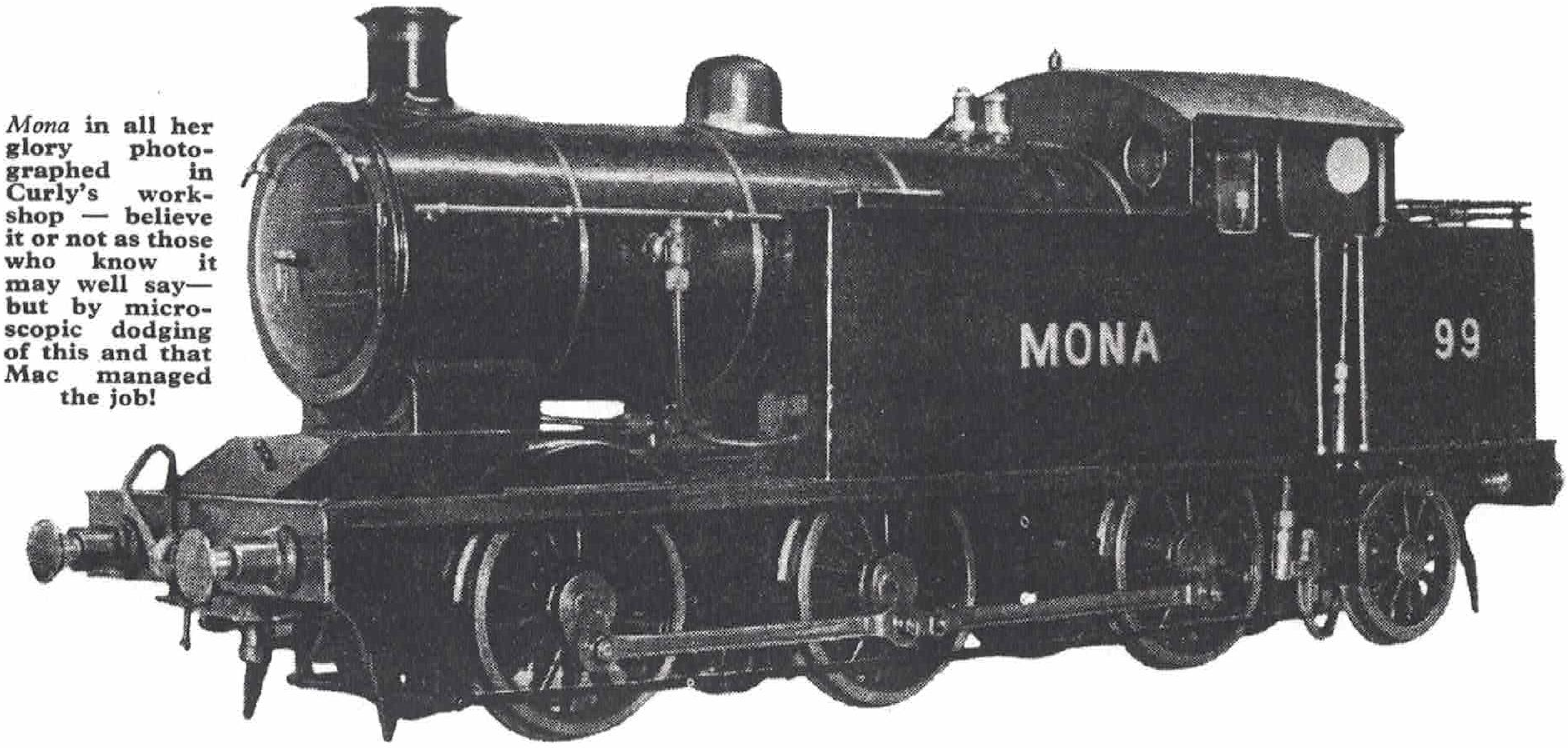
The cab front and roof can be cut from same material as the tanks, and attached by pieces of angle. There is no need to make the roof removable if a slot is cut in it to allow the regulator handle to come through, and a hole can be drilled in the back, to let the wheel of the blower valve project into the bunker. I have made no provision for filling the boiler under steam, to keep the job as simple as possible; but it is hardly needed, as one filling of the boiler should suffice for a non-stop run of anything up to half-an-hour or more, with a full-length surburban train or a tidy load of wagons, and after watching it at work for that time, I guess most folk would want a break.

The trimmings—buffers, couplings and so on, can be made pretty much the same way as those for the $3\frac{1}{2}$ in. job, but to half-size.

**Painting "Mona"**

Before bidding farewell to *Mona,* maybe a few notes on painting and operation may not come amiss. In the days gone by, when locomotives were regularly cleaned by day and night after every spell of duty, they usually were elaborately painted, as most railway companies realised that a fleet of spick-and-span locomotives was a great publicity asset. At the various running-sheds as on the London, Brighton and South Coast Railway, there was keen competition among the cleaner-boys as to who should have the cleanest engine. On that line, not only did each engine have a regular driver and fireman, with the driver's name painted up inside the cab, but a cleaner was assigned to "follow" it, and his turns of duty were arranged so that he should be on day or night work according to what trains the engine was booked to work, and ready to start cleaning her as soon as she was home in the shed. Nowadays, putting an engine away after running, is called "disposal"—a word that is used for throwing away rubbish in the domestic ashbin!!

Any colour fancied by the builder can be used to paint *Mona*—incidentally I don't suppose many of the engines built to the "words and music" will




*Mona* **in all her glory photographed in Curly's workshop — believe it or not as those who know it may well say—but by microscopic dodging of this and that Mac managed the job!**

bear that name, as builders will prefer to give each a name that suits their fancy. My own engine bears the original name, and as I had a small tin of maroon enamel which had been in stock for many years, I used it. The wheels were painted before I turned them. The castings were very clean, no sand or "fins" between the spokes, and I just washed them in petrol outdoors (best place, to avoid risk of a flare-up), and painted all over the spokes. They dried hard overnight, as I left them on top of our heating boiler, and when I turned them, the rims and bosses finished bright, leaving just the spokes and spaces coloured. I painted the outside of the frames black, and the inside brown, before putting any of the works in, so that Mac the staff photographer wouldn't have to worry about bright metal, which is difficult to photograph properly.

Anybody who is starting from scratch with a finished but unpainted engine should proceed as follows. First wipe all the oil and grease off her, and then give her a good wash-down in petrol. Stand her in a big tray outdoors, and give her a proper bath, using a fairly large paintbrush to scrub her clean. Let her drain, then wipe off any surplus with a clean rag, and let her thoroughly dry.

For the main colour, I suggest either blue, green, maroon, or "battleship" grey. Smokebox, running-boards and outside of frames are invariably black; some lines had black wheels also. Buffer-beams are usually red, same shade as a pillar-box or post-office van. Valances may be same as body colour, or contrasting. Of course, the whole lot may be black, but this looks drab and depressing.

The best paint to use will be either a good heat-resisting enamel, or a modern hard-gloss paint such as "Valspar," "Sol" or similar, the advantage of these being quick drying, and their ability to stand the heat of the boiler without discolouring, or cracking, or flaking off. For applying it I use good quality soft hair brushes, such as used by artists for painting pictures. Did I hear somebody say: "Well, isn't *Mona* a picture?" Well, with careful painting she certainly *should* be, in another sense!

If the engine is all assembled, it doesn't matter about taking her to pieces. Start with the frames: don't paint the inside, for not only is that part out of sight, but I like to keep paint away from the working parts, for obvious reasons. The part behind the wheels can easily be done by putting the brush between the spokes. If they get splashed, it doesn't matter, for when painting the spokes (the next job) the splashes are covered up.

The boiler, tanks, cab and bunker can then be painted. With the paint mentioned, no undercoat is necessary. Use a fair-sized brush, don't put the paint on too thickly, and when doing large flat surfaces, such as the sides of the tanks, do what painters call "cross it well." When applying the colour, take strokes with the brush longways and then down, so that the strokes of the brush cross at right angles. If properly done, the slight streaks settle down into a perfectly smooth surface, like a mirror.

In full-size in the old days, some of the engines had six or eight coats of paint applied, each one being rubbed down with pumice; but there is no need for that with the little engine. One coat only of the kind of paint mentioned will give a good cover. As to drying, I painted "Mona the First" at night, and as I have a bench over my heating boiler, I put her on that, so that she kept nice and warm. To prevent dust settling, I rolled a sheet of stiff brown paper into the shape of a tunnel, and put it over her. By morning, the paint had set perfectly hard.

Tip—when applying the paint, look out for hairs coming out of the brush. With new brushes two or three usually come out at first time of using, and if they are allowed to dry in the paint it looks as though the painter had been careless. If I spot one, I pick it off at once with a pair of jeweller's tweezers.

When the body colour is dry, paint the valances and buffer-beams, and make the smokebox, running boards and footplate the last job. Always dry out in a warm place with a cover (like the paper "tunnel" previously mentioned) over the engine, to keep the dust off, and after finishing, don't steam her for three days at least, to let the paint have a chance to get thoroughly hard.

If anybody has a yen for lining, and has a steady hand, lines can be put on with a thin brush.

Professional painters use brushes with a few very long hairs, and use them so that most of the hair length lies on the job. A rule or straight-edge is used to guide the brush. I lined my engine *Grosvenor* with an ordinary camel-hair water-colour brush which I had subjected to a severe haircut, leaving only about half-a-dozen hairs on it. This not only did all the fine lines, but managed the twiddley-bits around the corners as well. Although I have long since passed the "three-score-and-ten" which is supposed to be the alloted span of life, I still have a steady pair of hands and very good eyesight, so the job didn't worry me at all. In a human being, as in a locomotive, it isn't age, but condition, that counts!

Some folk recommend using a ruling pen for lining, but you can't use it to put lines on a glossy surface, or the line spreads. The surface would have to be rubbed down to a matt finish either with pumice or very fine glasspaper. A ruling pen will draw very fine lines on such a surface if the paint is thinned to the right consistency, either with thinners recommended by the makers, or with turpentine. After the lines are dry, the whole issue would need a coat of heat-resisting varnish.

I painted the name and number of my own engine with a very small water-colour brush; but anybody who isn't good at signwriting need not lose any sleep; there are more ways of killing a dog than hanging it, though why anybody should want to kill a dog is something I can't fathom! One trick is to scratch out the letters in the paint with a piece of steel having a narrow flat point like the business end of a watchmaker's screwdriver. I did that with my engine *Grosvenor;* not because I couldn't paint the letters, but on the full-size engine the letters were in gold leaf, and I wanted to imitate it. The bright brass showing through the paint looks just the cat's whiskers. After scratching out the letters I just shaded them, and we were all set.

Another dodge is to make a stencil out of stiff paper. Carefully draw the letters on the paper, using a rule for the straight strokes, and cut them out with a sharp pen-knife. Stick the stencil right in the middle of the tank or bunker with Seccotine or something similar, making sure there is plenty all around the letters, so that no paint can seep underneath them. When perfectly dry, paint over the letters with yellow or gold paint. Let it stand a couple of days, then soak the stencil with hot water applied by a sponge until the sticky stuff is soft enough to allow the stencil to be peeled off. Then there is the name or number, all-present-and-correct-sergeant!

Small transfer letters and numbers can be purchased from most signwriters, and applied according to the directions on the packet. The last resource would be to cut the letters and figures out of thin paper, stick them on the engine, and when dry, paint them over.

**How to run the engine**

The first thing a full-size driver or fireman does when booking on is to look at the water-gauge, and that goes for *Mona* too! The water should be about three-parts up the glass. Then, still emulating full size, oil all the moving parts with a good quality lubricating oil. I use Etna medium, same as I use for the machinery in my workshop; but a good grade of motor oil will do, such as Castrolite, Mobiloil A. or similar. Don't overdo it, so that oil runs down and makes the rails slippery; enough is as good as a feast! Then fill the side and bunker tanks with clean water.

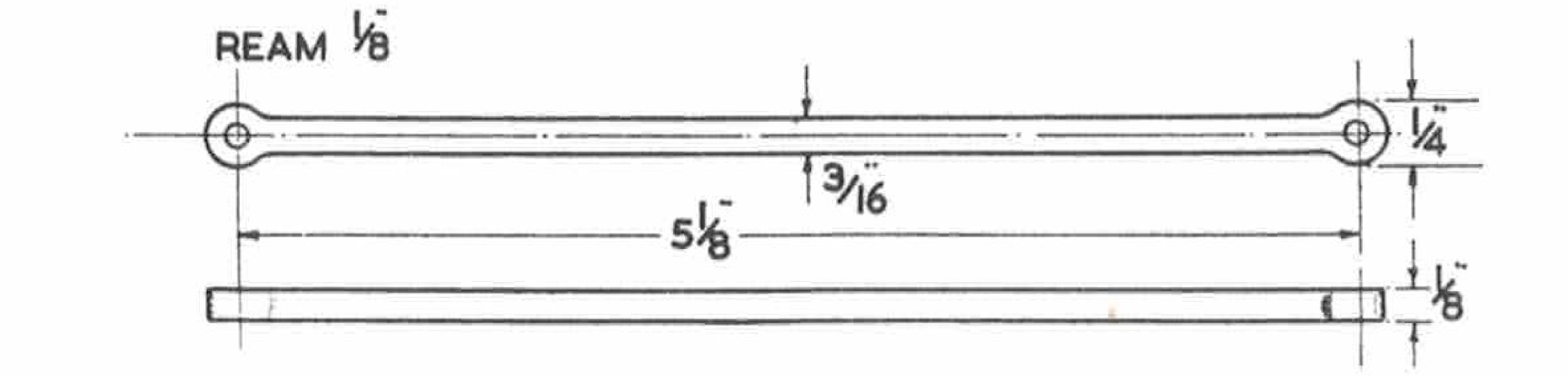
The mechanical lubricator should be three-parts filled with cylinder oil of superheater grade. I use Cyltal 80, but anything of similar grade, such as Mobiloil 600 W, will do. Note—it must be a *mineral* oil; anything of a fatty nature will cause corrosion in the cylinders. Turn the ratchet wheel by hand for a few turns; if you feel resistance on the forcing stroke, the lubricator is working O.K.

In a fire box as small as *Mona's* a fire can't be started without artificial draught. There isn't enough natural draught to get sufficient air through the fire to support combustion. To "blow her up" I use a suction fan mounted on the end of the spindle of a little electric motor, the gadget looking like a hair-drier used on its side. The short tube attached to the suction side of the fan is pushed into the engine's chimney, and when switched on, there is a terrific draught induced through the firebox.

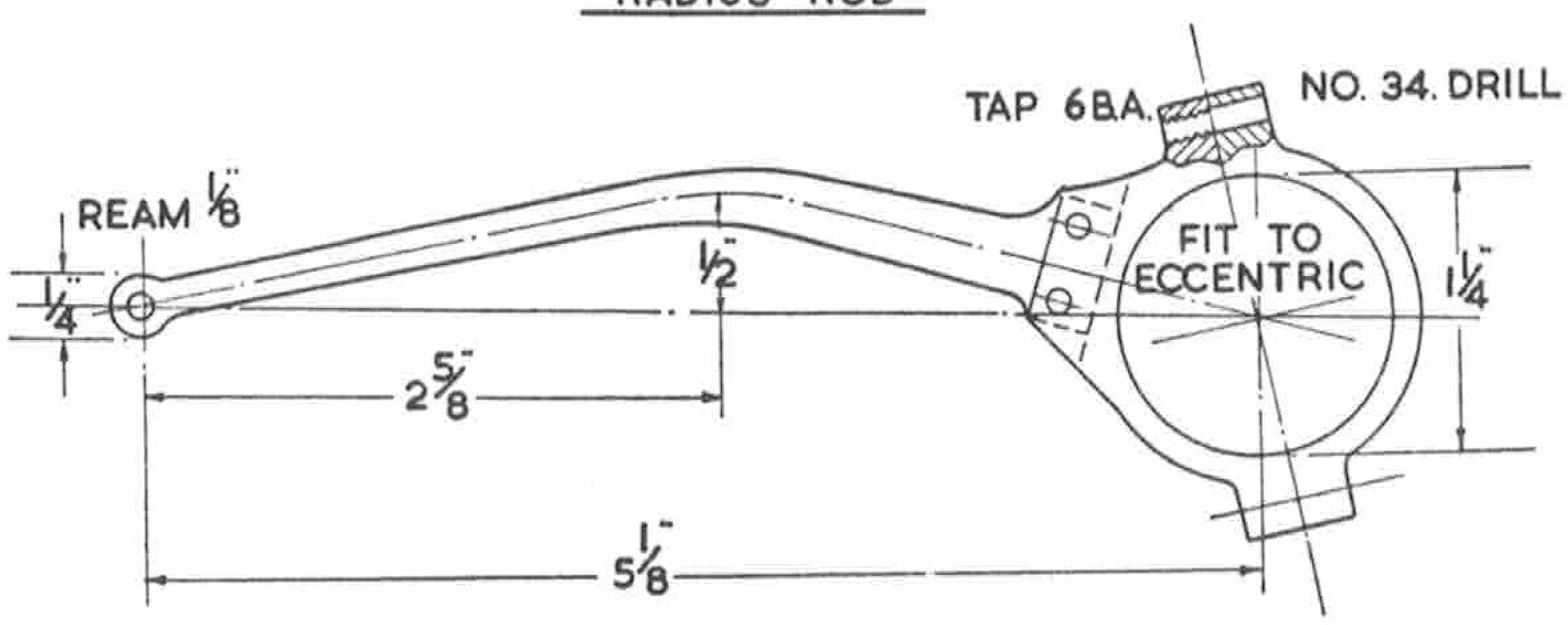
A simple way needing no electricity is to use a piece of tube about 6 in. long and just big enough to enter the chimney. A piece of 1/8 in. copper tube is silversoldered into this about 1 in. from the bottom, the end inside the chimney being turned up to form a blower jet. The end is knocked up to close it, and then drilled No. 65. The other end is soldered into a coffee-tin, which has had all the seams and lid soldered to make it airtight. A cycle or motor tyre-valve is also soldered into the tin, and a tyre-pump connected to it. When the pump is operated, the tin acts as an air-reservoir or balancing chamber, and a continuous stream of air is forced from the jet in the extension tube, inducing a current of air through the firebox.

Charcoal is used to start the fire, and when it is well alight it can be fed with coal. House coal is no good, as it not only cakes and tars the tubes, but it doesn't give enough heat, and smokes badly. I use a mixture of Welsh steam coal and anthracite. The Welsh coal lights up quickly, but burns away more rapidly than anthracite, which is slower to light up and needs more draught. Either can be used separately, but I mix them to strike the happy medium. Coke will make steam very well, but it corrodes the copper firebox. Coalite is good, but it burns away so rapidly that constant firing is needed, and when the engine is working hard there is a Fifth-of-November appearance around the chimney top. Warning—the grade of Welsh coal most suited to the job is the harder kind which has a bright appearance. It breaks readily, and the dust is like little crystals. There is a grade of Welsh which should be avoided. It is soft, and breaks into powdery dust. In the firebox it cakes; you think you have a good fire, when really it is hollow underneath, and the engine won't steam. Anthracite peas, as used for Salamander and similar slow-combustion stoves, make excellent fuel once the fire is really going, but need plenty of draught.

Break up both coal and charcoal into pieces about the size of large peas, and sift all the dust out. Put a good handful of charcoal into a tin lid and wet it well with paraffin, then shovel into the firebox enough to well cover the bars. Throw in a lighted match, and as soon as the paraffined charcoal starts to flare up, start the blower, either electric or hand pump. As soon as the fire is alight all over and roaring, feed in the rest of the charcoal, and then some coal on top of it. Don't overdo it and fill the firebox up to the door, or you'll choke the poor girl and she will die, as the enginemen say. Steam will be up in about three minutes (didn't this surprise our Knight of the Blue Pencil fully mark off on them, the location of the holes for pins as shown. Note—these are *very* important, so keep strictly to the dimensions shown. Round off the end around the upper hole, then slot down to 5/16 in. depth, removing the rods from straps, and doing the job as described for slotting the coupling-rod knuckles. Replace rods, taking care that the slots line up with the straps. Squeeze a $\frac{5}{8}$ in. length of $\frac{1}{8}$ in. round silver-steel into each lower hole, letting 3/16 in. project at each side, to accommodate the die-blocks.




RADIUS ROD




ECCENTRIC STRAP AND ROD

## Radius Rods

The radius rods are made from two $5\frac{1}{2}$ in. lengths of $\frac{1}{4}$ in. x $\frac{1}{8}$ in. mild steel. Drill the pinholes with No. 34 drill, and then ream them $\frac{1}{8}$ in. The middle part of the rods can be reduced to 3/16 in. by filing or milling, but it really doesn't matter if they are left full width, as they will be out of sight when the tanks are fitted. Round off the ends with a file.

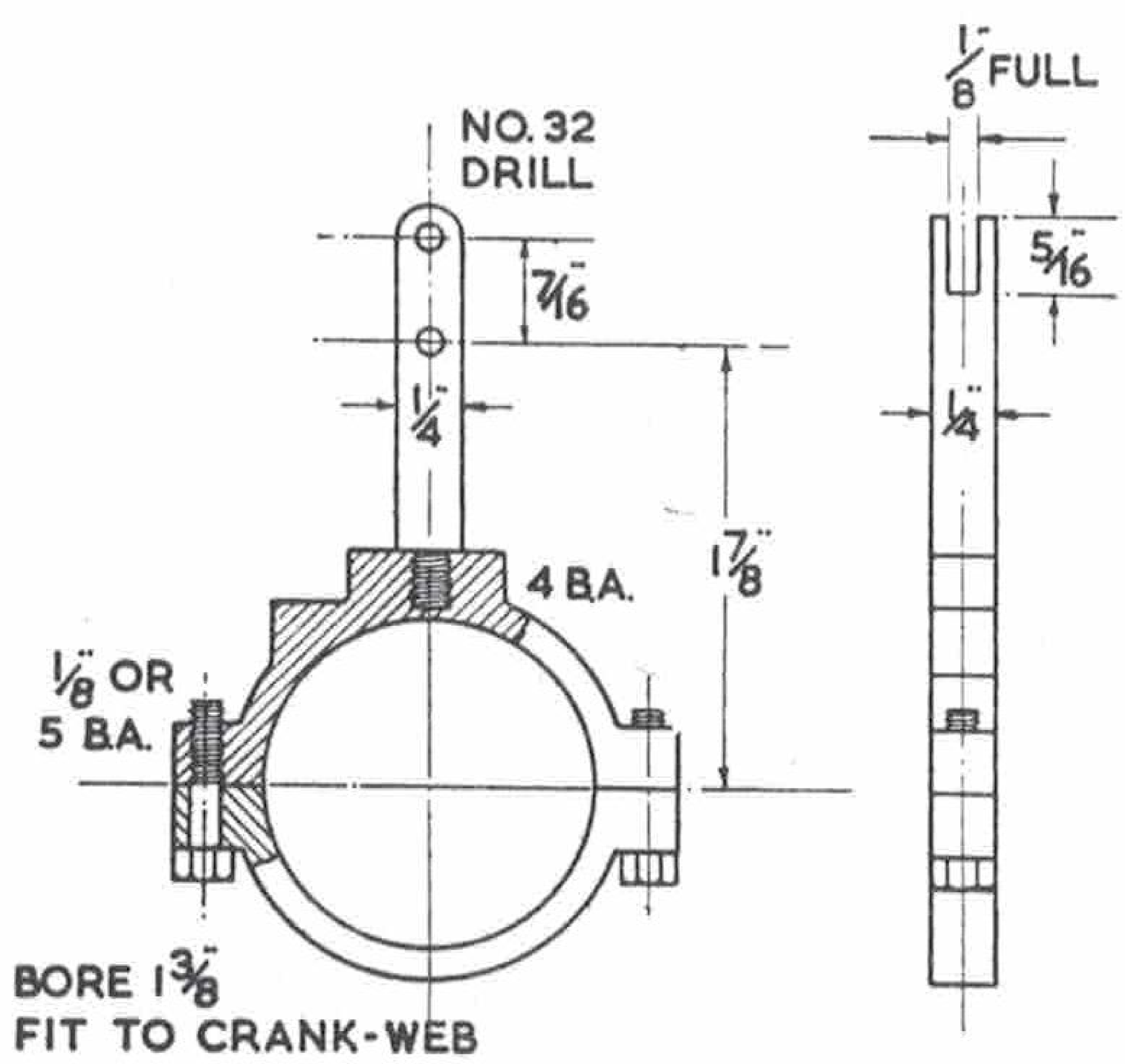
Then make the reversing arm, marking off the centres as shown, on a piece of $\frac{3}{8}$ in. x $\frac{1}{8}$ in. mild steel, or an offcut left over from frames will do quite well. Drill both holes No. 34. Chuck a piece of $\frac{3}{8}$ in. round steel in three-jaw, face off, and turn a pip $\frac{1}{8}$ in. long, to a tight fit in one of the holes, parting off at 3/16 in. from shoulder. Squeeze in the pip, and braze or silversolder it, by methods previously described. File the arm to shape shown, then chuck by the boss, centre, and drill right through with $\frac{1}{4}$ in. drill. This should fit tightly on the end of the slide-shaft as shown in the end view.

## How to Erect the Valve Gear

First fit the bearings; put the projecting boss in the U-shaped opening above driving axle, and hold it in place with a cramp. Check distance from centre of hole, to centre of crank axle; this should be $1\frac{7}{8}$in. At 7/16 in. each side of the hole in boss, and level with it, drill a No. 40 hole clean through frame and wing of bearing. Remove bearings and tap the holes $\frac{1}{8}$ in. or 5 B.A. Open the holes in frame with No. 30 drill, and countersink them. Put the bearings on the ends of the slide-shaft, drop the lot into place, and secure the bearings to frame with countersunk screws.

Put one end of the radius-rod between the sides of the slotted end of eccentric-rod, and squeeze a $\frac{1}{8}$in. silver-steel pin through. If the pin isn't tight in the eccentric-rod, rivet the ends over very slightly, but not enough to make the radius-rod work stiffly. The joint must work easily, but without any sign of slackness. Put a dieblock on each side of the pin in the eccentric-rod, and take the strap apart. Now be careful—put the crank on bottom centre, then push the dieblocks up into the grooves in the slide-shaft until you can guide the upper half of the strap on to the grooved crank-web. Hold it there while the lower half of the strap is replaced, and the screws put in. The slide-shaft should be temporarily clamped in a vertical position while doing this job, because if it tilts, the dieblocks will slip out, and the ceremony thus far will have to be repeated; probably with the addition of a little railroad Esperanto! Put the other ends of the radius rods between the jaws of the forks on the valve spindles, and secure them with weeny bolts made by turning down the ends of $\frac{1}{2}$ in. lengths of $\frac{1}{8}$ in. silver-steel to 3/32 in. dia. and screwing 3/32 in. or 7 B.A. to take commercial nuts. When the nuts are tight against the shoulders, the bolts should be free enough to turn with your fingers.

Now pin the reverse arm to the shaft, setting it so that its centre-line is at a slight angle to the centre-line of the slides. If the pinhole at the top is a bare 1/16 in. ahead of the centre-line of the slides, it will be just right. Drill a No. 43 hole through boss and shaft, and squeeze in a piece of 3/32 in. silver-steel. Put a $\frac{1}{8}$ in. reamer through the pinhole. This arm wants keeping fixed in place until the reverse lever is fitted, otherwise the shaft will tip up and the dieblocks will come out. I used a fork, like the one on the valve spindle, with a setscrew in one side of the jaws, and a bit of $\frac{1}{8}$ in. wire screwed into the boss, the end of wire being bent at right angles. The angle was put through the hole in the arm, the fork slipped over the frame, and




ECCENTRIC STRAP & ROD

tightened with the setscrew. The arrangement is shown in one of the pictures. If the wheels are then turned by hand, the dieblocks will slide up and down the shaft, and the amount of movement imparted to the valve spindles will depend on the extent to which the shaft is tilted. The valve setting can be left until the lever is fitted.

### Loose Eccentric Valve Gear

This is a very simple and reliable valve gear, and is the only valve gear which gives equal port opening at both ends of the stroke in both directions. It cannot be reversed from the footplate, and the cut-off cannot be altered; but on a little engine running on a continuous line, these are no drawbacks, because no reversing is required, and the cut-off can be set early enough to ensure economical steam consumption, and provide easy starting at the same time. I always recommend it for beginners, as it only needs one eccentric per cylinder, with one solitary pin joint between eccentric and valve spindle.

Owing to the position of the motion plate, an offset eccentric rod will be needed, to clear the top of it; and the lug on the strap, to which the rod is attached, must be arranged as shown. The strap is faced both sides, and bored, in exactly the same manner as described previously for the straps on the radial gear, but to the dimensions shown on the drawing. The offset lug has a $\frac{1}{8}$ in. groove about $\frac{1}{4}$ in. deep, milled or filed in it, to take the larger end of the eccentric-rod. Failing a regular milling-machine, this can be done by clamping the strap in a machine-vice (regular or improvised) on the lathe saddle, and traversing under a $\frac{1}{8}$ in. saw-type cutter mounted on a spindle between lathe centres.

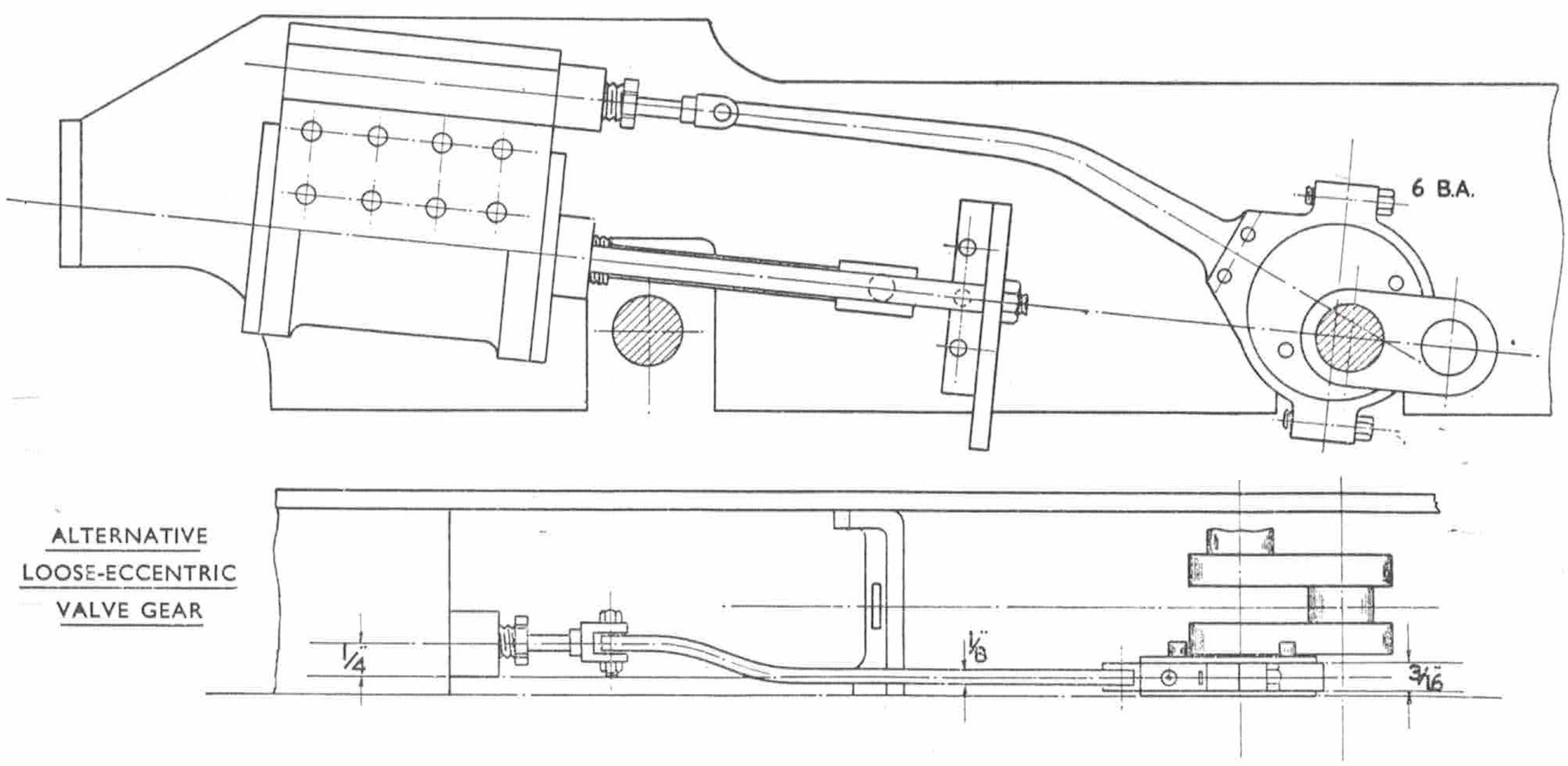
The rod should be marked out on a piece of $\frac{1}{8}$ in. steel, same as used for frames; allow about 1/32 in. extra length for the side bend. Saw and file to shape shown. Put the large end into the groove in the strap, and solder it with ordinary soft solder; then drill two 3/32 in. holes through strap and rod, countersink both sides, drive in two pieces of brass or iron wire, rivet the ends into the countersinks, and file flush. The completed straps and rods can then be erected, putting the straps over the loose sheaves between the cranks and securing with 6 B.A. screws, and attaching the small ends to the valve-spindle forks by $\frac{1}{8}$ in. bolts made as described above. When the wheels are turned by hand, the eccentrics should work quite freely.

There is little to do in the way of valve-setting with this arrangement, as the timing is controlled by the pins already fitted in the eccentrics and driven by the cranks. Just take off the steam-chest cover, and adjust valves on spindles if necessary, by taking the bolt out of the fork, and turning the spindle, until the valves uncover the ports an equal amount at each end of the movement, when the wheels are turned by hand. Check by turning in each direction and watching the valve. The port should show as a black line at the edge of the valve, when the crank arrives at the dead centre, and the valve should close the port when the crank is just past the half stroke.

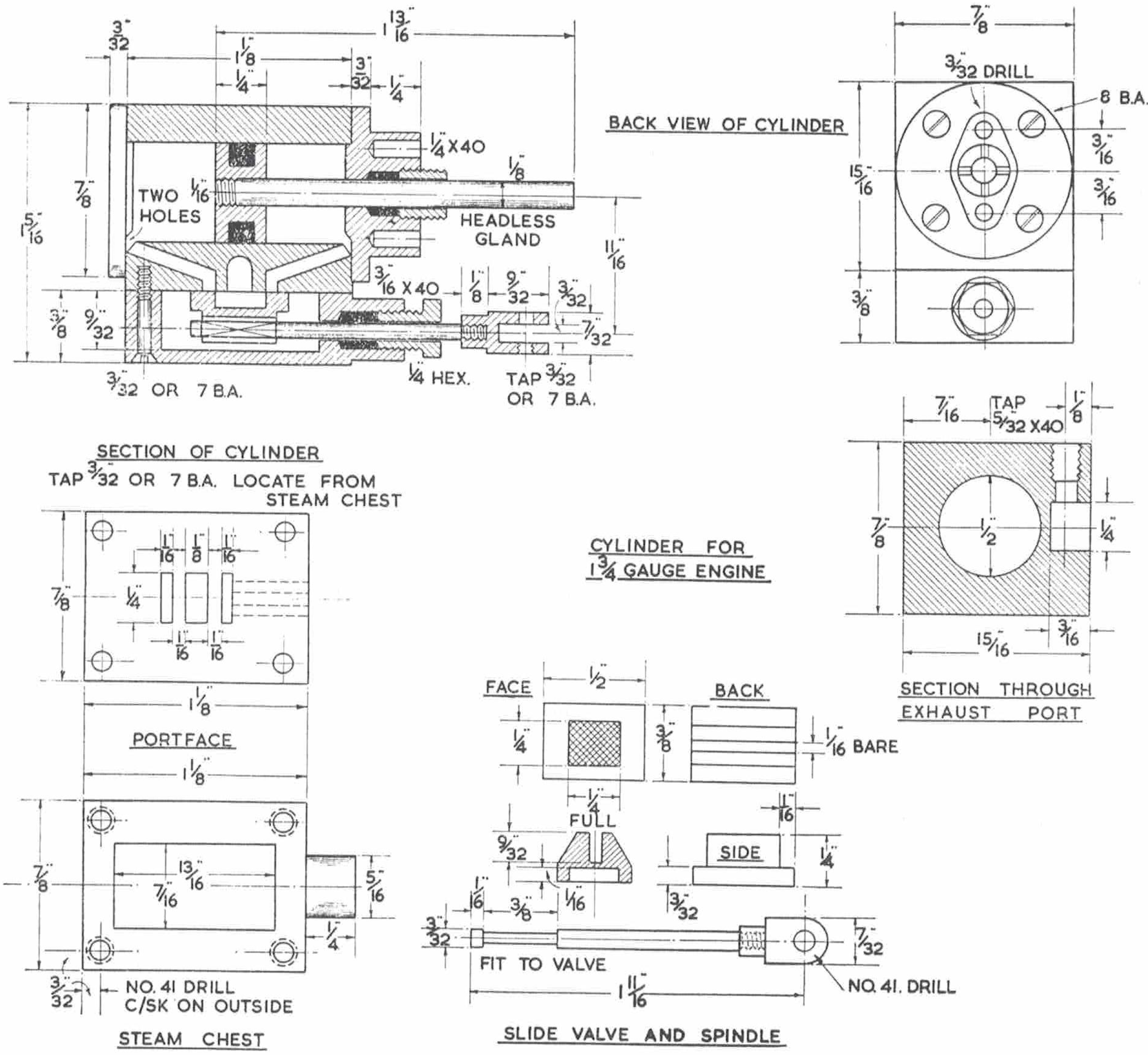
### Cylinder for $1\frac{3}{4}$ in. Gauge Engine

Although castings will be available for the little cylinder, builders can, if they wish, make it from bronze or gunmetal bar. The machining and fitting is exactly the same in either case. The casting, or piece of bar, should be gripped in the four-jaw chuck, and machined off with a roundnose tool set crosswise in the rest, to a length of $1\frac{1}{8}$ in., width 15/16 in. and depth $\frac{7}{8}$ in. Scribe a line across one end, at 7/16 in. from one of the shorter sides, and in the middle of this, make a deep centrepop. Chuck in four-jaw with this running truly, drill a 3/16 in. pilot hole through, open out with 31/64 in. drill, and put a $\frac{1}{2}$ in. parallel reamer through. If a casting with a corehole is used, bore it out as described for the $3\frac{1}{2}$ in. gauge cylinders, the block being held in the chuck, or mounted on an angleplate as desired. It doesn't matter which road you take, as long as you get there!

The ports are set out and cut, and the passageways drilled, in the same manner as described for the $3\frac{1}{2}$ in. gauge job, working to the dimensions shown. Watch your step when drilling the passages, as a 1/16 in. drill is rather fragile, and wee drills cost muckle bawbees the noo, ye ken. Beginners note, that the principal cause of breakage




ALTERNATIVE LOOSE-ECCENTRIC VALVE GEAR

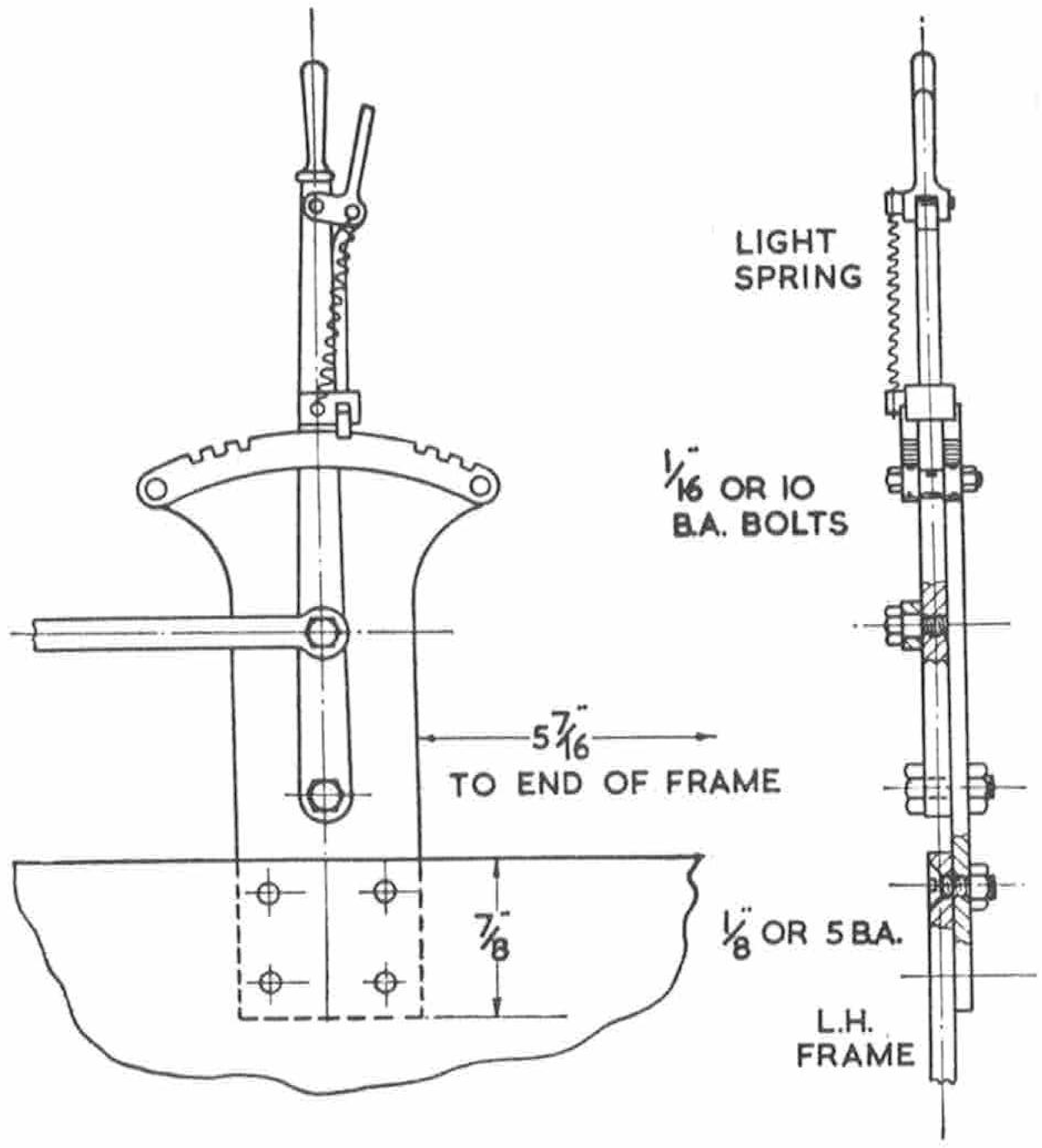



of tiny drills is choking of the flutes with chips, which jams them in the hole. If you drill in about 1/16 in., then withdraw the drill and knock the chips off—if they don't fall off of their own accord—it is possible to put a No. 80 drill, which is only 0.013 in. (thirteen thousandths) right in to full depth of the flutes, as I have demonstrated to sceptics many times.

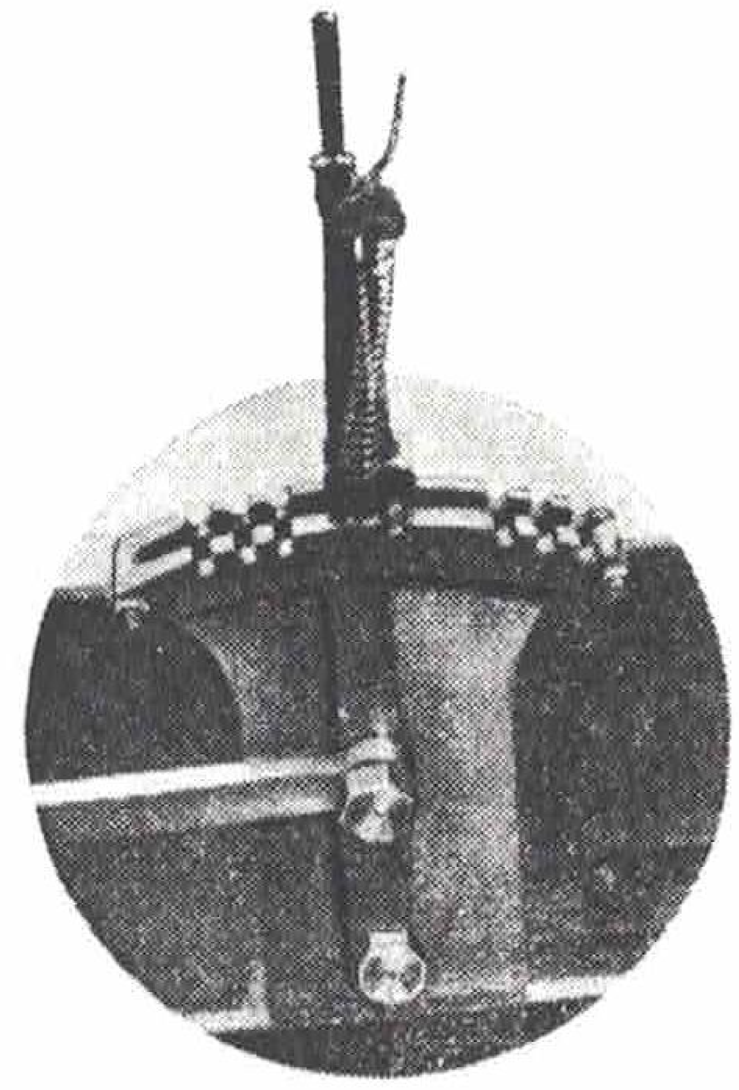
The covers, headless gland, piston and rod, are all turned and fitted as per 3½ in. instructions, the covers being drilled No. 43 for four 8 B.A. screws. The 3/32 in. holes for the ends of the guide bars in the back cover should be drilled either on a drilling-machine, or in the lathe, with the cover temporarily attached to the cylinder block. This ensures them being square with the block.

A cast steam chest will have the recess cast in. Chuck in four-jaw to face off both contact side and back. Set it endwise in the four-jaw, with boss running truly, to turn same, and drill and tap for gland, which is made from ¼ in. hexagon brass rod, similar to the 3½ in. gauge pump gland. For the built-up steam chest, take a piece of brass 1⅛ in. long ⅞ in. wide, and 5/16 in. thick, and cut a hole in it 13/16 in. x 7/16 in. by drilling and filing. Lay it on a piece of 3/32 in. brass sheet, same size, and silversolder it. The gland boss may be a ¼ in. slice of 5/16 in. brass rod attached by a screw and silver-soldered at same heat, the lot being machined up same as the casting. The No. 41 holes for attaching screws are countersunk on the outside of the steam chest.

The slide valve is made from a piece of bronze or gunmetal ½ in. long, ⅜ in. wide and ¼ in. thick, milled or filed to dimensions and shape shown. The valve spindle and fork are similar to the 3½ in. size, but instead of being screwed, the end of the spindle has a flat filed on each side, to fit in the slot in the valve. It must fit easily but without end play; very important, that! Use thin oiled paper for jointing, and graphited yarn in glands. The next instalment will show the erection, and how the guide bars, crossheads, and connecting-rods are fitted.




REVERSING LEVER ASSEMBLY

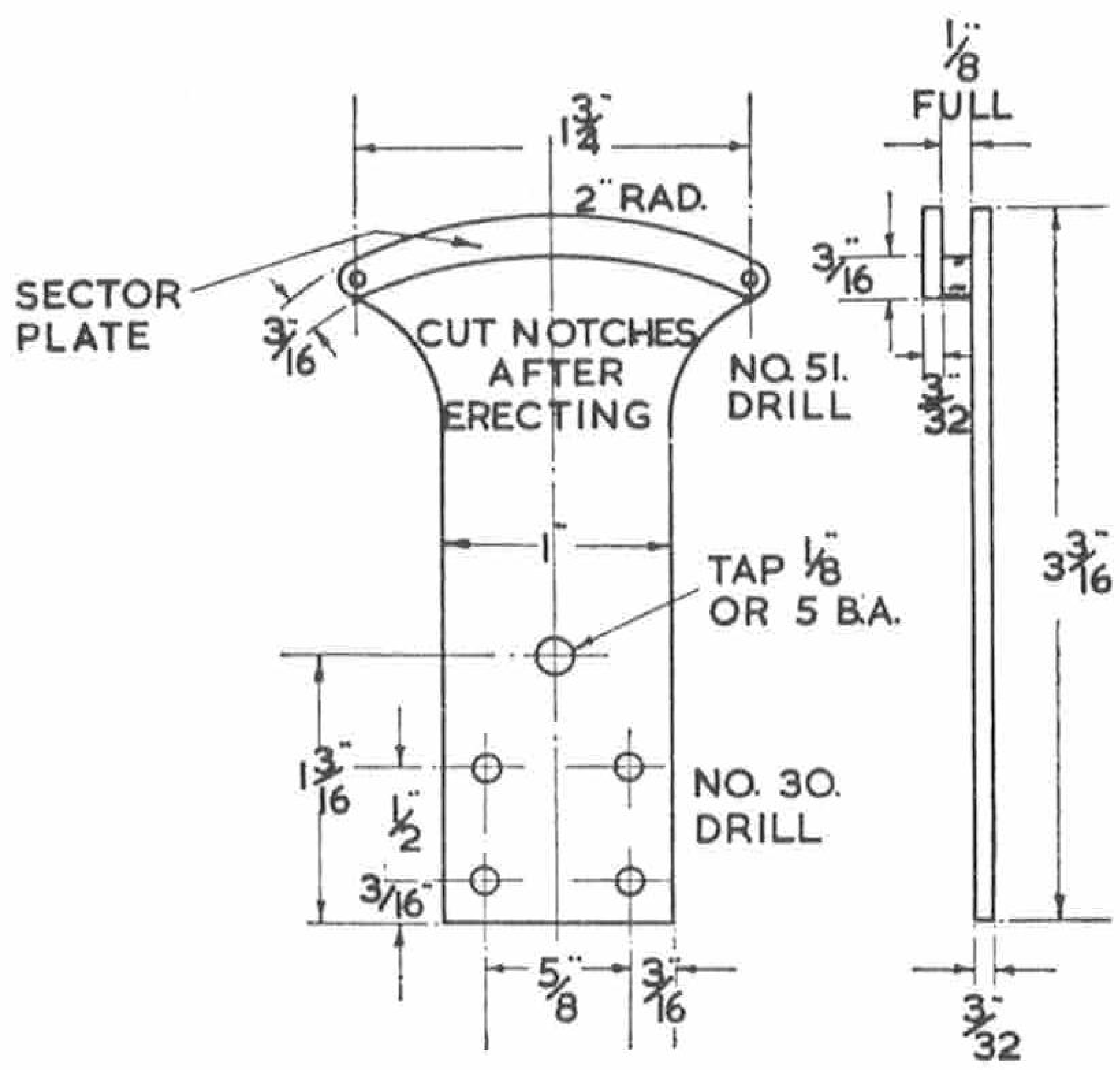


## Reversing Lever

While a wheel-and-screw reverser gives a much finer adjustment than what enginemen call a "pole" lever, the latter is much handier on a tank engine, especially for use on a straight line where constant reversing is needed; so I am specifying this type. A photograph of the lever on my own engine appeared at the head of the December instalment, and when I saw what our merry caption-writer had miscalled it, I thought "Base deceiver—it's the lever!" Anyway it's O.K. about the sackcloth, but if he lets any of the ashes find their way into the motion, there's going to be trouble!

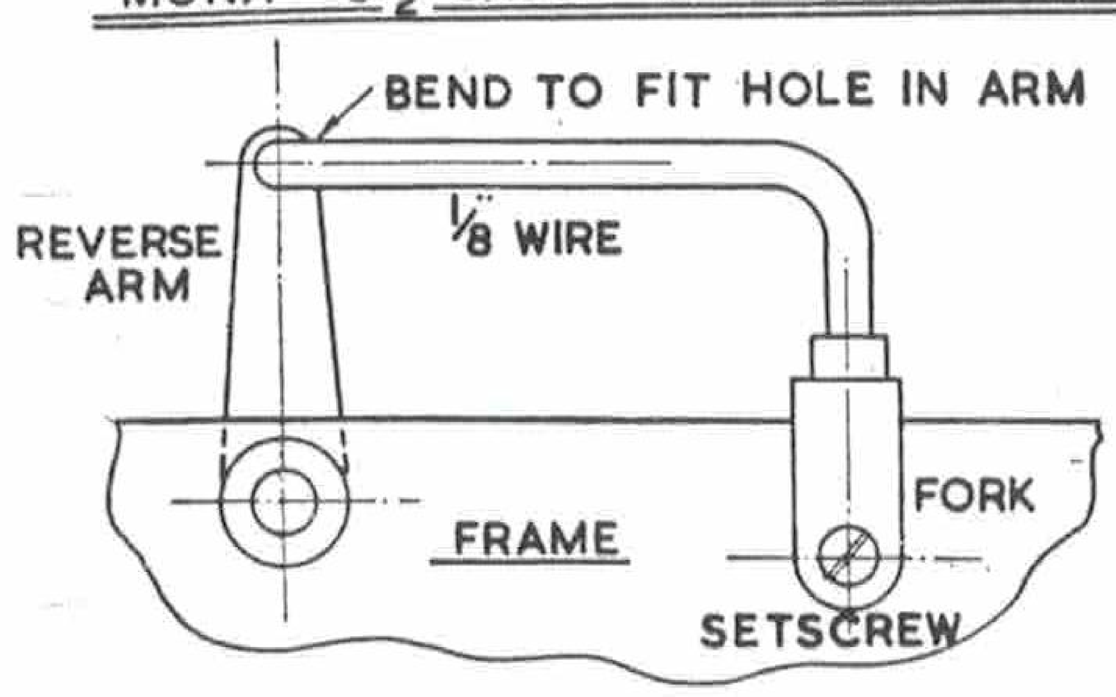
To make the stand, mark out on a piece of 3/32 in. mild steel, the outline of the stand as shown, saw and file to outline, and drill the holes. Note that the upper edge of the stand is 2 in. radius, not the centre-line of the sector-plate. This is a strip of the same kind of steel, 3/16 in. wide, and should be marked out on a flat piece of metal and cut to outline by sawing and filing. Don't attempt to bend up a piece of strip. Clamp it to the stand, and drill the No. 51 screwholes through stand and sector together. For the spacers, chuck a piece of 3/16 in. round rod, centre, drill No. 51 for about $\frac{1}{2}$ in. depth and part off two slices a full $\frac{1}{8}$ in. thick.

Anybody fond of work can make the lever from a piece of $\frac{1}{4}$ in. square rod, chucking it truly in four-jaw to turn the grip, and milling or filing away both sides to form the flat part. Being naturally lazy I always go the easiest way to work, and cut the flat part of mine from a piece of $\frac{1}{4}$ in x $\frac{1}{8}$ in. steel, which was filed to the necessary taper in two wags of a dog's tail. A bit of 3/16 in. round steel was then chucked, and the grip turned and parted off. A spot of Sif-bronze joined the two together. Tip for beginners—when parting off the grip from the rod in chuck, there will be a weeny pip left on it. If you drill a little hole in the narrow end of the flat part of the lever, and push this pip into it, the two parts will stay put while being brazed. Simple, but very effective!

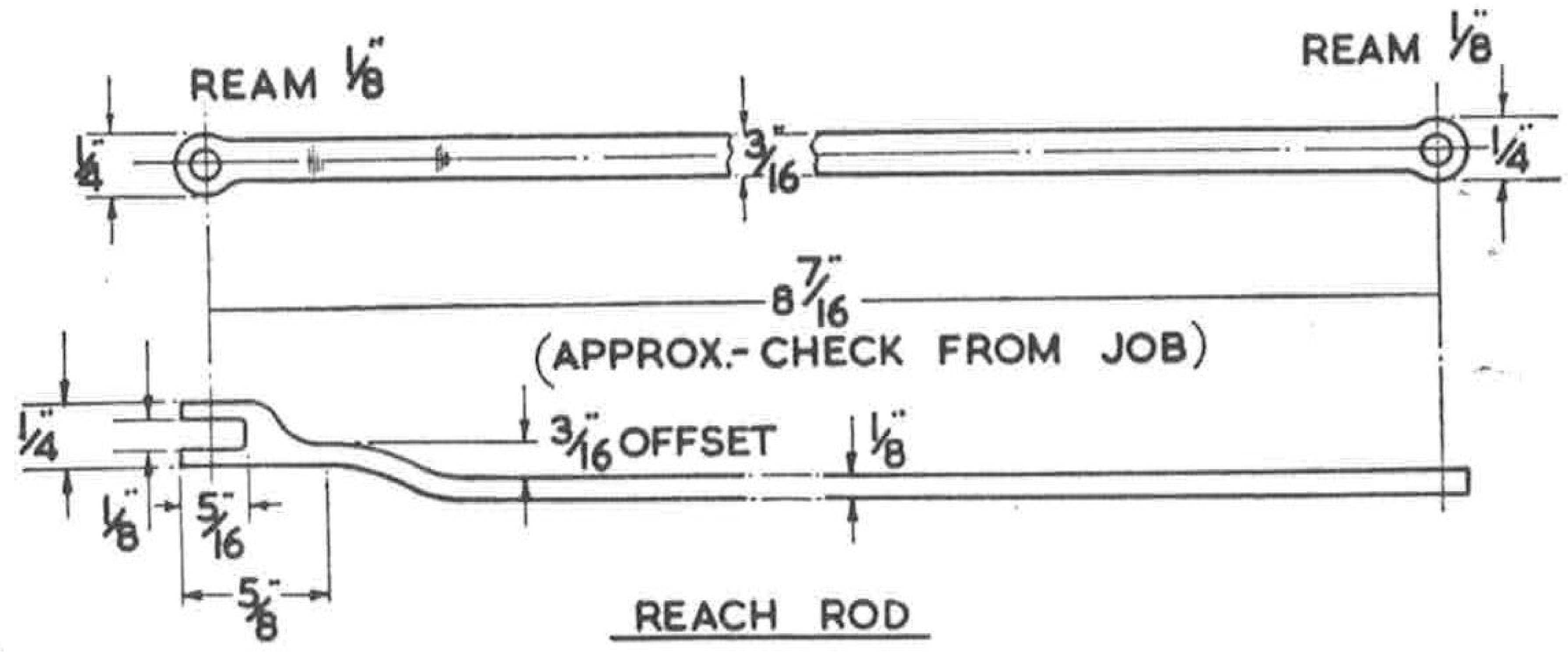



REVERSER STAND

MONA 3½" GAUGE REVERSING LEVER




TEMPORARY LOCK FOR REVERSE ARM




REACH ROD

Drill a 9/64 in. hole in the bottom of the lever, and at 7/8 in. above it, drill another, with No. 44 drill, and tap 6 B.A. for the reach-rod pin. To make this, chuck a piece of 1/4 in. hexagon mild steel, face the end, and turn down a full 1/4 in. length to 1/8 in. dia. Turn down a bare 1/8 in. of this to 7/64 in. dia. and screw 6 B.A. Part off to leave a head a full 3/32 in. thick; reverse in chuck, and chamfer the hexagon. For the fulcrum pin, chuck the rod again, turn down 3/8 in. length to a nice fit in the hole in the bottom of the lever, then turn a further 1/4 in. bare to 1/8 in. dia. and screw 1/8 in. or 5 B.A. Part off for head as before, reverse and chamfer corners of hexagon. Incidentally, builders who object to paying fancy prices for hexagon-headed screws and bolts, can make their own very easily by above process. Mild steel of hexagon section is a commercial article, and not too expensive.

**Trigger and Latch**

Take pains to make the locking gear, or the lever will look clumsy; it merely requires care. The trigger is made from 1/4 in. x 3/8 in. mild steel. Square off the end in the chuck, and cut a slot in it, 1/8 in. wide and a bare 1/8 in. deep. This can be done by process described for eccentric rods. Then on the wider side, mark off the shape of the trigger as shown in side view, and saw and file to outline; mind that you don't file the radius at each side of the tongue too sharp, or you'll cut into the groove. Be careful also when rounding off the ends. When drilling the pinholes, put a piece of metal in the groove, or else drill each side separately; better still, drill the holes before cutting the groove, but be sure they are dead square with the sides.

The latch is filed or milled from a piece of 5/16 in. x 3/16 in. steel. This job requires care, as it is rather fragile, but it isn't really difficult. What I do, is first to thin down the end of the rod for 1 1/8 in. length to 1/16 in. thickness, then cut away each side to 1/8 in. thickness leaving 1/8 in. head at the bottom, looking like an upside-down T; the rod is cut off just above the thinned-down section, and the "bird's head" finished off by a careful spot of hand filing. It should fit nicely in the slot in the trigger.

The latch-block is made from 1/4 in. x 3/16 in. steel. Square off the end of a piece of rod, and slot it 1/8 in. wide and 1/4 in. deep by method described for eccentric-rods; then at the end of this slot, make a cross-slot 1/8 in. deep. Part off at 1/16 in. beyond the cross slot. The open end of the block should fit snugly on the lever, and the bottom of the latch should fit in the cross-slot without shake.

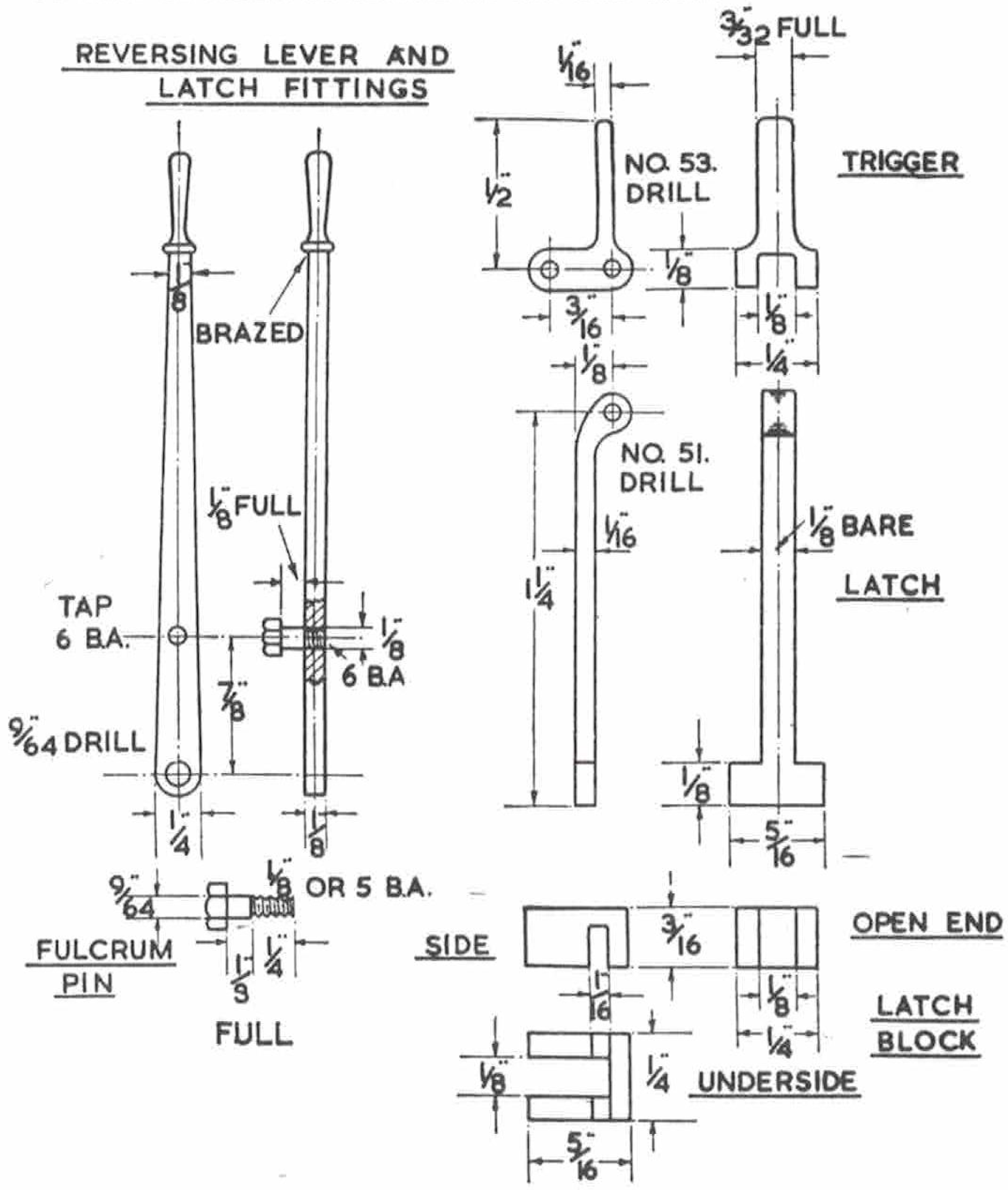
**Assembly and Erection**

First attach the lever to the stand by the fulcrum pin. When the nut on same is tight, the lever should be free to move back and forth, without being sloppy. Now put the sector-plate with the distance-pieces between it and the stand, and fix it temporarily with a couple of 1/16 in. screws and nuts. Next, put the latch block over the lever in such a position that it just clears the top of the stand and sector-plate; see illustration of complete assembly, also the photograph. The edge of the latch-slot should be flush with the lever. Clamp it there with a tool-makers' cramp, and drill a No. 51 hole clean through block and lever, then remove from stand.

Chuck a piece of 1/8 in. steel and turn two pins 1/16 in. dia. and a full 1/4 in. long. Before parting off, form a little groove with a pointed tool, about 1/16 in. from the shoulder, and part off to leave heads about 1/8 in. long. Then follows the tricky bit, something like watchmaking. Fit the bird's head into the slot in the trigger, under the tongue, and pin it with one of the 1/16 in. turned pins driven through the lot. This should be tight in the trigger, and free in the hole in the bird's head. Next, put the latch block over the latch, and slide it down until the cross-slot is over the wide bit at the bottom; then set the assembly at the side of the lever, adjusting the latch-block so that the holes in it line up with the one in the lever, thus restoring it to the position at which you first set it. Pin it to the lever with the other turned pin.

Push the end of the latch right up into the cross-slot in the latch-block, so that it doesn't stick out below the bottom edge, then put the open end of the trigger over the lever, and squeeze the tongue tight up against the lever grip. Temporarily clamp it there, and drill a No. 53 hole through the lever, using the hole in the trigger as guide. Remove trigger, open out the hole in lever with No. 51 drill, replace trigger and pin it to the lever with a bit of 1/16 in. silver-steel, driven through the lot. This should be tight in trigger and free in lever. Now, when the tongue drops away from the lever grip, the bottom of the latch should drop below the bottom of the latch-block about 1/16 in. or so. The lever can now be replaced on the stand "for keeps," the ends of sector and spacers being secured by little bolts made from 1/16 in. silver-steel, screwed and nutted at both ends. The lever should move from end to end freely, the latch being right home in the cross-slot. Fit a light spring as shown.

To erect the lever on the frame, clamp it in position shown, viz: 5-7/16 in. from back end, and bottom of stand 7/8 in. below top line, but on the *outside* of frame, left-hand side. Then drill the screwholes through frame with No. 30 drill, using those in the stand for guide. Remove lever assembly, countersink the holes in frame on the outside, replace lever assembly, this time *inside* frame, and secure it with 1/8 in. or 5 B.A. countersunk screws nutted against bottom of stand as shown in the end view.



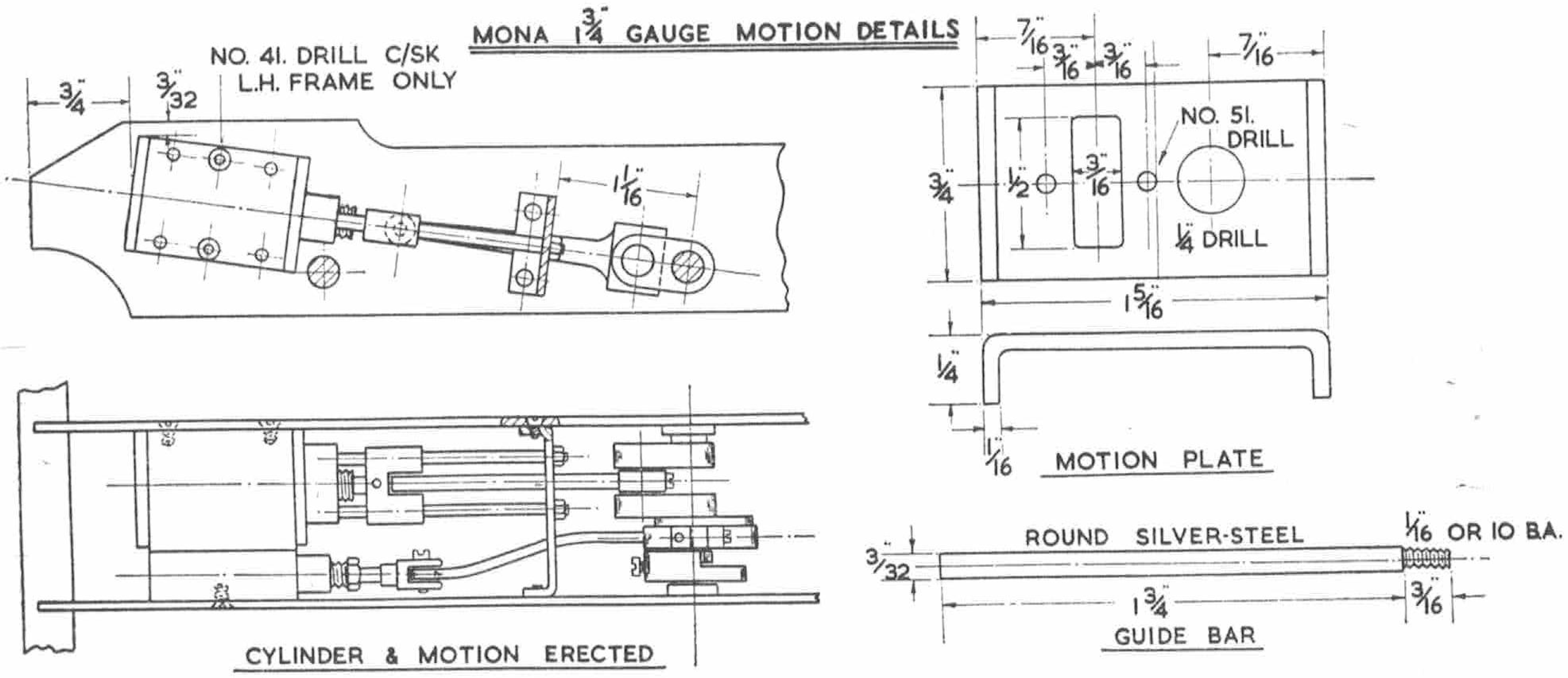
## Reach Rod or Reversing Rod

The reach rod is made from a piece of $\frac{1}{8}$ in. x $\frac{1}{4}$ in. mild steel. Braze a little piece of the same material on the end of it, to thicken it up for the forked end; this is easier than cutting the whole issue out of the solid. The fork is formed by clamping the rod under the slide-rest tool-holder, and running it up to a $\frac{1}{8}$ in. saw-type cutter on a stub mandrel or arbor held in the chuck. Just after the Kaiser's war, I bought a few "Government surplus" saw-type cutters of various sizes and thicknesses, at a London tool store, for a few pence apiece. I used old bolts to mount them on, clamping the cutter either between two nuts, or between the bolt-head and a nut, if the thread was long enough; and they did all the slotting that I needed, for years and years. They were still going strong when I bought my milling-machine, and I gave them away. They certainly earned their keep!

Drill and ream the fork as shown, and finish to shape with a file. Now before drilling the hole at the lever end, we must check the exact length of the rod, as the valve travel and setting depends on the amount of tilt given to the reversing shaft. This is how I got the length of mine. I have already explained how I rigged up a gadget for preventing the reversing arm from moving accidentally and letting the dieblocks drop out. As it has not appeared in the photographs, I'm including a sketch of it here, as it is a help in doing the job. The fork clamps over the edge of the frame, and is tightened by a setscrew, the attached piece of wire going through the hole in reverse arm and holding it in any position desired. First tilt the reverse arm forward so that the hole in the end of it is a bare $\frac{1}{2}$ in. ahead of the centre of the slide-shaft bearing. Take off the steam-chest and note how much the ports are opened when the wheels are turned by hand. Now pull the arm back until the hole is a full $\frac{1}{8}$ in. behind the centre of the bearing. On my own engine, this gave exactly the same amount of port opening as in the forward position, and the movement of the hole at the top reversing arm is $\frac{5}{8}$ in. Turn the wheels by hand, and check off. If not exactly right, move the reverse arm slightly forward or back, as the case may be, until you get the same amount of port opening as when the arm was tilted forward. These two positions give the full forward and full backward positions of the arm.

Now be very careful indeed—move the arm to a position *exactly* midway between the two, and lock it there. Set the reverse lever exactly vertical as shown in the drawing. Measure the distance between the centre of the hole in the reverse arm, and the centre of the 6 B.A. tapped hole in the lever, and that will give you the exact distance of the holes in the reach-rod, between centres. Offset the reach-rod at the fork end, by careful bending, as shown in the drawing; put a little piece of $\frac{1}{8}$ in. silver-steel in the hole in the fork, projecting 3/16 in. on the straight side of the fork. Lay your rule with the end exactly level with the centre of this and mark on the rod, the exact distance between the holes in arm and lever, mentioned above. Centrepop the spot, drill No. 34 and ream $\frac{1}{8}$ in. Cut the rod a full $\frac{1}{8}$ in. behind the hole, then finish it off with a file, to the outline shown. Connect the eye end to the lever with the turned pin already made, and couple the fork to the reverse arm by a $\frac{1}{8}$ in. bolt made as described for the valve spindle forks. Mark the position of the latch on the sector-plate when the lever is vertical, and file a notch across with a thin flat file as used by key-cutters. Put the lever forward as far as it will go, and file another notch at the position of the latch; ditto-repeato at the back end, then file the other notches at 1/16 in. intervals, as shown in both drawing and the miscalled photo in the December issue. All that is then needed to set the valves, is to adjust them on the spindles so that the black line of the port just shows at the end of the valve, when the crank is on dead centre. If one opens too much and the other not at all, take out the pin connecting the radius rod to valve-spindle fork, and turn it forward or back as the case may be, until you get the even opening on either centre.

If a tyre pump is conected to the steam pipe by a suitable adapter, easily made by fitting a $\frac{1}{4}$ in. union nut to the end of a discarded tyre valve, the wheels should turn freely in either direction, according to the position of the lever, when the pump is operated the exhaust beats being even. They are on my engine, even when the lever is in third notch from the end, which denotes correct setting and proper steam distribution.



**Working Parts for 1¾ in. Gauge Engine**

Here are the drawings for the motion-work of *Mona's* baby, and as they are made in the same fashion as those for "mum", no detailing-out should be necessary. The guide-bars are pieces of 3/32 in. round silver-steel turned down and screwed at one end as shown. The motion-plate is bent up from a piece of 16-gauge mild steel ¾ in. wide. The crossheads are little blocks of brass 9/16 in. long, 7/16 in. wide and 7⁄32 in. thick. First drill the crosshole for the little-end pin, then cut the slot for the little-end, and drill the hole for the piston-rod. Finally mark off and drill the holes for the guide-bars; these *must* be parallel and dead square with the ends and sides of the crosshead.

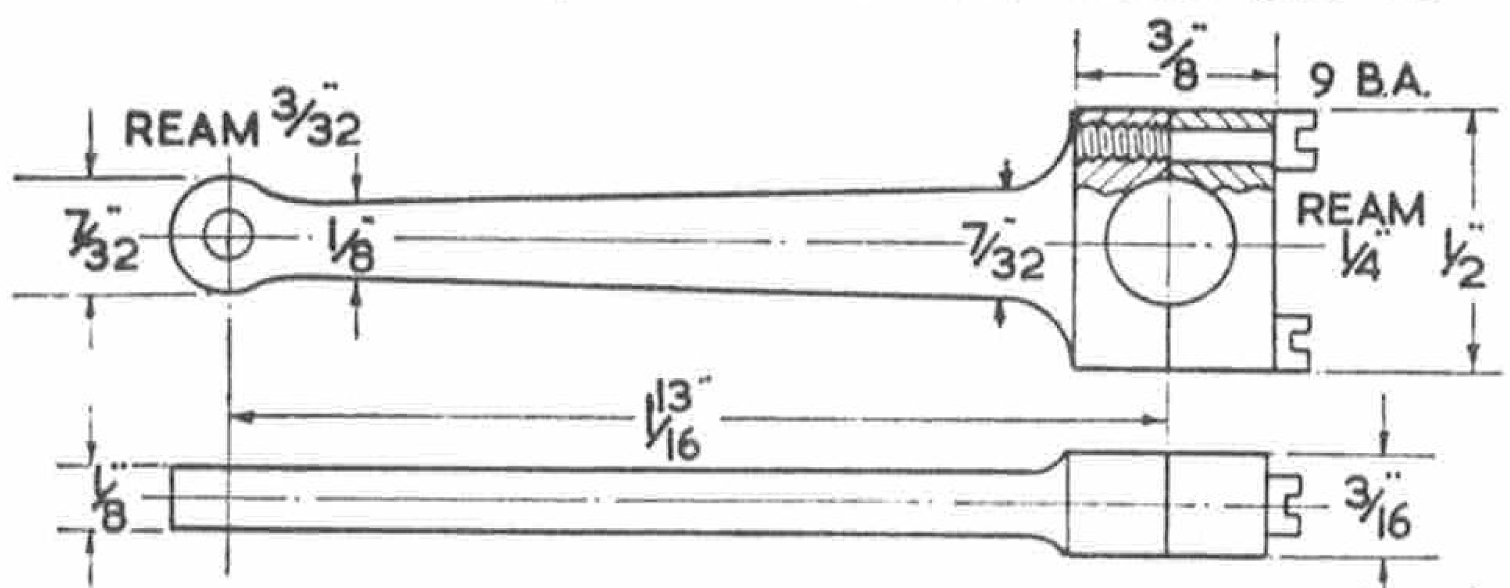
The connecting-rod can be cut from a piece of brass ½ in. x 3/16 in. section, all in one piece if desired. Alternatively, the brasses can be made separately from the rod, which can be sawn and filed from ⅛ in. steel, and silver-soldered to the half-brass with the tapped holes in it. Drill and ream the hole for the crankpin after screwing the halves of the brasses together.

The eccentric strap is machined up in the same manner as those for the 3½ in. gauge engine, the lug for the rod being drilled No. 48 and tapped 3/32 in. or 7 B.A. The rod itself is a piece of 3/32 in. round silver-steel, bent as shown, one end being screwed to suit the tapped hole in the strap, and furnished with a locknut. The other end is reduced to 1/16 in. diameter and screwed 1/16 in. or 10 B.A., on which is screwed a little block of brass as shown, filed to fit the fork on the valve spindle. This should be silver-soldered as well, for extra security.

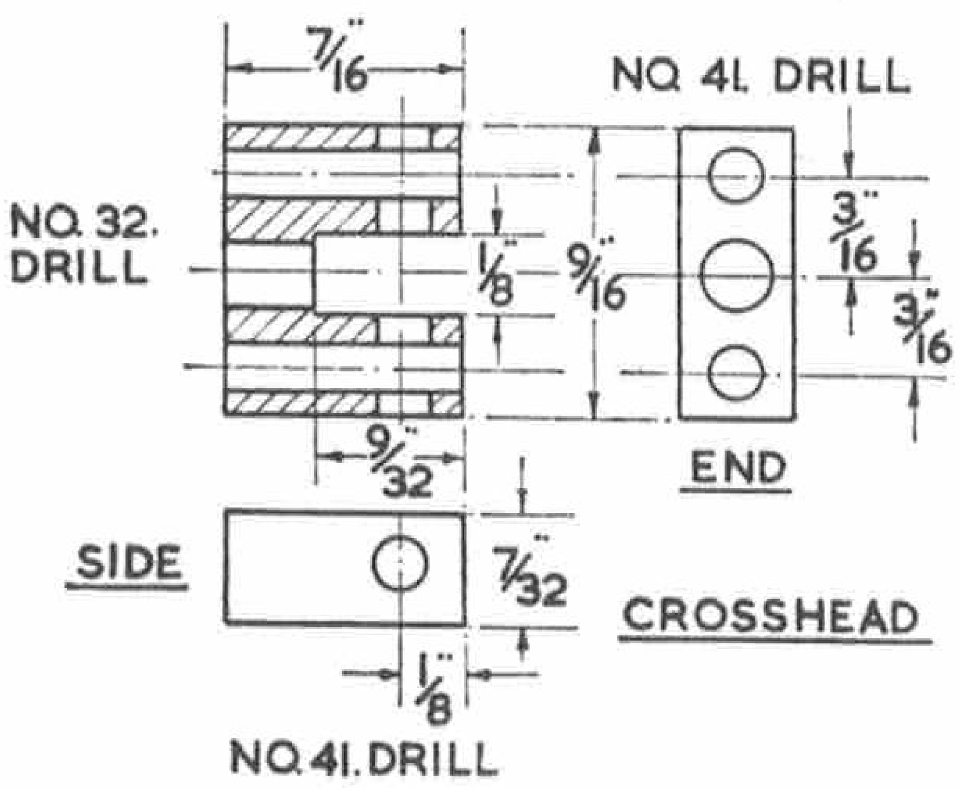
The erection is a simple job, easier than putting together a jigsaw puzzle if you follow the correct sequence. First erect the cylinder. Two extra No. 41 countersunk holes will need drilling in the left-hand frame, for the screws holding the steam-chest side. These are drilled halfway between those already in, as shown in the assembly drawing. Set the cylinder between frames in the position shown, with the middle of the front cover ¾ in. from the end of the frames. The front end of the cylinder block should be 3/32 in. from top to frame, and the whole doings tilted so that it is parallel with the centre-line of motion. Pull the piston-rod out, as far as it will come, and see that it points to the centre of the driving axle; this can be "sighted" quite easily if the chassis is turned upside-down on the bench. Put a cramp over the frames to prevent the cylinder from shifting, then run the No. 41 drill through the four holes in the right-hand frame, and the two middle holes in the left-hand-frame, making countersinks on the cylinder and steam-chest. Remove cylinder, drill the countersinks No. 48, tap 3/32 in. or 7 B.A., replace cylinders and secure with countersunk-head screws.

Put the little-end of the connecting-rod in the slot in crosshead, and pin with a piece of 3/32 in. silver-steel a full ¼ in. long, pushed through the crosshole. This pin floats, and should not be long enough to foul the guide-bar holes when in middle position. Take off the half-brass, and put the motion-plate over the end, with the flanges toward the crosshead. Slide the guide-bars through the holes in crosshead, enter the screwed ends in the holes in motion-plate and put nuts on. Put the lot between the frames, and enter the plain ends of the guide-bars in the holes in the back cylinder cover, which will automatically line them up with the piston-rod, and locate the position of the motion-plate. This can be fixed by screws put through the holes already in the frame, into tapped holes in the flanges of the motion-plate. Put the brasses over the crankpin, put the screws in, and put the crank on front dead centre; this will force the piston against the front cylinder cover when the rod enters the hole in crosshead. Take off the front cylinder cover, and very carefully drive the piston backward 1/32 in. so that the rod enters the crosshead that amount extra; the crosshead can then be pinned to the rod by drilling a No. 53 hole through both, between the little-end slot and the back, and squeezing in a pin made from 1/16 in. silver-steel, slightly tapered at one end to give it a start.

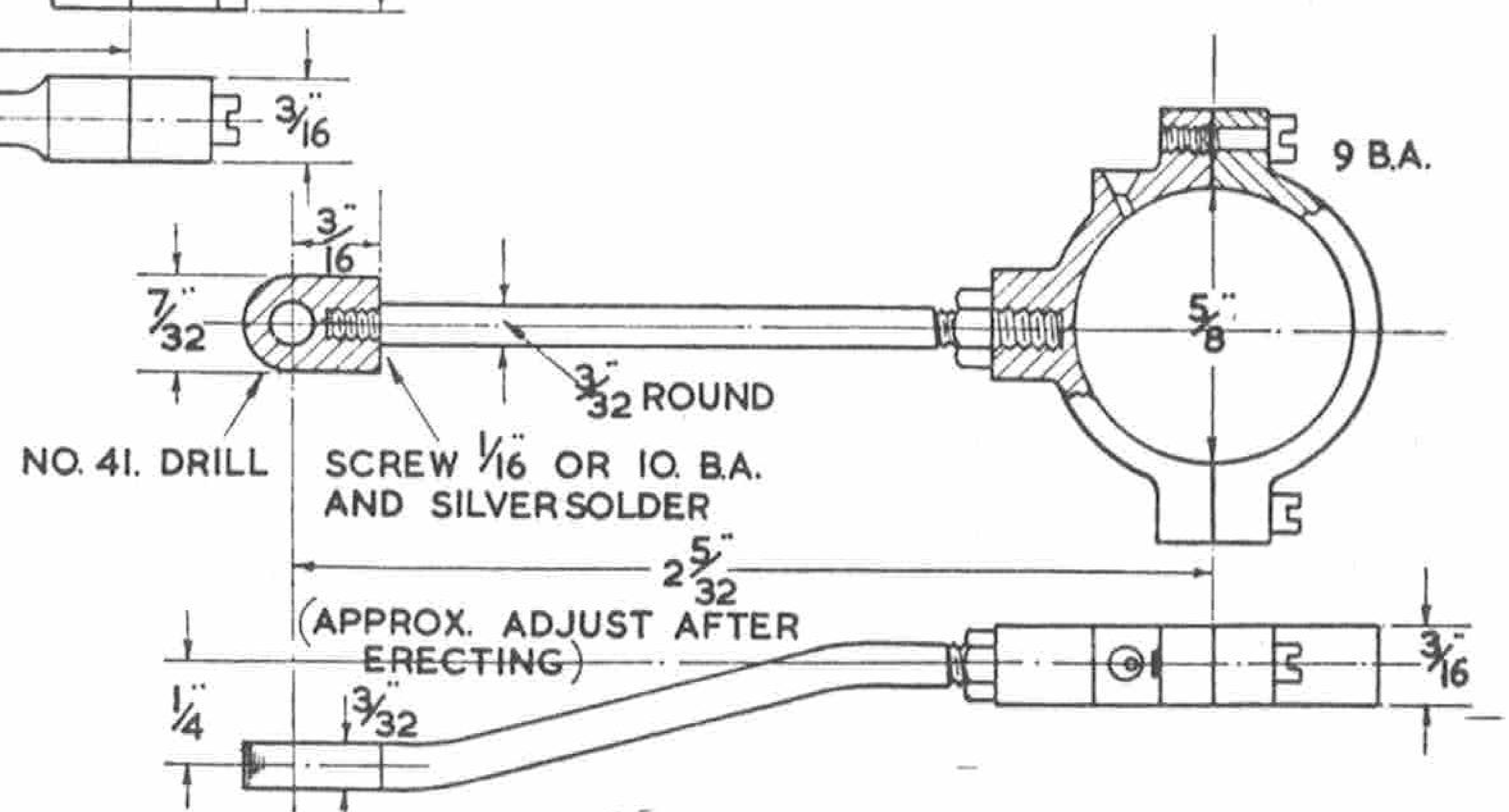
Put the eccentric-rod through the hole in the motion-plate, and fit the strap to the eccentric. The little block which goes between the jaws of the fork on the valve spindle, is kept in place by a 3/32 in. screw with about ⅛ in. of "plain" under the head, running through the clearing hole in one side of the fork. Tighten the setscrew in the stop collar, the position of which doesn't matter for the time being, and turn the wheels by hand. If there are any tight places, these should be eased before going any farther. The valve setting may be left until the steam pipe and lubricator are fitted, when the "works" can be tested under air pressure.



CONNECTING ROD



CROSSHEAD



ECCENTRIC STRAP & ROD

BEFORE starting to make the lubricator, builders should take a good quiz at the two photographs at the top of the middle pages of last December's instalment of this serial. They show pretty clearly the arrangement of the whole outfit; and when anybody knows beforehand exactly what they are going to do, the job is ever so much easier. I find it so, anyway. In the left-hand one you'll see that the middle eccentric, which has a round rod, with a circular boss at the end, is connected to the lower end of a swinging arm, which hangs from a fork attached to the top of the motion plate. The off-centre hole in the drawing of the motion-plate was for attachment of this fork. The pin on which the boss works, projects right through the arm, and on the other side, it carries another boss attached to the rod which drives the ratchet lever. You can just see this merchant curving away from the arm (I beg its pardon—suspension lever is the correct title!) in the left-hand picture, but if you now look at the other one, you can trace it right to the bottom of the ratchet lever, to which it is attached by a small fork, like a valve-gear fork.

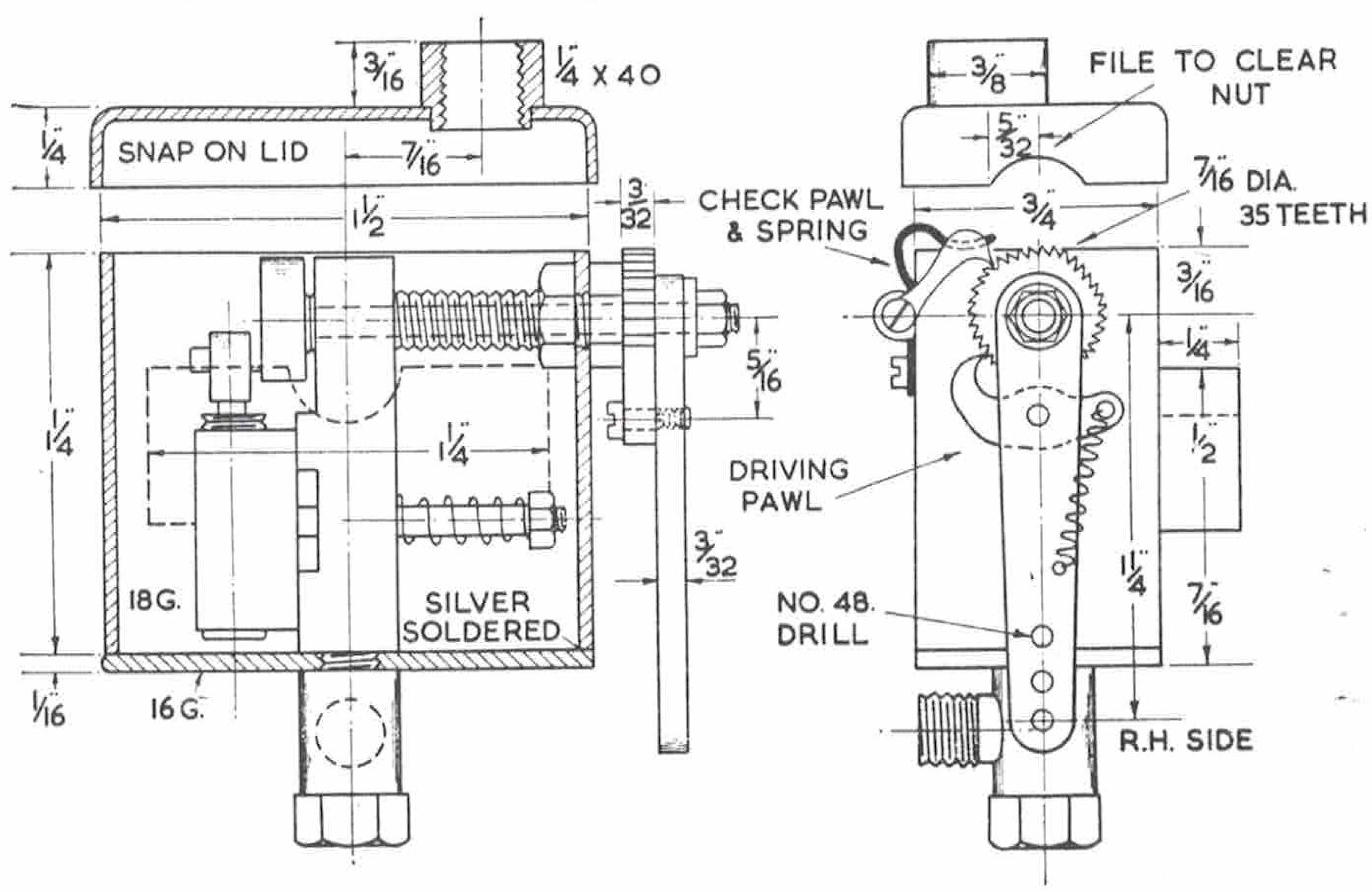
The position of the oil tank is also clearly shown. The tank has a block of brass silver-soldered to the front, which fits nicely between the two angles securing the frame to the buffer-beam, and is attached to the beam by 3/32 in. countersunk screws. The filling-plug projects up behind the top member of the beam, but it will be normally hidden by what the enginemen call the cylinder flap, that is, the piece of running-board which fits between the frames at the front end. Note—the beams on my *Mona* have narrow tops, as I used some angle which I had in stock, but to allow the filler to come up in the right place with the wider-top beams specified, a half-round clearance will need filing, as shown in the drawing of the complete assembly.

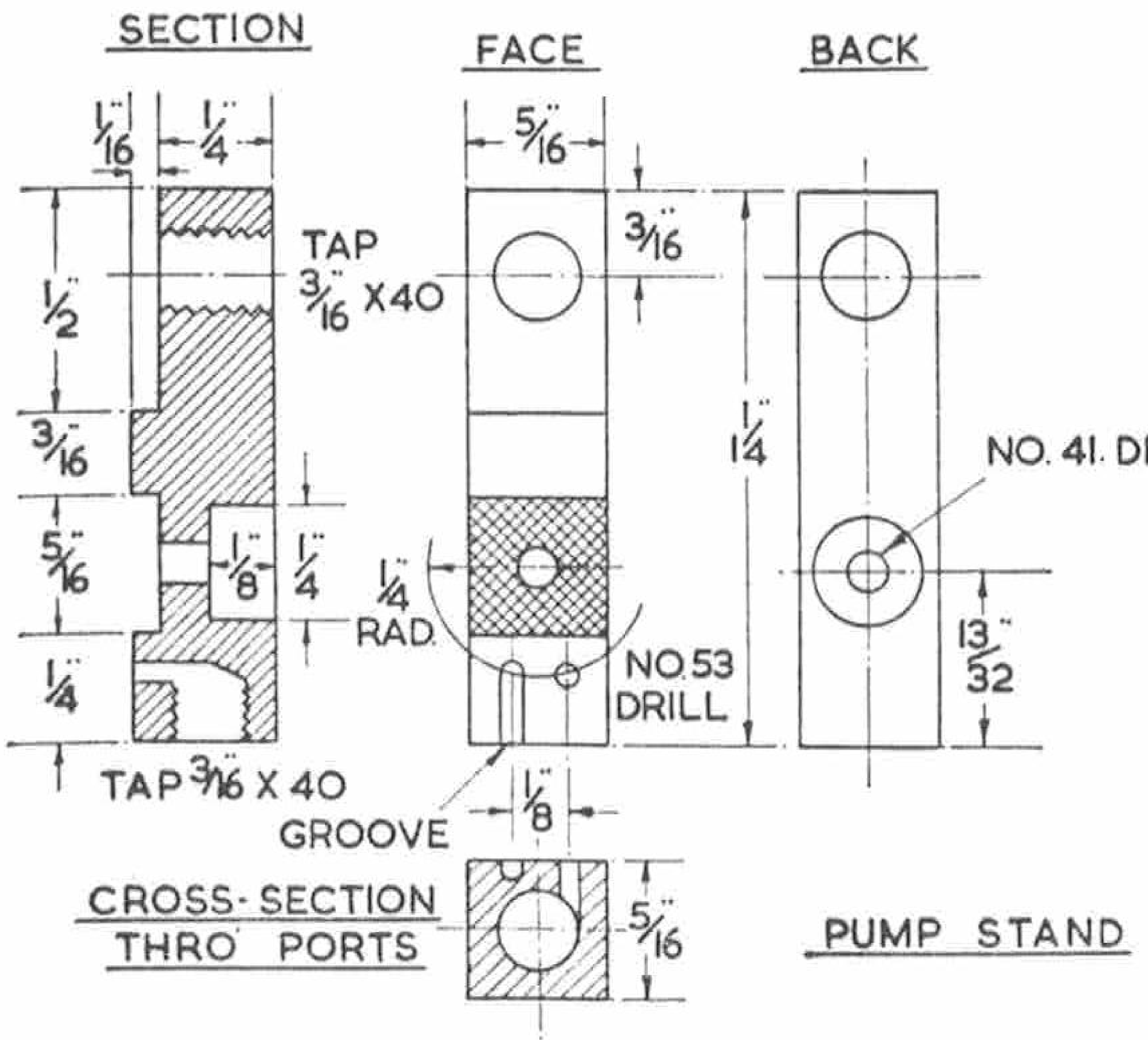
The underside view also shows the simple oil-pipe connection, the oil entering at the bottom of the little duct drilled through the cylinder casting between the bores. It comes out exactly on the spot where it is needed most, viz., right between the slide-valves, and is carried by the rush of steam to the pistons and glands, ensuring perfect lubrication and minimum wear. The whole arrangement works fine on my own engine. I would have liked to put the eccentric on the leading axle, and used a short drive rod, as I always do on tender engines wherever possible; but there was no room on *Mona*, and as a single rod from the eccentric to the ratchet lever would have been far too long to be stable, the suspension lever was fitted, and did the trick. Well, let's get busy!

### Oil Tank

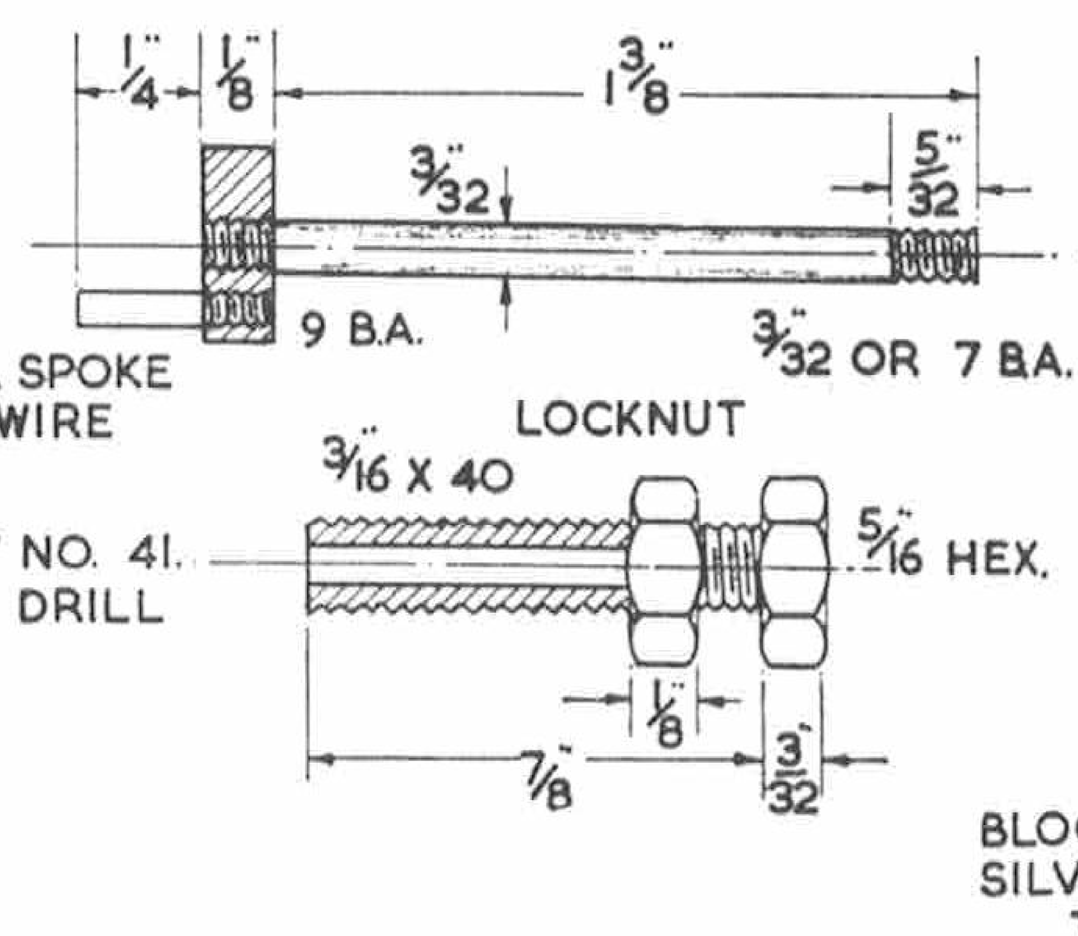
Cut a piece of 18-gauge sheet brass a full $4\frac{1}{2}$ in. long and $1\frac{1}{4}$ in. wide, and bend it into a rectangle measuring $1\frac{1}{2}$ in. x $\frac{3}{4}$ in. This can be easily done in the bench vice. Before I had a bending machine, my pet way of making the vice act as substitute was to take out the hardened steel jaw insets (two screws apiece—a few seconds' work) and replace them with two pieces of ordinary mild steel of similar section, but long enough to stand out 3 in. or so from one side of the jaws. You can see at a glance how to bend up the tank in two wags of dog's tail, if you fit the extensions to your own vice. Only one bend could be made without them, as the jaws would get in the way, but the extensions allow the other two to be made entirely clear of the jaws. Tie a bit of thin iron binding-wire around the top, to keep the edges of the open corner (says Pat) together.

Next cut the brass block by which the tank is attached to the buffer-beam. This is a $1\frac{1}{4}$ in. length of $\frac{1}{2}$ in. x $\frac{1}{4}$ in. section. In the middle of it, file a half-round nick about $\frac{1}{4}$ in. wide and deep, to clear the nut on the drawbar shank. Rivet this to one of the long sides of the tank, at $\frac{3}{8}$ in. from the bottom, using two 1/16 in. copper rivets. On the opposite side, at 3/16 in. from the top, rivet another little piece of brass about $\frac{1}{8}$ in. square and $\frac{1}{4}$ in. long, to carry the check-pawl screw; one rivet will hold it. Now cut out a piece of 16-gauge brass sheeet, to a little over the size of the tank; say $1\frac{5}{8}$ in. x $\frac{7}{8}$ in. Lay this in the brazing-pan with the tank on top of it, set as centrally as possible; a big tin lid, or small tray, with a layer of coke nuts or breeze in the bottom, makes a swell brazing-pan for these little jobs. Cover the joints with a paste made from powdered borax and water, not forgetting the brass blocks; heat the lot to dull red (the simple self-

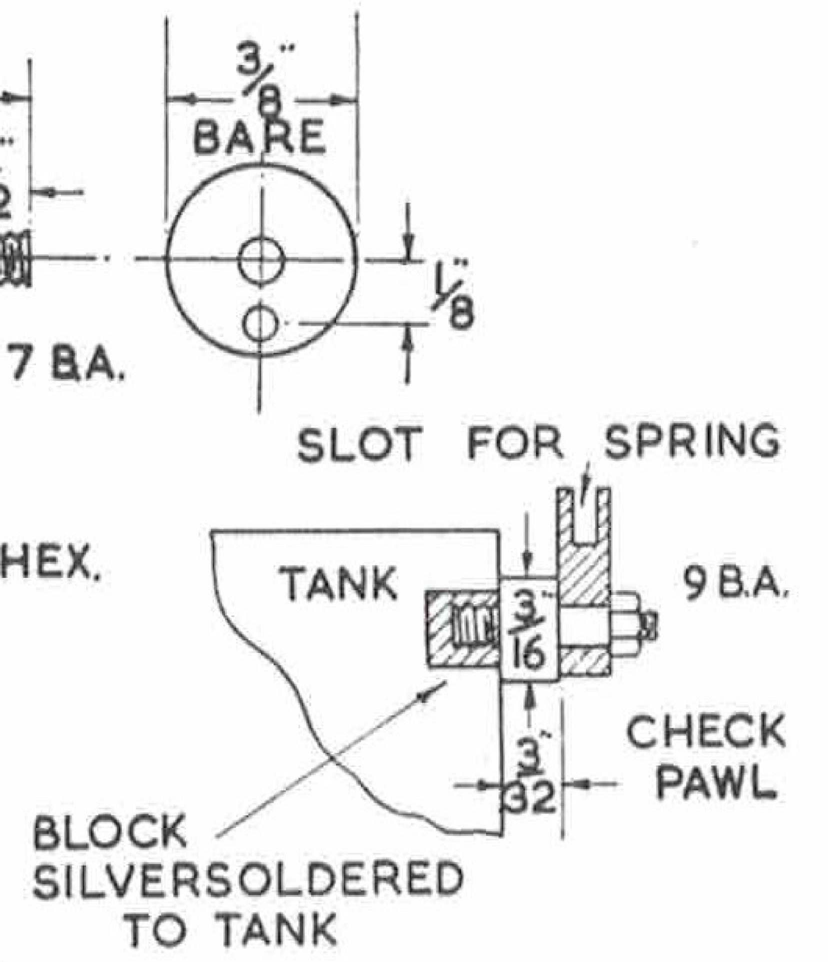




PUMP STAND



CRANKSHAFT AND BEARING



HOW CHECK PAWL IS FITTED

blowing gadget that I mentioned in a previous article will do the job) and apply a thin strip of best-grade silver-solder to the joints. This will immediately melt and flow into them, running all around the bottom, in the corner, and at the joints between brass blocks and tank. Personally I use "Easyflo" silver solder, and the special flux sold for use with it.

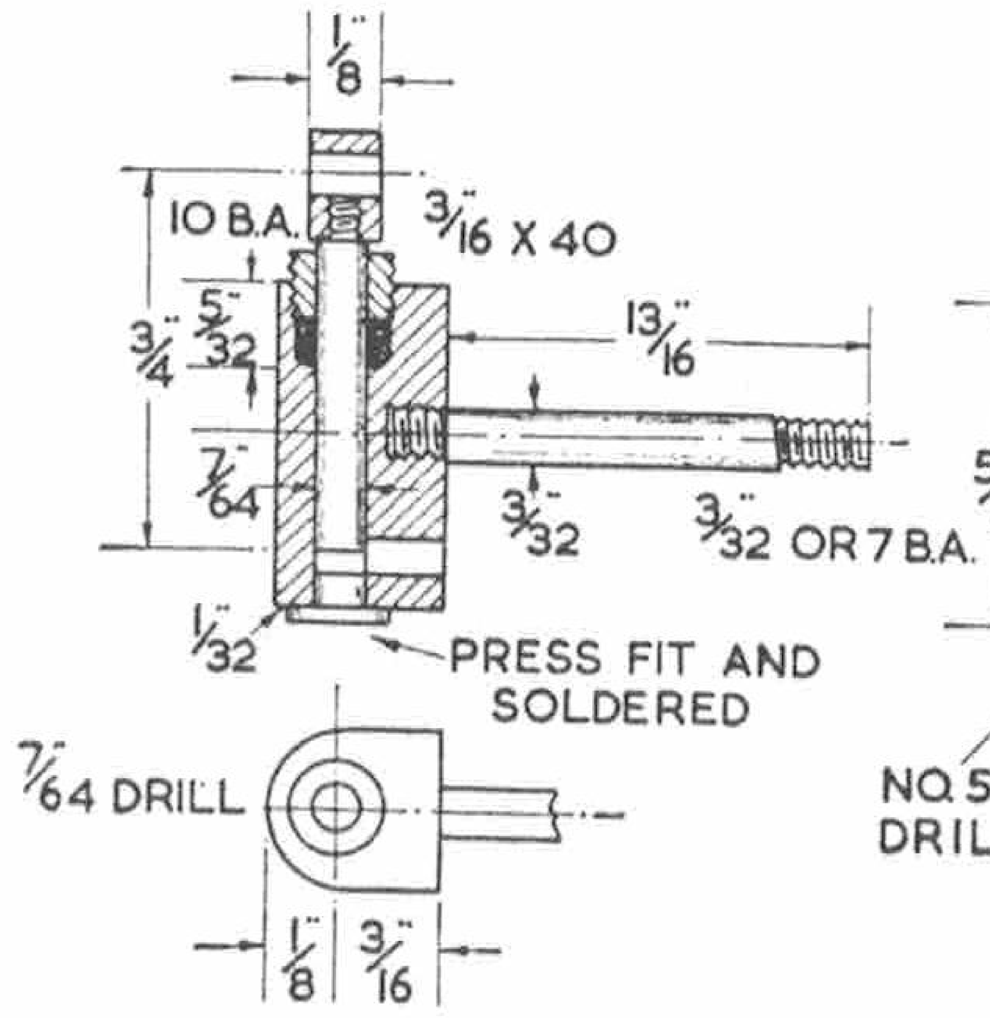
Make sure that all the joints are sound, then let cool to black, and quench out in acid pickle, to remove the burnt flux. I keep some in an earthenware jam-jar at the back of my brazing forge, nice and handy for quenching small jobs. The pickle consists of one part of commercial sulphuric acid added to about 15 of water. Stale accumulator acid will do, diluted with three times its bulk of water. Let the tank stay in the acid for about 15 minutes, then fish it out, and well wash it under the kitchen tap. File the projecting bottom edges flush with the sides. The lid can be made by cutting out a piece of thin sheet brass 2 in. x 1¼ in. and cutting a ¼ in. square nick out of each corner. Bend up ¼ in. of each edge, to form a kind of tray ¼ in. deep, which should fit nicely on top of the tank. Then silver-solder the corners (process described above) only using just the weeniest bit of silver-solder at each corner, or the lid won't fit the tank. It should be a snap-on fit when finished, but only has to go on for half its depth, otherwise the pump ram will hit it at the top of the stroke. Finally drill a 3/16 in. hole in the bottom of the tank, right in the centre; and another, on the centre-line of the short side where the little block is fixed, and 3/16 in. from the top.

**Oil Pump**

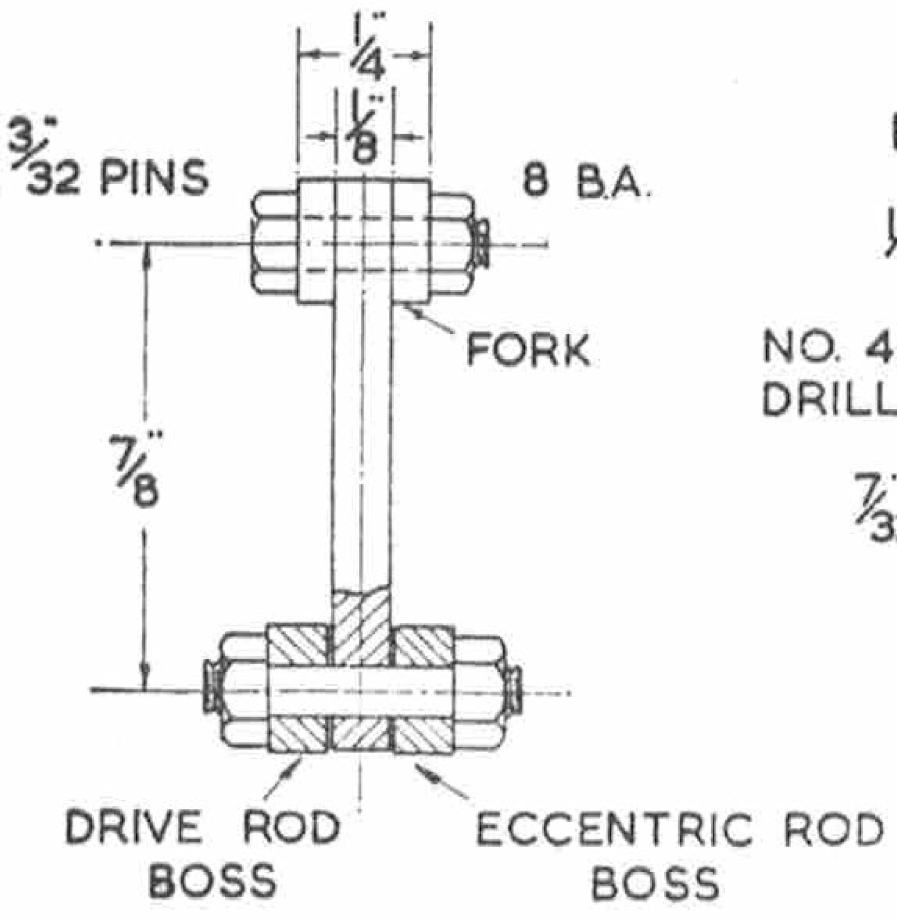
The oil pump consists of a tiny oscillating cylinder working over a portface on a brass stand, and although the absolute rock-bottom of simplicity, has amazing power; one was tested in a full-size locomotive works, and pumped against 450lb. pressure. The stand is a piece of 5/16 in. square brass rod, both ends being faced off in the lathe, to a length of 1¼ in. The 1/16 in. rebate and recess can be milled by any of the processes previously described, or they may be just hand-filed. At 3/16 in. from the top, drill a 5/32 in. hole and tap it 3/16 in. x 40. This hole must go through dead square with the side, so use drilling-machine or lathe; don't drill it by hand. In the middle of the recess, drill a No. 41 hole, also dead square with the face, and pin-drill it at the back with ¼ in. pin-drill, to ⅛ in. depth. If a pin-drill isn't available, an ordinary drill can be used, but don't go too deep.

Next, chuck the piece truly in the four-jaw, square end outwards; centre, drill a hole 3/16 in. deep with 5/32 in. drill, and tap 3/16 in. x 40. Then comes the bit requiring care. At ¼ in. from the centre of the hole in the recess, on the flat face beneath it, make two centrepops *exactly* ⅛ in. apart. The best way for beginners to ensure that they are marked out correctly, is to strike the arc with a pair of dividers set with points ¼ in. apart, from the centrepop for the hole in the recess, before drilling same. I usually slip a wee 3/32 in. bush over one point of my dividers, and put it in the hole while scribing with the other point—lazy again! Now drill the right-hand centrepop with a No. 53 drill until it breaks through into the tapped hole in the bottom of the stand; and watch your step as it breaks through, at that, or you'll have a break of another kind, the sort that delights the heart of the tool-merchant who sells small drills! The left-hand hole is only drilled in for about 1/16 in. depth, and a groove is chipped in the face, from the hole to the bottom of the stand. A chisel for this can be made by turning a long cone point on a short bit of ⅛ in. silver-steel; file off the point at an angle, to form an oval about 1/16 in. wide, and harden and temper it to dark yellow. True the faces above and below the recess, by rubbing them on a piece of fine emerycloth, or similar abrasive, laid business-side-up, on the lathe bed or something just as flat.

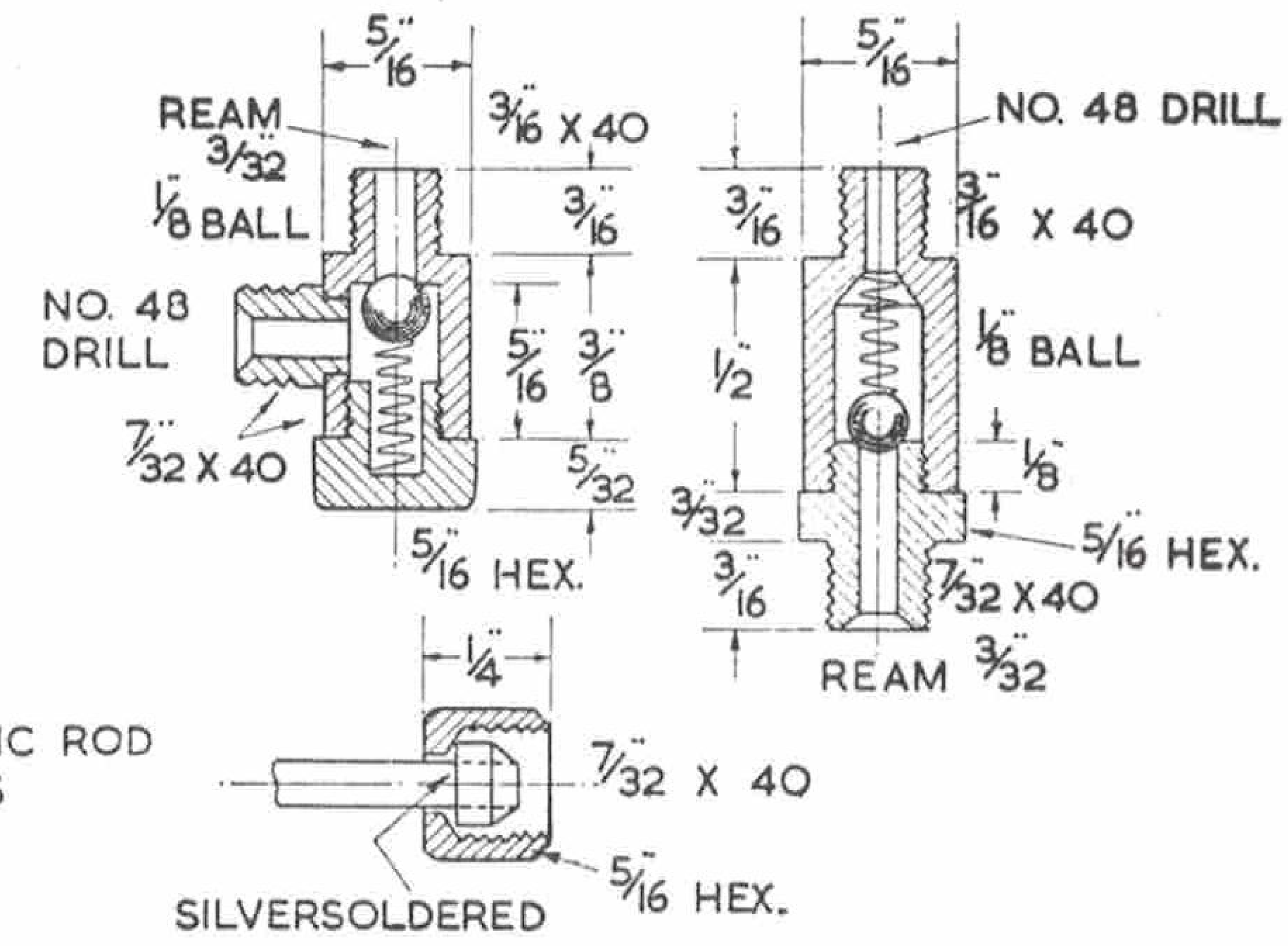
The pump cylinder is a piece of 5/16 in. square brass rod faced off to ⅞ in. length. Make a centrepop on one end at ⅛ in. from one of the facets, chuck in four-jaw with this running truly, drill right through with 7/64 in. drill, open out the end to 5/32 in. depth with 5/32 in. drill, and tap 3/16 in. x 40. Make a little gland to suit, from a piece of 3/16 in. rod, by same process as cylinder glands. Scribe a line down the middle of the side farthest away from the bore, make a centrepop 3/32 in. from the bottom, and another at ¼ in. above it. Drill the former with No. 55 drill, right into the bore. Drill the upper one with No. 48 drill to ⅛ in. depth; don't pierce the bore if you can help it, but if you do, there is no need to lose any sleep as long as the trunnion-pin doesn't go through far enough to hit the pump ram. Tap the hole 3/32 in. or 7 B.A., and put the drill through the bore again, to clear away any burring. Turn up a plug as shown, from 3/16 in. rod, to a drive fit in




PUMP CYLINDER




FRONT VIEW OF SUSPENSION LEVER




CHECK VALVES AND UNION

the bottom of the bore, squeeze it in, and solder it over. This plug should just reach to the bottom of the port.

The pump ram, or plunger, is a piece of 7/64 in. rustless steel or phosphor-bronze rod 11/16 in. overall length, with a little big-end (it's that Pat again!) screwed on to the end as shown. The ram should be an exact sliding fit in the bore; if a piece the given size isn't available, turn it from the next size larger. Turn down 3/32 in. of the end, to 1/16 in. dia. and screw it 10 B.A. The "big-end" is filed up from a little piece of 1/8 in. brass, drilled No. 48 to fit the crankpin, and drilled No. 55 and tapped 10 B.A. to screw on to the ram. From the middle of the crankpin-hole to the end of ram should be 3/4 in. True up the drilled face of the cylinder in the same way as the portface on the stand, then screw in the trunnion pin, which is a piece of 3/32 in. silver-steel 15/16 in. overall length, screwed at each end as shown. Pack the gland with a few strands of graphited yarn. The ram should slide easily, but must not on any account be slack.

**Crankshaft and Bearing**

The crankshaft is a piece of 3/32 in. silver-steel 1½ in. long, with 1/8 in. of 3/32 in. or 7 B.A. thread on one end, and 5/32 in. same pitch on the other. For the crank, chuck a piece of 3/8 in. round rod in three-jaw, face, centre, and drill to 3/8 in. depth with No. 48 drill. Part off a 1/8 in. slice. Tap the hole to suit the thread on shaft, then at 1/8 in. from centre, drill a No. 53 hole and tap it 9 B.A. In this, screw a 3/8 in. length of 15-gauge spoke wire with 1/8 in. of 9 B.A. thread on it. Cycle spokes of various gauges can be bought cheaply at any cycle shop, and they make nobby long-wearing pins for valve gears and other uses.

To make the bearing, chuck a piece of 5/16 in. hexagon brass rod in three-jaw; face, centre, and drill to a full 1 in. depth with No. 41 drill. Turn down 7/8 in. of the outside to 3/16 in. in dia. and screw 3/16 in. x 40. Part off at a full 3/32 in. from shoulder, reverse in chuck, and chamfer the corners of the hexagon. Make a locknut 1/8 in. thick, from the same size rod, tapping it 3/16 in. x 40.

**Check Valves**

Both check valves are made from 5/16 in. round rod. Chuck in three-jaw, face, and for the one under tank, turn down 3/16 in. length to 3/16 in. dia. and screw 3/16 in. x 40. Part off at a full 3/8 in from shoulder. Reverse in chuck, centre, drill right through with No. 43 drill, open out and bottom to 5/16 in. depth with 3/16 in. drill and D-bit, slightly countersink the end, and tap 7/32 in. x 40, but don't run the tap in far enough to damage the ball seat. Poke a 3/32 in. parallel reamer through the remnant of No. 43 hole. Drill a 5/32 in. hole halfway between end and shoulder, in the side of the valve body, and fit a 7/32 in. x 40 nipple in it, make like those on the crosshead pump. Silver-solder the joint. For the cap, chuck the 5/16 in. hexagon rod again, face, centre, and drill to 1/4 in. depth with No. 30 drill. Turn down 1/8 in. of the end to 7/32 in. dia. and screw 7/32 in. x 40. Part off at 5/32 in. from shoulder, reverse in chuck, and chamfer the corners. Seat a 1/8 in. rustless ball on the reamed hole, and assemble as shown, with a light spring wound up from tinned steel wire of about 26 gauge, around a piece of 1/16 in. silver-steel. Touch both ends of the spring on a fast-running emery wheel, to square them off, before assembling.

To make the other check valve, screw the end as above, but part off at ½ in. from the shoulder. Reverse in chuck, drill to 7/16 in. depth with 3/16 in. drill, slightly countersink the end, and tap 7/32 in. x 40. Chuck the 5/16 in. hexagon rod, face, centre deeply, drill to about ½ in. depth with No. 43 drill, and turn down 3/16 in. of the end to 7/32 in. dia. screwing 7/32 in. x 40. Part off at 1/4 in. from shoulder. Reverse and rechuck in a tapped bush; turn down 5/32 in. length to 7/32 in. dia. and screw 7/32 in. x 40, put a 3/32 in. parallel reamer through the hole in centre, and then skim 1/32 in. off the end to true it up. Seat a 1/8 in. ball on the hole, and assemble as shown, with a spring similar to the one previously described.

Beginners note, the reason for spring-loading the clack-balls is to reduce lift to the absolute minimum needed, and prevent steam blowing back into the oil tank and condensing. These tiny balls have a tendency to kind of float in the thick cylinder oil, and without the springs, their movements would be too sluggish.

**Assembly**

Attach cylinder to stand by a spring and nut as shown; the spring should be wound up from 22-gauge tinned steel wire around a bit of 3/32 in. steel. Stand the pump in the tank, over the bottom hole, and screw the check valve into it, through the hole, but don't tighten it up yet. Put the bearing through the hole in the tank side, put on the locknut, and then