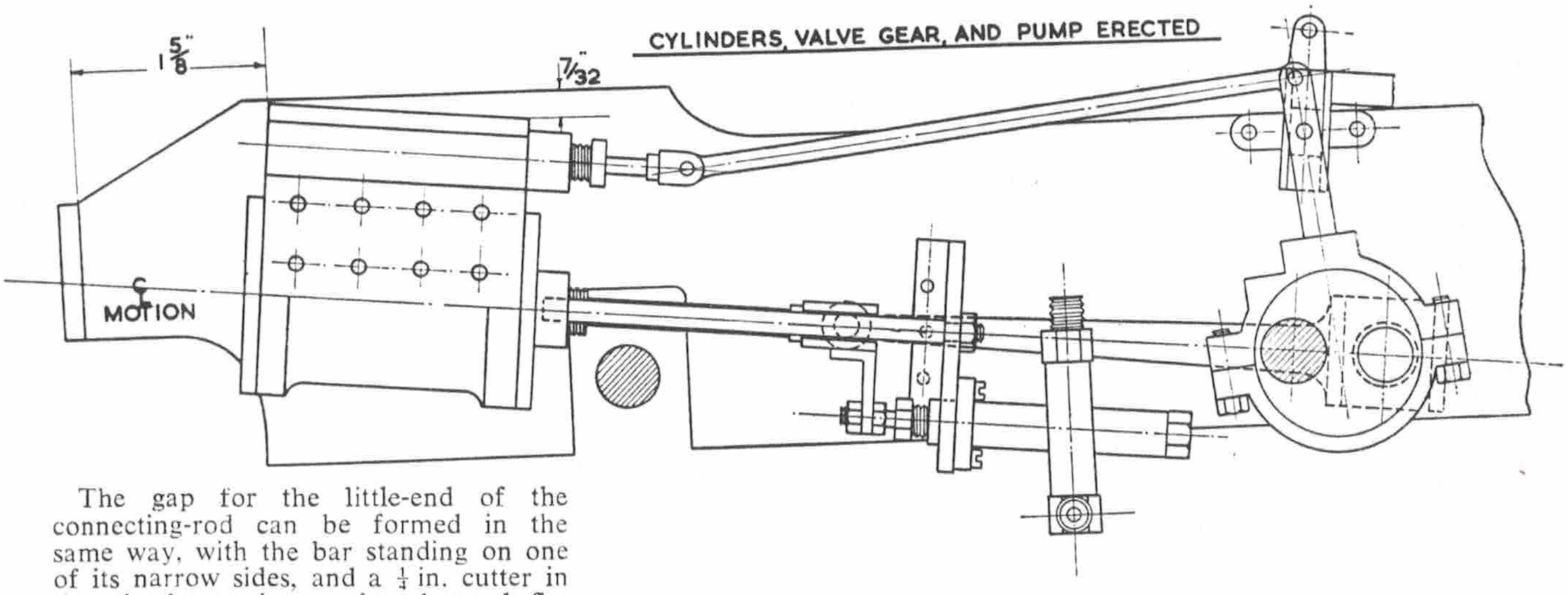
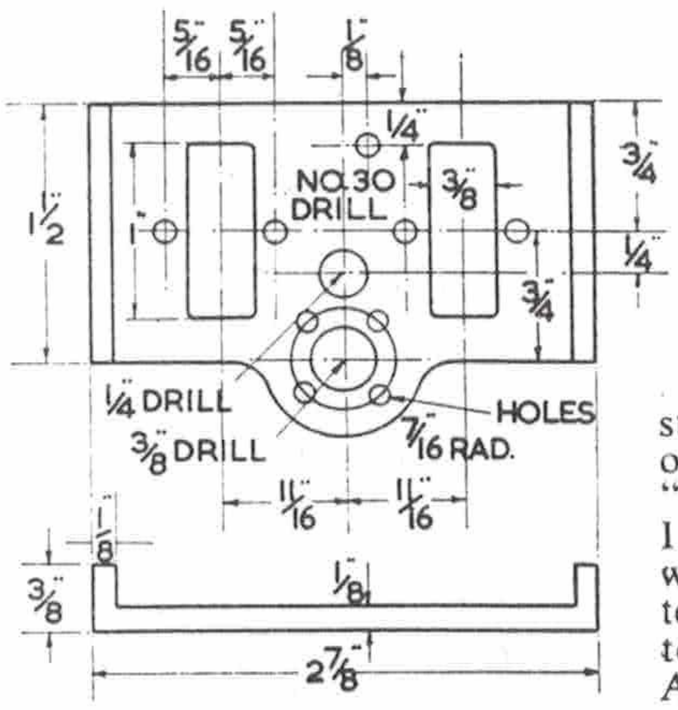


The gap for the little-end of the connecting-rod can be formed in the same way, with the bar standing on one of its narrow sides, and a ¼ in. cutter in the chuck; or it can be clamped flat under the slide-rest tool-holder at right angles to the lathe centres, and run up to a ¼ in. saw-type cutter on a stub mandrel in three-jaw, or between centres. In my "'ard-up-'n'-'appy" days I cut any width of slot with my one-and-only cutter, by taking enough bites to get the width desired. After cutting one end, reverse the bar and slot the other end. If the ends are not dead square, face them off with the piece of bar held in four-jaw. At ¼ in. from the end, in the middle of the groove, drill a No. 14 hole right across, for the wrist pin, and poke a 3/16 in. parallel reamer through it. Tip to beginners—do this before cutting the gap; then you won't have trouble with the drill trying to wander, and drilling the hole out of truth.



MOTION PLATE

NO. 41 DRILL ON 19/32" CIRCLE

Next, saw the piece of bar in half. Chuck each half with the sawn ends outwards, setting truly in the four-jaw; face off to ¾ in. overall length, then turn ⅛ in. length to 5/16th in. diameter. Don't drill the boss yet; the hole for piston-rod should be located with the crosshead between the bars, when the motion-plate is made and fitted. As the feed-pump is driven from the crosshead on the left-hand side, we need an arm for that purpose, and this is just a piece of 3/32 in. steel, bent to the shape shown in the drawing, and brazed to the crosshead if the latter is steel, or silversoldered if bronze. Another tip to beginners; use a piece of 3/32 in. × ¾ in. steel angle, or bend a piece of 3/32 in. steel to a right angle in the bench vice, mark out the shape of the arm on that, and saw it a little oversize. Attach it to the crosshead by a 1/16 in. screw, shown by the dot in the illustration; braze or silversolder it, clean up, then finish to size with a file, and very carefully mark out and drill the hole for the end of the pump ram, to the location and dimension shown.

Connecting-rods

The connecting-rods are of the marine type as used on the Stroudley engines of the L.B. & S.C.R. in my time, and are the easiest type to make. The main part of the rod, from the brasses to the little end, can be milled, or sawn and filed, from a piece of 1 in. × ¼ in. mild steel 4½ in. long, by the method described for coupling-rods. I have shown the centre part reduced to ⅛ in. as on my own engine, but anybody feeling a little tired of pushing a file could leave this full width without interfering with the efficiency of the locomotive. The little end is bronze-bushed, also like the coupling-rods, so no repetition is necessary.

My pet antic for making big-end brasses is to get two bits of bronze bar, half the width of the finished bearing, solder them together temporarily, and drill and ream the hole for the crankpin slap-bang on the joint. Then when parted, you know that exactly half the hole will be in each half of the brass. In the present instance, take two pieces 1 in. long, ⅜ in. wide and ¼ in. thick; clean two of the narrow sides, and solder them together. Grip in vice, and make a centrepop right in the middle of the joint. Transfer to vice on drilling-machine; drill first with, say, 3/16 in. drill, then open out to 31/64 in. and ream ½ in. Alternatively, drill against a pad on lathe tailstock; not by hand. Then mark off and drill the two bolt-holes through the thickness, using No. 41 drill.

The keep is just a strip of ¼ in. × ⅛ in. steel 1 in. long. Clamp it against the end of the brasses (they are always called brasses, whatever the material) and drill the bolt-holes in it, using those in the brasses as guide. Then clamp the brasses against the end of the rod, run the 41 drill through the bolt-holes, and make counter-sinks on the tee-head. Remove brasses, drill the head with No. 48 drill, tap 3/32 in. or 7 B.A., and fit studs made from 1¼ in. lengths of 3/32 in. silver-steel, or 13-gauge spoke wire. Cycle spokes can be purchased from any cycle dealers' store, in several gauges, and they make swell pins for valve-gear and other locomotive purposes. When screwing the studs, set the die to cut a wee bit large, so that the nuts will stay put when *Mona* is doing the knots with a big load. Melt the brasses apart,

wipe off all the solder, then assemble the big-end as shown, trimming off the sides with a file so that the width is 15/16 in. and putting the reamer through the big hole again. The brasses should just fit nicely between the crank webs, and be easy on the crankpins, but without shake. If too tight, you'll get a full-size driver's headache, viz. hot big-ends, and if too loose, they will sound like a kettledrum.

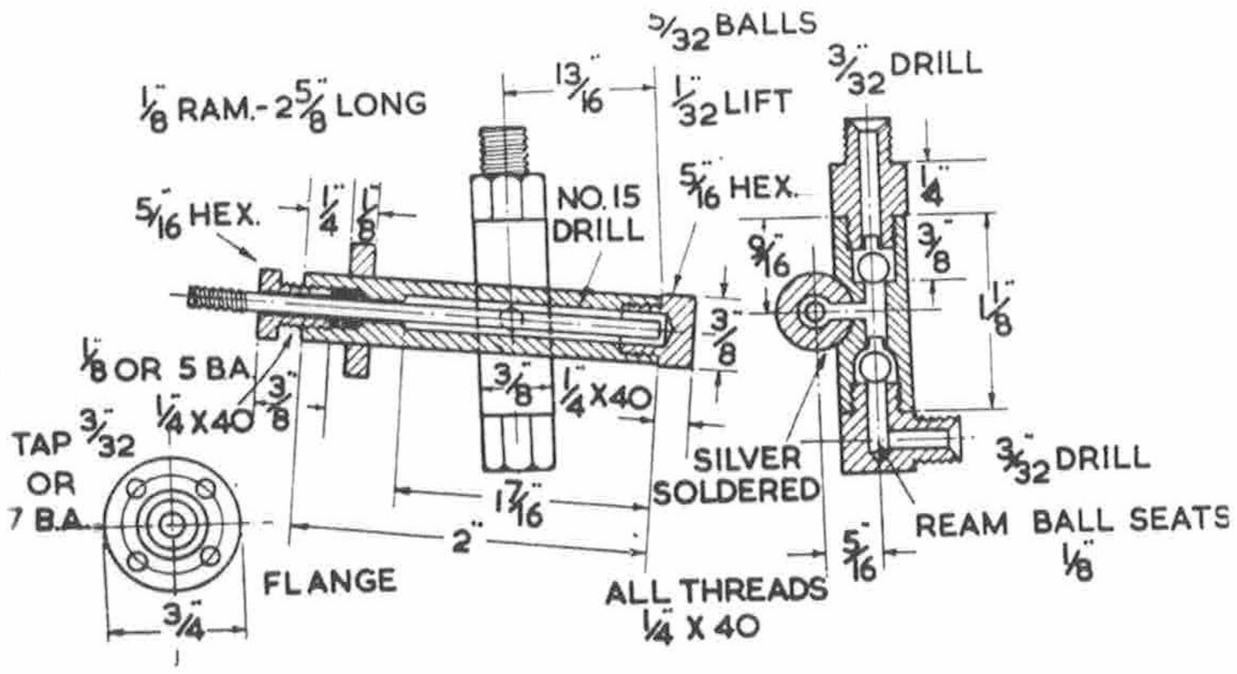
Motion-plate

This merchant requires care in setting out, as it is responsible for the alignment of the piston-rods, guide-bars and cross-heads. I made mine from a piece of $\frac{1}{8}$ in. mild steel plate (an offcut from the frames, to be exact) and I brazed on the side flanges; but it would be easier to use a casting, which can be of bronze or gunmetal, or cast-iron. This should be milled, or carefully filed, to fit nicely between the frames; alternatively, it could be clamped flat on an angleplate attached to the faceplate, and the sides faced off, with a round-nose tool set crosswise in the rest. Butt the first side up against the faceplate when facing off the second side, then they must of necessity be parallel.

Scribe a horizontal line right across the middle, and on this set out the holes for the ends of the guide bars and the slots for the connecting-rods. The $\frac{1}{4}$ in. hole between is for the eccentric-rod for the drive to the mechanical lubricator. The little one at the top, offset from centre-line, is for the shank of the bracket carrying the pendulum link supporting the same rod. The $\frac{3}{8}$ in. hole at the bottom carries the pump barrel. Around the centre of this, strike a circle 19/32 in. dia. and set out on it the four holes for the screws holding the pump flange. Then drill the whole bunch of holes to sizes given. The rectangular slots can easily be formed by drilling three 5/16 in. holes close together on the centre-line of the slot, and finishing to shape with a square file.

First Stage of Erection

Now we're coming to the important jobs! Push the plain ends of the guide bars into the holes in the gland bosses on the back cylinder covers, put a crosshead between each pair of bars, and put the motion-plate over the screwed ends of bars, with nuts to keep the lot together, on the projecting ends of bars. The crossheads should slip from one end of the bars to the other, easily but without shake. If tight, ease the grooves with a file. Now take off the back cylinder covers, leaving bars and motion-plate attached. Jam the crosshead against each gland and put a 7/32 in. drill through the piston-rod hole in the cover, making a countersink with it on the boss of each crosshead. Remove crossheads and drill out the countersinks with No. 4 drill, using lathe or drilling machine to ensure that the holes go through the boss truly. Then replace the crossheads between the guide bars, hold them against the glands, and with a 7/32 in. parallel reamer put through the piston-rod holes in the covers, ease out the holes in the crosshead bosses until the piston-rods will enter a very tight fit. This ensures alignment and free operation even when the guide bars are a little out of correct position, and is well worth the trouble spent in doing the job.



BOILER FEED PUMP

Replace back covers, take off motion-plate, and pin a connecting-rod to each crosshead with a 7/16 in. length of 3/16 in. silver-steel, which should push easily through the holes in sides of crosshead jaws, and little-end bush. Replace crossheads and motion-plate, push crossheads a little way on to piston-rods, and take off half of each big-end brass; the brasses should be marked so that they can be replaced properly again. Now carefully put the whole complete bag of tricks between the frames in the position shown in the drawing. The top of the front edge of steam chest should be level with top of frame, and exactly $1\frac{5}{8}$ in. from the front edge of it. The back edge of steam chest should be approximately 7/32 in. below top of frame, which should give the correct slope. A line drawn through centres of cylinder bore, piston-rod, and connecting-rod when extended straight from crossheads, should cut through centre of axle, as shown. The side flanges of the motion-plate should cover the three holes drilled in each frame midway between leading and driving axles.

Put a big cramp over the frames, to keep the assembly from slipping, then put a No. 30 drill through the holes in each frame by the side of cylinders, and make countersinks on the side of the cylinder blocks. Ditto repeato on the flanges of the motion-plate. Carefully remove the assembly, then drill the upper row of holes in the cylinder with No. 40 drill to about 5/16 in. depth, *and the lower row to $\frac{1}{8}$ in. depth only;* very important that. If you go deeper, you'll pierce the bore. It may be asked here, why I didn't specify a cylinder casting with a full-length flange each side, same as that for the $1\frac{1}{4}$ in. gauge engine (see next instalment). The simple reason was that I used a casting that I had in stock, for my own engine, and these castings were already available from our advertisers. Making special fresh patterns puts up the price—nuff sed!

Tap all the holes both in cylinder block and motion-plate flanges either $\frac{1}{8}$ in. or 5 B.A., then replace assembly, and line up the tapped holes with those in the frames. The assembly will then be in exactly the same place as before, and the screws can be put in. Countersunk-head screws are used for the cylinder, and cheese or hexagon for the motion-plate. The screws in the lower row at each side of the cylinder should not be more than 7/32 in. long; they only act as dowels.

To set the crossheads in the right place on the piston-rods, so as to get correct clearances between piston and cylinder cover, put a slip of metal 1/32 in. thick between the brasses and the head of the tee at the end of the connecting-rod; then put the front half-brass against the crankpin, put on the back half and the keep, and tighten the nuts. Now carefully turn the wheels until the crank is on front dead

centre. This will force the crosshead boss over the piston-rod with the piston hard up against the front cover. Drill a No. 43 hole through crosshead boss and piston-rod, and squeeze in a pin made from 3/32 in. silver-steel; alternatively, broach out the hole to a slight taper with a taper-pin broach, and fit a commercial taper-pin. I did that, as I happened to have some pins. You can see the end of the pins above the crossheads in one of the pictures. Now, if you slack the nuts on the big-end bolts, take out the slip of metal between brasses and tee, and tighten up the nuts again, the piston will be pulled 1/32 in. away from the cylinder cover, and that gives the amount of clearance needed.

The wheels should now turn by hand fairly easily, with no tight places in a complete revolution. They won't be absolutely easy until the engine has been under steam, and the packing has settled down; but the crossheads should slide freely on the bars and the big-ends turn freely on the crankpins. Should there be a tight place, trace it and correct it before going any further.

Boiler Feed Pump

Mona will have three means of feeding her boiler; the pump described below, which will feed warm water from the side tanks; an injector taking its supply from the bunker tank, which keeps cold, and an emergency hand pump in one of the tanks; so if the driver lets the water disappear in the gauge, and burns the firebox crown, he deserves to be set up against a fence and shot at dawn, or fined a week's beer money. I based the dimensions of the crosshead pump on that fitted to my L.B. & S.C.R. *Grosvenor* (the engine shown on the cover of the September issue) and as that puts in more than the boiler needs with a normal load, *Mona's* should do the same.

No castings are required. The pump barrel is a piece of $\frac{3}{8}$ in. round bronze or gunmetal rod squared off in the lathe to 2 in. length. Chuck in three-jaw, centre, and drill a hole with No. 30 drill about halfway through. Open out to $\frac{3}{8}$ in. depth with 7/32 drill, and tap $\frac{1}{4}$ in. × 40. Reverse in chuck, centre the other end, drill to 1-7/16 in. depth with No. 15 drill, further open out 3/16 in. of the end to 7/32 in. dia. and tap $\frac{1}{4}$ in. × 40. The gland is made from a bit of 5/16 in. hexagon rod, same process as valve-spindle glands, but screwed $\frac{1}{4}$ in. × 40. The end cap is made same way from same material, but the screwed part is only 5/32 in. long, and the hole, which is drilled No. 15, only goes in for $\frac{1}{4}$ in. depth.

To make the flange, chuck a piece of $\frac{3}{4}$ in. brass rod, face off, centre, and drill to 3/16 in. depth with 23/64 in. drill. Part off a $\frac{1}{8}$ in. slice; set this truly in the three-jaw, holding by the edge, and put the leading end of a $\frac{3}{8}$ in. parallel reamer in just far enough to enlarge the hole to a very tight fit on the pump barrel. Press it on to $\frac{1}{4}$ in. from the gland end, and silver solder it. If there should be a fillet or blob of silver solder on the side which will butt against the motion-plate, chuck the barrel in three-jaw and face it off.

For the valve box, part off a $1\frac{1}{8}$ in. length of the same kind of rod used for barrel. Chuck in three-jaw, face, centre, and drill right through with No. 32 drill. Open out and bottom to $\frac{3}{8}$ in. depth with 7/32 in. drill and D-bit, slightly countersink the end, and tap $\frac{1}{4}$ in. × 40. Reverse in chuck, and repeat operations on the other end, except that the D-bit need not be used; instead, nick around the hole with a little chisel which can be made from a couple of inches of $\frac{1}{8}$ in. silver-steel. Finally, put a $\frac{1}{8}$ in. parallel reamer through the remnants of the No. 32 hole.

Drill a No. 32 hole halfway along the side, breaking into the reamed hole. Across this, with a $\frac{3}{8}$ in. round second-cut file, file a slight depression at the angle shown in the drawing. When the pump barrel is attached to the motion-plate, and in line with the motion, the valve box should be vertical. Next, at 13/16 in. from the plugged end of the pump barrel, drill another No. 32 hole. Now the pump barrel and valve box need to be silver-soldered together, with these two holes coinciding. How I made them stay put while the job was done, was just to squeeze a little stub of thin tube, a full $\frac{1}{8}$ in. long, halfway into the hole in valve box and halfway into the hole in the barrel. The two were then set at the right angle, and the joint silver-soldered. After quenching in acid-pickle and washing off, the reamer was put through the valve-box again, and the No. 15 drill down the barrel, in case anything got through.

Seat a 5/32 in. rustless steel ball on the D-bitted hole, by holding a short length of brass rod on the ball, and hitting it with a hammer. It only needs one fairly hard crack. Take the depth from top of ball to top of valve box, with a depth gauge, which can be made in a couple of minutes by drilling a No. 41 hole across the middle of a piece of $\frac{1}{4}$ in. square rod about 1 in. long, fitting a 3/32 in. setscrew in the side, and using a piece of 3/32 in. silver-steel about 2 in. long, for the gauge rod. For beginners' benefit, lay the $\frac{1}{4}$ in. square rod across the top of the valve box, push the gauge rod down until it touches the ball, and tighten the setscrew to hold it in that position. Chuck a piece of 5/16 in. hexagon rod in three-jaw, face, centre deeply with size E centre-drill, and drill to about $\frac{7}{8}$ in. depth with No. 40 drill. Turn down $\frac{1}{4}$ in. of the outside to $\frac{1}{4}$ in. dia. and screw $\frac{1}{4}$ in. × 40. Part off at $\frac{3}{4}$ in. from end, reverse in chuck, and turn down the length indicated by depth gauge, to $\frac{1}{4}$ in. dia. screwing $\frac{1}{4}$ in. × 40. Face off 1/32 in. and cross-nick the end with a thin flat file.

Drop another ball in the other end, and take depth as before. Chuck the 5/16 in. hexagon rod again, and turn down the length as indicated by gauge, to $\frac{1}{4}$ in. dia. screwing $\frac{1}{4}$ in × 40. Centre and drill to $\frac{3}{8}$ in. depth with No. 32 drill, reaming $\frac{1}{8}$ in. Face 1/32 in. off the end, and part off at $\frac{3}{8}$ in. from shoulder.

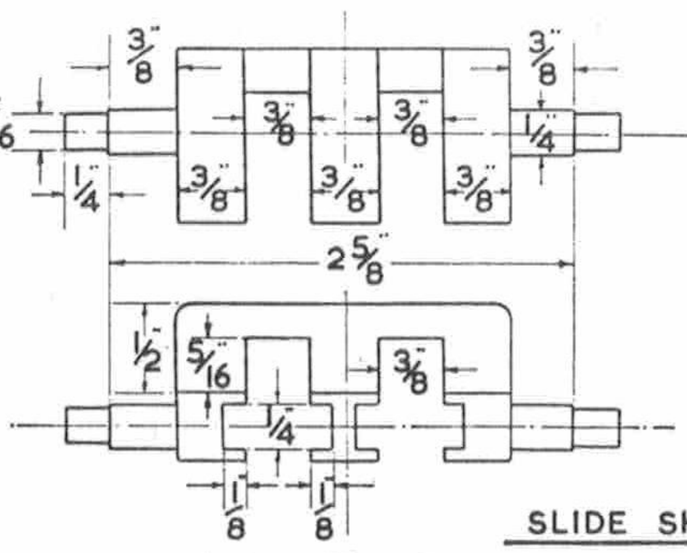
Halfway along, in the middle of one of the facets, drill a 5/32 in. hole, and in it fit a union nipple. To make this, chuck a piece of $\frac{1}{4}$ in. round brass rod in three-jaw; face the end, centre deeply, and drill to about $\frac{3}{8}$ in. depth with 3/32 in. or No. 40 drill. Screw $\frac{1}{4}$ in. length with $\frac{1}{4}$ in. × 40 die in tailstock holder. Part off at a full 5/16 in. from the end, reverse in chuck, and turn 1/16 in. of the other end to a tight fit in the hole in the facet. Squeeze it in and silver-solder it. After pickling and cleaning, seat the ball on the hole with the hammer-and-brass-rod antic, and assemble the lot as shown. The pump ram or plunger is just a $2\frac{5}{8}$ in. length of $\frac{1}{8}$ in. rustless steel or drawn bronze rod, with 5/16 in. of $\frac{1}{8}$ in. or 5 B.A. thread on the end, and the gland is packed with a few strands of graphited yarn.

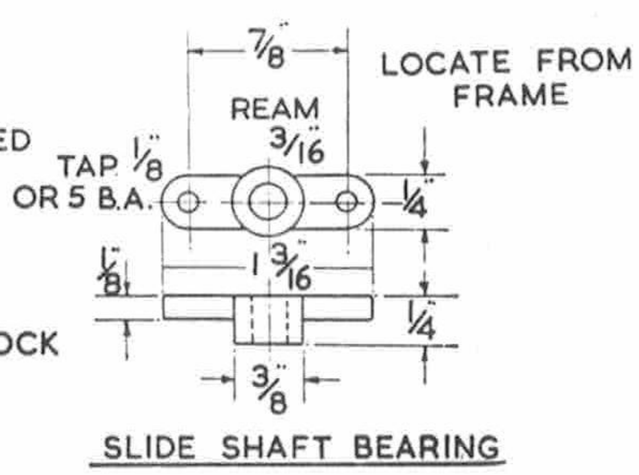
To erect the pump, push the end through the hole in the bottom of the motion-plate, and with the valve box set vertical, run a No. 41 drill through holes in the motion-plate, making countersinks on the pump flange. Remove pump, and drill the

countersinks with No. 48 drill, tapping 3/32 in. or 7 B.A. Replace pump and secure with four screws as shown. Run a nut to the end of the thread on the pump ram, push the rest of the thread through the hole in the crosshead arm, and secure it there with another nut on the other side. As the crosshead moves back and forth when the engine is running, it takes the pump ram with it, the water which flows into the barrel from the side tanks on the outward stroke, being forced into the boiler on the return stroke. Having no eccentric, and such a small diameter ram, these pumps take very little power to drive. Next stage, the valve gear.

Beginners' self-acting blowpipe.

A simple blowpipe which needs no air pressure can be made in a few minutes by any beginner. All you need is a piece of $\frac{3}{8}$ in. brass or copper tube, with a teat-shaped nipple pressed into the end, to take a rubber tube from the domestic gas supply. Two air holes are drilled across the tube. The one I use has a nipple drilled No. 48, which suits our gas pressure and gives a short blue roaring flame. The higher the gas pressure, the smaller the hole, and vice versa. This blowpipe will do all the silver-soldering jobs mentioned above. Simply smear with wet flux, which is made by mixing powdered borax, or Easyflow flux, to a paste with water; heat to dull red, and apply either a thin strip of best grade silver-solder, or Easyflo wire, which will melt and run into the joint. Don't quench iron or steel jobs in acid pickle, but use clean water only.



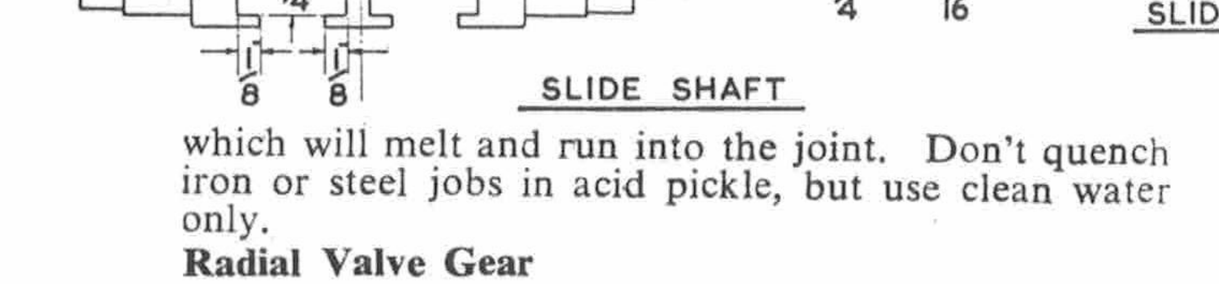


Radial Valve Gear

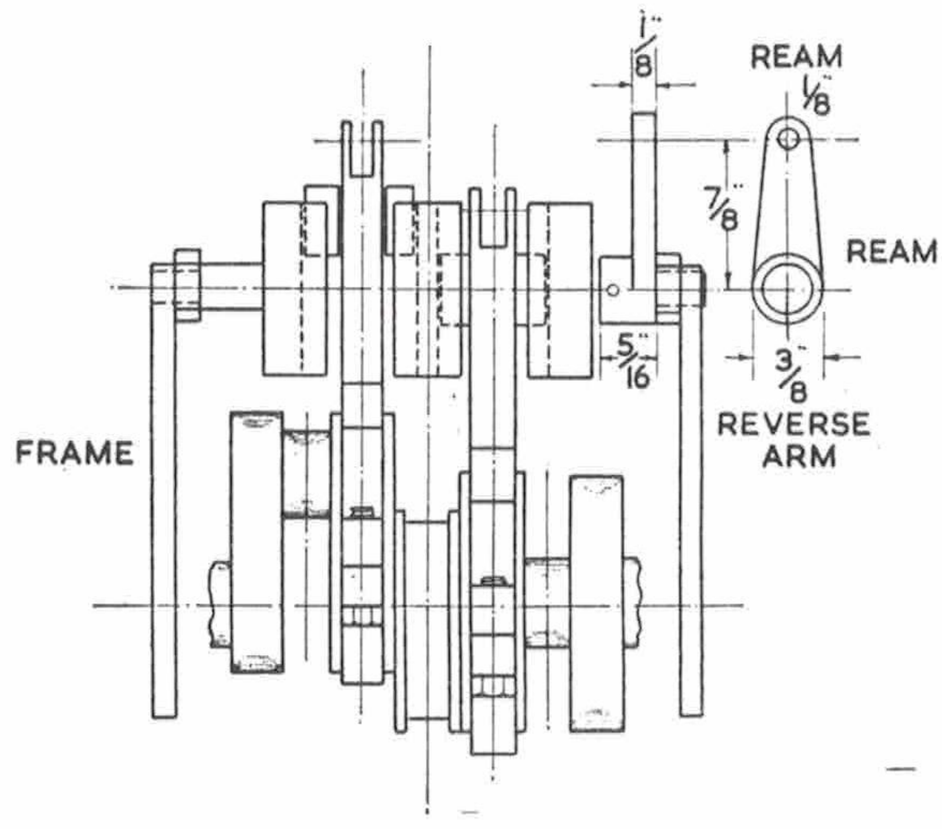
As promised I'm giving details of alternative valve gears, a radial type, and the loose eccentric. The radial gear is quite simple, being a variation of the Hackworth gear. On the original Hackworth gear as fitted to certain full-sized locomotives, the eccentric was placed opposite the crank, at 180 deg. to it; the connection to the radius rod was below the dieblocks, and the engine ran the opposite way to the inclination of the slide-shaft. As we are utilising the circular crank webs as eccentric sheaves, they are of necessity in step with the cranks; therefore to get the lap-and-lead movement, we must connect the radius rods above the dieblocks, and the engine will run the same way as the inclination of the shaft, same as a Joy gear. This arrangement works champion on my own engine, and the drawing of the whole box of tricks shows exactly how I fitted it up.

Kick off with the shaft. This needs three pieces of $\frac{3}{8}$ in. square steel or hard bronze, each 1 in. long. Two of them need a groove $\frac{1}{4}$ in. wide and $\frac{1}{8}$ in. deep milled in one of the facets, and the other, a similar groove in both sides. I did the job on my milling machine, putting a piece of $\frac{3}{8}$ in. square steel in the vice on the table, and traversing it under a $\frac{1}{4}$ in. side-and-face cutter on the arbor, which did the job at one cut. The piece was cut into three, each faced off in the four-jaw to correct length, then one of the pieces was put on the miller again, and a groove cut in the opposite side to the one already in. That settled that mighty quick. To do the job in the lathe, either use a $\frac{1}{4}$ in. cutter on an arbor between centres, holding the piece of rod in a machine-vice (regular or improvised) on the saddle, set at the right height to take out the groove at one traverse; or grip the piece under the slide-rest tool-holder, and traverse it across a $\frac{1}{4}$ in. endmill or slot-drill held in three-jaw. Use plenty of cutting oil, to get a clean groove. If using the first-mentioned antic, run the lathe at slow speed with the back-gear in, and it will do the job as good as a milling-machine.

Now the next bit is very important, so watch your step. Find the *exact* centre of the two pieces with the single groove; and I mean exact—slap-bang in the middle of the length and width. Centrepop the spot, and drill a $\frac{1}{8}$ in. hole right through into the groove; and that must go through dead square, too. Check it off and see if it is still in what one of my



BEGINNERS' SELF BLOWING BLOWPIPE



END VIEW OF RADIAL VALVE GEAR

young acquaintances calls the "miggel"; if so, open out with a 3/16in. drill. Chuck a piece of ¼ in. round steel rod either in a collet, or in a split bush held in three-jaw; it must run truly. Face the end, and turn down a bare ¼ in. length to a squeeze fit in the hole in the slide. Part off at ⅞ in. from the end, reverse in collet or bush, and turn down ¼ in. of the other end to 3/16 in. diameter. This should leave ⅜ in. between the shoulders. Repeat operation then carefully squeeze the shorter ends into the holes in the slides. If the holes are very slightly countersunk, the shoulders will butt up tightly against the slides.

The yoke, which holds the slides in position, is made from a piece of ½ in. x ¼ in. steel bar 1⅞ in. long. Square off to length in the four-jaw. At ⅜ in. from each end, cut a gap ⅜ in. wide and 5/16 in. deep. This can be milled out in the same way as the grooves in the slides, and the same cutter can be used, by taking two bites. The gaps can also be easily cut by hand; just mark off their position, make a heavy centrepop in the middle of each gap, drill a 9/32 in. hole clean through each centrepop, which will remove most of the metal, and finish with a hacksaw and file.

Beginners will probably wonder how the merry dickens they are going to assemble and braze the lot, so that the result is quite true. Dead easy! *Everything* is easy *when you know how*. You want two bits of ¼ in. x ⅝ in. bar, about 1½ in. long. The metal doesn't have to be clean; ordinary "black" bar is just the thing. If the bits are bright mild steel, rub them over with graphite or grate polish. Put the double-grooved slide between them, and the single-grooved slides on the outside, lining up all three; then put a cramp over the outsides of the outer slides, to hold the lot securely. Next, at ⅛ in. from each end of the yoke, drill a No. 51 hole right through the thickness. Place the yoke in position at the end of the slides, temporarily clamp it there, run the 51 drill through the holes in it, and make countersinks on the two end slides. Remove yoke, drill the countersinks No. 54 and tap 1/16 in. or 10 B.A. Replace yoke and attach it by two steel screws. As you'll now see, the bits of bar are holding the three slides exactly in line, and the yoke is keeping them level; so all you have to do, is to braze the yoke to the slides.

Remove the cramp holding the slides to the bars, taking care that nothing shifts. Lay the assembly in the brazing pan, yoke upwards, smear a little wet flux around the joints between yoke and slides, heat to bright red if steel, and touch each joint with a bit of soft brass wire, or No. 1 Sifbronze rod, 1/16 in. thick. Use just enough to make a tiny fillet at each joint, and take care to avoid letting any run into the slots. If bronze is used for the slides, silversolder should be used. Let cool to black, then quench in water. Very carefully knock out the the pieces of bar; my own, which were blackleaded, slid out easily. Then clean up the whole assembly, and Bob's your uncle. The screwheads can be filed off the back of the yoke, as they won't be wanted any more.

For the dieblocks, chuck a piece of ¼ in. x 3/16 in. silver-steel in four-jaw, face the end, and part off four ⅜ in. slices. Drill a No. 33 hole in the middle of each, and ream ⅛ in. They can be hardened right out by heating to red and dropping into cold water. Rub them on fine emerycloth to polish. They should slip easily up and down the grooves in the slides.

If castings are used for the bearings, they only need gripping by the boss in three-jaw, facing off, centring, drilling and reaming; the other end of the boss can be faced off if the bearing is mounted on a short bit of rod held in three-jaw. I built mine up by chucking a piece of ⅜ in. round bronze rod in three-jaw, facing, centring, and drilling No. 13 for about ⅝ in. depth. Two ¼ in. slices were parted off. A piece of ⅛ in. x ¼ in. flat brass rod was then clamped under the slide-rest tool-holder, and run up against the side of a ⅜in. endmill in the chuck, which formed a radius in the end. The rod was cut off at ½ in. from the radius, and the process repeated three times. The slices of bronze were then laid on a piece of asbestos millboard in the brazing pan, with the pieces of flat rod at each side, the radiused ends butting close up against the bronze slices. The joints were then anointed with wet flux, the lot heated up to dull red, and a strip of silversolder applied. After a dip in the acid pickle and a rinse under the kitchen tap, the ends were rounded off with a file. The result was O.K. and you can see the bearings in the pictures, at the ends of the slide shaft. The bosses were reamed 3/16 in. to accommodate the turned ends of the shaft.

Eccentric Straps and Rods

CLEAN the castings with a file, and scribe a line across the centres of the side lugs or ears. Centrepop ends of same, and drill right through with No. 40 drill. Grip casting in bench vice with the marked line showing just above the jaws, and saw right across with a fine-tooth hacksaw, keeping the blade pressed down on the vice jaws, which will guide it truly. Mark both halves of the strap with letters or figures, so that they can be replaced correctly at any time. Open out the holes in the "ring" half of strap, with No. 30 drill, and tap those in the other half ⅛ in. or 5 B.A. Rub the sawn parts on a flat file laid on the bench, to remove sawmarks, then screw the halves together. Chuck in four-jaw with the centre hole running as truly as possible, face off with a roundnose tool set crosswise in rest, and then bore out, by same process as cylinder-boring, to a nice running fit on the grooved crank-web. To gauge this, use a bit of rod turned to same diameter as the crank web. The other side of the casting can be turned by holding the strap on the smallest step of the chuck jaws, or gripping the bit of steel used for a gauge, in the chuck, and clamping the strap on it by its own screws, with a strip of paper between strap and gauge, to prevent slipping. The upper lug to which the eccentric-rod is attached, is drilled No. 34 and tapped 4 B.A. An oil hole is drilled 1/16 in. and countersunk in the step alongside.

The eccentric-rods are made from 1¾ in. lengths of ¼ in. square mild steel rod. Chuck in four-jaw and set to run truly; face the end, and turn down 3/16 in. length to 9/64 in. diameter screwing 4 B.A. Screw these into the eccentric straps, and then care-

heating, you can use anything that may be available. I use a simple home-made gas burner, which merely consists of a 4 in. length of 1 in. thin tube, closed at one end and cross-slotted with a hacksaw. It is silver-soldered to a strip of 16-gauge metal bent at right angles about ¾ in. from the open end. A nipple, drilled No. 48, is screwed through the angle, and connected to the nearest gas point by a rubber tube. This goes under the firebox and supplies plenty of heat for the test.

Don't screw the safety-valve nipples too tight for the kick-off. When the water boils, watch the gauge pointer. If the valves start to blow off before it reaches the 75 mark, screw them down a shade. If it reaches the same place without any steam escaping, they need slacking off. It is an easy matter to adjust the nipples so that the valves start to blow at 75 lb. Let the boiler stand with the valves just sizzling for about 30 minutes, and if no leaks have shown up, nor anything else has happened, the boiler is O.K. for service.

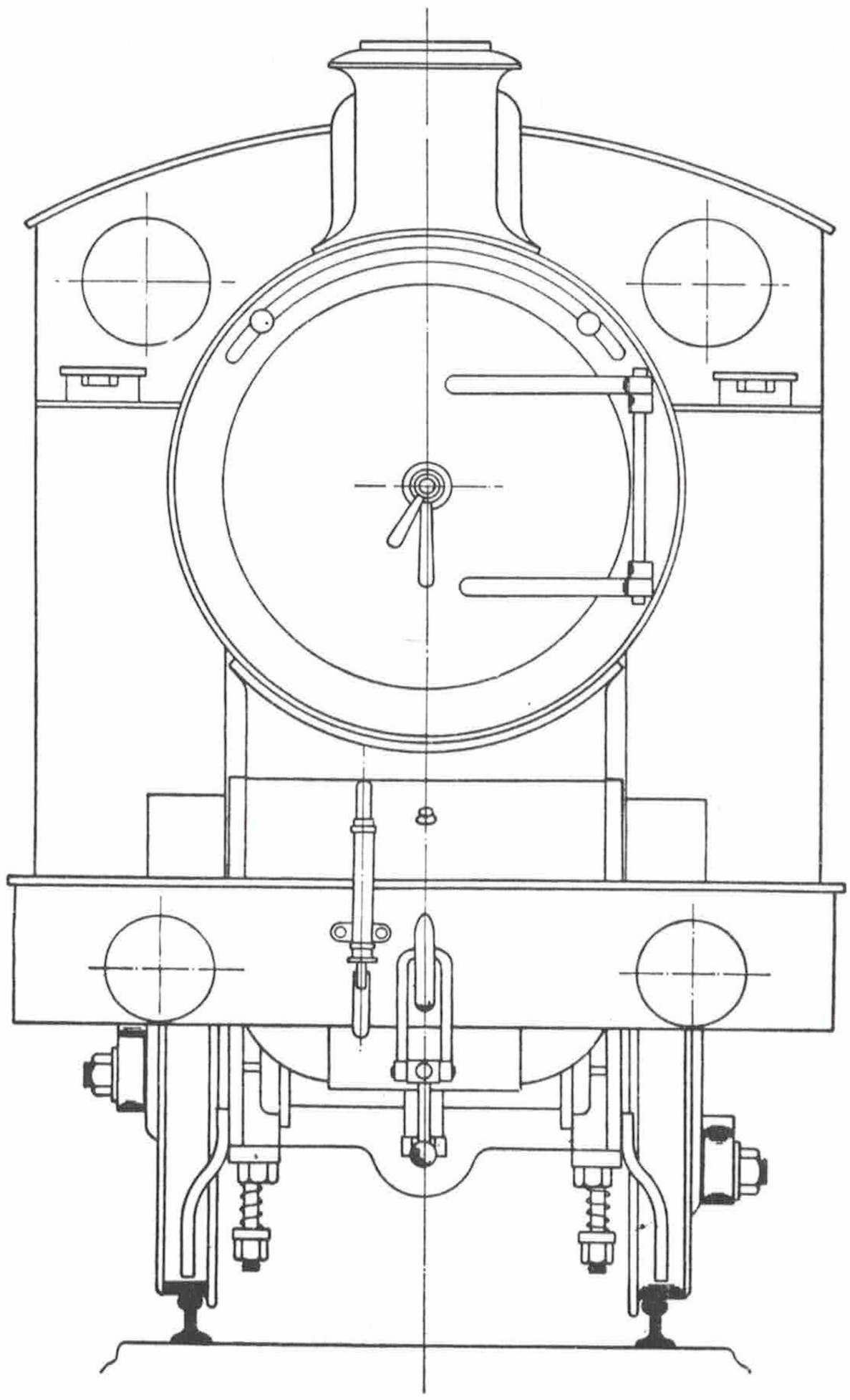
Smokebox

The barrel of the smokebox is made from a piece of 16-gauge brass tube 4⅛ in. outside diameter, squared off at both ends in the lathe, to a length of 2¾ in. Half-way along, cut a 1 in. hole for the chimney liner. Don't use a 1 in. drill, even if you have one that size, as it will make a polysided hole in the thin metal. Cut out the circle a little undersize with a piercing-saw, or an Abrafile, or drill holes around the circle and break out the piece; then finish with a 1 in. reamer, or failing that, by careful filing until a 1 in. tube will fit tightly. Diametrically opposite (that sounds very posh, doesn't it?) drill a 7/16 in. hole for the blastpipe, and ¾ in. ahead of that, a 5/16 in. hole for the steam pipe.

Our "Baernegum" friend Reeves should be able to supply castings for the smokebox front and door, but they can also be made from commercial brass blanks. The front casting should be chucked in the three-jaw, faced all over, and the hole cleaned up with a boring-tool to 3 in. dia. It can then be chucked by the hole, on the inside jaws, with the flange outwards, and turned to a tight push fit in the smokebox barrel. If the hinge lugs are cast on, they will have to be cut off, otherwise you won't be able to face the front all over; separate lugs are preferable. Cast-on hinge straps on the door are O.K. because they save fiddling work. The door will have a chucking-piece on the outside, and if this is gripped in the three-jaw, the edge of the door can be faced off truly, so that it will make an airtight joint with the front. Centre the door and drill it No. 30, then reverse in chuck, holding by the rim; turn away the chucking-piece and face off the stub. It can't be turned all over, on account of the hinge straps, but a file will soon shift any roughness. Full-size doors are not machined, anyway!

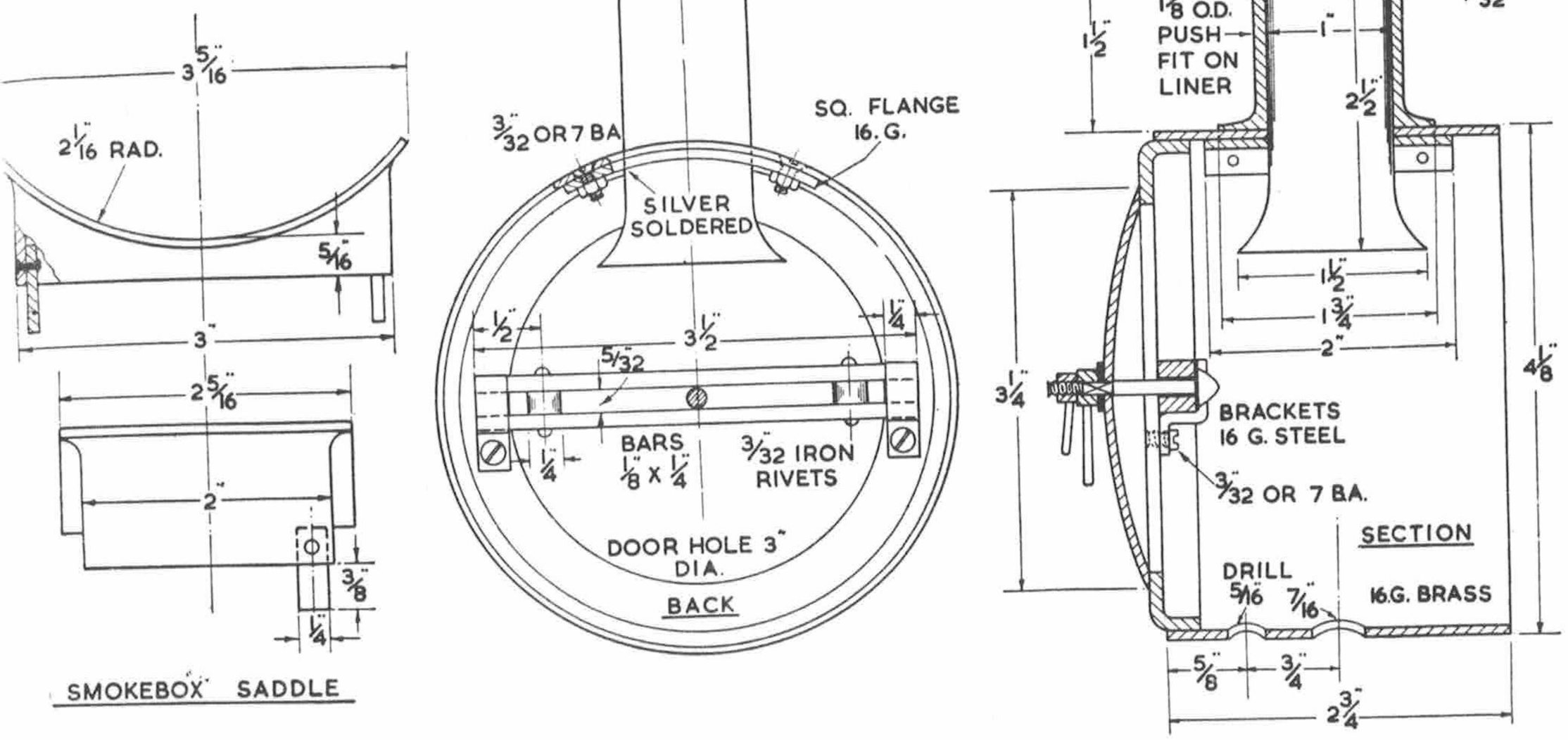
The front can be made also from a disc of brass 4¾ in. dia. and ⅛ in. thick, or a commercial stamped brass blank same size. The flanging is exactly the same as described for flanging the smokebox tube-plate. After flanging, chuck in three-jaw and turn off any ragged edges. Reverse in chuck, holding by the inside of flange on the top step of the outside jaws; cut the 3 in. hole with a parting-tool set cross-wise, face all over, and turn the flange to fit tightly in the smokebox barrel.

The door can be made from a disc of ⅛ in. brass 3⅜ in. dia. or a stamped blank. Anneal by making



FRONT VIEW
(MOTION WORK NOT SHOWN)

redhot and plunging into water, then lay it on a block of lead, and as Bert Smiff would say, "'it it wiv an 'ammer" using the ball end, starting from the middle and working outwards, until it becomes saucer-shaped. Chuck in three-jaw, concave side out, centre, drill No. 30, and face off the middle for about 1 in. dia. Chuck a short bit of brass rod, any odd bit will do, and turn a pip on the end to fit tightly in the hole. Put it through from the concave side, with the faced shoulder butting up tightly to the faced-off centre of the door; solder it in place, then chuck the stub in the three-jaw. The dished disc (try and say that quickly six times!) can then be turned all over, and the edge trued up at the one go. Melt out the stub, and there is



your door. The hinge straps can be made from $\frac{1}{8}$ in. x 18-gauge strip, any metal except aluminium, the ends being bent into a loop with a small pair of roundnose pliers, and silver-soldered. If the loops become stopped up, just put a drill through; use No. 51 for a 1/16 in. pin. Rivet the strips to the door about $1\frac{1}{2}$ in. apart (see front view) using bits of domestic pins for rivets.

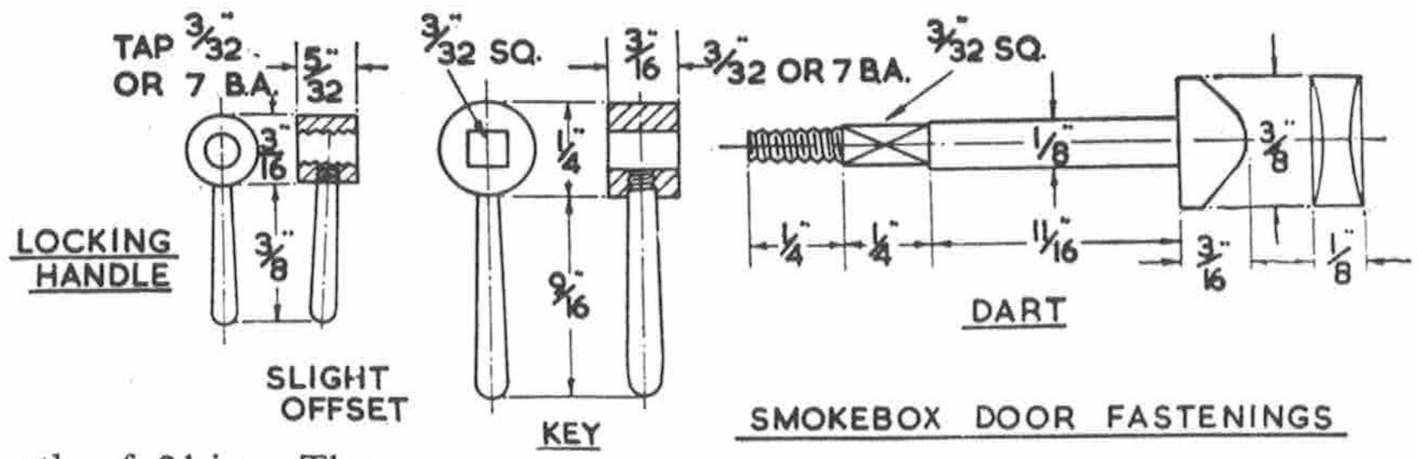
THE door is closed airtight by the traditional British dart and crossbar arrangement. The crossbar is made from two pieces of $\frac{1}{8}$ in. x $\frac{1}{4}$ in. black steel strip $3\frac{1}{2}$ in. long. Clamp together and drill a No. 14 hole at $\frac{1}{2}$ in. from each end. Chuck a piece of $\frac{1}{4}$ in. steel rod, face, centre, and drill No. 41 for about $\frac{1}{2}$ in. depth. Part off two 5/32 in. slices, put them between the pieces of strip, opposite the drilled holes, and put a couple of 3/32 in. iron rivets through the lot. The brackets are bent from 1/16 in. x $\frac{1}{4}$ in. strip, and need no detailing.

To make the dart, chuck a piece of $\frac{3}{8}$ in. round steel, face the end, turn down $\frac{1}{4}$ in. length to 3/32 in. dia. and screw 3/32 in. or 7 B.A. Turn the next $\frac{1}{4}$ in. to $\frac{1}{8}$ in. dia. and set it back in the chuck until the turned part is level with jaws, then file it square a la blower-valve instructions. Turn the next 11/16 in. to $\frac{1}{8}$ in. dia. and part off at a full $\frac{1}{8}$ in. from the shoulder. File the head flat both sides, flush with the pin, and bevel it off as shown.

For the key, chuck a bit of $\frac{1}{4}$ in. rod, face, centre, and drill No. 40 for about $\frac{1}{4}$ in. depth. Part off a 3/16 in. slice, square the hole as described for the blower-valve wheel, and screw in a bit of 1/16 in. steel for the handle, rounding off the end. Next chuck a bit of 3/16 in. rod, face, centre, drill No. 48, part off at 5/32 in. from the end, tap 3/32 in. or 7 B.A. and screw in a shorter handle, as shown. Now assemble the whole front as shown in the section. Put the crossbar over the middle of the hole, with the dart through it, put on the door, then a $\frac{3}{8}$ in. steel washer, then the key, and finally the locking-handle.

Adjust the door until it is exactly in the middle of the front, and see that the crossbar is also central. Then fit the two brackets which hold the bar in place when the door is open. They are bent up from strip as mentioned above, and attached by a single screw in each; any projecting through the front must be filed flush. Carefully mark off the position of the hinge lugs above and below the eyes in the ends of the straps. Centrepop, drill No. 44 and tap 6 B.A. Then remove door, and fit the lugs. Chuck a piece of $\frac{1}{4}$ in. x $\frac{1}{8}$ in. brass rod truly in four-jaw, face, turn a full $\frac{1}{8}$ in. length to 7/64 in. dia. and screw 6 B.A. Part off at 3/16 in. from shoulder, repeat process, screw the shanks into the tapped holes in the smokebox front, replace door with the hinge eyes above and below the lugs, and file off the lugs to match the eyes. Put a No. 51 drill down each eye and carry on right through the lug, so they are certain to be in line. The pin is merely a piece of 1/16 in. silver-steel, with a few threads on one end, on to which is screwed a wee collar made from a 1/16 in. slice of $\frac{1}{8}$ in. round rod with a tapped hole in the middle. Just push the pin through the eyes and lugs from the top. It

needs no other fixing. The front view of the engine shows the whole bag of tricks assembled, but don't fit the complete front to the smokebox shell yet. This must be left off until the boiler is erected and the pipes all connected up.



SMOKEBOX DOOR FASTENINGS

Chimney liner

The liner is made from a piece of 1 in. brass or copper tube about 18-gauge, squared off in the lathe to an overall length of 2½ in. The bottom is belled out as shown. This can be done by softening the tube and driving into it one of those gadgets that plumbers use for belling out lead pipes; it looks like a kiddies' old-fashioned whip-top (where are they now?) and is usually made from boxwood. The belling can also be done by resting the end of the tube on a block of lead or hardwood, and coaxing it with the ball end of a hammer applied from the inside. I usually spin them out by chucking in three-jaw and forcing out the end with a burnishing-tool or a piece of round silver-steel, but you have to get the knack.

Cut out a 2 in. square of 16-gauge brass or copper, and make a 1 in. hole in it, same as the one in the smokebox shell. Bend it to the same radius as the inside of the smokebox, push the liner through until it stands 1-9/16 in. above the convex side, then silver-solder it. Be verra frugal wi' the silver-solder, ye ken, not only because it costs muckle bawbees the noo', but if there is any around the joint, it will have to be filed off to allow the flange to bed tightly against the inside of the smokebox, and that is sheer vaste, vot you tink, eh? Pickle and wash off, then smear a taste of plumbers' jointing around the liner above the flange, insert it from inside the smokebox, and fix it by drilling a No. 41 hole through the lot at each corner, countersinking the holes, and putting in 3/32 in. or 7 B.A. countersunk-head screws, with nuts on the inside.

The chimney can be turned from a casting, or a piece of cored bronze as used for making bushes in full-size jobs. The process is the same in either case; just chuck in three-jaw and bore out to a nice fit on the liner, then mount on a mandrel, either in the chuck or between centres, and turn the outside to the given outline, or any other shape that you may fancy. I turned mine something after the style of the Stroudley chimneys on the Brighton engines of days gone by. Incidentally I use a patent expanding mandrel for jobs like these, for the sake of the time it saves—time is very precious to me now!—but a piece of steel shafting, or anything similar, will serve the purpose if turned to a drive fit in the casting.

The flange at the bottom, being irregular in shape to suit the smokebox, cannot be turned, so must be finished by careful application of a half-round file, the final touches being given by a strip of fine emery cloth while the lathe is running. A casting will have the radius cast on, and will only need slight cleaning with a half-round file, to bed nicely on the smokebox barrel. If the chimney is turned from round stock or cored stick, the bottom will need machining. Failing a regular milling-machine, use a fly-cutter. This is a small roundnose tool set in a crosshole drilled near the end of a short piece of round rod about ¾ in. dia. and secured by a set-screw in the end. Put this in the three-jaw and adjust the cutting edge until it is 2-1/16 in. from centre of rod. Clamp the chimney under the slide-rest tool-holder at centre-height and at right angles to the bed. Feed it very carefully on to the revolving cutter, and the same time traversing it along by moving the top slide; and the cutter will carve out a radius that will exactly fit the smokebox barrel. Warning—look out for flying chips, or you'll have them down your neck or in your eyes!

Regulator

The regulator is of the Stroudley type, the advantages of which are that the valve is fully exposed when the top of the dome is taken off; it can be lubricated by taking out the screw in the dome top and dropping a spot of cylinder oil in it, and it is easy to make and erect. The stand can either be cast, or built up by cutting a piece of 5/16 in. x ⅞ in. brass bar to shape shown, and silver-soldering to it a ⅝ in. x ⅛ in. disc of bronze for the portface, and a 5/16 in. length of 7/16 in. brass rod for the steampipe boss. The machining is the same in both cases, but time is saved if the disc is drilled for ports, also drilled and tapped for the steampipe before fitting and silver-soldering them.

Drill a 3/16 in. hole down the middle of the stand, and tap the end 7/32 in. x 40. If cast, drill the ports and trunnion hole in the portface, and drill the steampipe boss at the bottom with 3/16 in. drill breaking into the vertical hole. Then open out with 9/32 in. drill and tap 5/16 in. x 32. The little boss for the end of the regulator rod is drilled No. 40. Don't pierce the vertical hole—but if you're unlucky, don't fret! Just open the hole with 3/16 in. drill, tap 7/32 in. x 40, turn up and drill a separate boss from ¼ in. brass rod, and screw it in with a taste of plumbers' jointing on the threads. A similar boss is fitted to the built-up stand.

For the valve, chuck a bit of ⅝ in. round bronze rod, face, centre deeply enough to make a countersink about 5/32 in. dia. and drill No. 41 for ¼ in. depth. Part off a ⅛ in. slice, and drill and tap as shown, and mind that you get the ports right in relation to the tapped holes. True the valve and the portface as described for slide-valves, then fit a trunnion pin of 3/32 in. rustless steel or bronze rod, put on the valve and secure it with a light bronze or hard brass wire spring and a brass nut.

The lever is filed up from ¼ in. x ⅛ in. brass rod, and drilled and tapped as shown. The links are strips of 3/32 in. x 5/32 in. nickel-bronze or brass, drilled No. 43 at 1 in. centres, and rounded off at the ends. Make the screws from 5/32 in. bronze rod, as commercial brass screws will rot and break inside the boiler. Assemble as shown. Note—when the screws are tight, the joints must be free to move,

so don't thread the screws right up to their heads. Put a link over the screw blank before applying the die, and screw up to the link, which thus acts as a gauge for length of thread.

To erect, drill a No. 30 hole in the boiler just ahead of the dome bush, and countersink it. Insert regulator through the bush (you will have to take off the lever and links temporarily for this) and hold it in position on the centre-line of the bush, the front of the stand being about 1/16 in. away from it. Make a countersink on the part inside the boiler with a drill down the hole in front of the bush, remove regulator, drill the countersink No. 40, tap $\frac{1}{8}$ in. or 5 B.A., replace regulator and secure with a brass screw, then put the links and lever back.

For the backhead gland boss, chuck a piece of $\frac{3}{4}$ in. round brass rod, face the end, turn down $\frac{1}{4}$ in. length to fit the 7/16 in. hole in the backhead, and part off at $\frac{1}{8}$ in. from shoulder. Reverse in chuck, centre, drill through No. 30, open out and tap $\frac{1}{4}$ in. x 40 to 5/16 in. depth, and drill four No. 48 screwholes through the flange. Make the gland from 5/16 in. hexagon rod. The regulator rod is a piece of $\frac{1}{8}$ in. rustless steel or drawn bronze rod $8\frac{1}{2}$ in. long. One end is reduced and screwed 9 B.A., and the next $\frac{1}{8}$ in. squared for the handle. Turn the other end for $\frac{1}{8}$ in. length to 3/32 in. dia. and file the next $\frac{1}{8}$ in. square, to fit the hole in the lever, in which it must be a good fit. If sloppy you won't be able to get proper regulation of the speed of the engine, also it will wear at the corners and make matters worse.

A collar is needed, which is merely a 3/16 in. slice of $\frac{3}{8}$ in. brass rod with a No. 32 hole through it. Put this on the rod about 1 in. from the handle end, then poke the other end through the hole in the backhead and wangle it into the lever. This isn't as tricky as it might seem at first sight. What I do is to bend the end of a bit of wire into a hook, and fish down the dome bush until I catch the rod in the hook, which is easy, as you can see it. Then it is quite easy to guide the end of the rod into the hole in the lever, the pin on the end going into the hole in the little boss, and the squared part stopping in the lever. Put on the backhead fitting and push it right home, then try the rod of end-play. If it has any, the collar is too far on, and must be shifted back. When you can turn the rod and operate the valve without any endplay on the rod, pin the collar to the rod with a bit of brass wire, replace rod, and put the gland fitting on with a 1/64 in. Hallite or similar gasket between flange and backhead. Pack the gland with graphited yarn. The handle is filed up from $\frac{1}{8}$ in. x $\frac{1}{4}$ in. nickel-bronze and needs no detailing; turn the grip from $\frac{1}{8}$ in. material. The hole in the boss is filed or punched square, to fit the squared part of rod, but be careful to form the square so that when it is put on, the handle leans to the right when the regulator is shut.

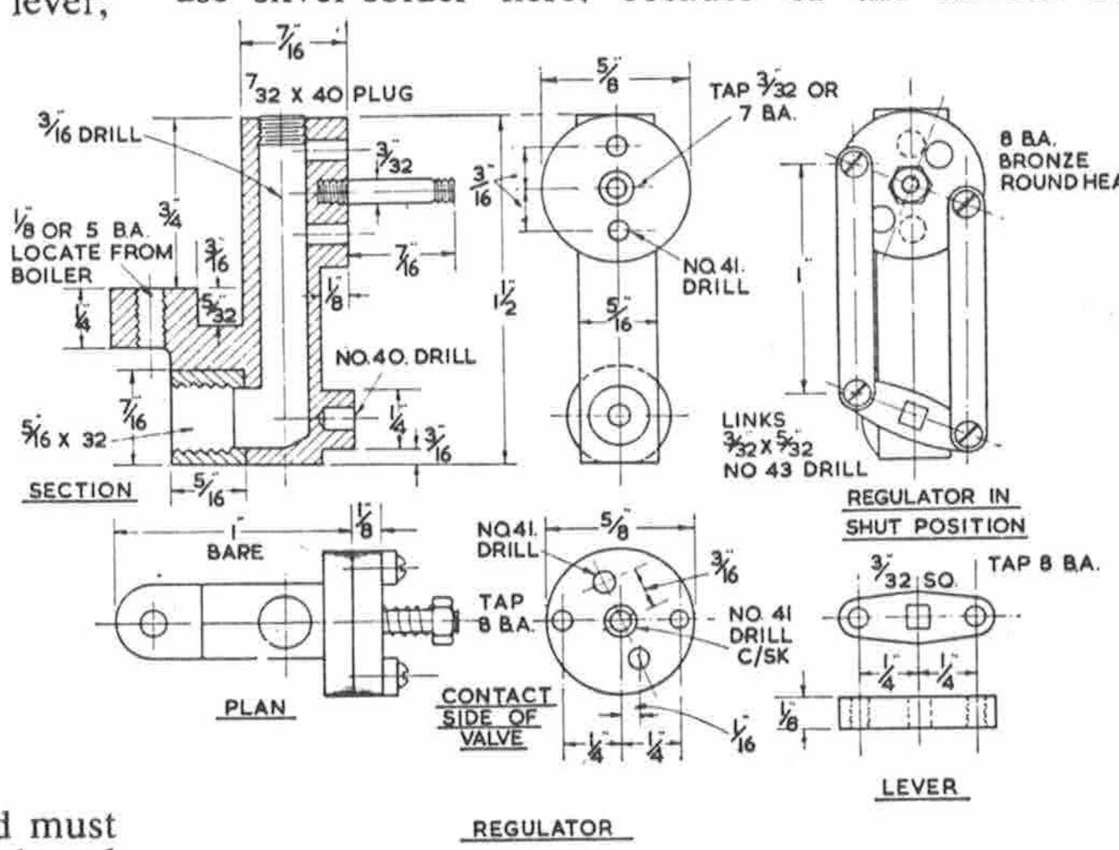
Steampipe and flange

The main steampipe is a piece of 5/16 in. x 20 gauge copper tube $4\frac{1}{8}$ in. long with 3/16 in. length of 5/16 in. x 32 threads on one end, and 5/16 in. length on the other. Anoint the threads with plumbers' jointing, and poke the end with the shorter thread through the hole in the smokebox tubeplate, screwing it into the boss at the bottom of the regulator stand. This is easy if you put the end of a coarse round file in the outer end; it will jam and turn the pipe until screwed home, but comes out of the pipe when turned backwards.

Chuck a piece of $\frac{5}{8}$ in. round brass rod, face, centre, drill 9/32 in. for $\frac{1}{2}$ in. depth, tap 5/16 in. x 32, turn $\frac{1}{4}$ in. of the outside to 7/16 in. dia. and screw it 7/16 in. x 32. Part off 3/16 in. from shoulder, reverse in chuck and skim the flange true. Smear the threads with plumbers' jointing, screw the fitting on to the projecting end of the steampipe and carry on until the flange beds tightly against the smokebox tubeplate. The internal and external threads being same pitch, the whole issue makes a perfect front-end joint; I've found nothing to beat it.

Superheater

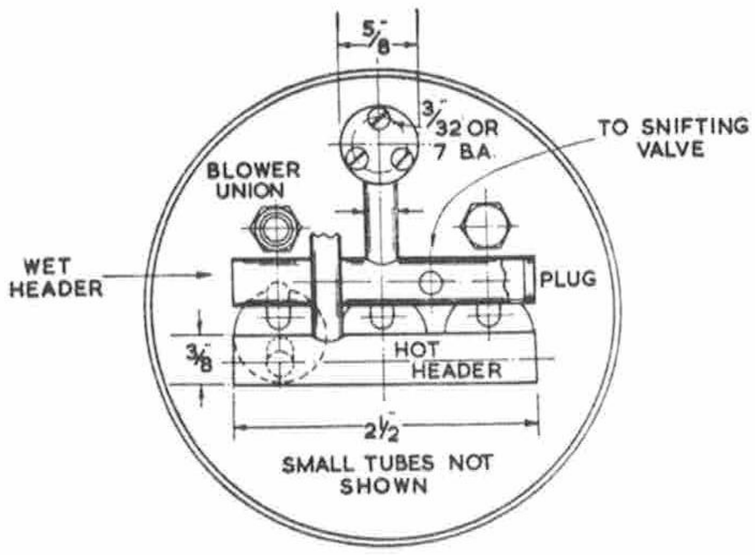
The multiple-element type of superheater really does put some pep into the steam. For the elements, cut three lengths of 3/16 in. x 22 gauge copper tube $6\frac{1}{4}$ in. long, and three 6 11/16 in. long. Three block bends are required; these are made from $\frac{5}{8}$ in. lengths of 5/16 in. x 9/16 in. copper rod. Make two centrepops on one end at $\frac{1}{4}$ in. apart and drill in with No. 14 drill on the slant, so that the holes break into one inside the block, see section. File the outsides to shape shown, fit one longer and one shorter element into each, and braze them. Don't use silver-solder here, because of the intense heat



they have to stand. Just put some wet flux around the pipes, heat to bright red, and touch the joints with a bit of soft brass wire or a 1/16 in. Sifbronze rod. Pickle and wash off.

The headers are $2\frac{1}{2}$ in. lengths of $\frac{3}{8}$ in. copper tube; left-over ends from the boiler tubes do fine. Plug each end with a disc of 1/16 in. copper, then drill three holes with No. 14 drill at $\frac{7}{8}$ in. centres for the elements, a $\frac{1}{4}$ in. hole in the top one at the angle shown, for the main steampipe, and a No. 23 hole at right angles to it for the pipe leading to the snifting-valve. In the bottom one drill a $\frac{1}{4}$ in. hole for the steampipe leading to the cylinders. The position of all these holes are clearly shown in the drawing.

First fit the elements into the holes, then the short vertical steampipe into the top header; this is a $\frac{7}{8}$ in. length of $\frac{1}{4}$ in. pipe. The pipe for snifting-valve is a $3\frac{1}{2}$ in. length of 5/32 in. copper tube. The main steampipe which is fitted to the hole in the bottom header is $\frac{1}{4}$ in. dia. and 4 in. long. For the steam



FRONT VIEW OF SUPERHEATER

flange, chuck the 5/8 in. rod again, face, centre, drill ¼ in. for a full ¼ in. depth, and part off at ⅜ in. from the end. Drill a ¼ in. hole in the side to meet the middle one, and drill the three No. 41 screwholes around it, see front view. Put this merchant on top of the short steampipe.

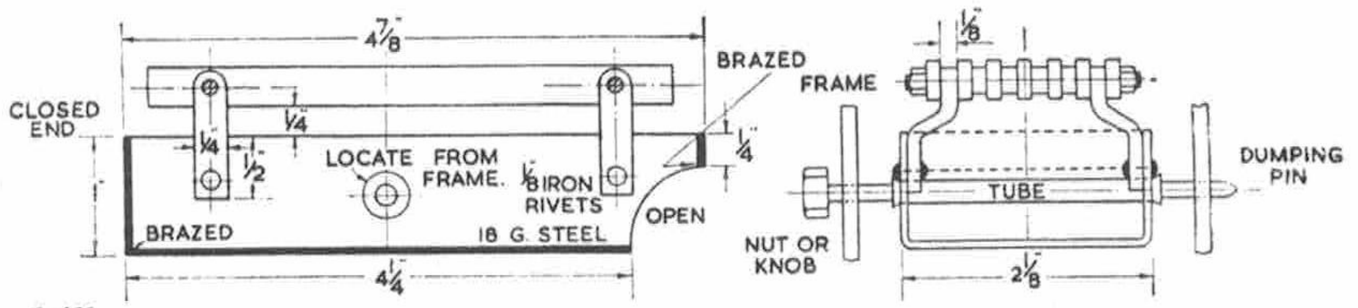
The whole bag of tricks can then be silver-soldered at one fell swoop, silver-solder being all right at the smokebox end as it is out of reach of the fire. Just put wet flux around each joint, heat the lot to medium red, and touch each joint with a piece of best grade strip silver-solder, or Easyflo. Pickle and wash off, letting the water run through to clear out any scale left inside, otherwise it might eventually find its way into the cylinders and "do them a bit of no good" as the kiddies would say. On the end of the steam pipe, fit a 7/16 in. union nut and cone, and on the snifting-valve pipe fit a ¼ in. x 40 union nut and cone, silver-soldering the cones. I mentioned before, but it is worth repeating, be sparing with the silver-solder and don't get any on the taper part of the cone, or you've had it. Bend the steampipe into a swan-neck, and bring the snifter pipe down beside it, then push the elements into the flues, and attach the flange to the one on the boiler steampipe by three 3/32 in. or 7 B.A. screws, with a 1/64 in. Hallite gasket between—and don't forget to punch a hole in the gasket for steam to pass!

How to erect the boiler

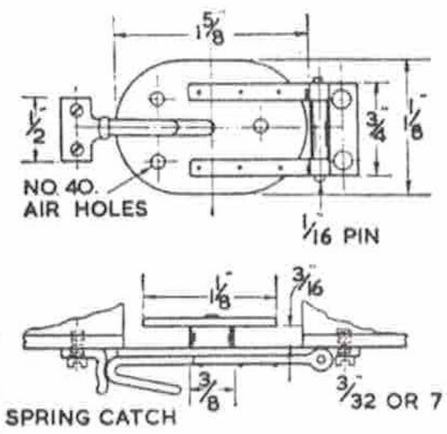
Set the smokebox saddle in the position shown by dotted lines, and fix it with a screw each side running through the hole already in the frame, into a hole drilled and tapped in the tag on the saddle. Fit a 1¼ in. length of ⅜ in. copper tube with a few ⅜ in. x 40 threads on each end, into the exhaust boss on the cylinder top. Smear the end of the boiler barrel with a little of the plumbers' best friend, and put on the smokebox for ¼ in. It should fit tightly; and above all, be quite sure that the chimney is dead in line with the dome. Now set the boiler on the frame, with the hole in the bottom of the smokebox over the blastpipe. The height of boiler above frame is automatically set by the smokebox bedding down on the saddle.

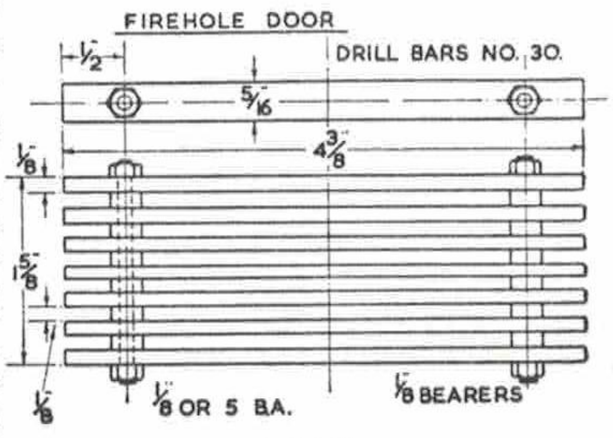
Carefully set the bottom of the boiler parallel to the top of frame, putting a bit of packing (wood block or anything handy) to keep it there. The dimple made in the bottom of the barrel to clear the eccentric-rods in highest position, should be just to the rear of the slide-shaft. Cut two 1 in. lengths of ¼ in. x 1/16 in. angle, drill a couple of No. 41 holes in each, put them on top of the frames with the holed sides against the firebox wrapper, and fix them with two 3/32 in. or 7 B.A. brass screws in each. Either use plumbers' jointing, or better still, solder over the lot later on, when attaching the boiler fittings. Bend up two little clips from ¼ in. x 1/16 in. steel strip, and attach them to the frames in the middle of the brackets, so that they hold them down as shown in the side view.

Don't attach the boiler permanently yet, as it is more convenient to have it off the chassis when attaching the blobs and gadget, but make the steampipe connecting the swan-neck to cylinders. This is merely a ⅞ in. length of ¼ in. copper tube screwed at one end to fit the boss on the steamchest cover; on the other end, silver-solder a 7/16 in. x 26 union screw, made from a bit of ½ in. hexagon rod in the same way as the small ones previously described, and drilled ¼ in. to fit on the pipe. The blastpipe nozzle is similar to a union nut (see detail sketch) but tapered off at the top, and the blower ring rests on it.



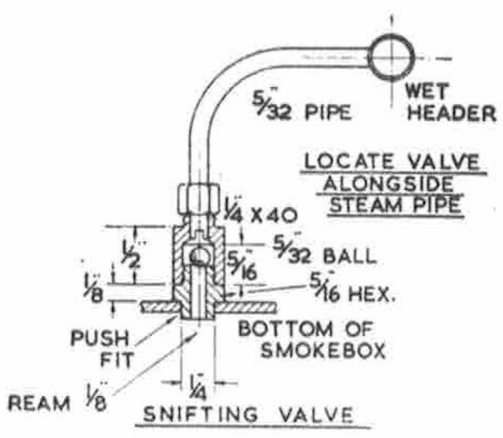
ASHPAN WITH GRATE ERECTED

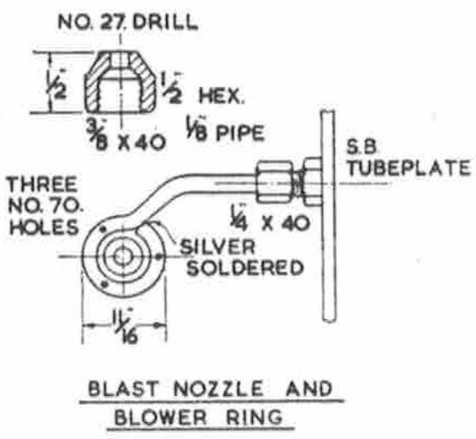




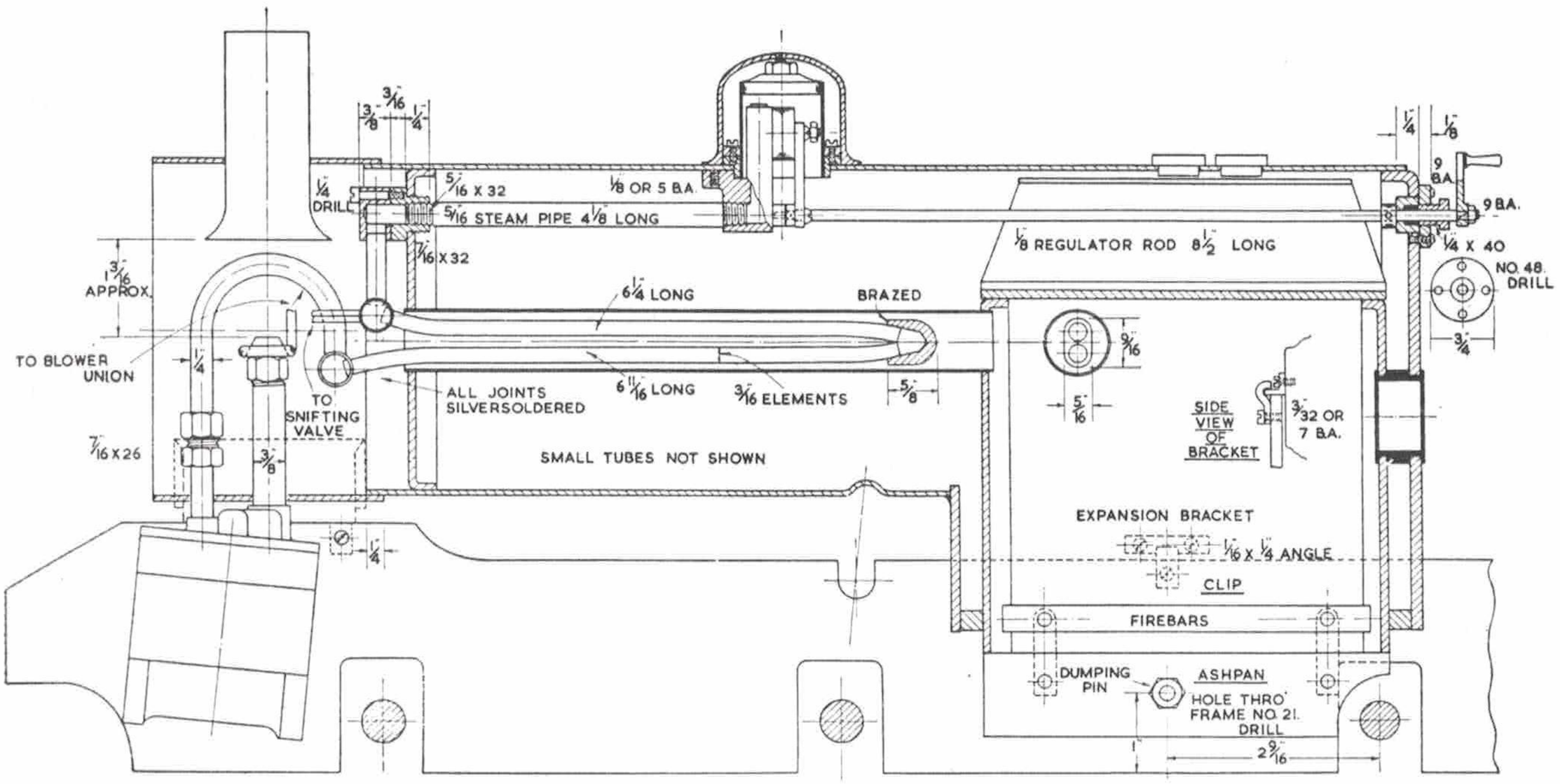
GRATE

The snifting-valve, which "officially" is the vacuum-relief valve, admits air to the top header when coasting with steam off, and not only prevents the superheater elements from overheating, but stops ashes and grit being sucked into the cylinders down the blastpipe. It is made the same way as the oil check-valve, so there is no need to repeat details, but no spring is needed. Drill a ¼ in. hole in the bottom of the smokebox, about ½ in. or so away from the hole for the steam pipe, to take the spigot at the bottom of the valve, which isn't fitted "for keeps" until the boiler is finally fixed.





BLAST NOZZLE AND BLOWER RING



BOILER ERECTED, WITH SUPERHEATER AND REGULATOR

Blower

Bend a piece of $\frac{1}{8}$ in. copper tube into a ring about 11/16 in. dia. and silver-solder the joint where the open end butts against the end of the circle. Make three centrepops equidistant around the circle, as shown by the black dots in the drawing, and drill them No. 70, canting the drill slightly inwards towards the middle of the circle. Cut off the tube at $3\frac{1}{2}$ in. from the circle, and fit a $\frac{1}{4}$ in. x 40 union nut and cone on it. Screw the nut on to the nipple at the end of the hollow stay.

When the boiler is permanently erected, the ring is fitted over the blastpipe nozzle as shown in the assembly drawing, so that steam from the jets goes up the chimney liner.

Grate and ashpan

It is quite likely that friend Reeves will supply cast grates. I had one in stock that fitted my own engine. A grate can also be easily built up. The firebars are seven $4\frac{3}{8}$ in. lengths of $\frac{1}{8}$ in. x 5/16 in. commercial black strip steel. If a posh long-wearing job is desired, rustless steel strip could be used, as this is very resistant to burning.

Grate and ashpan

AFTER my old 4-4-2 Ayesha (now in her 36th year) burnt out nine sets of mild-steel bars, I fitted a rustless set, and they have stood the racket for five years now and still O.K. Cast-iron grates also last longer than mild steel. Anway, drill a No. 30 hole $\frac{1}{2}$ in. from each end of one bar, and use it as a jig to drill similar holes through the rest.

The bearers are two 2 in. lengths of $\frac{1}{8}$ in. steel, rustless recommended, with a few $\frac{1}{8}$ in. or 5 B.A. threads on each end. For the spacers, chuck a piece of $\frac{1}{4}$ in. round steel rod, face, centre drill No. 30 to the end of the drill flutes, and part off eight $\frac{1}{8}$ in. slices. The brackets are four $1\frac{1}{8}$ in. lengths of the same stuff used for firebars, drilled No. 30 at one end and rounded off.

To assemble the grate, put a nut on the end of a bearer, poke it through one of the holes in a firebar, then put on a bracket, then another bar, then spacers and bars alternately until the sixth bar. Put a bracket between the sixth and seventh, then put on the other nut. Thread the other bearer through the other ends of the bars, putting brackets and spacers between, then well tighten the nuts, cut off any projecting bit of bearer, and rivet over the ends to prevent the nuts slacking under the heat and expansion and contraction.

If a cast grate is used, fit the brackets in a similar position between the end firebars, but use screws through bars and brackets, simply drilling and tapping the holes for them through the outer bars.

The ashpan is just a trough bent up from 18-gauge steel. A $\frac{5}{8}$ in. gap is cut out of the end, to clear the trailing coupled axle. The front end is closed, either by a flat piece of the same kind of steel brazed in, or by a wider piece with each end bent to a right-angle (like the sides of the boiler throatplate) to fit between the sides, and riveted by 1/16 in. iron rivets. A $\frac{1}{4}$ in. strip is fitted over the gap at the other end in similar fashion. I brazed up my own ashpan; the small tip of my oxy-acetylene blowpipe

does these jobs easier and quicker than a similar soldering job in tin.

Bend out the lower ends of the brackets on the grate, as shown in the cross-sectional view, and rivet the lower ends to the sides of the ashpan so that the bottom of the grate is ¼ in above the top of the ashpan, and level with it all ways.

The whole bag of tricks is supported by a 5/32 in. pin put through a hole in each frame, and passing through a tube in the ashpan. Drill a hole wih No. 21 drill through each frame, 1 in. from the bottom and 2 9/16 in. ahead of the centre of the trailing axle. With the boiler in its proper position on the chassis, as shown in the drawing, put the grate-and-ashpan assembly in position as illustrated, and temporarily jam it there with a block of wood or anything else handy underneath it. Run the No. 21 drill through the holes in the frame, and carry on right through the sides of the ashpan.

Remove the ashpan, open out the holes to suit any piece of tube that you happen to have, which will allow a 5/32 in. pin to pass through it, cut the tube to about 2⅜ in. length, put it through the holes in the ashpan, and bell out the ends. The pin is a 3¾ in. length of 5/32 in. steel, slightly tapered at one end, and furnished with a turned knob, or a nut as desired, screwed on the other end. When the ashpan is pushed up in place, the pin is inserted through one of the holes in frame, and the tube guides it to the other hole, the pin then holding the lot in place. After a run, pull out the pin, and the grate and ashpan drop clear, along with the relics of the fire.

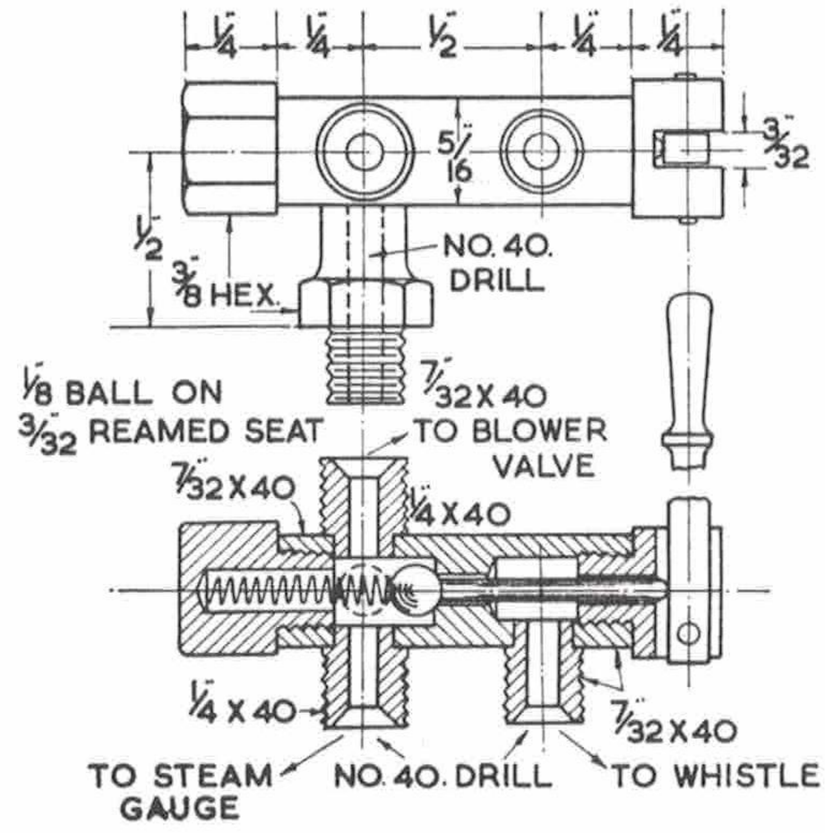
Boiler fittings

The boiler fittings are mainly what I call "jewellery jobs", as they consist of turning up little twiddley bits and silversoldering them together. By this time, however, readers who are building *Mona* as a first attempt should be able to manage quite well without a lot of repetition of detailed instructions, as I have done my best to make the drawings self-explanatory. Incidentally our tracer, who is a real artist at the job, traces them exactly as I draw them, and doesn't alter them to "conform to standard drawing-office practice". I have always tried to make my drawings so that the veriest tyro can read them at a glance; something they can't do with "professional" drawings —nuff sed!

The reproduced photo shows the layout. The horizontal handle under the cab roof operates the whistle-valve. The whistle itself is mounted under the footplate longways, over the pony axle. The pipe to the left of the water-gauge carries steam to it. The steam gauge, ¾ in. dia. and reading to 120 lb. is connected to the left-hand union on the turret. The pipe to the right of the regulator handle conveys steam from the right-hand turret union to the blower valve just below. Out of sight under the roof ahead of the turret, an elbow with union is screwed into the top of the boiler and takes steam to the injector steam-valve (extreme right) the pillar of which is screwed into the wrapper and through the backhead flange. This arrangement is shown in one of the detail drawings.

Just below the injector valve is the bypass valve. The union at the bottom connects with the delivery pipe from the crosshead pump. Inside the tank on which the valve is mounted, a pipe leads from the side fitting of the valve to the filler hole. When the lid is open, the end of the pipe can be seen, and the valve adjusted so that the amount of water bypassed can be regulated to suit the needs of the boiler. The clackbox or check-valve close to the bypass valve is connected to the emergency hand-pump in the tank.

To get a reasonable length of glass, the upper fitting of the water-gauge screws into a socket attached to the top of the wrapper by two screws. You can see the level of the water in the glass in the picture—and that's just where you want to keep it when the engine is running! The left-hand handle showing above the bunker plate operates the injector water-valve, and the right-hand one is the brake handle, on which the fireman sometimes does physical jerks. As the photo shows, little fittings can be made quite reliable without being clumsy; the drawings show how, so let's get busy.

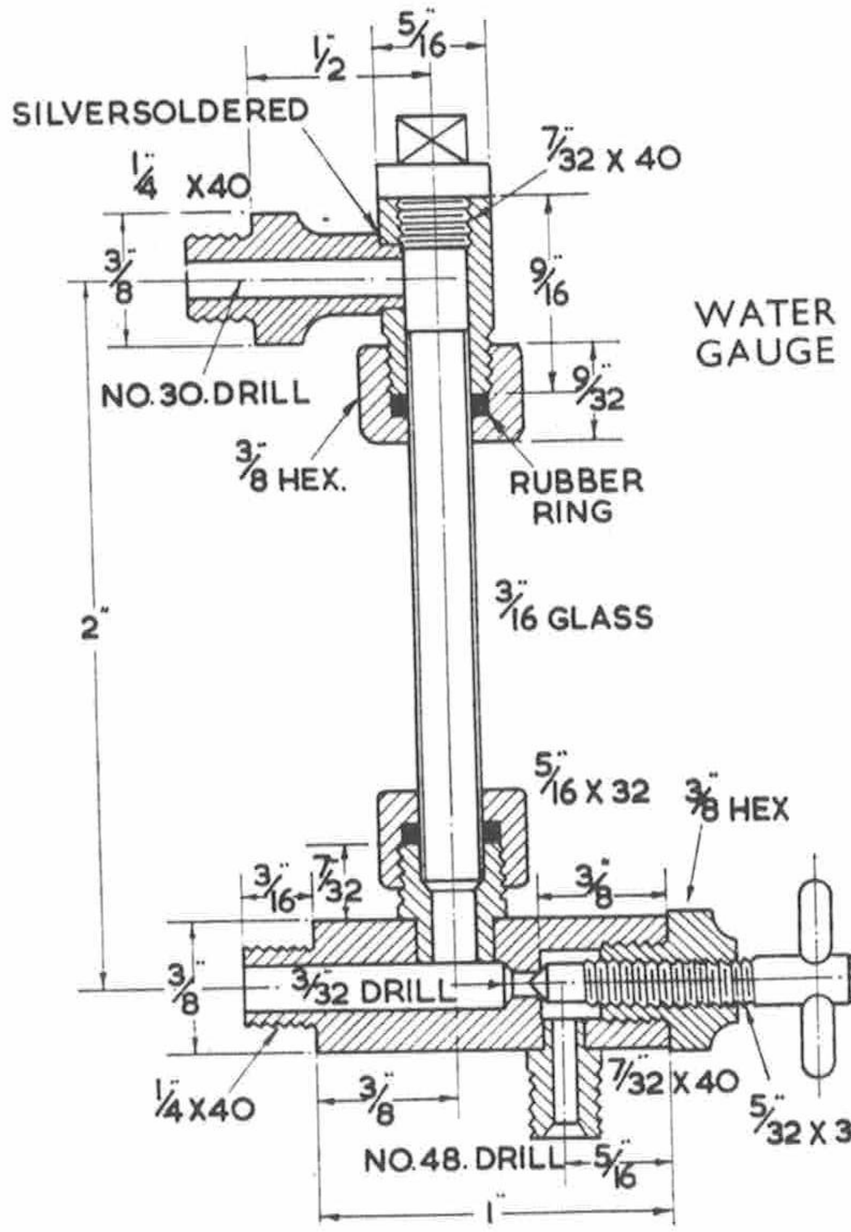


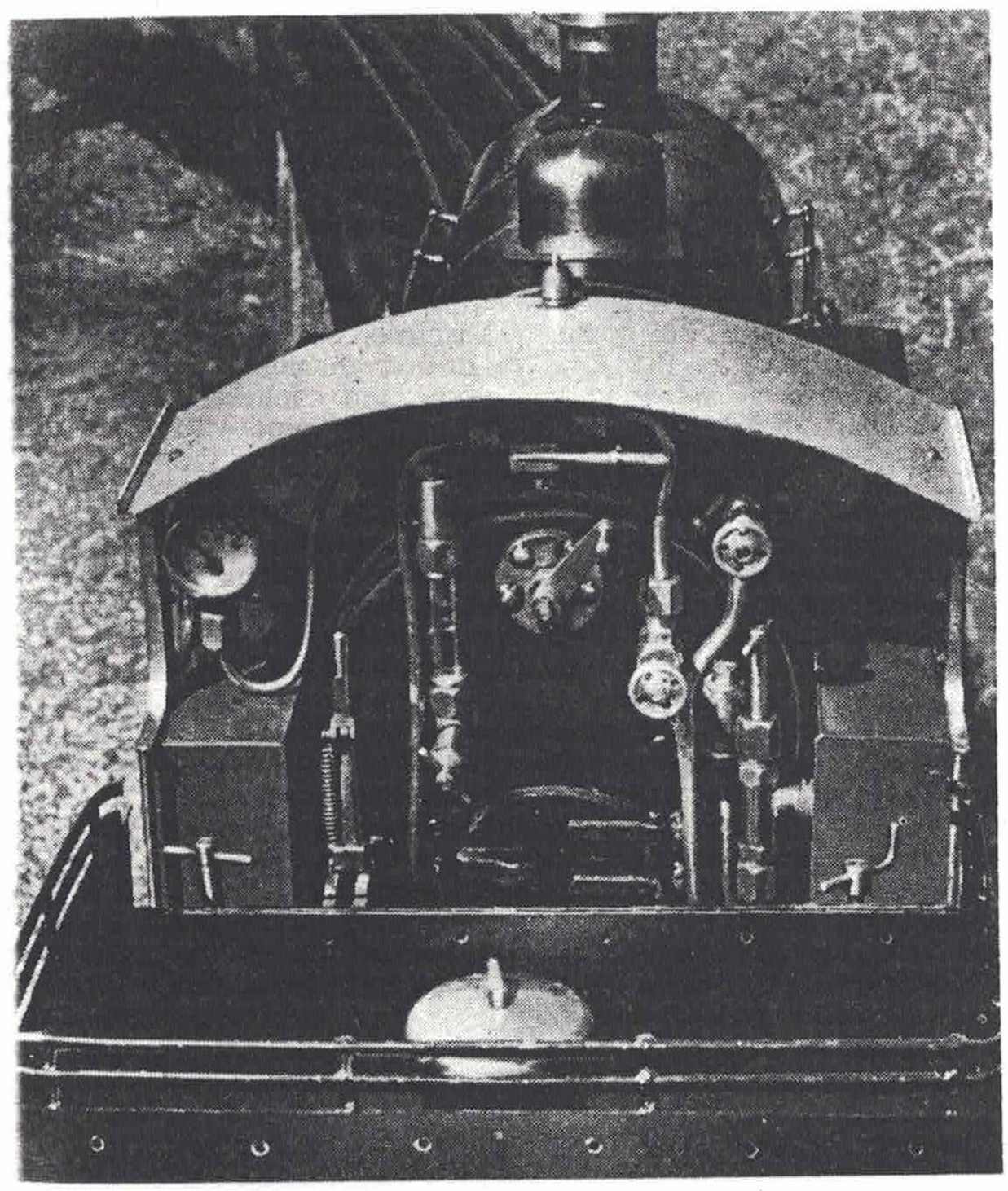
TURRET AND WHISTLE VALVE

Turret and whistle valve

Part off a 1 in. length of 5/16 in. rod. Chuck in three-jaw, centre, drill right through with No. 44 drill, open out and bottom to 7/16 in. depth with 3/16 in. drill and D-bit, slightly countersink the end, and tap 7/32 in. x 40. Reverse in chuck and repeat operation, but only go 3/8 in. deep and don't use the D-bit. At ¼ in. from the D-bitted end, drill a 5/32 in. hole right across and fit a ¼ in. x 40 union nipple in each side. At ¼ in. from the other end, drill a 5/32 in. hole in one side only and fit a 7/32 in. x 40 union nipple in it. In line with the first two, on what will be the underside of the fitting (see drawing) drill another 5/32 hole for the pillar. To make it, chuck a bit of 5/16 in. hexagon rod in three-jaw, face, centre, drill No. 40 for ¾ in. depth, turn 3/16 in. length to 7/32 in. dia. and screw 7/32 in. x 40. Part off at a full 3/8 in. from shoulder, reverse and rechuck in a tapped bush, turn a full 1/16 in. length to a tight fit in the hole in the valve barrel, and turn the rest to shape shown. Squeeze the pillar into the hole, and silversolder it and the three nipples at one heating.

Poke a 3/32 in. parallel reamer through the remains of the No. 44 hole, and seat a ⅛ in. rustless ball on the D-bitted end. Turn up a cap for the end from 3/8 in. hexagon rod, and drill it No. 30 as shown in the section, to take a light spring (brass or bronze) to keep the ball against the





seating. Make a cap for the other end from 3/8 in. square rod chucked truly in the four-jaw: but centre and drill it No. 48 before parting off. Cut a 3/32 in. slot right across it as shown, and in the slot fit a lever, just a baby edition of the reversing-lever made the same way. Screw in the cap and put a piece of 15-gauge bronze or rustless steel wire in the hole, letting the end stand out in the slot, just far enough to allow the lever to press it home and push the ball off the seating when the driver wants to sound the whistle. Steam then passes the ball and goes down the pipe to the noisy gadget under the footplate.

Drill a 3/16 in. hole in the edge of the wrapper above the regulator; this should go through the backhead flange as well. Tap 7/32 in. x 40 and screw the shank of the pillar into it with a taste of plumbers' jointing on the threads. Couple up the unions as mentioned previously, and Bob's your uncle.

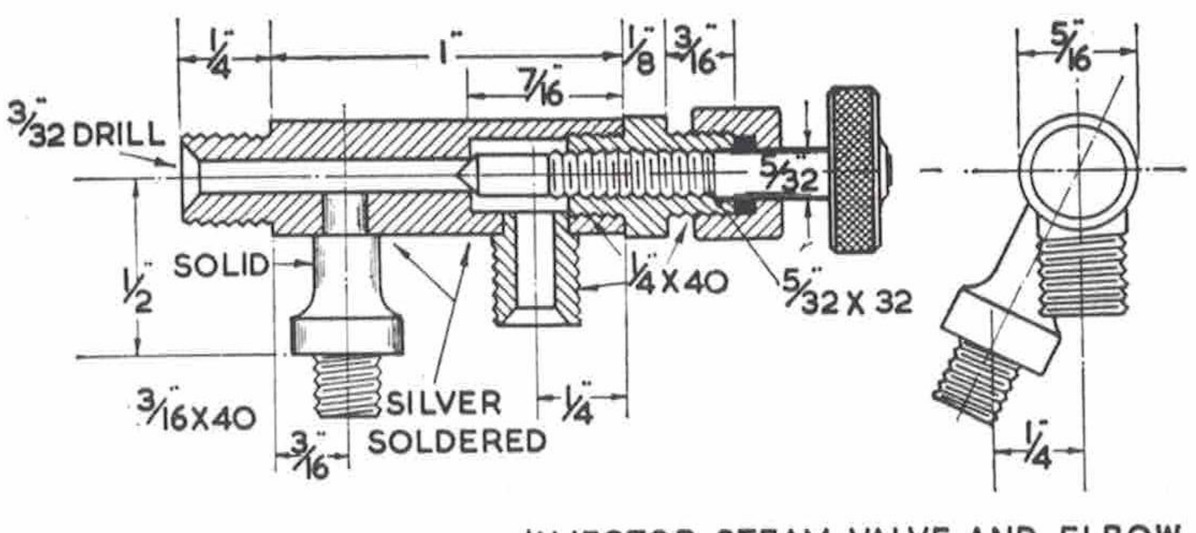
Water gauge

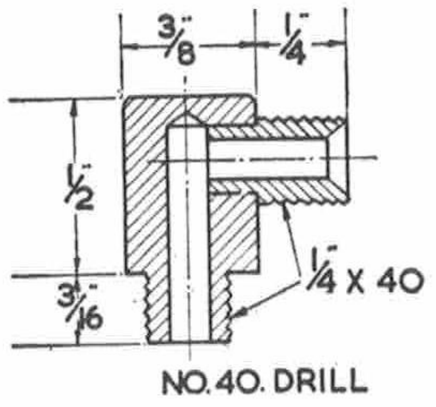
Part off a 9/16 in. length of 5/16 in. rod, chuck, centre, and drill through with No. 11 drill. Tap the end 7/32 in. x 40, reverse in chuck and screw the other end 5/16 in. x 32. Drill a 5/32 in. hole in the side, and fit a pillar in it just like that on the whistle turret but made to the size shown. Silversolder the joint, and make a cap from the same kind of rod, filing the head square.

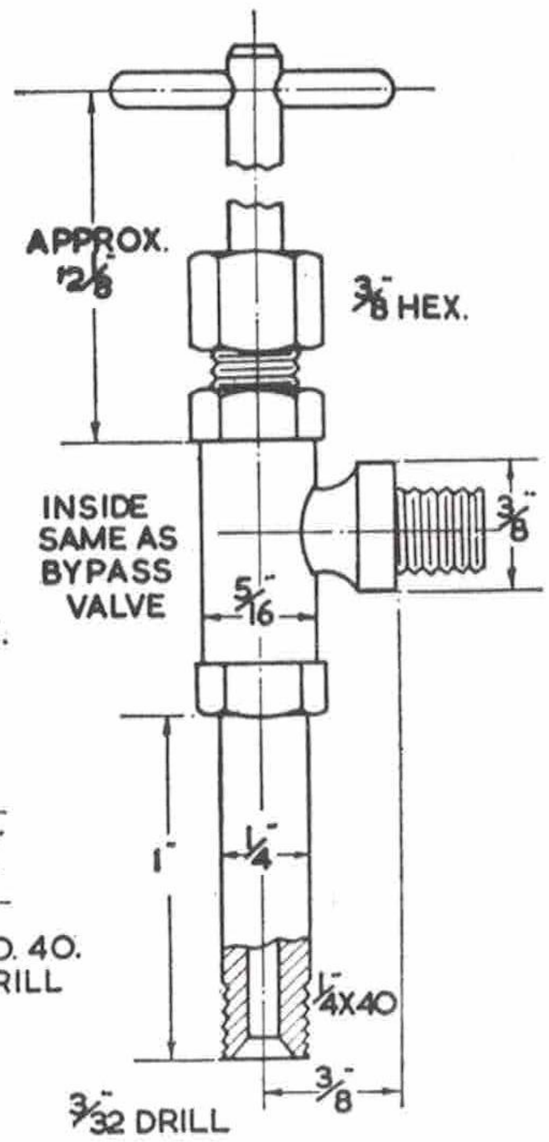
Chuck a piece of 3/8 in. rod 1¼ in. long. Face, centre, put a 3/32 in. drill right through, and open out with No. 30 to ¾ in. depth. Turn down 3/16 in. of the end to ¼ in. dia. and screw ¼ in. x 40. Reverse in chuck, open out and bottom to 3/8 in. depth with 7/32 in. drill and D-bit, and tap ¼ in. x 40. Make a cap from 3/8 in. hexagon rod, but before parting off, drill it No. 31 and tap 5/32 in. x 32. At 5/16 in. from the end, drill a 5/32 in. hole in the side and fit a 7/32 in. x 40 union nipple into it. At 3/8 in. from the shoulder at the other end, and exactly opposite, drill a 3/16 in. hole, and in that, fit a 5/16 in. x 32 nipple drilled No. 30 and counterbored No. 11. Silversolder both nipples at one fell swoop. Make the two gland nuts from 3/8 in. hexagon rod in the same way as union nuts. The valve pin is just a bit of 5/32 in. rod (rustless steel or bronze) screwed 5/32 in. x 32 to fit the cap, turned to a blunt point at one end, and furnished with a cross-handle of 13-gauge spoke wire at the plain end as shown.

The socket for the top fitting is made from a block of brass 1-1/16 in. long, 3/8 in. wide and a full ½ in. deep. The curved base should fit the boiler exactly. I did mine by holding it in the machine-vice on the table of my milling-machine, and running it under a 4 in. end-and-face cutter on the arbor (two minutes' job!), but it can be done in the lathe by holding it in a machine-vice (regular or improvised) on the lathe saddle at the proper height, and traversing it under a flycutter; the little boring-tool fixed in a hole in a piece of bar held in the chuck, which I described previously.

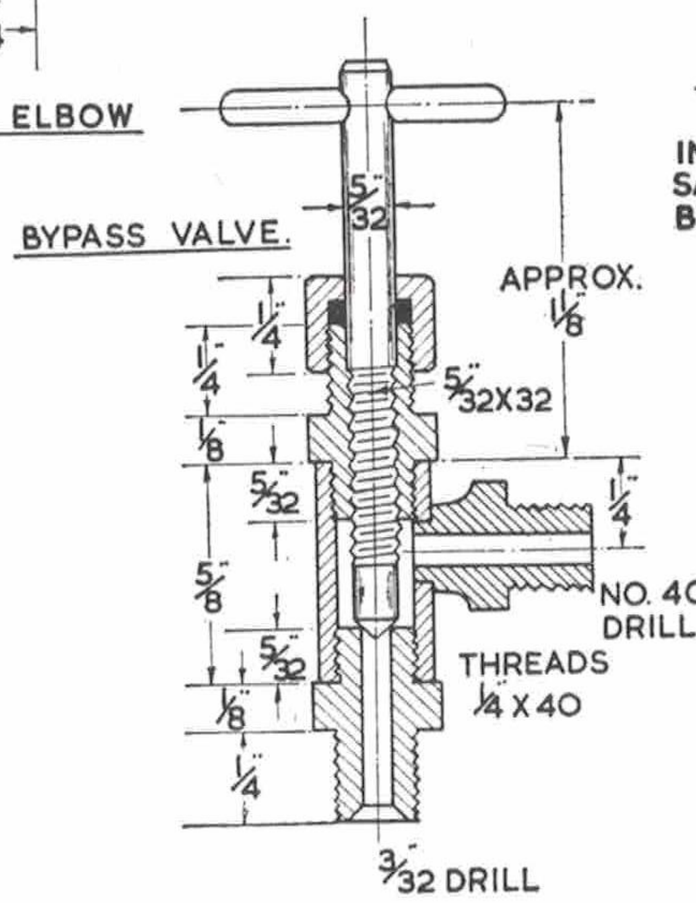
File to shape, then drill and tap the hole for the gauge fitting, which must be dead square with the face; then drill the screwholes, and the hole from the curved seating to the tapped hole. Attach it to the top of the wrapper with two 3/32 in. or 7 BA brass screws, so that the face is ⅛ in. from the backhead, and the centre of the tapped hole







INJECTOR STEAM VALVE AND ELBOW



INJECTOR WATER VALVE

is 13/16 in. to the left of the regulator spindle. Don't forget to drill a No. 12 hole in the wrapper under the socket, to let steam get to it, or you've had it good and proper! As the socket won't have to come off the boiler any more, sweat over the flange and screws with solder. That will prevent it leaking for ever and a day.

Exactly 2 in. underneath the middle of the hole, drill a 7/32 in. hole in the backhead, tap ¼ in. x 40 and screw the bottom gauge fitting into it. Screw the top fitting into the socket, and line them up by putting the No. 11 drill down the top one. When both fittings are right home, the drill should drop easily into the counterbore. The piece of 3/16 in. glass tube can then be fitted, using rubber rings in the gland nuts as shown. To make them, put a bit of rubber tube of a size that will fit in the nuts, on a bit of 3/16 in. rod. Hold in chuck, start the lathe, and apply a discarded safety-razor blade (wet it) to the rubber at 3/32 in. intervals. Push the tube off the rod—and there are your rings!

Injector steam valve

Chuck a 1¼ in. length of 5/16 in. rod, centre, put a 3/32 in. drill right through, open out with 7/32 in. drill and D-bit to 7/16 in. depth and tap ¼ in. x 40. Reverse in chuck, turn down ¼ in. of the other end to ¼ in. dia. and screw ¼ in. x 40. At 3/16 in. from the shoulder, drill a 5/32 in. hole and fit a pillar in it like that in the turret, but leave it solid. At ¼ in. from the tapped end, fit a ¼ in. x 40 union nipple, but note they are not in line. Set them at the angle shown in the end view.

For the gland, chuck a piece of 5/16 in. hexagon rod, face, centre, drill to 5/8 in. depth with No. 31 drill, turn 3/16 in. of the end to ¼ in. dia., and screw ¼ in. x 40. Part off at 5/16 in. from shoulder, reverse and rechuck in a tapped bush, repeat turning down and screwing, open out the hole with No. 21 drill for ⅛ in. depth, and tap the rest 5/32 in. x 32. The gland nut is made from 5/16 in. hexagon rod same as a union nut, and the valve pin from 5/32 in. rustless steel or bronze rod. Square the end and fit a little handwheel which can be turned from 7/16 in. rod, any metal you like. Dural makes nice wheels.

Chuck a piece of 3/8 in. round rod for the elbow. Face, centre, drill No. 40 for 5/8 in. depth, turn 3/16 in. of the end to ¼ in. dia. and screw ¼ in. x 40. Drill a 5/32 in. hole in the side at 5/16 in. from the shoulder, part off at 11/16 in. from the end, fit a ¼ in. x 40 union nipple in the hole, and silversolder it.

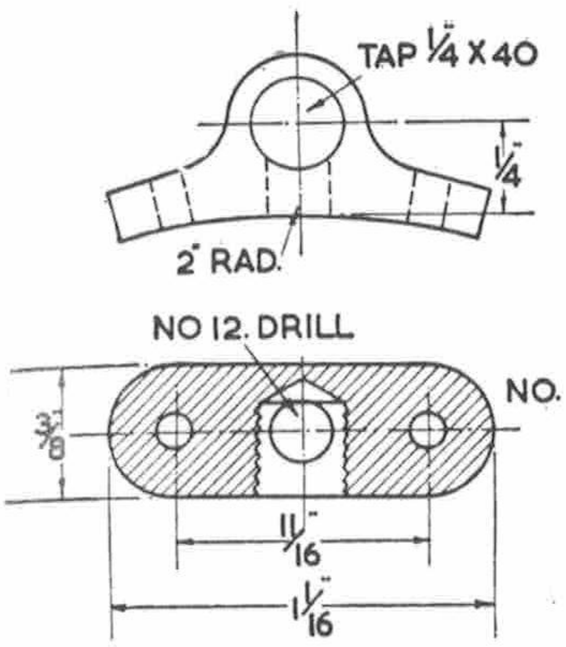
On the top of the wrapper, at 1¼ in. to the right of the regulator spindle and as close to the edge as possible, drill a 5/32 in. hole and tap it 3/16 in. x 40. Screw the pillar of the steam valve into this. When right home, the body of the valve should be parallel with the boiler, and the union nipple should hang straight down. About 1 in. from the backhead, near the top of the boiler, drill a 7/32 in. hole through the wrapper and crownstay flange, and tap it ¼ in. x 40. This gives more depth of thread than if the hole is drilled through the wrapper alone. Screw in the elbow and connect it to the end of the steam valve by a 5/32 in. pipe with a union nut and cone at each end, as shown in the diagram.

Water and bypass valves

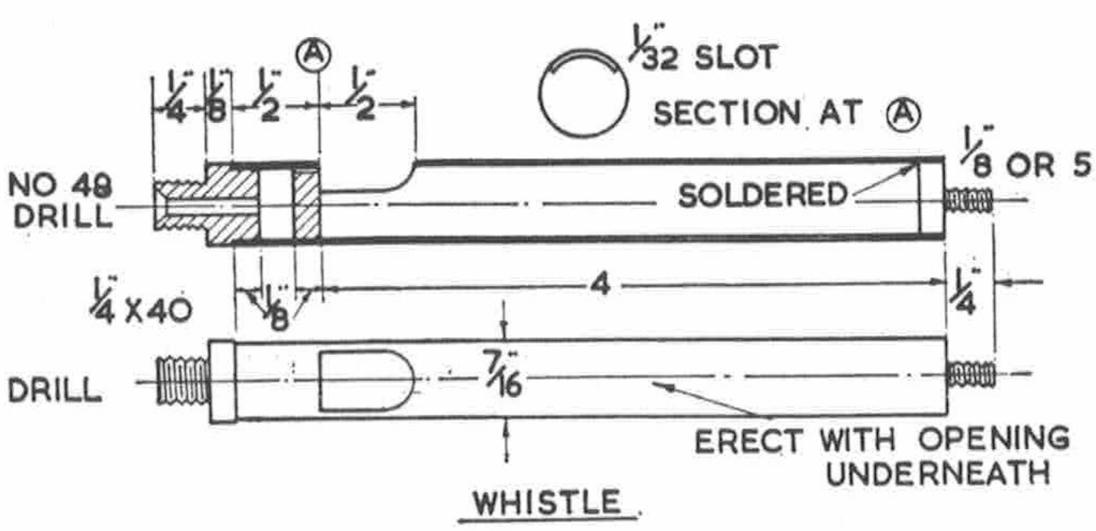
There is no need to dilate on these merchants, as both their internal anatomies are made pretty much the same way as the injector steam valve, but to given dimensions. Instead of union nipples in the side, fit shortened versions of the doings at the top of the water-gauge. The long handle of the water-valve is needed to bring it above the level of the bunker plate (wouldn't the driver and fireman say a mouthful if they had to grope on the footplate to turn on the water!) and the long tail is needed to enable the union connecting the valve to the injector to be placed below footplate level, so that it is accessible from the side of the engine.

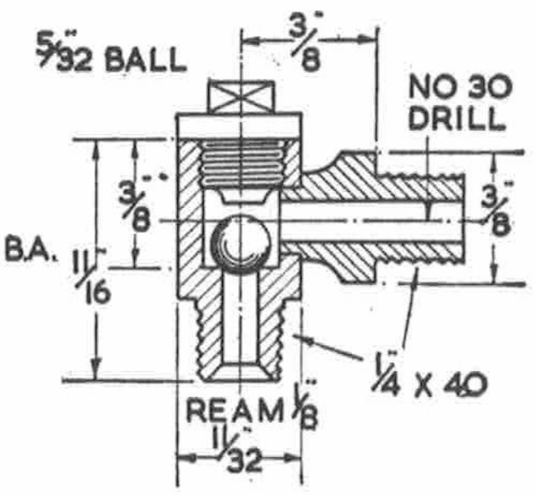
Clackbox or check valve

Chuck a piece of 3/8 in. rod and turn about 1 in. of it to 11/32 in. dia., then face the end, and centre it deeply. Turn down ¼ in. length to ¼ in, dia. and screw ¼ in. x 40. Part off at 11/16 in. from

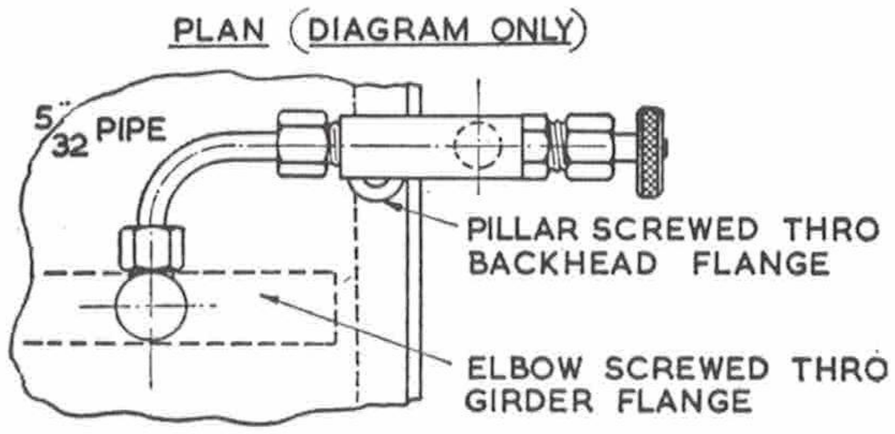


WATER GAUGE SOCKET





CLACK BOX



HOW TO CONNECT INJECTOR STEAM VALVE

the end, reverse in chuck, centre, drill through with No. 34 drill, open out and bottom to 3/8 in. depth with 7/32 in. drill and D-bit, tap the end $\frac{1}{4}$ in. x 40, and poke a $\frac{1}{8}$ in. reamer through the remnant of No. 34 hole left. Drill a 3/16 in. hole in the side just clear of the ball seat (see drawing) and silversolder in it, a fitting like the one at the top of the water-gauge. Seat a 5/32 in. ball in the hole, and fit a cap made like that on top of the water-gauge, allowing the ball a full 1/32 in. lift.

Three clackboxes are needed altogether. Screw one into the bush at each side of the boiler barrel, and the third into the backhead in the position shown in the photo, below the injector steam valve.

Whistle

The whistle barrel is a piece of 7/16 in. brass tube squared off at each end in the lathe to 4 in. length. The hole where the noise comes out is filed to the shape shown, at $\frac{1}{2}$ in. from the end. The other end is plugged with a disc of brass soldered in. The screw can be either a separate stud, or turned solid with the disc.

A similar disc is fitted at the end of the sound hole, the edge of this being carefully filed away for 1/32 in. depth, to the length of the hole. It should be a tight fit in the barrel. For the union, chuck a bit of 7/16 in. rod face, centre, drill to 5/8 in. depth with No. 48 drill, turn down $\frac{1}{4}$ in. length to $\frac{1}{4}$ in. dia. and screw $\frac{1}{4}$ in. x 40, parting off at $\frac{1}{4}$ in. from shoulder. Reverse in chuck and turn $\frac{1}{8}$ in. of the end to a tight fit in the whistle barrel.

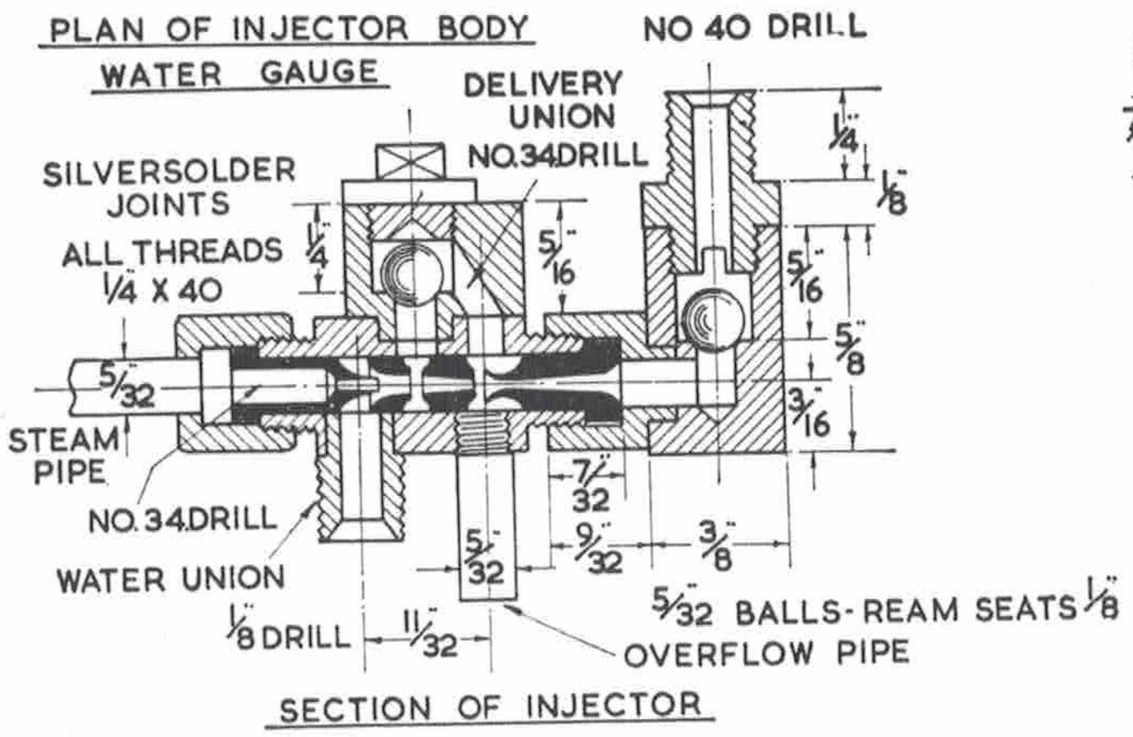
Be careful over this—before inserting it, put a few spots of liquid soldering flux in the barrel, and a bead of solder, about the size of a pinhead. Then put in the union fitting, and hold the whistle over a gas or spirit flame with the sound hole uppermost. The bead of solder will then melt and seal both the sound disc and the union fitting. If you use too much solder, or turn the whistle over, the solder will choke the slot—and it's a safe bet you won't be very pleased!

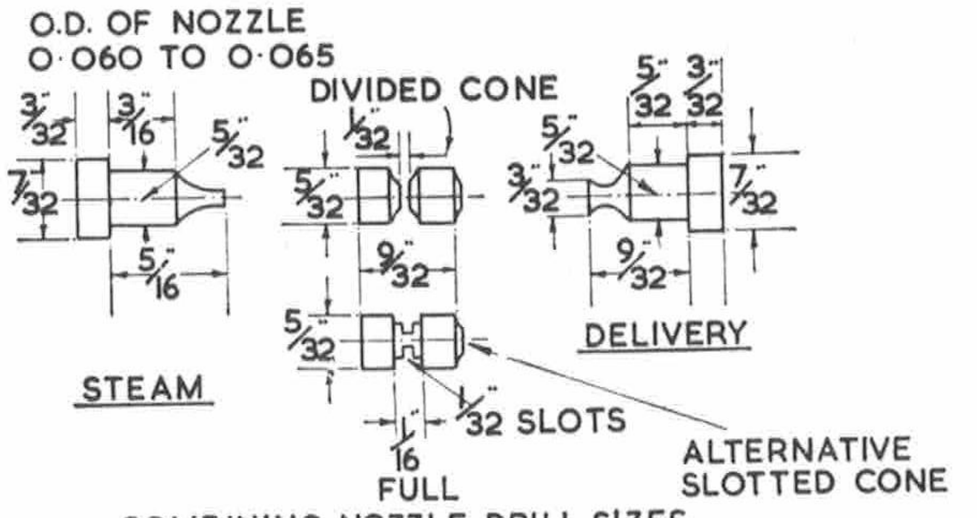
SORRY, boys and girls, I clean forgot to mention that the firehole door illustrated in our September number can be made from a casting, or built up from two little ovals of 16-gauge sheet steel cut to given dimensions and riveted together with a spacer between, like those in the grate, but $\frac{3}{8}$ in. dia. and $\frac{1}{4}$ in. thick. The hinges are weeny editions of those on the smokebox door. The catch is a small piece of springy bronze strip, like the material used for brush springs on Milly-Amp motors, bent to the shape shown, and attached to the backhead by a 3/32 in. bronze screw. It engages with the bent-over end of the handle. Only enough tension should be put on it to keep the door shut, so that the door can be easily flicked open with the shovel while firing the engine on the run.

Injector

Now we come to what the beginner usually regards as the *pons asinorum*—but it needn't be! The only tricky thing about the whole job is drilling the weeny holes without breaking the drill:-you don't have to be hamfisted. Any of the munition girls in the little factory I looked after during the latter part of the Kaiser's war, could put a No. 80 drill in to the full depth of the flutes without breaking it.

Chuck a piece of 3/8 in. square rod in the four-jaw, and set it to run truly. Face the end, centre, and drill to a full 1 in. depth with No. 24 drill. Turn down 5/32 in. of the end to $\frac{1}{4}$ in. dia. and screw $\frac{1}{4}$ in. x 40. Part off at 15/16 in. from the end. Reverse in chuck (to do this and reset truly in a four-jaw, slack off Nos. 1 and 2 jaws, turn the work



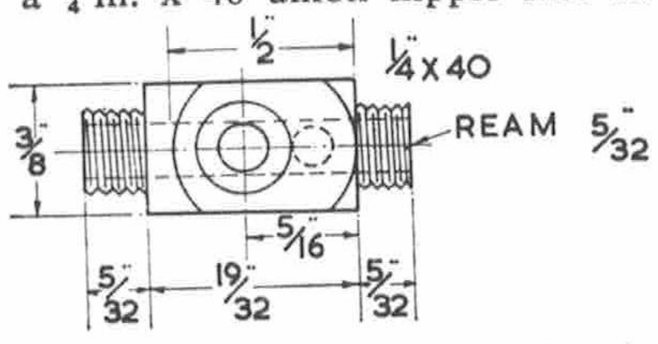


COMBINING NOZZLE DRILL SIZES

	FOR 80 LBS. MAX.	FOR 100 LBS. MAX.
STEAM	63	65
COMBINING	70	71
DELIVERY	75	76

DETAILS OF INJECTOR CONES

end-for-end, and retighten the same two jaws) turn and screw the other end likewise, and put a 5/32 in. parallel reamer through. On one of the facets, at 1/8 in. from the end, drill a No. 34 hole clean across. At 3/16 in. farther along, drill a 1/8 in. hole into the reamed central hole, and pindrill it to 1/16 in. depth with a 3/16 in. pindrill. On the opposite side, open out the end of the 34 hole to No. 30 size, and tap it 5/32 in. x 40. At 1/8 in. from the other end, drill a 3/16 in. hole into the central passageway, and fit a 1/4 in. x 40 union nipple into it. This should have a 1/8 in. hole through it.



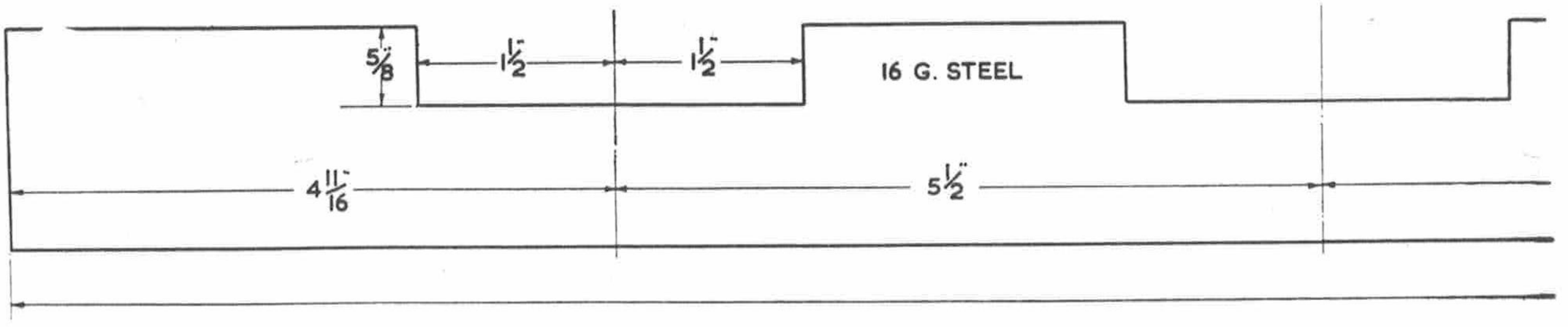
Chuck a piece of 1/2 in. rod in three - jaw, face the end, and part off at a bare 3/8 in. The true centre will be shown by the toolmarks on the faced end. Make a centrepop 1/16 in. away from this, and chuck in four-jaw with the pop mark running truly. Open it with a centre-drill, drill right through with No. 34, open out and bottom to 1/4 in. depth with 7/32 in. drill and D-bit, and tap the end 1/4 in. x 40. Chuck a bit of 3/8 in. rod in three-jaw, turn down about 1/8 in. of it to 1/4 in. dia., screw it 1/4 in. x 40 and screw the other piece on to it. Turn down 1/16 in. of the other end to a tight fit in the pindrilled hole in the square piece. In the wide space between the spigot and the side, at 3/16 in. from the centre of the hole in the spigot, drill a No. 34 hole slantwise into the tapped hole. The exact angle doesn't matter, so long as you don't spoil the D-bitted seating. Put a 1/8 in. reamer through the hole in the spigot, then fit it into the pindrilled hole in the square piece. Note carefully, the slanting hole must come exactly over the No. 34 hole in the square piece; this is very important, and is shown in the section.

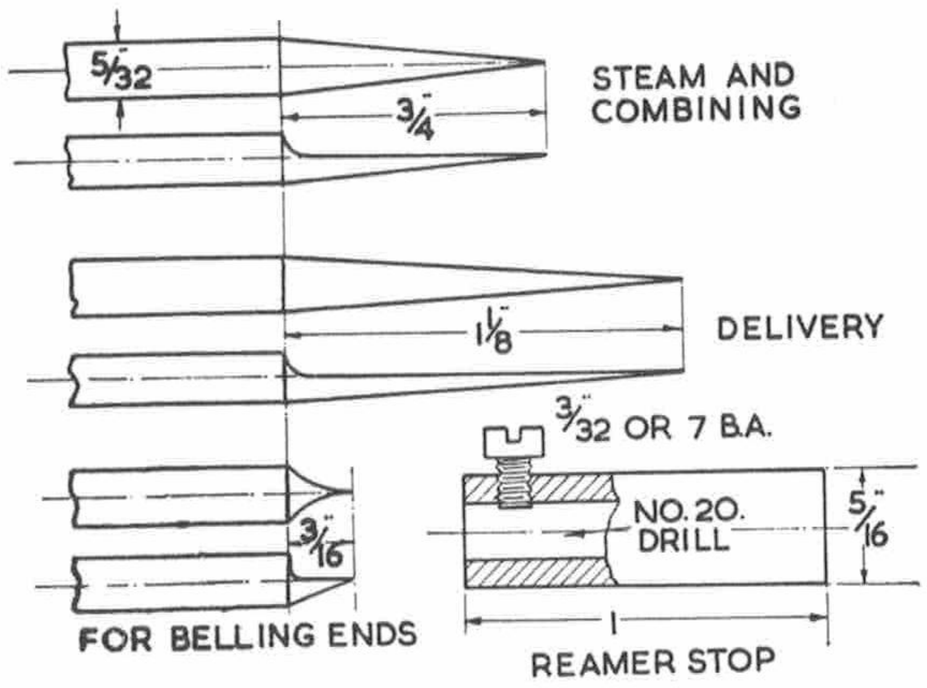
Silversolder the joints at one heating, and be sparing with the silversolder, making the job as neat as possible. Pickle, wash, and clean up. Mill or file the overhanging sides of the round piece flush with the square piece (see plan) then seat a 5/32 in. ball on the reamed hole, and make a cap for it from 3/8 in. rod, like the top of the gauge glass, countersinking it to allow the ball about 3/64 in. lift. You now have a nice little injector body.

Injector cones

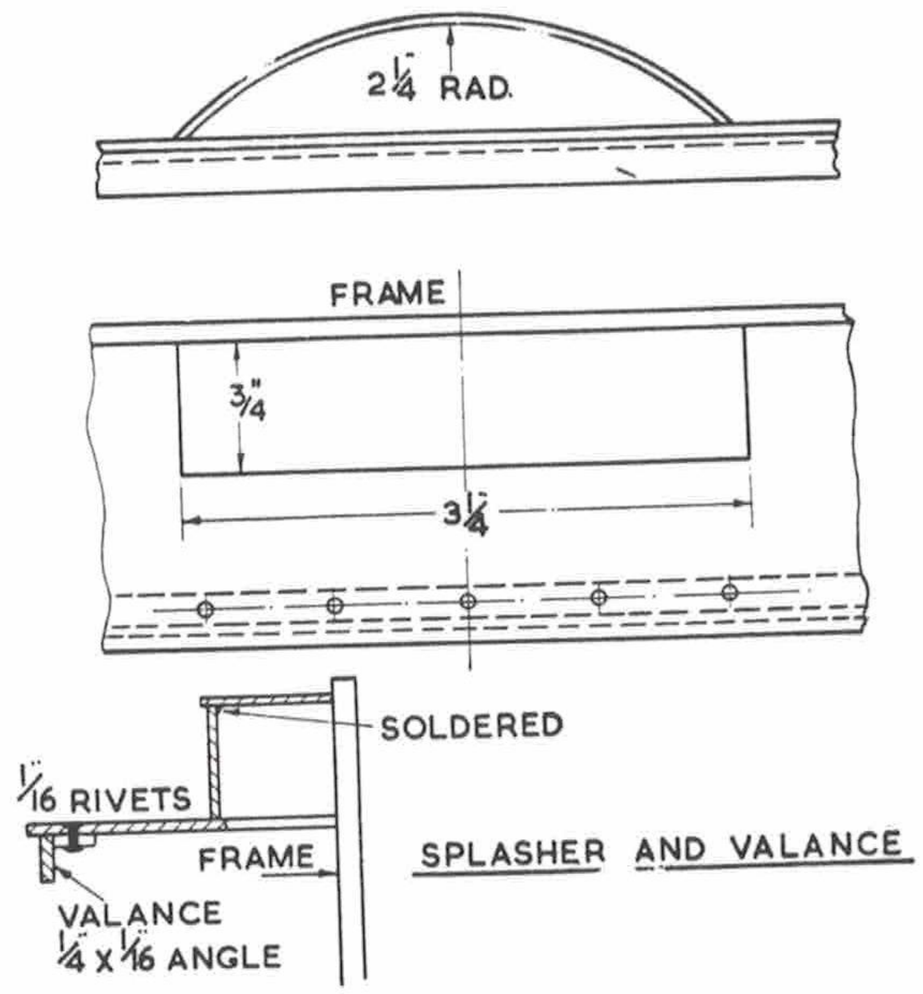
The cones are made from 7/32 in. brass rod. Before making them you need three reamers for reaming the tapers, and these can be home-made from 5/32 in. silver-steel. Chuck a piece in three-jaw, and turn a cone point on it 3/4 in. long, setting over the top slide to get the taper. Cut off to leave a shank about 1 1/2 in long. Repeat operation, but this time turn the taper 1 1/8 in. and then make a third, with a curved end 3/16 in. long only. File away half the diameter of each taper, as shown, then heat the tapers to red and plunge them vertically into cold water. Rub the flats on an oilstone to brighten them, then put each in turn on a piece of sheet iron, and hold it over a gas or spirit flame. As soon as the bright parts turn yellow, tip the reamer into the water, and they are ready for use.

The combining cone should be made first, and is turned to a press fit thus. Slightly ease out the nipple end of the injector body with a taper broach for about 1/8 in. depth; put the 5/32 in. parallel reamer through again to clear out any burring left from drilling operations. Chuck the 7/32 in. rod and turn about 3/8 in. length until it will just enter the broached end of the body very tightly. Face the end, and centre it, but not with a centre-drill, which would be too big. Make a special one; turn a cone point 1/4 in. long on the end of a bit of 1/8 in. silver-steel, file away half the diameter, and harden and temper it just like the cone reamers described





CONE REAMERS AND STOP



SPLASHER AND VALANCE

above. Used like an ordinary centre-drill, it is O.K. for the job.

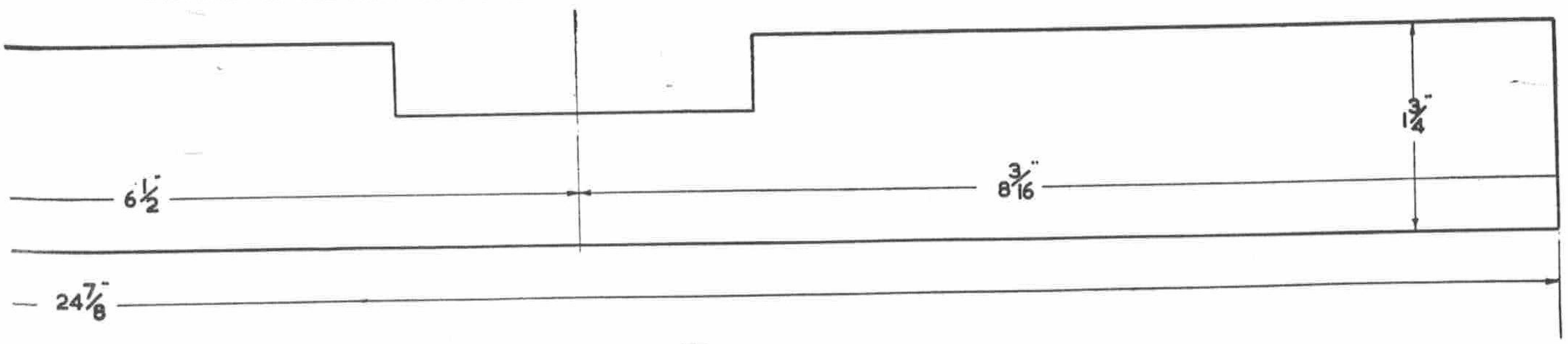
Drill the rod to 5/16 in. depth with No. 72 drill. Hold this in a pin chuck, which in turn is held in the tailstock chuck. Drill in for 1/16 in. depth, withdraw drill to clear chips, and ditto-repeato until you have drilled to required depth. That's the whole secret! Keep the microscopic flutes clear of chips, and the drill won't seize and break. Run the lathe as fast as possible without causing an earthquake. Turn the end to a very blunt nose as shown, and part off at 9/32 in. from the end. Reverse in chuck, and open out with the $\frac{3}{4}$ in. tapered reamer held in the tailstock chuck. To prevent this going through too far, make the stop shown, from a 1 in. length of 5/16 in. rod. Put this on the reamer and adjust it so that a bare 5/16 in. of the tapered end is showing, then you can't put it through the cone too far.

For the divided cone, hold it in the chuck with half projecting, and saw it across with a jeweller's tenon saw, which is very thin and has fine teeth. Run the lathe slowly while sawing. Then chuck each half with the sawn end outwards, smooth off the saw marks, and very slightly countersink the half with the smaller hole in it, using the stubby reamer for the job. Enter this half in the broached end of the injector body, and press it in, using the vice as press. Put a $\frac{1}{4}$ in. x 40 union nut on the end of the injector to protect the threads, and use a piece of 5/32 in. brass rod slightly reduced at the end, as a pusher. Press in until the end is just past the hole under the airball chamber, see section. Follow with the second half likewise. To get the gap O.K. merely put a sliver of 1/32 in. brass down the hole, and press in the cone until it touches the sliver. Finally poke the $\frac{3}{4}$ in. taper reamer into the cone, using a tapwrench to turn it, and ream it very carefully, a mere scrape at a time, until a No. 70 drill will just pass the nozzle. You've now done the worst of the job! Put the stubby reamer in and slightly bell out the entrance to the cone as shown.

For the delivery cone, chuck the 7/32 in. rod, face the end, centre, and drill to about $\frac{1}{4}$ in. depth with No. 76 drill "by instalments" as above. Turn down the outside to a tight push fit in the injector body, for a length sufficient to allow it to come within 1/32 in. of the combining cone. Turn the end to shape shown, and bell it with the stubby reamer. Part off at 3/32 in. from shoulder. Reverse in chuck, and centre and drill with No. 60 drill until it meets the 76 hole. Open out with the $1\frac{1}{8}$ in. tapered reamer until the point just shows at the bottom of the bell, and a 75 drill can just be pushed through. Finally radius out the flange end with the stubby reamer.

To make the steam cone, chuck the 7/32 in. rod again, face off, and turn to a tight fit in the injector body, until when pushed in tight against the combining cone, the shoulder stands 1/32 in. away from the screwed end of the body. Test with the sliver of 1/32 in. brass previously mentioned. Turn 5/32 in. length to a curved nose as shown. If you have a mike, make the nozzle anything between 0.060 in. and 0.065 in. If you haven't, make it as near 1/16 in. as you can measure. Centre it and drill No. 65 for about 3/8 in. depth. Open with the $\frac{3}{4}$ in. tapered reamer until the nozzle is practically knife-edged. Part off at 3/32 in. from shoulder. Reverse in chuck, and drill to $\frac{1}{4}$ in. depth with No. 34 drill. Open out the remains of the 65 hole with a 63 drill. When the steam cone is right home, the nozzle should enter the combining cone by 1/32 in. as shown in the section.

The check valve is made from a 5/8 in. length of 3/8 in. rod. Chuck, face, centre, drill to 9/16 in. depth with No. 34 drill, open out and bottom to



RUNNING BOARDS

5/16 in depth with 7/32 in. drill and D-bit, and tap ¼ in. x 40. Drill a 3/16 in. hole in the side at 3/16 in. from the blind end, and in it fit a tapped socket made from 3/8 in. rod. Centre and drill it to 3/8 in. depth with No. 30 drill, then open out and bottom with 7/32 in. drill and D-bit to 7/32 in. depth. Tap ¼ in. x 40 and part off at 3/8 in. from the end. Reverse in chuck, and turn a full 1/16 in. to a tight fit in the hole in the valve body; fit and silver-solder it.

Put a ⅛ in. reamer down the 34 hole, then seat a 5/32 in. ball on it. Make a cap to fit the top, just the same as the one on the valve box of the cross-head pump, but to sizes shown, and allow the ball a bare 1/16 in. lift. When an injector is working, the clack ball stays up all the time, instead of bobbing up and down like a pump ball, and there is no fear of water running back.

The whole bag of tricks is assembled as shown. When the check-valve is screwed right home, it holds the delivery cone in position and should stand vertically. If it doesn't, take a skim off the flange of the delivery cone, just enough to allow the fitting to come right. The gadget that holds the steam pipe to the other end is just an ordinary union nut which has been D-bitted, to allow the flat collar on the end of the steam pipe to seat home in it. Well, there's nothing alarming in making an injector, is there—I'll tell you how to erect it along with the rest of the pipe-fitting.

Running-boards and splashers.

As the running-boards or side platforms are straight, and the same width from front to back, the easiest and quickest way to make them is to get two pieces of 16-gauge steel strip, 1¾ in. wide (Reeves supplies it) then all that has to be done is to cut out the wheel clearances and rivet on the valances. These are 24½ in. lengths of ¼ in. x 1/16 in. angle, and are set back 1/16 in. from the outer edge. Use 1/16 in. rivets at about 1 in. centres. The holes in the running-board may be countersunk, and the rivets hammered flush, as on the old Brighton engines, or they may be snapped to form cup heads by builders who love to see arrays of pimples all over their engines. It's just a matter of taste! I don't like treading on nobbly surfaces, so I prefer the flush rivets.

Mark out the wheel clearances on one strip, clamp the two together in the bench vice with the marked line just showing, saw straight down at each end of the marked space, file a clearance at one end wide enough to take a hacksaw blade on its side, put the blade in the frame sideways, and saw along the line, using the top of the vice jaw as guide. The bits will fall out when the saw reaches the other vertical cut, then all that remains is to file away the sawmarks.

Only one splasher each side is required, as the other wheels are under the tanks. Cut the sides from 18 or 20-gauge steel or brass, to size shown. The tops are ¾ in. strips of the same kind of material, bent to the curve of the splasher, and soldered on the inside. The complete splashers are soldered to the running-boards over the clearances for the leading wheels, as they don't have to come off any more. The complete running-board with splasher attached, can then be placed in position, close to frame, and overhanging the buffer-beams 1/16 in. at each end; they are secured by two 3/32 in. screws, roundhead or countersunk as desired, put through No. 41 clearing holes in the board, into tapped holes in the top of the beam. For additional support, fit a small bracket made from ½ in. or ⅜ in. angle, between each pair of coupled wheels, under the running-board. Attach bracket to frame with a 3/32 in. screw, and put another one through the running-board into the bracket.

Side tanks.

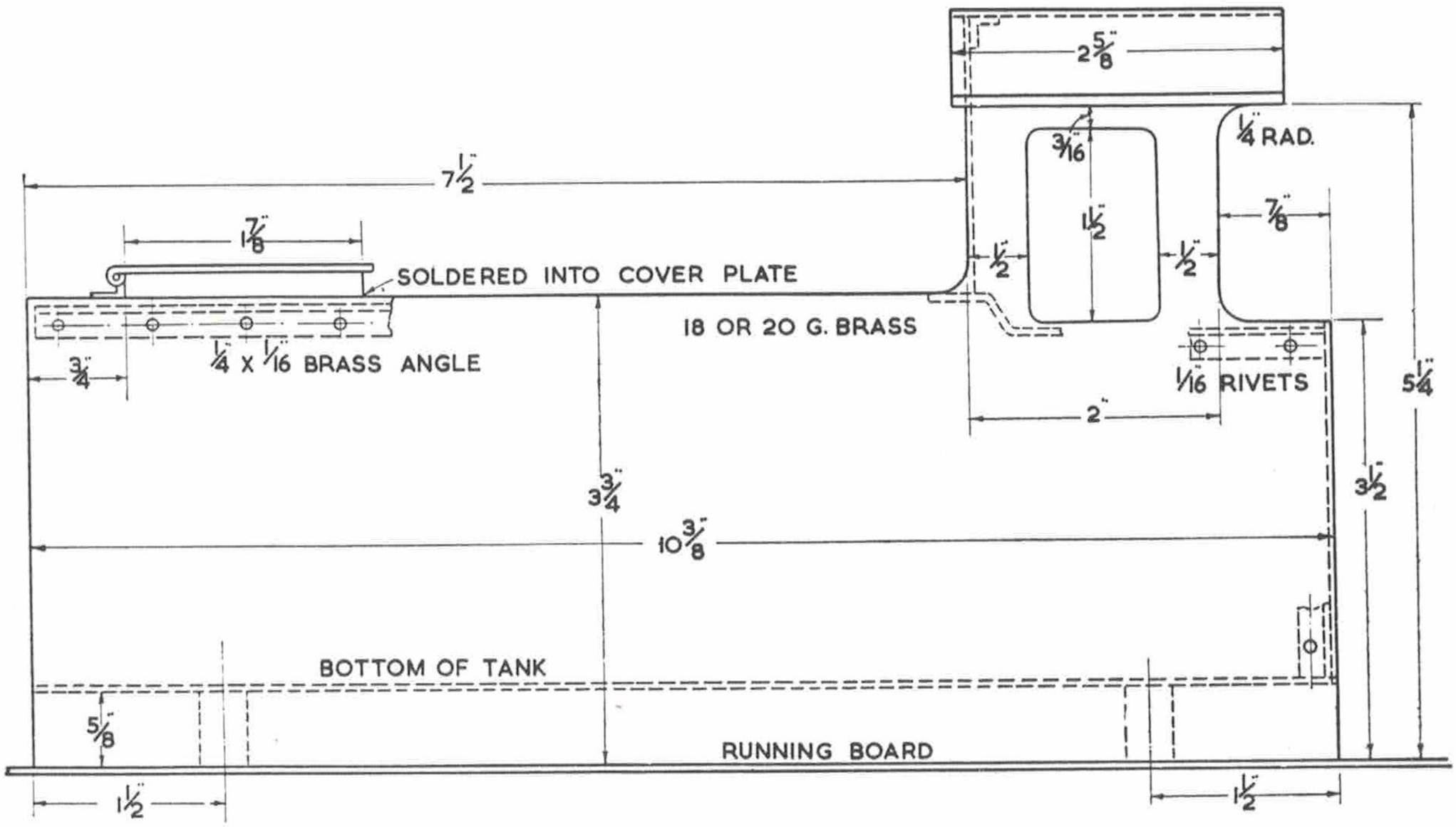
Sheetmetal work isn't a very congenial job after the interesting one of making the working parts, and the excitement of seeing them go; but as the tanks, cab, and bunker are among the first things that catches the observer's eye, they want to be about right. The side tanks, which are in one piece with the cab sides, can be made from 18 or 20-gauge brass. hard-rolled for preference, as this is quite flat to begin with, and it usually stays flat while being bent, riveted, and soldered, which is more than can be claimed for some of the usual soft kind, especially thin sheet.

The side and front of each tank are in one piece, so after marking out the tank, add the outline of the front end to it, cut it out as a single piece, and then bend the end section at right angles. You'll see what I mean if you look at the bottom left-hand corner of the plan view. The two tanks can be cut out together; clamp in the bench vice, and use a fine-toothed hacksaw for the straight parts, and a piercing-saw (like a fretsaw with a metal-cutting blade in it) for what the kiddies call the "johnny-horners". Bend one front section to the right, and the other to the left, which will give you right- and left-handed tanks.

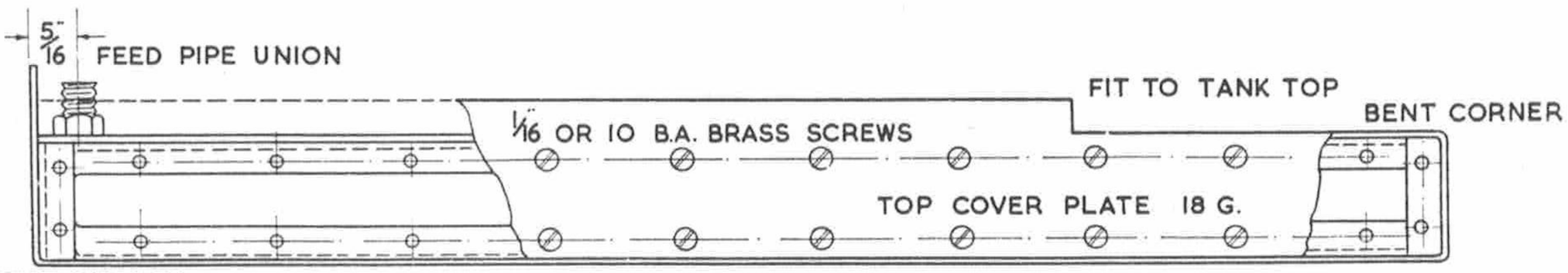
The inside sheet of each tank is also in one piece with the back end and the bottom. On your sheet of brass, mark out a rectangle 3 in. x 10⅜ in. At the bottom, add a strip 1 in. wide, and an extension at the end 1 in. wide and 2¾ in. high. On the top line, at 7¾ in. from the front end, draw a ¼ in. step (see section of right-hand tank) and continue right to the end of the extension. Cut carefully to outline, then bend the end extension at right angles, to form the other end of the tank (see top right-hand corner of plan view of left-hand tank) and finally bend the strip at the bottom to meet it. Don't forget, one right-hand and one left-hand. When the pieces are put together as shown in the drawings, there are your tanks.

Rivet pieces of ¼ in. x 1/16 in. angle along the bottom, ends and top as shown in the drawings, then fit the two parts together, finish riveting the angles, and finally solder over all the joints to make them water-tight. Note carefully—the bottom of the tank should be approximately ⅛ in. above the bottom of the outside sheet or tank side, to allow clearance for the driving and trailing wheels. The top of the inside sheet should be 1/16 in. below the level of the top of the outer sheet, as the top plate should be flush with the outer sheet when fitted, but rests on top of the inner one.

The top plates are cut as shown in the plan. They are the same width as the top of the front end as far as the cab, but between that point and the back end, they are only as wide as the tank itself, to afford more room in the cab. This can be seen in the footplate photograph in the October issue. The tops are attached by 1/16 in. or 10 B.A. brass screws put through clearing holes in the plates (No. 51 drill) into tapped holes in the angles. The left-hand top plate is one strip only, but the right-hand one is divided at 5½ in. from the front end, for



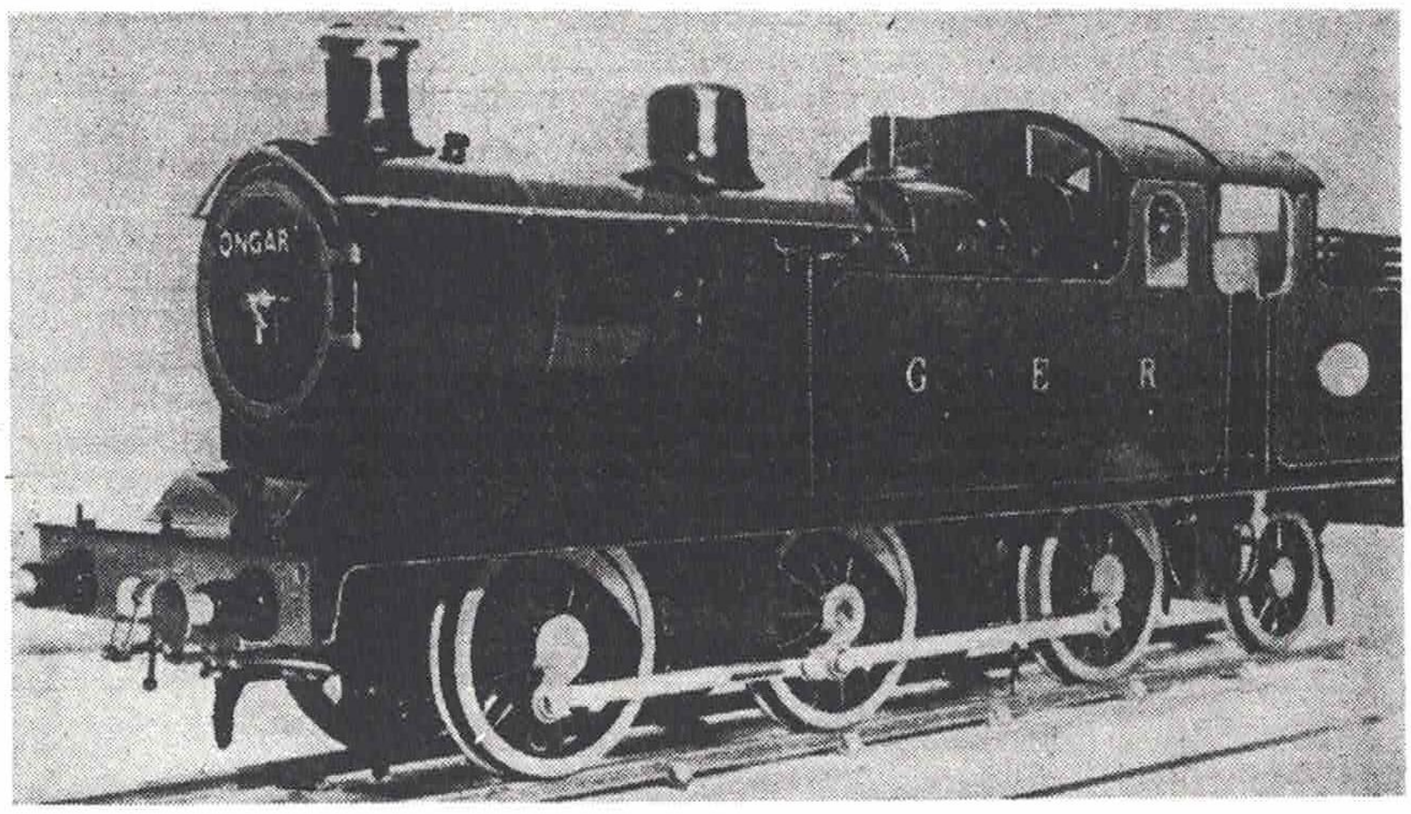
LEFT HAND SIDE TANK



PLAN OF L.H. TANK

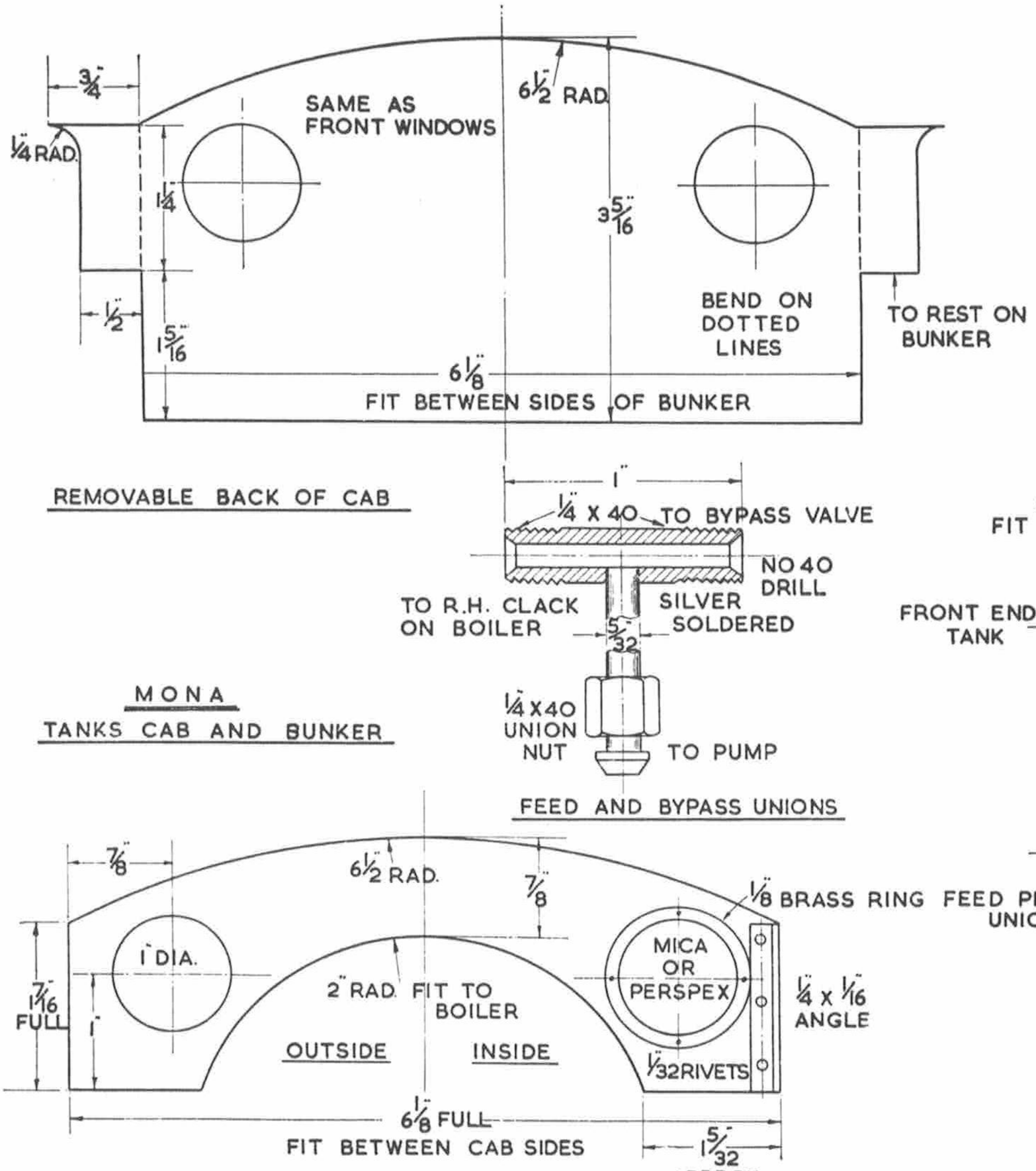
convenience in getting at the hand pump if needed. The front part only need be removed.

At $\frac{3}{4}$ in. from the front end of each plate, cut a rectangular hole $1\frac{7}{8}$ in. x $\frac{1}{2}$ in. with rounded corners. In this fit the filler, which is just a $\frac{1}{4}$ in. strip of brass bent to a rectangle to fit the hole, and soldered in. Put the joint at the front. Fit a hinged lid to this, made from 16-gauge brass, as shown in the drawing. When cutting out the lid, leave two tags at one end, 3/32 in. wide and 3/16 in. apart. Bend them into loops with a pair of round-nose pliers. Cut a strip $\frac{5}{8}$ in. long to fit between them, bend one end into a loop, and put a pin through the lot. Bend the other end of the strip at right angles as shown, and solder it to the tank top. Don't go and solder up the hinge at the same time !



Jumping the gun! This engine by John Sumpter of North London S.M.E. embodies *Mona* frames, motion, cylinders and the rest is based on Great Eastern N.7 tanks, all in the Curly tradition, so, needless to say, it runs as well as it looks

(Photo: G. M. Cashmore)



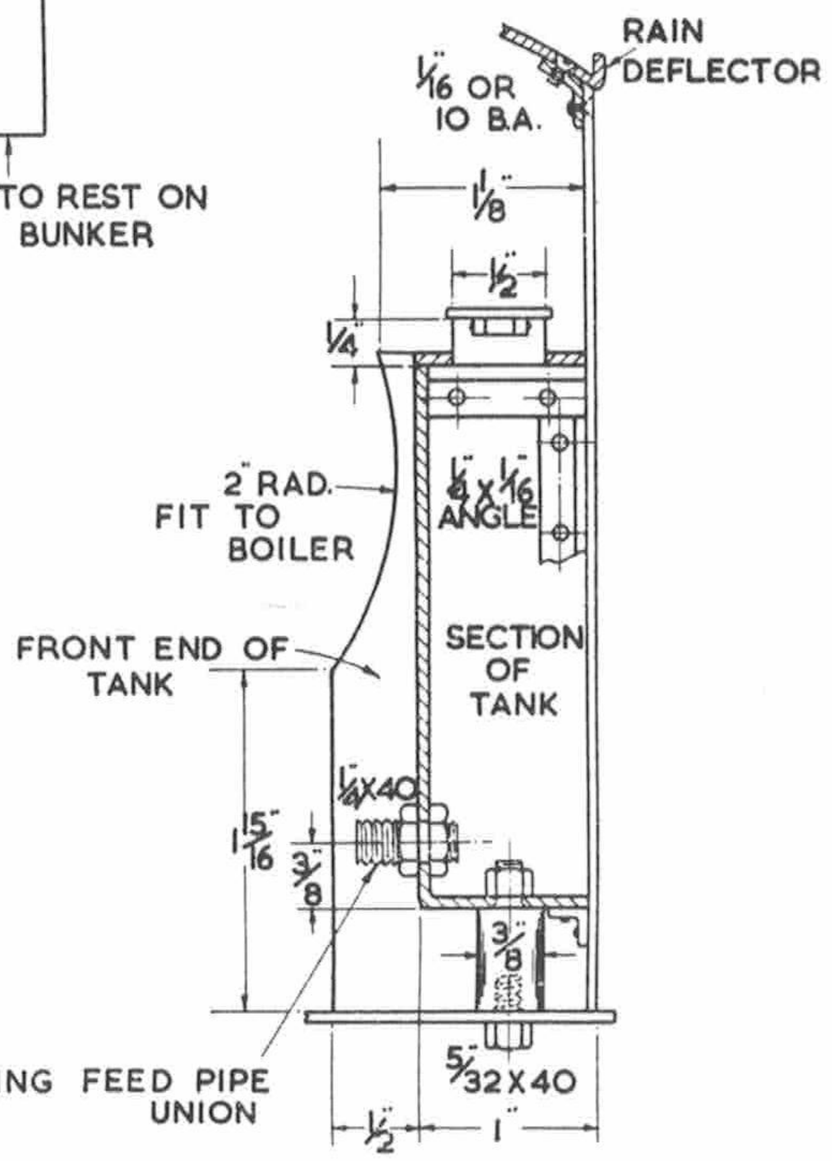
REMOVABLE BACK OF CAB

FEED AND BYPASS UNIONS

MONA

TANKS CAB AND BUNKER

CAB FRONT



PART SECTION OF L.H. SIDE TANK