made from 20-gauge steel. Both hinge and spring catch are attached to the backhead by $\frac{3}{32}$ in. or 7 B.A. screws; I usually make special bronze screws for this job, from $\frac{3}{32}$ in. drawn bronze rod as I find the heads of ordinary brass screws break off with the strain of constantly opening and shutting the door. The catch should be adjusted so that a very slight pull is needed to open the door.

Erection of Boiler

The erection of "Roedean's" boiler is quite a simple job. It is held down at the front end by four screws at each side, passing through the frame above the cylinders, and the bottom of the smokebox wrapper where it fits between the frames. Expansion has, of course, to be provided for at the firebox end; to save using the ordinary type of expansion bracket and clip, which would be fully exposed owing to the height of the frames, and consequently unsightly, we use a couple of swinging links, pivoted at their upper ends to the back corners of the projecting part of the firebox; and attached to the frames at their lower ends. These may be fitted first of all; they are made from $\frac{3}{32}$ in. or 13-gauge sheet copper, $\frac{5}{16}$ in. wide, and bent outwards so that when attached to the projecting part of the firebox by a $\frac{1}{8}$ in. or 5 B.A. screw, as shown in the illustration, the lower ends splay out and touch the frame, just behind the trailing hornblocks. Don't drill any holes in the lower ends yet; these are located from frame.

If you haven't already done so, put a smear of plumber's jointing around the stepped ring which joins the smokebox in place. On my own engines, I find that no further fixing is required, as I usually arrange for a tight fit, to make certain the joint is airtight; but should the fit be not quite as good as it might be—beginners and inexperienced workers sometimes slip up!—put a few $\frac{3}{32}$ in. or 7 B.A. countersunk screws, brass for preference, clean through smokebox or boiler barrel, or both if necessary, and the ring. Before doing so, make absolutely sure that the smokebox is vertical in relation to the firebox; you don't want to set the firebox end between the frames, and then find that the chimney looks tired, and is emulating the Leaning Tower of Pisa!

The boiler can now be placed in position; if your workmanship is above reproach, and the hornblock and cylinder castings "spot on" to size, the boiler will automatically locate itself for height, with the foundation ring resting on top of the trailing hornblocks, the bottom edges of the smokebox wrapper on the inside-cylinder casting, and the bottom of the boiler barrel approximately $\frac{3}{16}$ in. above the top edges of the frames ahead of the driving axle. Castings vary, and so does workmanship, so this may not be accomplished right away, and a little adjustment may be necessary.

If the cylinder casting is on the large side, the boiler may slope upwards slightly, and the bottom edge of the smokebox wrapper may need filing a bit to bring the boiler level. Alternatively, the back end may be raised slightly; the correct distance above frames is, as stated above, $\frac{3}{16}$ in., but this isn't comparable to the laws of the Medes and Persians and if the height is raised $\frac{1}{32}$ in. or so, the difference will [illegible] perceptible, and neither the working [illegible] appearance of the locomotive will be [illegible] in the slightest.

Having levelled your boiler, drill [illegible] the screwholes at the bottom of the [illegible] box, drilling the first about $\frac{3}{8}$ in. fr[illegible] front, and the other three at 1 in. in[illegible] all being $\frac{5}{32}$ in. below the top of the [illegible] Use No. 44 drill, countersink the ho[illegible] 6 B.A. and use steel screws with co[illegible] sunk heads, otherwise they will fo[illegible] running boards when same are fitted [illegible] At $1\frac{1}{8}$ in. behind the centre of the [illegible] axle, and $\frac{1}{8}$ in. above the running [illegible] of same, drill a No. 30 hole in each [illegible] and countersink it. This can be do[illegible] tween the spokes of the wheels. [illegible] the lower ends of the swinging lin[illegible] the holes in the frame, drill right [illegible] No. 30, and put a couple of $\frac{1}{8}$ in. o[illegible] steel screws through frames and lin[illegible] ting them on the inside. That se[illegible] boiler.

NOW we can tackle the pipe connections. First connect up inside the smokebox. The circular flange on top of the vertical steam pipe leading to the cylinders is coupled to its mate on the hot header of the superheater by four $\frac{3}{32}$ in. or 7 B.A. steel screws, cheesehead for preference, a gasket of $\frac{1}{64}$ in. "Hallite" or similar jointing material being placed between the faces. Don't forget to cut the hole in the middle for steam to get through! Put the blastpipe nozzle on, and try it for being central with chimney liner.

I usually get a piece of silver-steel, straight and true, which fits the nozzle; this is placed in the nozzle so that the end projects out of the chimney top like a sweep's rod minus the brush, and the blastpipe is then bent until the rod stands exactly in the middle of the chimney. The blower ring, already described, is then placed in position over the blastpipe nozzle, and the union at the other end screwed on to the fitting on the end of the hollow stay.

If you haven't pressed the front of the smokebox in, this job can now be done, and all interstices and openings in the bottom of the smokebox made airtight. Asbestos flock or string, soaked with plumber's jointing and pressed well down in the gaps, will do the trick. So will scraps of asbestos millboard, kneaded up to a sort of putty, with a little water. On two of my locomotives, I packed the space above the cylinders with asbestos flock, and pressed the smokebox down on top of it. This not only blocked up all the gaps, but kept the cylinders warm and comfortable when the engine was running. The hotter they are, within reason of course, the more efficient the engine will be.

Heat is the source of power—lose it, and you lose power. It's surprising what a jolly lot you can lose, too, if you are not mighty careful, and it all makes it harder on the boiler, which has to stand the racket of all deficiency. Anyway, whatever else you do, make quite sure that the smokebox is absolutely airtight, for if it isn't, the engine won't steam for toffee-apples.

A diagram is appended showing the run of the pipes. As with a radio set, or other piece of electrical apparatus in which the exact course of the wires doesn't matter, as long as they start and finish in the right places, so it is with our pipes. But there is this difference; the pipes should have neat bends, and run as near a direct course between terminal points as is consistent with the layout of the engine.

The bottom of the ashpan must not be obstructed, or it will not be possible to dump the grate; therefore the water pipes must be led along at the sides of the frames, between pump and drag-beam connections. For the benefit of beginners, here is how I do my "plumbing." To save wasting very precious copper pipe, I get the exact length of each pipe by using a bit of lead fuse wire, or soft copper wire, as a template, running it between the unions or fittings on the exact route to be taken by the finished pipe. I then straighten out my wire, cut the pipe to exactly the same length, and fit the cones and union nuts. I do not use the conventional type of "lining," as it is known among plumbers and gas fitters.

The usual union comprises the screwed part on which the nut fits, one end drilled for the pipe, and the other end countersunk for the cone; a "lining" which is also drilled for the pipe, and the other end turned taper to fit the countersink (the trade term is male and female cones) and the nut connecting the two. The screwed part of our little unions is integral with the fitting; e.g., the union screws on the tee-piece which is connected to the pump by a short pipe, described along with that component. No separate lining is necessary, as the cone which fits the countersink is silversoldered direct on to the pipe, enabling a much smaller nut to be used, which is not so unsightly on the small engine, as the "regulation" size would be.

To save turning up back numbers, the cones are made by chucking a piece of round rod (copper for preference, as it beds down easier in the countersinks) in three-jaw. Turn down until the nut just slides on, then centre and drill down about ½ in. or so, with a drill the same size as the bore of the pipe. Turn the end to a blunt cone, either by slewing the top slide around to 30°, or using a tool ground off to correct angle and fed straight in. Part off about 1/16 in. behind the cone, reverse in chuck, and open out about 1/16 in. to a tight fit on the pipe. Repeat operation until you reach the end of the hole.

To make the nuts, chuck a piece of suitable-size hexagon brass rod; 5/16 in. is right for 5/32 in. and ⅛ in. pipes. Face, centre, and drill down about 1 in. with a drill the clearing size of the pipe. For ¼ in. by 40 nuts, open out to 3/16 in. depth with 7/32 in. drill, tap ¼ in. 40, and part off a full ¼ in. from the end. Chamfer both ends of the hexagon. Nuts can be made at the rate of one per minute, without any special tools, on any ordinary lathe, merely by having the drills and tap handy, and acquiring a little dexterity.

When the pipes are cut to length, put the two nuts on, back to back; fit a cone on each end, and silversolder with best grade silversolder, taking care not to get any on the taper part of the cone, or the union will leak badly. Heat the whole length of the pipe, when doing the silversoldering, quench out in the acid pickle, and let the water run through the pipe to flush it out well when washing off. Rub it up with a handful of steel wool, which will make it shine in a few seconds; then bend to required shape by finger-pressure only. This will avoid kinking entirely.

Nice bends and clean pipes are a sign of careful and efficient workmanship. When coupling up, don't tighten the nuts sufficiently to strip the threads; as previously mentioned, soft copper cones make best joints, and very little pressure is required to make them steamtight. The pipes for the whistle and injector are, of course, left until those fittings are made, and ready for erection.

Grate and Ashpan

The grate and ashpan on "Roedean" are arranged a little differently from that described for the G.W.R. "1,000" class engine, inasmuch as the grate is composed of straight bars, and permanently attached to the ashpan. It can be replaced, after dumping the residue of the fire after a run, without lifting the engine off the rails. An "ashpit" should be formed at any convenient point in the railway, by removing the cross sleepers and substituting a couple of longitudinal sleepers extending about the length of the engine, giving a clear open space between between the two running rails.

It is quite possible that our advertisers supplying materials for "Roedean" will be able to offer the grate as a casting; this will not only save work, but be a better job, as cast iron is much more resistant to burning than cut steel firebars. If, however, for any reason a casting is not obtainable, make up the grate from ⅛ in. by 5/16 in. black mild steel strip, seven 6-in. lengths being required. Drill one of them with No. 20 drill at 1 in. from each end, and use it as a jig to drill the rest.

The bearers are made from two 1⅞ in. lengths of 5/32 in. round steel, rustless for preference, as this does not deteriorate from the effects of condensation in the firebox when the engine is cold. The spacer washers are made from 5/16 in. round mild steel. Chuck in three-jaw, centre, drill down about 1 in. with No. 20 drill, and part off ⅛ in. slices until you reach the end of the hole. Ditto repeato until you have eight spacers.

The legs are made from bits of the same steel as the bars, dimensions being given in the illustration of the grate. Put a few threads of 5/32 in. by 40 pitch on the end of each bearer. Nuts of this pitch are not made commercially, but ordinary 4 B.A. nuts can be used, if the 5/32 in. by 40 tap is run through them. Put a nut on one end of the bearer, then a firebar, then a leg, then another bar, and spacers and bars alternately, putting another leg between the last two bars, and securing the lot with a nut. Serve the other end in the same way. Slightly burr the ends of the bearers over the locknuts so that they cannot come loose. File if necessary to fit the firebox.

If a cast grate is used, fit the legs between the outermost bars, drilling a No. 40 hole through bars and leg, tapping ⅛ in. or 5 B.A., and inserting either a screw, or a stub of ⅛ in. steel rod or wire, screwed to fit, and cut off flush with the outer bar. Bend the legs outward, in either type of grate, to meet the ashpan sides.

The ashpan is made from 16 or 18-gauge sheet steel, the sides, bottom, and front end needing a piece measuring roughly 7½ in. by 7 in. Mark out as shown in the illustration of "ashpan in the flat," and bend on the dotted lines to a box shape. The front corners should be brazed up. Only an inch of the back end is left open, at the bottom. Above this, a piece of sheet steel is fitted between the sides of the ashpan, bent to the contours of the upper part, looking something like the stern of a ship; this is also brazed in position.

Anybody who owns, or has the use of an oxy-acetylene blowpipe, can do these small sheet-metal brazing jobs, using Sifbronze rod, and a 100-litre tip in the blowpipe, easier and quicker than soft-soldering. I have been using an "Alda" blowpipe for the past 18 years; and can say without hesitation, that it is one of the greatest time-savers I ever had the pleasure of using. The metal doesn't even need cleaning; I recently Sifbronzed a patch on a rusty coal-pail, and stuck a couple of patches on a rusty car silencer for a friend, the metal amalgamating perfectly; it forms a surface weld. *Note* — the upper part of the completed ashpan must fit easily into the bottom of the firebox.

The grate is now permanently erected in the ashpan by riveting or screwing the legs to the sides of the pan; see back view of the complete assembly, also the dotted lines in the side view. The grate is erected parallel with the sloping top of the ashpan, and the height is such that there is approximately ⅛ in. between the top of the ashpan and the bottom of the firebars. This can also be seen in the side view. The whole issue is supported in place by a bracket at the back, and a pin near the front end.

The bracket is made from a piece of 16- or 18-gauge sheet steel, 1 in. long and ¾ in. wide; this is bent up in the bench vice to an irregular angle, as shown in the side view of the complete assembly, and attached to the projecting bottom piece of the firebox door-plate by two screws (4 or 5 B.A.) as shown in both side and end views.

Now be careful over this bit. At 3¾ ins. ahead of the centre of the trailing axle, and 5/16 in. above the bottom line of the frame, drill a 3/16 in. clearing hole through the frame at each side (No. 11 drill). Both holes should be in line, so beginners had better drill No. 30 first, and test with a straight bit of rod put through both. If the rod isn't square and level across the frames, correct with a rat-tail file before opening to right size. Now insert the grate and ashpan assembly into the firebox, "stern first," letting the rear end drop down on to the angle bracket, whilst the front end projects up just inside the firebox; then set the bottom of the ashpan quite horizontal and level. If the engine is standing on the bench, or on a bit of rail, a piece of packing at each end, of same thickness, will do the needful.

Next—more care needed!—holding the drill brace level, and square with the frame, put the drill through the No. 11 hole in frame, and drill right through the side of the ashpan, at each side. Remove the ashpan; open out the holes to 5/16 in. diameter, and fit a piece of 5/16 in. tube, or better still, a piece of 5/16 in. round steel with a No. 11 hole drilled right through it. This should be brazed in; and the ends, if tube, belled out a little, or if drilled steel, countersunk, to give the fixing pin an easy start. Replace the ashpan, and secure it with a pin made from a piece of 3/16 in. round steel rod, approximately 3½ ins. long, slightly rounded off at one end, and furnished with a turned steel knob or button at the other.

If the engine is run over the ashpit, and this pin pulled out, the whole grate and ashpan will fall out, and discharge the residue of the fire; the grate and ashpan is replaced, without moving the engine, simply by inserting it in the firebox as mentioned above, rear end first, letting the "stern" rest on the bracket, then lining up the cross tube with the holes in frame, and pushing in the pin. The curved plate at the rear end of the ashpan, above the opening, protects the trailing axleboxes from grit.

THE injector is of the well-known "Vic" type, with my own pet sizes and arrangement of cones or nozzles, and is similar to others which have been described in these notes, for other engines. For the information of beginners, I might say here that the injector is, in effect, a small copy of the Holden and Brooke automatic lifting and re-starting injector at one time widely used on full-sized locomotives before the modern exhaust steam injector came into general use. The only fundamental difference is that a ball valve is used for the air release, instead of a flap valve as in full-size.

As so many silly tales have been put about by various people that injectors are unreliable, difficult to make, and so on, and should only be purchased from "specialists" (who do not hesitate to charge "special" prices!) I will state right here, that anybody capable of drilling holes to given sizes, and doing a little plain turning, can make a satisfactory and efficient injector. If made exactly to the given dimensions, it will work, and as long as it is kept clean, will continue to work every time steam and water are turned on. Unlike many "specialist" and commercially-made injectors, this one uses very little steam, and as long as the fire is all right, it will make no difference to the steam pressure whether used running or standing.

One more point; if the injector doesn't work, then either it is *not* made to specification, or there is something amiss with the steam and water supply, or the delivery. I will give a few likely causes of intermittent or faulty working when we come to the running hints and tips later on.

Cone Reamers

Before starting on the injector itself, it will be necessary to make a set of reamers for the little cones; this job is reduced to the rockbottom of simplicity, for if the tapers of the reamers are turned to the lengths given, the angles are automatically obtained without the trouble of measuring them. Chuck a bit of 5/32 in. round silver-steel in the three-jaw, and turn a cone point on it ¾ in. long. This can be done by slewing the top slide around a little, and using a roundnose tool of very small radius and plenty of top rake. Run the lathe at high speed, and use plenty of cutting oil. Part off to leave a shank about 1½ ins. long. Repeat operation, this time turning the cone point 1⅛ ins. long.

Finally make a stubby one only 3/16 in. long, but instead of being a regular cone, radius it out a little; the exact radius doesn't matter, as long as it approximates to that shown in the drawing. File away half the diameter, harden, temper, and oilstone up, exactly as described previously for the cylinder-cock reamer. Chuck a bit of ¼ in. or 5/16 in. rod rod in three-jaw, face the end, and part off 1 in. Rechuck, centre, and drill right through with No. 21 drill. Fit a setscrew as shown in the illustration, and you have an effective reamer stop.

Injector Body

The injector body can be cut from solid, machined from a casting, or built up; I build up all mine in the following manner, the only variation being for different pipe connections. Chuck a piece of 5/16 in. square brass rod truly in the four-jaw; face the end, centre, and drill down about 1 in. depth with No. 24 drill. Turn down 3/16 in. of the end to ¼ in diameter, and screw ¼ in. by 40; then face off a little until the screwed part is exactly ⅛ in. long. Small dies frequently produce torn or imperfect threads for the first turn or so, and this method ensures a full thread the required length, as the defective part is faced off. Part off at ⅞ in. from the end. Reverse in chuck; if you slack Nos. 1 and 2 jaws, reverse the piece, and retighten same jaws to same amount of grip, the reversed piece should run truly. Repeat screwing and facing-off job; the finished piece should be 9/16 in. long over the shoulders. Put a 5/32 in. parallel reamer right through.

In the centre of one of the faces, drill a ⅛ in. hole. At 3/16 in. from this, toward one end, drill a 7/64 in. hole. Right opposite to it, at ⅛ in. from the end, drill a No. 30 hole and tap it 5/32 in. by 40. With this hole down, and to your left, and the other two holes on top, drill a No. 24 hole in the side that is facing you, 1/8 in. from the right-hand end. Ream this 5/32 in., a tight fit for a bit of 5/32 in. tube, and fit a piece in it approximately 2 1/8 ins. long.

Chuck a piece of 1/2 in. round rod in three-jaw, and turn down 3/8 in. of it to 15/32 in. diameter. Part off at 5/16 in. from the end. Scribe a line right across the centre indicated by the tool marks: and on this line, 1/16 in. off centre, mark a centre pop. Chuck in four-jaw with this pop mark running truly. Open it out with a centre-drill, drill right through with No. 34, open out and bottom with 7/32 in. drill and D-bit to 1/4 in. depth, and tap 1/4 in. by 40. Ream the remains of the small hole 1/8 in. At 3/16 in. from the centre of this hole, on the same scribed line, make another centre-pop; from that, using 7/64 in. or No. 35 drill, drill a hole slantwise into the ball chamber, breaking through as close to the seating as possible without spoiling it, see section of complete injector.

Tie this fitting in position on the injector body with a piece of thin iron binding wire, so that the two holes in the bottom of it coincide with the corresponding two in the square part of the injector body; then silver-solder it, and the water pipe, at the same heat. For neatness sake, I mill the sides of the ball chamber flush with the square part of the body; it can be filed flush, if a milling machine is not available, or left as it is. The operation of the injector will not be affected in any way.

Run the 5/32 in. parallel reamer through the body again, to clean out any burring; then seat a 5/32 in. rustless steel ball on the seating in the ball chamber, and make a little cap to suit, giving the ball a full 1/32 in. lift, in the manner previously described for clack boxes.

IT is absolutely essential that the throats of the cones should be the exact size of the drill; the outside of the steam cone turned to shape and size shown, and the spacing correct. I recently examined a small injector which would not inject; the maker said it "was exactly to my specification." The delivery cone was drilled *nine sizes larger* than the given size—and that was only *one* of the faults! It is just as easy to do the job properly, as to make a mess of it.

Make the combining cone first. This must be a press fit in the injector body; and the simplest way I know, of ensuring a perfect fit, is to broach out the steam end of the injector body very slightly (the end where the water pipe is) with a taper broach. Only just take out a scrape. Now chuck a piece of 3/16 in. brass rod in three-jaw; face the end, and turn down 3/8 in. length until it will just fit very tightly into the broached end of the body. It must not enter more than 1/64 in. Then centre the end. An ordinary centre-drill is no good for this, as the smallest commercial size makes too large a depression.

Chuck a small piece of 1/8 in. round silver-steel and turn a cone point on it about 3/16 in. long; harden and temper this, same as the cone reamers. Then rub the point on your oilstone until you have a small flat both sides; back these off slightly to form an arrow-head, and you have a centring drill for starting twist drills right down to No. 80. Centre the rod with this, just making a depression large enough to start a No. 72 drill; and with this size, drill a hole a little over 1/4 in. deep. The secret of drilling tiny holes without breaking the drill, is to keep withdrawing it every 1/32 in. or so, to let the chippings fall out of the flutes; it is clogging of the flutes that causes a small drill to seize and break. I use a lever tailstock, operating it like a pump handle.

If you haven't a lever tailstock, hold the drill in a watchmaker's pin chuck; put a tapwrench or a small carrier on the chuck spindle as close to the cap as possible; put the chuck spindle in your tailstock chuck, and close the jaws on it just tightly enough to allow it to slide in and out without shake. You can then drill the hole by gripping the tapwrench or carrier, and running the drill in and out of the hole, by sliding the pin chuck back and forth in the jaws of the tailstock chuck. High speed and very little pressure are the secrets of success.

After drilling the hole, cut back the nose of the cone slightly, as shown in the illustrations, and part off at 1/4 in. from the end. Reverse the cone in the chuck; then put the reamer stop on the reamer with the 3/4 in. taper, letting the business end project 1/4 in. plus 1/32 in. beyond the stop. Put this in your tailstock chuck, and ream out the hole until the stop touches the end of the cone, and the point of the reamer sticks out 1/32 in. beyond the nozzle. Try the drills in, to check for correct size; No. 72 should pass through, but No. 70 should not. Radius the end with the short reamer.

To finish the cone as a Holden and Brooke divided cone, chuck it with a shade over half its length projecting, and saw it across with a jeweller's hacksaw pressed against the chuck jaws whilst cutting. Then pull the bit a little farther out of the chuck jaws, face off the sawmarks, cut back a shade to the outline shown in the illustrations, and very slightly radius the entrance hole with the stubby-pointed reamer. Rechuck the other half with the sawn end outwards, and repeat operation, except that the hole must not be radiused.

If the slotted, type of cone, used in the American "Sellers" injectors, is desired, form the groove *before* parting off, with the parting tool. The groove is 3/32 in. wide and 1/32 in. deep. Then part off, reverse, and ream as above; and finally, with a watchmaker's flat file, file two 1/32 in. slots across the bottom of the groove, cutting into the taper hole. Run the reamer in by hand, after filing the slots, to remove any burrs.

To press the divided cone in, use the bench vice. Drill a 17/64 in. hole in a block of brass not less than 5/32 in. thick, put it over the delivery end, screw on the injector body, and hold it against the stationary vice jaw. Start the smaller end of the cone in the broached end of the injector; put a piece of 1/8 in. brass rod, squared off truly at both ends, against the cone, to act as a pusher; then screw the moving jaw of the vice up to this, and keep turning until the half of the cone is 1/64 in. past the bottom of the hole under the air ball seating. Ball and cap must, of course, be removed whilst this operation is in progress.

Put a 1/8 in. strip of 22-gauge brass down the hole, behind the piece of cone; then press the second half in, the same way, until it touches the strip. When this is withdrawn, the two halves of the cone will be 1/32 in. apart, which is correct. Try the reamer in the cone, and give it a twirl or two with your fingers to remove any burr; then try a No. 70 drill in. This should not go through with a straight push, but if the drill is put in the pin chuck, and twirled, it should remove the tiny scrape of metal at the nozzle, and break through, the hole being then dead to size.

The safest way for a beginner or inexperienced worker, to open out the cone with the No. 70 drill, would be to chuck the injector body by screwing the delivery end into a tapped bush held in the three-jaw; put the No. 70 drill in the pin chuck, hold same in tailstock chuck, and feed it through the cone by turning the tailstock wheel or handle in the usual way. The hole must be concentric.

The slotted cone is pressed in, using block and pusher rod, in the bench vice, in exactly the same way, and is in correct position when the groove lies across the centre of the hole below the ball seat. Open the nozzle end with No. 70 drill as described above.

Steam Cone

The steam cone is a simple job. Chuck a piece of 7/32 in. brass rod in three-jaw, face the end, centre, and drill with 65 or 66 drill to about 1/4 in. depth. Carefully turn the end to a fairly tight push fit in the steam end of the injector, for a length of 5/16 in.; then turn about 3/16 in. of this, to a curved nozzle shape as shown. Beginners note particularly, this shape is important; a blunt cone is useless. The diameter of the nozzle at 1/32 in. from the end, should be .055 in., a little less than 1/16 in. If you haven't a micrometer, drill a hole in a bit of sheet metal with a No. 54 drill, and use that for a gauge. Ream the end of the hole slightly, with the reamer having the 3/4 in. taper, until the hole is almost knife-edged. Part off 3/32 in. behind the shoulder.

Reverse in chuck; centre, and drill No. 34 to a depth of 7/32 in.; then, with the same reamer, open the end of the 65 hole slightly. Try a 64 drill in with your fingers; if it won't go through, ream again, ever so slightly, not more than a thousandth at a time, until you can just push it through. Finally, put the No. 63 drill in the tailstock chuck, and put that through. You then know that the hole is the exact size of a 63 drill at its narrowest part, which is correct. The steam cone, when pushed into the end of the injector, up to the shoulder, should enter the combining cone exactly 1/32 in.

Delivery Cone

This is the most important one of all, for throat size. Chuck the 7/32 in. rod again, and turn down 1/4 in. length to a tight push fit in the delivery end of the injector. Turn 1/8 in. of the rod, to the shape shown in the illustration; the flat part should be 3/32 in. across. Centre with the special gadget, and drill down about 1/4 in. with No. 76 or 77 drill, by the methods described; keep withdrawing every 1/32 in. or so, or the drill will break. Next, with the stubby radiusing reamer, open the end of the hole until it is a full 1/16 in. across, funnel-shaped. Part off 3/32 in. from shoulder, as before. Reverse in chuck, centre, and drill down with No. 70 drill until you meet the other hole. Now open out with the 1 1/4 ins. tapered reamer, until the point just shows at the bottom of the funnel-shaped entrance.

If you try a No. 75 drill in with your fingers, you should just be able to see the point of it at the bottom of the "funnel," but it shouldn't come through; if it does, but a No. 74 doesn't, don't worry, you haven't "overshot the platform." Rechuck again, flange outwards, and radius out the hole in the flange with the stubby reamer; if the No. 75 drill didn't go through, put it through now. Push the cone into the injector body, and look through the overflow hole; the cone should be just 1/32 in. away from the combining cone. That completes the important parts of the little gadget, and *it will work.*

DELIVERY clack, or check valve is made with a right-angled union, to afford a straight connection to the delivery pipe leading to the left-hand boiler clack. Chuck a piece of 5/16 in. round rod in three-jaw; face, centre and drill down with No. 34 drill to a depth of 9/16 in. Open out with 7/32 in. drill and D-bit to 5/16 in. depth, tap 1/4 in. by 40, and ream the remains of the hole with 1/8 in. parallel reamer. Part off at 5/8 in. from the end. At 3/16 in. from the top, fit a 1/4 in. by 40 union screw, same as described for boiler fittings. At 5/32 in. from the bottom, at right angles to the union screw, drill a 3/16 in. hole into the central passage. Chuck the 5/16 in. rod again; centre, drill down about 7/16 in. depth with 1/8 in. drill, open out and bottom with 7/32 in. drill and D-bit to 7/32 in. depth, and tap 1/4 in. by 40.

Part off a full 5/16 in. from the end; reverse in chuck, and turn down 1/16 in. of the end to a tight fit in the 3/16 in. hole in the valve body. Press it in, and silversolder both that and the union screw at the same heat. Pickle, wash, and clean up, then fit a 5/32 in. ball and cap, same as on the injector. Screw this fitting over the delivery cone, as shown; if it doesn't stand exactly vertical, when screwed right home, take a tiny skim off the flange of the delivery cone, until it does.

How to Erect the Injector

Erection is the work of a few minutes only; simply bend the water pipe to the shape shown in the plan, and poke it through the hole in the supporting bracket. The steam end of the injector is connected to the valve on the boiler backhead by a 5/32 in. pipe, with unions; the top end carries the usual cone, but at the bottom, a plain collar 1/16 in. wide, is fitted in place of the cone. This butts up against the flange of the steam cone, and keeps it in place, the union nut holding them together.

The union on the delivery clack is connected to the left-hand boiler clack by a 5/32 in. pipe with union nuts and cones, running as close to the frame as possible. A piece of 5/32 in. pipe, with a bend near the end, is screwed into the overflow opening; the outer end of this comes under the left-hand footstep, when same is fitted, and will be held in place by a simple sheet-metal clip. The complete injector weighs under one ounce, and is easily supported by the pipes.

Running Boards

Running boards can be made from 16 or 18-gauge sheet steel, or brass if preferred, each being made in three pieces—a curved and tapered front piece, a long straight run above the cylinders and wheels, and another curve at the trailing end under the cab. The straight run is 20 3/4 ins. long and 1 3/4 ins. wide and has recesses cut in it as shown in the plan view to clear the tops of the wheels.

Clearances are also needed for the upper ends of the expansion links, and the lifting links of the outside valve gear. The exact position and dimensions of these can best be obtained from the actual job. The best way for a beginner or inexperienced worker to get an exact fit in this bit of platework, or, in fact, any of the sheetmetal jobs on the engine, is first to cut out a template in thin cardboard or very stiff paper. It doesn't matter then if you have half-a-dozen shots before getting a proper fit, as the value of the material is practically nil, and the only thing wasted is the time. A proper sheetmetal part can then be made from the cardboard one and it will fit.

A card or paper template will be especially valuable in making the front curved section of the running board as it tapers from

1½ ins. wide over the buffer beam to 1¾ ins. wide at the upper end where it is attached to the "high-level" board. The three sections of the running board are joined either by pieces of brass angle, riveted or screwed just as you prefer (see detail sketch) or they may, if of steel, be brazed or Sifbronzed. I use the latter method.

With a small tip in my oxy-acetylene blowpipe (150 litre) I find the job easier than soft-soldering. The pieces are simply held in place with a home-made cramp like a toolmaker's cramp—those I use for jobs like these are merely bits of ⅜ in. by ¼ in. mild steel with a couple of 3/16 in. stove screws, made in a few minutes—and set in the coke "sharp end down." A couple of blobs of Sifbronze are melted off the rod into the vee which has previously had a dose of wet flux, and a few seconds' application of the blowpipe flame, makes the Sifbronze run and form a perfect little fillet, the joint being actually stronger than the parent material. The actual operation takes far less time than the description of how to do it!

Valances

The valances, or edging under the running-board, can either be made wholly from ¼ in. by 1/16 in brass angle or a combination of angle and sheetmetal. If the angle is softened by heating to red and plunging into water it can be bent without distortion by putting a piece of square rod in the angle and carefully bending the whole lot around a piece of bar of the correct radius.

Tell it not in Gath, but I have bent many pieces of angle over my milling machine's top arm, which is a mighty hefty steel bar of convenient radius. I might add that the bar has not suffered in the slightest, otherwise I shouldn't have used it for such a purpose. I merely used a piece of square rod long enough to provide leverage enough to force the angle to the correct curve by the strength of my arms, alas, not what it used to be, but still sufficient for the job!

The valance on the long straight part of the running-board must be made in two sections, as the outer plate of the valve-gear frame comes flush with it. On the frame we made provision for attaching the two sections of valance by leaving a projecting tongue at each end of the frame. Front portion of the valance is 5¼ in. long; cut a piece of ¼ in. by 1/16 in. angle to this length then cut away the top part of it for about 5/16 in. length, so that it can overlap the tongue at the end of the gear frame. Rear part is 11¼ ins. long, cut to fit in a similar manner. The two pieces of valance can then be riveted to the underside of the running-board using 1/16 in. rivets, preferably brass or charcoal-iron. Valances should be 1/16 in. from the edge.

If the curved ends of the valances have been made from angle they can be riveted under the curved parts of the running-boards in similar manner. If you find you cannot make a good job of bending angle, cut the curves from flat sheet and solder them edgewise under the running boards in correct position. If the underside of a steel running-board is cleaned bright it will take the solder quite readily. Use a liquid flux and well wash off all traces of it after soldering. Where the curve butts up against the straight part of the valance at the top, put a piece of 16-gauge brass about ½ in. long and 3/16 in. wide behind the joint and solder over the lot, scraping all superflous solder off the outside for neatness' sake. The joint won't part company after that treatment. Put the running-board temporarily in place and drill and tap the holes for the two screws holding the valance to the tongues on the gear frame.

Splashers

Making the splashers for the driving wheels is a simple job; merely set your dividers to 2⅞ ins. radius, strike an arc on the sheetmetal (same kind as used for running-boards) and draw a straight line across it 4¼ ins. long as shown. Cut to shape; then cut a strip ¾ in. wide, bend to same radius, and solder it to the curved edge of the splasher plate. The ends are cut off square with same. Completed splasher can be attached to the running-board over the opening, either by soldering in position or by a small piece of metal ⅜ in. wide bent as shown in the detail sketch and either riveted or screwed to the underside of the running-board and the inside of the splasher. Here again, I always Sifbronze together the parts of steel splashers and running-boards.

The splashers over the trailing wheels are made in a manner somewhat similar, the only difference being that they are cut short to butt up against the front of the cab as shown in the assembly illustration. The length, from front of splasher to cab, is approximately 2½ ins. Don't fix these permanently in position until the cab has been made and fitted.

Steps

Steps are made from 16-gauge steel. Drawings show the back frame separate, with the steps made separately and riveted or bronzed to it. If preferred, the bottom step can be made by adding 5/16 in. to the depth of the step frame and bending it over at right angles. Don't forget you need one right-hand and one left-hand! Also note that there is a difference in shape between the steps at the front and rear ends. All sizes are given in the illustrations (next week). Note when cutting out and shaping the step frames that the upper half of the front step assembly follows the cut-away part of the buffer beam; in full-sized engines this is to clear the limited load gauge of the Tonbridge-Hastings section, where tunnel, bridge and platform clearances are the smallest on any section of the erstwhile Southern Railway. The back of the trailing step assembly is bent in so that the threads do not project beyond the valance.

On the full-sized engines the steps are supported by rod stays at the back. These would be fragile on the little engine, so I have adopted a simple stiffening rib of sheetmetal in place of them. This is just a piece of 16-gauge steel, cut out to shape shown, bent on the dotted lines, and bronzed at the corner. Lower part is riveted to the back of the step assembly as shown, close to the edge that comes against buffer or drag beam. The top can either be riveted to the underside of the running-board, or a screw can be put through the stiffening web and the buffer or drag beam as the case may be.

If the back of the step assembly were straight instead of curved, the whole issue could be made in one piece.

I FORGOT to mention that the angle used for the treads need not be the usual commercial stuff, but bits of 16-gauge steel bent up in the bench vice. As a refinement, if anybody cares to take the trouble, the ends can be bent up slightly to prevent the driver's foot skidding off sideways if he drops any oil on the step and treads in it.

Cab Construction

The "tumble-home" cab, being a prominent feature of the "Schools" engines, is shown in the drawings, though straight sides may of course be fitted if preferred, making a slightly easier job.

Cab front is shown, along with the illustration of the backhead with all the fittings, and the dimensions are included. The only thing not shown is the clearance for the trailing wheel at each side. This is cut out to a height of ¾ in. and a width of ⅝ in. The dodge previously mentioned, viz., cutting out a cardboard template, is especially useful here as by its means you can ensure a perfect fit to the boiler.

Same applies to the cab sides. Owing to the inward cant, which starts 2⅛ ins. above the running-board and the rounded top corner 1$^{13}/_{16}$ ins. above that, a correct and definite vertical measurement cannot be given. To make the joint between roof and sides as inconspicuous as possible it can be located at the rain strip or angle and the small detail sketch shows just how to do it.

First of all cut out a cardboard template ("Welldon patterns," I call them. When a child, I earned odd coppers by acting as a living "dummy" for a dressmaker — can you imagine a modern boy doing that?—and the use she made of paper patterns "put ideas into my head," as the saying goes) to the dimensions given for the cab side, leaving it full length at the top. Fit this to the outlines of the cab front. Then, at a distance of 4$^{5}/_{16}$ ins. above the running-board, cut the top level (See detail sketch). Cut out your sheetmetal cabside to the same dimensions; then, along the top, on the inside, rivet a strip of 13-gauge brass ½ in. wide, letting ¼ in. of it project beyond the cabside. When the roof is fitted the edge of it will butt up against the top edge of the cabside and can be screwed down to the projecting portion of the butt strip by $^{1}/_{16}$ in. or 10 B.A. countersunk screws. If the rain strip, which should be angle but may be flat if you cannot purchase or make the section, is attached to the cab roof by soldering it flush with the edge. The joint will be practically invisible.

Windows

Cab windows are "glazed" with mica or cellophane. After cutting the holes in the cab sides, cut two more in a piece of thin sheet brass, and then cut around the hole about ⅛ in. away, the result being a nobby brass window frame. Cut out a piece of thin mica or cellophane to the size of the frame, put it on the inside of the cab with the frame over it and rivet the lot together with bits of domestic pins. I usually indulge in a grin every time I write that. for many years ago a reader telephoned me and asked where he could buy some "domestick" pins, as none of our advertisers had ever heard of them! Personally I always use mica for the windows as it is heatproof, and a mica "window" sold by the ironmongery stores for replacing broken ones on oil stoves, provides material for quite a lot of cab windows, as it can be split into several layers. A brass beading can be fitted on the outside of the cab around the window, opening if desired, and the mica or cellophane placed between that and the cabside; just please yourselves. I have shown this alternative in the drawing.

The edging around the cut-away part of the cab sides can be made from strip nickel-bronze—the stuff we used to call German silver—about $^{3}/_{16}$ in. wide and 22-gauge. This is simply bent to the shape of the opening and soldered in. Leave about $^{7}/_{16}$ in. projecting beyond the bottom of the curve for attachment to the corner pillar. On the full-sized engines, these are turned from forgings and are tapered; a collar is formed at the point where the pillar passes through the cab beading and a nut above the collar makes all secure.

Pillars on the little engine need not be turned at all, but the lower part can be made from ⅛ in. round rod (nickel-bronze or rustless steel for preference) and the upper from $^{3}/_{32}$ in. ditto. Little turned collars can be silversoldered on at the positions indicated in the side view of the cab, and if a fillet of silversolder is left around each collar the effect will be as if the pillars had been turned. Put a few $^{3}/_{32}$ in. threads on the lower end of the upper half of the pillar and screw a nut on, leaving about $^{3}/_{16}$ in. projecting below the nut. Drill and tap the upper end of the lower pillar to match.

DRILL a No. 41 hole in the beading or edging; then, when the cab is finally assembled, the upper part of the pillar can be put in position with the spigot projecting through the hole in the beading and the lower part screwed on to it. The bottom end of the lower part of the pillar should project through the collar and fits into a No. 30 hole drilled in the running-board. Top of the upper pillar is soldered to the beading. Both extremities of the beading are rounded off.

The wheels inside the cab are covered by box-shaped splashers, as shown by the dotted lines in the drawing of the whole assembly. These occupy the full width of the space between frame and cab side. They can be made up similar to the round splashers, to the dimensions given, but of course are reversed, the open side being against the side of the cab. They can be attached to the cab sides by pieces of angle, or just merely soldered in position.

Cab sides are attached to the front by pieces of angle riveted into the corners, and pieces of angle are also used to hold down the cab to the running-boards. One piece of ¼ in. by $^{1}/_{16}$ in. angle, ⅝ in. long, is riveted to the bottom of the cab side behind the box splashers; a similar piece is fixed at the front end close to the cab front. When the cab is permanently erected, $^{3}/_{32}$ in. screws are put through clearing holes in the running-board into tapped holes in the angle. I usually stand the cab front and side in position and mark off the location of the angles on the running-board with a scriber. The cab is then removed, No. 41 holes drilled in the centre of the marked-out places, cab replaced, and the drill put through the holes from underneath to make countersinks on the angles. Countersinks are then drilled No 48, and tapped $^{3}/_{32}$ in. or 7 B.A.

A trick which I am very fond of doing and which has advantages, the principal one being easy and instant removal of the whole cab without trouble, is to make the cab front in two halves, dividing it by a vertical cut ahead of the whistle turret and riveting a curved piece of angle to one side. Each half is then permanently attached by riveted angles to its corresponding cab side. When each cab side and half the front are placed in position, the two halves of the front meet over the top of the wrapper. The piece that is not riveted to the curved angle overlaps the angle and is attached to it by a couple of $^{3}/_{32}$ in. or 7 B.A. countersunk screws.

Centre part of the cab roof is screwed down to the horizontal part of the angle and makes a strong, sound, and easily removable job. If the footplate fittings want cleaning up, or in the rare and unlikely event of a gauge glass bursting and needing replacement, the complete cab can be taken off in a couple of minutes, rendering the job easy to get at. The joint in the middle of the cab front is practically invisible when the engine is painted, although personally I shouldn't care a bean if it showed up. Experience has taught me that accessibility, utility and efficiency take first priority over such things as a crack showing!

Cab roof is a piece of the same kind of metal as used for sides and front, measuring approximately 5 7/16 ins. by 4 5/8 ins. This is bent to a curve same radius as the top of the cab front and attached by screws to the side strips by 1/16 in. or 10 B.A. countersunk screws, as previously mentioned, but before fixing permanently the sliding part must be fitted. An opening in the roof is necessary to get at the handles. Length of the opening from front to back is 3 ins. as shown in the assembly drawing. The width you can settle for yourselves. Anybody who has a fist like a pre-war ham (fond memories!) will need a wide opening, whilst any small person who only takes a size 6 glove will be able to operate through a narrower one. A good compromise would be, say, a gap 4½ ins. wide. In that case cut a piece out of the cab roof 4½ ins. by 3 ins. At each side of the opening a butt strip is riveted for the full length, top and bottom, as shown in the small detail sketch. A piece of metal is then cut to the exact size of the opening, so that when it is slid into place between the strips (or runners, as they now become) it completely fills it. A piece of angle is soldered along the back, lining up with those at each side to act as a stiffening rib. The sliding plate remains in place when the engine is not in service, but when under steam it is completely removed.

Running-boards, steps, splashers, cab sides (and half the front if the divided front is adopted) form one complete unit which is attached to the top of buffer and drag beams by two 3/32 in. or 7 B.A. countersunk screws at each end, as shown in plan. The screws run through clearing holes in the running-boards into tapped holes in the beam. To give additional support between the coupled wheels, brackets are provided at each side. These may be castings or pieces of metal, say 16-gauge steel, measuring 1¾ ins. by 1 in. and bent to a right angle with a stiffening rib of the same kind of material brazed in. They are riveted to the underside of the running-boards flush with the inside edge and attached to the frames by two 3/32 in. or 7 B.A. screws in each as shown in the drawing of the complete assembly.

Whistle

There is no convenient place for the whistle in the usual position under the cab but on this engine one can be mounted under the left-hand running-board in the position shown by the dotted lines in the plan view. It will be inconspicuous, as it only shows just below the valance and this location renders it very easy to erect and connect up, whilst steam escaping from it is blown clear of the engine. The whistle is made from a 4 ins. length of 7/16 in. brass treblet tube for preference, though ordinary tube will do if this is not available. Square off the ends in the lathe and then file an arch-shaped opening 3/8 in. wide and ½ in. long at ½ in. from one end.

Chuck a piece of ½ in. round brass rod in three-jaw and turn down about ½ in. of the end to a tight fit in the whistle tube. Square off the end, and part off two 5/32 in. slices. One of these is driven into the end of the tube and the other has a segment filed away for 3/8 in. of the circumference as shown in the detail sketch. This should be about 1/32 in. deep. This disc is driven into the tube so that the clearance is level with the arch-shaped hole; see section. By blowing into the end of the tube with all the power of your lungs you should just get a note from the whistle. If it blows easily it will screech under steam. Don't forget your lungs can only manage about 5 lbs. or so pressure, which is slightly below the working pressures of "Roedean's" boiler!

Chuck the ½ in. rod again. Centre the end and drill down about ½ in. depth with No. 40 drill. Turn down 3/16 in. of the end to a tight fit in the whistle tube and part off ¼ in. from the shoulder. At ¼ in. from the blind end drill a 7/32 in. hole into the side, piercing the longitudinal hole. Tap this ¼ in. by 40. Chuck a piece of 5/16 in. hexagon brass rod in three-jaw turn down 1 3/16 ins. length to ¼ in. diameter and screw ¼ in. by 40. Face the end, centre deeply, and drill down to 1 in. depth with No. 40 drill. Part off at 1½ ins. from the end, reverse in chuck—you can hold it by the screwed part as long as you don't tighten the chuck sufficiently to crush the threads —turn down 3/16 in. of the end to ¼ in. diameter, and screw ¼ in. by 40. Centre, and put the No. 40 drill in until it meets the other hole and completes the thoroughfare. Screw this fitting into the sides of the previously-turned piece, then squeeze the shouldered-down part into the whistle tube so that the long screw is opposite to the arch-shaped hole. If you now blow into the end of the screwed piece, the whistle should not sound at all, only make a sort of husky hiss. It is important that there should be no air leaks at either end or around the disc where it fits the tube so if these fitments are at all slack, solder them, otherwise you won't get a clear note.

To mount the whistle, drill a ¼ in. hole in the running board as indicated by the dotted circle in the plan view, about 5/16 in. from the side, and 3/8 in. or so from the end. Make a ¼ in. by 40 locknut to fit the long screw. Drill and tap the end of the whistle for a 3/32 in. or 7 B.A. screw. Bend up a little bit of 16-gauge brass to an angle and attach this to the end of the whistle by a brass screw. Now poke the long screw up through the hole in the running-board and put the locknut on it to hold it there. See that the whistle lies straight along under the running board close to the valance, then drill a No. 40 hole clean through the running-board and the bit of angle on the end of the whistle, countersink it, and put in a screw with a nut underneath.

Drill a 5/16 in. hole in the top of the box splasher inside the cab to allow the long screw to project through as shown in the illustration. Connect it to the union screw on the whistle valve, on top of the backhead by a 1/8 in. pipe with union nuts and cones on each end. That job will complete the engine part except for the "trimmings," which can be put on when the tender is completed, so the latter will be the next job.

Tender

Builders who have completed the engine thus far will find the tender a very easy job. Tenders supplied to the "Schools" class engines differ somewhat from the standard type of Southern tender inasmuch as they are of high capacity yet designed to suit the limited load gauge of the Tonbridge-Hastings section, the frame being lower and of different shape and the tops of the side sheets canted in to match the upper part of the cab. However, the construction is straightforward and simple, and there will be no need to detail out in full any parts of the machining and fitting where similar parts have been described for the engine.

This will speed up the job for those who have kept pace with the description to date.

Tender Frames

As the frames only have to carry the load and have no traction stresses to worry them, there is no need to use 1/8 in. steel; 3/32 in. or 13-gauge, is plenty stout enough. Two pieces 16 ins. long and 2 1/8 ins. wide will be needed. I recommend the soft blue ductile metal which does not spring when the axlebox openings are cut out. Mark one out, drill a couple of the holes, temporarily rivet together, and cut to the given outline by the same process used for engine frames. Drill all the holes, and mark the outside of frames before parting them; then file off any burrs left from drilling.

On the inside of each frame, about the middle of its length, rivet a 4 ins. length of 1/4 in. by 1/16 in. brass angle using 1/16 in. brass rivets. This is to form additional support. When the soleplate is screwed down to the angles the frames are kept in proper alignment. The sizes and positions of all holes are shown in the drawing. Note—the No. 30 holes 3/4 in. from top of frame and 1 3/4 ins. behind the centre of the axlebox openings are for the brake hanger pins. Also note that the top corners of the axlebox openings should be rounded off as shown.

Horncheeks and Spring Brackets

It is easier to fit the horncheeks and spring brackets whilst the frames are separate than when assembled, so we'll do that job right away. The advertisers supplying "approved" castings will be able to do the needful in the case of the horncheeks, which are small ribbed angles with the bolting faces slanted off at the top and bottom corners. As it is imperative that the bolting and sliding faces should be exactly at right angles, they should not be hand-filed unless there is no other available means of doing the job. Failing a milling-machine, they can be clamped under the slide-rest tool holder, then traversed across an endmill in the three-jaw in a manner somewhat similar to the process I have fully described for axleboxes. When one face is machined it should be turned downwards on to the topslide, under the tool clamp and the unmachined face presented to the endmill; then the two surfaces can't help being at right angles, provided that the lathe is reasonably accurate. A home-made cutter will do the job as well as the most expensive endmill. The cutter is made the same way as I have described for pin drills, but instead of having a pin, a nick about 1/8 in. wide is filed across the centre between the two cutting edges. I prefer these cutters to the regular kind.

Five No. 51 holes are drilled in each horncheek from the front through into the bolting face. Clear off any burrs by rubbing the machined face lightly on a fine file. Place one at the side of an axlebox opening and hold it temporarily with a toolmaker's cramp. My favourite trick to locate the horncheeks correctly is to use a piece of flat or square bar which exactly fits the slot, as a jig. The piece of bar is jammed into the slot and the horncheek held up tightly against it whilst the clamp is attached. The piece of bar is then removed and the frame drilled for rivets using the holes in the horncheek to guide the drill. Countersink the holes in frame on the inside, and use 1/16 in. charcoal-iron rivets to secure the horncheeks to the frame. If these are not obtainable use brass rivets; copper ones tend to become slack if used for these jobs.

To preserve the shape of the rivet heads use a holding-up dolly with a cup recess in it. Chuck a short piece of 3/8 in. square steel rod truly in the four-jaw, and turn one end of it taper until the end measures about 1/8 in. across. Centre it and make a countersink in it with No. 31 or 1/8 in drill. Put it upright in the vice and put a 1/8 in. steel cycle ball in the countersink. Two or three good hearty biffs with a heavy hammer will cause the ball to turn the countersink into a cup recess.

LEAVE the dolly in the vice, place each rivet head in the cup, and you can hammer down the shank into the countersink in frame as hard as you like without spoiling the personal appearance of the head.

If no castings are available for the spring brackets—they *should* be—they can be filed up from 1/2 in. by 1/8 in. brass or steel angle to the shape shown in the detail sketched inside the frame. In the longer end, which is rounded off, drill a No. 48 hole 1/4 in. from the back and tap 3/32 in. or 7 B.A. In the end which is slightly more pointed drill two No. 41 holes. Each bracket is temporarily clamped to the frame with the top of the horizontal part level with the bottom edge of frame, and the tapped hole 1 7/16 ins. from the centre of the axlebox opening. Rivet to frame as described for the horncheeks, using the holes in bracket as guides to drill frame, countersinking the holes inside frame and using a dolly with cup recess to support the heads outside frame whilst hammering down the shanks of the rivets into the countersinks. File off flush inside frames. Finally test alignment of axlebox slots and horncheeks by temporarily clamping the frames together again. If a piece of 9/16 in. square rod fits each pair of horncheeks exactly at the same time alignment is O.K. If not, correct before proceeding further. If the horncheeks have to be opened up a bit to give perfect alignment don't worry—the axleboxes are easily made to suit!

Tender Beams

Two 6 1/2 ins. lengths of 1 in. by 1/8 in. angle are needed for the beams. The front one, which is the drag beam, corresponds to the engine drag beam by having a drawbar slot cut in it 1 in. long and 3/16 in. wide. Ends are bevelled off as shown. The back one, which is the buffer beam, is also similar to the engine's front buffer beam but the holes are tapped instead of being plain. Owing to the width of the tender frames, nuts cannot be used, so the buffer sockets have to be screwed into the beam. The top of each beam is slotted 3/32 in. to allow frame plates to fit tightly, the inside edges of the slots being 4 1/2 ins. apart. A piece 1/2 in. long is cut away from each end as shown in the illustration. Slotting is done same way as on the engine beams with a 5/32 in. milling cutter, a parting tool in planer or shaper, or by hand with saw and warding-file. If by the latter means, be sure and have the slots square with face of beam, checking with try-square as described for the engine beams.

If the frames can be brazed into the beams no further preparation is needed, but if angles, rivets and screws will be used for erection—it is the builder's own choice—two 7/8 in. lengths of 3/4 in. by 1/8 in. angle, either steel or brass, must be riveted to each beam flush with the edge of slots as shown in the underside view. If a piece of 3/32 in. sheet steel is temporarily jammed in each slot the piece of angle can be butted up tightly against it and held in that position by a toolmaker's cramp whilst drilling the rivet holes. These should be countersunk outside the beam for neatness' sake. Use iron or steel rivets and hammer the shanks well down into the countersinks, smoothing the beam faces with a file after riveting.

Erection of Frames

There is no need to dilate on the erecting of the frame as the job is done exactly as described for the engine frames checking for truth and parallelism on the lathe bed, or something equally flat and true, before securing the frames to the beams "for keeps." If the frames are brazed or Sif-bronzed to the beams don't forget to put a couple of metal or hardwood distance-pieces or spacers between the frames, with a carpenter's cramp over each to maintain the frames parallel whilst the "hot job" is in progress. On the last tender I built (for the L.B. & S.C.R. single-wheeler "Grosvenor") the four corners of the frame took less than 15 minutes to fix, using an "Alda" oxy-acetylene blowpipe with 150-litre tip in it, and Sifbronze. My favourite spacer is a bit of iron "steam barrel" about 2 ins. diameter faced off in the big three-jaw chuck to the exact distance between frames. A hefty clamp over the outside of the two frames holds them tightly to the spacer and it would puzzle the frames exceedingly to get out of alignment once the clamp has been well tightened up.

Axleboxes

Axleboxes can be made up from either castings or bar material. If castings are used the whole lot will probably be cast in one stick, with the "ornamental" fronts (which form the lids in full size) cast integrally. The grooves, or sliding faces, are machined exactly as described for the coupled axleboxes on the engine. If your milling machine, or lathe as the case may be, can manage sufficient travel to do each side at one fell swoop so much the better —go right ahead! If not, saw the stick of boxes in half and mill each half separately. Whilst the fit of the boxes in the horncheeks should not, of course, be what the shopmen call "sloppy," there is no need for the same "precise fit" necessary for the coupled axleboxes on the engine. If you accidentally get a weeny bit of endplay there is no need for lamentations. In the other direction, the boxes should be free enough in the horncheeks to allow for a slight tilting movement so that the wheels can freely follow any irregularities in the road. Failure to allow for this leads to frequent derailments; the average back-garden line isn't usually as flat as a billiard table—the British climate sees to that (it does mine, anyway) unless the whole construction is of concrete and steel. I regret very much that I didn't use light steel girders on top of my concrete posts; it would have saved the eternal levelling up.

Failing castings, the boxes can be machined up from a piece of ⅞ in. square rod. If this is of good quality brass or bronze it will stand up to journal wear very well but if soft or of the grade known in the metal trade as "screw rod" it would be advisable to drill the bearing holes ⅜ in. diameter and squeeze in little bushes made from cast or drawn bronze rod.

After milling the grooves, either part off the separate boxes by holding the piece of metal in the four-jaw and using an ordinary parting tool, or saw them off by hand, chucking each in the four-jaw afterwards to square off the ends with a roundnose tool set crosswise in the rest. Journal holes can then be drilled ⅜ in. from the bottom. As it is important that these should be square with the box, a good way to make sure of it is to centrepop each box in the middle of its width and ⅜ in. from the bottom. Chuck in four-jaw with the pop mark running truly and drill with a ¼ in. drill in the tailstock chuck.

To prevent the drill going too far in and piercing the front of the box, put a stop bush on it, same as I described for the injector reamers, setting it at ⅝ in. from the point of the drill. A $\frac{1}{16}$ in. oil hole is drilled slantwise from the top of each box to the journal hole, and the end of this should be countersunk to hold a drop or two of oil which will feed down and lubricate the journal.

As mentioned above, cast axleboxes having the fancywork cast integrally will need no further attention but axleboxes made of bar material will need dummy lids attached. These may be cut from $\frac{1}{16}$ in. sheet brass filed up to the shape shown in the drawing (or any other shape you fancy; there's no necessity to be too precise!) and simply soldered to the fronts of the boxes. A countersunk screw can be put in below the bar for "safety first," or the lifting knob might be turned from ⅛ in. round rod, and made to screw in.

Springs

Springs may be cast dummies with a working spiral spring concealed in the hoop, or may be real working leaf springs which take very little longer to make up and fit. If in the former case the castings are as clean as some samples I have seen, all they will need will be the two No. 40 holes drilled in the ends for the spring pins (see plan view of frame erected) and a ¼ in. blind hole drilled in the buckle or hoop for the plunger or buffer. The latter is made from a bit of ¼ in. round rod, bronze for preference. Chuck in three-jaw and face the end, centre, drill down $\frac{5}{16}$ in. depth with $\frac{3}{16}$ in. drill, part off at $\frac{11}{32}$ in. from the end, reverse in chuck, and round off the sharp edge. Plunger should be an easy sliding fit in the hole in the hoop. The spring is wound up from 20-gauge tinned steel wire and should be an easy fit in the hole in the plunger. It should just start to compress as the plunger enters the hole in the hoop.

Spring pins are 1½ ins. lengths of $\frac{3}{32}$ in. round steel screwed $\frac{3}{32}$ in. or 7 B.A. at both ends; ⅛ in. length at upper end and ⅜ in. at lower end. Upper end is furnished with a round nut made from ¼ in. round steel and $\frac{3}{32}$ in. thick; you don't need detailed instructions for making that! This is screwed on tightly and the projecting fragment of thread riveted over as the nut never has to come off any more.

Put a spring in position over the top of each axlebox and poke a pin through each end hole, screwing down same through the hole in the hanger bracket below. Adjust temporarily by eye, and put an ordinary commercial nut on the pin below the bracket to act as a locknut when the springs are finally adjusted, a job which cannot be done until the engine is finished and the tender loaded up to working order. The axleboxes are prevented from falling out by hornstays made from 16-gauge steel filed up to the shape shown in the little detail sketch. The ends are drilled No. 48 and each hornstay is attached to the frame across the bottom of the axlebox slot by two 9 B.A. roundhead screws running into tapped holes in the frame.

If anybody cares to take a little extra trouble, working leaf springs may be fitted; their action when the engine is running is very realistic and fascinating to watch. To get the correct appearance with the necessary flexibility, the springs should be built up in the manner adopted by an old friend, Mr. Tom Glazebrook. Each leaf, instead of being one plate, is composed of two or more laminations. These are made from thin spring steel of about 28 or 30-gauge, which can be obtained commercially, and cut with an ordinary pair of snips. The plates are all ⅜ in. wide; top plates are 3¼ ins. long, second layer 2½ ins., third 2¼ ins. and so on, decreasing by ¼ in. until the rectangular hole in the hoop is filled. Holes for the spring pins are easily punched by means of a reverse-taper punch (as shown in the detail sketch), made from a bit of ¼ in. round silver-steel and hardened and tempered to pale yellow. The leaf to be punched is simply laid on a flat block of lead, the punch held vertically at the required spot and given one hefty crack with a hammer. The result is a perfectly clean hole.

To make the hoop or buckle, chuck a piece of ½ in. square steel rod in the four-jaw, face the end and turn down ¼ in. length to ¼ in. diameter. Centre and drill down about ⅜ in. depth with No. 40 drill. Part off at ½ in. from the shoulder. Drill an 11/32 in. hole through the square part and file it out until it is ⅜ in. square. Tap the hole in the shank ⅛ in. or 5 B.A. (it is easier than tapping after drilling, as you can run the tap clean through into the square hole and a "thoroughfare" hole is always easier to tap than a "blind" one) and fit a grubscrew in it. This should, for preference, be an Allen screw with a recess in the head which is much more readily tightened by the special key than the ordinary slotted type. The Allen key doesn't slip out of the recess but screwdrivers are renowned for slipping out of slots, especially under stress! Fit the plates into the slot in the hoop, set them centrally, well tighten the grubscrew, and erect the spring exactly the same as the cast one with the shank resting on the axlebox. The only difference is that with the cast one the plunger moves up and down in the hoop, but with the real one the whole spring flexes correctly, same as those on "Roedean's" full-sized sisters.

Wheels and Axles

Little need be said about these as the machining of the wheels is carried out in exactly the same manner as those on the engine. As many of the "Schools" engines have solid disc wheels we might as well use the same pattern for our little girl. After turning and facing, drill a 5/32 in. hole anywhere in the web of the wheel, close to the rim as shown; this will indicate the thickness of the metal as in full-size. The hole for the axle is reamed 5/16 in. and the profile of the tread and flange is exactly the same as the wheels on the engine.

Three pieces of ⅜ in. round mild steel will be needed for the axles, each approximately 5⅜ ins. long which will allow for turning the journals to correct length and slightly rounding the ends. The rod can be held in the three-jaw chuck with about 1¼ ins. standing out of the jaws, and if the chuck is slightly out of true it doesn't matter because both wheel-seat and journal are turned at the same setting without taking the rod out of the chuck, and therefore they must be exactly true with each other. Use a knife tool and plenty of cutting oil to ensure a clean and true finish. Wheel-seats should be turned to fit the reamed holes in the wheels exactly as described for those on the engine; they should be a good press fit but not tight enough to split the wheel bosses. Both wheels can be pressed on to each axle right away. To erect simply take out two opposite axleboxes, put one on each end of the axle, replace boxes, and screw the hornstays in position. The wheels should spin freely without any wobbling, in any position of the axleboxes, and the chassis should run freely if placed on the floor and given a push.

Soleplate

Soleplate, or bottom plate of the tender, is a piece of 16-gauge sheet brass or copper, hard-rolled for preference, measuring 16⅜ ins. long x 6⅝ ins. wide. It is held down to the chassis by three 6 B.A. countersunk brass screws at each end, put through clearing holes in both soleplate and top of buffer and drag beams and nutted underneath.

THREE 3/32 in. or 7 B.A. countersunk brass screws are put through the soleplate and the pieces of angle at each side of the chassis, and are also nutted underneath. This allows the complete tender body to be easily removed in case of emergency by simply removing the nuts, the heads of the screws being soldered over when the body is sweated up to render it watertight.

Valances may also be attached at this stage. They are simply lengths of ¼ in x 1/16 in. angle brass cut to fit between the buffer and drag beams, and are riveted to the underside of the soleplate at 1/16 in. from the edge—that is, level with the ends of both buffer and drag beams—by 1/16 in. brass rivets at 1 in. centres.

Tender Body

The best material for the tender body is hard-rolled sheet brass about 20-gauge. If this is not available, or price is a consideration, galvanised iron or lead-coated steel could be used. Ordinary steel would, of course, rapidly rust, but it could be used if a lining of thin copper is fitted inside. Incidentally, my old Atlantic engine, "Ayesha," has a steel tender body which has lasted 27 years, but it has a brass tank inside and no water comes in contact with the steel. The soleplate, or tender bottom, should be thicker than the sides and back, so for this you will need a piece of 16-gauge sheetmetal ⅜ in. long, and 6 11/16 ins. wide. This is fixed down by brass countersunk screws; any size between 3/32 in. and ⅛ in. will do. Put three or four through the top of each beam and four through each side angle. Drill clearing holes through both the soleplate and the beams and angles and fix with ordinary commercial brass nuts underneath. The body can be removed by merely undoing the nuts.

If a piece of sheetmetal long enough to make both sides and back of the tender body is available, make it in one piece, carefully marking and cutting out and bending at the corners. If not, mark out three pieces, two sides and a back. The two sides may be cut together like making frames. The corners are joined by pieces of ¼ in. x 1/16 in. angle riveted in place with 1/16 in. brass rivets. If commercial brass angle is in what the bureaucrats call "short supply" bend up pieces of the same material used for the tender body in the bench vice. I recently had presented to me, "for services rendered," a precision bench shear and a bending machine of American make. The former will shear a 12 in. length of sheetmetal up to 16-gauge and the latter will bend it to a perfect angle in a matter of seconds. Use a couple of small toolmaker's cramps to hold the pieces of angle to the sides and back whilst drilling and riveting. Countersink the rivets on the outside, hammer down flush, and smooth off with a fine file.

Front End of Tender

The front end of the tender isn't the same as on a full-size "Schools" engine for the simple reason that the driver and fireman do not stand on the footplate and the engine has to be driven and fired from the back of the tender. A front plate made as in full size would render the footplate fittings, and the firehole, very inaccessible. I have, therefore, shown a simplified arrangement as used on the engine of the old L.B. and S.C.R. It is made from a piece of sheet-metal, same gauge as tender sides, 7 ins. long and 3 ins. wide bent over at right angles for a distance of ⅜ in. each end. It should be wide enough to maintain the sides parallel all the way along when fitting nicely between the front ends of the side sheets.

Before erecting, fit the coal gate. In the centre of the top edge cut out a piece of metal 1½ ins. long and 1¼ ins. deep for the opening. At each side of this rivet a runner, made by cutting a 1/16 in. rebate in a piece of 3/32 in. x 3/16 in. brass strip. This can be done by the same process as cutting the grooves in the axleboxes. Bits of domestic pins make fine rivets for a small job like this. Cut a piece of metal to slide nicely in the grooves and fit a little turned knob to it (or a wire handle, just as you please). The whole arrangement is shown in the illustration. Next, set the complete plate between the sides of the tender at ½ in. from the front ends of the side sheets. Temporarily clamp in position, using a small toolmaker's cramp at each side; make certain the front and sides are at right angles by checking with a square, then rivet up with 1/16 in. brass rivets. Drill the holes No. 51, countersink them, hammer the rivets flush and smooth off with a file.

Supporting Angles

The pieces of angle supporting the coal plate and the tank top must, naturally, be the same height at each side and the easiest way to ensure this is to cut a piece of cardboard or thick paper to the outline of the tender side. Mark out on this the position of the angles, then cut along the line, removing all the paper or card above it. Stand this template inside the tender body against each side in turn; run your scriber along the top, making scratches on the tank side, and then they must be exactly the same height. The pieces of angle may be temporarily tacked with solder before riveting up. Beginners note—if the sides and back of the tender body are made from separate sheets the pieces of angle may all be riveted on before the sides and back are put together. This makes the job very easy. A piece of angle is also riveted along the bottom edge of each side, also along the back; and another piece at ⅛ in. from the top of the back sheet, which helps to support the removable part of the tank cover.

How to Erect the Body

Drill a few No. 40 holes in the bottom angles at about 2 ins. centres along both sides and back; the body can then be fixed down to the soleplate. The front ends should be ⅝ in. from the front edge of soleplate and the back sheet of the tank ⅜ in. from the back edge, whilst there should be an equal overhang at each side as shown in the end view. When the body is correctly located tack it in position with a few small blobs of solder applied inside, at either side and the ends; a hot soldering bit will do the trick fine. Then run the 40 drill through the holes in the angles, making countersinks in the soleplate; follow with No. 48, tap 3/32 in. or 7 B.A., and put brass screws in. Any heads will do. Note, none of these screws should penetrate the top of the buffer and drag beams, nor the side angles attached to the frame.

In case any beginner wonders how he is going to drill and tap so close to the sides and back when the handbrace chuck and tapwrench will not go anywhere near the holes, here is the solution. You'll probably have a few broken 40 and 48 drills; I never knew anybody yet who never broke a drill. If you cut a couple of 5 ins. lengths of round rod about 3/16 in. diameter the answer is in your hands. Chuck in three-jaw, face the end, centre, and drill down half the length of the broken bit of drill with a drill one size smaller. Force the broken piece of drill into the hole, put the other end of the bit of rod in your hand-brace chuck and you have an extensive drill which allows the chuck to clear the top of the tender side. To turn the tap, all you need is a piece of copper tube about 5 ins. long, big enough to go over the square on the tap shank. Hammer it into contact with the square, forming a square socket; put a tapwrench on the other end and you are all set.

The next job is to sweat around the bottom of the assembly to make it watertight, and the best tool for the job is a good big soldering iron. If you use a blowlamp or blowpipe, the chances are that the sides will buckle badly owing to local expansion of the metal; the trouble is that once they go wavy they won't go back to flat again. I usually press a couple of soldering irons or bits into service, heating one whilst using the other so as to make a non-stop job. By the way, both of them are home-made from pieces of 1½ ins. copper rod, one end wedge-shaped, the other drilled and tapped for a foot of ⅜ in. round mild steel which is screwed in. A file handle on the other end finishes the job. Warning—*don't on any account use a paste flux.* Use a liquid flux such as Baker's fluid, chloride of zinc, killed spirits of salts, or some other recognised liquid preparation and when you are through with the soldering wash away all traces of the flux with hot water. Beginners note—all the sweating-up is done on the inside of the tender body; be sure to cover all the angles, screwheads and rivet heads. If any solder oozes through to the outside scrape it off with an old flat file ground off square at the end and with the teeth ground off on both sides.

Hand Pump and Connections

Emergency hand pump is already made as we used it to test the boiler. Put the handle up straight and stand it in the tank midway between sides with the centre of the handle 1¾ ins. from the back. Drill four No. 30 holes in the soleplate, using those in the pump lugs as guides, and secure with four ⅛ in. or 5 B.A. brass screws (any shape heads) nutted underneath the soleplate.

About 1 in. ahead of the pump and a little to the left-hand side drill a ¼ in. clearing hole, and in it fit a double union. Chuck a bit of ⅜ in. hexagon rod in three-jaw, face the end and centre deeply. Turn down about ½ in. of the outside to ¼ in. diameter and screw ¼ in. by 40. Part off 7/16 in. from the shoulder. Reverse in chuck, centre, and drill right through with ⅛ in. drill. Turn down ¼ in. of the end to ¼ in. diameter and screw ¼ in. by 40. Make a locknut 3/16 in. long; chuck the hexagon rod again, centre, drill 7/32 in. diameter ¼ in. depth, tap ¼ in. by 40, and part off a 3/16 in. slice. Reverse in chuck, skim off any burring and run the tap through again. Poke the longer end of the fitting through the hole in the soleplate and screw the nut on tightly. Connect the upper end to the top union on the pump by a swan-neck of 5/32 in. copper tube with a union nut and cone on each end. I described how to make these in connection with boiler fittings and the pipe work on the engine, so needn't reneat instructions here. Another piece of 5/32 in. tube is connected to the lower end of the fitting as shown in the illustration; this should reach to the leading axle. On the end fit a bit of pressure-resisting hose such as a cycle pump connector, and in the other end of the hose fit a piece of similar tube about ½ in long furnished with a ¼ in. by 26 union nut and cone to make connection with the union screw under the engine beam.

To prevent the hose blowing off the pipes under pressure, solder a ring of thin wire around the end of each pipe. Work the hose over it—easily done if you wet the parts—then either wind three or four turns of thin wire around the outside, twisting the ends and soldering them, or making a proper little pipe clip secured by a 1/16 in. screw. Either wheeze will prevent the pipe from blowing back over the soldered ring.

Bypass Pipe

Drill another clearing hole in the soleplate anywhere near the pump union described above and in it fit a similar gadget to the double union but minus union nuts. Instead, drill each end No. 23 for about ⅛ in. depth. Before inserting it "for keeps" fit pieces of 5/32 in. pipe, as shown (next week) one to reach the leading axle or a little beyond it, and the other to reach almost to the pump handle. Then insert it and screw up the locknut, bending the pipes as shown. The lower one is connected by a rubber tube to the bypass valve outlet, merely a push-on fit both ends as there is no pressure to withstand. The upper pipe is bent to come under the filler hole when the top of the tank is in place so that the water may be seen squirting out of the pipe when the valve is opened, an indication that the pump is operating correctly. By regulating the bypass valve to allow more or less water to escape via the pipe a practically constant level may be kept in the boiler.

Pump Feed Pipe and Strainer

It is always advisable to pass the feed water for pump and injector through a strainer or "strum," as the enginemen call it. It is possible that our "approved" advertisers will be able to supply cast flange fittings and if so, they only need turning on the contact face and drilling for pipe and screws. The fittings can also be turned from [illegible] in. round brass rod held in three-jaw.

FOR the pump strainer, face and drill down about ½ in. depth with No. 23 drill. Turn down 3/16 in. of the end to 5/16 in. diameter and part off at 7/16 in. from the end. Reverse in chuck and turn down ⅛ in. of the other end to 5/16 in. diameter. Drill four No. 43 holes in the flange, as shown in plan view. Roll up a finger from a bit of fine brass or copper gauze and solder it to the shorter end; the longer end has a bit of 5/32 in. copper pipe silver-soldered in it. This should be about 3 ins. long and bent as shown.

Drill a 5/16 in. clearing hole in the soleplate about 1½ ins. behind the front axle and 1 in. to the right of the centre-line—don't forget that the right is on your left when the tender is upside down! Put the gauze finger through the hole and secure it by four 8 B.A. brass screws, any head, putting a jointing gasket of 1/32 in. "Hallite" or similar jointing material between flange and soleplate. The pipe is connected to feed pipe on the engine by a slip-on rubber hose or tube, same as the bypass.

Injector Water Valve

Injector water valve is made like a brake handle so that it can easily be operated whilst running from the driving car behind ⅜ in. round brass rod in the three-jaw. Face, centre, and drill down about 1⅜ ins. depth with 7/64 in. drill. Open out with 5/32 in. drill to about ¾ in. depth and bottom the hole with a 5/32 in. D-bit to 1 in. depth. Further open out with No. 11 drill to 3/16 in. depth, and tap the remains of the hole either 3/16 in. Whitworth or 3/16 in. by 26. The coarse thread allows for quick operation. Be careful not to let the tap cut into the D-bitted seating. Turn down ⅝ in. of the outside to 5/16 in. diameter and screw 5/16 in. by 32. Part off at 1¼ ins. from the end; reverse in chuck and open up the other end to ⅛ in. depth with No. 23 drill. At ⅜ in. from the bottom drill a No. 23 hole in the side, breaking into the central hole just above the valve seating. Make a locknut and a gland nut as already described; the gland nut is very similar to those on the water gauge, only 5/16 in. long.

Valve spindle is a piece of rustless steel or phosphor-bronze rod 3/16 in. diameter and 4 ins. long. Approximately 2¾ ins. of it should be turned down to ⅛ in. diameter as shown, for appearance' sake, though it makes no difference to the working of the valve if it is left full diameter for its full length. Beginners should chuck the rod in three-jaw with about ¾ in. projecting from chuck and turn that first; then pull out another ¾ in., turning that down, and "ditto repeatoing" until the desired length is reduced. If any ridges are left between sections, the application of a bit of emery-cloth or similar abrasive will soon remove them. Run the lathe at the highest possible speed. Reverse in chuck and turn down ¼ in. of the other end to a full ⅛ in. diameter; form a point on the end and screw either 3/16 in. Whitworth or 3/16 in. by 26 to suit the hole in the valve. Both operations are done as described for boiler fittings. The thread should be about ⅝ in. long. Don't fit the spindle to the valve yet.

At 1½ ins. to the left of the centre-line of the tender and 13/16 in. from the front edge of the soleplate, drill a 5/16 in. clearing hole (letter O drill). At about 2 ins. behind it, and in line, drill another similar hole.

Put the valve through the first one from underneath and hold it there temporarily with the locknut on top. In the second hole fit another strainer. This is made like the first one but instead of the hole going straight through, it only penetrates into the boss which is made ⅜ in. diameter and ⅜ in. long. A No. 23 hole is drilled in the side of the boss to meet it; see dotted lines in the drawing. Leave the gauze off till the pipe is silversoldered in.

With the strainer temporarily in place, measure from the hole in the boss to the hole in the valve; then cut a piece of 5/32 in. copper tube to that length plus 3/16 in. to allow the tube to enter about 3/32 in. into each fitting. Remove the valve and strainer; fit the tube, and put another ½ in. of tube into the bottom of the valve for the hose connection. Silversolder all three joints, and fit the gauze finger to the strainer. Wash off, clean up, and erect as shown, securing the valve with the locknut and attaching the strainer to the soleplate, same as the previous one, with a joint gasket between flange and soleplate.

Now screw the valve spindle temporarily in place in the valve. Bend up a little bracket from a piece of sheet metal 16 or 18-gauge and about 5/16 in. wide. Round off the front and drill a No. 30 hole in it approximately 5/16 in. from the bend: check this distance by measuring from the tender front plate to the centre of the spindle. Remove spindle, slip the bracket over the thin part (don't forget the back of the bracket hangs down!) then fit the handle.

Injector Valve Handle

IT consists of a boss made from 3/16 in. round steel about 1/4 in. long with the lower end slightly chamfered. Put a bit of steel in the three-jaw, face, centre, and drill No. 32 for 3/16 in. depth, chamfer slightly, and part off at 1/4 in. from the end. Drive it on to the spindle: drill a No. 43 cross hole through, force in a bit of 3/32 in. silver-steel or 13-gauge spoke wire cut to length and bend up the end as shown. Round off the ends so that the fireman doesn't cut his fingers, screw the valve spindle home in the valve, pack the gland, and attach the bracket to the tender front plate by a 3/32 in. or 7 B.A. screw and nut.

Coal Plate

Having got the "internals" in we can put the top on the tank. The front portion is fixed and forms the bottom of the coal space; the back part is removable. Both sections are made from the same kind of material used for the tender body. The fixed portion needs a piece of metal approximately 10¾ ins. long by a bare 6¼ ins. wide; get the actual width by measuring across inside the tank. Cut away the two front corners so as to leave a projecting lip ¼ in. wide and 1½ ins. long; this forms the shovelling plate and projects through the coal-gate opening. Now bend the plate to the shape shown in the longitudinal section of the tender and fit in place so that it rests on the angles. Don't forget that the upper part of the tender sides has to be bent in to the same angle as the tumble-home of the cab; the bends are 3½ ins. above the soleplate. Before the arrival of my bending machine, I used to take out the steel insets from the jaws of the bench vice and replace them by two pieces of rectangular steel bar of the same section, a little longer than the required length of bend. The metal was marked at the required place for the bend, then placed between the two bars with the line just showing; the vice jaws were tightened and the bend made by hand pressure on the sheet-metal.

Vertical part of the coal plate is cut to fit snugly between the bent-in sides and the top rounded off to 9½ ins. radius. The plate can then be secured to the angle by 9 B.A. countersunk brass screws and the whole lot sweated up to make it watertight. Don't forget to solder along underneath the lip forming the shovel plate. No angles are needed at each side of the coal gate; if the joint between plate and tender front is soldered, it will be plenty strong enough, as the lip—resting on the bottom of the coal-gate opening—takes the small amount of strain needed to support a few ounces of black diamonds. A piece of ¼ in. x 1/16 in. angle can, however, be placed along the back to support the front end of the removable part of the tank top (sketch last week). Just tack it with solder and put in a few rivets.

Removable Top

Detachable part of the tank cover is merely a piece of sheet-metal same gauge as tender body, a bare 6½ ins. long, and just wide enough to fit easily between the sides of the tender. It carries the filler. Starting at 11/16 in. from the back end, mark out a rectangle 2 ins. long and 1 in. wide on the longitudinal centre line. Cut this out with either a metal-piercing saw or an Abrafile, or by drilling, breaking out the piece and filing up. Leave the corners rounded. Cut a strip of metal ⅜ in. wide and 6 ins. long; bend to the shape of the hole and fit it in, having the joint in the middle of the short side at the front end. Leave ¼ in. projecting above the tank top and solder all around it on the underside.

Lid is a piece of metal the same shape as the filler but 1/32 in. bigger all around. Leave two 3/32 in. tags, ¼ in. apart, at one end when you cut it out, and bend them into loops with a small pair of round-nose pliers. Cut a ¼ in. wide strip of metal that will just fit between the loops and bend the end of that into another loop, same diameter as the first two. Put a piece of wire through the lot and you have a nobby hinge. The middle tag is cut short and soldered to the front of the filler, closing up the join; see longitudinal section. A wire handle can be fitted as shown, or a knob, just as you please. I am, of course, quite aware of the fact that the full-sized "Schools" engines have an entirely different type of filler; but did you ever see one with an emergency hand pump in the tender? Circumstances, and the size of the engine, alter cases! It is a much neater job to fit a long filler opening and operate the emergency pump through it when needed, than to fit a small round filler and have an unsightly open slot in the tank top with an outsize in hand levers sticking up through it as I have seen.

Another advantage of my pet type of filler is that it is easy to fill the tank without slopping any water over and flooding the coal space and the footplate. I've also never seen a full-size fireman use an outsize in tin funnels to fill the tender!

Drill a series of No. 48 holes all round the plate at 5/32 in. from the edge and at about 1 in. centres; drop the plate in place and attach it to the angles by 9 B.A. brass screws, roundhead for preference, running through the above-mentioned holes into tapped holes in the angles.

Beading

A beading of 3/32 in. half-round wire can be soldered all round the top edge of the tender. I made a few small toolmaker's cramps from odd bits of square brass rod and ⅛ in. screws, and use them for this job, clamping a few inches in place at a time, soldering it, and then shifting the cramps to a fresh section, working right round the tender by instalments. Leave a bit projecting from the front end to support the upper end of the handrail pillar. This may be turned as shown by anybody who fancies his skill on long flimsy pieces; it will need a travelling stay right behind the turning tool. However, you can get a result nearly as good in a much easier manner. Put a piece of ⅛ in. rod in your three-jaw with about 3½ ins. projecting and let the outer end run in a brass bush drilled No. 30 and held in tailstock chuck. Judicious application of a fine file will soon bring it to a taper. Cut to length and silversolder a washer on each end. Leave a little piece projecting through both washers; let the bottom piece rest in a hole drilled in the soleplate and wrap the end of the projecting bit of beading round the top piece, securing with a spot of solder and filing flush. Use just enough silversolder to form a small fillet against the washers; polish with emerycloth and the appearance is like a turned pillar.

Buffers

A FEW readers in the past have raised queries about fitting the usual type of spring buffer to the tender, saying that the socket screw and projecting spindle fouled the frames. They do; you can't help it, seeing that the buffer centres are 4¼ ins. apart and the frames 4½ ins. apart. How I get over it is to put a rose cutter down the holes in the buffer beam and cut clearances in the frame. However, to please the folk who object to this process, or who haven't a rose cutter, here is a buffer that just screws into the thickness of the beam and needs no clearance whatever behind it. The cast socket, which is the same as our advertisers supply for the engine, is turned and screwed same as described for the engine but the shank is cut down to ⅛ in. long and has a 3/32 in. hole drilled in the end. The head, for which I believe Mr. Reeves, of Birmingham, can supply nickel-bronze (German silver) castings, is turned same as the engine but instead of being solid with a ⅛ in. spindle or pin, is drilled up ¼ in. right to the head and a 3/32 in. hole is put through that also; a spring of 19-gauge steel wire fills the whole of the space, as shown in the section.

The head is prevented from coming clean out of the socket by the simple dodge of putting a bit of flexible wire between them. A bit of brass picture wire will do, or even a bit of electric flex. Strip off the insulation and double or treble the wires to make a bundle that will fit into the 3/32 in. holes. Poke one end through the buffer head and solder it; see that the solder sweats right through and smooth off the end so that the hole is invisible, if you don't look for it. Fit the spring in, poke the other end of the wire through the hole in the shank and insert the stem of the buffer head into the socket. Press in a little way, hold it there, solder the projecting end of the flex into the hole in the shank and cut off flush. The head cannot then come out but the buffer will function like nobody's business, the flex simply folding up inside as the spring compresses. Don't forget to give it a drop of oil! The completed buffers are screwed into the beam and cannot come out as they are prevented from turning by four 1/16 in. screws put through clearing holes in the corners of the square flange on the socket casting into tapped holes in the beam. The engine buffers, which are secured by nuts behind the beam, could have dummy screws in the corners of the flanges for appearances sake.

Drawbar and Coupling

Drawbar is a simple kiddy's practice job, being filed up from a bit of ½ in. x ¼ in. steel rod or a bit left over from the engine frames. The easiest way to form the slot in the hook is to drill a ⅛ in. hole in the middle of the blank and file down into it on an angle. Important—round off the sharp corners on the hook; this is always done in full size as sharp corners would cut the coupling shackles. No need to bother about turning the end for screwing; just take off the corners with a file and the die will do the rest if it is worth the name of a die. Some of my "Ken" dies are over 25 years old and still cut a good thread. The square shank of the drawbar is made a sliding fit in the square hole in the beam; a spring of 18-gauge wire goes over it and is secured with an ordinary commercial nut and washer.

Shackles for the screw couplings are made from pieces of 3/32 in. round steel or nickel-bronze wire. About ⅜ in. of the end is filed away to half its diameter and bent into a loop with a pair of round-nose pliers. The shackle attached to the hook must have one end poked through the hole in the hook before bending up the second eye. The eye joints are either brazed or silversoldered; if you stop up the eye in the process don't worry, just put a No. 48 drill through. The swivels are turned from 3/16 in. round rod, shouldered down for a full 3/32 in. each end to a running fit in the eyes, which are easily sprung over them. One swivel is drilled No. 48 and the other tapped 3/32 in. or 7 B.A. The screw is made from ⅛ in. round rod, turned to 3/32 in. diameter and screwed at one end, and turned to fit the plain swivel at the other. It is pushed through and riveted over, but must be left free enough to turn easily. As the weighted lever is pivoted, wrap a piece of thin sheetmetal around the centre part of the screw and drill a No. 55 hole through the ends. A touch of solder will prevent it slipping. The ball can be turned from brass or steel and it need not be a perfect sphere; you should see the shape of many of the big ones! Screw a piece of 15-gauge spoke wire into it, flatten the end, and drill a No. 55 hole in that too. Put a piece of a domestic blanket pin or bit of wire of equivalent thickness through the lot and slightly rivet the ends, letting the lever be free enough to swing. If preferred, the lever can be screwed direct into the middle part of the coupling screw; many full-sized couplings are made thus.

Vacuum Brake Pipe

Brake pipe is made from ⅛ in. copper tube, bent to shape as shown, the top joint being simulated by a wire ring soldered on to look like the edge of a pipe bend. Hose is a piece of grey rubber pipe slipped on the end of the bend, the clip being a narrow strip of thin copper squeezed on with a pair of pliers. The dolly, or dummy plug, is a little teat turned from 5/32 in. round rod, the shank being filed flat on both sides, drilled No. 55, and attached to the stand pipe in exactly the same way as the ball lever is attached to the screw coupling, as already described. The hose is pushed over the teat and a clip is squeezed on it, same as the upper end. The whole bag of tricks is attached to the buffer beam by a clip, as shown separately, the clip being soldered to the pipe and attached to the buffer beam by two 1/16 in. or 10 B.A. screws. The pipe on the engine is located to the right of the drawbar (on your left if you face the smokebox) and to your left on the back of the tender, about ⅜ in. from the drawbar hook.

Coupling Between Engine and Tender

On the inside of the drag beams, level with the bottom of the slot, rivet or screw a ¾ in. length of ½ in. x ⅜ in. x 3/32 in. angle. If the unequal angle is not obtainable, use ½ in. and file away the unwanted portion, or else bend it up from 13-gauge strip metal. On the centre line of the engine, ½ in. from the edge of each drag beam, drill a No. 20 or 11/64 in. hole, continuing it down right through the angle.

THE actual coupling bar is merely a 2½ in. length of ⅛ in. x ⅜ in. flat steel drilled as shown and rounded off at the ends, whilst the pins are ordinary 5/32 in. commercial split pins. If you drop one in the grass when coupling up or uncoupling on an outdoor track, don't bother searching—just get another. Slightly open the end on the pin in the engine but leave the tender pin straight to get it in and out easily.

For normal running on a straight line with easy curves, the pins are put in as shown, but for sharp curves it is advisable to allow for more play between engine and tender, hence the extra hole.

Tender Hand Brakes

Whilst the tender job is in hand we might as well finish it off and be done with it, so I'll describe the tender hand-brake before dealing with the engine brake gear. The tender brake is of the usual pattern with a vertical spindle actuating a cross-shaft which carries a drop-arm to which is attached a pull-rod, operating the actual brakes via flat cross-beams. No compensating gear is fitted; many full-sized engines had no compensating gear on their tender brakes, the rods being adjusted so that all the brake blocks pressed on the wheel treads at the same time. Normal wear kept the pressure even on all wheels.

The first items will be the brake blocks and hangers. It is quite likely that our advertisers who sell "approved" castings will be able to furnish a set of cast-iron brake blocks for both engine and tender; and if so, a lot of work will be saved, as the only attention they will need will be drilling for the pin and slotting for the brake hanger. If no castings are available, the blocks can be cut from steel bar of ¼ in. x ⅝ in. section. Owners of a milling machine can cut six lengths off the bar, each just over 1⅛ ins. long, clamp them all together in a machine-vice on the table, and run the whole bunch under a cutter of the end-and-face type of the correct diameter, on the arbor. If a cutter of right diameter isn't available, a fly-cutter can be used. I made a fly-cutter for my milling machine in an hour or so: and a similar one can be made just as easily for use in the lathe. All I did was to turn a taper on the end of a short length of round steel bar, 1 in. diameter, to fit the taper hole in the spindle. A 5/16 in. cross-hole was drilled about ¼ in. from the outer end, and a ¼ in. setscrew fitted in the end so that when screwed home it projected into the cross-hole. To use it, an ordinary roundnose lathe tool was put through the cross-hole with the business end projecting the same amount as the required radius and the setscrew well tightened. The cutting edge then swept a circle when the machine was started: and the work was set in a machine-vice at the correct height and traversed under the cutter which promptly carved out the radius. There isn't even any need to turn a taper on the bit of bar for lathe use as it can either be held in the three-jaw chuck or a longer bar used between centres. The machine-vice is, of course, mounted on the lathe saddle.

Another way to cut the radius in the lathe is to scribe a circle 2¾ ins. diameter on a bit of ⅛ in. brass plate and solder the brake-block blanks to the plate with their ends touching the scribed line. The whole lot is then bolted to the lathe faceplate with the centre of the circle coinciding with the lathe centres; and with a boring tool in the slide rest the inner edges of the blocks can be "bored" to correct radius. However, if you find you are unable to machine out the radii, the humble but necessary file used with discretion can be made to do the job. Use a wheel to gauge the radius; and "mike" measurements are unnecessary.

Slots in the backs of the brake blocks can be machined by clamping in a machine-vice in the lathe saddle, and running under a saw-type slotting cutter ⅛ in. wide mounted on a spindle between lathe centres. Alternatively, a couple of hacksaw blades side by side in the frame will rough out the slots and a thin flat file, as used for forming wards in keys, will easily true up the slots to required size. Filing the blocks to the given shape and drilling the holes for the pins requires no description.

Hangers and Pins

Brake hangers are merely 2 ins. lengths of ⅛ in. x ¼ in. flat steel drilled as shown in the illustration and the ends nicely rounded off. Put a brake block over each hanger and squeeze a 5/16 in. length of ⅛ in. round silver-steel through the lot. Don't forget you want three right-hand blocks and hangers and three left-hand. You can't turn them upside down to counteract a mistake as the pinhole for the brake block isn't in the middle of the hanger; so watch your step!

For the hanger pins, chuck a piece of ¼ in. round steel rod in three-jaw. Face off the end and turn down ¼ in. of the end to ⅛ in. diameter. Slip one end of the hanger over it, then screw down with a die in the tailstock holder till the die just touches the hanger. This ensures that when the nut is at the end of the thread the hanger is still free. Part off at ¾ in. from the end; reverse in chuck, turn down ¼ in. length to ⅛ in. diameter and screw ⅛ in. or 5 B.A. This end is put through the hole in the frame and nutted on the outside; the plain part is on the inside of the frame. The hangers are mounted on the inner ends; and in that position the brake blocks should line up nicely with the wheel treads.

Beams

Three pieces of flat mild steel rod of ½ in. x ⅛ in. section and a full 4¼ ins. long are required for the brake beams. Chuck truly in four-jaw, face off, and turn ¼ in. length to ⅛ in. diameter. Further reduce a bare ⅛ in. length to 3/32 in. diameter, and screw 3/32 in. or 7 B.A. Repeat on each end of each beam and file or mill them to the shape shown in the illustration. In two of the beams drill two No. 40 holes on the centre-line a full ¼ in. apart as shown, and in the other drill one only, ⅛ in. from the edge; *not* in the centre or the pull-rod fork won't reach it. This single-hole beam goes between the trailing pair of hangers; the others fit between the leading and middle pairs. Put them in place and secure with ordinary commercial steel nuts, as shown in beam assembly sketch.

Brake Shaft

Brake shaft is made from a piece of ¼ in. round mild steel 5 ins. long. Chuck in three-jaw, face the end, and turn down 5/32 in. lengths to 5/32 diameter. Reverse in chuck and repeat operation; the shaft should then be 4 13/16 ins. between shoulders. The shaft carries three arms altogether; two of these support the brake nut and the other is connected to the first pull-rod. Both the former arms are made from ⅜ in. x 3/32 in. steel strip. One of them is fixed and one adjustable; if you didn't have one removable you couldn't get the nut between, as the pivots are turned solid with it. First of all, file or mill out the two arms to the shape shown in the illustration; drill two holes in each at ⅞ in. centres with No. 40 drill and slot those at the narrow end of the arm as shown, the slot extending 3/32 in. each side of the centre. The hole in the large end of one arm is opened out with 15/64 in. drill and reamed ¼ in. so as to be a tight fit on the brake shaft. The other arm has a boss. To make it, chuck a bit of ⅜ in. round rod in the three-jaw and turn a ⅛ in. pip on the end to a tight fit in the No. 40 hole. Part off at 5/32 in. from the end. Squeeze the pip into the hole and braze or silversolder it; that process ought to be second nature to "Roedean" builders by this time. Clean up, then chuck the boss in the three-jaw; face off the fragment of pipe protruding from the arm, centre it, drill 15/64 in. and ream 1/4 in.

THE drop-arm is simply a bit of 1/8 in. steel filed or milled to a pear shape, with a 1/4 in. reamed hole one end and a No. 30 drilled hole in the other. Use either drilling machine or lathe, as the holes *must* go through square. Squeeze this on to the brake shaft so that it is exactly in the middle; then put on the arm with the boss which should point toward the drop-arm. Now put on the plain arm and set it 1/8 in. from the end and at right angles to the drop-arm; when the drop-arm is hanging straight down, the longer arms should be to your left and pointing towards you as shown in the erection view. The two fixed arms are then brazed or silversoldered to the shaft and the whole lot cleaned up.

Brackets to carry the shaft are filed up from 1/8 in. x 1/4 in. steel rod and drilled as shown, a simple job needing no detailing. They are attached to the frame by two 6 B.A. screws and nuts in each as shown in the erection sketch. Fix one at the extreme end of the frame so that the centre of the bearing hole is 3/8 in. below the bottom of the frame at this point; then put the brake shaft temporarily in place, put on the other bracket, and clamp it temporarily to the frame with a toolmaker's cramp, adjusting the brake shaft until it is square across the frame and quite level. Then tighten cramp, and use the holes in the bracket as a guide for the drill, when drilling the corresponding holes in the frame.

Brake Column

Hand-brake column is turned from a piece of brass rod 7/16 in. diameter and 3 3/8 ins. long. The first job is to get a No. 30 hole clean through the full length. An ordinary drill of that size won't do it because it isn't long enough and unless you have an extra long drill (I have; they are sold commercially) you'll have to do the job with a D-bit. Make a D-bit from a piece of 1/8 in. silver-steel about 3 ins. long; harden and temper to dark yellow. Chuck the bit of brass rod in three-jaw, face, centre, and put an ordinary No. 30 drill in as far as it will go; say to the end of the flutes, but keep withdrawing and removing chippings. Then put the D-bit in the tailstock chuck with about 2 1/4 ins. standing out from the jaws, and carry on with that until almost full depth. Note, it is absolutely imperative to keep on withdrawing and cleaning chippings every 1/8 in. or so, otherwise the whole issue will jam up. Reverse the piece of rod in the chuck, then repeat the whole performance from the other end, first drilling and then D-bitting until the holes meet.

Next, push the rod back in the chuck until only about 3/4 in. is protruding. Turn down 1/2 in. length to 1/4 in. diameter and screw 1/4 in. x 40 with die in tailstock holder. Make a tapped bush from a bit of brass rod about 1/2 in. long and any diameter over 3/8 in. Chuck the rod in three-jaw; face, centre, and drill right through with 7/32 in. drill. Open out for about 1/8 in. depth with 1/4 in. clearing drill (letter F, or 17/64 in. will do) and tap the rest of the hole 1/4 in. x 40. Skim off any burr, then screw the brake column into it. Bring up the tailstock centre to support the outer end, the centre-point entering the drilled and D-bitted hole. Slew the top slide around just a bit and turn the column to a taper as shown, leaving a parallel piece 1/4 in. diameter and 1/4 in. long at the end, and a flange about 1/16 in. wide, and full diameter, at the screwed end. Make a nut from a bit of 3/8 in. hexagon brass rod to fit the screw.

Spindle is a piece of 1/8 in. round silver-steel or rustless steel approximately 5 7/8 ins. long. Chuck in three-jaw and put about 7/8 in. of 1/8 in. or 5 B.A. thread on the end. For the handle turn up a little piece of 1/4 in. steel rod to the shape shown in the illustration; centre and drill it No. 32 before parting off the length. Squeeze this on to the plain end of the brake spindle and drill a cross-hole with a No. 48 drill through the top part of it as shown. Cut a piece of 15-gauge spoke wire (you can buy 15-gauge cycle spokes at any cycle shop) about 1 3/8 ins. long, round off the ends; and squeeze it into the hole for 1/2 in., bending up the end to form the well-known fireman's muscle-tester. As followers of my childhood reminiscences will recall, I had the strange combination of relatively enormous physical strength in a slight girlish figure; and although the strength didn't develop in proportion to the figure, it remained well above average for many years. One night when firing a Willow-Walk—Portsmouth goods train—our air brake on the old "Vulcan" 0-6-0 temporarily failed when going down Ockley Bank with about fifty wagons; and trying to hold her with the tender hand brake, I managed to bend the handle. After that, whenever anything went amiss with a tender hand brake the shed staff always reckoned it was your humble servant's doing—"give a dog a bad name," etc. ! !

CHUCK a bit of 1/4 in. round brass rod in the three-jaw; face, centre, drill down about 1/4 in. depth with No. 32 drill, and part off a 3/16 in. slice to form the collar on the brake spindle. Put the spindle down the column and press the collar over the screw until it comes up against the bottom of the column as shown in the illustration. The spindle should be free enough to turn easily without moving up and down. The collar is pinned to the spindle by drilling a No. 53 hole clean through the lot and squeezing in a bit of 16 gauge steel wire. File flush each side.

Nut is made from 1/4 in. square steel or bronze rod. Chuck truly in four-jaw, face the end, and turn down 1/8 in. length to 3/32 in. diameter. Part off at 1/2 in. from the end, reverse in chuck—this is done by slacking No. 1 and 2 jaws, turning the bit of rod end-for-end and re-tightening the same jaws—and turn down 1/8 in of the other end likewise. Drill a No. 40 hole through the nut and tap to match the thread on the spindle.

At 3/4 in. from the front edge of the sole-plate and 2 in. to the left of the centre-line, looking at the front end of the tender, drill a 1/4 in. clearing hole right through the sole-plate and the top of the beam. Fit the brake column into this and secure it with the special nut underneath. Next, put the brake nut between the two longer arms on the brake shaft and set the movable one close up to the nut so there is just a small amount of play; the pins at each side of the nut must be able to move freely from end to end of the slots. Then pin the boss of the movable arm to the shaft by drilling a No. 43 hole through boss and shaft and squeezing in a piece of 3/32 in. steel wire or rod. Put the nut, with shaft attached, under the brake spindle and screw the spindle through it for about 3/8 in. or so; this will bring the shaft into the right position for erecting. Put a bracket on each end and attach the brackets to the frame by 6 B.A. screws and nuts as shown.

WHEN the brake handle is turned, the shaft should move quite freely, the slots in the arms on the brake allowing the nut to move up and down in a straight line.

All that remains is to couple up the drop arm to the first beam and couple the other beams together, and this s done by pieces of ⅛ in. round silver-steel with forks or clevises at each end. The forks are made from ¼ in. square mild steel. Take a piece long enough to clamp in the slide-rest tool holder and slot both ends as described for valve gear forks and other similar components; then saw or part them off to a little over finished length. Chuck again in four-jaw with the blank end outwards; face off, centre, and drill No. 40 into the slot, tapping ⅛ in. or 5 B.A. Turn ⅛ in. of the outside to a diameter of 7/32 in. Drill for the pin and round off the end. I usually drill the pinholes before slotting as the drill goes through perfectly square, a thing it doesn't always oblige in doing when put through in the ordinary way after slotting. It has a tendency to wander when doing the second side of the fork. If I have occasion to drill a slotted fork I always put a bit of scrap metal of correct thickness in the slot and the drill goes through the lot without deviating from the straight and narrow path.

The piece of ⅛ in. round steel for the front pull-rod should be approximately 3 in. long, and those for middle and rear 4⅛ in. long. Put about ⅛ in. of ⅛ in. or 5 B.A. thread on each end to match the threads in the fork. Screw them on tightly, then check measurements between centres of pinholes, adjusting if required. Either turned pins or ordinary 3/32 in. commercial split pins can be used for pinning the forks to the beams. For pinning the fork to the drop arm on the brake shaft, use a piece of ⅛ in. silver steel shouldered down to 3/32 in. at each end, screwed 3/32 in. or 7 B.A. and furnished with commercial nuts. The holes in the fork are drilled No. 30 to suit.

Engine Brakes

The full-sized "Schools" class engines are fitted with the vacuum brake apparatus. This consists of a huge cylinder no less than 30 ins. in diameter, actuating a long horizontal lever on a hefty cross-brake shaft from which the power is transmitted to substantial double-tapered cross-brake beams, the ends of these being attached to brake hangers on the frame in the usual way. Pull-rods are central and have compensation gear; the brake hangers and brake blocks are rather smaller than the usual Southern pattern.

There are two main objections to copying this arrangement exactly on our little engine; one is that the fitting of an ejector for creating the vacuum for operating the brake is taking unnecessary time and labour when the brake apparatus is fitted to the engine only and not used for service stops. The more serious objection is that the central pull-rods would pass underneath the ashpan and so prevent it from being dropped to remove ash and clinker after a run. If the brake gear were fitted as per big sister, it could not be operated successfully by steam instead of vacuum, as the cylinder is far too large and the power impulse is upward, which would necessitate admitting steam under the piston and fitting an outsize in glands to the piston-rod. I have therefore substituted a simple form of steam-operated brake which only needs a small steam cylinder and employs a form of rigging which leaves the ashpan quite clear, allowing same to be dropped for cleaning-out purposes.

Steam cylinder, with a brake shaft complete with power lever and two drop-arms for operating the side pull-rods, are mounted on a self-contained cast frame. They can be finished and assembled as a single unit, which simply needs putting between the frames and securing by a few screws. The two side pull-rods are connected by special pins to the bottoms of the trailing-wheel brake hangers; and from these, extension rods connect with the driving-wheel brake hangers which are kept at correct distance apart by a plain round tee-rod and two distance pieces or spacers. The brakes are operated by a very simple but realistic two-position driver's brake valve. Now to construction.

Brake Blocks and Hangers

There is no need to go into full details of these as they are made by exactly the same methods described for the tender hand brake. The hangers are just filed or milled from ⅛ in. x ¼ in. mild steel rod to the given dimensions and outline, and drilled No. 30 as shown. The lower ends of the trailing-wheel hangers require special pins, as shown in the detail sketch. Part off two pieces of ¼ in. round mild steel, each ⅞ in. long; turn down ¼ in. of one end to ⅛ in. diameter, and screw ⅛ in. or 5 B.A. Reverse in chuck, and turn down 5/16 in. length to ⅛ in. diameter but only put a bare ⅛ in. of thread on it. The ¼ in. end is pushed through the hole at the bottom of the hanger and secured with an ordinary commercial nut. Don't forget you need one right-hand and one left-hand, as the hangers are not reversible. The threads can be burred over slightly to prevent the nut slacking; alternatively you could, if you so desire, leave the spigot plain instead of screwing it, simply push it through the hole in the hanger and rivet it over. The pins, once assembled, never have to come out any more.

If our approved advertisers cannot supply small cast-iron brake blocks, cut them out of steel, of ¼ in. x ⅝ in. section, as described for tender blocks; slot and drill same way. The blocks are attached to the hangers by ⅛ in. silversteel pins, which should be a driving fit in the blocks but a working fit in the hangers.

Hanger pins are turned up from ⅞ in. lengths of ¼ in. round mild steel, as described above. The longer screwed ends go through the holes already provided in the frames, and are nutted inside. The hangers, with blocks complete, are then placed over the plain part of the pin and secured by 3/32 in. or 7 B.A. nuts. When these are screwed up tightly, the hangers should be free to move "fore and aft," as our nautical friends would say, but have no appreciable side movement.

Gear Frame

GEAR frame is a casting and requires very little in the way of machining. The two hanging lugs for supporting the brake shaft may be left straight when cast, but a bronze or gun-metal casting is ductile and the lugs may easily be bent so that the outside measurement at the bottom ends is 2½ ins., as shown in the cross-section. The ends of the girder are faced off to fit between the frames and should measure 2⅞ ins. over the outside. The facing can easily be done in the lathe with the casting held on the slide-rest and traversed across an endmill or slot drill not less than ⅝ in. diameter, held in three-jaw. It could also be held in a four-jaw chuck and the ends faced off with a roundnose tool set crosswise in the rest. A little careful hand-filing will also do the trick; test with a try-square. The inside faces of the two lugs for carrying the brake cylinder are smoothed off to allow the bosses on the sides of the brake cylinder to fit nicely between; the correct distance apart is 13/16 in. If the clearance for the fork or crosshead isn't cast in (or out!) the opening can be marked out, and then cut by sawing across from corner to corner and filing to the outline shown.

As the brake shaft must lie squarely across the frame, mark off the position of the holes at the bottom of the lugs, centrepop them, and drill a No. 30 hole at each point. Beginners should put the drill in the three-jaw, hold one of the pop marks against it, then bring up the tailstock of the lathe, and enter the centre-point in the other pop mark. Feed on to the drill by turning the handwheel on the barrel; then reverse the whole issue and put the tailstock centre in the hole first drilled whilst you drill the other one. The holes are then certain to be in line. Put a bit of ⅛ in. silversteel rod (which is usually dead straight) through both holes, and you'll see at a glance if they are O.K. or not. If by chance, the steel rod doesn't lie true and square across the frame, correct the holes with a rat-tail file; then finally open out with 15/64 in. or letter C drill, and put a ¼ in. parallel reamer through both holes. The holes for the cylinder trunnion pins may be drilled in similar fashion; start with No. 40, and finish with No. 30.

Brake Shaft

Brake shaft is made from a piece of ¼ in. round mild steel, faced off at each end to a length of 2⅞ ins. Turn down 3/16 in. of each end to 7/32 in. diameter. The two drop-arms at the ends are made from ⅜ in. x 3/16 in. flat steel rod. Beginners should get a piece of rod long enough to hold in the slide-rest tool-holder, then drill a No. 32 hole about 5/32 in. from each end. The piece of steel can then be held in the tool-holder, and each end slotted in turn by running it up to a 3/32 in. saw-type cutter, mounted on a spindle held in the chuck, same as described for forming slotted ends in valve-gear components. Use plenty of cutting oil and run the lathe at slow speed. If no cutter is available, start with a hacksaw and finish with a watchmaker's flat file or a key-cutter's warding file. Next, at 5/16 in. from the centre of each cross-hole, make another centre-pop, drill it out with 13/64 in. drill and finish with either 7/32 in. drill or reamer. Saw off the drilled and slotted ends and file to the shape shown. These arms should be a squeeze fit on the ends of the brake shaft, so if you are doubtful about the accuracy of your drills or reamer, make the holes first and turn the ends of the brake shaft to suit them.

The long lever which takes the thrust of the brake cylinder is made from ⅜ in. x ⅛ in. flat steel rod, filed up to the given dimensions. Boss is made and fitted exactly as described for the bossed lever on the tender hand-brake shaft, so there is no need to repeat the instructions in full. The boss is drilled 15/64 in. or letter C drill, and reamed ¼ in., both operations being done with the boss held in three-jaw, lever outwards; centring, drilling, and reaming being carried out just as specified for the similar one on the tender.

Squeeze one of the drop-arms on the end of the brake shaft and put the shaft through the holes in the cast frame, threading the long lever on as you put the shaft through; then squeeze on the other drop-arm, so that the assembly looks like what is shown in the end view illustration. The long lever must be set centrally, and the two drop-arms exactly opposite to it, as shown in the elevation. Don't pin the rods yet, in case any slight adjustment is needed when the unit is assembled.

MAKING the brake cylinder is quite simple after the job of making the engine cylinders. Our "approved" advertisers will be able to supply the necessary castings. As the cylinder hasn't any steam chest it can be held in either the three-jaw or four-jaw chuck, the flange faced off, and the corehole bored out and reamed to ⅜ in. diameter by the same process described for the engine cylinders. The covers are also turned and fitted, same as the bigger ones, attachment being made by four 9 B.A. screws in each. No piston-rod gland is needed, as steam doesn't go in that end at all. Drill a small vent hole in the front cover with a 1/16 in. or No. 52 drill; this will destroy any vacuum and also allow an occasional spot of oil to be introduced with a small syringe or pressure-feed oil can. Very little lubrication is required; as a matter of fact, the graphited yarn on the piston would probably provide all the lubrication needed for the small amount of movement that the cylinder is likely to be called on to provide. However, no engine-driver worthy of the name, or the tradition of his craft, would be happy if the oil supply to any part of his engine is at all doubtful; and the provision of the oil hole will set his mind at rest!

After locating the back cover (the plain one) and drilling and tapping the screwholes in the cylinder flange, scribe a line vertically across the cover as shown in the back view. Centrepop this for the two holes shown, both of which must be drilled so that they don't overlap the ⅜ in. spigot which registers in the bore of the cylinder. The upper hole, drilled No. 31, is left plain as a short length of ⅛ in. pipe is silversoldered into it. The lower hole is drilled 5/32 in. or No. 22, and tapped 3/16 in. by 40. Make up a cylinder cock, exactly as described for the engine cylinders, and screw it into the hole as shown. When the frame carrying the cylinder and shaft, etc., is erected, a wire handle projecting up through the footplate is coupled to the cock so that condensate water can be blown out before operating the brake gear.

Piston-rod

Piston-rod is a piece of ⅛ in. rustless steel, or bronze rod, 1 3/16 ins. long, with a few threads, ⅛ in. or 5 B.A., on each end. The piston may be turned from a piece of bronze or gunmetal rod, any size over finished diameter; the method of turning and fitting it is exactly the same as described for the engine cylinders, so we needn't wade through all the rigmarole again. The fork or crosshead is the same as on the tender brake gear. The two bosses for carrying the trunnion pins are smoothed off at the ends, centred, drilled No. 48 and tapped 3/32 in. or 7 B.A.; take care you don't "overshoot the platform" and pierce the cylinder bores. The pins themselves are turned up from 3/16 in or 7/32 in. hexagon steel rod held in three-jaw, which is another kiddy's practice job needing no detailing.

Bend up a tiny ring from 1/16 in. wire, leaving a stem on it about ⅛ in. long. Screw this 1/16 in. or 10 B.A. Drill and tap a corresponding hole in the cylinder flange at the front end, right at the bottom, and screw in the ring. This is the anchorage for the pull-off spring, as shown in the elevation drawing of the complete gear. Now assemble the cylinder temporarily, and put it in place in the gear frame, coupling the fork to the top of the long lever by a pin made from a bit of 1/8 in. round silversteel shouldered down to 3/32 in. at each end, screwed, and furnished with ordinary commercial nuts. No need to put any paper gaskets between covers and cylinder yet.

Pull Rods

Pull rods may either be cut from solid or built up. If the former, mark out one of each length on a piece of 1/4 in. x 3/32 in. steel strip; drill the holes, using the drilled pieces as a jig or guide to drill two similar pieces, then temporarily rivet each pair together and cut them out by milling or filing, exactly the same as described for coupling rods. If built up, use pieces of 1/8 in. x 3/32 in. strip for the rods and 1/4 in. x 3/32 in. for the eyes. File up and drill the eyes, leaving a little tag on each, which is filed away for half its thickness; file away half the thickness of each end of the rod to suit and form a stepped joint, which is brazed or silversoldered. The eyes can be riveted lightly to the rods by pieces of domestic pins to hold in place whilst the brazing operation is taking place.

Tie rod which goes between the front hangers, is a piece of 1/4 in. round mild steel 4 1/8 ins. long. Chuck in three-jaw and turn a bare 11/16 in. of the end to 1/8 in. diameter; then further reduce 1/8 in. length to 3/32 in. diameter and screw 3/32 in. or 7 B.A. Reverse in chuck and repeat operations. The two distance-pieces or spacers are also made from 1/4 in. round steel rod held in three-jaw. Face, centre, and drill No. 30 for about 7/8 in depth, then part off two 5/16 in. full lengths.

Assembly and Erection

Put one end of each long pull-rod over the ends of the tie rod; put a distance-piece on the outside of the pull rod, then set the lot between the front pair of brake hangers as shown in the plan view and secure with ordinary commercial nuts. Don't strain the hangers to get the tie rod in place; take one off and do the job easily. The rear ends of the pull rods are then placed over the pins at the bottom of the trailing hangers, as is also shown in the plan view.

Put one end of each rear pull rod in the slot in the drop arm on the end of the brake shaft and pin by squeezing a piece of 1/8 in. silversteel through the lot, filing flush each side. The gear frame can then be erected as one unit. Four No. 34 screwholes are needed in the main frames just behind the trailing hornblocks. The first is drilled 3/8 in. behind the hornblock and 5/32 in. from bottom edge of frame, and the second 5/16 in. behind it. The other two are drilled 9/32 in. above the first two and the whole lot is countersunk. Now put the complete gear-frame assembly in place, and adjust it so that the brake shaft is 13/16 in. below the bottom of the frame and 2 1/2 ins. from the rear end, as shown in the elevation view of the complete brake gear. Hold temporarily in that position, then run the 34 drill through the screwholes in frame and make countersinks on the contact faces of the gear frame. All this can easily be done between the wheel spokes there being no need to dismantle anything. Remove gear frame, drill the countersinks No. 44 and tap 6 B.A. Replace frame, put a couple of screws in each side and put the loose ends of the rear pull rods over the pins in the bottoms of the rear hangers. Operate the long lever with your fingers and note if the blocks all touch the wheel treads together. If they don't, it is simply a matter of adjusting one of the drop arms until they do.

WHEN O.K., take the frame out again and remove the cylinder. Pin the drop arms and long lever to the shaft with bits of 15-gauge spoke wire driven through No. 49 holes drilled through bosses and shaft. Take off back cylinder cover and in the top hole silversolder a couple of inches of 1/8 in. copper tube, with a 1/4 in. x 40 union nipple (made as described for boiler fittings) on the other end. Wash off, clean up, bend into a swan-neck as shown in plan, then fix the cover with an oiled paper gasket between cylinder and flange; also replace the drain cock. Put a similar gasket between front cover and flange, then replace cylinder and couple up the fork to the lever. Wind up a close-coiled spring from 22-gauge tinned steel wire and hook the ends through the hole in the long lever and the eye in the cylinder. Replace the frame, put all the screws in, connect the front ends of the pull rods to the rear pair of hangers and put the nuts on.

Extension handle for the drain cock is made from a piece of 1/16 in. steel wire flattened at one end and pivoted to the handle of the cock by a 1/16 in. or 10 B.A. screw in the same way as the connections on the engine cylinder cocks. The handle goes up through a No. 50 hole drilled in the drag beam. You now have a working steam brake gear which allows the ashpan to be dropped, but *don't use it for service stops*, as you will probably lock the wheels, make them slide (enginemen call it "picking them up") and make flats on the treads. Use the brakes on the passenger car for service stops; the steam brake can be applied in addition, in cases of emergency.

Driver's Brake Valve

We now come to the final job, to wit, the making and fitting of the driver's brake valve. It will be noticed that it is of a different pattern from that which I specified for "Princess Marina" inasmuch as the moving part is entirely enclosed, steam pressing the valve on its face instead of tending to push the faces apart against the pressure of a spring. Whilst the earlier valve was perfectly satisfactory in action and did not leak if properly made and fitted, some builders apparently had difficulty in getting the working faces steam-tight, and any slight leakage of steam near the handle naturally made it uncomfortable to operate. In the case of the valve shown here no steam whatever can escape from the casing; and any leakage past the valve is just blown away through the exhaust pipe under the footplate, so cannot damage the operator's fingers.

Valve Body

Body is made from 3/4 in. bronze or gunmetal rod. Chuck a piece in the three-jaw, face the end, centre with a small centre-drill, letting it make a countersink about 1/8 in. diameter, then drill about 1/4 in. depth with No. 51 drill. Part off at a full 3/16 in. from the end. Scribe a circle 5/16 in. diameter on the countersunk side and a straight line right down the centre. Where the lines cross make a centrepop. At the opposite side where the lines cross, and at 3/32 in. each side of the intersection point, make two more dots. Drill these out to a depth of 3/32 in. full just over halfway through the block, using either 1/16 in. or No. 52 drill. Next, using the same drill, drill three holes edgewise in the block, letting them break through into the previously drilled ones. Open out for about 3/32 in. depth with No.

32 drill, then silversolder a piece of 1/8 in. thin-walled copper tube into each one. The pipe in the single upper hole should be about 3 ins. long and those in the lower holes about 6 ins. long.

FACE off the countersunk side of the block by rubbing it on a piece of emerycloth or similar abrasive, laid business side up, on the lathe bed or something equally flat and true, same as I specify for slide valves and other parts needing a perfectly true flat face. Be careful not to leave any grains of the grinding material in the ports: wash off in a little paraffin.

To make the cover, chuck the rod again, face the end truly, then cut a recess in it 9/64 in. deep and a full 1/2 in. diameter. The easiest way of doing this is to centre it, put a 1/2 in. drill in until it has just cut to the full diameter (the depth of the cutting edges) and finish with a 1/2 in. D-bit. If you haven't a D-bit (they are easy enough to make, and I have described several times how to do the job) use a square-ended boring tool. Part off at a full 7/32 in. from the end. On the centre-line of the flange set out five points at equal distances apart, centrepop them and drill No. 51. Exactly opposite one of them and 5/32 in. from centre, drill a No. 55 hole and tap it 1/16 in. or 10 B.A. This is for the stop screw. Temporarily clamp the cover to the block with the hole for the stop screw at the top; run the 51 drill in all the screwholes, making countersinks on the portface; remove the cover, drill on the countersinks No. 55, and tap 1/16 in. or 10 B.A. Rub the faces on the emerycloth again to remove any burring caused by the drilling and tapping.

Circular Valve

Chuck a length of 1/2 in. round bronze or gunmetal rod in the three-jaw and take a small skim off about 1/4 in. length of it, so that it will easily enter the recess in the cover. Face the end, centre, and drill No. 55 for about 1/4 in. depth. When centring, let the centre-drill make a countersink to correspond with the one in the port face. Part off at 7/64 in. from the end, and then carefully tap the centre hole with a 1/16 in. or 10 B.A. taper tap, leaving the thread on the small side. Now be very careful about the next job. Take a good look at the drawing of the valve and then bear in mind that you are looking at the *back* of it. Scribe two lines at right angles right across the centre. At 5/32 in. from centre, on the horizontal line and to the left of centre, make a pop-mark and drill a hole clean through the valve at that point with a 1/16 in. or No. 52 drill. Also at 5/32 in. from centre on the vertical line drill a similar hole. Drill yet another, still 5/32 in. from centre, but 3/16 in. to the right of the last one. Run these two into an elongated slot, as shown, by aid of a rat-tailed file or preferably an "Abrafile" if you have one.

Now turn the valve over: scribe a vertical line across it, corresponding to the vertical line on the back. Be sure you get that dead true. At 3/32 in. each side of this and 5/32 in. below centre make two dots and drill *only halfway through* the valve. Connect these two "behind" holes by chipping a groove between them; you can easily make a suitable chisel from a bit of 1/8 in. silversteel, the cutting edge being 1/16 wide. Harden and temper as described for the injector reamers. Now carefully face off the grooved side of the valve by rubbing on the emerycloth as above.

The valve spindle is a piece of 1/16 in. or 16-gauge rustless steel or nickel-bronze wire 11/16 in. long. It must be perfectly straight. Put 3/32 in. of thread on one end and 5/32 in. on the other, either 1/16 in. or 10 B.A. to match the tapped hole in valve. Do this job with the wire in the three-jaw and the die in the tailstock holder as the threads *must* be true. Chuck the valve faced side outwards in three-jaw, setting to run truly; put the spindle in the tailstock chuck, shorter threaded end outwards, and screw the spindle into the valve exactly as I described for fitting the pistons to the rods. It must fit tightly.

For the handle chuck a bit of 3/16 in. round rod in the three-jaw; face, centre, drill about 3/16 in. deep with No. 55 drill and part off a slice, a full 3/32 in. thick, or you can make it wider if you like—it doesn't matter a bean. Drill another No. 55 hole in the edge of this, and tap them both either 1/16 in. or 10 B.A. to match the spindle. The handle can be turned up from a scrap of 1/8 in. nickel-bronze or rustless steel rod, a simple job needing no detailing; screw it into the tapped hole in the side of the little collar.

Assembly and Erection

Put a spot of cylinder oil between the working faces of valve and port block, then poke the spindle through the hole in the latter. Attach the cover to the port block by five 1/16 in. or 10 B.A. roundhead brass screws, putting a little gasket made from thin oiled paper between the contact faces. Make certain this doesn't extend inside, or it will throw the valve off its face and cause a blow-by.

FILE the threads off another similar screw all except about 3/32 in. close to the head and screw this into the stop-screw hole, turning the valve around until the threadless end of the screw enters the steam slot. Note, when attaching the cover, that the stop-screw hole must be at the top of the valve in line with the steam inlet pipe as shown in the illustrations. A smear of plumber's jointing on the threads will prevent any steam leakage.

Wind up a little spring from 22-gauge tinned steel wire, put it on the spindle and screw the handle on to the end of the threads. With the spindle pointing towards you, turn it in a clockwise direction until the end of the steam slot catches the stop pin. This is the "brake on" position, and the handle should be adjusted until it stands vertical: secure it with a commercial nut used as a locknut as shown in the illustration. When the handle is pulled back the other end of the steam slot should come up against the stop pin when the handle is about 30 degrees from horizontal: this is "brake release" position.

To erect the valve, drill a hole with No. 48 drill about 1/8 in. deep in the edge of the valve as shown in the erection sketch, and tap it 3/32 in. or 7 B.A. Turn up a little distance piece about 1/2 in. long from 1/4 in. round rod with a 3/32 in. or 7 B.A. screwed pip at each end; just another kiddy's practice job. Screw this into the hole in the edge of the valve. Drill another No. 48 hole in the backhead close to the steam gauge (the exact position doesn't matter, as long as the brake valve doesn't foul any of the other fittings) and tap that 3/32 in. or 7 B.A. Make up a little elbow union fitting from a piece of 1/4 in. round brass rod about 3/8 in. long: chuck in three-jaw, face, centre deeply, and drill No. 40 for about 1/2 in. depth. Screw the outside for about 1/4 in. length with 1/4 in. x 40 die. Drill a 5/32 in. hole in the side at the blind end: and in it silversolder a little fitting, same as used to attach the whistle valve to the boiler. Drill and tap a hole in the wrapper, to suit, a little to the left of the whistle valve, and screw in the elbow with a smear of plumber's jointing on the threads.

Now hold the brake valve temporarily in place and cut the pipes to length to reach the elbow, and the union fitting on the brake-cylinder steam pipe. Put a union nut on each and silversolder a union cone to each of the pipes. The brake valve can now be screwed into the tapped hole in the back-head—you can temporarily bend the pipes to enable it to be easily turned—and then the pipes can be connected to their respective unions as shown in the diagram. The exhaust pipe is left open below the foot-plate.

The reason I specified the pipes silver-soldered directly into the port block was for neatness' sake, as small unions are very much outsize when compared with those on a big engine: but anybody who cares to do so may substitute union fittings at the three places on the valve body where the pipes are silversoldered in. They can be made from ¼ in. hexagon rod.

How the Valve Works

As the "thoroughfare" steam slot in the valve is always over the steam port, whatever the position of the handle, it naturally follows that the cavity in the cover is always full of steam which holds the valve on its face irrespective of the spring outside. The latter is merely provided to keep the valve and port face in contact when there is no steam in the boiler, and so prevent scale and grit getting between the truly-faced surfaces and causing a blow-by. When the brake handle is pushed forward the small hole drilled right through the valve moves round and lines up with the port leading to the brake-cylinder pipe. Steam at once rushes down the pipe to the cylinder, pushes out the piston, and applies the brakes. Before working the brakes the drain cock should be opened to let any condensate water be blown out; this need only be done when the engine is starting from "all cold."

When the brake handle is pulled back the steam hole in the valve moves away from the port, which is thus closed; further movement of the handle brings the groove in the valve face over both the steam and exhaust ports. Steam from the brake cylinder is thus allowed to escape via the groove and the exhaust pipe, and the pull-off spring releases the blocks from contact with the wheels. The stop screw prevents the handle being moved too far either way, and it serves a double purpose as it may be removed and a few spots of cylinder oil squirted through with a small syringe or force-feed oiler. This not only lubricates the valve, but the rush of steam, when applying the brake, takes some oil down into the brake cylinder and keeps the piston from running dry.

Warning—although this brake works and is pretty powerful it must not be used for "service stops," or the wheels will lock, slide, and develop flats on the treads. Any passenger engine-driver will tell you that the engine pulls the train, but the train stops the engine, as all the coaches are fitted with continuous brakes. The little engines pull a greater proportionate load, and travel at a higher proportionate speed, than their big sisters: and advantage should be taken of the load by fitting good brakes to the passenger cars and using them exclusively for service stops.

There was one thing I forgot to mention when dealing with the erection of the brake-gear frame under the trailing end. The injector may foul the brake cylinder: if so, all you have to do is to shift the injector a little to clear, which merely entails bending the steam and water pipes.

THESE notes conclude the work of building a 3½ ins. gauge Southern "Schools" class engine; and I hope all those now in course of construction will turn out to be as good, hard-working, reliable and sturdy as their big sisters have been. I have included all the fundamentals of the full-sized locomotive, viz., three cylinders, three independent sets of valve gear, a fast-steaming boiler with high superheating equipment, mechanical lubrication and so on; things which the "old school" said were "utterly impossible." I have seen a commercially-made locomotive of this type with two small cylinders, no superheat worth writing home about, and the inefficient boiler fed merely by a hand-pump in the tender, sold at a price running well into three figures. It was proudly described as a "scale model"—perhaps that will explain to some extent why it is an insult to apply the term "model" to a *real* little locomotive like "Roedean."

The engines were originally painted a pleasing shade of green, lined out in black and white. During the war years some of them were painted plain black. British Railways are also painting them black but lining them similar to the old London and North Western engines, with grey bands edged in red and cream. Why they should be painted thus instead of the regular passenger colours of blue or green has aroused some controversy, as they are not mixed-traffic engines but express passenger engines "pure and simple." However, builders of "Roedean" can take their choice! There is nothing difficult about painting a little locomotive. The engine must be thoroughly cleaned; the parts to be painted must be entirely free from any suspicion of oil or grease, and I find that a good clean-down with some petrol (it doesn't need much!) will do the needful. Warning—do this job outdoors on a warm dry day. If you do it indoors, or even in your workshop, there is risk of fire, and the smell will hang around for days.

My experience of painting is that the less you put on the better, provided that the metal is covered and doesn't show any "bald patches"; so I never use any under-coating, simply painting with a camel-hair or similar brush as used by water-colour artists. I have seen engines looking as though the paint had been applied with a trowel! If the first coat doesn't hide the metal, let it dry well and apply a second coat, which should do the trick. Ordinary air-drying does quite well for cab, splashers, tender and other parts which do not become very hot when the engine is in steam: but the boiler requires special treatment. I have found that the following wheeze answers perfectly. No special kind of paint is needed; any good brand of enamel, as used for domestic radiators, baths, hot-water cans and suchlike does fine, or a good synthetic hard-gloss paint may be used.

After cleaning the engine down as above, fill the boiler nearly full with warm water; just lukewarm will do, then go right ahead and carefully paint it, keeping the colour thin, even, and free from brush-marks. If any hairs come out of the brush and stick to the boiler pick them off with a pair of tweezers. When through, stand the engine in some place within reach of a gas point. Rig up a little bunsen burner (the self-blowing blowpipe which I described and illustrated some time ago, made from a bit of ⅜ in. boiler tube, is just the berries for this job) and couple it to the gas point by a flexible pipe. Light up, turn down the flame so that it is silent, bluish-orange colour and about 1½ ins. long, and poke the end of the blowpipe through the firehole door so that the flame is about in the middle of the firebox. This will gradually heat up the water to just below boiling point but won't make steam. Let it stand thus for about 12 hours all told; they need not be continuous. By the end of that time the coating of paint or enamel will have set hard. Oil spots will not affect it; and a rub with an oily rag or bit of cotton waste will make it what the old-time engine-cleaners used to call "bobby-dazzle." Whilst the "stoving" process is going on the engine should be protected from dust by being covered with a sort of tunnel made from thin cardboard or stiff paper.

Anybody with a steady hand should have no difficulty in lining out. Lining brushes can be bought cheaply at any oil-and-colour merchant's store; and the brush can be coaxed to draw long straight lines by guiding it with a ruler packed up clear of the metal. Curves can be put in by guiding the brush by aid of a cardboard template cut out of an old cardboard box, or anything else that might be handy. If you find that painted-on lines are beyond your scope the lining can be put on by means of transfers, which are used to line out bicycles, etc., and can be purchased at cycle shops and certain motor garages.

In conclusion, here are two or three hints on running the engine. I have already explained several times how to get up steam. When starting away from all cold, don't put any load behind the engine; open the cylinder cocks and let her run slowly in full gear until dry steam issues from the cocks, indicating that the cylinders are at working temperature. Then you are ready for a load. Always start in full gear, opening the regulator just enough to get the load under way. I have seen numerous people on club and exhibition tracks trying to "show off" by smacking the regulator open and making the driving wheels spin like a buzz-saw. If these misguided folk knew what *real* drivers thought of their antics, they would hasten to hide their diminished heads in shame! When the engine "gets hold of the load," as the enginemen call it, gradually bring the reversing gear back until you feel the engine begin to "kick," then advance it just sufficient to stop the "kicking." That is your best running position and the most economical from the steam-using point of view. Speed can be governed by the regulator. In full-size, with a normal load, the regulator would be wide open but I'm afraid that unless the load was very much outsize and sufficient to hold her back, the little "Roedean" would just accelerate and run clean off the road, with the regulator wide open. Any of my own engines would.

When approaching a curve, on a continuous line, and running at a good speed, do exactly the same as a full-size driver would do, viz., shut off steam and make your brake application to reduce speed *before you get to the curve*. Then open up again and take the curve under steam. The engine then kind of "pulls herself straight," as we used to say. Try and adjust the pump bypass valve to keep the water about three-parts up the glass; not high enough to cause priming, but keeping plenty over the firebox crown sheet. The proper time to pop a bit more on the fire is when the coal is fully incandescent, and the safety-valves are just going to blow off. Don't put too much on at once. After finishing a run, dump the residue in the firebox, replace grate and ashpan, give the engine a thorough clean down as the surplus oil wipes off easily when still hot. Never put an engine away dirty. Well, that will be all for now, and here's wishing you many happy hours of good steaming!

THE END

Roedean items available solely from
A.J.REEVES & Co.Ltd.

Drawings set RV11 - 13 sheets	
Frame steel	9/062
Buffer beam steel	9/063
Hornblocks (hot pressed)	9/064
Axleboxes	9/065
Frame stay	9/066
Axlepump & stay	9/067
Driving/Coupled wheels	9/068
Cylinder castings set	9/069
Piston blanks (G)	9/070
Motion plates	9/071
Eccentric straps	9/072
Buffer heads & plain stocks	9/073
Bogie bolster	9/074
Bogie centre	9/075
Bogie hornblocks	9/076
Bogie axleboxes	9/077
Bogie spring beams	9/078
Bogie wheels	9/079
Smokebox door & ring	9/080
Dome & chimney	9/081
Inner dome	9/082
Ring bush for dome	9/083
Regulator stand	9/084
Petticote pipe	9/085
Tender frame steel	9/086
Tender buffer beam steel	9/087
Tender horns & cast springs	9/088
Tender axleboxes	9/089
Tender disc wheels	9/090
Handpump casting & tee	9/091

Boiler flanged plates
Boilercopper materials with flanged plates.
Etched plates for:
30900 Eton, 30902 Wellington
30918 Hurstpierpoint
30919 Harrow, 30925 Cheltenham.
30926 Repton, 30928 Stowe
30929 Malvern, 30930 Radley
30932 Blundells, 30934 St.Lawrence
30936 Cranleigh.
Etched plates to order only, order well before requirement date.