A 3-1/2-in.Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

IN fulfilment of a promise made some time ago, that I would offer something that would prevent the tools and equipment of 3-1/2in. gauge locomotive builders lying idle, I now have pleasure in introducing you to " Doris of the L.M.S." Nice young lady, isn't she ?-but she hasn't half caused some stirring of grey matter during the last three weeks or so, time of writing.

The locomotive is a fairly close copy of the full-sized Class 5 mixed-traffic engines, which in your humble servant's opinion (and in that of a good many " high-ups " in the locomotive world) are the best " all-round " engines running on British metals today. They are equally at home on a 1,000-ton coal drag, an ordinary loose-coupled freight (one of them has just gone by, on the daily through mixed coal-and-goods service to Three Bridges), a fast " stopping " train, where their rapid acceleration is of the greatest value, or an express passenger train needing a maximum speed of 90 miles per hour on favourable parts of the road ; and the way they can march over the Pennines or climb the Cumberland hills, is just nobody's business.

Brief Specification

The principal dimensions of the 3-1/2in. gauge engine correspond to the 4-ft. 8-1/2in. version in proportion to size ; the details vary, because, as I've often remarked, you can't " scale " Nature. I might remind all beginners that this engine, like all other " Live Steamers," is intended for real hard work, and is arranged accordingly. The main and bogie frames are 1/8in. mild-steel plate, with buffer and drag beams made either from stout angle or castings. The main frames are stiffened up by the bogie bolster, also a casting, and the crossitay carrying the pump. Horn-blocks and axle-boxes are the same as " Molly," " Petrolea," and other engines described in these notes ; this brings in " stock " castings, cutting down both price and labour. Coupled wheels are 4-1/2 in. diameter, the equivalent of 6 ft., but the bogie wheels are slightly smaller in proportion to size (2-1/4 in.), as we have to use proportionately deeper flanges, which would bring them oversize if the treads were " scale " diameter, and so reduce the clearance.

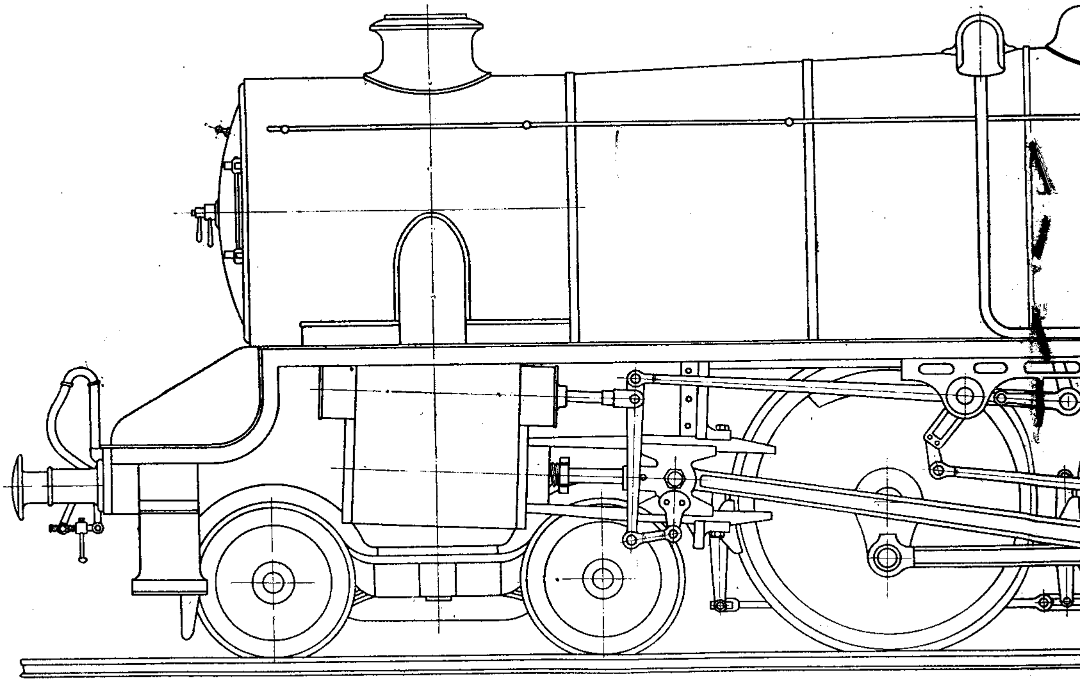
The cylinders are correct piston-valve type, one and five-thirty-seconds inches bore (I've written that in full because the printers set it up as though it were 15/32 in.-you'd be surprised the number of letters I have received telling me I've made mistakes in measurements !) and 1-3/4 in. stroke, which corresponds to the 18-1/2 in. by 28 in. of the full-size job ; but you can bore to I-3/16 in. if the castings will stand it. The boiler will, I might add ! The piston-valves are 5/8 in. diameter, corresponding to big sister's 10-in. valves. I fancy we have about smashed up the old hoary idea about piston-valves being " impracticable " on little engines ; my " Fernanda " is fourteen this year, and hers are as steam-tight today as when she was " born." Beginners may be surprised to learn that piston-valve cylinders are easier to make and fit than slide-valve cylinders. There are no steam-chest and cover joints to make, no array of studs around a flat steam-chest, no laborious port-face and valve truing-up jobs, and no valve-sticking-off-the-face trouble when the engine is at work. There are also no valve-spindle glands to keep tight ; these are a prolific source of steam leakage on many engines, and if tightened too much, they put strain on the valve-gear.

Walschaerts' valve-gear is used, with box links carried by a small replica of the characteristic link girder of big sister. Eh-what's that ? No, I'm nor offering a bunch of roses-nor a whisky-and-soda !-to Inspector Meticulous ; it just happens that this type of girder suits young " Doris " very nicely, and so she uses it. She also has her full-sized relation's long combination-lever (the " new look " ?), but I have left out the valve-spindle guides, as they are not necessary in this size, and a fiddling job to make and fit, anyway. The light appearance of the whole valve-gear is retained without sacrificing any strength.

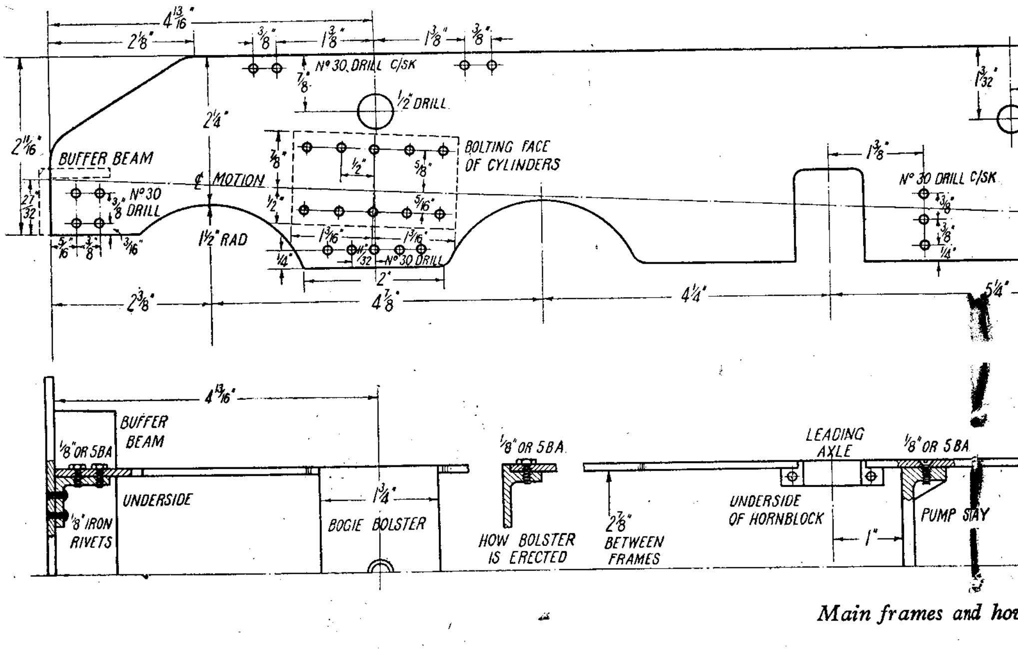
The boiler is a true L.M.S. type kettle, of " scale " diameter over the laggeing of the full sized job, and is made from 3/32in, or 13-gauge sheet copper throughout, except for the backhead and tubeplates, which are 1/8in. or 10-gauge. All joints are brazed or Sifbronzed, except the tubes which are silver-soldered. The firebox and tube arrangement will be to my usual specification, with plenty of superheating surface ; high superheat and mechanical lubrication are two of the factors contributing to the success of real " Live Steamers." A grid regulator and top feeds are included, supplied by one eccentric-driven pump and one injector, with a tender hand-pump as emergency stand-by. All fittings and mount-ings will be to my usual tried-and-proved " standards," and I will also give, all being well details of steam brake, working sanders, and other oddments. The tender will be a one-sixteenth copy of the standard L.M.S. tender, with the usual accessories, and working hand brake. Well, I guess that is enough about generalities ; let's get down to the job, and I hope to be able to keep it running parallel with " Maid " and " Minx " in the same way as " Juliet " kept company with " Hielan' Lassie."

Main Frames and Buffer Beams

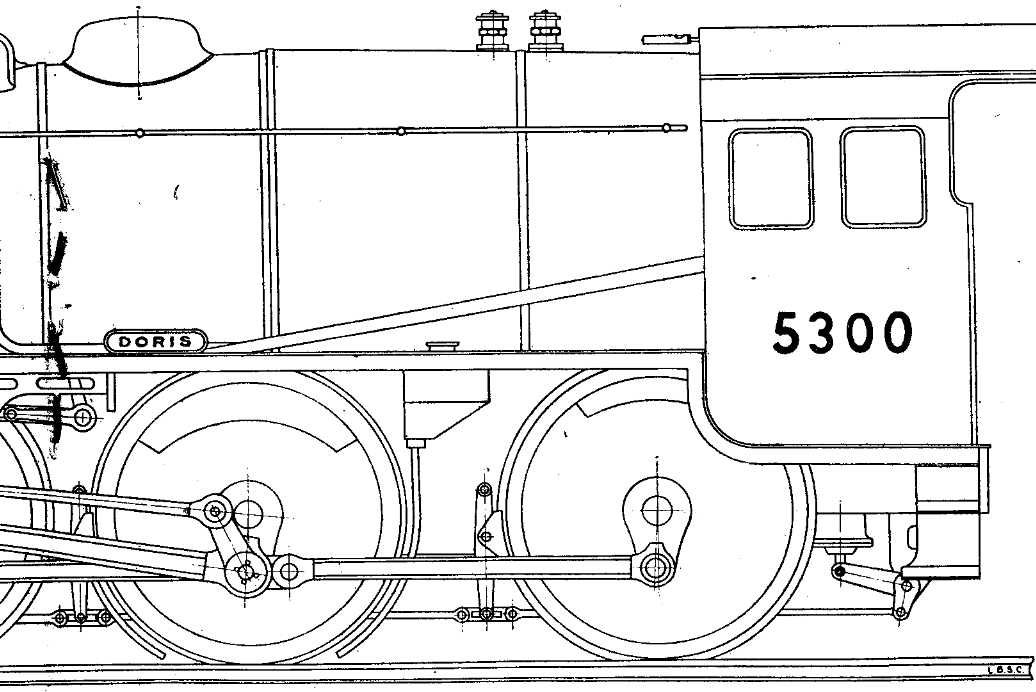
Two pieces of 1/8in. mild-steel plate 28 in. long and 3) in. wide will be needed for main frames. Either bright or blue will do ; but if you use the former, it should be of soft quality, not the hard-rolled kind, which assumes a bow shape as soon as the openings for the hornblocks are cut out. By this time, followers of these notes won't need any detailed instructions about marking and cutting locomotive frames ; just mark one out, drill a couple of holes through both, rivet tem-



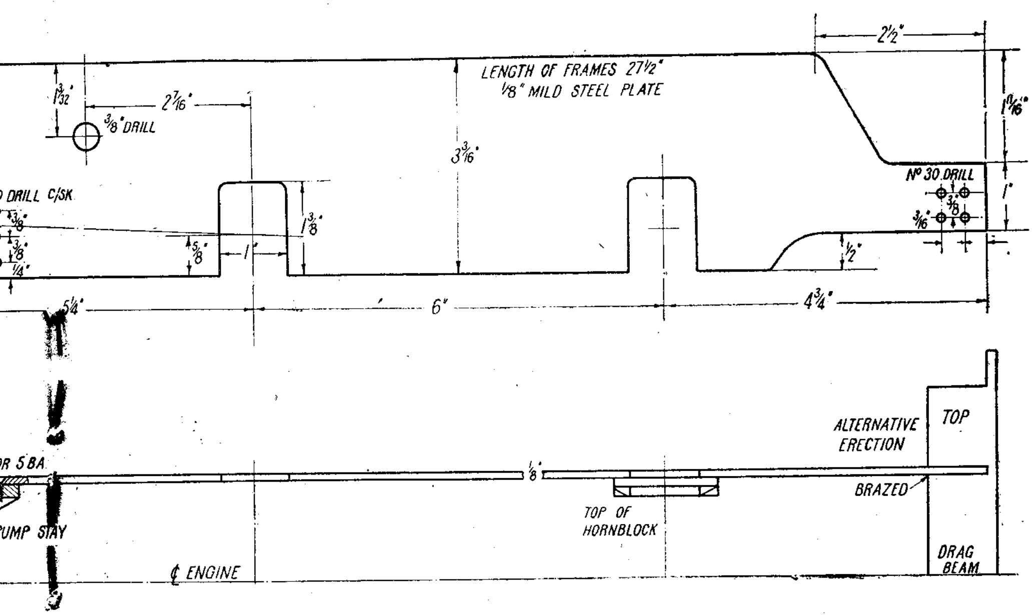
3½-in. gauge L.M.S. C



Main frames and ho



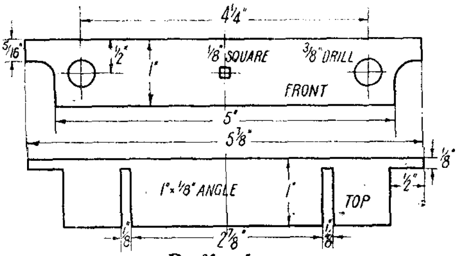
L.M.S. Class 5 locomotive



es and how to erect them

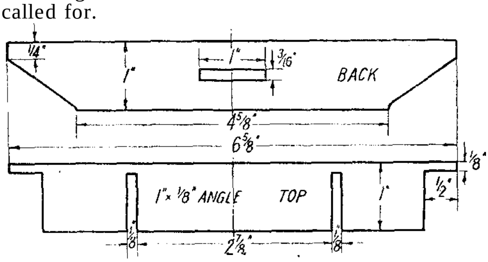
porarily together, and get busy with saw and file.

When marking out, be careful about the holes for cylinder fixing studs, and the hole for the reversing-shaft bush. First get the centre-line of motion ; make a centre-dot 5/8 in. from the bottom of the frame, on the centre-line of the driving hornblock opening. Next, at the extreme front edge of the frame, at 27/32 in. from the bottom,



Buffer beam

mark another point, and scribe a line from one to the other. This gives you the centre-line of motion ; and from it, the position of the cylinders is set out, as shown by the dotted lines on the drawing. The centre of the cylinders is 4-13/16 in. from the front edge of the frame. The five upper stud-holes are 5/8 in. above centre line, and the lower ones 5/16 in. below it, all at 1/2in. centres and drilled No. 30. The five holes right at the bottom are for the screws attaching the bogie bolster. The 1/2in. hole for the exhaust-pipe is on the vertical centre-line of the cylinders, and 7/8 in. from the top of the frame. The " two-twos " at the top are for the smokebox saddle screws. The three holes behind the hornblock opening of the leading coupled axle are for the screws holding the pump stay. The 3/8in. hole between leading and driving horn openings is for the reversing-shaft bushes, and the position of this is important ; it should be 2-7/16 in. ahead of the vertical centre-line of the drivmg axle and one and three-thirty-second inches below the top of frame. The holes at either end are only for screws holding frames to buffer- and drag-beams, so no " mike measurements " are called for.

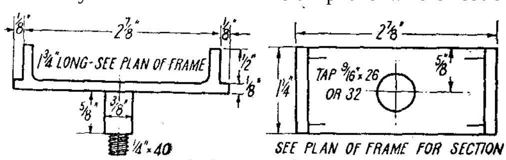


Drag beam

The buffer- and drag-beams may be made from 1-in. by 1/8in. angle, or from castings. Steel angle is best, but brass would do at a pinch. Note, the buffer-beam is shorter than the drag-beam, and the vertical parts of both are finished off to fancy shapes, as shown. The most important thing is to' get the slots for the frames absolutely dead square with the beams, otherwise the frames won't line up properly, and you'll have one side of the engine running ahead of the other. If a 1/8in. saw-type milling-cutter isn't available to cut the slots, and hand work has to be made do, use the vice-top to guide saw and file. If you have a cutter, mount it on an arbor either between centres or in the three-jaw, former for preference and clamp the beam under the slide-rest tool-holder parallel to the lathe bed. Feed straight in, using slow speed and plenty of cutting-oil.

Rivet a piece of 3/4in. by 1/8in. angle flush with the inner edge of each frame slot, a shown in plan view. I always jam a scrap bit of 1/8in. steel in the slot, and clamp the angle to it with a toolmaker's cramp, if I use this method of frame attachment, whilst drilling the holes for the rivets, and putting them in. When all four angles are fixed. the whole issue can be erected as described for the " Maid " and the " Minx," laying the frame upside down on your lathe bed, seeing that the top edges touch the bed full length, and adjusting the beams so that they are exactly the same distance from the bed at each end of the frames, and exactly parallel all ways. Then drill and tap the screw-holes, and everything should be Sir Garnet.

If preferred, the frames can be Sifbronzed or brazed into the slots in the beams-my favourite method now-and no angles are needed ; but take the same strict caution as before, to have the frames parallel and the beams square. I have already described how to clamp the whole issue



Bogie bolster and pump stay

with a couple of packing-blocks between the frames, to prevent them going out of parallel when heated ; so need not repeat here. Before brazing, however, it is advisable to fit the hornblocks, as this job is easier with the frames apart ; besides, the hornblock jaws are more easily trued up when the frames are temporarily bolted together " inside out," as the kiddies would say.

If cast beams are used, there will be lugs cast on, for attaching to frames ; and the whole lot should only need cleaning up with a file, and the slots made for the frames as mentioned above.

Bogie Bolster and Pump Stay

Little space need by used in describing these, as they are both similar to the " Maid of Kent's," only smaller ; the drawings give the sizes. Castings will be available for both, and machining as described for the " Maid." Hold the bolster in the three-jaw by the chucking-piece opposite the pin; turn the latter and screw the end to given sizes, then face the flat surface, cutting off the chucking-piece when through. If you have a small machine-vice which can be attached to the lathe saddle or boring-table, the casting could be held in that, at the correct height, and traversed across an end-mill or home-made slot-drill not less than 1/2 in. diameter, held in three-jaw, which would clean out the rebates each side, so that the casting fitted nicely between frames. Lucky

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The screw itself is of carbon-steel and has eight threads per inch, Acme form. It is splined to provide the means for securing the power feeds, leaving the threads for screwcutting only. The spline was cut in the Exe lathe, using a small milling cutter in a head mounted on a vertical slide, this method being necessitated by the fact that the only available milling machine had not a sufficiently long traverse to do the job.

The leadscrew bracket is fitted with lapped cast-iron bushes and takes the end thrust of the leadscrew in both directions, no thrust being taken at the gearbox end. The bracket was fitted to the bed by trial and error as regards positioning for the correct alignment of the leadscrew and is dowelled in position. The leadscrew is aligned to the bedways with an error of not more than 0.001 in. in 18 in. in either plane. A micrometer index is fitted, since, although the screw as a screw is not used for feeding the tool in normal work, it is very useful on occasion to have a means of moving the saddle along the bed to a definite measurement.

The **Apron**

The internal arrangement of the apron is shown in Photo No. 3. The half-nut is of- phosphor-bronze, and this is attached to a cast-iron slide having V ways which slide in corresponding ways, machined in the body of the apron. The tightness of the slide can be controlled by a gib strip adjusted by grub screws in the apron end. A supporting pad below the leadscrew maintains the screw in correct alignment by preventing bending under the thrust imposed in operation. An adjustable stop limits the downward movement of the nut slide, thus controlling the depth of engagement of the nut with the screw.

Two brackets, dowelled in position, carry the worm, which has a fixed key engaging with the spline in the leadscrew. The worm is of steel and drives a worm-wheel of phosphor-bronze. The latter is mounted on a sleeve which carries a pinion on its other end. The drive is then taken through reduction gearing to the rack pinion. This drive is thrown in and out of engagement by a swinging arm having a plunger lock on the outside of the apron. This swinging arm carries a claw which engages with a projection on the nut slide and provides the interlocking arrangement referred to earlier, which prevents the simultaneous engagement of the nut and the power feeds.

The gear shafts are supported on their inner ends by the bar shown in the photograph, and all shafts are drilled up and provided with oil gun nipples for easy lubrication. Other nipples enable oil to be fed to the teeth of the gear wheels themselves. The worm runs in an oil bath which can be filled and drained without dismantling.

An unusual problem was presented by the necessity of the worm brackets being bored in strict alignment with the leadscrew, and the same requirement applies to the half nut and the supporting pad below it.

It will be seen from the photographs that the leadscrew passes through two holes in the ends of the apron, though it takes no bearing in them, there being considerable clearance. These holes were marked out for position and rough bored undersize, though just sufficient to pass the leadscrew through. All other machining to the apron having been finished, it was bolted in place to the saddle, the latter being in its working position on the lathe bed. A boring-bar was substituted for the leadscrew, being connected to the gearbox shaft at one end and running in the leadscrew bracket at the other. A pulley driven by a belt revolved the boring-bar and the saddle was moved along the bed by coupling it up to the tailstock barrel (the tailstock had been made at this stage). Thus, the holes in the ends of the apron were bored in line with the axis of the leadscrew. It was not possible to bore out the worm brackets and the rest by this means, due to their inaccessibility, so the apron was removed and the holes just bored were bushed up to support a boring-bar running between the centres of the Exe lathe. Then with the apron (open side upwards) being fed along the bar by means of the lathe saddle, the required holes in the brackets, etc., were bored truly in line with the holes in the ends of the apron, and consequently in line with the leadscrew when all was assembled. The bored nut blank was then removed from its slide, carefully centred in a four-jaw chuck so that its bore ran truly, and then screw cut.

(To *be continued)*

" L.B.S.C."

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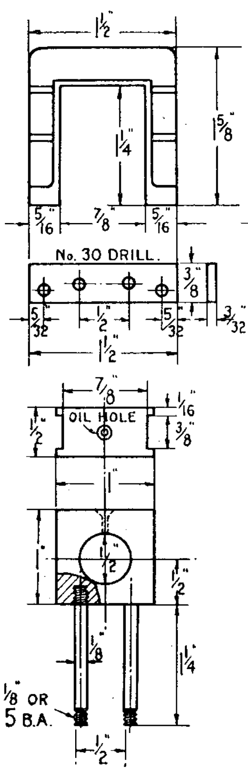
owners of milling-machines can do the job in a few minutes, with the casting in th- machine-vice on the table and an ordinary end-and-face cutter on the arbor ; but if no machining methods are available, you'll have to fall back on the good old file. A planer or shaper would, of course, finish the rebates as easily as a miller, holding the job in the machine-vice and using an ordinary knife tool in the clapper-box.

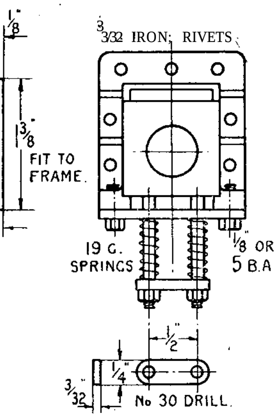
The pump-stay only needs cleaning up to size over both flanges, which can be done in the lathe, as described for the frame-stay on the " Maid " ; milled or planed, if machines are available ; or simply hand-filed, using a try-square to get the flanges exactly at right-angles to the main part. Drill a 1/2in. hole in the middle, and tap it 9/16 in. by 26 ***or*** 32 ***(or any*** other ***fine*** thread for which you have taps and dies), making sure the tap goes through square. Both bolster and pump-stay can then be located in the frames as shown in the plan drawing, and the screw-holes drilled and tapped, using those in the frames as guides ; but don't erect them " for keeps " yet, as the frames have to come apart again for fitting the hornblocks.

A 3-1/2 in. Gauge L.M.S. Class 5 Loco.

by " L.B.S.C."

SECOND thoughts are best, says the old saw. Well, at time of writing (don't forget that I write several weeks ahead of publication-this isn't the " Daily Moan " !) correspondents who are waiting to get on with a 3-1/2in. gauge locomotive are asking for an early start of the serial, and plenty to keep them busy whilst I deal with more items of the "Maid" and the " Minx." To the best of my knowledge and belief, nobody building either of the 5-in. gauge engines has yet caught up with the instructions, nor anywhere near it; those big wheels and big cylinders are not turned, bored and fitted in the proverbial five minutes ! Therefore, the best thing I can do, appears to be to give an extra-special instalment of detail drawings for the 3-1/2in. gauge job, without going into full details of all the machining and fitting. As this isn't really necessary, in view of the fact that only just recently, full details have already been given for similar jobs ; so here are some components of " Doris " and a brief description of each.





Hornblocks and axleboxes

The hornblocks and axleboxes are the same as specified for " Molly," " Juliet" and other engines, so stock-castings can be used, and plenty are available. The contact faces can be end-milled, or if the castings are clean, merely filed to fit the openings in the frames. Note, however, one small difference :-As the top of the openings have rounded corners, the hornblock flanges must be rounded off to suit. The hornblocks are riveted into the openings, using seven 3/32 in. iron or steel rivets in each ; the feet or lugs are smoothed off with a file, flush with the bottom of frame, and the jaws filed or milled out to 7/8 in. width with the frames temporarily bolted together " inside out." Use a piece of bar, 7/8 in. wide, as a gauge; it should slide in easily, but without shake.

The hornstays are 1-1/2in. lengths of 3/8in. by 3/32-in. mild-steel rod, drilled as shown, and attached to the hornblock lugs by 1/8in. or 5-B.A. screws, hexagon-head for preference, though any available heads will do.

The axleboxes are made from cast. or drawn bronze or gunmetal bar, of 1 in. by 1/2in. section. Our advertisers will supply a stick long enough for all six. If your lathe won't end-mill the full length for the groove, cut the stick in half and take two " bites." Saw, or part-off the six lengths, face the ends in the four-jaw, then drill as specified for other engines, first drilling 1/8in. pilot holes in Nos. 1, 2 and 3, and " mating " them with the boxes on the other side of the 'engine, 1 to 4, 2 to 5, and 3 to 6. Ream each pair of boxes when in position in the hornblocks, and don't forget to locate the holes for the spring-pins by jamming the boxes up against the hornstays and poking the drill through the spring-pin holes in same. Screw the spring-pins by holding them in the three-jaw, and using the die in tailstock chuck, or else the pins will screw in as the kiddies call " wonky," and will bind in the hornstays. Assemble as shown in the illustration, and jam a bit of 1/8in. wire, or square rod, between each hornstay and axlebox, to keep the latter in position whilst the engine is being erected.

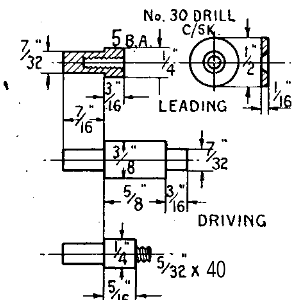
Coupled-wheels and Axles

The average 4-in. three-jaw chuck will open out enough to grip the treads of the 4-1/2in. coupled-wheel castings, so you can go ahead on the usual instructions for doing the job, viz. first grip by tread, turn the back, and boss, drill and ream. Then reverse in chuck, turn the front, and projecting boss, also cut the rebate simulating the joint between centre and tyre on a full-sized wheel. Finally, mount on an improvised faceplate made from an old wheel or iron disc, and turn the treads and flanges. Beginners note that the treads are parallel ; leave a good radius between tread and flange, to avoid railhead grind, and bevel off the outer edge of the tread as shown. The crankpin holes are drilled by aid of the well-known jig consisting of a bit of bar with a 7/16in. peg and a 7/32-in. hole in it, at 7/8 in. centres.

If your chuck won't open sufficiently to grip the wheels, you'll have to follow the instructions I gave for turning the " Maid of Kent's " coupled wheels on the faceplate.

The crankpins are shown in the illustration, which gives the sizes. They are quite easy to do ; the only point you want to watch is that the spigots are turned so as to press in tight enough to prevent movement, but not tight enough to split the wheel bosses. This is especially desirable on the driving-pins, which carry the return cranks actuating the valve-gear, as any shifting of the pin would upset the valve-setting. Put a nut on the thread of the trailing-wheel pins when pressing home, to protect the threads.

If your chuck is true, within reasonable limits, turn the axles from +-in. ground steel, or failing that, ordinary mild-steel, holding in chuck. If the chuck is far from being like Caesar's wife, turn the axles between centres, and so make sure they are O.K. The remarks above, applying to



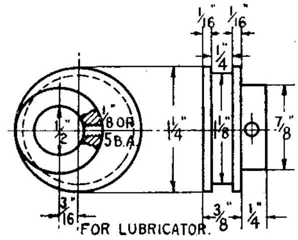
Crankpins

crankpin spigots, apply also to wheel seats. If they don't want to enter the holes in the wheel bosses, don't use brute force, or the result will be a sudden crack, and a bit more profit for the casting merchant. Take the axle out of the wheel and ease the seat with a file, with the axle held in the three-jaw. Press one wheel on each axle, and make the eccentrics before you put on the second one.

'Eccentrics

Two eccentrics are required, one for pump and one for lubricator. They can both be turned -from a bit of steel bar held in the three-jaw ; a stub end of mild-steel shafting does fine, and is easily obtainable. Face the end first, then turn diameter over flanges ; form groove with parting-tool, and part off at 5/8in. from end. Mark axle hole from the true centre left by facing tool ; centre-pop,' and chuck in four-jaw with pop-mark running truly.Drill a pilot hole first, 1/8 in. or No. 30 ;open out to 31/64 in. and ream 1/2 in.. Finish the boss with the eccentric mounted on a stub mandrel held in three-jaw ; drill and tap hole for set-screw, and it's " finis Johnny." Put the eccentric for the lubricator drive (3/16 in. throw) on the leading coupled axle, and the bigger one on the driving axle.

Beginners, remember that when erecting wheels, the best plan to prevent the whole issue from becoming mixed up, is first to number each

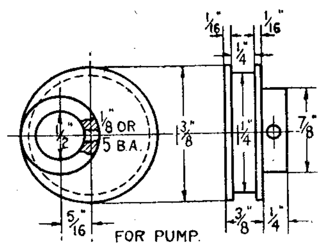


Eccentric** for **mechanical lubricator

axlebox and hornblock ; then poke the axles through the boxes before removing from frame, not forgetting to put the eccentrics on ; then put the second wheel on each axle as far as it will go by hand. ***Then*** take out the hornstay screws, lift the assembly out of the frames, and go ahead and quarter the wheels by aid of try-square and scribing-block, as I described for the " Maid," or by Mr. Adams's quartering gadget or any other that you fancy ; after which, the wheel is pressed right home, and the axleboxes replaced in the frames. All three axles should be dead parallel ; the wheels should spin freely, and there should be no sign of what our motoring friends would call wheel-wobble. If there is, either you have not bored and reamed the wheels truly, or the seating is out. Same should be corrected before anything further is done.

Eccentric-driven Pump

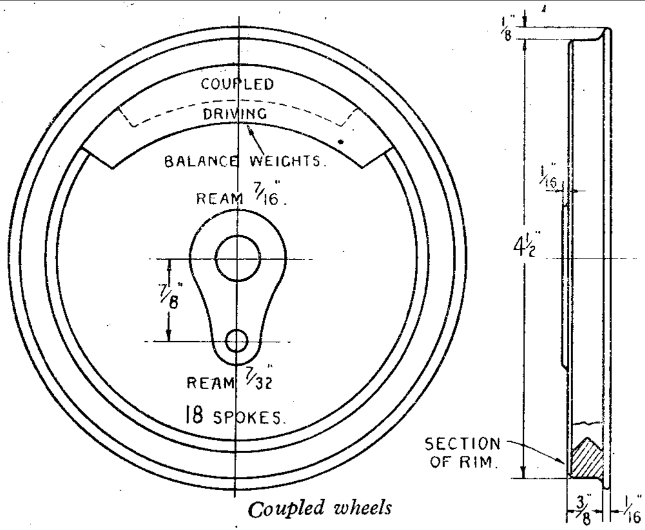
The big sisters, of course, have injectors to feed their boilers, and no pumps, but little engines get on all right with one of each, as some



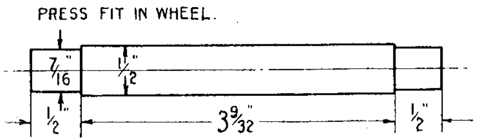
Eccentric for feed pump

good folk find it difficult to manipulate little valves when the engine is under way, especially steam valves on the backhead. A pump by-pass valve doesn't get hot, and you can set the pump to maintain the level without attention on a continuous run, though personally I like to operate the injector.

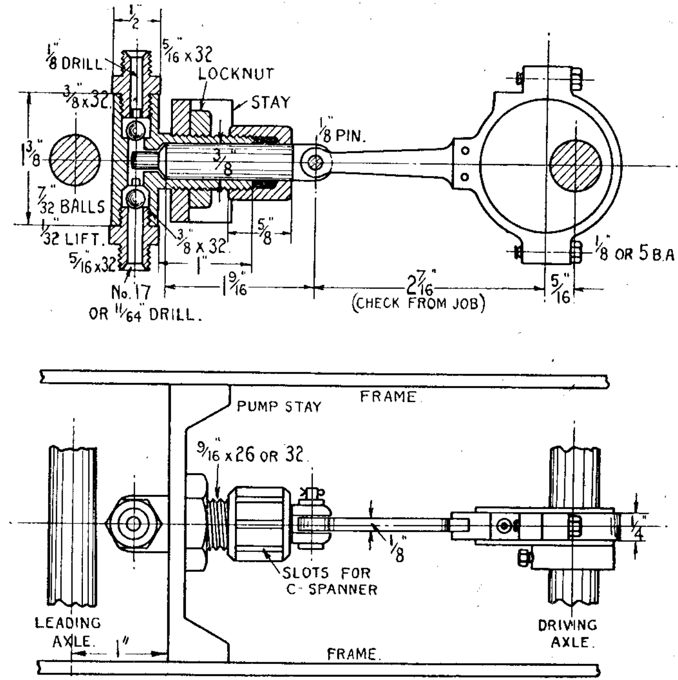
Castings are available for the pump, with a chucking-piece opposite the barrel. Machine the valve-box first by gripping one end in the three-

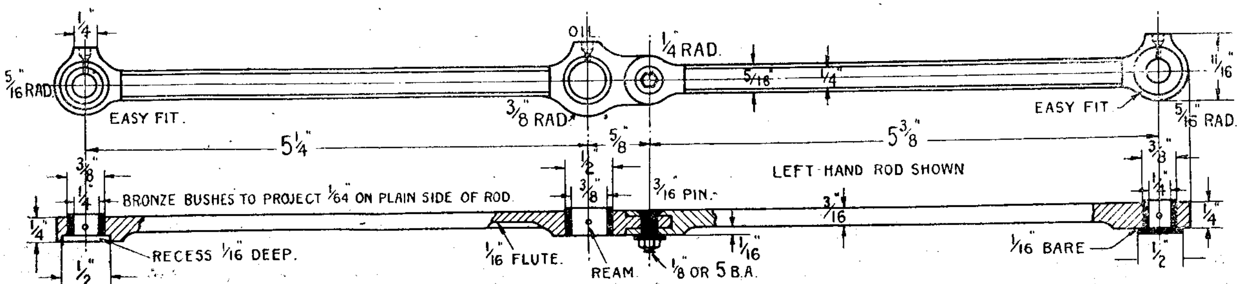


Coupled wheels



Coupled axles





Above—Boiler feed pump

Left—Coupling rods

jaw and setting the other to run truly. Then face, centre, drill right through, open up, and tap for the ball-chamber cap. To turn the other end, screw the turned end on to a screwed pip formed on a stub end of rod held in three-jaw. Then grip the casting in the three-jaw by the chucking-piece, and drill and screw the barrel ; the hole for the anti-airlock pin is 3/16 in. Cut off the chucking-piece, fit the balls and ball-chamber union caps, and make the ram from a piece of 3/8in. ground rustless steel or drawn phosphor-bronze. The gland-nut is made from a piece of 3/4in. round bronze, drawn or cast, and is slotted to take a C-spanner ; but anybody who prefers a hexagon nut may, of course, use one.

The eccentric-strap is turned up from a casting. First, clean up with a file, drill the lugs No. 40, and saw across ; then open up the clearing holes, and tap the screwholes, screwing the bits together, and boring and facing one side, with the casting held in the four-jaw. The other side is faced on a stub mandrel in the chuck.Cut a 1/8in. slot in the lug, by milling or planing, and in it fit a 1/8in. steel eccentric-rod, as shown. Don't finish off the eye to the fixed dimension shown, but check from the actual lob when the pump is erected'- *see* below.

Screw) the pump through the stay, and erect same in frame, as shown in the illustrations ; beginners, be mighty careful not to put the whole bag of tricks upside down, which has been done by more than one enthusiastic but thoughtless tyro ! Line up the eccentric with the barrel, and put the eccentric-rod in the slot in the ram. Tighten up the set-screw, then push the pump ram right home, -and put the eccentric on front dead centre, that is, as near to the pump as possible. With a bent scriber, scribe a mark on the eccentric-rod through the hole in the pump ram. Take off the eccentric-rod, make a centre-pop on it 1/32 in. nearer the strap than indicated by the mark, and drill a No. 30 hole. When the pump is connected up, and the pin put in, this will ensure 1/32 in. clearance between the end of the ram and the end of the pump barrel, which is correct. I have shown a pin secured by a washer and a weeny split-pin ; but you can, if you so desire, use a pin with a nut at each end, or a bolt. The gland may be packed with graphited yarn, or a bit of unravelled hydraulic pump packing, but it shouldn't be screwed up tight enough to cause the eccentric to act as a band-brake.

The coupling-rods are made by the same process as described for the " Minx," so there isn't the slightest need to detail out all the rig-marole again. The leading end differs from the " Minx's " rods, inasmuch as it cannot have a nut projecting beyond the boss, otherwise the outside connecting-rod couldn't pass. Instead, the rod is stopped from coming off the pin by a washer recessed into the boss, and held by a set-screw. Drill a No. 30 hole in the boss, and form a recess 1/16in. deep with a pin-drill 1/2 in. diameter, having a 1/8in. pilot pin. Then open out the hole to 3/8 in. diameter, and squeeze in a bush turned up from good hard bronze, with a 1/4in. hole through it. This bush must be flush with the bottom of the recess, but should project 1/64 in. at the back, so as to prevent the boss of the coupling-rod rubbing over the face of the wheel boss. Same applies to the other bushes. The driving bush is flush with the face of the boss, and should be reamed to an exact fit on the driving crankpin ; but the other bushes should be an easy fit, otherwise the rods will bind when the axleboxes move up and down, as the engine travels at speed over a bad road, or through crossing frogs or " diamonds." The trailing bush has a flange a bare 1/16 in. thick, on the front of the rod. Drill a 1/16 in. oil-hole in each boss, and counterbore it with a 5/32in., or No. 22 drill.

The knuckle is a proper forked joint, made as described for the " Minx " the pin being turned up from 1/4in. rod, reduced to fit the 3/16 in. holes in the fork and tongue, and further reduced to 1/8 in. and screwed to take a nut. When the rods are placed on the crankpins and the wheels turned, there shouldn't be the slightest sign of stiffness or binding. If there is, the cause is usually incorrect quartering, so check that off before you start to ease the bushes or adopt any other expedient. A good tip for beginners, when marking-out coupling-rods, is not to set your dividers to the measurement given on the drawing, but to the actual centres of the axles on which the coupled wheels are 'mounted, as they must, of necessity, be the same. When the rods are O.K. put a nut and washer on each trailing pin, and fix the washer in the recess in the front boss by an ordinary countersunk screw.

Petrol Engine Topics

(Continued *from page 511)*

enthusiast than as an employer. Of the many jobs I have had in the course of a patchwork career, none has been happier than that under the guidance of " P.M.," whose human qualities, no less than his technical and organising genius, I have always esteemed very highly.

The many hundreds of readers who knew "P.M." in person, and even those who have only had a glimpse of his' personality through the intimate paragraphs in " Smoke Rings," will know that he does not need a fulsome eulogy of praise ; but only those who have been actively associated with his life's work can fully realise to what an extent he was devoted to the interests of model engineers. Not only was he an admirer of -good "models, and the fine craftsmanship in their construction:; he also loved the people who made them.

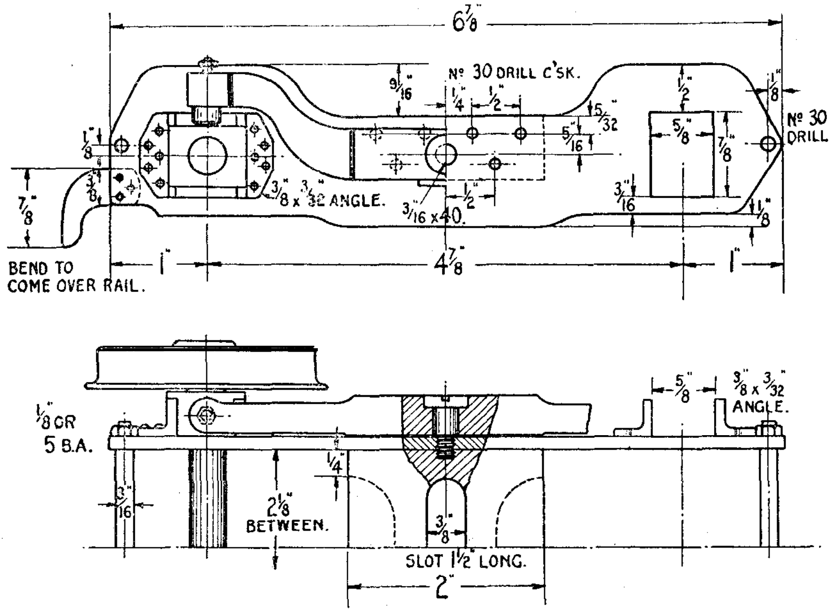
Though " P.M." has passed on, the torch that he lit some fifty years ago still bums as brightly as ever, and has'been the means of kindling many lesser lights all over the world. For my part, I avow my intentions to carry my small brand to the best of my ability and do my utmost to promote that SPIRIT OF MODEL ENGINEERING to which "P.M.'s" whole life was dedicated.

A 3-1/2in. Gauge L.M.S. Class 5 LOCO.

by " L.B.S.C."

THE full-sized engine has a really " Bill Massive " bogie of the Adams type, with equalised axleboxes, the equalisers being of the double-plate pattern with a hefty laminated spring sandwiched between each pair. When I tell **you** that this spring has 13 plates 5 in. wide

Bearing the above in mind, and-as always-trying to make the job of building " Doris "'as easy as possible, I am specifying a bogie that looks like that on her full-sized relations, Yet is in fact a compromise. The bogie frames are set closer together than the main frames, with the



Bogie details for " Doris "

and 5/8 in. thick, maybe you'll realise just what it has to carry. It would be quite possible to make a copy of this in 3-1/2in. gauge ; but to get proper flexing, the springs would have to be made on Mr. Glazebrook's system of laminated plates, and the full suspension arrangement would be a bit of a tiresome job. If we use a cast equaliser each side, with a couple of spiral springs in the centre (same as I have specified for 2-1/2in. gauge engines) there is a tendency to derail on curves, as in this size the leverage between the end of the equaliser and the point where the spring takes a bearing allows the wheel to lift easily, even if very stiff springs are used. It is a significant fact that in full-size practice the bogie with independent springing for each axlebox can be found on some of the fastest engines, such as the G.W. " Kings " and the L.N.E.R. A4's, the Southern " Nelsons " and so on ; and I have found on my own little railway that I can dash around my south curve with perfect safety with an engine having separately-sprung bogie axleboxes at a speed which would cause an equalised bogie to jump the road.

horn-cheeks outside, same as big sister, but a cast equaliser is used each side. This is attached to the bogie frame by a big-headed fulcrum pin, so that the equalising effect is retained, ditto the appearance of the full-sized bogie .; but each end of the equaliser has a headless sprmg-buffer in ***it,*** bearing on the axleboxes, and giving the full effect of separate independent springing. Thus we kill two birds with one shot. The job looks all right, and works all right.

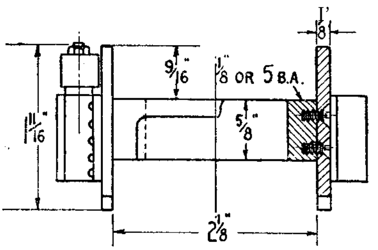
Bogie Frames

Two pieces of 1/8in. soft steel plate, 7 in. long' and I) in. wide, will be needed for the bogie frames. Mark out, rivet temporarily together, and drill and file to outline, same as main frames. There is nothing very special to note about the job. The holes for the tie-bars, drilled No. 30, are1/8 in. above the centre-line of the axlebox openings, instead of being level with them, as is usually the case ; and the holes for the screws that hold the frames to the centre casting are countersunk, as projecting heads cannot be used, owing to the equalisers being close to the frames.

A piece of 3/8in. by 3/32in. brass angle is riveted to each side of each axlebox opening, to serve as horn-cheeks ; the side that goes next to the frame is filed away top and bottom to the shape shown. Use 3/32in. charcoal-iron rivets if available ; they don't work loose like copper rivets often do. The guard-irons can be cut from 3/32-in. steel and riveted in place whilst the frames are separate ; leave them long enough, so that when the bogie is assembled, they can be bent to come over the railheads.

Bogie Centre

The bogie centre is a simple casting. As there is nothing projecting beyond the frames at either



Part cross-section of bogie

side, all you have to do is to smooth off the sides, either by milling or simply hand-filing. If you have a milling-machine, just catch the casting in the machine vice and run it under an ordinary side-and-face cutter. If a cutter over 5/8 in. wide isn't available, use the widest you have, and take two or more " bites " without shifting the vertical adjustment of the table. The machine-vice on my horizontal milling-machine is a special type, with the movable jaw mounted just like the top-slide of a lathe, working over a flat slide with vee-edges and operated by *a* central screw. As this slide is quite true and parallel with the miller-table, work can be set truly by simply dropping it between the jaws and letting it rest on the slide ; tighten up, and right away. If the work is too narrow to reach above the tops of the jaws, a piece of parallel packing is interposed between the work and the slide, and for this I use what our friends the printers call " furniture " ; not the kind you need priority dockets for, though it certainly comes under the heading of " utility " ! This furniture consists of pieces of type metal, 'perfectly parallel and of varying thicknesses ; and its legitimate purpose is for spacing out printers' type when setting out headlines and so on. I bought the vice, which also has a swivel base fully graduated, just over ten years ago from Jones and Shipman, and it has served me well, saving a vast amount of time.

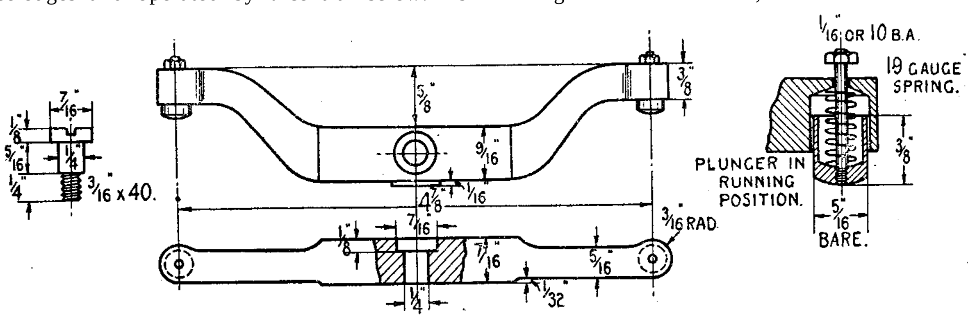
The sides of the casting can also be cleaned off by clamping under the slide-rest tool-holder and traversing across an end-mill or a home-made slot-drill or facing cutter held in the three-jaw ; I have already described how to make these, and our " Duplex " friends have also dealt with the matter. A planer or shaper will also do the job ; or the casting may be gripped in a four-jaw chuck, endwise, and the edges faced off with a round-nose tool set crosswise in rhe rest. If you do it that way, be careful not to take too greedy a cut, or the tool point will go west ; beginners should always be mighty careful when facing. anything, the cut of which isn't continuous. I've heard more than one tale of woe about the corner of a cylinder casting administering the K.O. to a carefully-ground tool, when a raw recruit started in to face off the flat surfaces.

The top and bottom of the casting can be faced-off by gripping in the four-jaw, and using a round-nose tool as above ; the slot for the bogie-pin can either be end-milled out, or simply cleaned with a file, so that the bogie-pin slides easily from end to end. The distance between top and bottom of the casting should be slightly less than the length of the bogie-pin.

How to Erect Bogie Frames

Put the centre-casting between the frames, level with top of same, and put a cramp over the lot, to hold them temporarily together. Then lay them upside down on the lathe bed, or something equally flat, and line them up just like the main frames, putting two pieces of 1/8in. straight rod through the tie-bar holes, to make certain the frames are exactly opposite. Run the No. 30 drill through the screw-holes, making countersinks on the casting ; follow with No. 40, and tap 1/8 n. or 5-B.A., using countersunk screws when finally assembling.

An alternative way would be to make and fit the tie-bars first. For these, you need two pieces of 3/16in. round mild-steel, each 2-3/4 in. long. Chuck in three-jaw and turn down 5/16 in. of each end to 1/8 in. diameter, screwing 1/8in. or put these spigots through the end holes in the



Bogie equaliser

frames, and nut them outside, using ordinary commercial nuts ; see plan illustration. This should bring the frames quite into line, and the proper distance apart, which is 2-1/8 in. ; so make quite certain that the tie-bars are just that distance between the shoulders before you start erecting. If all O.K., put the centre casting in place between the frames, level with top line ; hold temporarily with a cramp over the lot, and proceed to drill and tap for screws as above. Beginners shouldn't forget that on this bogie the horn-cheeks are outside the frame, contrary to those on the main frame.

Finally, on a line with the centre of the axlebox openings, and midway between them, drill a 5/32in. hole through frame, well into the casting on each side ; tap this 3/16 in. by 40, for the equaliser fulcrum-pins. Tighten up the screws well, and file off any burrs, so that the frames are perfectly smooth at each side.

Equalisers

Clean up the castings with a file ; centre-pop the middle of the thick part, and drill a 1/4in. hole clean through each, counter-boring to 1/8 in. depth with a 7/16in. pin-drill. Tip for beginners : I never bother to make pin-drills of similar size, with different size pilots ; I just make one with a small pilot. sav. 1/8in..and put a sleeve or bush over it for whatever other size may be needed, according to the diameter of the hole. In the present instance, all you want, to use the 1/8in. pilot in the 1/4in. hole, is a weeny bit of 1/4in. rod with a 1/8in. hole in it, slipped over the pilot ; time and trouble saved !

Next item is to centre-pop and drill the extremities, at 4-7/8in. centres, as shown in the plan. Put a No. 50 drill clean through each, then open out with 5/16in. drill for 5/16 in. depth (see small detail sketch). For the plungers, chuck a bit of 5/16in. steel rod, and if it won't slide easily in the holes in the ends of the equalisers, take a skim off. and teach it better manners. Face the end, centre and drill down 1/4 in. depth with 15/64in. or letter " C " drill ; part off at a full 3/8 in. from the end. Ditto repeato until you have four plungers ; then reverse one in chuck, centre, drill No. 55, and tap 1/16 in. or 10-B.A., and watch vour step because these little drills and taps break easily, and are comparatively expensive nowadays ! A drop of cutting oil on the tap works wonders. Slightly round the end-beginners can do that easiest with a file, whilst the lathe is running fast-then fit the pins, which are merely pieces of 16-gauge silver-steel or spoke-wire, about 3/4 in. lone, with a few threads of 1/16in. or 10-B.A: pitch on each end. Wind up a length of 19-gauge tinned steel spring wire over a bit of 1/8in. steel held in three-jaw (I have fully described spring-winding many times), snip off four bits about 1/4 in. long, touch each end of each spring on your emery-wheel, and put them in the' cups. The detail illustration shows the assembly ; if the nuts are not a good fit on the threads, give the end of the pin a slight tap with a hammer, to burr it a weeny bit, so that you don't lose the nuts on the road. The pins are merely " free passengers," their only function being to prevent the plungers falling out and getting lost when the equalisers are off the bogie, and retain them in place during erection. The plungers should have approximately 1/4 in. of movement, the running position being halfway in, with the axleboxes in the middle of the openings, as shown in the assembly illustration.

The fulcrum-pins are turned up from 7/16-in. round mild-steel held in three-jaw. Face the end, turn down 9/16in. length to 1/4in. diameter, further reduce 1/4 in. of the end to 3/16 in. diameter, and screw 3/16 in. by 40. Part off to leave a head 1/8 in. thick, and slot it with a hacksaw.

Axleboxes

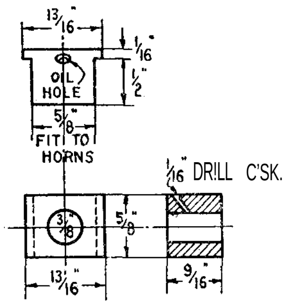
Our advertisers will probably supply a length of cast bronze rod for the axleboxes. and this can be dealt with exactly the same as described for the main axleboxes, either milling the rebate in a regular machine, or in the lathe, with a n end-mill in the three-jaw and the work under the slide-rest tool-holder. Drill 1/8in. pilot holes through the boxes first, and " pair them off," same as main boxes, finally drilling 3/8in. clearing (letter " W " drill, if you have it), or if you have a 3/8in. expanding reamer, set it to cut a weeny bit oversize. Bogie axles should never be an exact fit, as the bogie twists about " all over the shop " on the kind of railway most little engines operate over ; and if they are too good a fit, they will bind, and the wheels will slide. Don't forget the oil-holes go on the flange side, so you can poke the spout of your oil feeder between the spokes of the wheels, and apply a drop of the needful where it can do good. Writing about that always reminds me of an amusing incident at Stourbridge which occurred whilst we were " evacueeing." I had just left a " port of call " on the gasoline cart, when I was hailed by a friend and fellow-conspirator coming in the opposite direction in another car. We both stopped and exchanged greetings, and when about to depart, my friend took a look underneath the front of my chariot. I said," What's up-something coming adrift ? " He replied with a broad erin. " Oh. no ! I onlv wanted to see if you treated your king pins and steering joints same as you did the works of the old Brighton engines." He didn't catch old Curly out-I'm just as fond of an oil feeder now, as I was when " back in the days." The car may be short of petrol, but I'll see she never goes short of oil !

Wheels and Axles

Little need be added about these. One at least of our advertisers wili be supplying the proper L.M.S. type wheel castings with triangular-section rims same as big sister has. They are turned exactly as described for the coupled wheels, the bosses being reamed 5/16 in. and the treads turned parallel or cylindrical, merely being slightly chamfered off, to avoid catching crossing frogs and bad rail joints. The axles are turned from 3/8in. round mild-steel held in three-jaw, if same is reasonably true, or else turned between centres, from steel of the next largest available size. Friends and relations of Inspector Meticulous may, if they so desire, drill a 1/8in. hole for a short distance in each end, to simulate the hollow axles of full-size practice, which are pretty conspicuous ; this may also be done to the coupled axles.

How to Assemble the Bogie

First, fit the equalisers to the side frames, and see that when the fulcrum-pins are screwed home as tightly as possible the equaliser is quite free to " see-saw " on the pin, yet without any side movement. Then put the axleboxes between the horn-cheeks, making sure that they are quite free to move up and down, and see that the plungers in the equalisers also work freely. Press one wheel on each axle, poke the axles through the axleboxes and press on the other wheel, taking the same strict caution as before, when dealing with the coupled wheels, to prevent splitting of the bosses. The wheels, when right home, should run freely and without wobble.



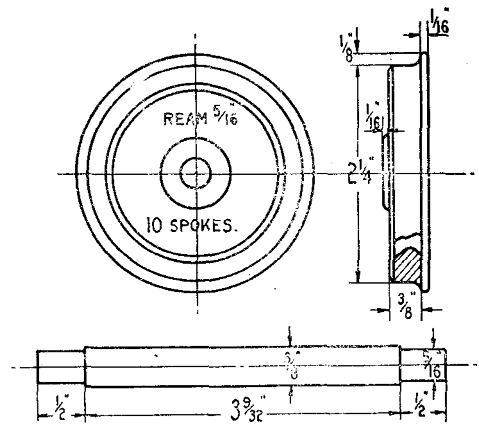
Bogie axlebox

When erecting the bogie on the main chassis, jam a bit of 1/8in. rod or wire under each box, between it and the bottom of the slot, to keep it in running position. Then put it on a flat surface, or a length of rail mounted on a flat board, and put the chassis over it, the bogie-pin entering the slot in the centre casting. When the coupled wheels are resting on the rail, or flat surface; the under-side of the bogie bolster should just touch the centre casting of the bogie ; no rubbing washer is needed. When the large washer and nut are placed on the bogie-pin, and the nut screwed up tightly, the bogie should be quite free to move from side to side. If it doesn't, the bogie-pin is too short, but you needn't worry about that ! Just make a thin washer the same diameter as the bogie-pin, with a 1/4in. hole in it, and slip it over the pin before putting on the big washer. That will pack out the nut a shade, and allow the necessary play.

Follow the "Words and Music ! "

The next item will be the cylinders, and here I would like to say a reassuring word to those builders who are now on their first job. Rumours have reached me that certain club members have been advising first-timers-and others-not to fit the piston-valve cylinders which I am specifying, on the grounds that these require the use of elaborate grinding attachments, and so on and so forth. Fiddlesticks ! Your humble servant, during the whole 24 years these notes have been running, has never knowingly " led anybody up the garden path " yet ; and I have certainly no intention of doing so now. To make the piston-valve cylinders for " Doris," you need nothing more elaborate than your own lathe, an ordinary &in. parallel reamer, and a modicum of what I should imagine everybody who builds locomotives possesses, viz. patience and common sense.

When I specified piston-valve cylinders for " P. V. Baker," I received many letters from prospective builders who were " afraid " of the piston valves, and wanted to use slide valves. I advised them all to stick *to* the "words and music," and up to the present, have had no complaints, nor tales' of failure. Indeed, the examples of this engine that have operated on my own road, have put up most excellent performances. Personally, I've never had any trouble in all my own long experience, and the piston valves on fourteen-year-old " Fernanda " are as good now as when first fitted. Her sharp clear blasts, perfectly " separated " and distinct, even when running at high speed, were remarked on by the members of the North London S.M.E. who drove her on my road last November. The valves are simply bits of commercial ground rustless steel in ordinary reamed liners ! The " secret," if you can call it such (I've broadcast it enough, goodness only knows !), is efficient lubrication. As long as there is a film of oil between bobbin and liner, the valves will remain steam-tight but not mechanically tight ; and the lubricator I shall specify will look *after* that part of the business. 'Nuff sed !



Bogie wheel and axle

For the Bookshelf

The " B. J." Photographic Almanac, 1948. (London : Henry Greenwood & Co., Ltd.) Price 5s., postage 6d.

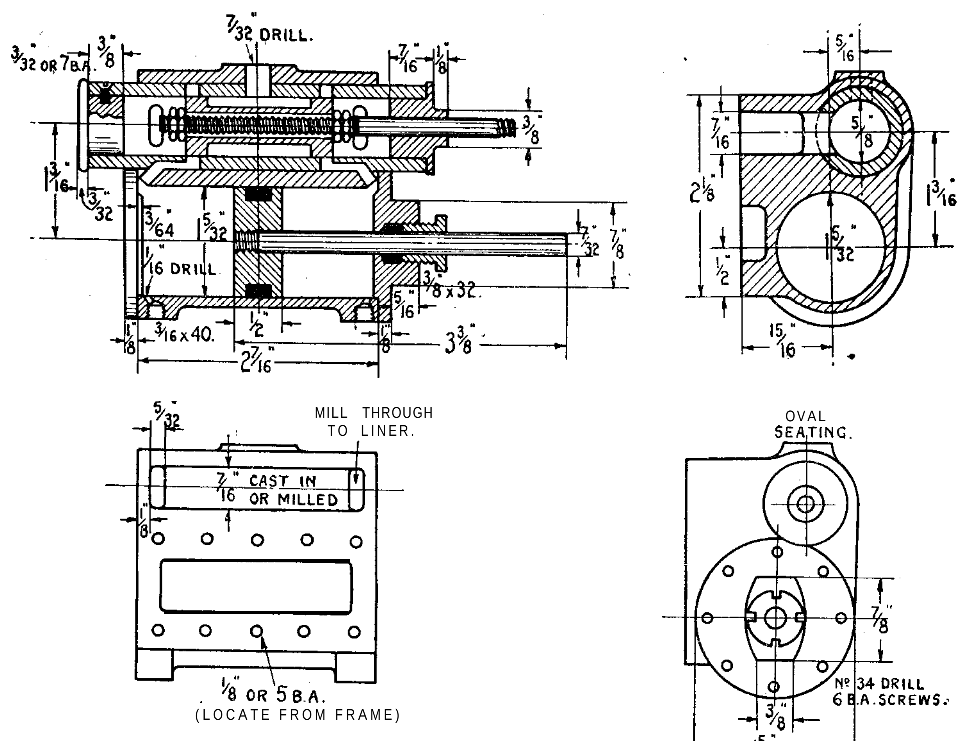
Perhaps the greatest compliment one can pay this well-known annual publication is that little comment on it is necessary. As every amateur and professional photographer knows, it is an infallible guide to the most exact up-to-date information on the theory and practice of their craft, containing articles by well-known writers on current technical and artistic aspects of photography, useful formulae and data, and descriptions of the latest available apparatus. The usual art gallery of notable photographs of the year, reproduced in toned photogravure, is included in the contents,

A 3-1/2in. Gauge L.M.S. Class 5 LOCO.

by " L.B.S.C."

SO, brother beginners, you ***still*** think that proper piston-valve cylinders as fitted to the full-sized L.M.S. class 5 locomotives, are difficult to make ? Somehow or other, I have an idea that after you have read, marked, learned and inwardly digested (as we used to'say at school) the following simple instructions on how to do the job, you Will completely alter your opinion. In my early days, when anybody started in to tell me " Oh, you can't do that, it's too difficult," it made me eager to get on with the job, and do it ; and to quote an early-Victorian phrase which formed a part of every letter, " I hope this finds you the same." Everything is easy ***when you know how ;*** and here is the " how."

First of all, take a good look at the reproduced drawings. You will see that the job is reduced to the rockbottom of simplicity. There are no exhaust passages to drill in the cylinder casting, as I have substituted a cast-in " entrance to the way out " There are no long steam-passages in which to break your all-too-precious-and-expensive drills ; and there are no arrays of studs to fit, for securing a separate steam-chest, very few holes to drill and tap, no ports to mill or chip, and no flat valves to file up. The whole job is simply a matter of careful boring and turning ; and as for the piston-valve being difficult to fit to the liner, it isn't any more difficult than turning the piston to fit the cylinder bore. In fact, if your 5/8in. reamer is anything like accurate, and the casting merchants supply a bit of 5/8in. ground rustless steel for the valves, you won't even have to bother about turning the valves to fit the liner. If you haven't a reamer, there is nothing at all to worry about, either ; all you will have to do, is just to bore out the liner to suit the valves, and run a D-bit through after pressing home.



Sections, back and end views of cylinders for " Doris "

How to Machine the Casting'

First check off the coreholes. If the centres are to the given measurements, no marking out is necessary ; if not, smooth off one end with a file, plug the ends of the coreholes with bits. of wood, and mark the correct centres on them, striking out the circles for bores and liners from these. centres. For beginners' benefit I might repeat that an excellent marking-out fluid can be made by dissolving shellac in methylated spirit, and adding some violet or blue dye. Brushed lightly over the work, it dries in a couple of minutes, and scribed lines stand out very clearly. If there are any bumps on the bolting face of the casting, smooth them off with a file, and set up the casting by fixing it on a small angle-plate bolted to the faceplate ; a bar across its back, with a bolt at each end going through the slots in the angle-plate, will do the needful. Adiust the angle-plate on the faceplate until the corehole for the mainbore, or the scribed circle as the case may be, runs truly. When the lathe mandrel is revolved, the edge of the corehole, or scribed circle, should run true to the point of a tool in the slide-rest, set 37/64 in. from lathe centres, or to the needle of a scribing block standing on the lathe bed. The castingshould slightly overhang the edge of the angle-plate.

If you have a Keats angle-plate, you're in clover, as all you do is to drop the casting in the vee, tighten the clamp, and adjust the angle-plate on the faceplate till the corehole or scribed circle runs truly. I have one. and it saves a ereat deal of precious time. With the ordinary angle-plate the casting must also be set in line with the lathe bed, by applying a try-square, stock to the faceplate, and blade to the casting ; but the Keats gadget locates it automatically,

With a round-nose tool set crosswise in the rest, if the coreholes are true, you can face off the end of the casting. If working to marked circles, face off a part a little bigger than the finished bore, leaving the second circle showing, as you'll need it to reset the casting for boring the hole for the liner. Should the lathe vibrate and set up an " 0 " gauge earthquake when running, bolt a counterweight to the faceplate, opposite to the angle-plate ; anything handy will do, I use a couple of change wheels or an old cast-iron pulley. Set up an ordinary boring tool in the slide-rest, and bore out the casting ; if you have a I-5/32-in. parallel reamer, bore out until the " lead " end will just enter. If you haven't (not many amateur locomotive builders have one this size, and they cost a tidy bit at present prices) bore to finished size, using the inside jaws of a slide gauge, or a pair of inside calipers set to a steel rule, to get the correct diameter. Take the last two cuts without shifting the cross-slide, which will allow for any spring in the tool, and ensure a true bore. Beginners should bore to 1/64 in. of finished size, and then regrind the tool, as they will probably take the sharp edge off when taking the first cut and removing the skin from inside the core hole. The first cut should always be pretty deep.

If the lathe has self-acting feed, or is screw-cutting, use the auto feed, and set the wheels for the finest possible traverse. If only a plain lathe is available, set the top-slide to turn parallel before startmg operations on the cylinders. Chuck a piece of rod in the three-jaw, and take a light cut along it. Try with a " mike " or calipers, and if there is less than 0.001 in. difference in diameter at each end of a 2-1/2 in. cut. or if vou cannot detect any difference in the feel' of the calipers applied at each end, the top-slide is O.K. for the boring job. If not, adjust and try again until it is.

After finishing the main bore, shift the angle-plate bodily on the faceplate until the corehole, or marked circle for the liner bore, runs truly ; then repeat the boring operation, until the hole is 7/8 in. diameter, or the " lead " end of a 7/8 in. parallel reamer will enter, if you have one. Face off the end of the casting right across, after finishing the second bore ; then chuck a stub of brass rod in the three-jaw, turn it until the cylinder will just push on very tightly, mount it thus, and face off the other end with a round-nose tool, until the length of the casting is 2-7/16 in.

Steam and Exhaust Ways

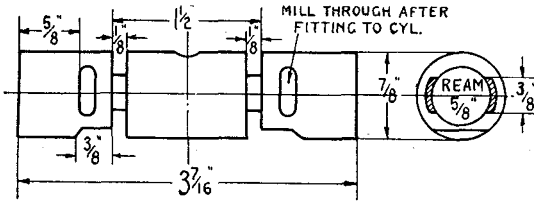
You'll soon realise that the steam and exhaust ways in these cylinders are vastly easier to form, than the ports and passages in an ordinary slide-valve cylinder. File a flat on the lip of each main bore, make three or four centre pops on it, and drill 1/8in. holes slightly on an angle. into the steam-chest bore ; see longitudinal section. Run them into a slot with a rat-tail file, and scrape off any burrs. The exhaust ways are formed with a 5/32in. end-mill or slot drill. My home-made slot drills, described several times, cut far easier and quicker than commercial end-mills. Put the cutter in the three-jaw, then up-end the casting on the slide-rest or saddle, packing it up so that the end of the exhaust recess comes level with the cutter. Then feed the casting on to the cutter with the longitudinal traverse, and work the cross-slide until the cutter has formed a passage 7/16 in. long, from the end of the recess, into the steam-chest bore. as shown in the illustrations. The exact location doesn't matter ; it has nothing to do with the valve setting. Incidentally, this job provides another instance of the usefulness of a vertical slide, when a milling machine is not available ; a vertical slide should form part of the regular equipment of every home-workshop lathe. With an angle-plate attached to it, and the casting mounted end-up and secured by a bolt through the bore, with a big washer under the nut, the bolting face of the cylinder being set at right-angles to the bed of the lathe, both the exhaust ways could be milled out at one setting, using the vertical adjustment provided by the slide, to bring each end of the recess level with the cutter in the chuck.

The two slots can, of course, be formed by drilling holes from the recess into the bore, and running them into a slot with a rat-tail file, but the end-milling process is far less laborious !

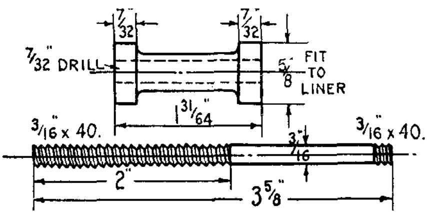
All piston-valve cylinders need drain cocks, to release trapped condensate water when starting from cold, so drill a 5/32-in. blind hole at 3/16 in. from each end of the cylinder, in the bottom of the flange, as shown ; then from the ends of this, drill a 1/16in.hole slantwise into the cylinder bore, scraping off any burrs. Tap the blind hole 3/16in. bv 40 Finallv. face off the little boss on top of the steam-chest--a file will do that-and drill a 7/32-in. hole in the middle, for the steam inlet ; then put the angle-plate on the faceplate again, up-end the casting on it, securing with a long bolt and washer as mentioned above, and setting the bolting face at right-angles to the lathe centres. With a round-nose tool set crosswise in the rest. machine off the bolting face until it is exactly 23/64 in. from the edge of the main bore. This brings the centre-line of the bore to the correct distance from the frame, viz. 15/16 in. as shown in the illustrations.

Cylinder Covers

Little need be said about the covers, as they are the same as those on slide-valve cylinders, and I have described the modus operandi umpteen times already. The front covers are chucked by spigot provided, faced off, register turned to fit cylinder bore, and flange faced ; turn to diameter, part or saw off the chucking piece, rechuck either by gripping edge in three-jaw, or in a stepped ring with a saw-cut in it, held in three-jaw, and face off the outside, leaving the cover 1/8 in. thick.



Steam-chest liner



Piston-valve and spindle

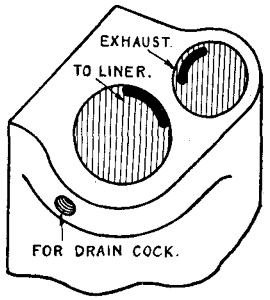
In the case of the back covers, the register, flange, and diameter are turned precisely as above, but the register should be an exact fit in the bore ; then centre, and drill 7/32 in. or No. 2, clean through the lot. Cut off the spigot, reverse in chuck, face off as much of the outside as you can without cutting into the gland boss, then face that off too, leaving it projecting 5/16 in. beyond the cover. Open out the hole to 11/32 in. diameter for 3/8 in. depth-it is advisable to use a pin-drill for this, for if the holes are not concentric, the gland will screw in “ all wonky ” as the kiddies would say (I’d far rather hear a kiddy explain things than any radio announcer or professional orator !) and the gland will bind on the piston-rod. Tap 3/8 in. by 32, and make a gland to suit, from a bit of 5/8in. bronze rod ; a job that needs no detailing. The threads should be a good fit, so that the glands cannot work out when the engine is converting miles into minutes. Ream the hole 7/32 in., as the piston-rod should be a nice sliding fit in the gland.

The guide-bar seatings at top and bottom of the gland boss can be end-milled off in the same way as the sides of the axleboxes ; just clamp the cover under the slide-rest tool-holder, packed up to correct height, and traverse across a 3/8 in. or larger end-mill or slot-drill held in the three-jaw. The part of the cover that could not be turned, can be hand filed ; a little job to test your ability to get a nice finish by hand work.

Eight No. 34 screwholes are drilled in each cover, as shown in the end view. You should know by this time, how to use the holes in covers to locate the screwholes in the flange, which are drilled No. 44 and tapped 6-B.A. The flats for the guide-bars must be at right-angles to the bolting face, so lay the cylinder, bolting face down, on the lathe bed or something equally flat, put a try-square beside it, and adjust the cover until the flats touch the blade for their full leagth ; the work of a few seconds only.

Piston and Rod

These are also the same as for slide-valve



Steam and exhaust ways

cylinders. The piston-rods are merely 3-3/8 in. lengths of 7/32in. ground rustless steel, with 1/4 in. of 7/32 in. by 40 thread put on one end. Hold rod in chuck, and screw with die in tailstock holder, true threads being essential.

The pistons are made from either cast or drawn bronze rod, any diameter available over I- 3/16 in. Chuck in three-jaw, face the end, centre, and drill down about 1-1/4 in. with 3/16in. drill. Turn down about 1-1/4 in. of the outside to a shade over 1-5/32 in. diameter, say about 1/64 in. bigger ; then rough out a groove 1/4 in. wide and a little over 1/8 in. deep, with a parting tool. Part off 1/2 in. full from the end, and " ditto repeato ” for piston No. 2. Chuck one of the roughed-out pistons in the three-jaw, open the centre hole for a 1/4 in. depth with No. 3 drill, and tap the rest 7/32 in. by 40. Put one of the piston-rods in the tailstock chuck, thread outwards ; run it up to piston, enter it, and pull the lathe belt by hand, letting the tailstock slide, until the rod is right home, with 1/4 in. of the plain part drawn into the piston. I have detailed this out again especially for beginners, and would remind them that this is absolutely the best way I know of, to ensure the piston being true on the rod ; it is similar to the manner in which chucks are fitted to precision lathes, both my Milnes and Boley having this system.

Finish-turn the piston on its own rod by chucking a bit of 1/2in. brass rod, about 3/4 in. long, in three-jaw. Centre, and drill through with ***No. 5*** drill, and either ream 7/32 in. or bore out the hole with a weeny boring tool made from the tang of a file, or a D-bit, until the piston-rod fits exactly. Make a dot opposite No. 1 jaw, remove bush, split it down one side with a fine hacksaw, replace in original position, put a piston-rod in, and tighten chuck. The rod should run dead true. Turn the piston very carefully, a mere scrape at a time, until it will just slide into the cylinder bore, and skim off the end to bring the piston to exact length. Note : if you are going to ream the cylinder bores, don’t finish-turn the pistons until this is done.

Steam-chest Liners

The casting merchants should be able to supply the liner castings long enough to allow for chucking and machining the lot at one setting. Chuck ‘in three-jaw, face the end carefully, and bore out exactly the same as you bored the cylinder, until the “ lead ” end of a 5/8 in. parallel reamer will just enter. Run up the tailsfock centre, and let it support the end of the casting whilst you rough-turn the outside to about 1/64 in. over 7/8 in. diameter. Now the relations of " Mona Lott ” say that it is exceedingly difficult to turn the liner to a press fit in the cylinder casting ; don’t you believe it ! Proceed like this : turn down 1/8 in. of the end, same as the pistons, until it is a very tight fit in the hole in the cylinder casting. Use the casting itself for a gauge. Now turn the cross-slide handle half-a-revolution back, and bring it forward again to within one division of its original position. With that setting, take a cut along the outside of the liner. Then move the handle half a division further. and take another cut. The liner should then be exact to size for pressing in. If your cross-slide has no divided collar, you will have to judge the amount, but it is quite easy, you’ll see for yourself how much to allow, far better than I can tell you, when you have turned the 1/8 in. to enter the bore tightly. Leave the 1/8 in. of “fit ” on the end of the-liner, to start it truly in the bore ; part off at a bare 3-1/2 in. from the end, then rechuck the liner and face off to dead length.

At 31/32 in. from each end, form a groove 1/16 in. deep with a 1/8 in. parting tool ; then mill or file away the bottom of these grooves straight across, so as to cut into the bore of the liner at top and bottom, leaving a bridge 3/8 in. wide between the openings. See illustration of liner, which shows them clearly. These openings form the ports, and I fancy you’ll agree that they are far more easy to locate and cut, than ordinary ports on a flat face. Now file away 3/8 in. of the underside of the liner at each end, starting from the outside edge of the port, cutting away a full 1/16 in. depth, and finishing the end on the slant, as shown ; you’ll also agree that this is easier than drilling several small holes to a great depth with a small drill. Finally, enter the reduced end of the liner into the cylinder casting, taking care to line up the filed-away portions underneath, with the sausage-shaped passages at each end of the main bore. Squeeze the liner right home, using the bench vice as a press (you can wangle a wider jaw opening by removing the steel inset jaws) and inserting a block of metal with a hole about 11/16 in. diameter in it, between the casting and the vice jaw, to allow the liner to come right through the cylinder-block. Each end should stand out 1/2 in.

Should any beginner slip up on the above. simvle job. and turn the liner too easy a fit for pressing home, don’t worry ! Simply tin over the outside of the liner, anoint the inside of the steam-chest bore with a drop of Baker’s fluid., or other good liquid soldering flux, insert the hner, then heat up the casting steadily until the solder melts and seals the joint.

Poke a 5/8in. parallel reamer clean through the liner, holding the castinginthe benchvice, and letting the reamer kind of “ float ” in your hand. A tap-wrench on the shank will drive. it. The cylinder bore can be done at the same time if you have a reamer big enough. Set up the cylinder again same as you did when milling the exhaust ways, and continue milling them right through into the liner bore ; or drill and file if you prefer. Also put the 7/32in. drill down the steam inlet, and carry on into the liner bore. Clean off any burrs by running the reamer through again.

The little covers for the ends of the liner are simple turning jobs needing no detailed description, and can be turned from a bit of 1-in. rod held in the three-jaw.Turn down 3/8 in. length to a push-fit in the liner. The front one is parted off 1/2 in. from the end, reversed in the chuck, and the end turned as shown. Ditto repeato first operation for the back covers, then centre, drill down about 3/4 in. depth with No. 14 drill. part off 9/16 in. from the end: reverse in chuck. turn to outline shown, and poke a 3/16in. parallel reamer through the hole: No gland is needed ; there is only exhaust pressure-to withstand, and that is precious little on any of my engines. The covers will not fall out if they are held by two or three 3/32in. or 7-B.A. screws put through the liner into the spigot’of the cover, as shown in the longitudinal section of the cylinder.

Piston-valves

Try a piece of 5/8 in. ground rustless steel in the liner. If it just slides in nicely with no suspicion of shake, you can use it as it is, for the piston-valves. Chuck in the three-jaw, face the end, centre, and drill a 7/32 in. hole just over 1-1/2in. deep. Bring up the tailstock centre to support the piece whilst you form the reduced part between the bobbins. Make a cut with a parting tool 1-1/2in. from the end ; then turn away the middle to 3/8 in. diameter with a round-nose tool, leaving a bobbin exactly 7/32 in. long at each end. Part off at 1-1/2 in. then rechuck and take a weeny cleaning-up skim off each end, so that the finished valve is 1/64 in. under 1-1/2 in. long. Did I hear somebody murmur something about piston-valves being difficult to make, and requiring precision grinding machines and so on ?

The valves can also be made from bronze. Turn down a length held in the chuck, to a little over 5/8 in. diameter, for 1-5/8in. length, then proceed exactly as above : but before parting off. skim down the two bobbins, “ scrape by scrape” in a manner of speaking, until they just slide in the liner, like the piston in the cylinder bore. Then part off, and finish to length as above.

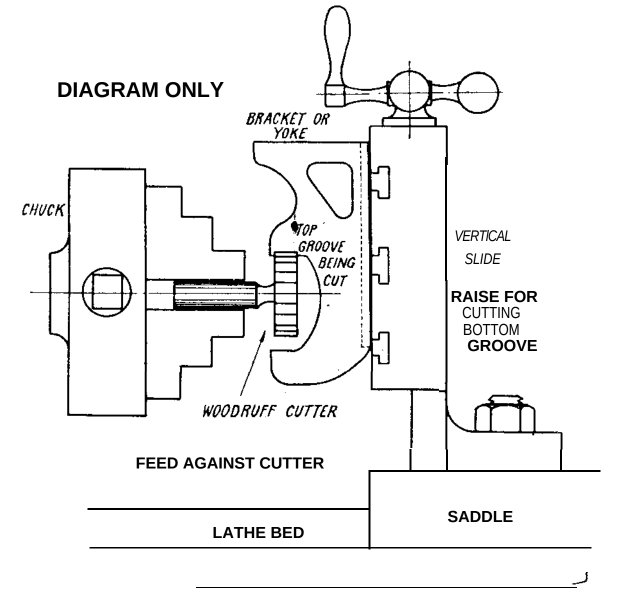
The valve spindle is a 3-5/8in. length of 3/16in. rustless steel or drawn bronze rod, with 2 in. of 3/16 in. by 40 thread on one end, and about 3/16 in. of same pitch on the other. The valve is held between two pairs of locknuts which you can easily make from 1/4in. hexagon brass rod, no detailed instructions being necessary for that simple job ; the valve must be free to turn, but must not have end-play. The assembly is shown in the illustration ; pack the pistons and glands with graphited yarn, and put oiled paper gaskets between the cylinder covers and casting.

Brother locomotive builders-do you really, honestly, and truly, as my only niece used to say in her schoolgirl days, now think that piston-valve cylinders are difficult to make ?

A 3-1/2in. Gauge L.M.S. Class 5 Loco.

by " L.B.S.C."

THE guide-bars I am specifying for the little L.M.S. " Class 5 " engine are a one-sixteenth edition of the full-sized article, and are made from 7/32in. by 5/16in. section steel, or the nearest larger size available. Silver-steel is about the best for wear-resisting qualities ; rustless may, of course, be used by anybody who fancies it, and ordinary mild-steel will give excellent service. No detailed instructions are needed ; it is a simple job to mill or file the pieces of steel to the dimensions and outline shown' in the illustration. The longer-tapered end should be filed, or faced off in the four-jaw chuck, to be absolutely dead square with the sides, so that it can be butted up tightly against the cylinder cover, and will be parallel with the piston rod.

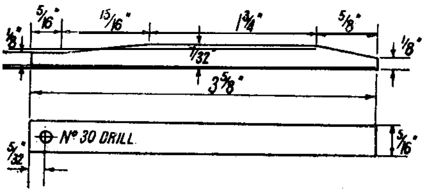


How to mill guide-bar grooves, using vertical slide

The brackets or yokes for supporting the bars, may either be castings or built up from 1/8in. plate. Castings are best, and also most realistic, as the beading around the edge will be cast on, and the effect is the same as in full size. The supports or extensions to which the bars are bolted, will be cast on, and save a lot of trouble. Little is required in the way of machining. Failing a regular machine, the easiest way to machine up the flange which bolts to the main frame is to clamp the casting under the slide-rest tool-holder with the flange at right-angles to the bed, and level with lathe centres. It can then be cleaned up with an end-mill or home-made slot-drill or facing cutter, held in three-jaw, the job being fed into cut with the top-slide, and traversed across the cutter with the cross-slide. If you don't fancy that, just catch the casting. in the bench-vice with the contact face of the flange showing just above the jaws, and exercise your muscles with a big flat file, second-cut for preference, until you have smoothed off the flange level with the tops of the vice jaws. Beginners note : don't file any more, once the file touches the vice jaws, or you'll need a new file for the next iob. They are pretty expensive at today's inflated prices ! The bolt-holes are drilled No. 34 at 1/2in. centres.

The part where you need to watch your step is machining-out the grooves into which the guide-bars fit. The latter must be the correct distance apart, and at the right distance from the frame, or else the crossheads and piston-rods will bind, If any builder of this engine has a Woodruff key-seat cutter, and either a vertical milling machine or a vertical slide, for his lathe, the job is in the bag. All I have to do, is to put a 5/16in. cutter in the spindle of my vertical miller, grip the casting in the machine-vice on the table, holding by the flange, with the jaws upwards, and adjust the table so that the cutter is between the jaws, and the correct distance from the flange. The casting is then fed into cut by the longitudinal movement of the table, and traversed across the cutter by the cross-slide, repeating the operation for the second groove, the correct setting being obtained merely by adjusting the table longitudinally. I don't even have to bother about measuring the distance between the top and bottom grooves, as the table is operated by a screw having twenty turns to the inch, and there is a collar with 100 divisions on the spindle between handle and table ; so it is as easy as eating cake, to give the handle the required number of turns and divisions, to get any spacing between the grooves, to a limit of half-a-thousandth of an inch.

To do the job with a vertical slide, put the cutter spindle in the three-jaw. Bolt the casting to the vertical slide in an upright position, and adjust top-slide or saddle until the cutter is between the jaws of the casting, and the correct distance from the bolting side of the flange. Then adjust by means of the vertical slide, and traverse across the cutter with the cross-slide. The illustration shows the rig-up better than I



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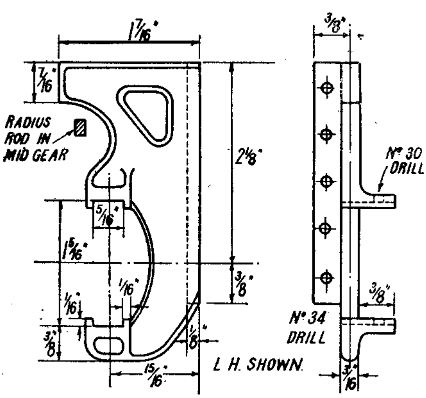
can explain it, and you don't have to have a 5/16in. cutter, or even a Woodruff key-seater, at that ! Any cutter less than 15/16in. in diameter, and less than 5/16 in. wide, will do ; a home-made one mounted on the end of a bolt about 3/8 in. diameter, will do the trick. I have explained how to make them in previous notes. With a narrower cutter, simply take two or more " bites."

The grooves can be easily cut on a planer or shaper, by gripping the casting by the flange, jaws upwards, in the machine-vice, and using a cranked tool in the clapper-box. If no methods of machining are available, the humble but necessary file, used with a mixture of care and perseverance, will do the job quite well.

If you have no castings and want to use plate material for the yokes, cut them from 1/8in. brass or steel, to the given outline and dimensions ; and for the bar supports, rivet a bit of 3/32in. or 1/8in. by 3/8in. angle, at the top and bottom of the grooves. To attach them to the main frames, simply rivet a 2-1/2in. length of 5/16in. by 3/32in. angle to the side which goes to the next frame. Don't forget you need one right-hand and one left ! Drill holes as shown on the casting.



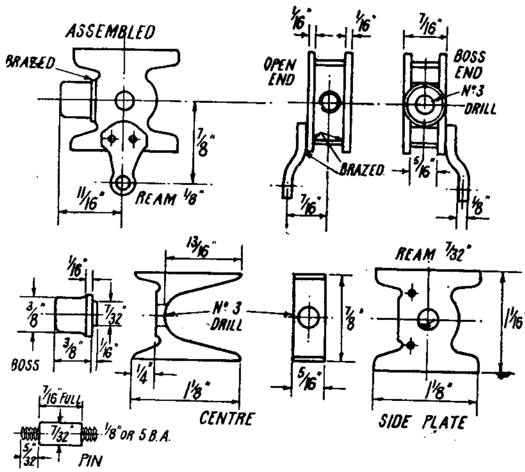
Guide yoke or motion bracket

Erection

Put the bars on the seatings at top and bottom of the gland bosses, see that they are exactly over the piston-rods, parallel with them in all ways, put the No. 30 drill down the hole in bar, making a countersink on the gland boss, follow with No. 40, tap 1/8 in. or 5-B.A. and put a screw in, hexagon head for preference, appearance, and Inspector Meticulous. The brackets or yokes are then slid over the ends of the bars, and adjusted to correct position, which is with the vertical centre-line of the bracket 2-3/4 in. ahead of the leading coupled axle centre, but don't drill the bolt holes in the frame until you have made and fitted the cross-heads and connecting-rods. Just put a couple of clamps over flanges and frame, to hold them until finally adjusted.

Crossheads

Scheming out the crossheads gave me the proverbial " pain in the neck." It's easy enough to write " take a piece of steel, mill and groove top and bottom, cut away the centre, drill holes



Built-up crosshead

for pin and piston-rod, and turn the boss " but there has been much too much of that sort of " instruction " save the mark! -in the past. Don't I know it-my correspondence tells many tales. I'd just love to see one of these merchants with a chunk of steel, trying to follow his own directions for getting out the deep cavity in which the little-end of the connecting-rod works !

If our advertisers who are supplying castings can manage to produce cast crossheads in nickel-bronze (German silver) with a recess for the little-end cored out, it will save a lot of work. The grooves at top and bottom can be milled out exactly as described for axleboxes, clamping the casting under the slide-rest tool-holder level with lathe centres, and traversing across a 5/16in. end-mill or slot drill held in three-jaw. The boss can be turned with the casting held in four-jaw ; the sides smoothed with a file, drilled No. 3 and reamed 7/32 in. for crosshead pin ; and the cross-head arm, or drop arm, filed out of a bit of 1/8in. steel, fixed temporarily with a screw, and silver-soldered.

Howsumever, as the poet saith, if no castings are available, or if you prefer steel crossheads, proceed as follows : Chuck a piece of 7/8in. by

5/16in. steel bar (commercial size) in the four-jaw, with about 1-1/4 in. projecting, and set to run truly. For beginners' benefit, set a pointed tool in the slide-rest, and adjust chuck jaws until, when the belt is pulled by hand, all four corners of the piece of steel just scrape the tool. By setting the tool close to the steel, you'll see in a jiffy, when the belt is pulled, which way to adjust the jaws. Face the end, centre, and drill 7/32 in. for about 3/8 in. depth ; then, with a rather pointed round-nose tool set crosswise in the rest, recess out the end as shown in the side view of the crosshead centre, leaving about 1/2 in. in the middle, faced off dead flat. Part off at 1-1/8 in. from the end, and repeat operation for second crosshead. Next, grip the piece of metal in the vice, blank end upward, and saw a V-shaped piece out, finishing to outline shown with round and flat files. Turn up two bosses from 7/16in. mild-steel rod, to the dimensions shown ; turn the large end first, centre and drill No. 3, and after parting off, reverse in chuck and turn the pip to a very tight fit in the hole in the back of the crosshead centre.

The next stage of the proceedings is to saw and file the side plates : all four can be done at once, same as you-would-saw main or bogie frames. Cut four pieces of I6-gauge bright steel, a little over 1-1/8 in. square, mark one out, and drill a couple of holes with No. 51 drill, about the position of the two little circles. Use the piece as a jig to drill the others, temporarily rivet together with 1/16in. rivets, and saw and file the lot to outline. Put a No. 3 drill through the middle. Part the plates, and file off any burr.

To assemble, drive the pip on the boss into the hole in the centre section, then put one of the plates each side. A temporary bolt through the middle hole, will hold the plates to the centre-piece whilst you adjust the latter so that it is equidistant between top and bottom of the side plates, overlapping 3/32 in. in both places, and level with the ends of the centre piece. Screw up the bolt tightly so that the centre piece is firmly held, then run a No. 51 drill through the lot, using the holes in the plates as guide. Put in a couple of rivets (bits of 16-gauge wire will do) and rivet over tigbtly. You needn't bother about forming proper heads, as long as they hold tight. Then cut out and bend the drop arm from 1/8in. mild-steel, to shape and size shown, and attach it to the crosshead either by two small rivets or a single screw. The temporary bolt through the crosshead pin-hole can then be taken out, the rivets holding the bits together for the brazing process.

Put a little wet fIux, such as Boron compo, Sifbronze flux, Tenacity No. 3 or any other good brand, around the inside of the cavity. the boss. and the joint between drop arm and side plate: Heat the whole issue to bright red, and touch the joints with a bit of I6-gauge soft brass wire ; if you have used Sifbronze flux, use. 1/16in. Sifbronze rod. Either will melt and flow into the joints ; warning-be sparing with the brazing material, for if you get a blob in the cavity, it will want some getting out, and a little in the proper place is just as strong and effective. Let cool to black, then quench in water ; wash off, and clean up. Both sides are smoothed off with a file, and you can polish them up a bit with emery-cloth if you wish; any brazing material that has-seeped through into the top and bottom grooves, should be smoothed off with a file, and the side plates trimmed to outline if thev need it. Put a 7/32in. reamer through the centre pinhole, and enter the " lead " end of it into the hole in the boss, so that you can start the piston-rod truly, when attaching crossheads to piston-rods.

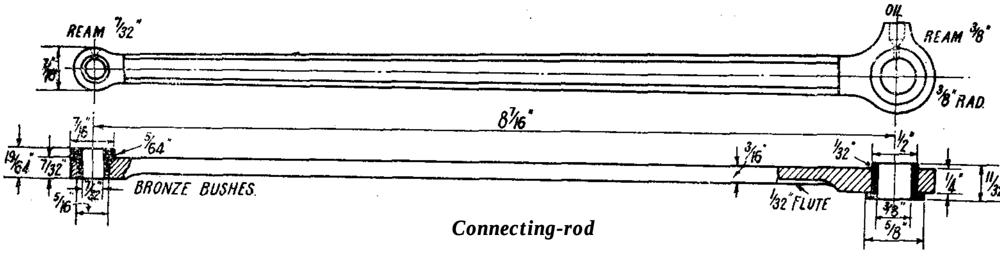
The crosshead pin is a bit of 7/32in. round silver-steel 3/4 in. long with 5/32 in. of each end turned down to 1/8 in. diameter and screwed 1/8 in. or 5-B.A. Ordinary commercial nuts are used.

Connecting-rods

As the connecting-rods are made by exactly the same process as the coupling-rods, no detailed instructions are necessary, as it is only " repetition of ritual." Each rod will need a piece of mild-steel of I-in. by I-in. section. and approximately 9-1/4 in. long, milled, or sawn and filed to the outline and dimensions shown. In case anybody starts to write in and tell me that I can't tell top from bottom, and have shown the flange of the little-end bush on the wrong side, I had better make it clear right awav. that this is intentional, and quite O.K. "If you care to lay out for yourself, a plan of the driving-wheel with the connecting-rod in place at the outer end of the crankpin, and the cylinder with the crosshead in section, you'll see that the outer side of the little-end boss on the connecting-rod just enters the cavitv in the crosshead. almost touching the outer plate, but leaving a gap of 3/32 in. between the inner side of the boss and the inner plate of the crosshead. It is a pity to waste valuable bearing space at a point where the full power of the cylinder is transmitted ; also, it wouldn't be very good engineering practice to leave the little-end flopping about, in a manner of speaking. So, if you put in the headed bronze bush shown, with the head on the inside, you kill two birds with one shot by providing greatly increased bearing surface, and taking up the side play. The connecting-rod is also maintained parallel to the centre-line of motion, so that the push and pull on the crankpin is " all fair and square."

A similar bush is fitted to the big-end ; and both should be made of good hard phosphor-bronze, which our advertisers should be able to supply. After pressing in the bushes, drill oll-holes clean through bosses and bushes. as shown by dotted lines. I have not shown any top cover to the oil-box on the big-end ; but if any builder wants to make a posh job, he can tap the counter-bored part, and make a couple of dinky little hexagon brass caps to screw in. I bet that will raise a loud cheer from that worthy magician of the pencil, Mr. F. C. Hambleton ; and that reminds me of something. I don't know **of a** single locomotive " fan " who doesn't share your humble servant's admiration of friend Hambleton's outline drawings ; but he has a powerful rival in **Mr.** J. N. Maskelyne. Their efforts at delineating locomotives that have been, or are, needs no praise-they speak for themselves, if you can apply such a term to drawings-but what of the future ? In this age of perambulating spam cans, it is a relief to give free-rein to imagination, and speculate on what might be ; so what about each of the above-mentioned lovers of locomotive grace and beauty, setting down what they consider the most suitable outline for the future express passenger engines of British Railways ? I'd love to see the drawings ; so would hundreds of others to whom the sight of a " Flannel Jacket " or a " Silver Link " is a nightmare.; and I would gladly do my little bit by providmg suitable " works " and the inside arrangements of boiler, etc., so that anybody who wished, could make F.C.H.'s or J.N.M.'s dreams come true in 3-1/2in. gauge.

in the stroke ; if they go hard anywhere, slack the clamps holding the brackets to the frame, and try again, leaving the clamps slack until the crossheads pass the brackets and reach the extremity of their travel. If the clamps are tightened with the crossheads in that position, they should work freely on full stroke ; the No. 34 drill can be put into the holes in the flanges of the brackets, and the holes continued right through the frame. File off any burrs, and put in 6-B.A. bolts to keep the brackets in place. Alternatively, make counter-



Connecting-rod

Final Assembly

Coming back to realities, try the crossheads between the guide-bars whilst the yokes are still temporarily clamped to the frame, and see that they slide easily without being slack. Also try if they will go on the piston-rods ; they shouldn't be an absolute drive fit, but should be fairly tight. Now put the connecting-rods on, entering the little-ends in the crossheads, and fitting the pins. Push the piston-rods right in, and put a crank on front dead-centre, the boss of the crosshead going over the piston-rod. Now carefully advance the piston-rod another 1/32 in. into the crosshead, giving that much clearance between piston and cover on dead centre ; drill a No. **43** hole clean through crosshead boss and piston-rod, and squeeze in a 3/32-in. silver-steel pin, or a bit of 13-gauge spoke-wire, to act as a cotter.

Repeat operation on the other side of the engine, then turn the wheels by hand. The crossheads should slide easily between the guide-bars, with neither binding nor slackness at any point sinks on the frame with the No. 34 drill, and continue through frame with No. 44, tapping 6-B.A. and using hexagon-head setscrews to hold the bracket to the frame. Turn the wheels so that crossheads are between the bars at the point where the jaws of the brackets are bearing against them. Run the No. 30 drill through the holes in the projections, making countersinks on the guide-bars. Shift the crosshead, drill the bars No. 40, tap 1/8 in. or 5-B.A., and put in hexagon-headed set-screws, carefully filing off any of the screw that protrudes through the sliding surface of the,. bar. Weeny spring washers are now on sale by some of our advertisers, and I recommend their use under the heads of the set-screws, also in any other part of the motion work where there is likely to be vibration. I have used spring washers on all the eccentric straps and big-end bolts of my L.B. & S.C.R. engine " Grosvenor," as I'd just hate to have anything come loose when that lady is knocking five minutes off her big sister's record between Victoria and Portsmouth !

The Wicksteed Regatta

IN spite of the threatening weather, the Wicksteed Model Yacht & Power Boat Club was able to hold its first power boat event since 1939.

We were pleased to welcome members from Coventry, Bournville, Altrincham and Guildford, making it possible for three boats to enter for each event.

In the 30-c.c., or " A " Class for the Timpson Trophy; 1,000 yd., Mr. Williams (Bournville), with Faro, showed a fine turn of speed, and clocked a speed of 35.948 m.p.h. Mr. Waterton (Altrincham), MU.4, managed to obtain 29.601 m.p.h. For the Newman Loake Cup, 500 yd., " A " Class, the result showed : Mr. Williams's ***Faro*** still tuned up well with 34.091 m.p.h., with MU.4 giving 27.056 m.p.h. The Wicksteed boat evidently did not like getting wet, as she refused to show what she could or could not do.

Thus Mr. Williams gained both trophy and cup.

In the " B " Class, 15 c.c., we had ***Annette*** (Mr. Churcher, of Coventry), B.v.16 belonging to Mr. Dalziel, of Bournville, and Vesta II, owned by Mr. Jutton, of Guildford. The latter was very unlucky, as it was unable to make the course, having come to grief ***on*** two occasions. It was noted that perhaps the centre pole was a little too high for this flash-steam boat, and maybe this may have accounted for the mishaps. ***Annette*** was also unable to make the grade, and so Mr. Dalziel carried away the Perkin's Cup with 21.946 m.p.h., on a 500 yd. circular course.

We were very pleased to see Mr. Whitworth and party from Bedford, who are building up a strong club, also Mr. Randal and friends from Derby.

The trophy and cups were presented by Mr. L. A. Garrett. the club president. who also timed the events, assisted' by Mr. Dalziel (Bournville), and Mr. H. Carr (Wicksteed).

A 3-1/2in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

THE valve-gear on the full-sized L.M.S. Class5 engines is a pretty good example of a modern arrangement combining_ lightness, strength, accessibility, and good steam distribution ;and the arrangement you see in the reproduced illustrations, follows full-size practice as far as consistent with working conditions on 3-1/2in. gauge. Nobody would mistake the " new look " combination-lever, the slender expansion-link, or the slotted girder which carries it ;and I might mention that the girder gave me the biggest headache of the whole doings. On big sister, the gear frame and its forward extension are castings.- To reproduce them in 3-1/2in. gauge size would give our advertisers' pattern-makers and foundrymen another headache ; so I wangled out a wheeze whereby the whole bag of tricks can be built up, yet the personal appearance of the completed job "complies with the regulations "in a manner of speaking. Just as some folks raise an awful moan about using slotted screws in small locomotive work, whilst all the time they are freely used in full size, so others shed tears about using offset rods in a valve-gear ; yet on the full-sized Class 5's, both the combination-lever and eccentric-rod are bent inwards from the drive end, to connect with the valve fork and the tail of the expansion-link respectively. Well. on the little one, I have considerably reduced the offset on the combination-lever, and done away with it entirely on the eccentric-rod, substituting a straight rod ; as I guess somebody or other will be writing in to tell me that isn't right-what a life ! Finally, the lengths of the various rods between pin centres are nearlv all in strict proportion to those on the big engines, the only differences being those necessitated by my own idea of ports, valves, and setting ; so young "Doris " should be able to perform in the manner usually observed among her full-sized relations. Now let's get on with the job.

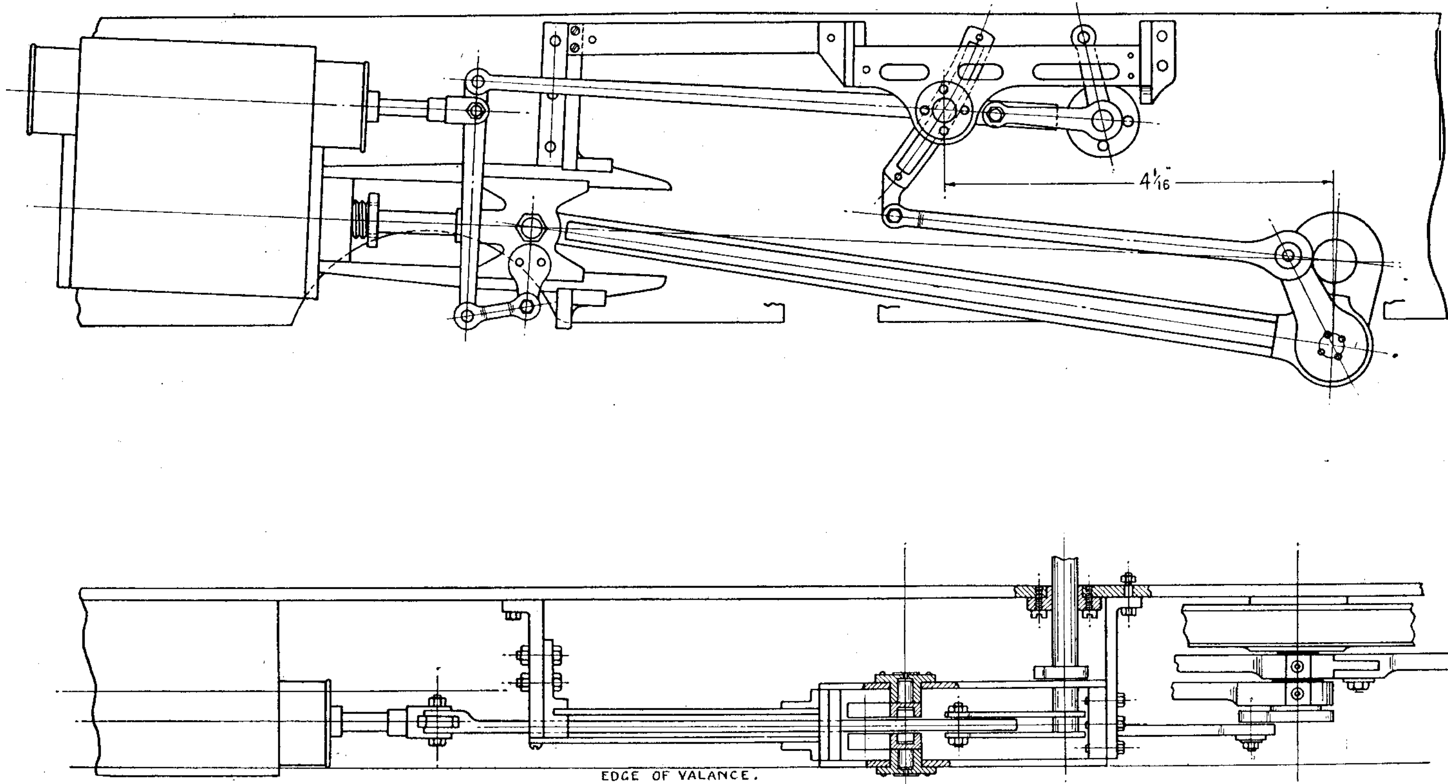
Lap-and-lead Movement

The first thing you will notice about the combination-lever, is that it hasn't any forks at all, but is simply a plain bar with a small offset in it. Owing to its length, it is possible to separate the pins at the top, to a spacing sufficient to allow two ordinary forks to be used, one above the other. This cuts out right away, the usual extra-wide valve-fork or crosshead, and a forked combination-lever to take the radius rod. No detailed instructions are needed ; simply. file or mill it from a piece of ordinary 1/8in. by 1/4in. mild-steel, and case-harden all the holes. Alternatively, use " gauge "steel (ground flat stock) and after bending to shape, harden it, and then draw the hardness out of the centre part by applying a red-hot piece of iron bar, or something else with plenty of " therms " in it, to the middle part of the lever. Clean well, and polish up with fine emery cloth or other abrasive. Beginners especially, remember that as the holes in all valve-gear parts should go squarely through the rods and links, all holes must be drilled either on a drilline machine. or in the lathe : and it is advisable to' ream them that way too, to ensure perfect fits and sweet working. I use a little round cast-iron block, truly faced on both sides, with a lot of varying-sized holes in it. It was originally part of the boss of a chuck-plate casting which was too long. The work is placed on this block, over a hole of appropriate size to receive the drill or reamer, and a dead square (Pat again !) hole is the result, although, begob, it's round !

Union Links

These items are made from 1/4in. square mild-steel. If you get a bit long enough to grip under your slide-rest tool-holder, you can run it up to a 1/8in. slotting cutter on a spindle in the chuck, and then reverse it end-for-end to cut another slot. Then saw the bits off to a bare I in. length, and slot the sawn ends by running them up to the same cutter, as the cross-head arms are same thickness as the combination-levers. When I had no milling machine, and did my slotting as above, I held short bits like these, in a-sort of tool-holder ; this was merely a bit of square mild-steel bar., with a round hole drilled down the end, the diameter of the hole being equal to the size of the square across the corners. A set-screw held the short bit in the holder. They say a square peg doesn't fit a round hole ; well, just recently I made a flv-cutter spindle for-my milling machine, simpiy drilled a round cross-hole through it, and fitted a set-screw. Up to the present, all I've used in that round hole are square tools, and nary one has slipped yet, although the intermittent clouting they get-when in use (one whack per revolution !) would shift anvthina the least bit shiftable.Round off the ends of The union links by aid of a Wihnot tiling jig or button-described umpteen times-and recess the middle for the sake of appearance. Note : as the union-link misses the guide-bar bracket by a small fraction of an inch, twice per stroke, the fixing bolt attaching same to the crosshead arm mustn't project on the inside ; so countersink that side of the union-link fork, as shown in the section, and turn up a little bolt for each. link, from a bit of 3/16in.round mild-steel, as shown in the detail sketch.

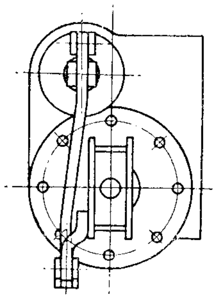
The valve forks or crossheads are made from 5/16in. square mild-steel. Take a piece, as before, long enough to hold in your slide-rest ; cross-drill the end, using No. 32 drill, then slot as above. Saw off the piece to about 3/4 in. length, and ditto repeato. Chuck each in four-jaw, plain end outwards, set to run truly, and face to length, 1/2 in. from centre of cross-hole.



Valve-gear for "Doris"

Turn down 3/16 in. of the end to 1/4 in. bare for the sake of appearance. Centre, drill No. 22 or 5/32 in., and tap 3/16 in. by 40. Round off the other end, then reduce the thickness across the jaws to 9/32 in., so as to give the fork of the radius-rod plenty of room to operate. Poke a 1/8in. parallel reamer through the holes, and make a little bolt to fit, from a piece of 1/8in. silver-steel shouldered down each end to 3/32 in., screwed 3/32 in. or 7-B.A. and furnished with commercial nuts.

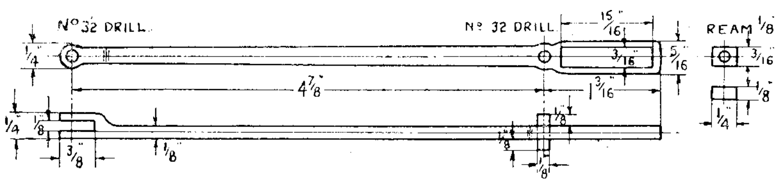
No need to assemble the lap-and-lead movement yet ; we will do the whole bag of tricks at one fell swoop later on.



Clearances in lap-and-lead movement

Radius-rods

There are two ways of making the radius-rods. If you have a milling machine, make them from 5/16 in. square mild-steel. When milling a long thin rod, I usually solder it to a bit of much stouter bar, say about 1/2in. square in the present instance, and grip that' in the machine-vice. You can then mill down to 1/32 in. thickness, if a job calls for it, without fear of buckling or bending .; it was the only way I could mill the long spidery brake-rods for " Grosvenor's " clasp brakes on her big driving wheels. If no milling machine is available, use 1/8in. by 5/16in. flat mild-steel for the main part of the rod, and braze a little block on the end from which to form the fork or clevis. You should know how to do the latter job by now! At 45 in. from the centre of the hole in the fork, drill a No. 32 hole ; and if ever one hole in the valve-gear needed more than another, to go through dead square with the rod, this is the boy. The reason is, that it carries the pin on which the two curved die blocks are' mounted ; and if those merchants aren't exactly dead in line, they are going to bind in the link slots, and cause undue wear in all the pin joints in the gear. The pin itself is nothing startling, being merely a 3/8in. length of 1/8in. round silver-steel squeezed in when erecting the gear ; but it's just one of the little things that matter, like the odd inch of wire in the fuse box, that chooses the exact minute when you are halfway through a cylinder bore, to stop the lathe and put your workshop lights out. The slot at the end can be drilled and hand-filed in less time than it would take to set up and machine ; drill a few 3/32-in. or No. **20** holes down the middle, join them with a rat-tail file, and finish with a warding tile until you can run a bit of 3/16in. square steel from end to end, easily, but without shake. The straight die-block is just a 1/4in. length of 1/8in. by 3/16in. silver-steel, with a 1/8in. reamed hole in the middle, and is fitted when the gear is erected.



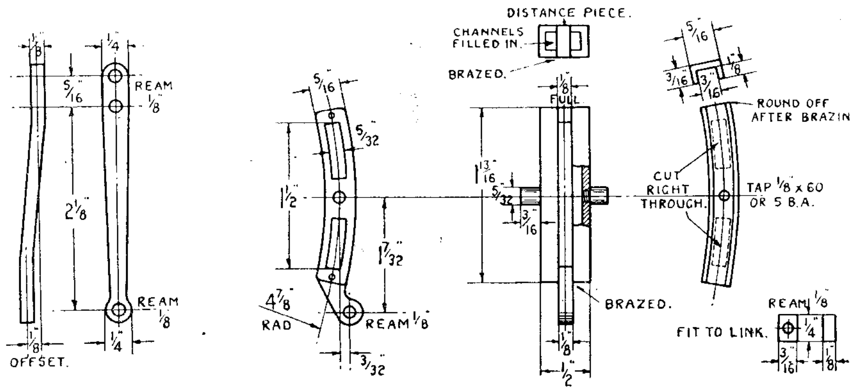
***Radius**-rod*

Expansion-links

Two pieces of curved channel steel, 1-7/8 in. long, and of a section as shown in the illustrations, are needed for each expansion link. These will probably be available from two or three of our advertisers; but they can be made by exactly the same processes as described a few weeks ago for the Joy curved guide for "Maid of Kent" and "Minx." Owing to the length of the radius-rod, they would need a 10-in. faceplate at least, for forming with a parting too ; but could easily be done by aid of the simple rig-up I described for use on the average small home-workshop lathe. Incidentally, this type of expansion-link has far greater wear-resisting properties than the kind using a single central link and forked radius-rod. Anyway, whether you make the bits of channel, or buy them, cut them to the given length ; and then, exactly in the middle of each, drill a No. 41 hole. Put them together channel to channel, with a bit of 1/8in. steel as a distance-piece at each end ; at the top, it should go down between the links to a depth of 5/32 in. The bottom bit should be big enough to form the link tail after brazing. Now put a bolt through the middle holes, to hold the bits together ; and to make a posh job, fill in the channel each side of the distance-pieces, with a little bit of steel filed to suit. See top view of assembled link. Drill a No. 52 hole each end, clean through links, channel blocks, and distance-pieces; drive in a bit of 16-gauge spoke-wire, or 1/16in. silver-steel, and rivet over the ends. Don't bother to form proper heads, they are filed off afterwards. Now braze each end solid ; just apply a dab of wet flux (Boron compo or anything similar) to the outside-not between the links on any account-heat to bright red, touch with a bit of brass wire, let cool to black, quench in water, and clean up.

Take the bolt out of the middle, put a No. 40 drill through, and tap both sides either 1/8 in. by

60, if you have the necessary tackle, or 5-B.A. Drill a couple of holes through with No. 30 drill, above and below the tapped holes, and with round and flat files form two slots. as shown by the dotted lines. Be careful not to file these wide enough to come level with the inside of the channel, or the die-blocks will come out. Trim off the top of the link, then mark out, drill and ream the tail, and file it to outline, as shown. It is-much easier to form the tail *after* the two halves have been brazed together ; if the tail is filed to shape and drilled ***before*** fitting to the link, the chances are a million dollars to a pinch or slightly round it if you like ; then screw both trunmons tightly into each side of the link. Come loose? Not on your life-how can they get out when the bushes in which they work are drilled " blind " ? Take a look at the plan view of the assembled gear. Also, when I say screw them in tightly, I mean just that. They should go in about one thread with finger pressure ; then put a bit of copper sheet over each jaw of your bench vice, grip the trunnion in it, and turn the link. That should screw them home tightly enough to " stay put " for the lifetime of the engine. If you're still dubious,



Combination lever ***Expansion link***

of snuff that it will shift during the riveting and brazing processes, and then, as our R.A.F. friends would say, you've had it, chum !

The trunnions are two 1/4in. lengths of 5/32-in. round silver-steel, with 1/16 in. of the end reduced to 1/8 in. and screwed to fit the tapped holes in the sides of the links. Don't forget the wheeze of making them from a longer bit of steel, turning down 1/8in. or more and screwing it, so as to get a full thread, then facing off until the screwed part is 1/16 in. long only, and the thread jolly tight in the hole. Reverse in chuck, and face the other end until the plain part is a bare 3/16 in. long. Chamfer off the sharp edge, give them a dose of " Easyflo " ; you can do that without melting the brazing. Let it form a weeny fillet between trunnion and link, and countersink the bearing bushes to clear, when making the latter. There is nothing special to note about the die-blocks, as the dimensions are given in the illustration, but they should be fitted to the links before the latter are brazed up, I don't mean left in whilst brazing ; just see they slide properly without being slack, then take them out again. They should be case-hardened, if mild-steel ; if " gauge " steel (ground flat stock) is used, they can be hardened right out, and will last the lifetime of the engine.

Operating Repeater Motors

(Continued from page 271)

24-volt supply in the orthodox way. You will find your little 3-phase repeater motor running quite well, and in step with the motor generator or alternator.

Should the power of the repeater motor not be all that is desired, try putting a load on the motor alternator shaft to slow it up a bit, this will reduce the frequency, and in case the windings of the repeater motor have too many turns, and thus too much reactance, you will find that the speed of the repeater motor will be also reduced, but the power output may. be much improved.

An improvement on the above method would be to insert a variable resistance into the field circuit of the motor-alternator, when the same result would be obtained much more conveniently.

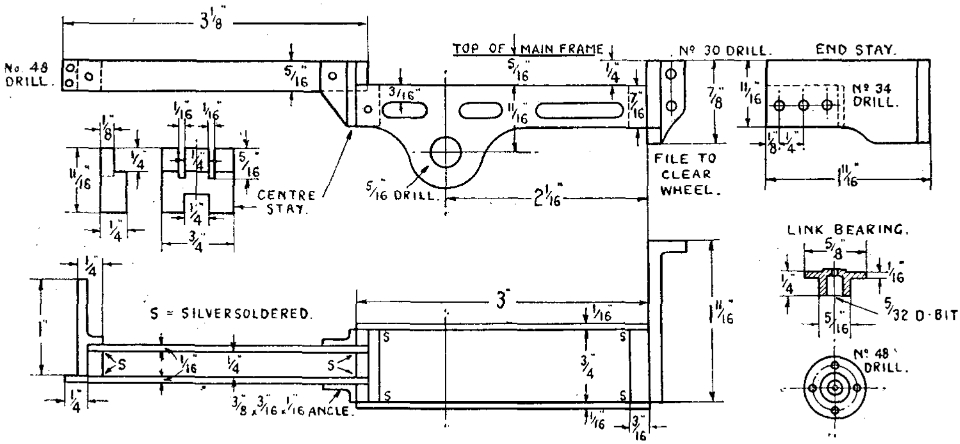
Readers will find this an extremely interesting little experiment which is well worth trying, and which can increase one's knowledge of 3-phase electricity considerably.

A 3-1/2in., Gauge L.M.S. Class 5 Loco.

by " L.B.S.C."

NOW we come to the bit that caused me a lot of heartburning. The making up and assembly of the frame plates and stays doesn't appear difficult when you examine the illustrations, but I tried a lot of different arrangements before getting the easiest solution of the job. For the main parts of the frames carrying the expansion links, four pieces of 1/16in. bright steel, a little over *3* in. long, and 1-1/8 in. wide, will be needed. Mark one out to the given outline, and drill a couple of 3/32in. holes anywhere in the location of the ornamental slots. Use as a jig to drill the other three plates, then temporarily rivet all four together, and saw and file the frames to outline. Drill a 1/8in. pilot hole through at the location *of* link bearing, then open out with a 5/16 in. ; this will ensure correct size and truth of holes. The ornamental slots need only be cut in two of the plates-or in none at all, if you don't care a bean what Inspector Meticulous thinks ! They are 5/32 in. wide, the two short ones are 7/16 in. long, and the long one 7/8 in., spaced 1/4 in. from each end of frames.

Our advertisers will probably supply a piece of cast angle which will be large enough for both the end stays or rear brackets carrying the back ends of both gear frame ; and all that it will need in the way of machinmg, will be to cut it in two, file or mill up the bit that butts up against the frame, file the rest to the shape and size shown in the illustrations, and drill the holes for the screws. Two No. 30 holes are needed for the 1/8in. or 5-B.A. screws holding the bracket to the frames, and three No. 34, for the 6-B.A. screws holding the end of the gear frame to the bracket. Drawn or extruded angle can be used if desired.



Details of gear frame

The back ends of the gear frames are joined by a piece of 7/16in. by 3/16in. brass bar, squared off in the lathe to a dead length of 3/4 in. A single screw, any small size you have handy, can be put through a clearing hole drilled in the frame, into a tapped hole in the end of the stay, to hold the lot together whilst the silver-soldering operation is in progres ; the heads are filed off afterwards. For the centre stay, which supports the leading end of the main gear frames and the rear ends of the two supporting girders, a piece of brass bar 3/4in. wide, 1/4in. thick, and 11/16in. long will be required. A detail sketch of this is shown, illustrating how it will need machining. A rebate is first milled along one. of the 3/4in. sides ;this is 1/4 in. deep, and cuts away exactly half the thickness of the block, leaving 1/8in. tongue projecting upwards The. milling can be done exactly as described many times for milling axleboxes, with the bit of metal clamped under the slide-rest tool-holder, at the correct height for an endmill in the three-jaw to form the rebate at one cut. Feed into cut with the top-slide, and traverse across the cutter with the cross-slide. If you have a vertical slide, and a small machine-vice to attach to it, you're in the clover for jobs like these.

The next item is to mill two 1/16in. slots, 5/16in. deep and 1/4in. apart, in which to fit the ends of the forward girders. These slots can be cut exactly as described for valve-gear and other forks, clamping the bit of metal under the slide-rest tool-holder, and running it up to a 1/16in. saw-type slotting cutter on a stub mandrel held in the chuck. The gap underneath can be formed with a file, its exact size being of no great importance, as It is merely to afford clearance for the radius-rod in back gear. The finished block is placed between the forward end of the main gear frames, and attached to same temporarily by another screw each side, same as the back end. The slotted part of the block should project upwards, above the main gear frames as shown. and the back ends of the front girders can then be jammed in the slots. The girders are simply bits of 5/16in. by 1/16in. steel strip ; the outer one is 3-1/8 m. long, and the inner one 2-7/8in. long. When the gear frame is erected, the outer one comes in front of the guide yoke or motion bracket, right at the top, see elevation of complete gear assembly:

The leading ends of the girders are supported by what looks like the " fag-end " of a gauge " 0 " buffer beam ; in fact, that is where I got the idea.A piece of 1/4in. by 5/16in. (or 5/16in. square) brass rod is needed, I in. long, with one end squared off in the lathe. At 1/4in. from this end, mill a 1/16in. slot about 5/32 in. deep : about 3/32 in. beyond this, the block can be filed or milled away, as shown in the plan, or left full thickness, just as you fancy. Jam the inner girder into the slot, and attach the outer one to the faced end of the block, by another temporary screw. Now watch your step very carefully ; see that both the main gear frames are absolutely parallel all ways, ditto the girders, and that the three supports are all nice and square. As extra support at the middle, two pieces of 3/8in. by 3/16in. by1/16in. brass angle, filed away at the bottom, as shown in the elevation, are attached to the girders by a single screw, the narrow ends butting up against the centre stay as shown in plan.

All the joints marked " S " are now silver-"soldered. Anoint each joint with a dab of wet flux, lay the whole doings on a piece of stiff asbestos millboard (if it rests directly on the coke in the brazing-pan; instead of on the millboard, it may probably go out of truth under the heat), heat to dull red, and apply a strip of good-grade silver-solder to each joint. Only a little is needed ; I use " Easyflo " and the special flux sold with it, for jobs like these. Quench out in water only, on account of the steel, then clean up. When carefully carried out, this construction will be as strong as any casting, and a sounder job than putting the bits together with screws and rivets. All the superfluous temporary screwheads may be filed off, leaving a nice neat gear frame assembly. The bearings for the link trunnions may then be made and fitted ; and for these, chuck a short bit of 5/8in. round bronze or gunmetal rod in three-jaw. Face the end, centre, start a hole with No. 22 drill, and finish it to 3/16in. depth with a 5/32-in. D-bit, so that it is square-ended. Turn down 3/16 in. length to a tight push fit in the holes in the gear frame, and part off a full 1/4 in. from the end. Reverse in chuck, face off the head, and then centre and drill a 1/16in. hole in the middle, as an air vent, and for oiling purposes. Four No. 48 holes are drilled in each flange as shown ; and when the gear is finally assembled, the flanges are attached to the gear frames by four 9-B.A. roundhead screws in each.

How to Erect Gear Frames

First of all, attach the back support or end stay to the rear end of the gear frame, as shown in the plan view. The gear frame is located 1/4 in. below the top of stay, see elevation, ***but note particularly that the gear frame projects beyond the end of the stay, by the thickness of the outer plate.*** The reason for this is, that the outer plate of the frame comes exactly under the running-board valance, which is the same thickness, and the stay projects upwards behind the valance ; so that if stay and gear frame are erected level, you won't get the running board in place later on, and the G.P.O. will have to put on a special-mail van to carry the half-a-million odd letters which would come along to emphasise my relationship with Billy Muggins. Temporarily clip the stay to the end of the gear frame in the position indicated, run the No. 34 drill through the holes in stay, making counter-sinks in the end member of frame, drill through No. 44, tap 6-B.A. and put screws in. I've shown hexagons on the assembly plan. but any kind will do, that you happen to have' handy.

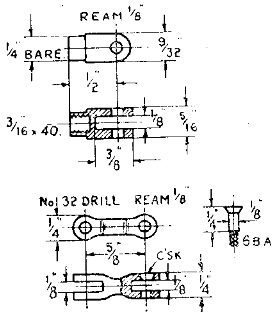
Now temporarily clip the whole bag of tricks to the main frame, setting the weeny hole in the middle of the link bearing at I in. from top of frame, and 4-1/6 in. ahead of the centre of driving axle. The outer front girder should iust overlap the front of the guide-yoke or motion bracket, as shown on the elevation of the complete assembly, but note, as the motion bracket is tilted a weeny shade, the front support which holds the girders together (the bit of " 0 "-gauge buffer beam) will have to be filed to suit. No good having fitters if they don't do an occasional spot of fitting ! The top line of the girders should be 1/16 in. below top line of main frames, and the top of the gear frames 5/16 in. below ditto. When you have the whole doings in the right position, poke the No. 30 drill through the holes in rear stay flange, carry on through main frames. and secure the lot with a couple of 1/8in. or 5-B.A. bolts. Put two small round-head screws, say 9-B.A., through the outer girder into the guide-yoke, and either another 1/8in. or 5-B.A. bolt, or two 3/32-in. or 7-B.A.'s, through the front stay and the top of the guide yoke. That should be enough to stop the whole issue from falling off.

Fitting Up the Gear

Before making the eccentric-rods and fitting the return cranks, it will be necessary to erect the parts of the gear already made, as the exact length of eccentric-rods, and position of return-crank, have to be determined from the actual job. First of all, insert a pair of die-blocks in the expansion-link. They will go in quite easily through the space between the links, and if you put a little motor grease on each, they will stay in the grooves whilst the radius-rod is inserted. Line them up so that you can see the two pin-holes through the slots in the link, then put the radius-rod between them, lining up the hole in that, with the holes in the die-blocks ; then drive or squeeze a 3/8in. length of 1/8in. silver-steel through the lot. This will be a squeeze fit in the rod, but a working fit in the die-blocks, which is as it should be.

Now put the top of the combination-lever in the fork of the radius-rod, and squeeze a 1/8in.

silver-steel pin through that, filing off flush each side, and attach the plain end of the union-link to the bottom of the combination lever in the same way. Take off the gear frame, and remove the two link bearings, then put the link m position ; you'll find it easy enough to get the trunnion pins into the big holes, then hold each trunnion in the middle of the hole whilst you put the bearings back. When all the screws around

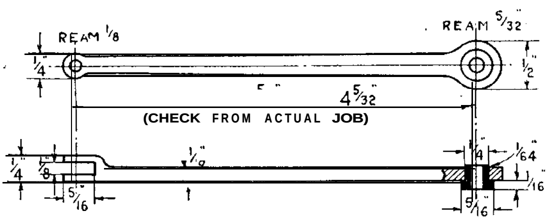


Valve fork and union link

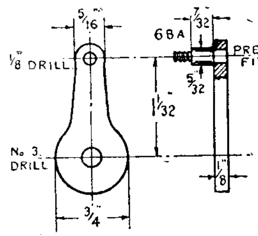
the flanges are in, the link should oscillate easily but without any slackness whatever. Replace the gear frame ; screw the valve fork or cross-head on to the valve-spindle, put the combination-lever between the jaws, and fix with a little bolt made from 1/8in. silver-steel, shouldered down each end to 3/32in., screwed and furnished with nuts. Beginners note, these bolts should always be long enough in the plain part, to allow of them being turned by fingers when both nuts are screwed right home. This eliminates any chance of the bolt pinching in the jaws of the fork, and causing unnecessary friction in the gear parts. Finally, couple the loose end of the union-link to the drop-arm on the crosshead,

to protect it whilst squeezing in the pin ; then press the crank on the reduced part of the main crankpin, setting it in the position shown in the assembly elevation, as near as you can " by eye." Note, the spigot on the main crankpin will project 1/16 in. through the return-crank boss ; that is all in order for the time being.

For beginners' benefit, I will once more detail the method of gettmg the correct setting for the return-crank, and the exact length of the eccentric-rod, and this applies to any engine with Walschaerts valve-gear. You don't need any elaborate instruments, merely an ordinary pair of dividers ; and regarding calculations, you don't even have to know how many beans make five. 'First of all, set the expansion-link in such a position that the die-blocks can be run from top to bottom and vice versa, without moving the valve spindle ; then temporarily fix it there. I usually jam a bit of soft wood between the link and the gear frame. Now put the main crank on front dead centre ; then with your dividers, take the distance from the centre of the hole in the tail of the link, to the centre of the return-crank pin. Next, shift the main crank around to back dead centre, and apply the dividers, without altering their setting, to the same points. If they tally exactly, you have an excellent excuse for a mild celebration ; if they don't, shift the return-crank so that the pin moves half the difference, and try again. I have never known anybody to need more than three shots, to get it correct. When the distance between the centres of hole in link tail and return-crank pin, tally exactly on front and back dead centres of the main crank, the return crank is correctly set, and ***the distance between the divider points is the*** exact ***length of the eccentric-rod between centres of bush and fork, so*** don't shift them under any circumstances !



Eccentric-rod



Return crank

by means of the little countersunk bolt illustrated along with the union link, and " Bob's your uncle " for the time being.

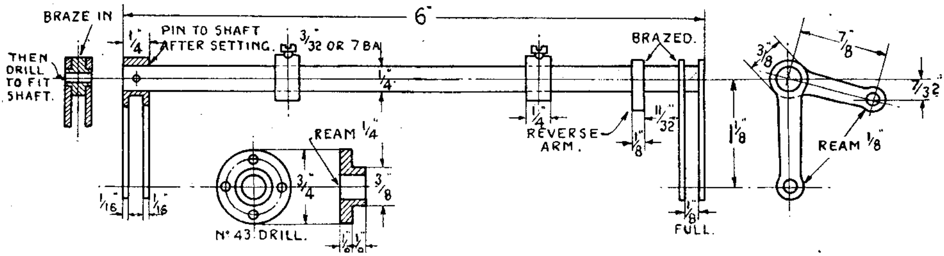
Return-crank and Eccentric-rod

The, return-crank itself is simply a plain filing job, made from 3/4in. by 1/8in. mild-steel. Drill both holes 1/8in. for a kick-off, then open out the hole in the larger end with a No. 3 ; slightly broaching it until it will just " start " on the end of the main crankpin. The little pin is made from a bit of 5/32-in. round silver-steel a bare 9/16 in. long ; one end is turned down for1/8in. length, to a tight squeeze fit in the 1/8in. hole in the crank, and the other end is turned for a full 3/16 in. length to 7/64 in. diameter, and screwed 6-B.A. Put a nut on the thread

File the projecting stub of the main crank-pin spigot, flush with the return-crank boss. Drill four No. 55 holes half in boss and half in spigot ; countersink them, tap 1/16 in. or 10-B.A. and put in four countersunk screws. They will hold the crank from slipping around or coming off of its own free will and accord.

As the eccentric-rod is made in the same, way as the radius-rod, there won't be any need to recite the ritual again. The drawing shows the shape and size of it, but the distance between centres of fork holes and bush, must be measured from your already-set dividers, as mentioned above. Drill the boss 1/4 in., and fit a little bronze bush in it, with a 1/16in. head, and allow the end of the bush to stand proud of the back of the rod, by 1/64 in., so as to prevent the rod rubbing on the return crank. On the big engines, a ball-bearing is fitted here, and a needle-bearing could be used on the little engine if available ; but of this, more anon. I have *some very* weeny ball and needle bearings, thanks to the kindness of two or three esteemed correspondent-friends, and hope to do a little experimenting in the not-too-distant future. The bush of the eccentric-rod is slipped over the return-crank pin, and

Centre and drill right through with No. 48 drill. Squeeze an arm on to each pip, lining up the, with the No. 32 drill through the holes in the small end ; then braze in the distance-piece. Quench out, clean up, ream the small ends 1/8 in. and drill the large end with letter C or 15/64 *in.* drill. This will cut out the pips, leaving a ring between the arms. Ream it so that it goes on the shaft very tightly.



Reversing shaft or weighbar shaft

stopped from falling off by a commercial nut and washer ; the fork is attached to the link tail by a bolt similar to the one in the combination-lever.

Weighbar or Reversing Shaft

All we now need, is a means of reversing and notching up.The weighbar shaft itself is a piece of 1/4in. round steel, mild or silver, 6 in. long. Make the reversing-arm first, from a piece of 1/8in. by 3/8in. mild-steel 1-1/4in. long, filed to shape shown. Drill both ends No. 32, ream the small one 1/8 in., open out the larger one with letter C or 15/64-in. and ream until it will just drive tightly on to the shaft, at 19/32 in. from one end. The lifting-arms are double, as on the big engines, and are made from 3/8in. by 1/16in. steel, filed to shape shown. Drill all four, same as reverse-arm, but only enlarge the bigger ends of two of them. These are driven on to the shaft at the same end as the reverse-arm, and set at an angle of 75 deg. from same, so that when the lifting arms are horizontal, the eye at the end of the reverse arm is 7/32 in. ahead of the vertical line. The distance between the two lifting-arms, is 1/8in. full, so that the end of the radius-rod can slide freely between them. Braze all three arms to the shaft.

The lifting-arms at the opposite end of the shaft cannot be brazed to it, otherwise the shaft could not be put into place through the frame ; also, the arms need adjustment, so that both pairs of die-blocks are in the middle of the expansion-links at the same time. I saw a professionally-made job some little time ago, in which, when the reverse-lever was in mid gear, one die-block was above centre and the other below it ; so that the engine should have emulated the famous American locomotive of film conception, that went both ways at once. The two detachable lifting-arms are first brazed to a distance-piece. Chuck a bit of 3/8in. round mild-steel in three-jaw, and turn a 1/16in. pip on the end, to a tight fit in the hole in the larger end of one of the lifting arms. Part off a full 1/4 in. from the end ; reverse in chuck, and turn a similar pip, leaving a piece 1/8 in. full wide between the two shoulders.

The two bearing bushes are plain turning jobs, made from 3/4in. bronze or gunmetal rod ; or hard brass would do, as the wear is exceedingly small. Make them same as the link bearings, except that they are drilled right through, and reamed 1/4 in. They are fitted to the 3/8in. holes already drilled in the main frames, and secured by four 8-B.A. screws running into tapped holes in the frame. The collars for preventing side movement of the weighbar shaft, are simply 1/4in. slices of 1/2in. round rod, with a 3/32-in. or 7-B.A. set-screw in each, drilled a sliding fit on the shaft.

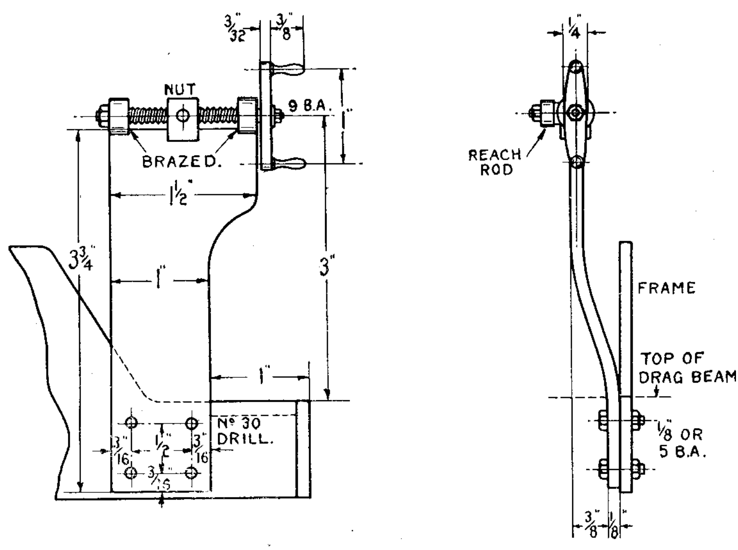
How to Erect the Shaft

Poke the free end of the shaft through the left-hand bush, put on the two collars, continue through right-hand bush, and press on the other lifting-arm, setting' the two pairs of lifting arms in line, as near as possible " by eye." Stick the two straight die-blocks in the slots in the ends of the radius-rods, with a bit of grease (don't get robbing the " marge " ration !) same as the die-blocks in the expansion-link ; then turn up the weighbar shaft so that the arms embrace the radius-rod, and line up the die-block with the holes in the lifting-arms. Put a little bolt through the lot, same as those in the combination-levers and eccentrics-rods. Now set the left-hand die-block in the middle of the expansion-link; it is O.K. when you can turn the wheels, and the oscillation of the link doesn't move the radius-rod. With the weighbar shaft held in that position, see if you get the same effect the other side. If the radius rod moves when the wheels are turned, shift the lifting arm on the shaft until it doesn't. When the wheels are turned, and both radius-rods remain stationary with the reverse-arm in mid-gear position, the detachable arm is correctly set, and can be pinned to the shaft by drilling a No. 43 hole clean through boss and shaft, and driving in a stub of 3/32-in. silver-steel or 13-gauge spoke-wire. Run the two collars back against the bushes, tighten the set-screws, and the job is done. We will set the valves after the wheel-and-screw reverser is made and fitted.

A 3-1/2in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

I 'M going to tell you right away, that the screw reversing-gear I am specifying for " Doris " is ***not*** a copy of the kind used on her big sisters, and shouldn't be at all surprised if that fact causes Inspector Meticulous to hie him to the local hostelry and drown his sorrows in a pint of the best (jolly good excuse, anyway !) ; but, as a cast stand, with bearings for the screw cast on. If they do, you only need clean up with a file, drill the screw-holes and the back bearing, and drill and tap the front bearing as shown for the built-up stand. If the casting is supplied straight, it can be set over as shown in the illustration, as cast bronze or gunmetal bends readily without



Screw reversing-gear

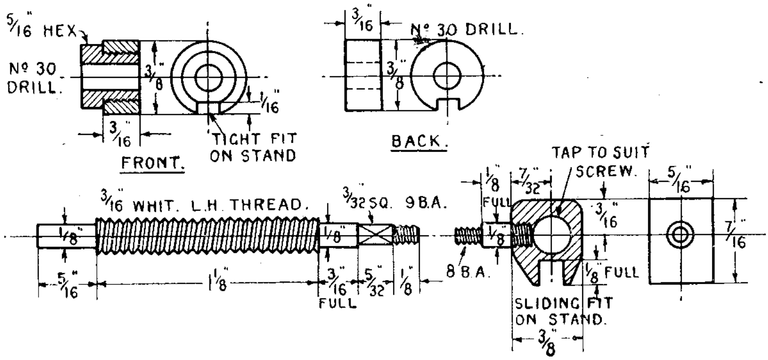
usual, there is "method in my madness." On the big Class 5's, the driver rides on the footplate ; and to keep him well under cover, and have everything nice and handy, Sir W. A. Stanier put the reverser up in the corner of the cab. Drivers of 31/2in. gauge Class 5's have to perform under open-air treatment, and the relationship of their fingers and the boiler isn't exactly " to scale." On top of that, the little boiler gets as hot as the big one (again, you can't " scale " Nature) and' the amount of feeling in the fingers of a driver of 3-1/2in. gauge engines is exactly the same as in those of the 4 ft. 8-1/2in. gauge driver ; in fact, maybe a bit more so, as the former isn't " hardened." I reckon my fingers have asbestos skin ! However, to make the reverser more get-at-able, I have brought it back to the edge of the cab ; and to save the complication of a box casting and other attachments, I have substituted a simple stand, of the kind I use on my own engines. It is easy to make, and efficient in operation ; here are the details.

Stand and Bearings

Maybe our advertisers wil! be able to supply breaking. If a casting isn't available, or if you prefer to build up, make the stand from a piece of 1/8in. steel, same stuff as used for frames. A piece 3-3/4in. long and 1-1/2in. wide is needed and this is cut away at one side as shown. Four No. 30 holes arc drilled at the bottom for the bolts attaching the stand to the main frame. For the bearings, chuck a bit of 3/8in. round bronze or steel rod in three-jaw ; face, centre, drill about 1/2in. depth with No. 30 drill, and part off two 3/16in. slices. Rechuck one of them, open out with 7/32-in. drill, and tap 1/4 in. by 40. Both these bearings must have a groove filed or milled along their length, 1/16 in. deep and a tight fit on the top edge of the stand. The tapped one goes at the straight edge of the stand. Put them on, make certain they are dead in line, and then braze if steel, or silver-solder if bronze or gunmetal. Clean up, run the tap through the front again to clear the threads, then make a little screwed bush, same as a piston or spindle gland, from 5/16in. hexagon brass rod, to fit the tapped bearing. I forgot to mention above, that if the grooves are milled, it is easier to do the job on the piece of rod, before parting off the bearings.

Screw and Nut

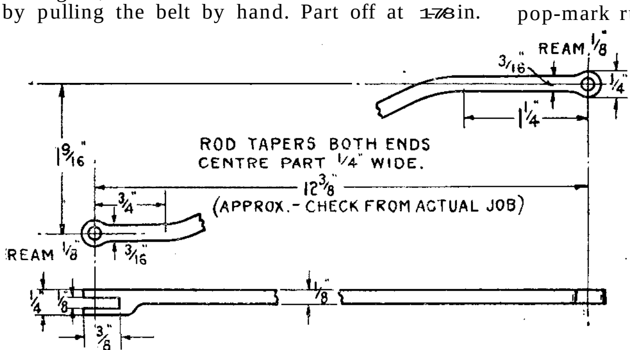
The screw is made from a piece of 3/16in. round mild-steel or hard bronze. Chuck in three-jaw, face the end, turn down 1/8in. length to 5/64 in. diameter and screw 9-B.A. Turn down a bare 3/8in. length to 1/8in. diameter ; file 5/32in. of this to a 3/32in. square, a process I have described umpteen times already, so needn't repeat here. The next stage of the proceedings depends on what screwing-tackle you have available. If you have a tap for 3/16in. Whitworth left-hand thread, use it. If not, right-hand will do, in fact, all our Stroudley engines on the L.B. & S.C. Rly. had right-hand screws. If you haven't a Whitworth pitch, a finer one could be used, but it will take a month of Sundays to reverse the engine. Anyway, put your die, whatever it is, in the tailstock holder ; pull enough of the steel out of the chuck to cut a full thread 1-1/8 in. long, and get busy. Use plenty of cutting oil, and work the mandrel back and forth by pulling the belt by hand. Part off at 1-7/8in. from the shoulder. Reverse in chuck-you can hold the thread in the jaws without hurting it, if you don't tighten them too severely-and turn down 5/16 in. of the end to 1/8 in. diameter., The threaded part should now be exactly the same length as the distance between the bearings on the stand.



Bearings, screw and nut

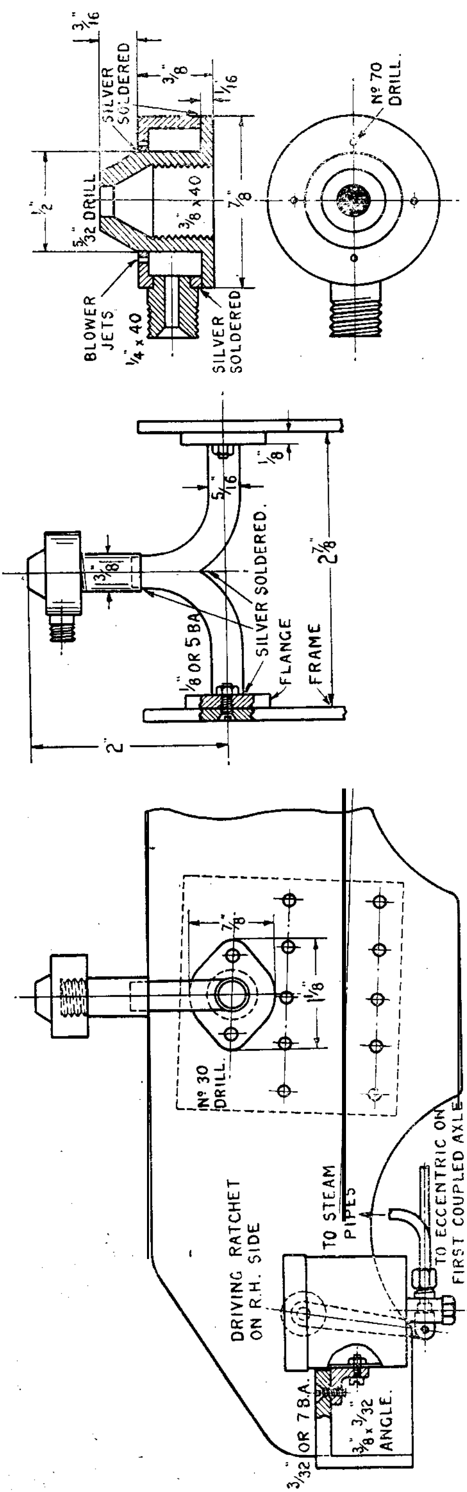
Anybody who has a screw-cutting lathe and knows how to use it, and needs a quick reversing-gear for an up-and-down line, can make the thread two-start. Set up your change wheels to cut 12 threads per inch, and instead of using a screw-cutting tool, put a 3/16in. Whitworth chaser in the slide-rest tool holder. Proceed to cut your thread in the manner usually observed among screw-cutting artists, and you'll automatically get a lovely two-start. To make the tap for the nut, repeat the process on a bit of 3/16in. silver-steel, taper off the end, file it square for about half the length of the thread, harden and temper to dark yellow. The squared tap will be quite O.K. for the one nut. One of my own engines has a three-start thread, and reverses in four turns of the wheel. I made the screw by setting up the change-wheels for 8 threads per inch, and using the 24-tooth chaser as above, so that it cut three grooves per turn, the chaser advancing three teeth per revolution.

For the nut, part off a piece of 5/16in. by 3/8in. bronze or gunmetal to a length of 7/16 in. The hole for the screw is drilled and tapped off-centre 3/16in. from the top, and 5/32in. from one of the longer sides, see section. Make a centre-pop at the correct spot, chuck in four-jaw with this pop-mark running truly, open out with a centre-drill, then with 5/32-in., and tap it to suit the thread on the screw. The groove in the bottom must be exactly under the tapped hole, and a full $\frac{1}{8}$ in. wide and deep, so that it can slide readily on the top edge of the stand. In the wider side of the nut, drill and tap a hole for the reach-rod pin. If you have $\frac{1}{8}$-in. by 60 tap and die, use that ; if not, use 5-B.A. The pin is merely a piece of $\frac{1}{8}$-in. silver-steel, one end screwed to fit the tapped hole in the nut, and the other turned down to' a bare 3/32 in. diameter, and screwed 8-B.A. The plain part between nut and shoulder should be 1/8 in. full. Round off the upper edges of the nut, and bevel the sides as shown, for the sake of appearance.



Reach-rod

To assemble, poke the squared end of the screw through the tapped hole in the front bearing ; put the nut over the top of the stand, with the reach-rod pin to the left, enter the screw in the nut, and screw through until the plain part at the back of the square is right home in the back bearing. Put the little gland in the front bearing, the hole in same going over the front spigot of the screw, and screw right home. When the gland is tight, the reversing-screw should turn easily



Left.—How to erect lubricator. Right.—Exhaust pipes and blast nozzle

with finger grip only, the nut running easily from one end to the other. A spot of oil helps ! If O.K., make and fit the handle ; no detailed instructions are needed for that. File it up from a bit of 3/32in. by 1/4in. steel or nickel-bronze strip, drill a No. 48 hole at each end, and turn up two weeny hand-grips from 1/8in. rod, leaving a pip on the butt end of each, to fit the holes in the lever. Countersink the holes at the back, and rivet in the grips. Drill a 3/32in. hole in the middle, file it square to suit the square on the spindle, and secure with a commercial 9-B.A. nut and washer.

To erect the stand, simply clamp in place on the outside of the left-hand frame (the big Class 5's are all left-hand drive) with the back of the stand touching the top of the drag-beam, and the centre of the screw 3 in. above it. Run the No. 30 drill through the holes in bottom of stand, right through the frame, file off any burrs, and put in four 1/8in. or 5-B.A. bolts. I have shown hexagon heads, but it doesn't matter a bean what heads you use, as the screws can be put through from inside, and nutted outside, and Inspector Meticulous won't have any excuse for another journey to the " local."

Reach-rod or Reversing-rod

The reach-rod can be made from a length of 1/4in. by 1/8in. mild-steel rod, with a little block brazed on to machine up into a fork, as described already for valve-gear parts, so I needn't go through that part of the ritual again. The approximate length is 12-3/8 in. between centres ; but to get the exact length, measure from the actual job. Put the reversing-nut in mid-travel, and the valve-gear should be set with the die-blocks exactly opposite the link trunnions ; then measure from the centre of the hole in the reverse arm, to the centre of the reach-rod pin on the reversing-nut.

Note, the rod starts away level from the reverse-arm on the weighbar shaft, and proceeds thus for fin., when it takes a slight bend upwards, and runs up to the level of the reversing-screw ; see general arrangement drawing. The last 1-1/4 in. to the eye which goes over the pin on the reversing-nut, are also level, as shown 'in the separate illustration of the rod given here. The fork is coupled to the reversing-arm by a little bolt made from 1/8in. silver-steel, as described for the valve-gear ; and the eye end is held on the pin in the reversing-nut by a commercial 8-B.A. nut and washer.

How to Set the Valves

You can now do a spot of valve-setting if you so desire, or can leave it until the steam pipes are on ; please yourselves. If the former, jam a short bit of tube into the steam inlet on top of the cylinder, and connect it to a tyre-pump by a piece of rubber tube and a suitable adaptor. Put the valve-gear in mid-position, apply the air pressure, and turn the wheels by hand. When the main crank is just off the dead centre, say about one spoke of the wheels, a sound should come from the hole where the cylinder drain cock will be screwed in, about the intensity of the sigh of a love-sick cockroach ; and this should increase to a real sibilant hiss when the crank actually is on the dead centre. All that constitutes the valve-setting, is to adjust the valve on its spindle, by means of the locknuts, until the effect described above is obtained at each dead centre. The valve-gear itself will look after the rest of the doings. You hear at various functions and meetings what a frightfully specialised job valve-setting is ; well, as a famous strip-cartoon artist would say, believe it or not ! With the simple setting described above, young " Doris " will jump off the mark like a scalded cat with normal load, try to blow the chimney clean off the smokebox when starting an outsize load, and run like a deer with the reversing-nut just off middle, and the exhaust purring like a happy cat. You don't have to take my word for it - see for yourselves later on.

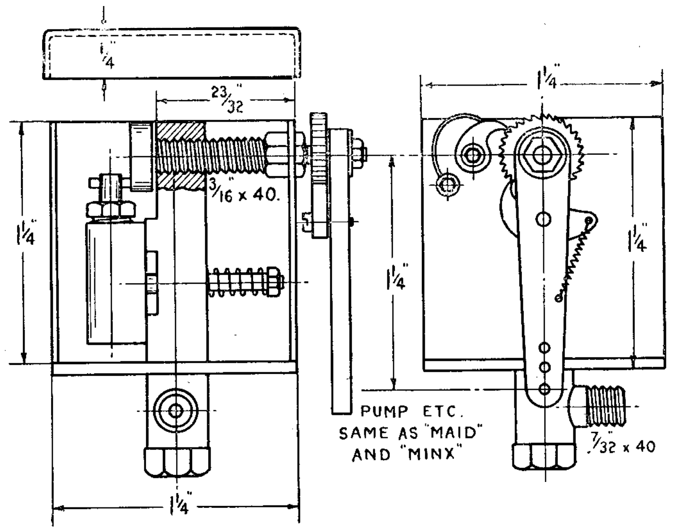
Exhaust Pipe Assembly

One of the most important essentials for a free-running efficient engine is an unobstructed exhaust. None of my engines has ever suffered from back-pressure trouble, and in the present instance I have gone a step farther and " streamlined " the pipes, as in full-size practice. The holes in the frames, where the exhaust comes through from the recesses in the cylinders, are covered by oval flanges, each carrying a 5/16in. copper bend. These are filed half away at their upper ends, and connected by the 3/8in. blast-pipe, which is surmounted by a combined blast-nozzle and blower-ring.

The flanges are either cast, or cut from 1/8in. brass plate ; don't drill the screw-holes yet, but drill the middle hole a tight fit for the 5/16in. pipe. If a piece of $-in. by 22-gauge copper tube is softened, and filled with lead or sand, it can be bent into a complete half-circle, and the two required bends sawn out of it. The upper halves of these are filed away for half their diameter, butted together, and inserted into the bottom of the blast-pipe. This is just a 7/8in. length of 3/8in. by 20-gauge copper tube with a few g-in. by Jo-pitch threads on one end. Silver-solder the joints, then cut the two arms to such a length that they will just go between the frames with the blast-pipe central. Carefully drive a flange on to each end, and adjust so that the assembly will just fit between the frames ; then silver-solder the flanges, pickle, wash, and clean up.

If you have already fitted the cylinders, they will have to be temporarily removed to erect the exhaust pipe assembly. At each side of the g-in. hole in the frame, drill a No. 30 hole, the centre of same being 5/32in. from the edge of the exhaust hole. Countersink it to take the head of a 1/8in. or 5-B.A countersunk screw. Now put the exhaust assembly in place, and very carefully adjust it for correct position, temporarily clamping it with a toolmaker's clamp each side. Poke the No. 30 drill through the brass flanges via the countersunk holes in frame, put brass screws in, and secure with brass nuts. If the frames are the least bit rough, so that steam might escape between flanges and frame, put a bit of very thin paper smeared with plumbers' jointing between flange and frame ; and don't forget, before putting the cylinders back, to cut out the piece covering the hole in the flange and frame, so that the steam can get out. It isn't exactly an unknown occurrence for a big engine to be erected with " blind " gaskets. One morning " back in the days " when our sand wouldn't run on one side, I found that " Sandy " had forgotten to cut a hole in the joint when he put the pipe back after a small repair. If the frames are at all rough on the outside, the same treatment may be given to the cylinders when re-erecting them.

To make the combined blast-and-blower cap, chuck a bit of 7/8in. round brass rod in three-jaw. Face, centre, and drill about 5/8 in. depth with



Mechanical lubricator

5/32in. drill. Turn down 1/2in. length to 1/2in. diameter; cone the end for 3/16 in. as shown, and part off 9/16 in. from the end. Reverse in chuck, open out with 11/32in. drill for 5/16 in. depth, and tap 3/8 n. by 40. Chuck the 7/8in. rod again; centre and drill 1/2in. for 3/8in. depth, then bore out to 3/4in. diameter and 1/4in. depth, either with a square-ended boring-tool or a big D-bit. Part off at 5/16 in. from the end, and drill a 3/16in. hole in the side. Fit a 1/4in. by 40 union nipple in this, as shown; a kiddy's practice job needing no detailing. Now drop the cup over the centre part, and silver-solder all the joints. I find "Easyflo," in wire form, about the easiest to use for these fittings; simply anoint the joints with wet flux ("Tenacity," No. 3), heat to medium red, and touch each joint with the wire. It only needs the weeniest bit to make a sound joint; and if you pick up the fitting in a small pair of tongs, and just dip in the pickle whilst stiil hot, every bit of the burnt flux cracks off. I keep a drop of pickle in a 2-lb. jam-jar on a shelf behind my brazing pan for this sort of job. After washing, a touch on a circular wire scratch-brush stuck on the end of the spindle of my grinder (speed 2,900 r.p.m.) brings them up like jewellery; not that this matters for anything going in the smokebox, but very nice for backhead fittings. Finally, drill four No. 70 holes as close to "Mount Vesuvius" as you can, so that the steam will all go up the liner. The cap is not fitted permanently until the smokebox is on.

Mechanical Lubricator

As I have oniy just described the mechanical lubricator for "Maid of Kent" and "Minx," and this one is exactly similar except for the length of the container- 1-1/4 in. instead of 2 in.- and, consequently, a shorter shaft and bearing (see sectional illustration), there is no need to go over the same ground again. Look up the issue for August 19th, pages 190 and 191, which gives a summary of the construction, and detailed drawings of the stand, pump, and ratchet gear, also a section of the check-valve. The complete lubricator is erected same as described for "Maid of Kent," by a piece of angle attached to the front of the lubricator, by three screws nutted inside the tank, and attached to the underside of the top of the buffer-beam by three more screws, countersunk-headed this time, running through clearing holes in the beam, into tapped holes in the angle, which need be only 1 in. long. The whole arrangement is shown in the drawing of front end of frames and cross section of exhaust pipe assembly.

The ratchet lever is waggled back and forth by a long1/8in. rod connected to the lever by a little fork made from 7/32in. or 1/4in. square steel, same as the forks in the valve-gear. The other end is screwed into the lug of an eccentric-strap, made to fit the eccentric on the first coupled axle, the method of machining being the same as the pump eccentric. The length of the rod is obtained from the actual job; when the eccentric is on top and bottom centre, the ratchet-lever should be exactly vertical, and should click one tooth with every revolution of the wheels. This will supply enough oil to maintain a film between the valve-bobbins and liners, and pistons and cylinder bores, so that the engine should run a very long time before any wear takes place. Next item, cylinder drain-cocks.

Tail Lamp

Here is an afterthought: if anybody would prefer a "pole" lever to a wheel and screw, for operating on an up-and-down line, in the issue mentioned above I described the reversing lever for "Maid" and "Minx." This would be "the cat's whiskers" for "Doris," if made to approximately three-quarters of the given dimensions, and erected in the same position as given for the screw reverser stand.

Locomotive "Pipe Dreams"

I WAS rather amused by "L.B.S.C.'s" recent suggestion that F. C. Hambleton and myself should commit to paper our respective ideas as to what should be the standard British Railways express passenger locomotive of the future. The results might be, not only still more amusing but, what is more to the point, very wide of the mark unless the future policy with regard to the loads, speeds and routes of express passenger trains is known.

At the moment of writing, no official information is available regarding the results of the recent interchanges of express locomotives among the four regions of British Railways; but, from what I can gather from a number of different observers, professional and amateur, the engine which gave consistently good all-***round*** performance in all her trials was the rebuilt 4-6-0 "Royal Scot" No. 46166, Queen's ***Westminster Rifleman.*** This engine seems to have been always well on top of the job, an excellent time-keeper, with plenty of reserve power, and she does not seem to have been heavy on coal. Even so, I am not prepared to accept this as evidence that the rebuilt "Royal Scot" is the engine best suited for the express passenger traffic of British Railways, unless all the conditions are to be so planned as to be everywhere similar to those in which the "Royal Scot" class is used.

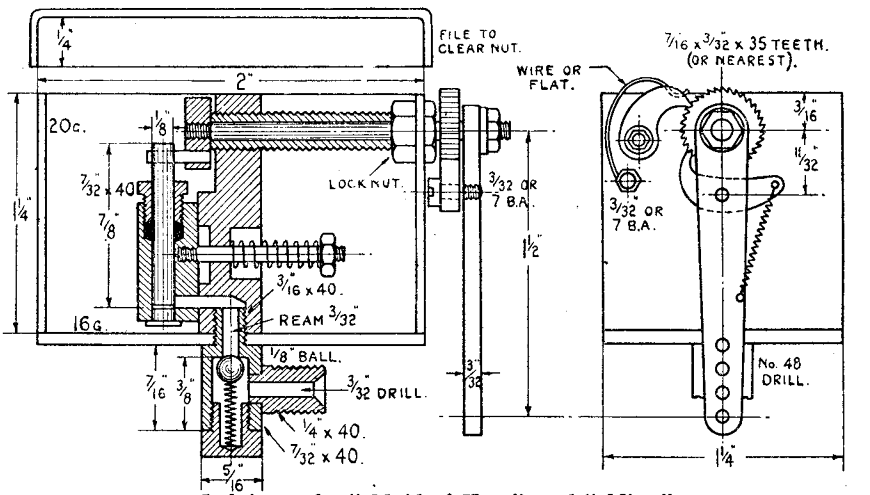
The problem is a very "sticky"' one, and its solution must be left to those whose lob is to solve it. They alone have the necessary information on which to work; but how they got it in eight days (actual) of running by each. type of engine, during the recent trials, I am at a loss to explain!

In the meantime, every locomotive enthusiast is free to have his "pipe dreams," the results of which will be interesting to compare with what the Transport Commission produces.-J.N.M.

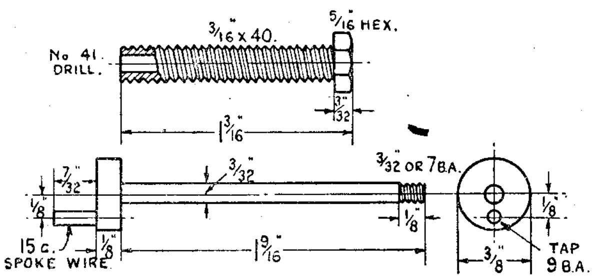
to hold it so that it moves freely without shake, when the nut is tight. Put the lever temporarily in place on the stand, and set the latch-block on it so that it just clears the sector-plate, as shown in the illustration of complete assembly. Clamp temporarily with a toolmaker's cramp, and remove lever ; drill two No. 53 holes through the lot, but don't pin it yet, or you won't be able to insert the latch. Next, fit the trigger just under

simply turn the stand completely around, and put the lever in it with the trigger nearest to you. You can, if desired, change over the tension spring, but it doesn't matter a bean which side of the lever it is on, as long as it holds the latch down.

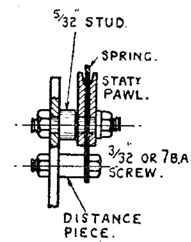
To erect, proceed as follows : Cut out a bit of $\frac{1}{8}$-in. steel plate 1 in. square, to serve as distance-piece. Clamp the stand temporarily to the *outside* of the frame, in the position shown,



Lubricator for "Maid of Kent" and "Minx"



Bearing shaft and crank



How to erect stationary pawl

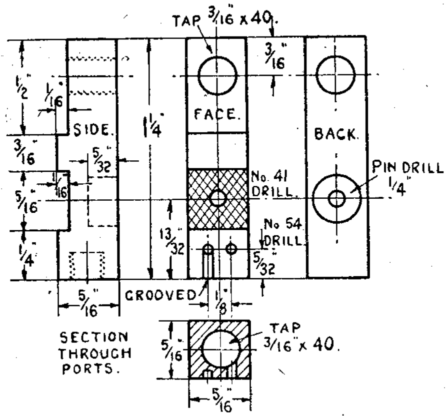
the handle as shown, drilling the hole through lever with No. 51 drill, and pinning with a bit of 16-gauge steel wire. Put the eye of the latch in the slot at the other end of the trigger, and pin that likewise, but let the pin project enough to take the end of a weeny tension spring. Then put the latch-block on, and slide it down until the cross-slot covers the horizontal part of the latch, and the holes in the block line up with those in the lever. Rivet the block in place with a bit of 16-gauge steel wire through each hole, letting one project to take the other end of the tension spring, which is wound up from a bit of 28-gauge steel wire, using a piece of $\frac{1}{16}$-in. silver-steel or 16-gauge spoke-wire for a mandrel.

NOTE : For a left-hand-drive engine, the assembly is exactly as shown. For right-hand drive,

hard up against the drag-beam angle, and the bottom of the stand 1 in. below top of frame ; put the square distance-piece between frame and stand. Run the No. 21 drill clean through the lot, using the holes in bottom of stand as guide. Remove stand and distance-piece ; countersink the holes in frame, replace with the stand *inside* the frame (either right or left, according to driver's position desired) with the distance-piece between, and secure with four countersunk screws and nuts. This procedure is exactly the same for both "Maid" and "Minx."

Reach-rod

To get the length of the reach-rod, set the lever vertically, and put the valve-gear in what our automobile friends call "neutral," that is, mid-gear. The reverse-arm on the weighbar shaft of the link motion will be inclined slightly forward, as shown, but the Joy arm will be vertical. The distance between the centres of the eye in the arm, and the tapped hole in the lever, is the length of the reach-rod between centres. This is made from $\frac{1}{8}$-in. by $\frac{5}{16}$-in. steel rod slightly tapered, and set downwards at the front end as shown. The fork is made by brazing on a



Pump stand

little block of steel, and giving it a dose of the same medicine as the forked ends of the eccentric-rods received. The other end is rounded off, drilled $\frac{1}{8}$ in. and attached to the lever by a shouldered pin turned from $\frac{1}{4}$-in. hexagon steel rod, as shown in section, whilst the fork is attached to the reverse-arm by a bit of 5/32-in. silver-steel shouldered down to $\frac{1}{8}$ in. each end, screwed, and furnished with ordinary commercial nuts.

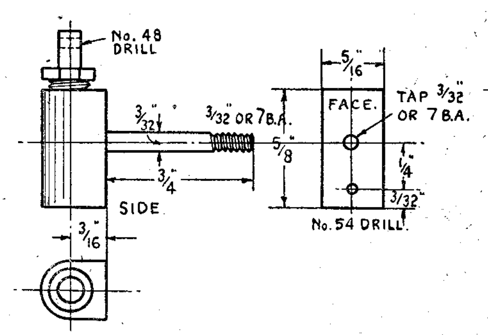
File a notch for the latch, across both sector-plate and quadrant, for the "neutral" position of the lever; then push the lever right forward, and turn the wheels by hand, if the engine has link-motion. The lever will move back a shade, due to the slip of the die; mark where the latch rests when in this position, shift the lever back, and file a notch at the marked spot. Ditto repeato for back gear; then file three more notches at $\frac{1}{16}$ in. intervals as shown in the illustration, and Bob's your uncle. For the Joy-gear engines you don't bother about die slip; merely file the front and back notches (full gear) with the lever up against the spacers at each end of the quadrant, and the intermediate notches as shown.

Mechanical Lubricator

This is the same for both "Maid" and "Minx"; and as it is of the same type which I have described and illustrated for many other engines in these "serials," we needn't go into full details again. I will therefore just give a brief summary of construction. I might remind beginners that I did a lot of experimenting with various types of mechanical lubricators, and settled on this as a "standard" because of its positive action and simplicity of construction. One has been tested on the gauge-testing machine in a full-size locomotive works, and when the little gadget had pumped up to 400 lb. the test was called off for fear of straining the master gauge. That ought to be convincing enough for anybody!

The tank is made from a strip of 20-gauge brass or steel $6\frac{1}{2}$ in. long and $1\frac{1}{4}$ in. wide, bent into a rectangle measuring 2 in. by $1\frac{1}{4}$ in. Stand it on a piece of 16-gauge metal a little bigger than that, braze or silver-solder all around the bottom and the corner joint, and file the bottom flush with the sides. Drill a $\frac{3}{16}$-in. hole in the centre of the bottom plate, and another $\frac{3}{16}$ in. from the top, on the centre-line of one of the short sides. The lid, of the same kind of material, can be flanged up over an iron former. The pump stand and cylinder are made from $\frac{5}{16}$-in. square brass rod. Chuck a length truly in four-jaw, face the end, then centre, drill No. 21 for $\frac{3}{16}$ in. depth and tap $\frac{3}{16}$ in. by 40. Part off at $1\frac{1}{4}$ in. from the end, then mill or file the rebate and recess shown, drill and tap the $\frac{3}{16}$ in. by 40 hole for bearing, drill the trunnion hole and pin-drill it on the plain side, and drill the ports. The right-hand port goes through into the blind hole at the bottom of stand; a groove is cut from the left-hand port to bottom of stand (see section).

Part off a $\frac{5}{8}$-in. length of $\frac{5}{16}$-in. square brass rod, and centre-pop it $\frac{3}{16}$ in. from one side; chuck in four-jaw with this pop running truly, drill through No. 34 and ream $\frac{1}{8}$ in., open out to $\frac{3}{16}$ in. depth with $\frac{3}{16}$-in. drill, tap 7/32 in. by 40, and make a gland to suit, from $\frac{1}{4}$-in. hexagon brass rod. The other end is closed by a little brass plug turned to a drive fit and soldered. Drill the port, drill and tap the hole for trunnion-pin, countersinking same slightly, and true up the rubbing face same as you did the slide valves; same applies to the rubbing face of the stand. The ram is a $\frac{7}{8}$-in. length of $\frac{1}{8}$-in. rustless steel, with a No. 48 cross-hole at the outer end.



Pump cylinder

The gland is packed with a strand of graphited yarn. The trunnion-pin is a piece of 3/32-in. silver-steel, screwed both ends, and the spring is wound from 22-gauge steel wire, and secured by a commercial nut.

For the bearing, chuck a bit of $\frac{5}{16}$-in. hexagon brass rod in three-jaw, face the end, centre, and drill down $1\frac{1}{4}$ in. with No. 41 drill. Turn down 1 3/32 in. length to $\frac{3}{16}$ in. diameter, screw $\frac{3}{16}$ in. by 40, and part off $1\frac{3}{16}$ in. from the end. The spindle is a piece of 3/32 in. round steel 1 $\frac{11}{16}$ in. overall length, screwed both ends. The crank is a $\frac{1}{8}$-in. slice of $\frac{3}{8}$-in. brass rod, drilled and tapped to suit the spindle, and furnished with a little crankpin made from 15-gauge spoke wire pressed into a No. 49 hole drilled $\frac{1}{8}$ in. from centre.

The check-valve is just an ordinary clack-box turned upside down and provided with a spring to hold the ball to its overhead seating. It is made from $\frac{5}{16}$-in. round rod. Chuck in three-jaw, face, centre, drill down about $\frac{3}{4}$ in. depth with No. 43 drill, open out to $\frac{3}{8}$ in. depth with $\frac{3}{16}$-in. drill and D-bit, and tap 7/32 in. by 40. Part off $\frac{5}{8}$ in. from the end, reverse in chuck, turn down $\frac{3}{16}$ in. of the other end to $\frac{3}{16}$ in. diameter, and screw $\frac{3}{16}$ in. by 40. Poke a 3/32-in. parallel reamer through the middle, seat a $\frac{1}{8}$-in. ball on the hole, and make a cap to fit, from $\frac{5}{16}$-in. hexagon brass rod. Drill a blind $\frac{1}{8}$-in. hole in the middle of this, before parting it off; wind up a little spring from 30-gauge steel wire, and assemble as shown in the sectional illustration. The union nipple in the side of the check-valve is made from $\frac{1}{4}$-in. round brass rod, and silver-soldered in.

The ratchet-wheel should be $\frac{7}{16}$ in. diameter by 3/32 in. thick, with about 35 teeth. My friend who used to supply them, to oblige followers of these notes, doesn't make them any more; one reason being that it was found that they were being purchased by non-users at his "bare-cost" price, and resold at from 300 to 400 per cent. profit! In your humble servant's estimation, turning an act of friendliness into a pocket-lining proposition is one of the meanest forms of "spivery"—I was "caught" that way once, and it taught me a lesson. Dick Simmonds and other advertisers can supply ratchet-wheels, although it isn't a very hard job to cut your own. The wheel is drilled No. 43 and pressed on to the spindle; and mind you set the teeth the right way around, sloping side to your right, vertical or buttress side to your left, or the gadget will work the wrong way, like the famous fish-filleting machine of music-hall fame, which when operated by a left-handed man, shot the bones down his throat and the fish into the garbage can.

The ratchet-lever is filed up from 3/32 in. by $\frac{1}{4}$ in. steel strip, and drilled as shown; the pawls can be filed up from odd scraps of 3/32 in. steel, and should be case-hardened. Both are drilled No. 41; the moving pawl is pivoted to the lever by a 3/32-in. or 7-B.A. screw, and the stationary one works on a stud, same size, going through a hole in the tank, and secured by a nut. A little tension-spring, similar to that on the reversing-lever, keeps the moving pawl in contact with the ratchet-wheel; and a swan-necked spring, made either of 20-gauge steel wire, or a bit of flat spring-steel as used for gramophone governors, does ditto for the stationary pawl. I purloined this idea from my old "Thunderer" alarm clock, purchased for half-a-guinea when I first went to work on the railway; I still have it, and it still does the job after over half a century's practically non-stop run, at a cost of four new mainsprings, all of which I fitted myself. The ratchets of both main and alarm springs are exactly the same as shown, with steel wire "click-springs." A test of "time" in more senses than one! Some of my own lubricators have similar springs, and they all give complete satisfaction. File a nick in the pawl to receive the free end of the spring, as shown.

To assemble, place the stand in the tank, and screw the clack-box into it through the hole in the tank bottom, just finger-tight. Poke the bearing through the hole in tank side, put on the lock-nut, then screw the bearing into the top of the stand. Tighten lock-nut and clack-box. Take off the crank, and insert the crankpin through the hole in ram; hold crank in line with the hole through bearing, insert spindle, and screw home. Put on the ratchet-lever, adjust pawl springs, and you've got it. Next item, erection of lubricators on both engines.

Model Engineers' Supplies

FROM A. J. REEVES & CO. of Birmingham, we have received a copy of a catalogue which lists a wide range of items useful to model engineers and especially to builders of small locomotives. Taps, dies twist-drills, bevel-wheels, spur-gears, gauge-glass, rubber tube, graphited yarn, asbestos sheet, stainless steel balls, brazing materials, solders and a useful selection of sheet metals are a few of the items included.

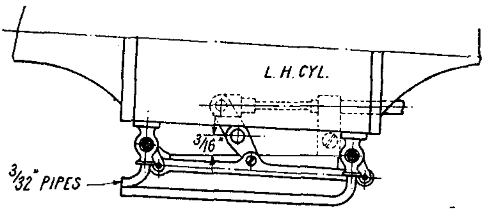
Castings, parts and sets of blueprints for several locomotives by "L.B.S.C." are listed and priced separately, and there is a large selection of wheel castings available from "O"-gauge to 5-in. gauge. We have inspected several samples of wheel castings and we find them to be of good, grey, close-grained cast-iron, clean and sharp. Small bolts, nuts, washers, and rivets, as well as useful steel and brass rods and angles are also available; and we notice that several of the screws, nuts, and bolts have "M.E." threads.

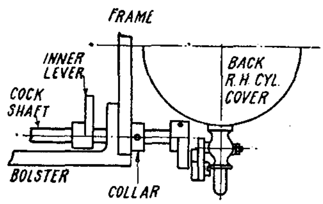
The price of the catalogue is 6d., and we can commend it to the attention of readers, whether or not they are locomotive builders; for, in addition to the above, die-castings and certain details for some of Mr. Westbury's well-known petrol engines are stocked, as well as a complete range of Percival Marshall & Co.'s publications.

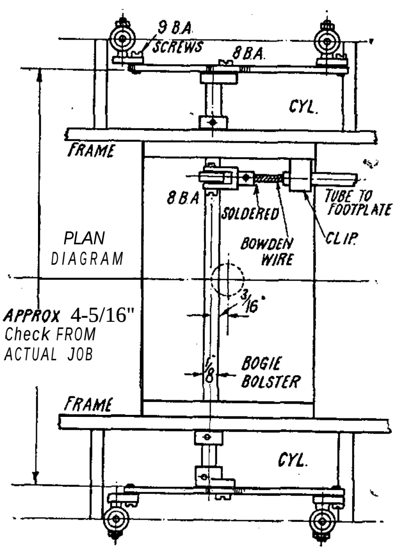
A 3-1/2in. Gauge L.M.S. Class 5 Loco.

by " L.B.S.C."

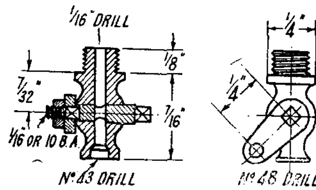
YOUR humble servant had a bit of a job to scheme out a satisfactory arrangement of cab-operated drain cocks for the cylinders of the little " Class 5 " engine, the " can't scale Nature " business being the chief cause. Whilst some full-sized engines have ordinary plug - cocks, others have small poppet-valve gadgets operated by a push-rod, whilst others have cocks with parallel sliding plugs working like a piston-valve. The plug has a groove in it, and when this lines up with the steamways through the cock body, it allows the steam and water to blow past to the outlet pipe. When the solid part of the plug is slid between the steamways, naturally it closes the " entrance to the way out." Whilst these cocks are easy to make, and need only a fraction of an inch lateral movement to open and close them, it is a fiddling job to get the weeny plugs steam- and water-tight, yet perfectly free to operate. The also-weeny poppet-valves are very fond of performing the sticking-up antic, as it only needs a speck of dirt on the seating, to cause a blow. Either type, in a size to be workable and absolutely reliable, would be far larger than " scale " ; so on weighing up the pros and cons, I thought it would be best to use our old friend the taper plug cock. This merchant can't play the usual stick-or-lezk tricks, as the plugs get plenty of lubrication from the cylinders ; and the cocks can be made small enough to avoid being unsightly.



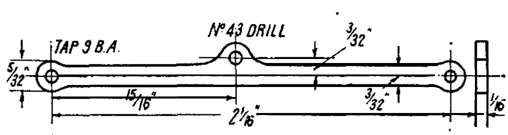




Arrangement of cylinder drain cocks

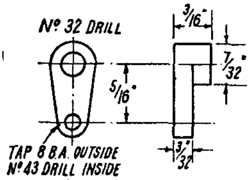


Details of cocks



Cock connecting-rod

Connecting the cocks to the operating lever in the cab, was another trouble, on account of the length of rodding involved. If connected as on the big engines, the rod would have to be in several sections with a hanger at each joint, otherwise it would simply have buckled ***on*** the " push " movement ; and a long continuous rod would have needed intermediate bearings or bridles. However, Sir H. N. Gresley got over the same trouble in full size by using a Bowden wire ; and what was good enough for that much-lamented eminent engineer, is good enough for me, so we can fix a cross-shaft underneath the cylinders, and connect the operating arm on it by a Bowden wire with the bottom of the lever in the cab. There is no need to *use* the Bowden casing, which is much too clumsy for our purpose ; just get a bit of the wire itself from your local cycle-dealer, and run it through a piece of brass tube. I've just been trying a short length in a piece of thin-walled brass tube 3/32 in. outside diameter (the Bowden casing is 3/16 in. diameter) and it works very well.



Adjusting levers

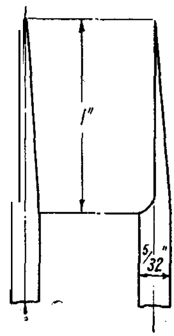
How to Make the Cocks

For the benefit of beginners, here is a brief summary of how to make little plug cocks. The novice's_trouble is to turn a taper plug that will fit the hole in the body of the plug-cock and work easily, yet be perfectly steam- and water-tight. I solved that problem over 45 years ago, when I had my first 3-1/2in. Drummond lathe. The specification said-that the headstock was made to set over, so that.(for example) small taper cock-plugs could be turned, and the holes bored exactly to the same taper. Well, I tried it, but somehow it didn't work out that way ! The cock bodies wanted some setting up for cross boring ; and the sort of boring-tool used for holes 3/32 in. diameter at the small end, was only suitable for use in a watchmaker's high-speed lathe. On a light cut it chattered ; if fed quickly or deep enough to avoid chattering, it broke. Also, unless the boring and turning tools were set "to mike measurements " in a manner of speaking, with a surface gauge, the internal and external tapers came out at different angles, and wouldn't fit for toffee-apples. Anyway, I wasted no more time, but went to work as follows. I chucked a bit of round silver-steel a little bigger than the largest diameter of the cock-plugs, turned a taper on it, filed away half the diameter of the tapered part, and hardened and temoered it to dark straw. finally giving the flat face a rub on the oilstone. Then I turned up about a couple of dozen bits of brass rod, same diameter as the largest end of the cock-plugs, to a taper at the end, without ***altering the lathe setting, nor the tool, in any way whatever.*** As both reamer and plugs were turned with the same tool, and same setting of the lathe. it stands to reason that the plugs would be a perfect fit in holes made with the reamer, and so it proved. I have always made cock-plugs that way. If I need more than I have turned after making the reamer, the slide is reset-to the degree I used for that job.

For the drain-cock job ***on the*** " Class 5," chuck a bit of 5/32-in. round silver-steel, and turn a cone point on it 1 in. long. Serve it as stated above. To temper ; rub the flat part on ***a*** piece of fine emery-cloth or similar abrasive-don't spoil the cutting edges-then hold a bit of sheet-iron over the domestic gas stove, with the reamer on top. As soon as it turns yellow, tip it off into some clean cold water. Rub on the oilstone, and you're all set. Turn a taper on the ends of half-a-dozen pieces of 5/32-in. bronze or gunmetal rod about 3/4 in. long. Don't turn to a point, leave the end about 1/16 in. wide ; 'and whatever you do, don't alter the setting of the slide-rest.

Turn the cock-bodies from 1/4in. round bronze or gunmetal rod. Chuck in three-jaw and turn 3/16 in. length to 3/16 in. diameter ; screw 3/16 in. by 40, then face off until the screwed part is 1/8 in. long. This ensures full threads to the end. Make half-a-dozen whilst you are at it, parting each off 7/16in. from the shoulder. Then chuck a short bit of rod about 3/8 in. diameter ; face, centre, drill 5/32 in. or No. 22. countersink the end slightly,-tap 3/16 in. by 40, and skim off any burrs. Screw each blank into this, and turn the outside as shown in the illustration. Centre the end, drill through with 1/16in. or No. 53 drill, and counterbore the end slightly with No. 43 drill, to take a bit of 3/32-in. pipe.

Cross-drill the bulge in the middle with 5/64-in. or No. 48 drill, and be sure the hole goes right across the " equatorial line " and doesn't wander sideways towards the tropics of Cancer and Capricorn. I have seen plenty of commercial plug-cocks which ***were*** apparently drilled by somebody with a bad squint. When drilling on the machine, I use a bit of rod with a 3/16in. tapped hole ***in*** the end, for a handle, and rest the cock-body in a dint made by a 1/4in. cycle-ball in a bit of hard wood ; mightly simple, but very effective. Put ***a*** tap-wrench on the end of the reamer, and ream out the cross hole until one of your plugs will enter, and project about 5/32 in. the other side.



Cock reamers

Chuck the plug by the parallel part, and turn the end to 1/16 in. diameter for 3/32 in. length ; screw 1/16 in. or 10-B.A. Directly after this, file a square on the plug, just long enough to enter the cock-body about 1/32 in. when the plug is right home. This allows for grinding-in. Part off the plug so as to leave 5/32in. projecting at the large end, then file a 3/32in. sauare on that end, to accommodate the-'handle. To hold the taper plug whilst filing this square, chuck a bit of brass rod 3/16 in. diameter ***or*** larger ; face, centre, drill down ***a*** little way with 3/32-in. drill, then ream it taper with the cock reamer in the tailstock chuck. Push each plug tightly into the taper hole, and it will hold quite tight enough to allow the square to be filed in the manner I have described so often, that most folk should be able to do it with their eyes shut.

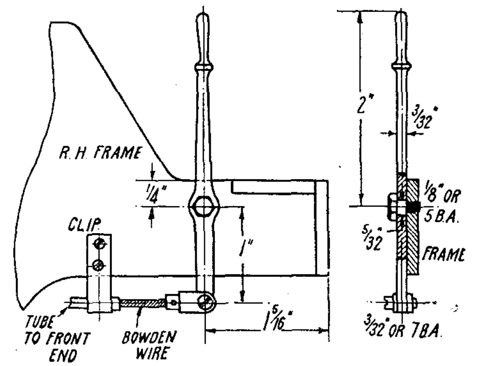
The handles are filed up from 1/16in. by 3/16in. steel strip, and need no detailing ; fit each to a square on the plug, and two or three taps with a hammer will burr the edge of the square sufficiently to prevent the handle coming off. Put each plug in place with a commercial nut and a 1/16in. washer (file the hole in this square, naturally, to fit the square on the plug) then screw the cocks temporarily into the holes in the cylinder flanges, marking which is which, on the cock handles. Then set the handles back 45 deg. as shown in the illustration. Take the cocks out without shifting the handles ; put the tapped bush in three-jaw, screw each cock into it, and run the 1/16in. drill up the bore, right through the plug. Take out the plugs, silver-solder a bit of 3/32-in. pipe into each cock (get the length from the actual engine) but don't bend it yet. Grind the cock-plugs in with a scraping off your oilstone ; just a few turns back and forth should be all that is needed. Clean the plugs well with a spot of paraffin, and poke out the steam ways in both plug and cock body ; then replace plugs, smearing a taste of cylinder oil, or a little graphite (off a soft blacklead pencil will do), leaving the nuts so that the plugs work easily. Finally, screw them into the cylinders with a weeny bit of plumbers' jointing on the threads, then bend the pipes as shown in the illustration.

Operating Gear

The cocks may, of course, be merely connected by a oooo-gauge coupling-rod between the two handles, and operated "at ground level " as desired for footplate control, proceed as follows? Make up the little connecting-rods from a bit of steel strip, to the dimensions shown ; a simple filing and drilling job. A cross-shaft will be needed underneath the cylinders, so drill a No. 30 hole in the position indicated, through the frame at each side ; these holes will pierce the flanges of the bogie bolster, but that doesn't matter an Assouan. Note : this location-3/16 in. ahead of the centre-line of the bolster, and 3/16 in. from the bottom of frame-won't do for anybody who has used a built-up bolster, as there will be a big nut in the middle, right in the way of the shaft. In that case, drill the holes a little farther forward, between the next pair of bolster screw-holes, and alter the position of the lugs on the rods connecting the cock handles, to a like amount. That will put things O.K. and the working will not be affected.

The shaft is a piece of 1/8in. round silver-steel approximately 4-5/16 in. long ; check this off from the actual engine by putting the connecting-rods temporarily on the cocks, and measuring the distance between them. This shaft carries three arms or levers, two for operating the cock-rods and one for connection to the lever in the cab. One lever is just a plain flat doings filed up from 3/32-in. by 1/4in. flat steel, and drilled as shown ; press this on to one end of the shaft, and braze it in place. The other two have bosses which are fitted in precisely the same way as described for valve-gear suspension-levers and the like, viz. brazing on a small solid boss and then drilling through the lot with the boss held in the three-jaw. The small end of the inside arm is drilled No. 43 to accommodate an 8-B.A. screw in the fork operating it. Two small collars are also needed, to prevent any side movement of the shaft when erected ; see illustrations. These should be drilled a tight fit for the shaft, say No. 31.

To erect the shaft, just remove the connecting-rods from the cock handles ; put a collar on the shaft, and poke the end through the hole in the



Operating handle

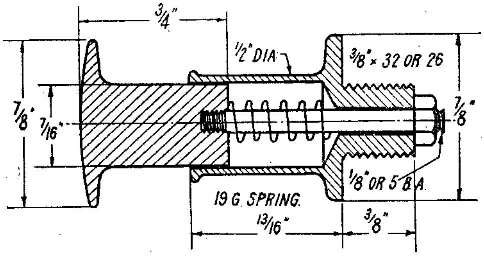
frame on one side. Put on the lever with the plain drilled end, push the other end of the shaft through the other hole in frame, put on the other collar, and finally the other lever. Line all three levers up, so that the end holes are both in line and the middle directly opposite ; push the collars against the frame at each side, so that the shaft cannot move endwise, then pin the collars and the levers to the shaft. I use bits of blanket pins for jobs like these ; a No. 57 drill is just right for a nice drive fit. Big pins are not needed ; and, anyway, if you drilled a hole for a 1/16in. pin in a 1/8in. shaft, it would soon break at the hole. I've seen plenty of this sort of error in the commercial jobs I have rebuilt, back in the days when I could find time to do them.

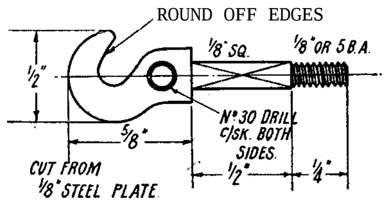
You will probably have to make the screws, as they should have a plain section under the heads, for the cock handles to take a bearing on ; this is dead easy, as it only means chucking a bit of +-in. round steel in three-jaw, turning down the end for about 5/32 in. length, and putting a few threads on with a die in the tailstock holder. The threads should be a tight fit, and when screwed right home, the cock handles should be quite free to move. Couple up the connecting-rods to the cock handles, then put an S-B.A. screw through the middle hole each side, into the lever on the end of the cross-shaft. Note again-as the cross-shaft levers are longer, from centre to centre, than the cock handles, the hole in the middle of the connecting-rod must be filed slightly oval, to allow for the difference in the radial movement. All four cocks should-. move perfectly freely, when the inner lever is operated with your fingers. Don't screw up the nuts on the cock-plugs so tight that they will be hard to turn, or scoring will result, and you'll get the old stick-and-blow trouble.

Cab Lever

The cocks are "remotely controlled " by a lever in the cab, connected as previously mentioned, by a Bowden wire, to the inside lever on the cross-shaft. The lever is a plain filing job, the handle being either turned solid with it, or turned up separately from 1/8in. round steel, and brazed on to the flat part. Drill a No. 41 hole at the bottom, and a 5/32-in. hole ɪ in. above it. Turn up a hexagon-headed screw from a bit of 1/4in. hexagon steel rod, leaving a full 1/8 in. of " plain " under the head, turned to a working fit in the 5/32-in. hole in the lever. The end is turned down to 1/8 in. diameter, and screwed 1/8in. or 5-B.A.

At 1/4in. below the top of the right-hand frame, at 1-5/16 in. from the drag-beam, drill a hole in the frame with No. 40 drill, tap to match the screw and file off any burr. Attach the lever to the inside of the frame as shown ; when the screw is tight home, the lever should move without any side-to-side movement. Make up two little forks or clevises, same as I described for valve gear work, from 7/32 in. or 1/4in. rod, drilling the stems 1/16 m. Measure the distance by the nearest route, between the bottom of the lever and the end of the middle arm on the cross shaft, both being vertical. By " nearest route " I don't mean a straight line, but the nearest way that misses the location of the bottom of the firebox, and any other obstruction. Cut the Bowden wire about 1/2 in: shorter than this, grease it well, and thread it through a piece of 3/32-in. brass treblet tube, or any other thin-walled tube that it will fit easily. The tube should be about ɪ in. shorter than the wire. Fix the two forks at either end of the wire ; solder the wire into the stems, and if desired, you can put a set-screw in as well. Couple up the forks to the arm of the cross-shaft and the lever, by screws as shown ; these should have a plain part where they pass through the levers, one side of the fork being clearing size, and the other tapped for the screw. Then set the tube so that it clears all obstructions, and secure it at each end by two little clips made from about 18-gauge sheet brass. If the clips tend to move or slip on the tube when the lever is operated teach them good manners with a touch of solder. The location of the clips, is shown in the illustrations. The cocks should now work freely by moving the lever back and forth, the lever staying wherever it is placed, merely by friction alone. No stops are required--you'd be, puzzled to miss the "on" and "off" positions .





Details of buffer and drawhook

Buffers and Drawhook

The above completes the working parts of the chassis, with the exception of the steam brake gear ; but as this is optional, and can be fitted at any time, I propose to describe it after the boiler is made and fitted, and the engine has been on the road. Then those who don't wish to bother about brake -gear on the engine, won't be delayed. It looks all right, and works all right, but is practically useless as an actual brake in 3-1/2in. gauge size. As any full-size driver will tell you, a passenger engine pulls the train, but the train stops the engine, in a manner of speaking, the continuous brakes acting on all wheels of the train. In 3-1/2in. gauge, an effective hand-brake on the driving car is the most satisfactory means of stopping ; applying brakes to the engine wheels would only cause them to slide, or " pick up," as the enginemen call it. A " scale " brake application, in which the brake-block pressure was sufficient to lock the wheels, would be about as effective with a dozen passengers up as putting your toe under the wheels of Princess Polwolly-galatzi" dropping down Camden bank mto Euston with an 18-coach load. Incidentally,. the brakes on the " Maid " and " Minx " can be used for their legitimate purpose, as the engines are bigger and heavier ; we'll see about those later on.

Meanwhile, any builder of " Doris " who has caught up with the notes and is stuck for a job, can make the buffers and drawhook to me dimensions shown in the illustrations. No detailed instructions are needed ; both are simple exercises in turning and filing. The buffer sockets may be made from castings, or turned from the solid ; I usually turn and screw the shank, part off to length, then screw the embryo socket into a tapped bush held in three-jaw, for turning the outside to correct profile, and drilling for pin and head. The heads are turned from round mild-steel rod. I had a bit of rustless steel of correct diameter, which I used for the buffer heads of " Grosvenor " ; but, holy smoke--was it tough ? I'm saving. the rest of it to use for pistons, if I build any more locomotives ; I'm sure they would never wear out ! As to the drawbar hook, just mark it out on a bit of 1/8in. steel, and saw and file to outline ; don't forget to round off the nose of same, so that it doesn't cut the coupling shackle, or Inspector Meticulous will be having another excuse to pop down to the "local" ! All being well, I will describe the L.M.S. type of screw coupling later on, with the " trimmings."

A 3-1/2in. Gauge L.M.S. Class 5'Loco.

by "L.B.S.C."

HERE, as promised, are some illustrations and details of a suitable boiler for young "Doris." Whilst following the outline of the boiler on the full-sized engine, I have introduced two or three variations, to make the construction easier. Big sister's boiler has a parallel front section, and a steeply-tapered second ring going up to the throatplate level ; but I have made the actual boiler taper gradually right from the smokebox, like the full-sized engine's lagging. Secondly, although the top of the Belpaire firebox-wrapper has the conventional back slope, the sides are parallel instead of tapering in. This makes it easier both for wrapper and inner firebox construction, and only those deliberately seeking something to moan about, would notice it. The firebox tubeplate is vertical, and the front section of the foundation-ring is dispensed with ; another " easier-to-make " innovation. The inside of the boiler is arranged according to my usual " tried, tested, and proved " specifications, so nobody need be afraid of being short of steam, as long as they keep using the shovel at the right time and in the right manner.

As I have only just finished detailing out the flanging, riveting, brazing, assembling, and other operations used in making a little locomotive boiler, in connection with those for " Maid of Kent " and " Minx " there is no need to repeat the ritual so soon afterwards. All the operations are carried out in exactly the same way ; so if I go through the general construction, and note the differences in the shape of the plates, crown-stays, throatplate joints, sloping backhead and so on, nobody should have the least difficulty in building a boiler that will " do the doings."

Barrel and Wrapper

The barrel may be made either from tube or sheet. If the former, a piece of 4-1/2in. diameter 13-gauge seamless copper tube will be needed, a little over 10-1/2 in. long. Cut a V-piece out of it. a full 1-1/2 in. wide at the end, tapering down to nothing ; close up the V, and rivet a butt-strip of 16-gauge copper inside,. extending almost full length, but leaving 1/4in. at the wide end, and 3/8in. at the narrow end, so that the smokebox tubeplate and the stepped joint-ring may be inserted. If the rivets are spaced about an inch apart, it will be quite all right, as this seam is brazed along with the throatplate joint. It is also an advantage to bevel the edges of the cut a little, so that when the job is riveted up, the edges form a V, in which the brazing material can run easily. Carefullv tile off both ends so that they are square with the bottom of the barrel, where the joint is. Beginners note, when the boiler is assembled, the bottom is parallel ; only the top slopes.

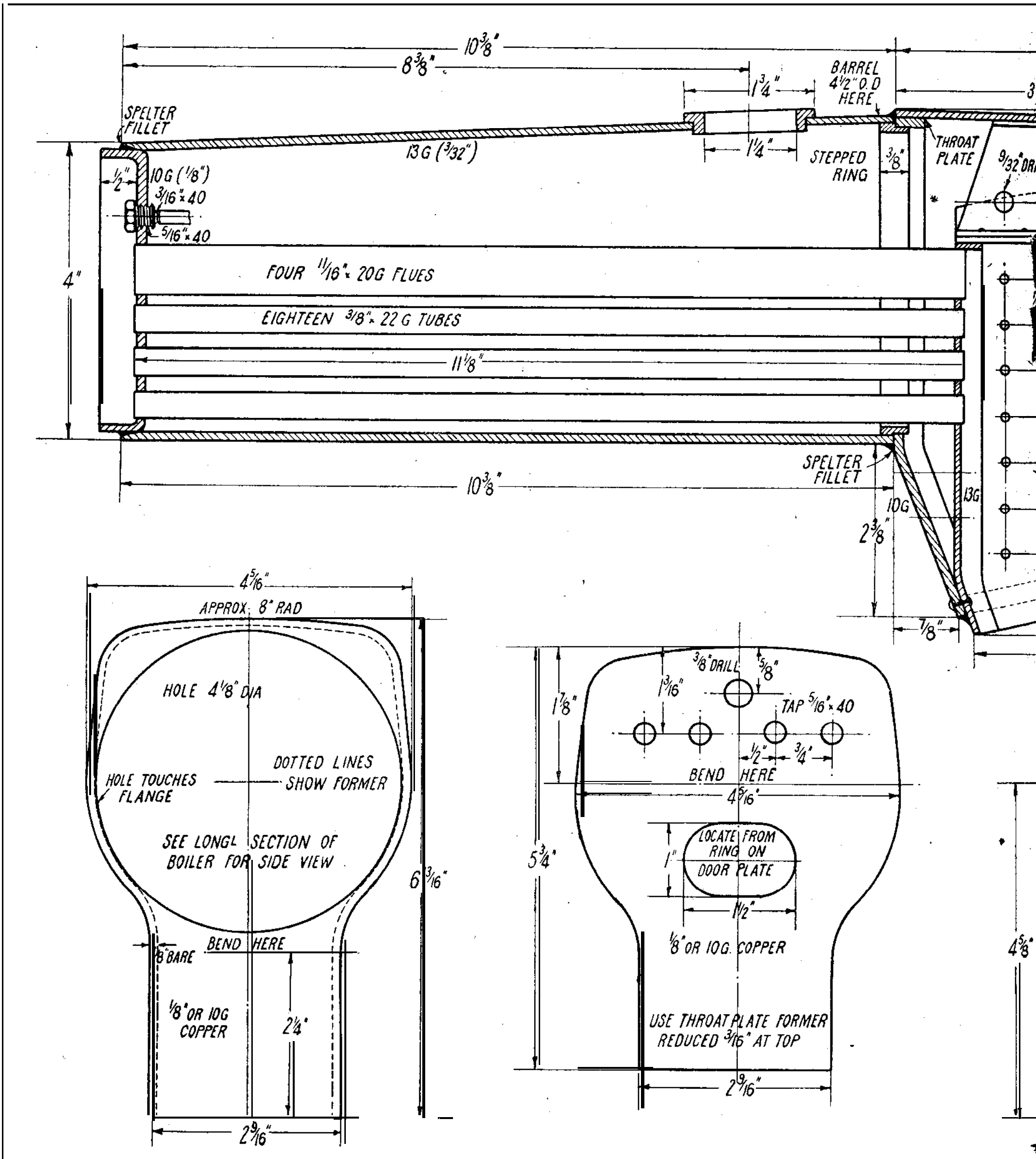
The barrel can also be made from a piece of 13-gauge sheet copper rolled up to a taper, and lapped over approximately 3/8 in. Rivet the lap seam with 3/32in. copper rivets at about 1-in. centres, and serve the ends as described above. The diameter outside the small end should be 4 in., and the larger end 4-1/2 in.

The throatplate is flanged up from 1/8in. or 10-gauge sheet copper, over an iron former, the shape and dimensions being shown in the composite illustration. Make it the same as a flat backhead for the kick-off; then, when you have flanged it, and filed off any raggedness, saw two nicks out of the flanges at the place where the bends have to come, and bend to the angle shown in the illustration. Then cut a circular hole in the upper part, as big as possible, touching the flanges at top and sides. Clean up the flanges with a file, and clean all around the hole.

It is quite possible that our advertisers may be able to supply a casting in good gunmetal, or even copper, for the stepped ring. Although I wouldn't use cast plates in a boiler under any circumstances, there is no harm in using the cast ring, as the strength of the boiler at this point doesn't depend on the casting, but on the brazed or Sifbrdnzed joint. The ring is merely to keep the barrel and throatplate lined up correctly, whilst the brazing is under way. Personally, I don't use a ring at all. I just stand the firebox wrapper, with throatplate attached, end-up in my brazing-pan ; set the barrel on it in the right uosition. letting it stand by just its own weight alone, and then-get busy with my "Alda" blowpipe and Sifbronze welding-rod. If a casting isn't available, bend a piece of 3/8in. by 1/8in. copper strip into a circle that will lust fit the larger end of the barrel ; silver-solder or braze the joint, then chuck it on the outside step of the three-jaw, and carefully turn down half of it to a push fit in the hole in the throatplate.

The firebox wrapper is bent up from a piece of 3/32-in. sheet copper a full 8 in. wide. The exact length can be obtained by running a piece of soft copper wire, or thick lead fuse-wire, around the throatplate flange, and then straightening it out.If you allow for the 3/16in. backslope, and the difference in depth between the front and back of the firebox, it is a kiddy's exercise in mental arithmetic to reckon up the length of the back end ; but it can be got from the backhead itself, if you like to make that component at this stage. Saw 3/16 in. off the end of the throatplate former, round the corners, and flange a bit of 1/8in. or 10-gauge copper sheet over it, same as throatplate, but cut to the length shown in the illustration. To make. the bend, nick the flanges with a saw, at the position indicated, and bend outward as shown. Incidentally, these nicks don't make the slightest difference to the strength of a brazed or Sifbronzed job.

The bends in the wrapper are made over a piece of bar held in the bench vice, as described for the 5-in. gauge boilers. If the copper is annealed, it will bend readily enough ; I find it does, although I'm not so strong as I used to be. Clean the edges, and rivet the longer end of the wrapper to the throatplate flange with a few 3/32in. copper rivets. Don't bother about fancy heads,

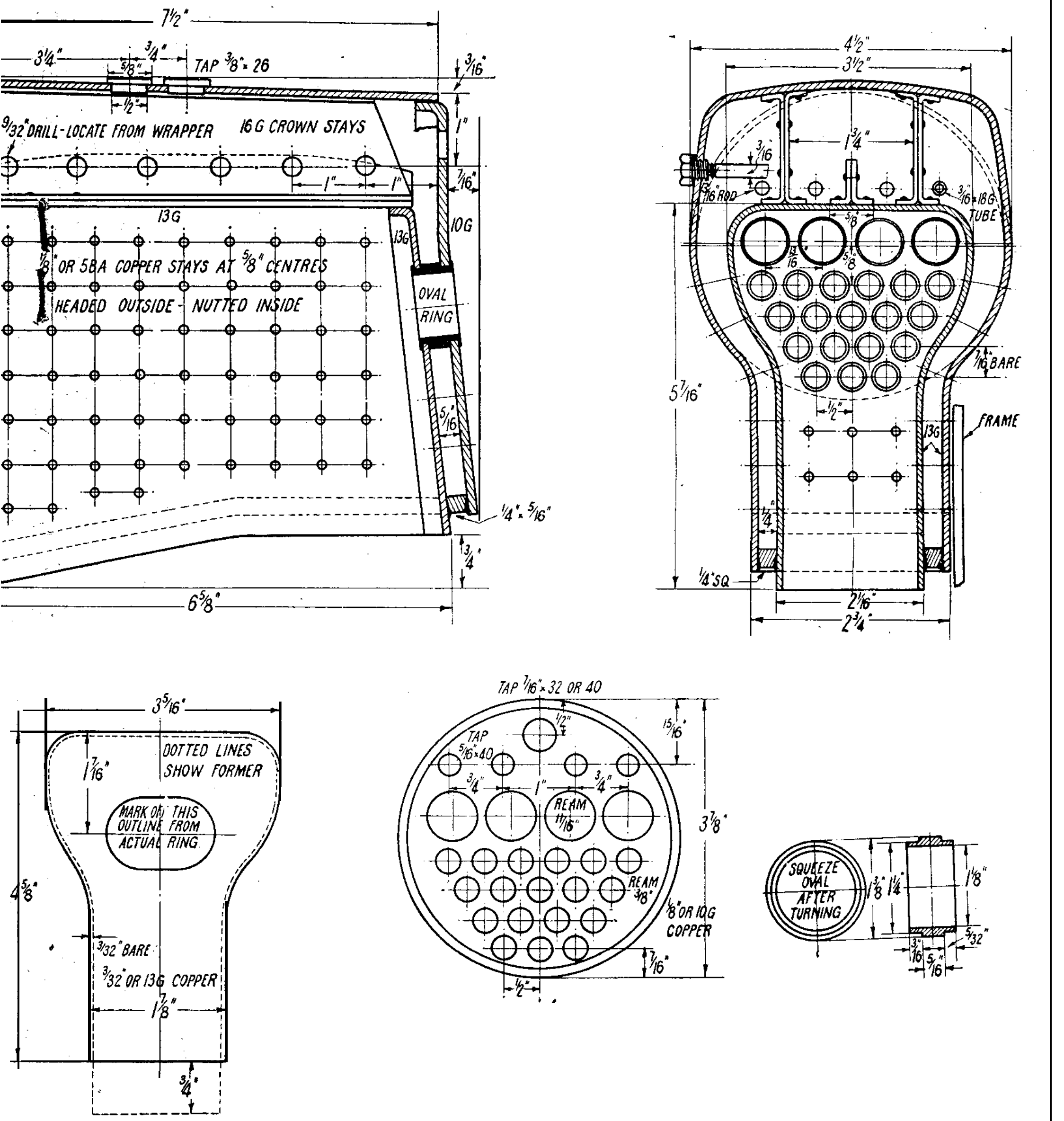


Top-Sections of boiler for " Doris " ***Bottom (left to right)-Throatp***

they are filed off after brazing, and only use enough to keep plate and flange in contact.. The lower part of the wrapper sheet *is* trimmed off to match the slope of the throatplate.

Brazing up the Shell

Put the smaller step of the ring in the hole in throatplate ; smear some wet flux around it, then put the barrel on. If the end of the barrel is bevelled off a wee bit, it will help the brazing material to penetrate. Put on some more flux, also give the joint between the wrapper sheet and throatplate flange a good dose. Then up-end the shell in your brazing-pan, and go right ahead with the brazing, exactly as described for " Maid " and " Minx." Start at one bottom corner of throatplate, work your way up, and continue around under the barrel, and down the other side. Then turn the shell in the pan, so that the open side of the firebox is away from you, go all around the joint between the wrapper and throatplate flange, and finally between barrel and throatplate.



tplate, backhead, door plate of firebox, smokebox tubeplate and firehole-ring

Run a really good fillet around the barrel wherever you can, such as at the upper part of the throat-plate. Where the barrel and throatplate meet flush, at each side, also on top, where they are nearly flush, see that the melted brazing material runs well into the joint. Don't worry if you get a blob or two projecting beyond the barrel ; it can easily be filed flush afterwards. Sound joints should be the first consideration ; you can make it look pretty afterwards.

The firebox is made similar to the " Maid's " but to the given dimensions. One former does for both tubeplate and door plate. Make it to the dimensions shown by dotted lines, then set out the tube holes on it, and drill them No. 40. Round off the sharp edge one side. When the tubeplate has been flanged, as previous instructions, run the No. 40 drill through all the holes, and carry on through the copper. Remove plate, file off any raggedness, open out all the holes with a 23/64in. drill, and ream the four lower rows 3/8 in. Open out the top row further still, with a 43/64-in. drill, and ream 11/16 in. Countersink all holes slightly on the side opposite the flange ; nick the flange, and bend the plate as shown.

Next, flange up the door sheet; making the top-to-bottom length as shown in the drawing, and fit the firehole ring. This is a 21/32-in. length of I-3/8in. by 1/8in. copper tube, turned down for 3/16 in. length to I) in. diameter at one end, and for 5/32 in. length at the other end. Anneal, and squeeze oval in bench vice. Lay the ring on the door sheet at position shown, scribe a line around, cut out the piece, insert the 5/32-in. lip of the ring, and beat outwards and down, hard on to the door plate. Don't forget that the ring projects on the side opposite the flange !

The firebox sides and crown are made from 13-gauge sheet copper, the exact size being obtained by measuring around the tubeplate and door-plate flanges, as described for the wrapper. Bend to shape over a piece of bar in the bench vice, and rivet the shaped sheet to the tubeulate and door-plate flanges- by a few 3/32-in. copper rivets. Be sure the surfaces in contact are perfectly clean.

The crown-stays are of my pet girder type, the outer ones being formed of two channels riveted back to back, and the centre one by two angles, similarly attached ; the bottom flanges of all the lot, are riveted to the too of the firebox at the spacing shown. All the channels and angles are bent up in the bench vice from 16-gauge copper sheet. Several of my own engines have crown-stays made from printing blocks, cheque plates, and so on ; these-are of excellent copper, and as Inspector Meticulous can't see through the firebox wrapper, it is O.K. to use them. Note that the side girders are I-3/8in. high at the back end, but I-9/16 in. at the front, to match the sloping top of the wrapper.

The firebox joints are brazed up in precisely the same way as the wrapper and throatplate joints. Do the door plate first. and run a good fillet around the firehole rine. Then do the tubeplate, and be mighty careful not to melt the copper between the tube holes. Finally,-run some silver-solder (coarse grade) along the crown-stay flanges, and see that it sweats clean through. also that it covers all the rivet heads ; then run a little fillet of brazing-strip along the edge of each flange, as a sort of finishing touch. Pickle, wash off and clean up.

Tubes and Smokebox Tubeplate

There are eighteen 3/8in. by 22-gauge fire-tubes, and four 11/16in. by 20-gauge superheater flues. If your lathe has a hollow mandrel big enough to take them, square off all the ends in the lathe, to a length of 11-1/8in. In passing, I might mention that this is about the limit of efficiency for a 3/8in. tube ; longer tubes would need to be a. little larger in diameter, to have any steam-producing effect at the smokebox end of the boiler. Clean up the ends with a bit of coarse emery-cloth ; brazing material and silver-solder " take " better on a roughened surface.

We Shall need the smokebox tubeplate, to act as spacer and " holder-up " when silver-soldering the tubes. This is a disc of 1/8in. sheet copper a full 5 in. diameter, flanged over a circular former 3-11/16 in. diameter. Countersink or bevel off the inside of the front end of the barrel, so that it tapers slightly the opposite way to the outside. After turning the raggedness formed off bv the flanging, reverse the tubeplate on the chuck-jaws, and turn down the outside of the flange to a very tight fit in the front end of the boiler. There should be a little V left all around the edge, for the brazing material to run into, as shown by the black marks in the sectional illustration.

Scribe a line across the middle of the flanged plate, on the opposite side to the flange, and at 7/16 in. from the edge, make a centre-pop. Put the firebox former over the plate, so that you can see the centre-pop through the middle hole in the bottom row ; then adjust so that you can see the scribed line crossing the centre of the middle hole in the third row. Clamp the former to the tubeplate in this position, put the No. 40 drill through all the holes, take off the former, and open out, drill and ream the holes, same as in the firebox tubeplate, but slightly countersink ***both*** sides. The tapped hole8 for the stay nipples and the steam-pipe flange can then be set out, drilled and tapped, as shown in the illustration.

The procedure of fitting and silver-soldering the tubes, is exactly the same as detailed out for " Maid " and " Minx " boilers a few weeks ago, and so it would only be a waste of time and space to set it all out again. Suffice it to say that whilst experienced boilersmiths can out the whole lot in-at one fell swoop, novices and inexperienced workers would be well advised to do this job in two or even three instalments. Far better spend a bit more time on the job, and have it perfect, than to find you have Welsh vegetables sprouting on the great dav when the 1ocomotive takes the road for the first time. As a famous radio artiste truly says, " it can happen-and it does ! " Don't forget to soften the smokebox end of the tubes after finishing the silver-soldering, as per previous instructions.

First Stage of Erection

Whilst the " technique " of erecting the firebox and tubes in the shell is practically the same as described for the " Maid " and " Minx," there are two details which differ. One is, that there is no front section of foundation ring to bother about, and the firebox tubeplate being bent at the bottom to the same angle as the bottom of the throatplate, the two are riveted together direct' with three or four 3/32-in. copper rivets. The second difference is that the smokebox tubeplate is inserted with'the flange outwards, forming a spigot on which the smokebox is fitted. Be careful to have the crown-stay flanges in contact with the top of the Belpaire wrapper for their full length, and put a few rivets through each flange. When brazing-in the smokebox tubeplate, proceed as described for the 5-in. job, using the " holey " tray. but the brazing-strip or Sifbronze is applied outside the flange; and the V-groove completely filled up. Don't worry if it overflows ; a file will put that right afterwards. The tubes are expanded and silver-soldered into the tubeplate, and the crown-stay tinges silver-soldered or brazed to the wrapper, in exactly the same way as previously described. In the issue of October

(Continued on page 564)

and sixteen trucks, so she has plenty of power.

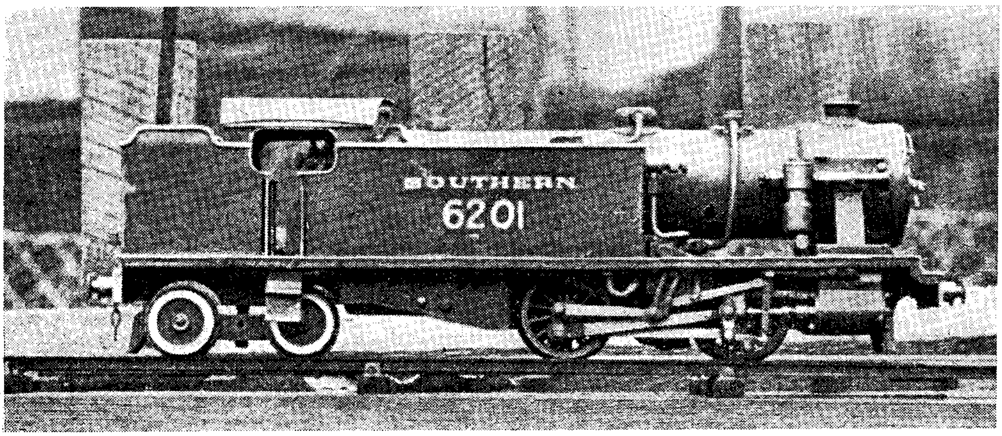
At the Chelmsford Model Engineers' Exhibition, where, much to my surprise she obtained a first prize, she was in steam on the Wednesday, Thursday and Friday nights, and all day Saturday till 8.30 p.m. The only difficulty was to stop wheel-spin on the new club track.

I am not troubled with this on my own outdoor track, a 56-ft. run, round the lawn, with one station, and passing loop.

The other locomotive is also for gauge " 0 " and may be of interest. It is free-lance, and makes no claim to beauty. It is coal-fired, with top-feed, and has a hand-pump in side tank as well as an axle-driven pump. The Walschaerts gear in this case does its proper job, and can be notched up, when the difference in steam consumption can be observed.

The reversing lever was a fiddling job, with working latch ! Lubrication is hydrostatic; the lubricator can be seen at the side cf the smokebox, an attempt being made to simulate a Westinghouse pump, she will certainly pull and go, though great care is needed when firing, " little and often " being the rule.

The photographs were taken by a friend-, Mr. Attridge, under very difficult conditions, the sky being overcast at the time.



Mr. A. Beale's " 0 " gauge, free-lance coal-fired locomotive.-Beauty not claimed !

"L.B.S.C."

(Continued from page 562)

14th last, I stated that a mate with an extra blowlamp, to play on the outside of the wrapper whilst the operator-in-chief looked after the inside, and manipulated the bits of silver-solder and brazing-strip, was desirable ; but " Doris's " boiler being much smaller, the single five-pint blowlamp should manage the job all right! though even in this case, to paraphrase an old saymg, " two lamps are better

The Rest is Easy !

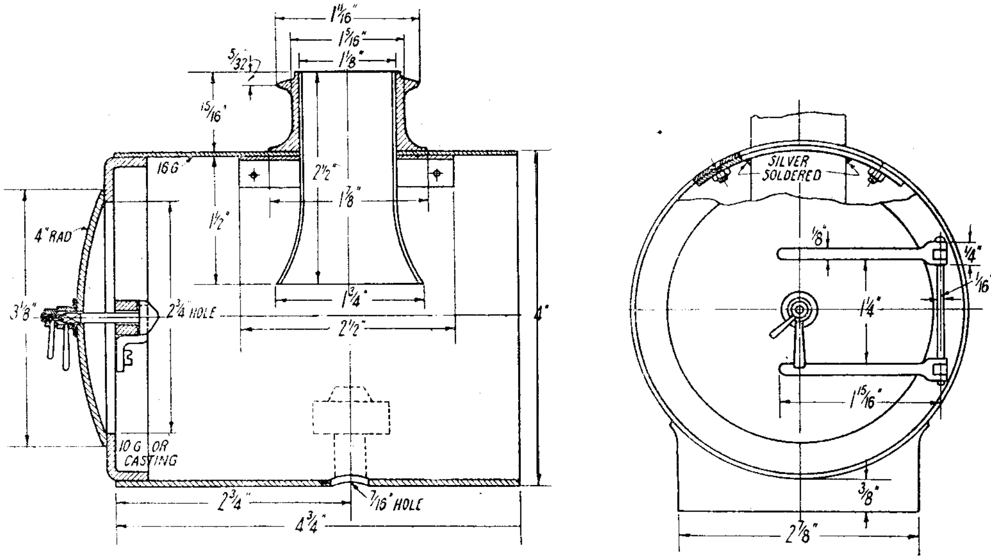
The backhead is fitted the same way as' the " Maid's," and the pieces of copper rod forming the foundation-ring, set in place and riveted. Note that the water-space at the back, is 1/16 in. wider than at the sides ; and don't forget to bevel off the sides of the pieces of rod, just a little, to let the brazing material flow in. There are only three bushes to fit ; the dome bush, and two for the safety-valves ; note that the latter should be set with-the flange seats horizontal, so that the safety-valves will not emulate the Leaning Tower of Pisa. Finally, set about the last " hot job " as previously described for the bigger boilers. If you can get a second blowlamp on the go, do so, but the five-pint one is powerful enough to manage the job single-handed. Anybody who is scared of damaging the brazed joints already made, as more heat is needed on " the final," can use coarse-grade silver-solder instead of strip, which melts at a dull red and is just as strong but more expensive. Use best grade silver-solder, such as " Easyflo," for the flange of the firehole ring and the bushes. Once more I'll repeat, mind the splashes and the vapour when you put the boiler in the pickle. Leave it in for about 20 minutes? then drain out, well wash in running water, inside and out ; clean up, and test for " pinholes " by the method already described.

A 3.1/2in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

AS last week's dissertation was all about smokeboxes, I thought it would be a good thing to follow it up with the notes and drawings of the smokebox for the L.M.S. Class 5 engine. Although " Doris " isn't as big as either " Maid " or " Minx," the construction of the smokebox is practically the same, so that the instructions already given, will serve also for this job. The diameter of the smokebox tubeplate over the flange, was given as 3-7/8in., the tapered end of the barrel being filed to suit ; so if we use a piece of 4-in. by I6-gauge brass tube for the smokebox, it will fit nicely on the projecting flange, and the outside will be flush with the end of the taper barrel, which is as it should be. If no tube is available, the smokebox barrel may be rolled up from I6-gauge sheet brass, and either lapped and silver-soldered, or butt-jointed, veed, and Sif-bronzed as mentioned last week. In any case, the tube, whether drawn or home-made, should be squared off in the lathe to a length of 4-3/4 in.

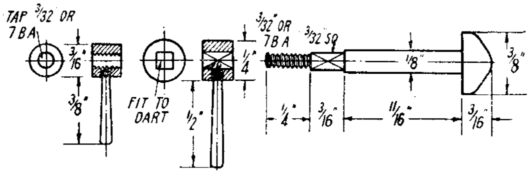
The hole for the chimney liner is 1-1/8 in. diameter, and 2-3/4 in. from front end ; the hole for the blastpipe is diametrically opposite and in line, and drilled 7/16 in. Note : if you have rolled up the smokebox barrel from sheet, and lapped the joint, there is no need for the blastpipe hole to go through the lap. Drill it first, as close to the joint as possible, and then drill and ream the hole for the liner afterwards, exactly " across the way." The lap joint doesn't have to be exactly on the bottom line of the smokebox, as long as it is inside the saddle.



Snwkebox for " Doris "

The liner is a 2-1/2in. length of 1-1/8in. tube, 18- or 20-gauge, brass or copper, it makes no odds. Soften it, and bell out the bottom end to approximately 1-3/4 in. diameter, as shown ; this is merely to ensure that all the steam from the four blower jets, which are set in a 5/8in. circle around the blast nozzle, goes up the liner. I might point out that there is no need for an outsize bell in a chimney liner ; in a little engine it can be overdone to an extent which, by obstructing the inside of the smokebox, defeats its own ends. Most of my engines have plain straight liners without any bell at all, old " Ayesha " being one, and nobody could ever accuse her of being short of steam. She is now trying to burn up her tenth set of firebars ! Engines with fairly long chimneys, such as my old " Ancient Lights," don't need, a liner at all; and the only reason I fitted them to " Jeanie Deans " and " Grosvenor," was to provide a sort of spigot over which to fit the chimney. They only just project into the smokebox. The liner for " Doris " is fitted in a 2-1/2in. square of 16- or 18-gauge brass or copper, same as the " Maid," and attached to the smokebox by four 3/32-in. or 7-B.A. countersunk bras's screws, nutted inside the smokebox as shown.

The chimney itself is a casting, and a plain turning job needing no detailing-out. If the corehole is rough and undersized, bore it out like a cylinder, so that a piece of 1-1/8/in. tube will be a tight fit in it. Then mount on a mandrel-bit of hardwood would do-and turn the outside to the profile given. The radius at the bottom can be cleaned up with a file ; or you could put a piece of thin emerv-cloth or other abrasive over the smokebox barrel, and give the chimney a few rubs on it. The slight difference in radius caused by the thickness of the emery-cloth, is nothing to worry about. As the chimney should have the proper " L.M.S. look," I have given all the diameters and the height. Somebody who built a " Princess Marina " told me he made six



Dart and handles

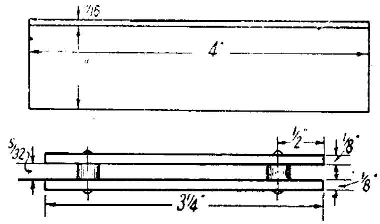
chimneys altogether, to try and satisfy a relative of Inspector Meticulous in his local club. Whilst I fully agree that the shape of a chimney can make or mar the appearance of the engine, there are some chimneys I detest. The awful nightmares that disfigure the smokeboxes of some of the Southern " Nelsons," " Schools," and Maunsell 0-6-0's are absolute eyesores, especially the latter, which are lower than the dome. Could you imagine a G.W. " Castle " or " King " with such an excrescence on the boiler-the thought is enough to make anybody feel queer! If I don't like the " regulation" chimney for any particular class of engine, I just fit another one altogether ; " Tishy " and " Cock-o'-the-North " both have neat stovepipe chimneys, and " Femanda " has one like the L.M.S. " Princess Royal." But " Jeanie Deans " and " Grosvenor's " chimneys just yell Crewe and Brighton at you !

The smokebox ring, door, crossbar, dart and handles are made as described last week, but to the sizes shown in the accompanying illustrations. Probably some builders will prefer to knock up the ring and door from brass blanks ; I rather favour this method myself in the smaller sizes. There is a little difference in the hinges. Instead of the usual solid lug on the end of the hinge strap, the full-sized " Class 5's " have a sort of bifurcated hinge, as shown in the drawing. Cast smokebox doors will probably have the lug cast solid ; and the recess for the corresponding lug on the ring, will have to be filed or milled, but that is a simple job, anyway. There is no difference in the manner of drilling and fitting the hinge pins. Use No. 51 drill, and 1/16in. silver-steel or rustless steel pins, slightly burred at the top, so that they can't fall through and get lost on the road. If the hinge straps are made separate, as in the case of a door knocked up from a brass blank, use a piece of metal the full width of the hinge lug; then, after bending the eyes to shape, and silver-soldering them, file away the surplus before bending to suit the contour of the door.

The saddle will be a casting, and all it should need is a bit of cleaning up with a file ; it should fit tightly between the frames, but not enough to spring them. Instructions for erecting will be given when we come to the job of erecting the boiler on the chassis. Next stage, staying. boiler fittings and mountings.

Misleading, Yet Correct !

A correspondent, in a recent letter, relates an experience which he thinks should be given publicity, in order to prevent others falling into a similar trap. Our friend was in the market for



Saddle and crossbar

a serviceable used engine, having a young hopeful who was decidedly " locomotive-conscious " ; he had managed to put up a garden line ***on*** which the boy could ride, but had not the time, nor the equipment, to build an engine to run on it. He was offered what was described as a " live steamer " at an attractive price ; and as he had read my notes for a considerable time, had come to regard the words as implying that the engine was one built to my specifications, and closed with the offer, paying the money without seeing the engine at all, and taking the vendor's word that it was in good order.

When the engine arrived, he found that not only was the workmanship very poor-the engine could hardly pull its own tender-but it was of a commercial type which I have never described in these notes. He took the matter up with the vendor, and said that calling the engine a " live steamer " was a gross misrepresentation, as it was not a " L.B.S.C." type. The vendor promptly repudiated this, saying that he did not claim it to be one of my designs, adding that any engine which took steam direct from the boiler, could legitimately be called a " live steamer." My correspondent asks if this is correct.

Unfortunately for him, it is. Your humble servant has not the slightest proprietary right over the use of the words " live steamer " ; a child's spirit-fired toy is as much entitled to be called a " live steamer" as my "Tugboat Annie," and the term is freely used in Canada and U.S.A. by writers who maybe have never seen a copy of this journal. My notes were formerly published under the heading ***Shops, Shed and Road-a Column of Live Steam,*** and by virtue of that, the term became unconsciously coupled with the locomotives described in those same notes, which I called " live steam" specifications. One of the reasons why I give my locomotives their distinctive names, is to avoid anybody being misled, inadvertently or otherwise. Although I cannot claim any proprietary rights over the generic term as mentioned, I can, and most emphatically do claim them over the designs of the locomotives specified by name or other distinction. Anyway, to save any misunderstanding in the future, I shall not refer to " live steam " specifications, but to " L.B.S.C." specifications, and then there can be no mistake ; so if you hear of, or see any engines advertised as " live steamers," remember our worthy friend's experience, and do not necessarily couple them with your humble servant. They may be something entirely different altogether !

Built " On the Quick "

The reproduced photograph shows a " Maid of Allsorts " built by Mr. P. S. Lamb, a Stratford-on-Avon follower of these notes. Mr. Lamb set out to do the job as quickly as possible, and completed the whole bag of tricks in just ten months. Although the locomotive is not a copy of anything running on British Railways at the present time, the various working parts, and the boiler, are made according to the instructions given in these notes ; and in consequence, the engine can do the job all right. Our worthy friend says that she is a " three-jaw-chuck job " throughout, the cylinders being held in same with some weird and wonderful nieces of packing: to get them to run truly for 'boring and facing ; it panned out all right, but took rather a long time setting them up, to the accompaniment of a little railroad Esperanto. The wheels were turned at one setting apiece, by gripping the little boss at the back. in the three-iaw : he savs that there was only about 1/8in. to hold them by. but they never came out, "and suggests that if all castings were provided with a chucking-boss, they could be machined at the one setting.

Some wheels are ; I have a set of " Fayette " coupled wheel castings here at this minute, with chucking pieces on the back about 5/8 in. diameter and just over 1/2 in. long. I have personally tried to turn iron wheel castings at one setting, but find there is a tendency to chatter when turning the treads and flanges, even on my " Type R." Milnes lathe. Also, each wheel needs at least four changes of tools for facing both sides, turning treads and flanges, and forming the little rebate at the front of the rim, which simulates the junction between tyre and wheel-centre, well in evidence on all my own fleet of locomotives. Then there is the trouble of turning all the treads to matching diameters, by separate measurement ; and finally, the wheel has to be chucked back outwards. to face off the chucking-piece. I think I have 'tried about every possible method of wheel turning ; and the one I recommend, is the one which I have found not only the easiest, but gives the best results, especially in getting all the coupled wheels to the same exact diameter. The support given to the tread and flange by the improvised faceplate, minimises chatter even on a small lathe of the rickety-rockety kind.

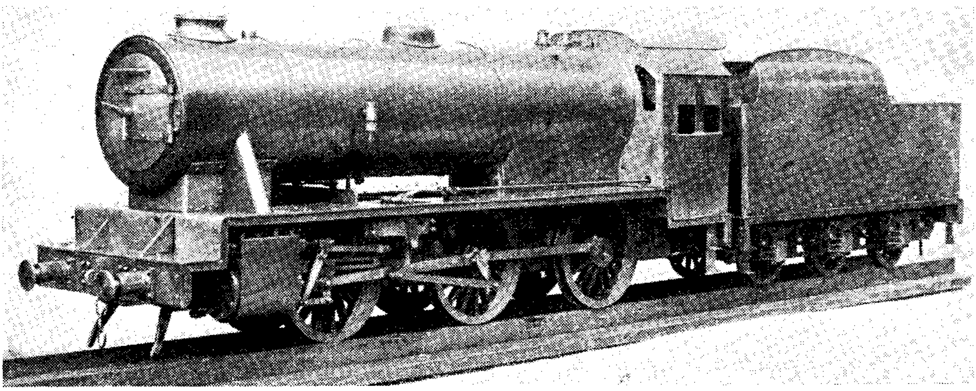


Photo by] *A quick job by Mr. P. S. Lamb* *[T. F. Holte*

Anyway, congratulations to Mr. Lamb on his quick and successful job, and good luck to the second attempt which he is now starting.

Ruminations on the Road

Sometimes, when making a long non-stop run on my little railway, my mind wanders back, perhaps over the years, or maybe I ponder over some of the problems that beset the builder of real little locomotives, recall incidents that have happened in my own personal experience, or compare the experiences of others, with my own. It so happens that just recently I was making a run of about three miles, doing a bit of experimenting, for the future benefit of the good folk who follow these notes. Towards the end of the run, I found that the seat was-well, beginning to feel a trifle hard, shall we say ?-and I recalled an article which appeared in this journal on driving positions. This weighed up the pros and cons of the sitting, kneeling, and lying-down attitudes adopted by drivers on ground-level roads. Different people, of course, have different-fancies ; it would be a tame sort of world if everybody thought alike, and each driving position has its advocates. However, it seems to your humble servant, that out of bed, the most restful position, or perhaps I should say the least fatiguing one, is sitting ; but this requires a qualification. Nature provided us all with something to sit upon, and our legs and feet should be below that level, for comfort ; anyway, it said so in the book on human physiology which I studied in my young days, by way of variation, as I wanted to learn all I could about the " human locomotive " as well as the mechanical one. Incidentally, I gained a first-class certificate in the advanced section, and the examiner said I should have entered the medical profession. Can you imagine Curly with a red lamp over the gate-1 should have whistled for it to turn green every time I went out ! However, according to that, the kneeling and prone positions would appear to be physiologically (good word that) wrong, and so would the sitting position when, as " 1121" aptly put it, the sitter " imitates a grasshopper."

Ergo, as the old actor would say, a small railway should be elevated so that the driver of the engine can sit behind her with his legs below rail level, in a natural position. Whether he rides astride or sits sideways, is a matter for his own choice. I always ride like Lady Godiva, though not in the same costume ; and apart from the little trouble mentioned above, on a long run, I do not feel the slightest discomfort. Most drivers of small engines of 2-1/2in. and 3-1/2in. gauges, prefer to ride astride, but this needs footboards. It is, as a matter of fact, a risky thing to ride astride on a narrow flat car with unsupported feet ; any doctor would tell you why. Personally, I should say that an astride rider would be most comfortable on a bicycle saddle, with foot rests set at the right height to suit his stature.

The most natural position I ever saw for the driver, on a ground-level line of 3-1/2in. gauge, was over in U.S.A. The line was a mile long, laid out like a full-sized American railroad, complete with all accessories, including a five-road roundhouse with turntable complete, and a typical trestle-bridge. There was a loop at each end, so that you could " keep on keeping on till the cows came home." I did five miles over it on one occasion. The owner was a tall man with long legs. On the front end of each tender, very low down, were two foot-rests ; and the owner sat on the end of the first car, as close to the tender as possible, and stretched out his legs each side of it, with his feet on the rests, just like a cyclist coasting in the davs before free wheels were invented. His body-was thus free to move in any direction ; he could reach anything on the footplate without losing balance, and had perfect control over the engine. Even if I could have " straddled," my legs were not long enough to reach the foot-rests, so I always sat on top of the tender ; but it wasn't very comfortable.

There is another point regarding driving positions and that is, distribution of weight, to avoid overloading any particular axle, and causing excessive flange friction. My weight, in proportion to old " Ayesha," for example, is equal to 27 coaches ; and no engineer in his right senses would put that load on four axles, in full-size practice. Unfortunately, we have no alternative ; so the only thing to do, is to see that the load is evenly distributed. I find it best to use a flat car with the bogies spread just far enough apart, to allow me to sit between them ; and I sit far enough over, to keep even pressure on both rails. The few friends who have ridden on my road, haven't always managed to do the same ; and it is quite easy to prevent an engine starting at all on a curve, by siting over one-bogie and-having your weight all one one side. so that the two wheel flanges are literally jammed solid against the railhead, like brake blocks against a wheel. For drivers of short reach and stature, I shortened my old original test car, so that both bogies are under the rider ; and on one occasion Driver Earl drove " Annabel," the Mallet, for four miles at high speed on this car without any discomfort or derailment. He thoroughly enjoyed himself !

Exhibition Paint-work

MR. R. PEMBLE writes :-" Arising out of Mr. R. H. Procter's letter in THE MODEL ENGINEER, September. 30th, even supposing the average model engineer can obtain a good finish when he has painted his model, it is odds-on that he will ruin the work when it comes to lining and lettering. This can be made to look " after the rate " by using transfers I will admit, but even these are difficult to obtain in many cases, and with fingers that may be dexterous enough with engineering tools, this method, too, can present enormous difficulties, as models being so much smaller than the original have many inaccessible comers and angles.

" Lettering and lining is an art in itself, equal to that of constructing models, and my advice to any modehnaker desiring his model to be lined or lettered, is to-hand it to someone who can do justice to the work already put into the model, and ask him to help ; if not, get the job done professionally.

" There are plenty of books in circulation giving every instruction possible, but unless a person has the capability, all the reading in the world will not give the results required.

" I am not a model engineer in the strict sense, but I do happen to be able to assist some of our own members in this particular direction, and can, therefore, speak with some confidence.

" I may not have been of much assistance to Mr. Procter, but I do hope that model engineers w-ill leave their models in all their perfection, and not spoil that evidence of patience, grand workmanship and loving care with clumsy attempts at doing something they should never have attempted."

A 3-1/2in. Gauge L.M.S. Class 5 Loco.

by "L. B.S.C."

AS the staying of " Doris's " boiler is carried out in the same way as fully described just recently for " Maid of Kent " and " Minx," there is no need to detail out all the ritual again ; so I will just call attention to the variations, where they exist. The three longitudinal rod stays are made from 3/16in. copper rod, screwed 3/16 in. by 40 at the ends ; the blind nipples are turned from 3/8in. hexagon brass rod, drilled 5/32 in. or No. 22, tapped 3/16 in. by 40, turned to 5/16in. diameter outside, and screwed 5/16in. by 40. The screwed part need only be about 5/16 in. long, with 1/8in. heads. The blower-valve., to which the footplate end of the hollow stay is attached, can be made to the drawing and notes starting on page 433 of the issue of October 2Ist last, the only difference being that the part which screws into the boiler is screwed 5/16 in. by 40, and drilled No. 13, to take the stay, which is made from 3/16in. by 18-gauge copper tube. The thoroughfare nipple is made to the same pattern as shown in the drawing on the page mentioned, but is smaller ; the part which screws into the smokebox tubeplate is 5/16 in. diameter, and screwed 40 pitch, drilled 5/32 in. or No. 22, and tapped 3/16 in. by 40. The union part is made 1/4 in. diameter, and screwed 1/4 in. by 40. The assembly of all the lot, both solid and hollow, is carried out exactly as described for the larger engines.

The cross stays in the Belpaire firebox wrapper are also made from 3/16in. copper rod, with similar nipples to those on the longitudinal stays ; but owing to the upper part of the wrapper sheets having what is known as a " tumble-home," or a slope inwards towards the top, the heads of the nipples cannot take a fair bearing on the copper sheet. Therefore, a wedge-shaped washer must be placed between the head of the nipple and the wrapper, as 'shown by a black mark in the cross-section of the boiler recently illustrated. To ensure these heads and washers being steam-and-water-tight, it might be as well to sweat them around with solder, at the same time the firebox stays are all sweated up. As beginners and inexperienced workers may have a little trouble in tapping horizontal threads in a sloping plate, and the threads may be " a bit wonky," the sweating-up process will cancel out the " wonkiness " as far as leak ge is concerned !

Firebox Stays

The firebox stays are just the same as in the two 5-in. gauge engines, viz., of copper rod or wire 1/8 in. diameter, and screwed 1/8 in. or 5-B.A., but they are not quite so numerous, amounting to 58 in each side of the firebox, and six each in backhead and throatplate. Make a staybolt tap with pilot pin as already described, and make and fit the stays as described for " Maid " and " Minx " ; but there is just one small point to note. Put the throatplate stays in horizontally, that is, parallel with the bottom of the boiler. barrel and not at right-angles to the slope of the throatplate. The reason for this is, that with this fitting, the lock-nuts will come up fair against the vertical firebox tubeplate ; and when the stays are headed over outside, the head will automatically form in accordance with the slope of the throatplate, whereas a nut would meet it at an angle, and require a wedge washer.

The sweating-up of the stayheads and nuts, is carried out as described for the bigger engines, and the boiler can then be tested to 160 lb. water pressure. The tender pump described for " Maid " and " Minx " will also suit " Doris's " tender, as the sides are high, and the, fact that it is a little bigger than absolutely necessary, is a fault in the right direction. The use of this pump will save a special drawing, and a further description. The above jobs, staying, sweating-up, and testing, should keep " Doris " builders busy whilst I get out the drawing for the Stanier-type regulator, and the superheater details. Incidentally, the little " Black Stanier " seems to have " caught on " all right, from what I hear via correspondence and other sources ; and some good folk are, at long last, beginning to wax enthusiastic about piston-valve cylinders. Listen to what Mr. L. J. Markwick, Hon. Secretary of the Hastings S.M.E., has to say ; I quote from his letter. " Up to time of writing, 'Doris' has reached the stage of frames erected, axleboxes and axles' all on, pump about half-done, bogie complete except for wheels, cylinders completed and erected. The job so far has been quite O.K. and no snags. The only thing I would like to say is, ***that there will be no more slide-valve cylinders where I am concerned*** !

" 'Doris's' cylinders were machined on a 3-in. 'Randa' lathe, and no vertical slide was used. When finished, I could blow in the steam pipe, and by operatmg the valve, smack the piston up against each cover. For that test, no gaskets were fitted, no piston packing, and no oil ! Also, the covers were only held on by finger pressure. When the valve was placed in mid-position, it was impossible to blow anything at all through the steam-pipe. Fair enough ? " I'll say it is !

A 3-1/2in. Gauge Brighton " Atlantic"

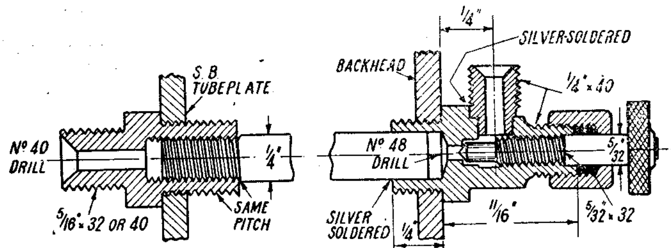
Nobody can say that Mr. Markwick isn't competent to give an opinion, as he has, already built a " Dyak, and a Brighton " Atlantic " engine, 424 " Beachy Head." When the former engine was started, all our friend had a-as an old 3-in. treadle lathe, with only a four-jaw chuck, plus a few hand tools. The necessary taps and dies, and other oddments, were purchased as needed. The engine was finished in a year ; but as experience came, improvements were made, and she has run about 200 actual miles so far.

"Maid" and "Minx" Boilers

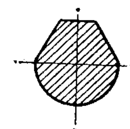
Final Brazing Operation

by "L.B.S.C."

WRITING instructions about how to do the final brazing job, on a hot day with bright sunshine, is enough to make anybody perspire, thoughts of it being quite sufficient; but I wouldn't mind betting that by the time you read these notes, the thoughts of a big blowlamp and a pan of glowing coke, will be as cheerful as a watchman's fire on a winter's night! Anyway, having got the boiler all assembled as mentioned last week, there is one more little item which might be done at this stage, to wit, the bushes for the dome and safety-valve. On smaller boilers, which have bushes in the backhead as well, I usually advocate silver-soldering the lot as a separate operation; but as there are only three for the "Maid" and two for the "Minx," on top of the barrel and wrapper, and the boiler is a tidy lump to reheat just for the purpose of silver-soldering them, we might as well kill all the birds with one shot. The dome hole on both boilers, is 2 in. diameter, and can be cut either by the usual method of drilling all holes around, breaking out the piece, and filing up, or else with a plumber's trepanning tool, which our friend who is reputed to forget to bring his tools, uses for cutting large holes in galvanised water tanks, and similar jobs. It is like a glorified centre-bit, but the cutting prong is adjustable, and can be set for any size hole within range. You could make one for yourself in a very little time, as shown in the sketch; a bit of brass rod would do for the spindle, and the cutter could be made from a bent piece of silver-steel, the cutting edge being ground up like a parting tool. To use, hold the gadget in a carpenter's hand brace; drill a hole in the middle of the circle to be cut, insert the pilot pin of the trepanner, and turn the brace. The cutter will soon carve out the circle of metal, a drop of ordinary cutting-oil aiding matters considerably. About sixty years or so ago, some long-forgotten person donated young Curly a couple of worn-out centre-bits, and that worthy found them very handy for cutting holes in the primitive boilers he made from coffee tins and similar "raw material."



"*Thoroughfare*" *nipple and blower valve*



Section of three-flat reamer

The holes for the safety-valve bushes may be drilled in the ordinary way; but, beginners should note, I always drill them undersize, and finish with a taper reamer, because it is seldom that a big drill will make a true hole in sheet metal. The hole usually comes out polysided, especially when drilled in a convex surface such as the round-backed boiler shells. If no reamer is available, finish with a file; but a reamer suitable for this work is easily made by turning a piece of round silver-steel slightly taper, and filing three flats on it, as shown in the section. Harden and temper to a dark yellow. This kind of reamer trues up any hole without chattering.

The bushes themselves are simple turning jobs, needing no detailing. Probably our advertisers will supply castings for the big bushes; the smaller ones can be turned from rod, or thick-walled copper tube. I use the latter wherever possible. They should be a tight fit in the holes in the boiler, so as to "stay put" whilst the backhead and foundation-ring are being brazed. If I haven't a piece of rod or tube big enough for a bush, I use a piece of copper plate. "Grosvenor's" dome bush was made from a piece of ¼-in. copper plate 1½ in. square. This was chucked truly in the four-jaw, faced off, and drilled to 1 in. diameter in two stages; the piece was then mounted by the hole, on the bottom step of the inside jaws of a small three-jaw which I keep especially for work requiring to be chucked from the inside, such as eccentric straps. The outside of the piece of plate was then carefully turned away, with due respect for the corners when starting the first cut, until it was a circle a bare 1½ in. diameter. This was further reduced for ⅛ in. length, to 1¼ in. diameter to fit the hole in the boiler, and there was a lovely copper bush, where once there was a piece of rough plate.

Sweat Without the Tears!

Have all your requirements handy, and plenty of oil in the blowlamp, for if it goes out during the process, the job may be spoilt. Put some wet flux all around the foundation-ring, backhead

A 3-1/2in. Gauge L.M.S. Class 5 Loco.

by " L.B.S.C."

THE full-size L.M.S. " Class 5 " engines have a regulator in the dome, arranged, horizontally. The top of the casting is faced off, and has three main ports. There are two valves ; a bronze one containing main ports and a small starting port, and a cast-iron one sliding on top of the main one. When the driver moves his handle up, the upper valve first slides on the lower one and uncovers the starting port ; then the actuating pin moves the main valve as well, and uncovers the big ports. The regulator I am specifying for " Doris " is a simplified edition of this. Instead of two valves and multiple ports, we have one valve only, and a single port with a little triangular bit cut out of one edge, so that this is uncovered first, and acts as a starting port. The actuating levers are small editions of the full-size article, arranged in much the same way.

Stand or column

Castings complete with bosses and brackets, should be available for the stand or column. If not, use a bit of brass bar, 1/2 in. by 5/8 in. section, faced off each end to a length of 1-3/8 in. Two pieces of 1/4in. by 16-gauge angle, 1/2 in. long, can be attached to the upper part by brass screws, or silver-soldering, for the brackets supporting the regulator. Drill a 3/32-in. hole about 1/8 in. deep, at the location of the bosses on opposite sides of the stand, and make the bosses from 1/2in. and 1/4in. brass rod. Leave a little pip on the end of each, about 3/32 in. long, and a tight fit in the holes.

In the upper end of the stand, cut a rectangular port as shown, making it about 3/16 in. deep. If end-milled, as described in these notes for ports in slide-valve cylinders, leave the ends rounded ; it doesn't matter whether they are round or square. If you cut the port by drilling and chipping, squared ends are easier to form. On the underside, make two centre-pops a full 1/4 in. apart, 3/16 in. from the side carrying the large boss ; then drill two 1/4in. holes running the length of the column, and well cutting into the port (see underside view). At 9/32 in. from the top of the column, on the centre-line of the wider side, drill a cross hole with No. 13 drill, cutting right across the two 1/4in. holes, and slightly countersink each end. In this is fitted the bush carrying the spindle for the two levers operating the valve. Chuck a piece of 3/16in. round rod, bronze for preference, but brass will do ; face, centre, and drill down about 5/8 in. depth with No. 32 drill. Part off at 1/2 in. from the end; rechuck, and poke a 1/8in. parallel reamer through. Squeeze this into the cross hole. Cut out a little plate from 16-gauge brass or copper, to cover up the two holes in the base, attaching same by a single brass screw ; then silver-solder the lot, if the stand has been built up. If a casting has been used, only the bottom plate and the bush will need this attention ; see that the silver-solder fills up the countersinks around the bush.

Centre-pop the bigger boss, drill 9/32 in., cutting well into the two 1/4in. holes, and tap 5/16in. by 40 for the steam pipe. Drill a No. 30 hole in the little boss, about 3/16 in. deep, for the end of the regulator-rod ; take mighty good care not to pierce the 1/4in. holes.

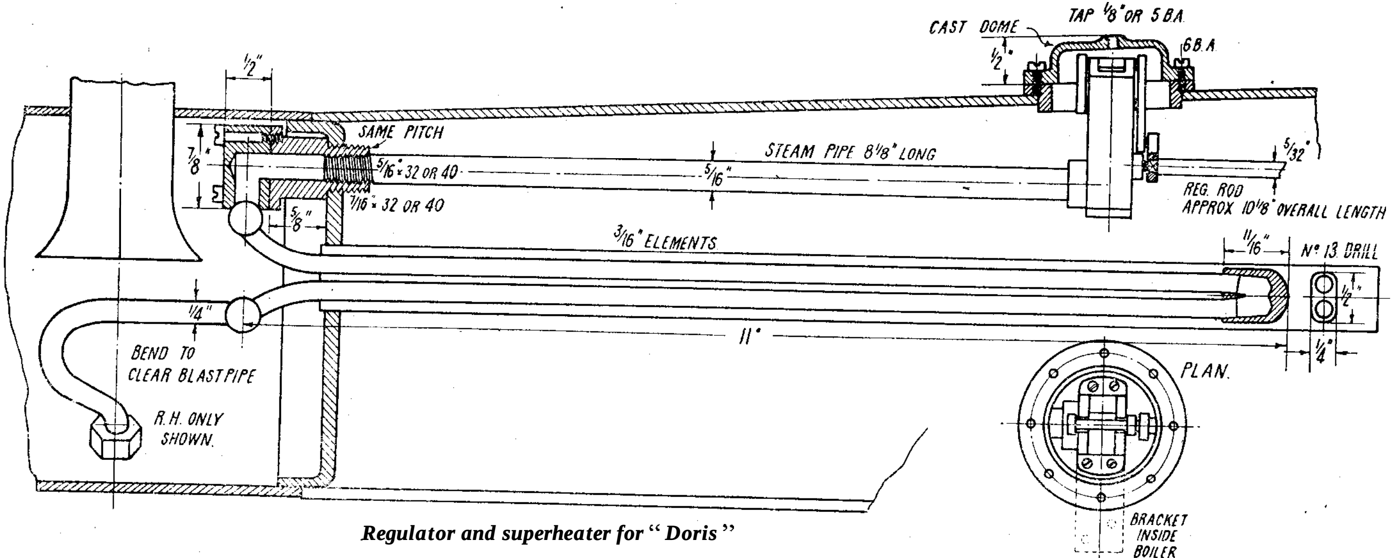
Regulator valve

The valve can be made either from a casting, or a piece of bronze or hard brass bar, 1/2 in. wide, 3/16 in. thick, and 5/8 in. long. The middle part must be milled out longitudinally, leaving a sort of wall at each side, like a glorified axlebox flange (see sectional illustration). If the piece of metal is clamped under the slide-rest tool-holder, lying on its edge, you can take out the centre with an end-mill or slot-drill in the three-jaw. Right in the middle, cut a port 1/8 in. wide and 9/32 in. long. Note, this is rectangular, no fancy bits cut out of the edge. Cut a U-shaped slot a full 1/8 in. deep, right across both side walls or flanges ; this should just admit a piece of 3/32in. bronze or rustless steel rod or wire. Face off both the valve and the port face, same as I described for slide-valve cylinders.

Levers and assembly

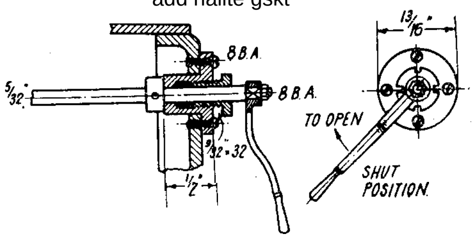
The levers are simple filing and drilling jobs, the double-armed one and its one-armed mate being made from 1/4in. by 3/32in. strip, and the one carrying the pin from 1/8in. by 1/4in. material. Use either bronze (phosphor or nickel) or good hard brass. Beginners note-to cut the 1/8in. sq. hole clean, first drill it No. 32 and then drive a square punch through. This is merely about 2 in. of 1/8in. sq. silver-steel, squared off truly at one end, and bevelled off at the other. Harden and temper the squared end to dark yellow. The bevelled end, when hit by the hammer, won't burr sufficiently to prevent the punch being driven clean through the hole. I have a little cast-iron block with various sizes of holes in it ; the article to be punched is placed over an appropriate-sized hole, and the punch driven right through, the result being a clean hole with sharp corners. Drill the hole for the pin No. 43, and squeeze in a pin made from 3/32in. rustless steel or hard bronze.

Assembling the regulator is only a few minutes' work.The spindle is a 3/4in. length of 1/8in. round rustless steel or bronze, and the valve-pin a 3/4in. length of 3/32in. ditto.Squeeze one end of each into the longer lever. Put the valve in position. Poke the spindle through the bush in the stand, the valve-pin going through the two U-slots in the valve at same time, then press the shorter lever on the other end. See that the two levers are exactly parallel, then fit a weeny key in each. end of the spindle, as shown by the black dot in the end view of regulator erected. If the

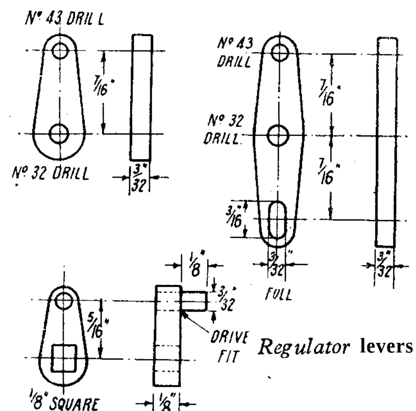


Regulator and superheater for "Doris"

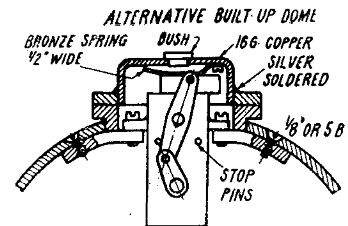
add halite gskt



Regulator gland and handle



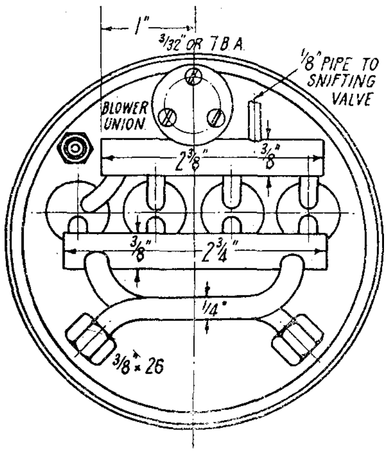
Regulator levers



End view of regulator

levers are a real press fit on the spindle, these keys are not necessary ; but if fitted, bits of domestic pins would do quite well, or bits of brass wire of equal diameter. I use blanket pins for iobs like these ; a No. 57 drill makes a hole which takes the microsco pickey a drive fit. Alternatively, 12-B.A. brass screws could be used, the drill size for which is No. 62.

Two stop pins are required ; these are merely screwed stubs of 1/16in. hard brass or bronze wire. They are shown in the end view. Move the valve so that the port is fully open, then drill a No. 55 hole alongside the lever, tap 1/16 or 10-B.A., and screw in the wire stub. Then shift valve until port is completely closed, allowing a little for overlap. The position will be approximately that shown in the end view, the valve having a travel of 1/4 in. from fully-closed to full-open.



Headers and connecting pipes

Fit another stop-pin as above, and Bob's your uncle.

How to erect the regulator

Two brackets are needed to carry the stand, as in full-size practice. They are made from 1-in. lengths of 1/2in. by 1/8in. brass, bent as shown in the end view and are attached to the boiler by two 1/8in. or 5-B.A. countersunk brass screws in each. Drill two No. 30 holes in the boiler shell, at each side of the dome-ring, as shown by dotted lines and circles in the plan view ; then hold the brackets in position whilst the location of one hole is marked on each with a scriber. Remove, drill No. 40, tap 1/8in. or 5-B.A., replace, put a screw in each, adjust brackets for parallelism then locate the other screw-hole with a No. 30 drill put through the other hole. Follow with No. 40, tap, and put the other screw in. File flush with boiler shell, and solder over, to ensure absence of steam leakage ; the screws won't have to come out any more. Drill the holes in the brackets of the regulator stand, as shown in underside and plan views ; put the regulator in position, and secure with four 3/32in. or 7-B.A. brass screws.

As the operating-gear for this regulator is precisely the same as that just recently described for " Maid of Kent " and " Minx," except for being a little smaller, and needing no stop on the spindle, there is no need to detail out the whole of the rigmarole again ; so I'll just run through it, giving the variations in sizes. The flange and stuffing-box is either turned from a casting, or from brass rod 13/16 in. diameter or larger, drilled No 21 for the rod, and drilled and tapped 9/32 in. by 32 for the gland, which is made from 7/16in. rod.The collar on the spindle is merely to prevent end-play, and does not act as an " open-and-shut " stop. The regulator-rod is a piece of 5/32in. bronze rod approximately 10-1/8 in. overall length. One end is turned to 1/8 in. diameter for 5/32 in. length, to fit in the boss on the stand, and a 1/8in. square is filed on it immediately behind, to accommodate the short lever with the pin in it. The other end is turned down and screwed 8-B.A., and squared for the regulator handle, which should be L.M.S. type as shown in the illustration ; I make similar handles by using a piece of round nickel-bronze, turning the grip, and filing or milling the flat part. The boss is made from round bronze and silver-soldered to the lever.

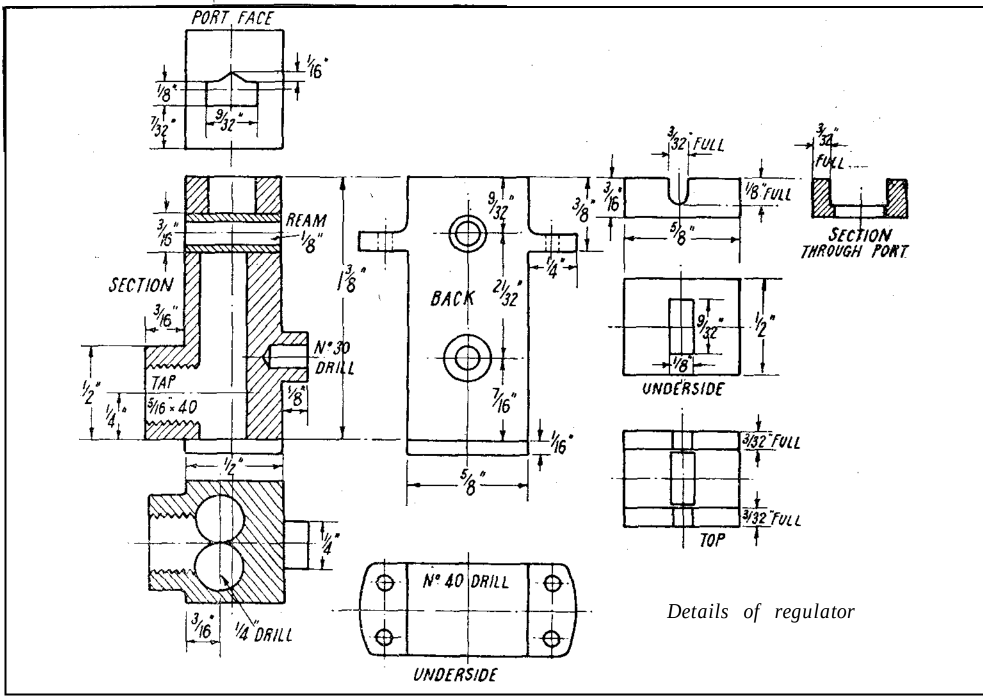
Put the collar on the regulator-rod approximately 7/8 in. from the square at the handle end ; then insert in boiler through the 3/8in. hole in backhead. Hold the actuating lever behind the regulator stand with a pair of long-nosed pliers, the pin on same engaging with the slotted hole in the bottom of the long lever. Put the end of the rod through the square hole, entering the spigot into the small boss on the stand. Now put the flange fitting on, and press against backhead. If the rod has about 1/64 in. end-play, the position of the collar is correct ; if more, or if no end-play at all, collar needs adjustment. When you have found the-right position, pin the collar to the rod, same as " Maid " and " Minx," and attach the flange fitting to the backhead by four 8-B.A. brass screws, putting a 1/64in. "Hallite" or similar gasket between the contact faces. Pack the gland with graphited yarn, put on the handle, and that's that. When the regulator is shut, the handle should be in the position shown ; pushing it up, opens the valve.

Cover for Dome-bush

The cover may be cast or built up. If cast, it simply needs the flange facing off and turning to diameter ; there will be a chucking-piece' cast on for holding it. Then reverse in chuck, and part off the chucking-piece, facing same almost flush with the cover.Drill No. 40 and tap 1/8in. or 5-B.A. for a screw ; this provides a ready means of oiling the valve. Lack of Iubrication is the chief cause of leaky throttles.

To make a built-up cover, turn up a copper or bronze ring, 1-3/4 in. diameter, with a 1-1/2in. hole in it ;thickness about 1/8 in. ; see instructions given for " Maid " and " Minx," Knock up a copper cup from 16-gauge sheet metal ; round off the end of a bit of 1-1/8in. rod to shape required, to act as a former, cut out a disc of copper approximately 2 in. diameter, and proceed as described for the smokebox tubeplate. Set the cup in the ring, so that the overall height is a shade under 1/2 in. ; fit a weeny bush, tapped, 1/8in. or 5-B.A., in the top, silver-solder the lot, and face off any of the cup projecting below the flange. The flanges of either cast or built-up covers should have eight No. 34 holes drilled in them ; and the cover is then fitted to the bush on the boiler, by eight 6-B.A. brass screws, in the same manner as you would fit a cylinder cover. Put a I/64in. gasket between the flanges.

the tubeplate flange. It can be made from a casting or a piece of g-in. round or hexagon brass rod chucked in three-jaw. Face, centre, drill 9/32 in. for 1-1/8 in. depth, tap 5/16 in. by 32 or 40 for 3/4 in. depth ;turn down 7/8 in. length to 5/8 in. diameter, further reduce 3/8in. length to 7/16in. diameter, and screw 7/16 in. by 32 or 40, same pitch as inside



Details of regulator

By the good rights, the pressure of steam should keep the regulator valve on its face, same as it does an ordinary slide-valve ; but to prevent the valve unseating when the engine is turned upside down for any purpose, and to avoid same when the engine is cold, a flat spring of thin bronze strip 1/2 in. wide, such as used for dynamo and motor brush springs, may be attached to the inside of the dome cover by a brass screw. This is shown slightly exaggerated in the end view. Note, the spring must press on the flanges or walls of the valve, and not in the recess, or it will obstruct the port ; and a small hole should be drilled in it, to allow oil to drop through on to the valve.

Superheater

The superheater is another component which only differs from that described for " Maid" and " Minx " in the sizes of the parts, and the connection to the cylinders ; so the same details of construction are applicable. Owing to the reversed-flange smokebox tubeplate, there is not much room available between the hole in the tubeplate, and the flange ; so, in order to get in a decent-sized flange for the wet header, I have shown the part which screws on to the steam-pipe, of extra length, the contact face being right clear of thread. Part off at I in. from the end, reverse in chuck, and take a cleaning-up skim off the contact face.

The steam-pipe is a piece of 20-gauge copper tube 5/16 in. diameter and 8-1/8 in. long. One end is screwed 40 pitch for about 3/16 in. length, to suit the boss in the regulator stand ; the other is screwed about 1/2 in. length, to the pitch used for tapping the header fitting. Put a smear of plumbers' jointing on the threads, screw the steam-pipe home in the stand, through the hole in the tubeplate, by aid of a round file stuck in the end, then fit the flange as described for " Maid " and " Minx " The header itself has a flange made from a 1/2in: slice of 7/8in. round rod ;the cross-tube is 3/8 in. diameter, and is let into a recess filed across the flange. The four elements are made from 3/16in. by 22-gauge copper tube, and the block return-bends from 11/16in. lengths of 1/2in. by 1/4in. copper bar. Don't forget, brother beginners-these must be either brazed or Sifbronzed to the elements, *not* silver-soldered. They are too close to the fire for silver-soldering to be safe.We use really hot steam, for economy and efficiency ; not the kind that comes out of the *scullery* copper on washing-day! Silver-soldering is, however, quite in order for the joints in the smokebox. The hot header is a 2-3/4in.

length of 3/8-in. copper tube 22-gauge, with four No. 13 holes drilled in it at 13/16 in. centres, for the ends of the elements. Two 1/4in. holes are drilled about 3/8 in. from the ends, for the two steam-pipes leading to the cylinders.. If these are crossed, as shown in the view of the smokebox tubeplate with superheater in position, it. will make the job of connecting up, ever so much easier, when the boiler is finally erected on the frames.

The superheater is assembled the same way as described for "Maid" and " Minx." First braze the return-bends to the elements,' as mentioned previously ; plug the ends of the wet and hot header pipes with discs of 16-gauge copper. Tie the wet header pipe with thin iron wire *to* the *circular* flange in the position shown, off-set to clear the blower union ; and don't forget to drill the hole in it, to allow steam to pass in from the flange. Mistakes are easily made ! Insert the elements in the holes in the header tubes ; they should " stay put " if the holes are drilled No. 13. Make up the two steam-pipes from 1/4in. tube, about 22-gauge, fitting a union' nut and cone on the end of each, a process described many times already. Make the nuts from 7/16in. or 1/2in. hexagon brass rod, and tap them 3/8 *in.* by 26. Allow about 6 in. of 1/8in. copper pipe for the snifting-valve connection (this will be described with the other fittings). Fit the steam-pipes to the hot header, then silver-solder all the joints at one heat. My favourite material for jobs like this, is Johnson Matthey's B6 *alloy,* but " Easyflo " or best grade ordinary silver-solder, will be quite all right. When you are quite sure there are no missed places-very important that !-pickle, wash, and be sure to let the water run well through the whole lot, to get rid of any internal scaling that his taken place in the silver-soldering process. You don't want it wandering down into the piston-valves ! Drill and tap the holes in the circular flanges, for the fixing-screws? but don't erect the superheater permanently until the boiler is complete with all the other fittings, and ready for mounting on the chassis.

For the Bookshelf

Newnes Television Manual (fifth edition), by F. J. Camm. (London : George Newnes Ltd. ; Tower House, Southampton Street, W.C.2.) Price 7s. 6d. net.

This book, first published in 1934 as ***Television and Short-wave Handbook,*** and progressively brought up to date in successive editions, now includes the latest information on modern systems of television, and also its many secondary applications such as noctovision, viso-telephony, and tele-projection in cinemas. The probable future trend of development in colour and stereoscopic television is also outlined. A comprehensive dictionary of television terms is included, together with the list of standard terms and control markings as agreed upon by the Television Committee of the Radio Manufacturers' Association.

The **Boy's Book of Engines, Motors and Turbines,** by Alfred Morgan. (London : The Stanmore Press, 25, Thurloe Street, S.W.7.) Price 10s. 6d. net.

Many books have been written with the object of instructing the juvenile mind on the elementary principles of engines and scientific apparatus, and nearly all of them have their merits, but this book deserves special praise, not only for the comprehensive nature of its contents, but also the lucid explanations and the 260 illustrations which it contains. It begins with a chapter on steam engines, followed by others on electric generators, turbines, hydro-electric plant, water wheels, oil power, internal combustion engines of all types, and electric motors. In the concluding chapters of the book, instructions are given on how to make demonstration models, illustrating the principles dealt with in the foregoing part, including a steam turbine, mill wheels and water turbines, electric motors, and a piston-valve steam engine. An attractive book for the coming generation of model engineers.

British Time, by Donald de Carle. (London : Crosby Lockwood & Son Ltd., 39, Thurloe Street, S.W.7.) Price 15s. net.

This book deals with horology from a somewhat unusual aspect ; namely, the development of time-recording methods and systems, which have become a British national institution, in a manner which has so far no parallel in other countries. It gives a good deal of information on the history and development of all kinds of clocks, leading up to the modern observatory methods of time recording, the public clock, of which Big Ben is the finest example, electric master and secondary clocks, synchronised and synchronous types, time signals by wire and wireless, and the evolution of the speaking clock

Great pains have been taken to ensure accuracy both in the historical and technical subject-matter of the book, and wherever possible, the most competent authorities in the particular fields of specialised design or development have been consulted, both before and after the compilation of the manuscript. As a result, the documentary authenticity of the information in the book should be bevond all auestion.

In an appendix to the book, a chronological table is given of the major inventions and items of interest in the development of horological science. This not only makes interesting reading, but should help to dispel that inferiority complex which is so prevalent in our country today, for it shows that most of the really important exponents of this science in the past were British, and even at the present day, Britain is still well to the fore both in the scientific and practical spheres of horology. The book is very well illustrated by line drawings in the text, and numerous full-page half-tone plates on paper.

"MAID", "MINX" and "DORIS"

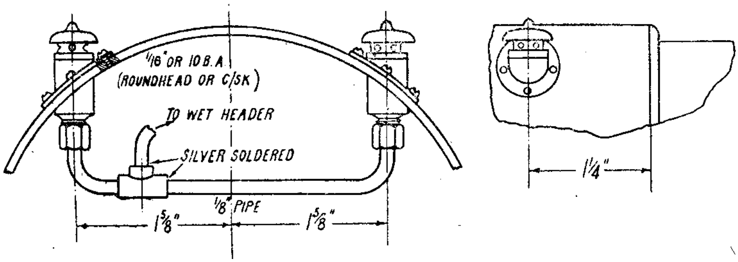
Snifting - Valves

by " L.B.S.C."

ALL three engines will require snifting-valves, or to give them their " scientific " name, vacuum relief valves. The full-sized Southern " LI " class, big sisters to the " Maid," originally had the well-known and familiar Maunsell " snails' horns " on either side of the smokebox, just behind the chimney. The present C.M.E. doesn't believe in them, and they are being removed, the holes being covered with patch plates ; an anti-carbonising device is being substituted. This procedure has become a debatable point in full-sized locomotive circles ; but whether the " ayes " or " noes " have it, there isn't the slightest doubt about the necessity for relieving the vacuum caused by the pumping action in the cylinder of a little engine, which takes place as soon as the regulator is shut. Unless some other means of admitting air is provided, it will go down the blastpipe, and take a certain percentage of the contents of the smokebox with it ; and it doesn't need a Sherlock Holmes to deduce that the ash and grit are going to do what the kiddies call " a bit of no good " to the valves, port faces, and cylinder bores. A mixture of smokebox ash, grit, and cylinder oil forms an excellent grinding paste ! This can be avoided, as has been done in full-size, by admitting air to the superheater header ***via*** an automatic valve-an air clack, if you like-and the " sniffing " action of this when running with steam shut off, gave it its nickname of snifting-valve. Air could, of course, be admitted direct to the steam chests (which has also been done in full-size) but this would tend to cool the cylinders, and cause the engine to throw drops of water from the chimney when opening up again. By sniffing the air through the superheater, the cylinders are not only kept warm, but overheating and burning of the superheater elements are prevented ; so we kill two birds with one shot. Most followers of these notes know the above already ; but, from my correspondence, I know there are a lot of new beginners on the job, so thought it desirable to explain, before going on to construction.

Types of Valve Required

As the " Maid " is, in effect, a small edition of the " LI " class, we might as well decorate her smokebox with " snails' horns." The full-sized " Minx " engines did not have snifting-valves at all, as the slide-valves were nearly vertical, and dropped off the port faces as soon as the regulator was shut, so there was no vacuum in the cylinders at all, both ports being open. You could hear them seat again with a loud crack when opening the regulator. As the valves on the little " Minx " are on top, and cannot fall away from the port faces, a smfting-valve is needed ; and we can put one upside down, inside the smokebox, close to the door, so that it takes air from outside, just ahead of the smokebox saddle. " Doris " needs one, because she has piston-valve cylinders, and, of course, they don't lift at all ; and it can be fitted exactly as on the " Minx," so one description does for both engines.

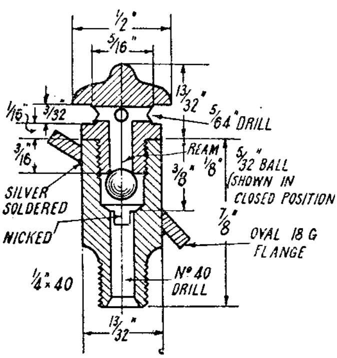


How to erect snifting-valves on " Maid of Kent "

How to Make the Maunsell Type

The valves shown in the illustrations are externally " to scale," both in appearance and size ; I'm with old Inspector Meticulous all the way, in objecting to any outsize and ungainly excrescences on the smokebox of a neat and pleasing type of locomotive ! However, the internals are considerably simplified, without sacrificing any efficiency, as the section will show. The valve is made from bronze or gun-metal rod, for preference, though brass will do if nothing better is available. Chuck a bit of 7/16in. round rod in three-jaw? and turn down about I in. of it to 13/32 in. diameter. Further reduce 5/16 in. length to 1/4 in. diameter with a round-nose tool, and screw 1/4 in. by 40 for a bare 1/4 in. length. Face the end, centre deeply with size " E " centre-drill, then drill down about I in. depth with No. 40 drill. Part off 7/8 in. from the end. Reverse in chuck, open out the other end to 3/8 in. depth with 7/32-in. drill, and tap 1/4 in. by 40.Nick the bottom of the hole with a little chisel made from 1/8in. silver-steel, so that air can pass the ball freely when it is resting on' the bottom of the hole, its position when coasting. Slightly countersink the end of the tapped hole, and skim it up truly.

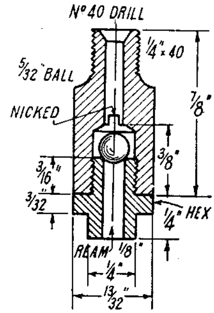
Chuck a piece of 1/2in. rod, and turn down a full 3/16in. length to 1/4in. diameter, using a knife-tool this time, to form the shoulder. Screw 1/4 in. by 40. Centre, and drill down with No. 34 drill, to a depth of 7/16 in. then follow up with a 1/8in. parallel reamer, putting same in as far as it will go. Take a skim off the end, to form a true seating for the ball. Part off at 13/32 in. from the shoulder ; this gives " scale " height. Re-chuck in a tapped bush held in three-jaw; any odd bit of round rod over 3/8 in. diameter will do for this. Just face, centre, drill 7/32 in., tap 1/4 in. by 40, slightly countersink the end, and skim it off truly. Screw the top of the snifting-valve into it tightly ; form the recess with a 3/32-in. parting-tool, the diameter at the bottom of the recess being 5/16 in. It is hardly worth while making up a special form-tool for turning the ornamental top, just for two valves. The outline can be formed by careful manipulation of



Section of Maunsell ***type snifting-valve***

both slide-rest handles, or by using a hand-tool, of the shape shown in the sketch. This is made from a bit of 3/8in. square tool-steel ;odd lengths of high-speed stuff which have become too short to use in the slide-rest, make nobby hand-tools if brazed to a bit of mild-steel of same section from 9 in. to 12 in. long, fixed in an ordinary tile-handle. No special hand-rest is needed ; I just put a tool in the slide-rest tool-holder with the shank end projecting, run same up to the job, and use the shank to rest the hand-tool on, whilst in use. Hand-tools are mighty useful for certain jobs ; for example, I can turn a dummy whistle, or a L.B. & S.C.R. type head or tail lamp body (loud cheer from Mr. Hambleton !) in next to no time, with a hand-tool.

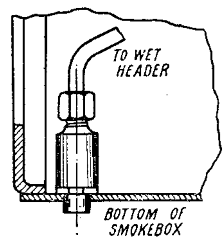
At 1-1/4 in. from the rear end of the smokebox, and 1-5/8 in. off top centre, drill a 3/8in. hole each side of the smokebox. If you have a 13/32in. parallel reamer, put a tap-wrench on the shank, insert into the hole, and as you turn it, bring it up vertical. If you haven't a reamer, use a drill same size ; hold it in a carpenter's brace for preference, and bring the drill to vertical position as you open out the hole. Carefully file off all burrs, and slightly countersink the holes with a small half-round file. Now drill two 3/8in. holes in a piece of 18-gauge sheet brass or copper, bend this to the radius of the smokebox, and give both holes a dose of the same medicine ; after which, cut around the holes, so as to leave a couple of slightly oval washers a full 1/8 in. wide. Screw the ornamental tops of the snifting-valves in the bodies (don't put the balls in yet) and put on the washers or flanges as shown in the illustration. Then try the snifting-valves in position, adjusting the flanges so that the valves fit exactly as shown ; bodies vertical, and the cap or top almost flush with the flange on the side nearest the top of boiler. Remove valves, being careful not to upset the position of the flanges ; remove the tops, and silver-solder the flanges to the valve bodies. Pickle, wash off and clean up.



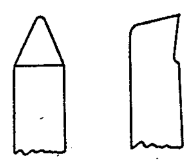
Section ***of*** *inverted* ***snifting-valve***

Seat a couple of rustless steel balls, 5/32 in. diameter, on the faced ends of the caps, by the same process described for seating pump valves. Drill two cross-holes, with 5/64-in. or No. 48 drill, at right-angles across the bottom of the recess ; these holes will cut into the central passage. Drop the balls into the pockets, screw home the caps with a touch of plumbers' Jointing on the threads-keep it off the ball seats !—then drill four No. 51 holes around the flange, put the valves in place on the smokebox, and attach them by four 1/16in. or 10-B.A. brass screws, roundheads or countersunk, whichever you prefer. As the slots will get bunged up when the smokebox is painted, and round screwheads will then become " rivets," I can anticipate the preference of quite a lot of builders !

These little snifting-valves are well worth the trouble of making and fitting, especially by those good folk who love a touch of realism in details. Apart from their usefulness, their personal



How to erect snifting-valves on " Minx " and " Doris "

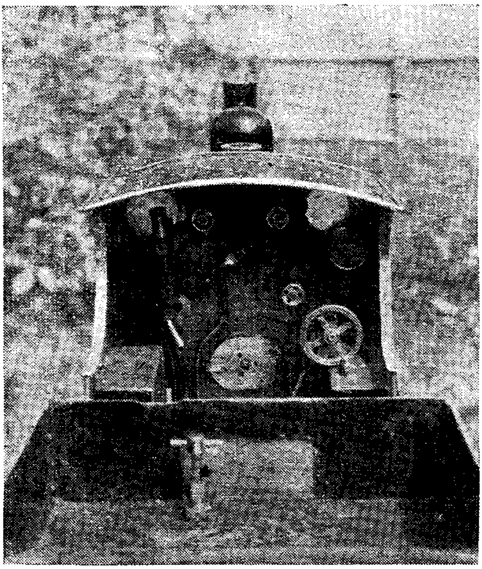


Business end of hand-turning tool

appearance, and the tiny puff of steam and the audible click, as the balls smack against the seats when the regulator is opened, reproduces one of the characteristics of a full-sized " LI."

How to Connect Up

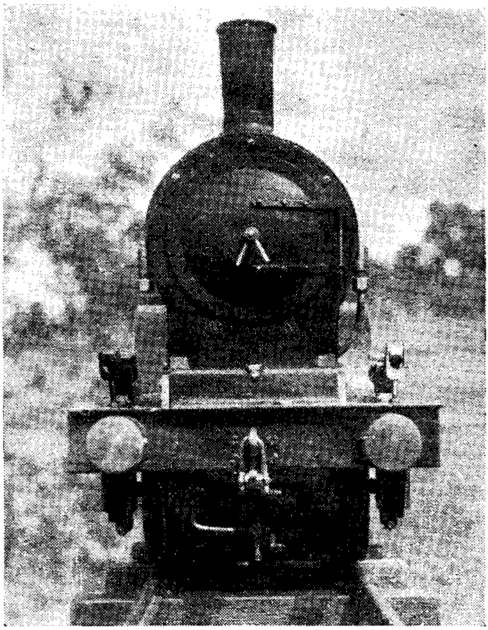
The pipe connections are simplicity itself, and the illustration hardly needs explaining. All that is needed, is a piece of 1/8in. copper tube with a union cone and 1/4in. by 40 union nut on each end, long enough to connect the two unions under the snifting-valves. A tee is provided anywhere in the pipe, and the 1/8in. pipe already attached to the wet header, is silver-soldered into the stem of the tee. Regular bends and a straight pipe are shown in the drawing (easier to draw, that way !) but actually it doesn't matter how or where the pipes are run inside the smoke-box, as long as they are out of the way of the other pipes. All the essentials are, that they start and finish at the right places, so that when steam is shut off, the balls drop, and admit air via the pipes to the wet header, whence it is drawn through the superheater into the cylinders and blown out through the blastpipe, thus preventing any grit or ashes going down.



Footplate of Mr. IV. W. Bunt's "Petrolea," at Sharon, U.S.A.

Snifting-valve for "Minx" and "Doris"

The same size and type of snifting-valve will do for both "Minx" and "Doris," the body of the valve being made exactly the same as described above. To make the cap, chuck a bit of 3/8in. hexagon rod in three-jaw; face, centre, and drill about 1/2 in. depth with No. 34 drill. Turn down a full 3/16in. of the end to 1/4in. diameter,



"Great *Eastern* " *all right-but a long way from Liverpool Street* !

and screw 1/4 in. by 40 ; skim off the end truly. Part off at 1/4 in. from tbe shoulder ; re-chuck in a tapped bush as described above, and turn down 5/32 in. of the end to 1/4 in. diameter. Run a 1/8in. parallel reamer clean through. Seat a 5/32-in. rustless steel ball on the faced end of the cap, and assemble as shown, with a smear of plumbers' jointing on the threads.

Drill a 1/4in. hole in the bottom of the smokebox, anywhere between the front ring and the saddle, and push the end of the cap through it. Fit a 1/4n. by 40 union nut and cone to the end of the 1/8in. pipe attached to the wet header, and screw this on to the union screw on the valve body, as shown in the detail illustration. The normal position of the ball in this valve is, of course, on the seating, and it *is' only* lifted off when the regulator is shut and the cylinders are "sucking." Beginners especially note? that although I have given the pipe connection above, the actual connecting-up is not done until the smokebox is permanently attached to the boiler before erecting same on the chassis.

A 5-in. "Pittler" for a Song

(Continued from page 110)

The first job, therefore, consisted of cutting a new gear-wheel and putting the shaft right. Then the crank handle on the cross-slide was thrown on the scrap heap and a new hand-wheel 4 in. in diameter turned up and an adjustable micrometer collar fitted. In passing, it may be of interest to add that the cross - slide feedscrew was 10 t.p.i. two start, which seemed very coarse after using my 4 in. Myford.

A hand-wheel was also fitted to the top-slide, and in this state the lathe was fitted with motor and countershaft and used quite a lot, although there was still no auto-feed. But feeding by hand the lathe simply laughed at a 1/4in. cut on a piece of 4-1/2in. diameter mild-steel-without back- gear in !

It can be imagined how sorry I was to have to part with the lathe, as it had great possibilities- and who knows if I shall ever get the chance again to acquire such a fine bit of machinery for a song ?

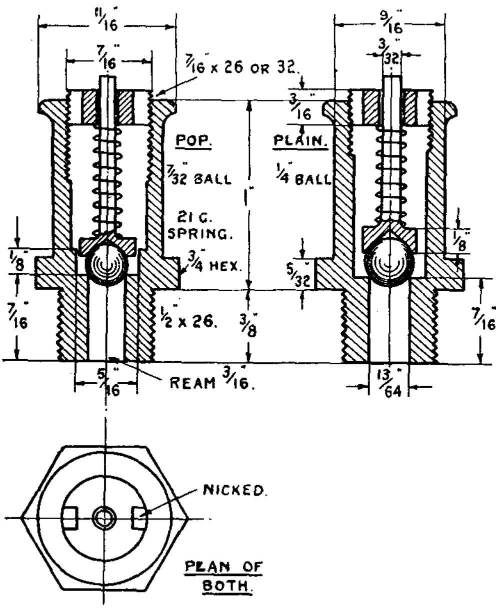
SAFETY - VALVES

for " Doris," " Minx " and " Maid of Kent "

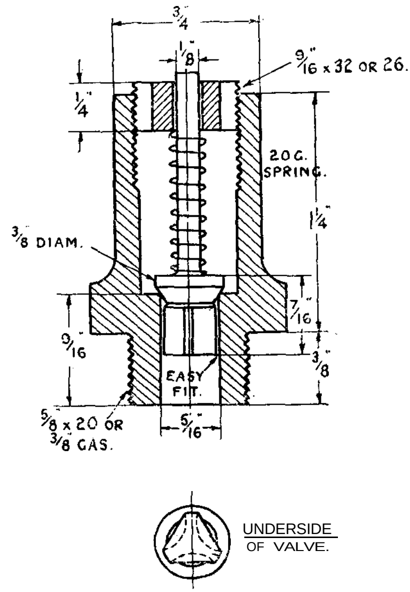
by " L.B.S.C."

IT will save time if I deal with the safety-valves of all three engines at once, so here is the " how-do." The full-sized " LI's " are furnished with a pair of 2-1/2in. Ross pop safety-valves set to blow at 180 lb., and I have received requests from several builders of the " Maid," to describe how to reproduce these in a suitable size for the ***little*** engine. Here is one instance where we cannot " scale down," as the little valves would only be 5/16 in. diameter outside the casing, and the valves themselves would be too weeny to let sufficient steam pass, to relieve the pressure if the regulator should suddenly be shut whilst the engine was running at a good clip, with a tidy load and a good fire. To be absolutely on the safe side, it will be necessary to use a valve with a 7/32in. ball on a 3/16in. seating ; and to get that in, will require a column or casing 9/16in. diameter. May I repeat for beginners' benefit, I don't personally care for pop safety-valves on little engines ; I fitted several to my own engines, but have taken them all off except those on " Annabel," the 2-6-6-4 Mallet. All my boilers are good steamers, and the valves will often start to blow off when running, as the few good folk who have seen my little railway in operation, can testify. The sudden rush of steam lifted the water ; I got the full benefit of it in my face and down my neck, and I prefer to take a " shower" in the bathroom ! For beginners who may be puzzled as to why this comes about, I'll briefly repeat that the sudden opening of the valve causes a reduction in pressure ***on*** the surface of the water right under it. Immediately, up jumps a miniature waterspout, which will reach the bottom of the valve if there is a full glass at the time, and out goes some of it with the steam. At the same time, the rush of the steam skims drops off the sides of the " hill of water," as it blows from the valves, and they go out as well. Once the action is started, it keeps on until the valve closes, and it will empty the gauge glass in a very short time. I have actually witnessed the above taking place, as I fixed up a fireproof glass laboratory gadget like a flat-bottomed boiler, with a pop safety-valve, and got up steam in it over a Primus stove. Seeing is believing !

Incidentally, the above is ***one*** of the reasons why pop safety-valves are not used on the taper boiler barrels of G.W.R. engines ; they would be too close to normal water-level. The first Stanier 2-6-0's on the L.M.S. had pop safety-valves on the firebox, and they also had the G.W.R. steam-collecting arrangement of two open pipes in the

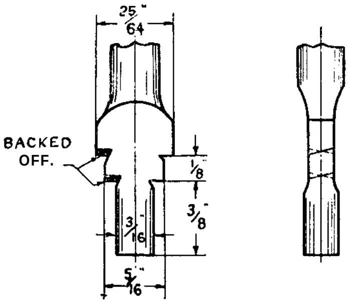


Safety-valves for "Maid of Kent"



Safety-valve for " Minx "

front corners of the Belpaire wrapper. Whenever the boiler blew off hard, the water was lifted, and went down the steam pipes. That was why a dome on the barrel was substituted for the G.W.R. arrangement ; it was the only way to stop the priming. Reverting to the " Maid of Kent," here are the details of the pop safety-valves as requested, along with a plain valve of similar shape and size. Fit which you prefer,



Double pin-drill for pop safety-valves

but don't blame me if you get a wetting from a pop-valve now and again !

Special Pin-drill

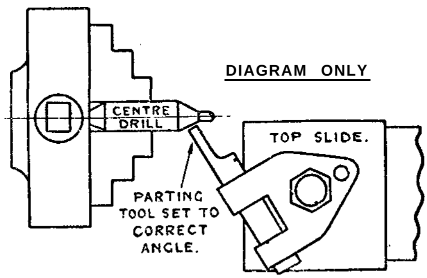
The first item required will be a special pin-drill with two different-diameter cutting edges, to form the valve seating and the pop recess in the column, at one fell swoop. It is easy enough to make. Get a piece of 7/16in. round silver-steel about 4 in. long. Chuck in three-jaw. face the end, and turn down 3/8 in. length to a bare 3/16 in. diameter. Drill a 3/16in. hole in any odd bit of metal, and use it for a gauge ; when the turned bit of the rod fits the hole easily, it is O.K. for size. Now turn 1/8in. length to 5/16 in. diameter ; use a knife-tool with the point well backed off, so that you can undercut slightly at the shoulder, as shown in the illustration. Turn the next 3/8 in. or so, to 25/64 in. diameter ; the rest of the-rod can then be reduced to anything below that diameter. If you like, you can reverse the process, turning down the top part first, then reversing in the chuck, and turning the business end, as above.

Next, file the piece of metal flat, right across the 5/16in. and 25/64-in. parts, as shown in the side view, leaving the 3/16in. part round, as it forms the pilot pin. Watch your step on the next job, it isn't difficult merely requires care. With a weeny three-cornered file, such as clock-makers use, back off the cutting edges, as shown in the illustration ; file right up to the cutting edge, but take care not to destroy the cutting edge itself. When that job is done, make the whole of the end red-hot, and plunge vertically into clean, cold water. Touch the flat part on your emery-wheel, or else wrap a piece of emery-cloth around a flat stick, and brighten up the flat part with that, taking care not to dull the cutting edges. Then lay the pin-drill on a piece of sheet iron or steel, and hold it over the domestic gas stove, or over a bunsen flame. As soon as the bright part turns yellow, tip it off into the cold water. Finally, brighten up the 3/16in. pin, make the kitchen noker red-hot, and hold it against the pin until it turns blue, then quench out. The pin-drill is then ready for use, unless you have accidentally filed or otherwise dulled the cutting edges, in which case another application of the emery-wheel is called for.

Valve Body

The externals of both pop and plain valves are the same. Either 3/4in. hexagon rod, bronze for preference, or a gunmetal casting can be used. Chuck in three-jaw, face the end, turn down 3/8in. length to 1/2in. diameter, and screw 1/2in. by 26. If rod material is used, part off I in. from shoulder. Re-chuck in a tapped bush held in the three-jaw ; this is made as mentioned in the note about snifting-valves. Centre the end ; and for the pop safety-valve drill right through with No. 14 drill. Open out with 25/64-in. drill to a depth of about 5/8 in. Put a 3/16in. parallel reamer through the remains of the No. 14 hole, then put your " patent " pin-drill in the tailstock chuck, and carefully feed it in until the leading cutting edge (the 5/16 in. one) has penetrated to a depth of 15/16 in. The method I use for depth-gauging on jobs like this, is precisely the same as I use on injector-cone reamers, viz. a little brass collar, with a set-screw, on the spindle. If you set this at a distance of 15/16 in. from the leading cutting edge of the two-step pin-drill, the veriest Billy Muggins among beginners couldn't " over-shoot the platform." Tap the upper part of the pin-drilled hole 7/16 in. by 26 or 32, and make a little nipple to fit it. This is merely a bit of 7/16in. round rod, chucked in three-jaw and screwed to match the valve. Face, centre, drill down about 1/4in. with No. 40 drill, part off a 3/16in. slice, and file two nicks in it to let the steam out, as shown in the plan view. The outside of the valve is turned to the outline shown, and needs no detailing out.

In case any beginner doesn't know why the valve opens with a sudden pop, and shuts down



How to set tool for turning valve cone

again with the same alacrity, I will explain in a few words, to save direct correspondence. As soon as blowing-off pressure is reached, steam lifts the ball and enters the recess under the "doings " which holds the ball down. As this is of much larger diameter than the ball seat, and it fits in the recess almost like a piston in a cylinder, the same pressure of steam which was only just sufficient to lift the ball off the seating, is enough to blow the " piston" clean out of the end of the " cylinder," entirely releasing the ball, and allowing the steam to escape with a sudden rush. As soon as the pressure has fallen 3 or 4 lb. below blowing-off point, the spring, aided by a small amount of back-pressure in the column, promptly takes command and plonks the ball back on the seating. That isn't exactly a " scientific " explanation-it isn't intended to be !-but it always seemed to your humble servant that the lingo of the running-shed and footplate is far more understandable than any text-book, and that is why I use it.

To get the correct size of the " piston," cup, or upper valve, whichever you like to call it, a dummy valve-seating will be needed ; and this is made in a couple of minutes with the two-step pin-drill. Chuck a piece of round brass rod (any odd scrap will do, 7/16 in. diameter or over, and about 1/2 in. long), face, centre, drill through with 3/16in. drill, and then open it out with the pin-drill until the first step has fully entered, and the wider step has just started to scrape the end of the stub of brass rod. Now chuck a piece of 3/8in. round brass rod in the three-jaw, and turn down about 7/8 in. of it to 3/32 in. diameter ; incidentally, I never have any trouble in turning fairly long thin spindles in the chuck without support, as I use a knife-tool with plenty of top rake (" against the book " again !) and the point very slightly rounded ; but high speed is essential. Turn the next 3/16in. or so to a full 5/16 in. diameter, just too big to enter the recess in the dummy seating. Part off 1/8 in. from the shoulder. Reverse in chuck, and grip by the thin spindle, having the blob at the end fairly close to the chuck jaws ; then turn it until it is an easy fit in the recess, using the dummy seating itself as a gauge.

Make a mark in the centre, with a centre-drill ; don't put this in farther than 1/16 in., or you'll cut into the spindle ; then form a countersink with a 7/32-in. drill in the tailstock holder. Now put a 7/32-in. ball-a cycle-ball will do fine for this part of the proceedings-on the seat in the dummy, and give it a crack with a hammer, so that it occupies the same position the valve ball does in the real valve. Try the countersunk disc on it ; when the countersink is hard down on the ball, the edge of the disc, upper valve, or " jazz-cup " as I usually call it, should enter the recess in the dummy, a full 1/32 in. If it doesn't, deepen the countersink until it does. If it enters a little more, it doesn't matter a bean.

Drop a 7/32-in. rustless steel ball into the column of the proper valve, seat it same as you did the pump valves, and assemble the lot as shown in the sectional illustration. The spring should be wound up around a piece of 1/8in. round silver-steel ; I have described many times how to make them. Use 21-gauge tinned steel wire ; this will last a long time before requiring renewal, as it does not rust easily, owing-to the tin coating.

How to Test and Adjust the Valves

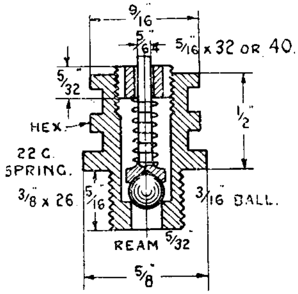
For testing and adjustment I use a small air reservoir that will stand boiler pressure. One can easily be rigged up from an odd bit of brass or copper tube, 16- or 18-gauge, and any diameter from 2 in. up to 4 in. or so. A 16-gauge disc can be soldered into each end ; and above 2-1/2 in. diameter, a stay will be needed through the middle. My own gadget is used horizontally, and is silver-soldered throughout, as it has done a lot of testing ; but one made up about the size of a condensed-milk can, is a convenient one for all the testing the average home locomotive builder would need. Three or four tapped bushes of different sizes are soldered into the top, also a union fitting like the adaptors used for testing the boiler ; thepressure-gauge you used for that job, will come in mighty handy for this. Another similar union is needed, to which a tyre-pump is connected ; and lastly, a cock, or simple screw-down valve like the air release on a Primus stove, or a blowlamp. The diagram shows the rig-up.

Screw your pop safety-valve into the appropriate bush, and plug the unused ones. Tighten the nipple at the top of the valve, pump air into the tank until the gauge registers 80 lb. and then slacken the valve nipple until the valve pops off. On such a small air tank, it should just give one hearty pop and shut down immediately, the hand on the gauge just giving a flick. If, however, it lets too much air out, and doesn't shut down until the pressure has fallen from 10 to 20 lb. or so, the disc is too close a fit in the recess. Take it out, chuck in three-jaw by the spindle, and take just the weeniest skim off the edge of the cup, say a thousandth or so ; then try again. If still releasing too much air, repeat process, and keep on until you get. the single pop with a barely noticeable reduction of pressure. That is all there is to it. You can fit the valves to the " Maid's" boiler, and needn't trouble about looking at the steam-gauge ; the valves will keep you well informed-but don't have the water-level too high, otherwise you'll finish the run with a wet shirt !

Plain Valve

The body part of the non-pop valve is made the same way as the pop-valve, and is turned externally to the same outline ; but instead of reammg 3/16 m., use a drill that size, and ream 13/64 in. If you have not the odd-sized reamer, don't worry, finish off with a 13/64-in. drill. The stepped pin-drill is not required ; finish the hole to 15/16 in. depth with a 3/8in. D-bit. The upper end of the hole is ouened out with a 25/64in. drill, tapped 7/16 in. by 26 or 32, and furnished with a nipple, same size as that on the pop-valve.

The cup and spindle is made exactly the same as for the pop-valve, but the cup is made 9/32 in. diameter, and countersunk with 1/4in. drill. If the 13/64-in. hole at the bottom of the valve has been drilled instead of reamed, it would be advisable to true up the ball seating, and this is easily done by putting a big taper broach down the hole, entering it from the top of the column, and just taking out a scrape. Don't be violent with the broach, or you'll make the end of the hole too big to suit the diameter of the ball, and the valve will be everlastingly dribbling, instead of shutting down steam-tight. Seat a 1/4in. rustless steel ball on the hole, same way as before, and assemble as shown. The valve can be tested, and set to blow at 80 lb. pressure, on the testing gadget referred to above. Screw the nipple down fairly tight, pump up the air tank to the desired pressure, and then slack back the nipple until the valve just commences to sizzle. Beginners note-the fit of the nipples in the valves must not on any account be slack ; they should be a little on the tight side if anything, otherwise the adjustment will alter whilst the engine is running, and the valves will blow off much too early. I have seen the nipple on a pop safety-valve work clean



Safety-valve for " Doris "

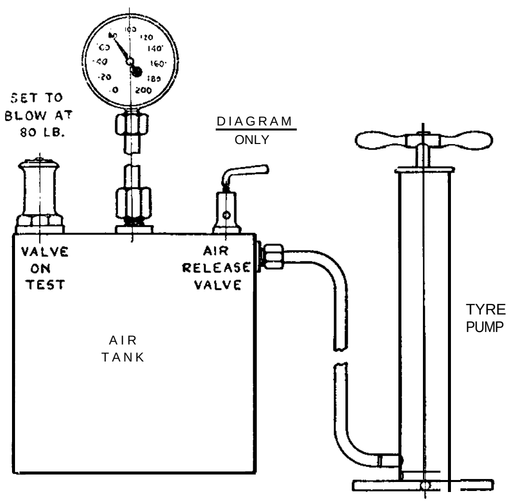
out, and disappear in company with the cup and spindle, ball and spring, and the boiler empty itself through the valve column, all because the nipple was a sloppy fit ; or rather, I should say, a non-fit !

Safety-valve for the " Minx "

As this lady has only one safety-valve, in an ornamental oval casing, it must be big enough to relieve the pressure " all *on* its own," as the kiddies would say. The illustration gives a section of it. The valve could, of course, be made on the same principle as the plain type of vaive for the " Maid," as described above ; but by the time you have put a 3/8in. ball in the column, and a big cup to match there isn't much room left for a decent spring, so I have substituted a wing valve of the proper type.

The body of the valve is made the same way as the " Maid's " valves, only larger ; a piece of r-in. hexagon bronze or gunmetal rod can be used, but our advertisers will probably supply a casting, as they will also cast the casing to match. Anyway, either rod or casting is chucked in three-jaw, the end turned and screwed either 5/8 in. by 20, or 3/8 in. gas thread, to match the boiler bush, and then re-chucked in a tapped bush, and the column turned, bored and reamed as previously described, but to the sizes given in the sectional illustration. The edge of the 5/16in. reamed hole at the base of the valve body must be slightly countersunk, to form a proper seating for the valve itself, and this is easily done ; after D-bitting to 1/2 in. diameter and 1-1/16 in. depth, put a big centre-drill in the tailstock chuck (size " F " or " G " would do, the bodies of both being 7/16 in. diameter) and give the edge of the hole just a touch with it. Just, that and no more ; the seating need be no more than 1/32 in. wide.

To make the valve, chuck a bit of 7/16in. round bronze rod in the three-jaw ; don't use brass this time, as the valve is formed on the end of the spindle and needs a good grade of metal, a different thing altogether to a " jazz-cup " ! Turn the spindle as described previously, but to 1/8 in. diamater and 1-1/8 in. length. Turn the next 1/2 in. length to 13/32in. diameter, and part off at 7/16 in. from the shoulder. Reverse in chuck, holding by the spindle, with the boss as close to the jaws as possible. Turn down 9/32 in. of the boss to an easy fit in the 5/16in. hole in the bottom of the valve column, using same' as a gauge. Undercut the shoulder, as shown in the sectional illustration ; then form a cone directly above it. There are several ways of doing this ; if your top slide has a graduated base, set it over to 30 deg. and use a knife-tool with the sharp point just taken off on an oilstone. A square-nose tool with one corner ground off to the same angle, would also do it ; but there is a " stone-ginger way," as we used to say at school, for a beginner with a cheap lathe sans graduated slide-rest. Put a centre-drill in the three-jaw ; preferably the same merchant that was used to countersink the seating. Put a fairly wide parting-tool in the slide-rest tool-holder, run the rest up to the centre-drill., and adjust the cutting edge to the taper on the centre-drill. Tighten the clamp ; re-chuck the valve, run the tool (now set at correct angle) up to the part to be turned taper, and *pull the belt by hand* as you carefully feed the tool into cut. If you try to form the cone at the usual turning speed, it will chatter like-well, I know what these cheap, flimsy lathes are !-but by pulling the belt by hand, and applying a drop of cutting-oil, you

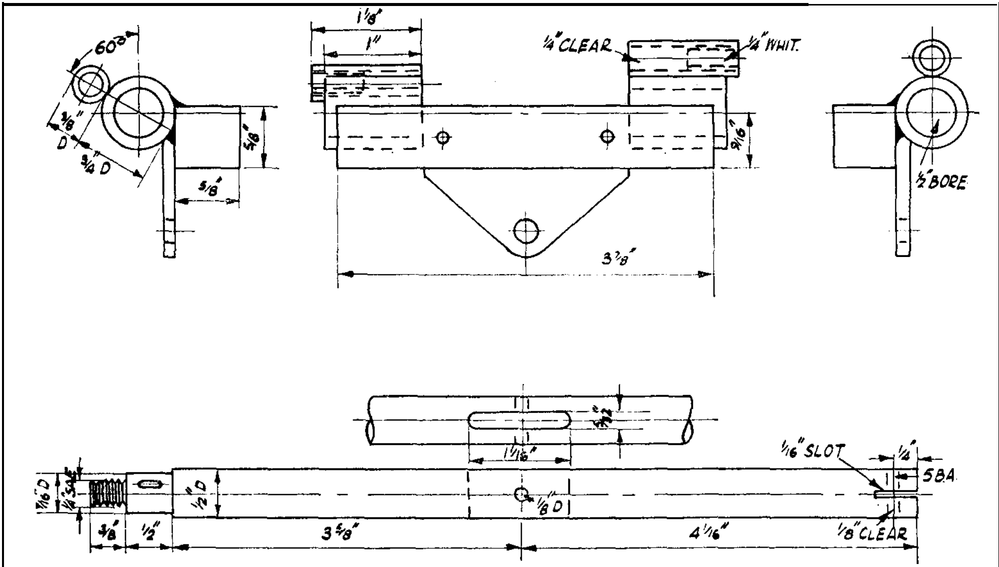


Rig-up for testing and setting safety-valves

will get a perfect cone. Young Curly learned that trick for himself, half-a-century ago.

Either file three flats on the bottom part of the valve, as shown in the underside view, or if you have a milling-spindle for the lathe, mill out recesses as shown by the dotted lines, forming three wings. Incidentally, these milling and drilling spindles seem to have gone clean " out of fashion," yet they are most useful, and easily

(Continued on page 140)



Details of the body and spindle for the index-marking appliance

"L.B.S.C."

(Continued from page 137)

home-maae. A simple spindle, running through a square bit of bar which can be clamped under the slide-rest tool-holder, with a pulley at the back end and a small drill chuck at the front end, can be rigged up and driven from a small overhead shaft, in turn driven from the same motor, or pedal-wheel, used to drive the lathe itself. A small end-mill, or home-made slot-drill, put in the drill-chuck and fed up to the valve whilst still in the three-jaw, would mill out the radii and form a proper wing-valve, almost as quickly as I can write these words. I have a similar gadget, which fits my type " R " Milnes lathe, but seldom use it, as I have the regular vertical and horizontal milling machines.

Make a nipple, same as for the smaller valves, to suit the bigger one, drilling it No. 30. Put a smear of grinding paste (a scrape off your oilstone does fine) on the valve cone, insert it in the column, put the nipple in, and twirl it back and forth a few times. Wash off all traces of the grit with paraffin, then assemble as shown, using a spring made from 20-gauge wire wound around a bit of 5/32-in. rod ; set to blow at 80 lb. as before, and that's that !

Safety-valves for " Doris "

It won't be necessary to detail out the making of the safety-valves for " Doris," because they are virtually the same as the plain type already described for the " Maid," but smaller. There is, however, one difference. Owing to the low height (says Pat) of the valves, the ball seating is set right down in the screwed portion, which allows of an adequate length of spring being fitted. The bodies are made from 5/8in. round bronze or gunmetal rod, the screwed portion being 5/16 in. long, 3/8 in. diameter, and screwed 3/8in. by 26 to suit the boiler bushes.Part off at 1/2 in. from the shoulder, re-chuck ***in a*** tapped ***bush,*** and form the body with a parting-tool, leaving a flange in the middle, and another at top and bottom. Reduce the top one to 9/16 in. diameter, and file the middle one hexagon shape. This is easily done whilst still in the chuck, ***using*** the chuck jaws as guides ; file a flat with each jaw vertical, at the top of the chuck, then three more with each jaw at the bottom, holding the file horizontally. Drill the body No. 24, open out with 9/32-in. drill, and D-bit it ***to 11/16*** in. depth. Ream the remains of the 24 hole with 5/32-in. parallel reamer ;tap the top 5/16 in. by 32 or 40, make a nipple to suit, seat a 3/16in. ball on the hole, and fit a cup and spindle as shown. The spring is wound up from 22-gauge tinned steel wire, over a 3/32-in. rod, and the valve is set to blow at 80 lb. as before. Should any of these plain valves fail to shut down tightly, but persistently dribble, the ball and seating being O.K., the cause will be the spring bearing unevenly on both the cup and the nipple. If the ends of the springs are ground flat by touching them on the side of a fast-running emery-wheel-and mind your fingers whilst doing it, also recollect that steel becomes hot whilst being ground !--they will take a fair bearing on both cups and nipples, and press the ball squarely on the seat, preventing any dribble. Next stage, decorations for the backheads.

Backhead Fittings for " Maid," " Minx " and " Doris "

by " L.B.S.C."

As the same sized fittings will be O.K. for the 5-in. gauge engines as well as the 3-1/2in., one description will do for the lot, and time will be saved. Most of the 5-in. gauge locomotives that I have seen, have had backhead adornments that were far too large and clumsy ; a case in point was the Carson " Precursor " purchased, very much used, by Mr. R. C. Hammett. I overhauled this engine as a friendly job after he had put our air-raid shelter in, at the latter end of 1940. It had the most awful conglomeration of pipes, valves, blobs and gadgets on the footplate, that I had ever seen on a similar engine of the same type ; I scrapped the lot, and replaced them with a few small ones, which not only did the job, but looked neat and tidy. It isn't a practical proposition to make " scale " fittings, even in 5-in. gauge, for actual efficient operation ; but there is no need to make them any bigger than necessary. With the exception of a water-gauge with a little bigger diameter glass, for easy reading and more accurate indication of water-level, the sizes of fittings I usually specify for 2-1/2in. gauge engines are also suitable for 3-1/2in. and 5-in. It will probably give beginners a shock when they realise that a gauge-glass of 3/16 in. diameter, on " Maid " or " Minx," would be 2-1/4 in. diameter on a full-size " LI," and 3 in. diameter on " Doris's " big relations ! I've never seen glasses that size on full-size locomotives, even in dreams ; and the driver and fireman would need hands like those of a giant gorilla, to turn handwheels 6 in. and 7 in. diameter, by gripping them in the manner usually observed among enginemen.

How to Set out the Fittings

The illustration given here, shows the way to arrange the usual fittings on the backheads of " Maid of Kent " and " Minx" ; the outline shown is the " Maid's," with a Belpaire firebox in full lines, and the roundback in dotted lines. The fittings can be arranged in the same way on either ; and a similar layout with slight variation will suit " Doris," only the fittings will be a little closer together, as the backhead is smaller. The usual combined turret and whistle valve is screwed into the top of the wrapper sheet, the hole for the stem being as close to the back as possible, so that the screw threads are tapped into the backhead flange. There are three unions on the turret ; one of them may be connected to the steam-gauge by a 1/8in. pipe and bent to form a syphon. Builders who have adopted the Belpaire firebox may, if they so desire, screw an elbow with a union, into the top left-hand corner, and connect the steam-gauge syphon direct to it, which makes a slightly neater job In that case, a blank cone can be attached to the union on the turret, to close the aperture ; or it may be used for the pipe leading to the driver's brake-valve, if steam brakes are fitted. I have shown the gauge in a position where it can be easily seen from the driving car, out of the way of both reversing-lever and injector steam valve ; but if you fancy any other position, why, go ahead-it doesn't affect the operation.

The pipe from the second union on the turret, on the opposite side goes to the union on the blower-valve already fitted ; and the third pipe is taken down below the footplate, to a big whistle.

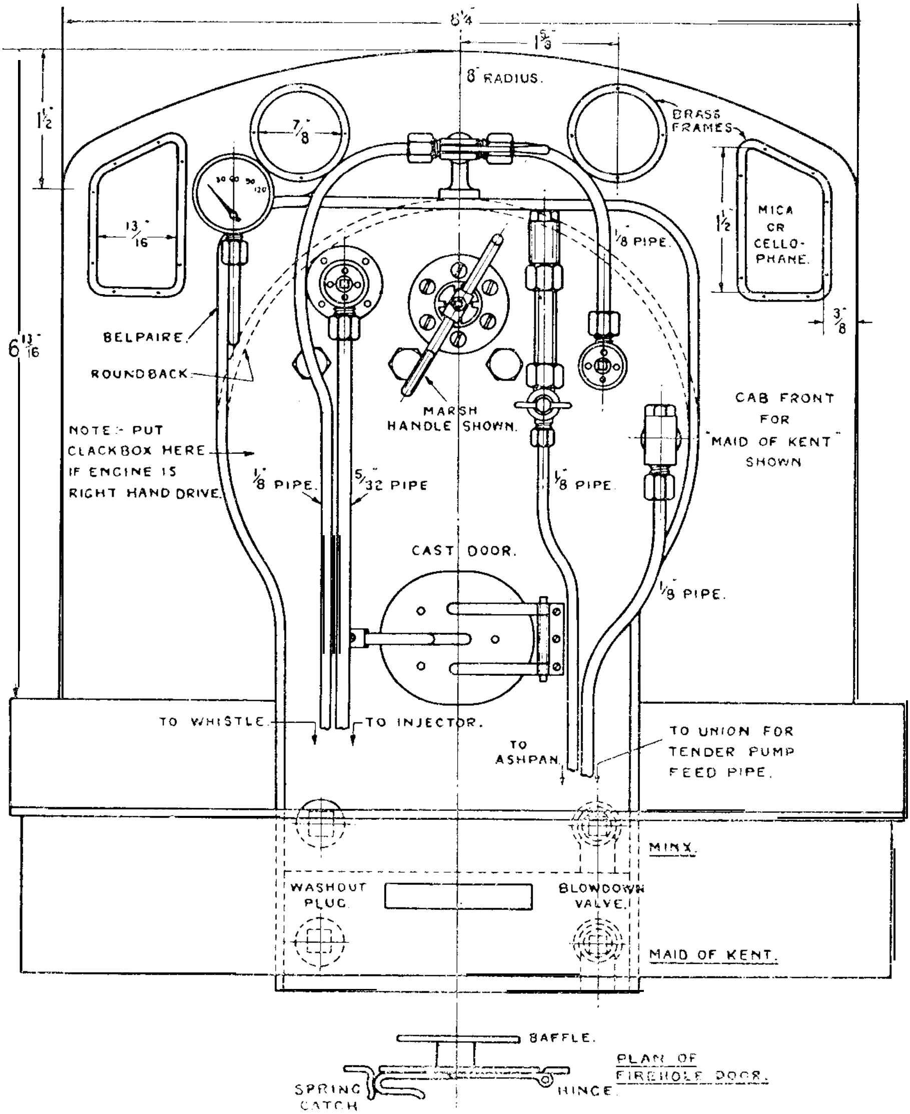
Water-gauge Whimsicalities

The water-gauge can be fitted to the right of the regulator handle, between it and the blower-valve ; it has a 3/16in. glass, with big waterways through the fittings, and a blow-down valve with a cross handle, which some folk find more convenient than a knurled wheel, though the latter may be fitted if preferred. I have purposely shown a short glass, as in full-size practice ; and it is set at such a height, that as long as you can see the water in it, everything is O.K. If the water goes out of sight in the top nut, the boiler will probably start to prime ; whilst if it should go below the bottom nut, it would be a good policy to dump the fire without twice thinking about it ! In days gone by, when I sometimes visited clubs and exhibitions, I have seen little locomotives fitted with over-long gauge glasses that still showed water when the level was below the crown sheet. This is misleading to a strange driver, and on- more than one occasion has resulted in a burnt and collapsed firebox.

Another thing that beginners often fail to take into account, is that small diameter water-gauges are subject to the effects of capillary attraction, and usually show a higher level than the water in the boiler. Any tyro can test this for himself, with a glass or cup full of water, and a bit of glass tube, such as we use for gauge-glasses. If one end of the tube is dipped into the water, same will promptly rise in the tube, from 1/8in. to 3/16 in. above the level of the water in the cup ; and the result is the same, no matter how far the open end is below the surface of the water. Exactly the same state of affairs takes place in a little water-gauge attached to a boiler, and I always allow for it.

Dry Steam for the Injector

The injector steam-valve should be fitted on the left of the regulator handle. It is attached to the backhead by a flange, with four screws, instead of being screwed in direct. The reason for this is that it is furnished with an internal pipe, with a bent end going up into the dome, as in full-size practice, so that the injector gets dry steam. If water goes over with the steam, it causes the injector to spit out and splutter at the overflow, and keep on "knocking off"; although it restarts automatically, if properly made, the feed is what the kiddies would call "all over the shop." pump is seldom or never used; in fact, fitting it is merelv a kind of "insurance." It comes in handy if a raw recruit lets the steam pressure and water level fall together, and there isn't enough steam to work the injector. Note-fit it on the opposite side to the reverse-lever; if you are



How to arrange the footplate fittings

In addition to the two clack-boxes or check-valves on the boiler barrel, another is screwed into the backhead, approximately on the centre line; and this receives the feed from the emergency hand-pump in the tender. Whilst it is really bad policy to introduce cold water into a boiler so close to the fircbox, in this case it doesn't matter much, because the emergency making your engine right-hand drive, the clack should go on the left of the backhead, and vice versa.

"Pass, Friend. and All's Well"

Talking about clacks, I enjoyed a chuckle a few weeks ago, when on my way to Ashford and Eythorne, in the wilds of Kent. Although

I never " tread on the corns ." of the good folk who specialise in I.C. engines in this journal, I'm not entirely ignorant of that kind of motive-power, and have done a little titivating to the engine of my gasoline cart (Series 2, Morris 12) so th-t her most economical speed is around 50 m.p.h. The carburettor " notches up," in a manner of speaking, and I don't lose any power. Well, the old girl was doing her steady 50 on a nice opcn stretch near Maidstone, when I caught up with a small car. I couldn't pass it for a minute or so, on account of traffic coming " up the line," so turned in behind it, and got a view of the driver through the back window. He had no hat, a close-cropped round head, and a pair of rather prominent cars ; and the whole lot so reminded me of a boiler-barrel with a clack-box each side of it. viewed from the smokcbox end, that I couldn't resist a grin. Instinct told me he was a cheery sort of individual, and so it proved ; for as soon as he caught sight of my chariot in his mirror, he started pulling into the near side and waved me on. Directly my road was clear, I " gave her steam " and passed ; and as I did so, he turned full face towards me, smiled pleasantly, and waved again, I waved back, and gave a farewell toot as my cnginc gathered speed. Just an incident on life's highway ; but whenever I pass that way, I shall always remember the " boiler with two clacks " and the smiling round face on the other side of them. The owner may read these notes? for all I know ; if he does, it will give him a big surprise to learn that the driver of the black saloon car who returned his smile and wave, and gave him a parting salute on the hooter, was the same person who writes them.

Keep the Boiler Clean

One thing which 99 per cent. of small locomotive builders and drivers seem to forget all about, is the necessity for keeping the boiler clean inside, especially in districts where the water contains chalk, lime and other impurities. At my old home at Norbury, boilers required a thorough washout after 20 hours' steaming. In the case of the " Maid " and " Minx," I am specifying a big washout-plug at one bottom corner of the back-head and a blow-down valve at the other ; the latter may be either a plain screw-down valve, the plug being operated by a key, or it can be a proper quick-acting blow-down valve as used on full-size engines. The type mostly used on British locomotives, is the " Everlasting " blow-down valve ; and by courtesy of Mr. F. S. Lovick-Johnson, managing director of the company of that name who makes the valves in this country, I am enabled to give drawings and instructions for making a weeny valve of the " Everlasting " type, suitable for " Maid," " Minx," and " Doris." If all goes well, these will sppoar next week. I have here at the present moment, a little " Everlasting " valve made by Mr. Lovick-Johnson himself, the same type used on Southern and L.M.S. engines. It is simple, very effective, easily made (very important, that !) gives a " full throttle " blow-down by one movement of the lever, and yet remains steam-and-water-tight " till the cows come home." Our worthy friend does a bit of locomotive-building himself. in the very limited snare time at his disposal, of which more anon.

Although the illustration shows a firehole door of my pet swing type, with spring catch, builders may, of course, fit any other kind they prefer ; but I certainly don't recommend the double sliding type fitted to manv full-size engines. It is all right in full size, where there is also an air flap, and baffle or deflector plate over the fircholc inside the box ; but my- personal experience of this type of door is, that in the small size it is an unmitigated nuisance. Just before Clnristmas, a friend resident in Lancashire, came south on a visit to his relations. He has built a 3-1/2in. gauge " Royal Scot," with three cylinders, and all the blobs and gadgets of the big sister. Externally, she looks a very fine job, and would get a prize in any competition which was judged by looks and " scale appearance " alone, but she won't go for toffee-apples. My friend has spent best part of eight years on her, and is naturally disappointed with her non-performance, so asked me if I would give her a test on my road, and see if I could diagnose the trouble, which I agreed to do, and she proved a " Royal Spot of Bother."

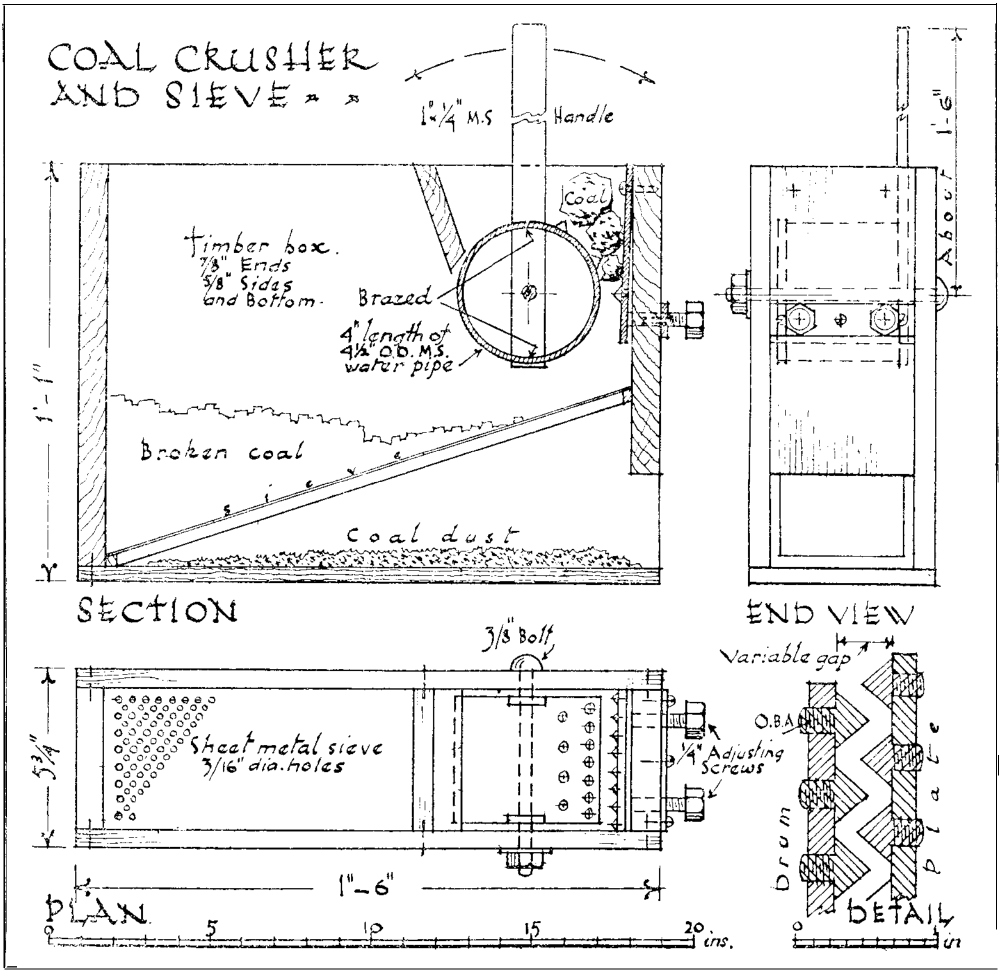
There is no need to detail out all the faults here ; suffice it to say there was just one continual roar up the chimney, denoting bad blowing on valves and pistons ; but among other faults she had a sliding firehole door which, every time it was opened, refused to shut properly because of coal dust and small chips getting in the slides. When closed as far as possible, cold air blew in between the two halves, right across to the tubeplate, as there was no deflector ; and as soon as the engine made her feeble attempt at running, the door started to work open. Nothing of the kind has ever happened on my own engines, which all have the swing doors. These can be opened easily with the shovel blade, for firing when on the run ; no cold air can blow straight on to the tubes, because each door is furnished with a baffle ; and the door cannot come open " on its own," because of the spring catch. If the boiler starts to blow off whilst running, as is usuaily the case on my road, the door can be opened as far as the end of the spring catch. It will stay there by aid of the pull of the blast.

To save time when describing the super-structure of the engines, I have included the outline of the cab front of the " Maid of Kent," with dimensions, also the size and location of the cab windows. The front is the same for either Belpaire or round-back boiler. Note, it is wider than the " scale " dimensions of a full-sized Southern " LI,"the reason being, that in the small size we have to use proportionately wider wheels, splashers, etc. which means wider running boards ; and the cabsides being set at the correct distance from edge of same, gives a wider cab. Next week, details of how to make the boiler fittings mentioned above, with suitable illustrations.

Breaking it Up to Pea Size

Regular followers of these notes may remember that I always advise drivers and firemen of little coal-fired locomotives, to break up coal to pea-size, and sift all the dust out. Some folk religiously follow the instructions, and never have any trouble with loss of steam pressure. Others don't trouble, but just break up the coal anyhow, and lose steam either because the lumps are too big (as long as they go through the doorway, that is " good enough " !) and cold air is drawn between them ; or else dust and all are shovelled into the firebox, choking the iirebars and stopping the draught. Admittedly, it is a messy job attacking bits of coal with a hammer, and then sifting the result ; our old and versatile friend Mr. Edward Adams found it so. His engines, like my own, like their coal in the specified pea-size lumps ; even the big Mallet, and " Monstrous," the engine with the " dustbin-size " cylinders, much prefer peas to pigeons' eggs. If friend Adams can find a way of doing a job easily and efficiently by aid of some simple mechanical gadget, you can bet your last dollar (if you have one) that he won't hesitate to make it up; the coal crusher and sifter is a case in point-in fact, quite a lot of points, as you'll see from the drawing !

The contrivance consists of a very strong, narrow and deep box, in which is a drum mounted on a spindle. This drum has a lot of pointed studs in it, like a glorified edition of the gadget in a piano organ, or a musical box. A similar array of studs is fixed in a plate on the end of the box, the setting being arranged so that the fixed and moving studs alternate, as shown in thc detail view. The drum is partly rotated or rocked by a long handle, which gives plenty of leverage. The coal, after passing between the studs, falls on to a sloping screen or sieve, which in our friend's case consists of a metal plate full of holes. The dust falls through to the bottom of the box, and the " peas " are left on top of the plate, all ready for USC.



Constructional Details

The box is made from I-in. wood ; one of the ends does not come right to the bottom, but an opening is lcft for the purpose of tipping out the dust. The drum is a 4-in. length of 4-1/2in. diameter mild-steel water-pipe, furnished with

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having 20 t.p.i., it follows that a full turn of the nut represents a difference of 50 thousandths of an inch in the thickness of the washer, so that the amount by which the thickness of the washer must be reduced to give a partial turn can be readily calculated. When fitting the handled clamp-nut, therefore, either a washer can be specially made and parted off to exactly the right thickness, or an existing washer can be reduced in thickness by the correct amount. For the latter operation, an easy method of filing the washer and at the same time preserving its flatness is to work it backwards and forwards on a flat file by means of a block of hard wood into which a drawing-pin, or a wood-screw and washer, has been fitted, as represented in Fig. 7.

Fitting the Parting-tool

These tools are supplied by the manufacturers with the tip ground to the correct front clearance angle, but it is advisable that the tool, before being clamped in the turret, should have its cutting edge sharpened truly at right-angles to the long axis of the blade by means of the honing jig.

When mounted, the tool should not project for a greater distance from the turret than is necessary for all ordinary parting-off operations. It is also of great importance that the blade should be clamped to stand vertically, so that it has an equal clearance angle on either side ; this is accomplished by adjusting the two blade-positioning screws and checking the lie of the blade either by eye or, preferably, with the aid of a protractor standing on the surface plate.

It is worth while carrying out the setting operation with care in the first instance, as this will enable the blade to be removed and replaced in the correct position on all subsequent occasions, provided that the setting of the adjusting screws remains unaltered.

A Tool-setting Gauge

Although the height of the parting-tool in the present instance is determined by the machined tool slot, this is not so in the case of the chamfering tool or the square section parting-tool where packing-strips are used to adjust the tool height. Moreover, when tools of the latter type are resharpened, some height may be lost, as a result of grinding the top face, and readjustment becomes necessary ; this can be more readily carried out if some form of height-gauge is used to indicate how much additional packing is required to bring the cutting edge of the tool exactly to the lathe centre height. For this purpose, the small setting-gauge illustrated in Fig. 8 was devised.

In the first place, the tool, while clamped in position in the turret on the lathe, is set to the lathe centre height by means of the surface gauge standing on the lathe bed, or in any other way that may be preferred. The turret is now removed and transferred to the surface plate, where the edge of the tool is brought into contact with the upper flat surface of the setting-gauge, also standing on the surface plate, and the threaded legs of the gauge are then adjusted until the tool makes contact with the zero-line shown in the drawing. The dial test indicator is next brought into use to enable the two lines marked L 5 and -5 to be set respectively five thousandths of an inch higher and lower than the zero-line.

The lock-nuts fitted to the legs are thereupon secured, and the device may then be used to determine not only the correct setting of a tool, but also the thickness of the packing required to attain this result.

(To be continued)

" L.B.S.C."

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end-plates and mounted on a spindle consisting of a 3/8in. bolt. A lever, made from I-in. by 1/4in. mild-steel, and about 18 in. long, is brazed to one end of the drum. The studs are 0-B.A. steel screws with the ends turned conical, and well case-hardened. The flap-plate, which has similar studs, is screwed to one end of the box, above the hole for discharging the dust, but it is only permanently attached at the top, the lower end being adjusted, so that the size of the broken coal can be regulated to requirements. Adjustment is made by two 1/4in. set-screws running through tapped holes in a piece of strip-steel screwed to the end of the box, as shown in the illustrations. The sifting-plate needs no description, but it would be easier to fit a piece of coarse-mesh iron gauze, as used for cinder-sieves and suchlike ; this is obtainable commercially, in grades from 1/8in. mesh upwards, and the ordinary hand-sieve which I use for sifting the coal for my own engines, has a mesh of approximately 5/32 in. Incidentally, the last lot of coal supplied by our coal merchant for the Ideal heating boiler, consisted of anthracite peas (all he had-some say " good old Coal Board " !) and it is what the kiddies call " a job for life," to keep on shovelling up what falls through the bars, sifting out the ashes, and putting what is left, on the fire again. However, they say that it's an ill wind that blows nobody any good, and I can use the stuff on my little locomotives? just as it comes from the coal yard, without sifting or anything else, as it is free from dust. It makes plenty of steam, and less than an inch of it on " Jeanie Deans's " firebars keeps her right on the pin, despite the absence of audible blast.

Mr. Adams's crusher has no difficulty in dealing with Welsh steam coal, and ordinary household coal, also Coalite ; he says he hasn't tried hard anthracite, but I should Imagine it would only need a bit more Sunny Jim" on the end of the operating lever. Anyway, it is an ingenious and useful gadget, and well worth the trouble of making up.

A 3-1/2in. Gauge L.M.S. Class 5 Loco.

by " L.B.S.C."

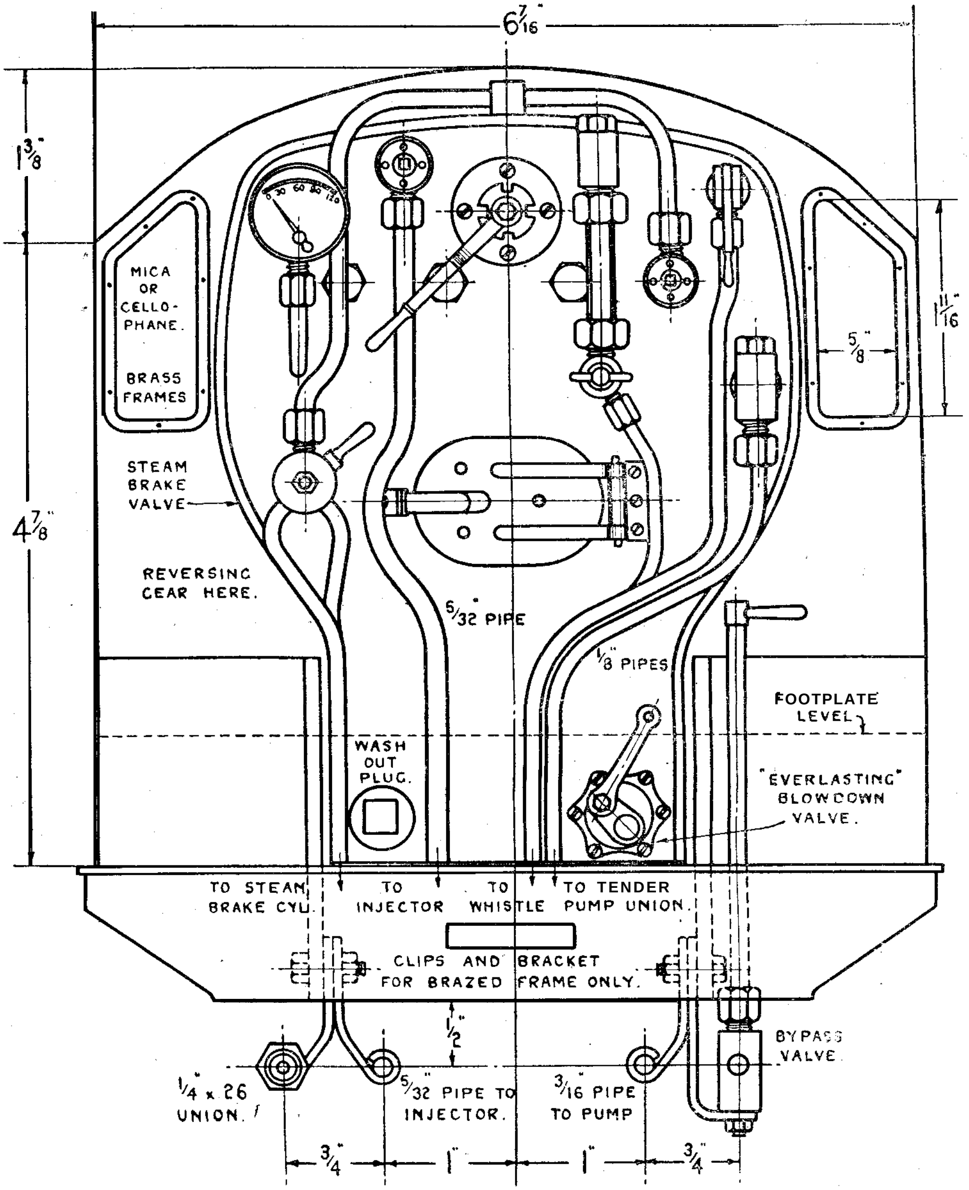
ON drawing out the arrangement of the footplate adornments for " Doris," I find that we can get a much better layout if we make a little variation *in* their consnuction and erection ; the reproduced drawing shows how this can easily be done. First and foremost, as the top of the firebox shell comes so close to the cab roof, there is no room for the usual kind of combined turret and whistle-valve, the " standard " kind of fitting which I always specify wherever possible. The only thing to do, is to substitute some kind of smaller fitting from which *a* pipe can be taken to the blower-valve ; and about the simplest, is a small square block of brass with a spigot for screwing into the wrapper. Two lengths of 1/8in. copper pipe are silver-soldered into this, each furnished with a union nut and cone ; the lengths are obtained from the actual job. They are left straight whilst screwing in the fitting, and bent to shape afterwards ; the right-hand one is connected to the blower-valve union, and the other to the steam brake valve. This will be described separately when we get to the brake-gear stage. Brakes, of course, are optional on the engine ; although they can be made to work perfectly, they. are useless for " service " stops. as the engine is not heavy enough for " solo " braking.

The steam gauge syphon can be silver-soldered into a similar block of brass, which is screwed into the top left-hand corner of the backhead ; and a separate detailed illustration of this is given, which is practically self-explanatory, so no instructions should be needed for what is really only a kiddy's practice job. The injector steam valve described for " Maid " and " Minx," had a flange for attaching to the backhead by screws ; but the one shown here, is screwed direct mto the backhead. The throatplate end of the firebox shell on this engine, supplies steam as dry as in the dome, provided that the steam is taken from the highest point. This can be done by silver-soldering into the injector steam valve, a piece of 5/32-in. pipe long enough to reach almost to the throatplate. Bend up the end of this, directly opposite to the union screw on the valve ; then, when same is inserted into the boiler and screwed right home, the open end of the pipe will be in a place where it can get dry steam.

When making the bottom water gauge fitting, don't put the blow-down union nipple right opposite the bottom gland, but set it a little on the skew-whiff, as shown in the picture. This will allow the blow-down pipe to clear the firehole door sufficiently to allow the door to swing well open. You'll appreciate this when firing the engine on the run.

The actual whistle-valve is made the same way as described just recently ; but it has no union at each side of the ball-chamber. The end cap which holds the spring in place, is made in a manner similar to a safety-valve nipple ; the end of the fitting is threaded, and screwed direct into the top right-hand corner of the backhead. The screwed stem is made to the length shown ; a piece of pipe can be silver-soldered into the nipple, and bent up in the same way as the injector steam pipe. This will ensure that the whistle gets dry steam and blows a clear note instead of a " watery bobble."

A washout plug is fitted down in the left-hand bottom corner of the backhead, and a blow-down valve in the opposite corner. This may be a screw-down valve as shown for the " Maid" and " Minx," or preferably the " Everlasting " valve as fitted *to* " Doris's " big sisters. I have already described how to make this type of valve, and here you see how it can easily be applied. Chuck a short piece of 3/16in. copper tube in the three-jaw, and screw about 3/8 in. of it with a 3/16in. by 40 die in the tailstock holder, squeezing in the adjusting screw of the die, so that it cuts full size. Cut off 5/16 in. of the screwed part, and screw half its length into the inlet hole in the "Everlasting " valve, on the opposite side to the lever. Drill a 5/32-in. hole in the bottom right-hand corner of the backhead, just above the foundation ring and tap it 3/16 in. by 40. Anoint the projecting bit of screwed tube on the valve, with a little smear of plumbers' jointing, and screw home. The position should be as shown in the illustration, so that when the boiler is erected, the valve will just clear the frame, and the handle will project through the footplate, a slot being cut for this purpose when the footplate is eventually fitted. Bend another bit of 3/16in. tube to a nice sweep-it won't kink if you use finger pressure only-screw the end, and fit it to the outlet hole of the valve, so that the end points down, or a little to the side, whichever you prefer. Then, in districts where the water contains chalk, lime, or other impurities, the boiler can easily be kept clean. Run the fire right down, until there is only about 20 lb. on the " clock " ; stand clear of the pipe, and " open her up." By the time she quits blowing, there won't be any " muck" left in the boiler ! However, be careful not to open the valve when the engine is running-a warning which reminds me of another exploit of a Southern " spam can." These engines are fitted with scum cocks, which require to be opened every now and again whilst the engine is running, to keep the boiler clean. Just recently when nearing Ashford, the scum cock on one of the " spam cans " refused to shut after being opened ; result, the train came to a stand, with the boiler completely emptied. The fireman did his best to throw out the huge mass of burning coal which these engines need to keep them on the run (they can lick the old L. & N.W.R. " Precursors " for coal consumption any day !), but he could nor

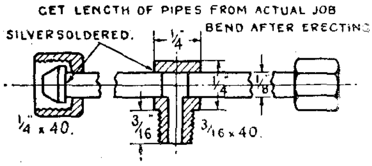


Footplate fittings for " Doris "

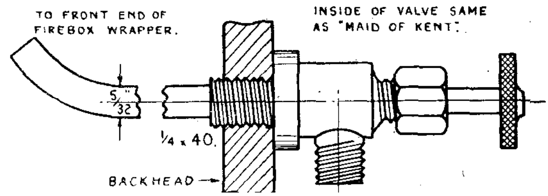
save the firebox. It is interesting to speculate on what would have happened if the lagging had caught alight at the same time, as it frequently does.

Three Fires on One Engine

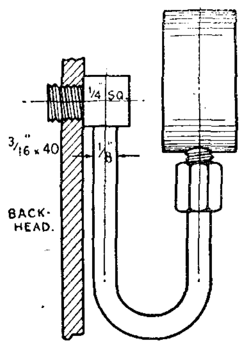
That also calls to mind an adventure of one of the old L.B. & S.C.R. " Vulcans." As I have previously stated, these engines were nothing to write home about, but the heroine of this tale certainly showed plenty of pluck ! The poor old thing was. plodding along to the best of her ability with all the regulator? nearly all the lever, and a jimmy in the blastpipe-which naturally " sent the rockets up," as the enginemen call it. She was nearing the end of her weary journey, and the smokebox had plenty of " char " in it ; half-burnt stuff which catches alight like tinder if it gets any air. It had piled up against the smoke-box door, and the same being extra hot, it began to " warp," as we used to say, and some air got in. Some of the " rockets " fell among the char, and presently it took fire. You don't need telling what the top of the chimney then looked like ; the smokebox door became red-hot, and then to crown all, the boiler lagging caught alight under the cleading plate. The poor old girl thus had three fires going-one in the firebox; one in the smokebox, and one around the boiler barrel ! The driver said she didn't half steam for a little while. Anyway, she struggled home ; I recollect the sorry sight she presented next morning, with



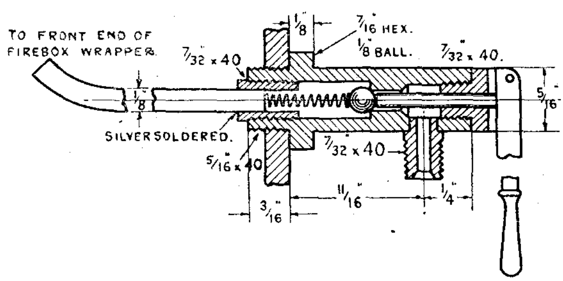
Simple turret



Injector steam-valve



How to fit steam gauge



Whistle-valve

every scrap of paint burnt off the boiler cleading, ditto the front of the smokebox, and the door so badly distorted that I could very nearly get my fingers between door and smokebox front at the bottom.

Engine and Tender Connections

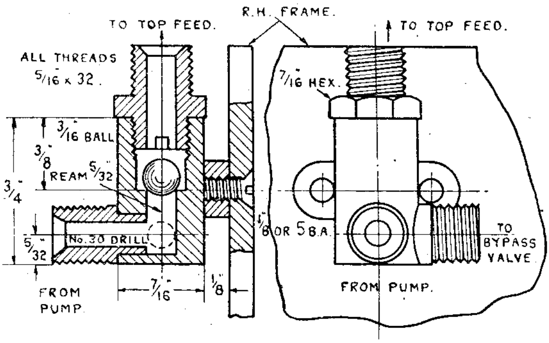
To save both time, and a separate drawing, I have shown in the one illustration, the arrangement of pipe connections normally specified for any 3-1/2in. gauge engine of my own design or build ; the spacing may, of course, be varied a little in any direction without upsetting the convenience of being able to couple any engine to any tender, the hoses being flexible, and the hand-pump pipe on the tender, of necessity, is springy. The clips shown, are suitable only for an engine in which the frames have been brazed into the slots in the drag-beam. If angles have been used, the clips will have to be arranged a little differently, or else plate brackets used to support the pipes ; details of these will be shown along with the piping diagram. As regards the pipes shown running down the backhead, the same remark applies, as to " Maid" and " Minx "-keep them neat and tidy ! Although the fittings are attached to the backhead whilst the boiler is still off the frame, the pipes are not put on until the boiler is erected, with the exception of the bend screwed into the outlet hole of the " Everlasting " blow-down valve ; you can't turn it whilst the boiler is in position, unless the bend is exceptionally sharp.

The illustration also shows the shape, and gives dimensions of the cab front ; and, as will be seen, all fittings and mountings are clear of the cab windows. These are glazed with mica or cellophane, secured by brass frames and weeny screws, or rivets made from domestic pins. The front may be made any time you wish, but is not fitted until the engine has been tested on the road and all adjustments made. Get her to do the job O.K. before you think about decorating her up !

Delivery Clack for Top-feed

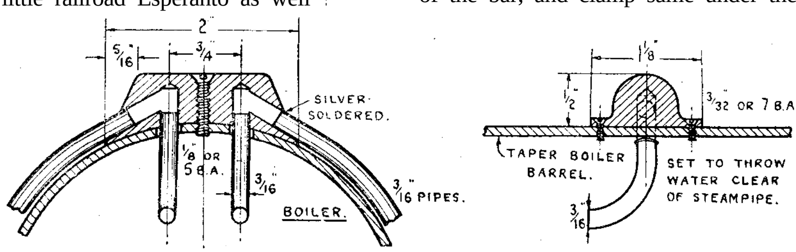
" Doris's " big sisters all have top-feeds, so we will follow suit on the little one ; personally, I prefer top-feeds, and have fitted them to " Tugboat Annie " and others in my " running-shed." I thought at first of following full-sized practice, to the extent of putting the top clacks actually in the casing on top of the boiler, and schemed out a simple arrangement whereby this could be done ; but the trouble was, that it would have been a rather ticklish job drilling the waterways without doing a bit of inadvertent " short-circuiting " (thanks, Milly !). so it was abandoned in favour of a plain top fitting with only two simple waterways in it, plus a separate clack, with union for bypass pipe, attached to the right-hand frame. just ahead of the weighbar shaft. The exact position doesn't matter ; anywhere within reason will do.

The clack is made from a 3/4in. length of 7/16in. rod, bronze or gunmetal for preference, and as the modus operandi of forming the ball-chamber, valve-seat and cap is exactly the same *as* in the feedpump, and other fittings, there is no need to detail out the whole ritual again. One



Delivery clack with bypass connection

5/32-in. by 32 union screw is silver-soldered in at 5/32 in. from the bottom, to admit water below the ball-valve, see section ; another ditto is put in also at 5/32 in. from the bottom, but at right-angles to the previous one. This is connected to the bypass valve under the footolate, bv a 5/32in. pipe. The boiler feed goes out through the cap, which is connected to the right-hand top feed by a 3/16in. pipe, furnished with nut and union at the lower end. and silver-soldered into the top-feed fitting at the upper end. To attach the clack to the frame, cut a piece of 1/8in. by 5/16in. or 3/8in. brass rod about I in. long ; round off the ends, tie it to the clack body with a piece of thin iron binding wire, in the position shown in the illustration, and silver-solder it at the same heating, when doing the two union fittings. A casting may possibly be available for this gadget, as one or two of our enterprising advertisers make castings for all my little fittings, where they consider that the use of a casting saves time and labour-and, maybe, a little railroad Esperanto as well !



Top-feed fitting

To erect the clack, merely drill two No. 30 holes about 5/8 in. apart, and 3/4 in. or so below top of right-hand frame, anywhere ahead of the weighbar shaft ; countersink them, then hold clack in position, and locate the holes on the fixing flange with the No. 30 drill put through the holes in frame. Drill No. 40, tap 1/8 in. or 5 B.A., secure the fitting with two countersunk screws, and connect the inlet union screw with the one on top of the pump valve box, by a bit of 3/16in. pipe with union cones and nuts on each end. A 5/32-in. pipe could be used, if very thin-walled, say 26-gauge or thereabouts.

Top-feed Fitting

If our advertisers can supply a little casting for the top-feed fitting, to the correct shape of the casing over the top clacks on the full-sized engine, Inspector Meticulous will surely award him a medal. Otherwise, file up a bit of brass bar to the approximate size and shape shown. Personally,. I would just use a piece of 1/2in. by 3/4in. bar 2 in. long, bevelled at the ends, rounded off at the top, and saddled to fit the boiler barrel. I made a fly-cutter spindle for my milling-machine some time ago-recollect the tale of the square tool in the round hole ?-and a cutter set with its edge 2-1/8 in. from centre, would make short work of cleaning out the radius in the piece of bar, held upside down in the machine vice on the miller table. " Lathe-only " users can get the same result by improvising a cutter spindle. Just drill a cross hole about 5/16 in. diameter near the end of a bit of 3/4in. round mild-steel about 3 in. long, and put a 1/4in. set-screw in the end. Use one of your 1/4in. square lathe tools (a round-nose for preference) in the hole, with the cutting edge set 2-1/8 in. from centre. Hold the bit of round steel in the three-jaw. Either set the piece of brass bar in a machine-vice bolted to the lathe saddle, or to a vertical slide ; or else solder a bit of square rod to the middle of the top of the narrower side of the bar, and clamp same under the slide-rest tool-holder, so that the part to be machined, is presented to the' cutter. Feed in about 1/16 in. at a time, and traverse the saddle or top slide so that the piece of brass bar moves across the revolving cutter. You'll soon get a perfect saddle. I did all mine that way before I had a milling-machine.

In the saddled part, drill two holes with No. 14 drill, at 3/4 in. centres, going within 1/16 in. of the top of the block. Then drill two holes in the sides, to meet them. These holes must be drilled at an angle, as shown, otherwise the feed-pipes won't lie flat on the boiler barrel. In case beginners wonder how the merry dickens they are going to start the drill in the right direction at such an angle, they don't have to tackle such a problem at all, as the holes can be drilled before shaping the block. Just leave the ends of the block square, make a good centre-pop, drill straight in until the point of the drill has just entered to its full diameter, then incline it over to the correct angle, and go ahead until the drill breaks into the vertical hole. Finally, file the block to shape, and there you are, as the old horse-cabby is reputed to have remarked when his horse fell down and one of the cab wheels came off.

Fitting Pipes and Erecting

Drill a No. 30 hole down the centre of the fitting, and countersink it. If a casting is used, there will be a ***flange*** in the middle ; and instead of the hole just mentioned, drill two No. 40 holes in the flange, for the method of fixing shown in the cross-section. Make two bends from 3/16in. pipe, also shown in cross-section. To get the lengths of the longer feed-pipes, from the injector on the left, and the delivery clack on the right, stand the boiler temporarily on the chassis, and measure the actual distances with a piece of soft copper wire. I use thick lead fuse-wire. The right-hand pipe goes straight down, around the boiler barrel (Pat again !) to the top union of the delivery clack. The left pipe follows the curve of the boiler to running-board level, then curves backwards, runs along ***at*** same level until it reaches the end of the boiler, where it turns down to connect with the clack on the end of the injector. The latter will be described, all being well, in the very near future.

Cut the pipes to the ascertained length, and fit them, also the two bends, to the top-feed fitting, silver-soldering the whole four at one heat. Next, at 2-1/4 in. from the centre-line of the dome, and 3/4 in. apart, drill two 3/16in. clearing holes in top of boiler barrel. Use 13/64in. drill Clean the top of the barrel all around the holes; then insert the bends, and seat the fitting well down on the barrel. This can be done whilst the boiler is still temporarily in place, and the pipes can be bent approximately to their final shape. Run the No. 30 drill down the screw-hole, countersinking the barrel, follow with No. 40, tap 1/8 in. or 5 B.A., and secure the fitting with a brass screw : or if a casting is used. secure by the two smaller screws, locating; drilling and tapping in similar manner. Apply a brushful of Baker's fluid or other liquid soldering flux all around the fitting, put a bead of solder at each side, and direct the flame of your small blowlamp or gas blowpipe on the fitting (keep off the dome !) until the beads of solder melt, and sweat in under the fitting, making a perfect and neat seal. The heads of the screws can also be soldered over.

There isn't the least objection to making the joint permanent, as it never has to come off again during the lifetime of the engine ; and even in an emergency, such as a bad collision, or a fall from an elevated line which results in damage to the boiler, it isn't a hard or difficult job to melt the solder again. I find that the solder seal is neater and far more efficient than soft gaskets for ton-feed joints. and use the same on my own engines, for example " Tugboat Annie " and " Cock-o'-the-North." Should any builder object to making the injector delivery-pipe in one length as specified, there isn't the slightest objection to a union being introduced at any desired point in its length ; but here again, I only " preach what I practise," and find the long pipes quite satisfactory, as they offer the least resistance to the flow of water. Next item will be to erect the boiler and connect up.

Old Files are Good Steel

*(**Continued from page** 283)*

the tools of a metal fettler, you will find that most of them are made from old files. Similar tools can be most useful for removing carbon from the ports of internal combustion engines, as shown in Fig. II.

Drills for piercing glass as shown in Fig. 5; and even parting-off tools for use in the lathe, are within the scope of the old file. One old-timer I knew as a boy, used to make practically all his lathe tools from old files. Of all the tools made from this steel! I should think beddmg scrapers are the favourites. I have made scrapers from " magic steel," ball-races, and all kinds of steel, but I think that if you can get a file just right, it takes some beating. For scrapers, hardening methods vary from sticking the finished scraper, red-hot, into a potato, to immersing it in sulphuric acid. The method of making scrapers from files is too well known to need mention here.

In conclusion, it is not suggested that the model engineer should equip his workshop with tools made from old files, but there are times when an old file will fill the gap, especially when dealing with special tools, and as mentioned at the beginning, it does seem a pity to see such good steel going to waste.

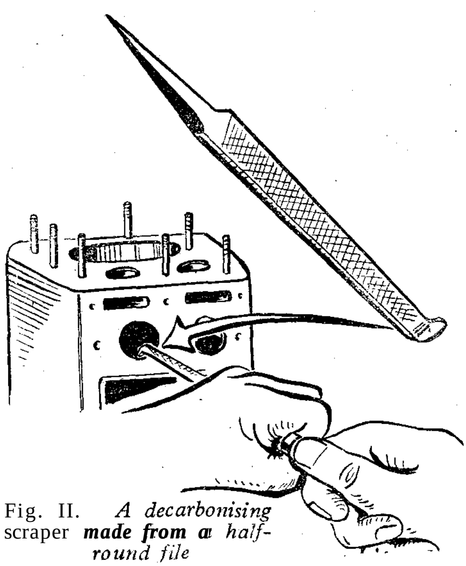
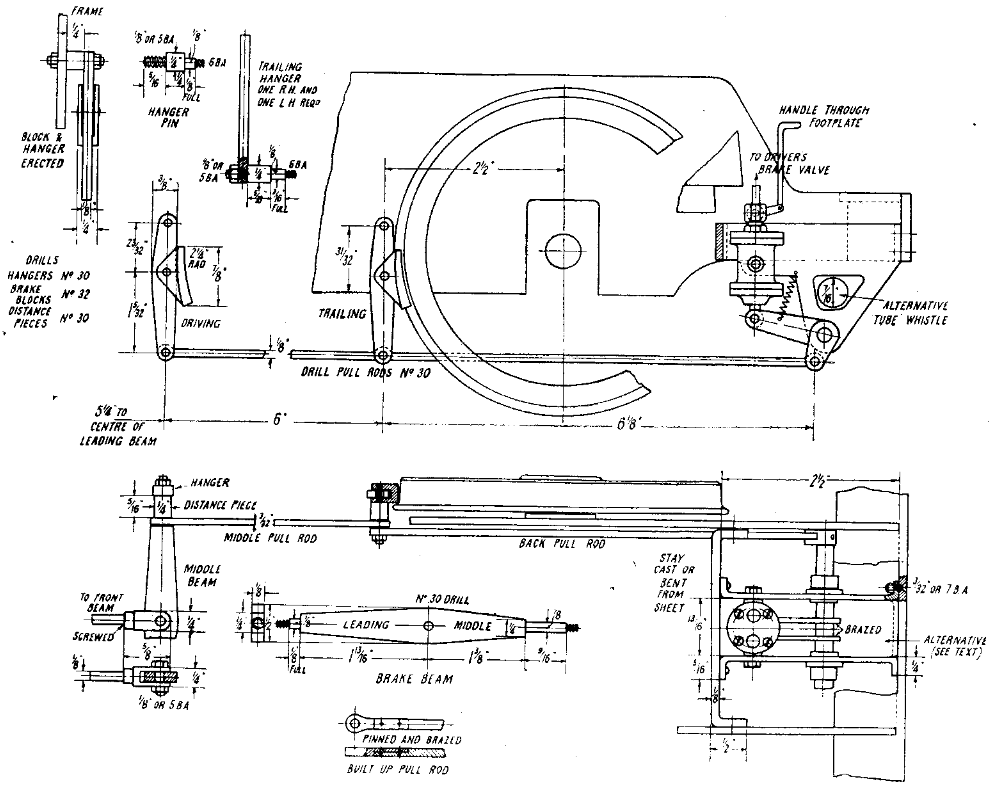


Fig. II. *A decarbonising* scraper ***made from a*** *half-round file*

A 3½-in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

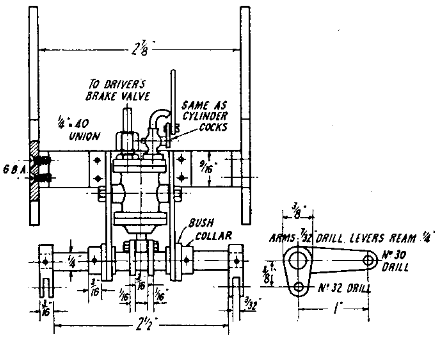
IT seems to me as though I have taken out a season-ticket on brakes, what with the "Maid of Kent," "Minx," and a set I schemed out for a Southern "Schools" class engine! However, this description of a steam brake for these, and they carry the brake shaft and cylinder. If you take a look at the reproduced drawing, you'll see that I have incorporated the same layout on "Doris." The cross stay fixed behind the firebox, may be a casting, or bent up from



Steam brake for "Doris"

the little L.M.S. engine, and the tender hand brake to follow, will finish off another "serial story"; and we shall then be able to have a talk about something else. The brake-gear described below, is a little different from those described for the Southern engines, inasmuch as the full-sized relatives of "Doris" have a steam brake-gear, which operates in conjunction with the vacuum apparatus; and I have endeavoured to make the small edition on pretty much the same lines as in full size. On the big engines, there are (according to the drawing I have) two short longitudinal girders under the trailing end, supported by a cross stay behind the firebox; two hefty brackets are attached to sheet metal, or a plate attached to the frame at each side by pieces of angle. The two side girders are extended downwards to form the brackets carrying the brake cylinder and the cross shaft; the front ends are bolted to the cross stay, and the rear ends to the drag-beam. I have given an alternative way of fixing the rear ends. These girder-brackets may be cut from sheet metal, bushed for the shaft, and have bent-over ends for attaching to drag-beam and stay. It is quite possible that our "approved" advertisers will be able to supply a casting for the whole complete gear frame, but it requires a little more complicated pattern-making than the frame specified for "Maid" and "Minx."

The brake cylinder is a small edition of the 5-in. gauge brake cylinders, but it is placed vertically, as in full size; the connections are made to the top cover. A cock, similar to the drain-cocks on the engine cylinders, is provided to blow out condensate water, and this is operated by a sort of damper-handle projecting through the footplate. The brake rigging is divided at the rear end, same as "Maid" and "Minx," to allow the grate and ashpan to be dropped, for clearing out ashes and clinker after a run; ahead of the firebox, it has the beams and rigging similar to the big engine. Important note: If this brake-gear is fitted, the big whistle previously described, cannot be used, the space



Cylinder and brake shaft erected

being required for the brake frame. In place of it, an ordinary "tube" whistle can be fitted, passing through the holes in the gear frame, as indicated in the drawing.

Brake-gear Frame

If a casting isn't available, the gear frame is very easily built up. The cross stay behind the firebox is simply a piece of $\frac{1}{8}$-in. sheet steel, or strip iron, $\frac{9}{16}$ in. wide, cut to a length of $3\frac{7}{8}$ in. and bent over $\frac{1}{2}$ in. at each end, to fit nicely between the frames. It can also be a piece of similar metal $2\frac{7}{8}$ in. long, with a piece of $\frac{3}{8}$-in. by $\frac{1}{8}$-in. brass angle riveted on at each end; or a pump stay casting could be adapted.

The two longitudinal girders, or side frames, can be cut from $\frac{1}{16}$-in. sheet steel, in exactly the same manner as a pair of locomotive main frames are cut, by temporarily riveting together, and cutting both at once. Note when marking out, that an extra $\frac{1}{4}$ in. has to be allowed at the back end, and an extra $\frac{5}{16}$ in. at the front end, to allow for bending over the parts for attachment to cross stay and drag-beam. It is hardly worth while bushing the holes for the brake cylinder trunnion pins, as the movement is so slight that they wouldn't show any appreciable sign of wear during the whole lifetime of the engine; but the brake shaft has a little more movement, besides which it is a heavy substantial component, and needs a little more support than the thickness of the metal. I have therefore specified bronze bushes. When cutting out the gear frames, drill the holes $\frac{3}{8}$ in.; and after parting the frames and bending the ends, turn up two bushes from $\frac{1}{2}$-in. round rod, and squeeze them into the holes. The bushes should be $\frac{3}{16}$ in. long, with a $\frac{1}{16}$-in. flange, and should be reamed $\frac{1}{4}$ in. after they are pressed in.

The illustrations show how the frames are assembled, and attached to the stay and the drag-beam; but don't erect them until you have made the brake shaft, or—if the long levers are brazed on—you won't be able to get the shaft in place.

Brake shaft

This is similar to those specified for the 5-in. gauge engines, but is made from a $2\frac{7}{8}$-in. length of $\frac{1}{4}$ in. round mild-steel, shouldered down at each end to 7/32 in. diameter, by chucking in three-jaw and operating with a knife tool. The two long levers by which it is actuated, are cut from $\frac{1}{16}$-in. by $\frac{3}{8}$-in. steel strip, to the shape shown. Drill the smaller ends No. 30, but as the levers should be a tight fit on the shaft, so that they "stay put" whilst being brazed, drill them 15/64 in. or letter "C," and then put the "lead" end of a $\frac{1}{4}$-in. parallel reamer in just far enough to make the holes a drive fit for the shaft. Drive them on the shaft so that they are $\frac{3}{16}$ in. apart (3/32 in. each side of centre) and braze or silver-solder them in position. Beginners should put a piece of $\frac{1}{8}$-in. round rod through the holes in the small ends whilst this job is in operation, in case of one trying to shift. After cleaning up, rivet one of the gear-frame plates to the cross stay; put the shaft through the bush, put in the other frame, and rivet that too. The two frames should be $\frac{13}{16}$ in. apart, and nicely in the middle of the cross stay. Turn up two little collars from $\frac{3}{8}$-in. round rod, $\frac{3}{16}$ in. wide, drilled $\frac{1}{4}$ in., and put them on the brake shaft outside the bushes. Pin them to the shaft with bits of $\frac{1}{16}$-in. silver-steel, or 16-gauge spoke wire, driven into No. 52 holes drilled through collars and shaft. Note: the levers must be central between the frames, and the shaft quite free but without end-play.

If a casting is used, with side frames cast integral with the stay, obviously you won't be able to get the shaft in place with the levers brazed on it. In that event, drill the long ends of the levers $\frac{5}{16}$ in. Chuck a piece of $\frac{3}{8}$-in. round steel rod in three-jaw; face the end, and turn down $\frac{1}{16}$ in. of the end to a tight fit in the hole in the lever. Part off at $\frac{5}{16}$ in. from the end; reverse in chuck, and turn down the other end in similar manner. Centre, drill 15/64 in. or letter C, and ream $\frac{1}{4}$ in. Squeeze a lever on each end, line them up with a bit of $\frac{1}{8}$-in. rod through the holes in the small ends, and braze or silver-solder them to the bush. Quench in water only, and clean up. After cleaning up and drilling the cast frame, put the lever in position between the bearings for the shaft, and poke the shaft through the lot, pinning the lever to the middle of it by a piece of 3/32-in. silver-steel or 13-gauge spoke wire, driven through a No. 43 hole drilled through boss of lever, and the shaft.

The drop-arms at the ends of the brake shaft are made and fitted in exactly the same way as those described for "Maid of Kent" and

" Minx," but to the sizes given in the accompanying illustration, so we needn't waste time and space by going into details again. Press them on the ends of the brake shaft, approximately at right angles to the levers, but don't pin them yet.

Brake Cylinder

The brake cylinder is exactly the same type as on the 5-in. gauge engines, but smaller, being only $\frac{3}{8}$-in. bore ; the way the casting is machined and fitted, is precisely the same, so beginners can refer back to the issue for July 7th last. All the dimensions are given in the reproduced drawing. It will be noticed that a different type of " big-end " is specified ; in place of the fork on the 5-in. gauge size, a circular bush is fitted to the end of the piston-rod. This is merely a $\frac{3}{16}$-in. slice off a $\frac{1}{4}$-in. bronze or gunmetal rod ; it is drilled No. 30, and has a 3/32-in. tapped hole in the edge. The end of the piston-rod is turned and screwed to fit. After screwing in, give the joint a dose of silver-solder (an easy job for " Easyflo " !) just to make certain it doesn't come off, as there is so little thread. Put the drill through again afterwards.

As the cylinder is vertical, we can't use the ball drain-valve, so the easiest way to blow out the condensate water, is to put a little cock in the cylinder cover, as shown. This is made exactly the same as the drain-cocks for the engine cylinders, so we needn't go over the ritual again. Screw it into one of the holes in the cylinder cover, and attach a wire to the handle. This wire can project up through the floor of the cab, and be bent over like a damper handle. When right down, the cock should be closed ; pulling it up, opens the cock and lets the condensate water blow away through a bit of pipe bent into a swan-neck, and silver-soldered into the nose of the cock. Take the plug out whilst doing this job. A bit of very small pipe will do ; 3/32 in. is plenty. The end of the pipe is left open, and set to blow the water anywhere between the rails.

In the other hole in the cylinder cover, fit a $\frac{1}{4}$-in. by 40 union screw (or smaller, if you like) to take a union nut and cone, for connecting the cylinder to the driver's brake valve. All being well, I will describe and illustrate this gadget next week ; it is slightly different from the valves specified for the 5-in. gauge engines.

The cylinder is placed between the frames, with the lugs opposite the No. 30 holes, and secured by a couple of little trunnion pins, turned from $\frac{3}{16}$-in. hexagon steel rod, to the dimensions shown. You can use round rod if you like, and slot the heads for a screwdriver ; Inspector Meticulous won't bother to poke his nose under the trailing end. Even if he did, it is a simple matter to open the drain-cock and turn steam on ! That reminds me of a certain driver who became a " bit too big for his boots and hat " when promoted to inspector. It was a funny coincidence, but whenever he passed close to an engine in the yard or sheds, he always seemed to choose the exact instant that the driver or fireman was trying to start the injector, the overflow pipe of which came out under the step !

How to Erect the Assembly

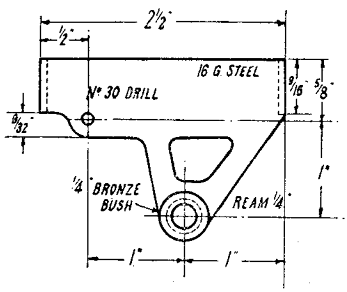
At $2\frac{5}{16}$ in. from the back end of the frame—that is, just clear of the trailing-wheel flanges, drill a couple of No. 34 holes, and countersink them. The lower one should be 5/32 in. above the bottom of the frame, and the next $\frac{1}{4}$ in. above it. The whole bag of tricks can then be placed in the position shown in the illustrations, and the stay secured to the main frames by two 6-B.A. countersunk screws at each side, running through the holes just mentioned, into tapped holes in the flanges of the cross stay. Cast frames will have similar flanges cast on, and the fixing is precisely the same. The turned-over bits at the rear end of the gear frame, will be found to fit in nicely between the angle supporting the draw-bar, and the two pieces of angle attaching the main frames to the beam. Drill No. 41 holes through the lot, as shown in the plan view, and secure by 3/32-in. or 7-B.A. screws and nuts. Use spring washers under the nuts if available : our advertisers can supply. If any pipes already fitted, come foul of the brake-gear frame, it is a simple matter to rearrange them to clear it.

An alternative way of fixing the rear end, may appeal to some of the good folk who are building " Doris." Instead of turning the ends of the gear frame outwards for $\frac{1}{4}$ in., turn them inwards, making them $\frac{3}{8}$ in. full length, so that they meet in the middle. When erecting, take off the angle supporting the draw-bar ; put a drill through the screwholes in the drag-beam, and drill holes in the gear frame flanges to correspond. File off any burrs, replace the piece of angle inside the gear frame, and secure the whole lot with longer screws, thus clamping the gear frame flanges between the drag-beam and the draw-bar angle. File the gear frame angle to coincide with the drawbar slot in the beam, replace the drawbar, and there's another good job done. The back part of a cast frame can be attached to the drag-beam in exactly the same manner.

Brake Rigging

As the pull-rods, beams, blocks and hangers are made and erected as described for the " Minx," there is little to add to the instructions already given. The only difference is in the size of the parts. The hangers are filed up from $\frac{1}{8}$-in. by $\frac{3}{8}$-in. flat steel rod, to the dimensions given ; note that the trailing hangers have a permanently fixed pin at the bottom, to carry the ends of the back and middle pull-rods, as there is no cross-beam at this point. The holes in the main frame for the pins supporting the hangers, are drilled $2\frac{1}{2}$ in. ahead of the centre-line of each axle, and 31/32 in. from bottom of frame. This is the " scale " dimension, according to the outline drawing which I have, of the full-sized engine ; but if you make it 1 in., it doesn't matter a Continental, as long as they are all the same. The pins themselves are turned from $\frac{1}{4}$-in. round steel rod, as shown in the drawing. The brake blocks, if castings are not available, may be cut from $\frac{1}{4}$-in. by $\frac{3}{8}$-in. bar, to the dimensions given.

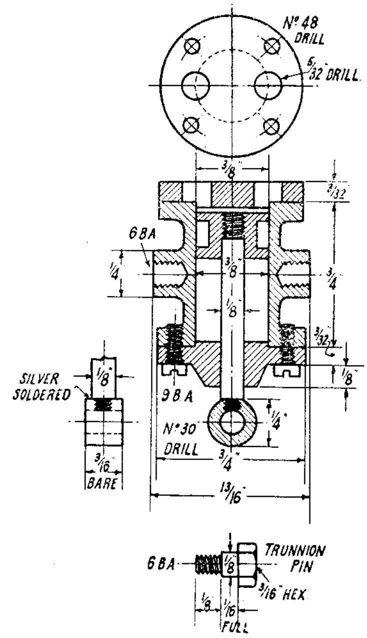
The leading and middle brake beams, which are of the same flat double-taper pattern as used on the full-sized engines, are filed or milled from $\frac{1}{2}$-in. by $\frac{1}{8}$-in. steel bar. The ends should first be turned, holding the bit of bar truly in the four-jaw chuck. Two pieces, each $4\frac{1}{4}$ in. long, will be required. Beginners especially, note that the ends of the leading beam only need $\frac{1}{8}$ in. of " plain " at each end, as they only have to fit into the lower ends of the leading hangers ; but the beam ahead of the driving wheels has to be reduced each end for a distance of $\frac{9}{16}$ in. beyond the screwed part, so that the middle



Brake-gear frame

pair of pull-rods will be parallel to the centre-line of the engine. A distance-piece, $\frac{5}{16}$ in. long, $\frac{1}{4}$ in. diameter, and drilled No. 30, is placed between the eye of the pull-rod and the bottom of the hanger.

The leading and middle beams are connected at their centres by a pull-rod consisting of a piece of $\frac{1}{8}$-in. silver-steel, screwed at each end and furnished with forks, or clevises, as our trans-atlantic cousins call them. They are made in the same way as the valve-gear forks, so there is no need for repetition. When the pull-rod is assembled, the distance between the pinholes in the forks should be $5\frac{1}{4}$ in., and they are connected to the holes in the middle of the brake beams either by $\frac{1}{8}$-in. bolts, or by $\frac{1}{8}$-in. commercial split pins, just as you prefer. The erection of the whole bag of tricks is exactly as described for the " Minx," and is shown in the accompanying illustrations. I forgot to mention that the piston-rod bush is connected to the operating lever, by a bolt made from $\frac{1}{8}$-in. silver-steel, shouldered down to 3/32 in. at each end, screwed, and furnished with nuts. When the nuts are screwed up tight, the bolts should turn easily with finger pressure, otherwise the levers will nip the bush, and the brakes will jam either on or off. The release is obtained by drilling $\frac{1}{16}$-in. holes in one of the levers, and one side of the gear frame, and connecting them by a close-



Section of brake cylinder

coiled spring wound up from 24-gauge tinned steel wire. Adjust rods until all the blocks touch the wheel-treads at one and the same time, then pin the drop-arms to the brake shaft, and you're all set. All we then need, is the driver's valve which will be described, all being well, in the next instalment.

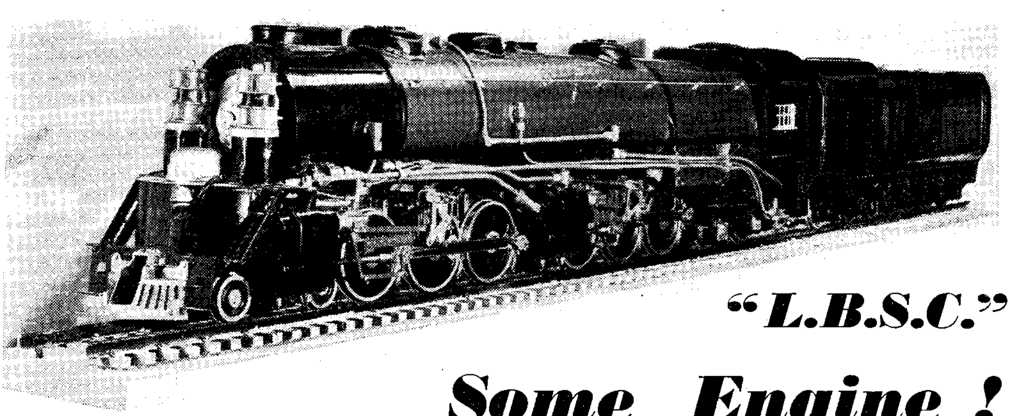
An Old Pumping Engine

MR. CHARLES LLOYD of Liverpool writes :—" It would appear that Mr. C. Lewis, whose letter on the above subject appears in THE MODEL ENGINEER of August 4th, 1949, has stumbled across an example of Davey's Differential Compound Mine Pumping Engine.

In the Science Museum's Handbook on Pumping Machinery, Part I, there is a photograph of a model of one of these engines, together with some notes. The prototype of the model in question had cylinders 34 in. and 64 in. bores by 7.2 ft. mean stroke.

Furthermore, I recently saw in the 1926 edition of *The Steam Engine and Other Heat Engines* (Ewing) an excellent diagram of the cataract valve and governing gear (which is the central feature of the Davey pumping engines), together with a description of its method of operation.

Since Mr. Lewis may not be able to refer to the publications I have mentioned, I shall be happy to make available to him the details of the information I have if he cares to get in touch with me, c/o, The Editor."



"L.B.S.C."

Some Engine!

GOOD folk in the United Kingdom who have built "Hielan' Lassies" and have become rather perturbed at their ultimate weight and size, should take a deep breath (if they haven't anything stronger handy!) before they have a look at the reproduced photograph above of Mr. D. W. Massie's latest achievement. She is a $3\frac{1}{2}$ in. gauge copy of the Union Pacific's mixed traffic engines, suitable for passenger or fast freight, and is of the simple articulated type, all four cylinders taking steam direct from the boiler. The engine closely follows her big sisters in outline and details, with the sole exception of the cab, which is of Canadian Pacific pattern, as Mr. Massie prefers the appearance of it. As the engine is 8 ft. long, and weighs roughly about 800 lb. it would seem that there is a "v" missing from our worthy friend's name, for he is certainly a close relative of Bill of that ilk!

Here are some details of the job. The bar frames are cut from $\frac{3}{8}$ in. steel, the axleboxes having double-row self-aligning ball-bearings. The working leaf-springs are fully equalised. The twelve coupled wheels are $4\frac{1}{4}$ in. diameter. The four cylinders are $1\frac{3}{8}$ in. bore, 2 in. stroke, with flat slide-valves in castings made to represent piston-valves. Lubrication is attended to by a six-feed Nathan lubricator, fitted ahead of the smokebox. Mr. Massie says the Nathan Company made the lubricator and just insisted that it was fitted to the engine; it is a beautiful job, but needed considerable adaptation to get fitted and connected. It now works fine. Ball-and-socket joints are fitted to the steam and exhaust pipes, same as on the full-sized engine; also three swivel joints on one side, and another ball-joint with a sliding sleeve on the other. Incidentally, great minds still thinking alike, as the classics say, I have schemed out a similar joint suitable for the hand-pump connection on British type locomotives of similar gauge; and all being well, will describe and illustrate it shortly. It is more flexible than a coiled pipe, and a better job than the usual "feed-bag" hose. The valve gear is Walschaerts, provision being made in the reversing gear, for the articulation. It will be noticed that the drive is taken by the third pair of wheels on each unit, same as my own "Annabel."

Our friend hasn't sent any dimensions of the boiler, though I understand it is built to the principles advocated in these notes. The fittings and mountings include a slide-valve type throttle, two superheaters, double chimney, two sandboxes, two safety valves, chime whistle, two steam-gauges, and two water-gauges. The boiler feed is supplied by two injectors, and there is also a twin-cylinder steam pump under the footplate, which operates a water pump by a Scotch yoke. The cab has all the usual footplate fittings, and also has sliding windows, working doors, and the C.P.R. type of vestibule. The firehole baffle, and the grates, are cast in stainless steel. The brake gear is steam operated.

The tender has fourteen wheels; leading bogie and five rigid axles as in full size. Sounds strange to speak of a 4-10-0 tender! The sides are made from 16-gauge brass sheet, and every rivet in the whole bag of tricks had to be individually turned, as our friend did not like the shape of the original heads—there's a lesson in patience for some of our fraternity! The baffle-plates inside, are all riveted in, and soft-soldered. The tank has a well-bottom, made from bronze, which in itself holds an American gallon. Ball-bearings are fitted to all the axles, also working leaf-springs, equalised throughout. Lester Friend, of the Yankee Machine Shop, Danvers, Mass., supplied many of the castings used in building the engine.

At the time the photo was taken (by Associated Screen News), there were still a few details to add, such as supplementary handrails, ladders, and so on. Anyway, the locomotive is a fine job, and our worthy friend deserves hearty congratulations on his handiwork. I don't think I would have tackled the job of turning the heads of all those rivets—life's too short!

Progress on the "cut-from-solid" Atlantic

There is certainly plenty of patience on the other side of the big pond, if you know where to look for it. Here is another illustration showing that Al Milburn is getting well along the road with the Atlantic type engine he is virtually carving

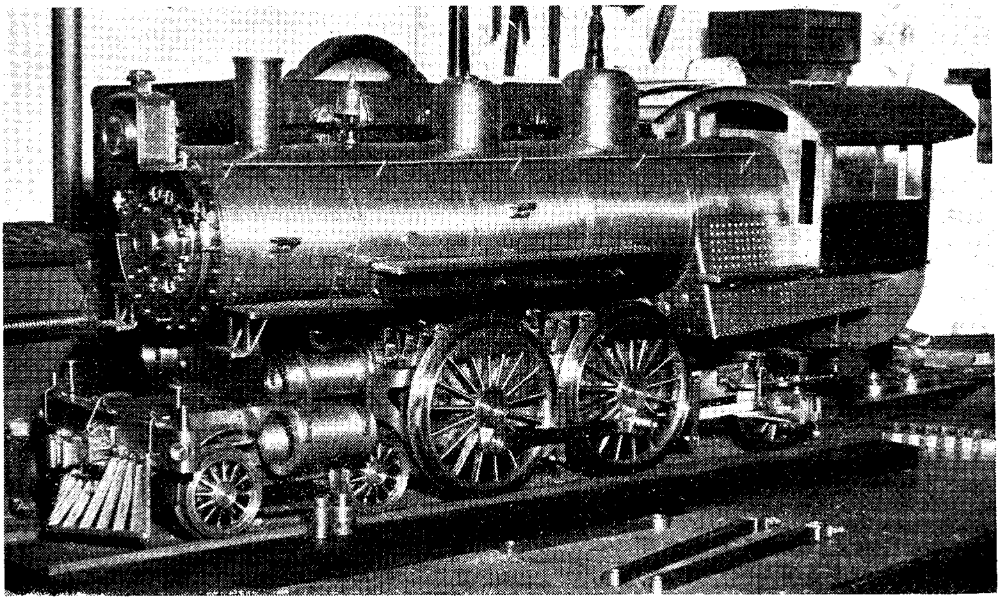


Photo by] [*Roy Curtis*

A fine example of patience and perseverance

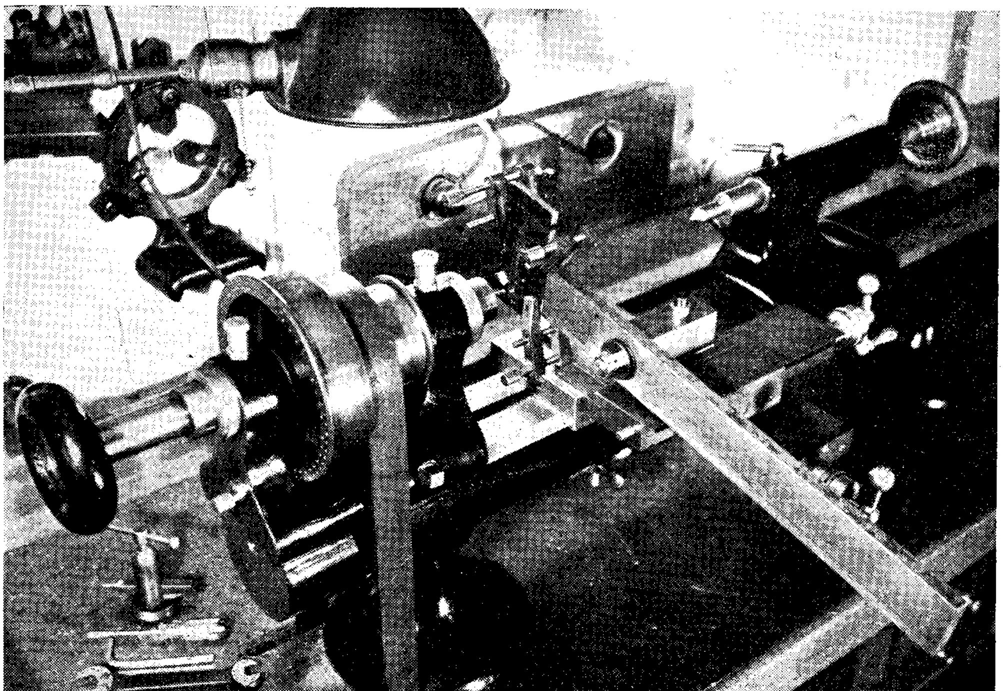


Photo by] [*Alvin Milburn*

How the Atlantic's links were milled

out of the solid. In a recent letter, he said that my reference to him as a friendly rival to Dr. J. Bradbury Winter, fairly put him on his mettle, and he is endeavouring to emulate the worthy Doctor's wonderful craftsmanship to the best of his ability. I'm open to bet that our old friend up at Coniston will be proud to learn of the stimulation given by his magnificent work, to yet another ardent follower of our craft. There is somebody else who is going to raise a smile when he takes a look at the picture of the Atlantic; and unless I miss my guess, it is our old pencil-magician friend Mr. F. C. Hambleton. What about that dinky headlamp, brother? Yes, I know it should, by the good rights, be an electric one, but that doesn't alter the fact that it is a nice bit of work. Also, those good folk who love to see lots and lots of rivet heads, can thoroughly enjoy themselves with this picture and a magnifying glass.

Mr. Milburn also sent a close-up shot, showing the way he milled the expansion links on his lathe, according to the method I described in these notes. Incidentally, Mr. Milburn built a $2\frac{1}{2}$ in. gauge 4-8-4, a double-sized edition of the "O"-gauge "Lucy Anna" which I described in a now defunct American journal, on this small lathe, which was his only machine-tool at the time. The filing-rest, shown hanging up on the wall in the top left-hand corner of the picture, was made from instructions given by another writer in this journal. The lathe itself is very similar, both in size and type, to my own Boley.

Steam Brake Valve for "Doris"

On the full-sized L.M.S. "Class 5" engines, the brake valve is a small affair located in the position shown in the view of the backhead fittings and cab front plate, published some time ago. This makes it rather difficult to provide a brake valve of the usual disc pattern, small enough to fit into the available space, and yet be robust enough to stand up to the job, at the same time providing adequate steam ports and passages. If builders of the engine don't object to fitting a valve that is a little oversize, they can make one of the type described for the "Maid" and "Minx," but just a little smaller. The body can be $\frac{3}{4}$ in. diameter instead of 1 in., and the valve $\frac{1}{2}$ in. diameter. The ports can be drilled with No. 50 drill; and the pipes leading to brake cylinder and exhaust, may be silver-soldered direct into the valve body, so that the valve may be made to look neater. The upper union can be made 7/32 in. by 40, and the nut made from $\frac{1}{4}$-in. hexagon brass rod. The complete valve can be placed in the location shown in the illustration referred to above, and supported by a little bracket attached to the valve body between the lower pipes, and to the backhead, similar to that shown in the accompanying illustration.

Valve Body

Builders who prefer a smaller valve, can make one as shown here. This is a simple three-way cock. I don't care much for plug-cocks as a general rule, they are too fond of leaking and sticking at the slightest provocation; I have one or two painful memories of trying to shut them off on the quick, when a gauge-glass burst on one of the old Brighton engines. However, I don't think you'll get any trouble with the gadget shown, if you do the same as I do with the plug-cock which drains our little portable gas-fired boiler that my fair lady uses on washday, viz., take the plug out now and again, and give it a dose of cylinder oil and graphite. The plug never leaks, and she has no difficulty in turning it on and off.

To make the valve body, chuck a piece of $\frac{1}{2}$-in. round bronze or gunmetal rod in three-jaw. Face, centre and drill about $\frac{1}{2}$ in. depth with $\frac{1}{4}$-in. drill. Part off at $\frac{3}{8}$ in. from the end. Next, set out and drill three No. 32 holes in the thickness of the body. I have shown one at the top, and each of the others at an equal distance from the bottom, the combined angle being 90 deg. (right angle), but there is no need to bother about "mike" measurements.

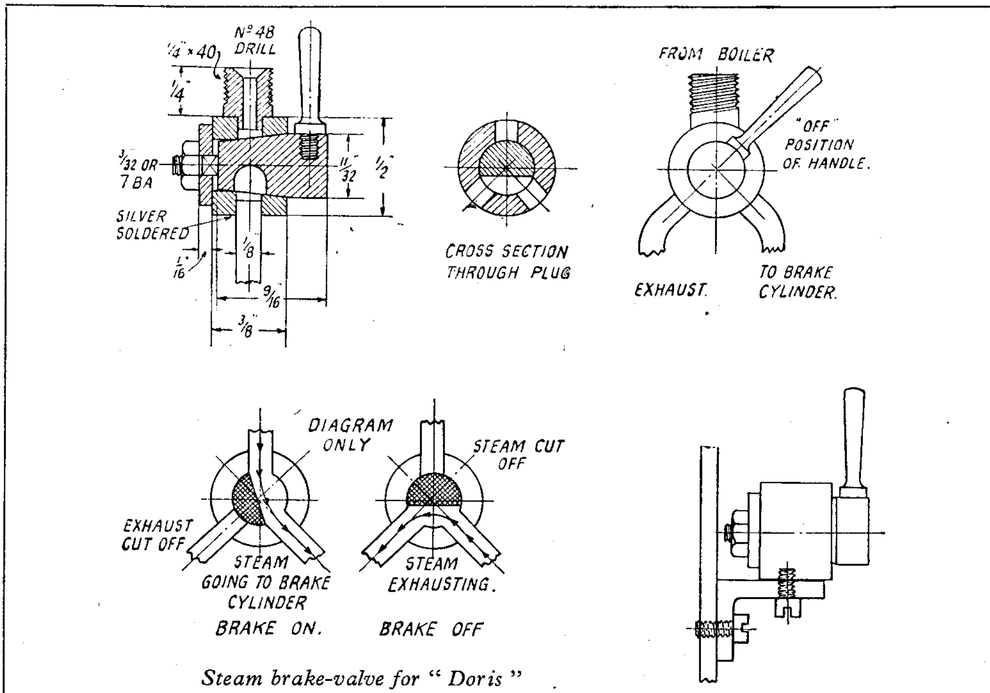
Valve Plug

For the plug, chuck a bit of $\frac{3}{8}$-in. round rod in the three-jaw, and turn down about $\frac{7}{8}$ in. of it to 11/32 in. diameter. Further reduce $\frac{1}{4}$ in. of the end to 5/32 in. diameter; then turn down 5/32 in. of that, to 3/32 in. diameter and screw it 3/32 in. or 7-B.A. File the remains of the 5/32 in. part to form a square, using a flat file with a "safe" edge. I've described how to file squares so many times, that I should imagine most builders could do the job with their eyes shut. Now the great trouble with most folk who try to make plug-cocks, is that they get the tapers on the plug, and in the body, to different angles; I've already explained the easy way to get over that, when describing how to make cylinder cocks. This one is done same way. Set your top slide over to, say, 5 deg. (if it hasn't a graduated scale, just guess the angle; it won't make the least difference) and turn a taper on the chucked piece, so that the end next the square, is just under $\frac{1}{4}$ in. diameter. *Don't shift the top slide*; take the embryo plug out of the chuck, put a piece of $\frac{3}{8}$-in. round silver-steel in, and turn a similar taper on the end, until the small end is about 7/32 in. diameter. Then put the other piece of rod back, set your top slide parallel again, and part off the plug at $\frac{9}{16}$ in. from the shoulder.

Be Careful When Reaming!

File away half the diameter of the tapered part of the piece of silver-steel, or file four flats on it, just as you prefer; then harden and temper to dark yellow, same as I describe for D-bits, injector reamers and so on. Rub the flat face on an oilstone, and put the gadget in the tailstock chuck. Put the valve body in the three-jaw, with the faced side inwards; make sure it runs truly. Then bring up the tailstock, and enter the reamer in the hole in the valve body, pulling the belt by hand. If you run the lathe, it is a million dollars to a pinch of snuff, that the reamer will chatter; that is the cussedness of things in general! Anyway, ream the hole carefully, but—very important this—don't let the reamer go too far in. There should be enough parallel left, at the faced end of the hole, to ensure that the plug stops short of the end, to allow for its being ground in. Take a look at the sectional illustration, and you'll see what I mean. The taper reamer will remove any burring left when drilling the pipe and union holes.

Next, with a $\frac{1}{8}$-in. rat-tail file, file a half-round groove across the tapered part of the plug; see sections. This should be just long enough to bridge any two of the holes in the valve body. plug lightly with a mixture of cylinder oil and graphite. If you haven't any graphite powder, scrape some off a blacklead pencil. The washer is made by chucking a bit of $\frac{3}{8}$-in. brass rod; face, centre, drill about $\frac{1}{8}$ in. depth with 3/32-in. or No. 40 drill, and part off a $\frac{1}{16}$-in. slice. File out the hole with a watch-maker's square file, until it fits easily on the square at the end of the



Steam brake-valve for " Doris "

See that there are no burrs left. Now fit the handle; this can be turned up from a bit of 5/32-in. rustless steel or nickel-bronze rod, and needs no detailing. Screw the end 3/32 in. or 7-B.A. When the groove in the plug is horizontal, and at the bottom, as shown in the section, the handle should incline about 45 deg. to the right, as shown in the front view, so drill a No. 48 hole at that location, tap it to suit the handle, and screw the latter into place.

Plug-grinding Tip

Before grinding in the plug, hold the valve body temporarily in position against the backhead, and see what length of pipe is needed to connect it to the brake cylinder. Cut a piece to length, also a similar piece for the exhaust, which may be a little shorter; also make a $\frac{1}{4}$ in. by 40 union nipple or screw, same as described for boiler fittings. Silver-solder the pipes and union screw into the holes in the valve body, then carefully grind in the plug. I never use emery for grinding non-ferrous metal; pumice-powder and water is all right, or scrape a few grains off your oilstone, and use that. Be careful to wash off any grit that may cling to plug and socket after grinding; then smear the plug. An ordinary commercial brass nut completes the job. Be careful, when assembling, that the truly-faced side of the washer goes next to the valve body. Adjust nut until the valve operates easily, without being slack.

Erection and Operation

The complete valve being so small and light, the pipes are easily capable of providing all the support needed, so that the valve really only needs steadying against the small amount of pressure needed for turning the handle. This can be provided by the little bracket shown in the illustration; it is merely a bit of 16-gauge brass about $\frac{3}{16}$ in. wide, bent to the shape of a bracket with unequal arms, one being about $\frac{9}{16}$ in. long, and the other about $\frac{7}{16}$ in. This is attached to the valve, and the backhead, by 3/32-in. or 7-B.A. screws as shown, running through No. 41 holes drilled in bracket, into tapped holes in valve body and backhead. Warning—be mighty careful not to pierce the plug; a safe alternative would be to silver-solder the bracket to the valve body at the same time the pipes were attached, and then there would be no risk whatever.

The connections are simplicity itself; the pipe leading from the boiler turret on the left side, is cut to length, and furnished with a union-nut and cone for connecting to the steam inlet of the valve. The right-hand pipe on the valve also has a union-nut and cone, for connecting to the union on the brake cylinder. The exhaust pipe is left open, the end being set so that the exhaust steam is directed anywhere between the rails.

The action is as follows. When the driver's handle is moved to the left, the groove in the cock-plug moves to the position shown in the "brake on" diagram; steam then passes from the upper hole, through the groove, to the lower right-hand hole, thence to the brake cylinder, pushing down the piston and applying brakes. Moving the handle to the right, causes the steam to be cut off, and the groove to connect the two lower holes; the steam then escapes via the groove and the left-hand hole, through the exhaust pipe, to the atmosphere. The release spring pulls the brakes off. Before operating the brakes for the first time on a run, open the drain cock, put the handle to the "brake on" position, and blow some steam through the cylinder to warm it. The drain valve should be left open when the engine is standing; incidentally the drain cocks on the engine cylinders should be treated likewise. I always leave them open on my own engines, when same are "dead," just as in full-size practice. Instances have occurred in more than one running-shed, where an engine with a leaky regulator valve has been lit up with the cocks closed. The reverse gear is *supposed* to be always in the middle, when the engine is in the shed; but what often happened, was, that in the far-off days before engine-cleaners became an extinct tribe, one of them would shift the lever, so that he would better be able to get at the rods and links, especially with inside cylinders and valve-gear. Human nature being what it is, he might probably forget to put it back again. Consequently, when the engine got up steam, leakage past the defective regulator valve would accumulate in the cylinders, and presently the engine would move herself; only a little, true enough, but it doesn't need much movement to crush some unlucky wight between the buffers, or maim a hand or foot under a wheel or amongst the "works." With the cylinder drain cocks left open, it couldn't happen. Some of the Stroudley engines had a little snifting valve under the steamchest, which remained open when the engine was standing, and automatically drained away any condensate water. This also took care of any steam leakage past the regulator, which was almost unheard of with the Stroudley type. On the "Gladstones," this valve was at the bottom of the underneath steamchest, alongside the solitary drain cock. Those engines which had steam sanding-gear, took steam for same direct from the steamchest via very short pipes, so we didn't have to wait a month of Sundays before the sands operated. On the Billinton engines, steam had to travel all the way from the valve on the backhead, to the sand ejectors below the driving wheels, via a $\frac{3}{8}$-in. copper pipe; and by the time it got there, and the condensate water had been blown out, we had usually got a start, and didn't want any sand at all!

Speaking about sanding gear, if anybody wants to fit a working sander to "Doris," it can be done on the lines described for the "Maid of Kent," only making the parts smaller in proportion; personally, I don't think it is worth the trouble with a small six-coupled engine. I have fitted one to "Grosvenor," but that is only a bit of swank, to show how much weight a single-wheeler can start, if she is put to it.

Well, all we now need to finish off little "Doris," is the tender brake gear; and all being well, I'll deal with that in a final instalment of this "serial."

In the Workshop

(*Continued from page* 371)

chuck for boring and reaming the bearing for the spindle (D), and at the same setting the recess for the head of the spindle is also turned to ensure concentricity. Finally, the index line is cut with a V-tool mounted on its side at centre height in the lathe toolpost.

The machining of the spindle (D) is a straightforward turning and threading operation, and, following this, the part is reversed in the four-jaw chuck for facing the head to the correct thickness and cutting the sixteen scale lines in the manner previously described. Although a lubricator screw is shown, this as already explained is, perhaps, best omitted.

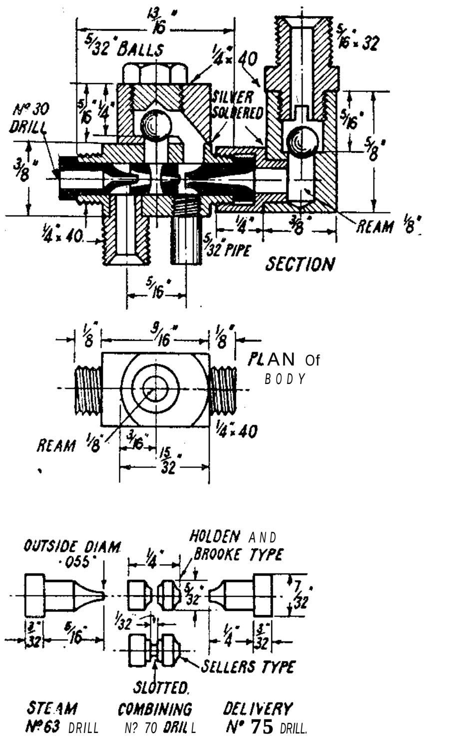
The sixteen-tooth skew pinion, which is screwed into place and then secured by a shouldered lock-nut, was obtained as a standard fitting from the lathe manufacturers.

The spindle should now be inserted in the body and clamped in position by placing a washer under the pinion and screwing it down firmly; a $\frac{1}{8}$ in. diameter cross-centre tommy hole is then drilled right through both the body and spindle, in order to facilitate locking the pinion securely on the shaft or dismantling the parts when required.

The indicator can now be assembled and attached to the lathe apron. The pinion is brought correctly into mesh by rotating the indicator bracket on the arm, and at the same time, the body is moved backwards or forwards to set the pinion on the centre-line of the leadscrew. With the clasp-nut closed and the leadscrew rotated in a forward direction, a division line on the dial is set to register with the index line on the body; this is effected either by rotating the body itself or by sliding the bracket along the arm, but in any case, for the sake of appearance, the index line on the body should be set to lie vertically.

Injectors for "Maid" "Minx" and " Doris "

by " L.B.S.C."



Details of injector

THE same size and type of injector will do for all three engines. It is practically the same as I have previously described for the " Lassie," " Petrolea" and other engines, and is the result of considerable experimenting, in the days gone by. I have personally made and tested out other types of injectors, such as the combination type, ordinary vertical, Gresham and Craven with sliding cone, Penberthy with flap valves, and so on, and got them all to work ; but the "Vic" type shown here is the simplest of the lot, and so will appeal to beginners. If made exactly to given dimensions, it will start easily, restart if accidentally " knocked off" by the jarring of the engine, or water swishing about in the tender ; will take feedwater up to 120 deg., and most important of all, it takes very little steam to operate. It will not " knock the steam-gauge sick," as the enginemen say, if operated whilst the engine is running ; up to time of writing, I have not heard of any commercially-made injector for which the same claim can truthfully be made. It will work right from blowing-off point, until there isn't enough steam to blow the whistle, and will start at 30 to 35 lb. Regulation of the water-valve on the tender will prevent the overflow dribbling at low pressure. The injector is 100 per cent. reliable, as long as ***it is kept clean ;*** full-sized injectors frequently fail through dirty and furred-up cones, and with the tiny holes in the cones of the small one, the veriest Billy Muggins will appreciate the necessity for thorough cleaning.

Beginners Please Note-

Before going into details, may I offer a word of advice, especially to beginners. As stated above, if made exactly to instructions, the injector will work perfectly. If it fails, then either it is not made to the given dimensions, or else there is an external fault ; maybe in the pipes, steam-valve or delivery clack. It isn't the slightest ***use*** writing in and telling me that you made it as stated, and it won't work ; I've heard that tale too many times before! Only a few weeks ago, a reader, without as much as by-your-leave, flung his failure at my devoted head, in a manner of speaking, with a request to try it, as " it was made to instructions and wouldn't work." I had no need to try it ; one glance was enough ! There was over 1/16in. gap between combining and delivery cone, which was sufficient to prevent it feeding ; but from curiosity, I checked over the rest. The steam cone was two drill sizes too small, the taper in the combining cone far too steep, the delivery cone nine drill sizes too large ! (" made to instruction "-I ask you) and the air release-valve leaking. If the maker had taken the trouble to check over the gadget, he would have saved both his own time and mine. Incidentally, I never even received a " thank you " for telling him why it failed. 'Nuff sed !

If your injector fails, when perfectly clean, on first trial, check over every detail ; and if you are absolutely and positively certain that the gadget itself is O.K.. then look for the following. Steam-valve not letting enough steam pass ; steam pipe too small in bore ; water going over with the steam ; hose connect ion between engine and tender kinked, or some other obstruction in feed ; air being drawn in with the water ; too sharp a bend, or other obstruction in delivery-pipe ; top clack not lifting freely. An injector clack needs more lift than a pump clack. One injector I tested for a friend, failed because he left a weeny air-hole when silver-soldering in the water nipple. So much for that ; well, let's get to business.

Cone Reamers

Before starting operations, make your cone reamers. Three pieces of 5/32-in. round silver-steel are needed, about 2 to 24 in. long. Chuck one in the three-jaw, and turn a taper on it 3/4 in. long. Ditto repeato on the second bit, only this time make the taper 1-1/8 in. long. No. 3 only needs a little stubby point 3/16 in. long, but it isn't a straight taper ; radius it a little as shown in the illustration. If you use a round-nose tool with plenty of top rake, run at a good speed, take light cuts, and use plenty of cutting oil, you'll get clean tapers and no chattering. The radius of the, tool doesn't have to be too big ; more like a pointed tool with the point rounded off (says Pat). Don't have more of the rod projecting from the chuck than is absolutely necessary.

The rest of the job is exactly the same as described for the drain cock reamer a little while back. File away to half the diameter, harden and temper to dark yellow, and oilstone up the flats. A stop is needed, to prevent the reamer going in too far ; this is merely a r-in. length of 5/16in. brass rod, drilled No. 27 and fitted with a 3/32-in. or 7-B.A. set-screw, as shown.

Injector Body

No castings-are needed, the body being either cut from the solid, or built up, which is far and away the easiest method. Part off a piece of 3/8in. square brass rod 7/8 in. long, and chuck it truly in the four-jaw. Turn down 5/32 in. of the end to 1/4 in. diameter, and screw 1/4in. by 40 ; then face off 1/32 in., which gives a full thread right to the end. Most dies tear the first thread slightly when they " take hold." Centre, drill right through with the No. 24 drill, and ream 5/32 in. Reverse in chuck ; if you slack No. I and 2 jaws, turn the metal end for end, and retighten the same two, to the same degree of tightness! the embryo injector body should run truly whilst you repeat the turning and screwing process on the other end. The overall length should now be 13/16 in., with 9/16 in. of " plain " between the shoulders.

In the middle of one of the sides, drill a 1/8in. hole. At 3/16 in. farther along, drill a 7/64-in. hole. On the other side, opposite to the latter hole, and 1/8 in. from the shoulder, drill a No. 30 hole and tap it 5/32 in. by 40. At 1/8 in. from the other shoulder, drill a 5/32-in. hole, and in it fit a 1/4in. by 40 union nipple, as described for boiler fittings.

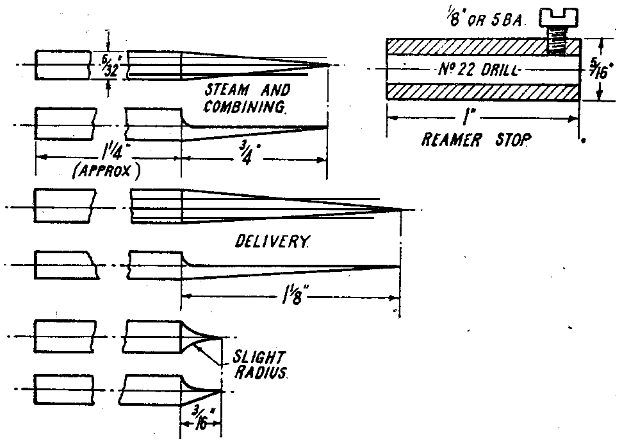
Chuck a piece of 1/2in. round brass rod, face the end, turn down about 3/8 in. of it to 15/32 in. diameter, and part off a 5/16in. length. Scribe a line across the centre indicated 'by the' tool marks ;on this line, at 3/16 in. from the side, make a centre-pop Chuck in four-jaw with this pop running truely. open out with a centre-drill, drill right through with No. 34, further open out about 5/32 in. depth with 7/32-in. drill, bottom to 1/4 in. depth with 7/32-in. D-bit, ream the remains of the small hole with a 1/8in. parallel reamer, and tap the enlarged part with 1/4in. by 40 tap for about 3/16 in. down. Mind you don't damage the ball seating by running the tap in too far. On the same centre-line, starting from a centre-pop 3/16 in. from the centre of the reamed hole, drill a No. 34 hole on the slant, to break into the ball-chamber about 1/32 in. or so above the ball seating ; get as near to the seating as you can, without damaging it. File off any burrs, seat the fitting on top of the 3/8in. square part, so that the reamed hole lines up with the 1/8in. hole, and the slanting hole lines up with the 7/64-in. hole, as shown in the sectional illustration. Tie it in position with a bit of thin iron binding-wire, and silver-solder it,. and the union nipple, at the same heating. Pickle, wash off and clean up ; then poke the 5/32-in. reamer through the long hole again; in case there are any burrs. Seat a 5/32-in. hall on the hole, and make a cap from 5/32-in. hexagon rod, same as described for pumps. The ball should have about 1/32 in. lift as usual. The projecting sides of the hall-chamber can he filed flush with the injector body, or left as they are, just as you fancy. I usually mill mine off.

Cones or Nozzles

Now we come to what is usually the beginner's ***pons asinorum,*** and yet it needn't be anything of the kind, if they will only remember that when I write " drill 75," for example, I mean ***exactly that,*** and not about ten drill sizes larger. A big injector becomes a bit finicky about two or three thousandths off correct diameter in the throat of the delivery-cone ; so you can bet your last dollar-if you have one-that these weeny gadgets must he about right. If O.K., they will do the job; if not, they take an unholy delight in putting water on the ground instead of in the boiler. Believe me, it is just as easy to get them right, as to make a mess of the whole doings ; all you need is just ordinary care, and there is no difficulty.

Start with the combining-cone. Chuck a bit of 3/16in. rod, and turn down about 3/8 in. of it to a tight squeeze fit in the 5/32-in. reamed hole. Now there's another point : I've seen injectors with the combining-cone soldered in, all because the cone was turned too small ; and yet it is so easy to get a squeeze fit. Simply put a taper broach in the end of the injector body (the union end) and broach it the tiniest bit ; just take out a mere scrape. Now if you turn the embryo cone so that it will just enter the broached end, 1/64 in. or less, it will be a proper squeeze fit in the reamed part. Simple, isn't it-like everything else when you know how ! Face the 'end, centre, and drill 5/16 in. deep with No. 72 drill first. An ordinary centre-drill isn't any use for centring the cones, as it makes too large a hole. I made a couple of centre-drills for the iob. from two broken dental burrs ; the broken ends were little more than 1/64 in. across, and they were just hand-ground to arrow points on a hard India oilstone. A cone point can he turned on a piece of 1/8in. silver-steel, a little over 3/16 in. long. Harden and temper to dark yellow, then grind. the extreme tip flat on either side, simpiy by rubbing on the oilstone. Very slightly back off each side of the arrow, and you have " the tool for the job." Beginners note-to drill a deep hole without breaking the drill, keep it clear of chippings ; the cause of a disaster-in 99 cases out of 100 is the flutes becoming choked with chippings and causing the drill to seize in the hole. I use a watchmaker's pin-chuck to hold the drill ; this is held in a larger chuck, and a lever tailstock used, the sliding barrel being worked back and forth just like a pump ram, entering the drill about 1/32 in. at each stroke. As the drill comes out of the hole at each bite the fragments of metal fall from the flutes, anh there is no risk of seizure and breakage.

Haven't a lever tailstock, you say ? Well, that doesn't matter. You must use the watchmaker's pin-chuck (they used to cost about ninepence each in Clerkenwell umpteen years ago) or failing that, solder the shank of the little drill in a bit of 3/16in. brass rod. Put a tap-wrench on the shank of the chuck, or the bit of rod, as the case may be ; hold it in the tailstock chuck, with



Cone reamers and stop

the jaws tightened up just sufficiently to allow it to slide, and feed the drill into the brass rod by sliding it back and forth. Run the lathe at the highest possible speed without causing an earthquake, and you'll get a clean hole. After drilling with the No. 72 drill repeat operation with No. 70, letting it penetrate about 1/16 in. at each go, and the result will be a hole of the right size. Cut back the nose slightly as shown in the illustrations, and part off at 1/4in. from the end.

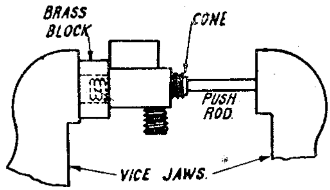
Reverse in chuck ; put the reamer stop on the reamer with 3/4in. taper, letting the business-end project through 1/4 in., plus 1/32 in., then put it in the tailstock chuck and ream out the cone until the stop comes up against the end, and the point is showing 1/32 in. beyond the nozzle end. Test for size ; a No. 70 drill should pass through, and a No. 69 shouldn't. If you get that result, the cone is O.K. Radius the end slightly with the short stubby reamer.

Two types of combining cone are shown ; the completely divided Holden and Brooke type and the slotted Sellers type, the latter being used in American injectors of that make. For the H. and B., put the cone in the three-jaw, letting it project a shade over half its length (nozzle end outwards) and saw it across with a jeweller's hacksaw. Pull out the bit left in the chuck a shade farther ; face off the saw marks, and form a nose on the end, similar to the one first made. Re-chuck the other bit, sawn end outwards, and be sure it runs truly. Repeat facing and cutting-back operation, and give it just one touch with the stubby reamer, to remove the sharp edge around the hole.

To make a Sellers cone, form a 1/16in. groove 1/32 in. deep in the centre of it, usmg a parting tool ; this should be done before parting it off the rod. Then file a couple of slots across the bottom of the groove, as shown in the illustration. Run the reamer in again, with your fingers, to clean off any burring inside the cone.

A Tight Squeeze

The cone can be squeezed in by using the bench vice as a mess. You will need a small block of brass with a 17/64-in. hole in it, to go over the screwed end of the body, and rest against one vice jaw. A piece of 1/8in. brass rod truly faced at the ends acts as a pusher. The set-up for pressing is shown in the illustration, which explains better than words. Turn the vice handle



How to press in combining cone

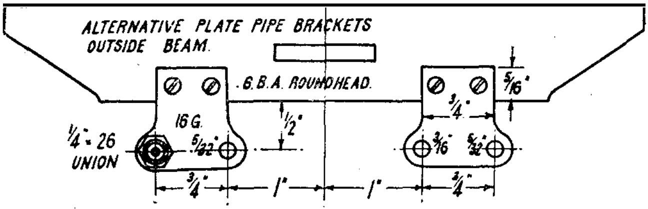
steadilv until the first half of an H. and B. cone is 1/64 in. past the centre of the hole at bottom of ball-chamber. Then press in the second half until within 1/32 in. of the first. If you put a 1/8in. strip of 22-gauge brass down the hole, after pressing in the first half, you won't get the second half too far in. A Sellers cone is pressed in until the 1/16in. groove is mid-way across the hole.

Steam Cone

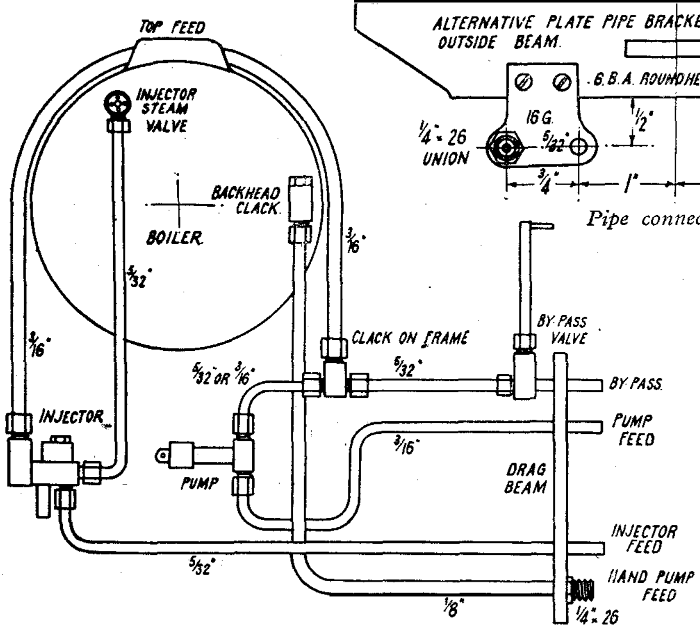
Chuck a piece of 7/32-in. brass rod, and turn down 5/16 in. length to a tight push fit in the injector body ; then turn 5/32 in. of it to a nozzle shape as shown, *not* a blunt cone. The diameter at 1/32 in. from the end should be 0.055 in. or a bare 1/16 in., and the end almost parallel. The shape is of great importance. Centre, and drill with No. 65 drill, then put the end of the 3/4in. taper reamer in until the nozzle is reduced almost to a knife-edge. Part off at 3/32 in. from shoulder, reverse in chuck, and drill No. 30 for a bare 1/4 in. depth. Ream the bottom of the hole very slightly with the 3/4in. taper reamer until, when you put a No. 63 drill in by hand, it won't pass through, but you can just see it by looking down the nozzle. Then re-chuck, back outwards, and put the No. 63 drill through. The steam cone should enter the combining cone just 1/32 in.

Delivery Cone

Chuck the 7/32-in. rod again, turn down 1/4 in. length to a tight fit in injector body, then turn outside to shape shown. Centre, and drill down 3/8 in. depth with No. 77 drill ; radius the end with the stubby reamer until it is a shade over 1/16 in. across. Part off at 3/32 in. from shoulder. Reverse in chuck, and ream out with the 1-1/8in. taper reamer until you can just see the point of it sticking through the hole at the bottom of the radius. Try a No. 75 drill in ; if you can't push it through, but can just see the point, the hole is reamed correctly, to the right depth. Re-chuck the cone with the flange outward ; put the No. 75 drill through (it won't need much pushing !) and radius out the end *of* the hole, with the stubby reamer, until about 1/8 in. across, as shown in section. Assemble the cones as shown, put a bit of 5/32-in. pipe in the overflow hole, and there is your little squirt, all-present-and-correct-sergeant. Terribly difficult job making injectors, don't you think ?



Pipe connections under drag-beam



Pipe diagram for " Doris "

Delivery Valve

Chuck a bit of 3/8in. round rod in three-jaw. Face, centre, drill down 9/16 in. depth with No. 34 drill, open out and bottom to 5/16 in. depth with a 7/32-in. drill and D-bit, ream the remains of the 34 hole with 1/8in. parallel reamer, and tap the larger one 1/4in. by 40. Part off at 5/8in. from the end. At 5/32in. from the bottom, drill a 3/16in. hole. Chuck a bit of5/16in. rod, face, centre, drill down about 7/16 in. depth with No. 30 drill, open out and bottom with 7/32-in. drill and D-bit to 3/16 in. full depth, tap 1/4 in. by 40, and part off at a bare 3/8 in. from the end. Reverse in chuck, and turn down 3/32 in. of the end to a tight fit in the 3/16in. hole in the side of the valve body. Squeeze it in and silver-solder it. Fit a 5/32-in. ball and cap, same as described for the pump ; make the union screw 5/16 in. by 32, as we are using a 3/16in. delivery pipe to " Doris's" top-feed fitting. Screw the fitting on to the delivery end of the injector, so that it stands vertical. If it doesn't come right, just take a weeny skim off the flange of the delivery cone, until it does ; don't wrench it and strip the thread. As the complete gadget only weighs about an ounce, the pipes are quite capable of sustaining its weight without any assistance ; and when installed by the left-hand step on the engine, it is the work of a few seconds only to unscrew three unions (steam, water and delivery) and remove the whole doings for cleaning. The way I clean mine is simply to put the requisite size drills through the cones, holding them in the pin-chuck and poking through by twirling between finger and thumb, whilst any scale in the tapers is instantly removed by an application of the little half-round reamer originally used for reaming the taper.

How to Erect " Doris's " Boiler

The erection of " Doris's " boiler is about the last word in simplicity. All you have to do is to put it on the frames, let the bottom of the firebox wrapper rest on the trailing hornblocks, set the front of the smokebox level with the angle at the front end of the frames, and drop the bottom of the saddle down between the frames until the bottom of the boiler barrel is parallel with the tops of the frames. Run four 1/8in. or No. 5-B.A. countersunk screws through the clearing holes already in the frame, into tapped holes in the sides of the saddle ; make countersinks with No. 30 drill through the holes, drill No. 40 and tap to suit screws. The rear end of the bailer is stopped from lifting by pieces of angle I in. long and clips, exactly as described for " Maid " and " Minx."

A diagram showing the pipe connections is appended and needs no explaining ; also a drawing of the drag-beam, showing alternative brackets for carrying the pipes, on a frame which has been built up with angles, screws and rivets. Next week, all being well, I will give details of the grates and ashpans for " Maid of Kent" and " Minx."

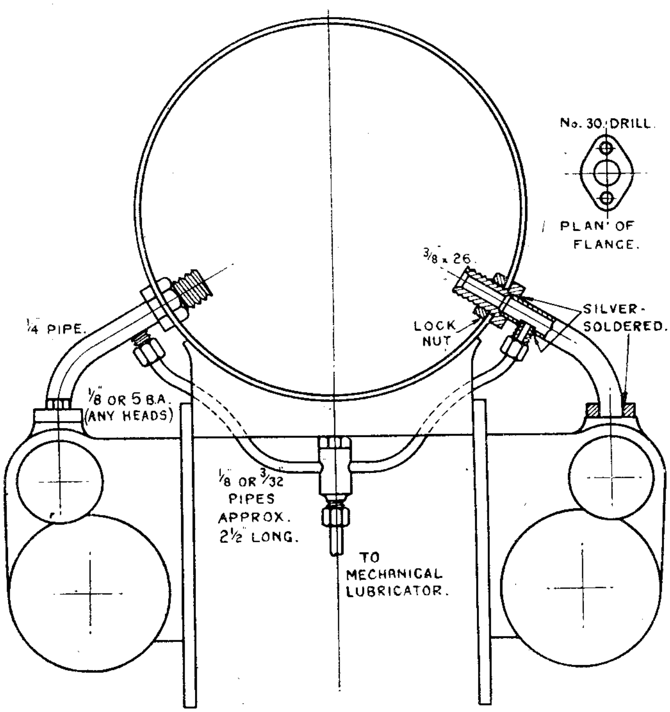
A $3\frac{1}{2}$-in. Gauge L.M.S. Class 5 Loco

by "L.B.S.C."

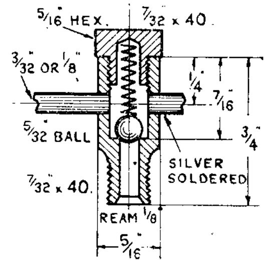
ON the full-sized L.M.S. "Class 5's," the steam-pipes are attached by flanged joints to the superheater header near the ends, pass through the sides of the smokebox at an acute angle, by way of a special fitting, and go straight down to the steam chest flanges. Whilst using the same principle for "Doris," I have simplified matters somewhat, taking the pipes from the superheater header to a couple of unions, the screwed parts of which project through the smokebox shell at right-angles to same, making it easy to connect up. A curved pipe is attached to each union screw outside the smokebox, and carries an oval flange on the lower end, which is bolted to the flat seating on top of the steam chest. Oil is introduced into the steam flow *via* a small union on each pipe. These unions are connected to a central oil check valve, which is in turn connected to the mechanical lubricator. The whole bag of tricks is shown clearly in the reproduced illustration.

The first need will be a couple of flanges for attachment to the seatings on the steam-chest; these are cut from $\frac{1}{8}$-in. sheet brass, or castings may, of course, be used if available. They are drilled No. 30 for fixing screws, and $\frac{1}{4}$ in. drive fit (letter D drill, if you have it, or 6 mm. would do) for the steam pipes. Face the contact side by rubbing on a smooth flat file.

The union screws are made from $\frac{7}{16}$-in. hexagon brass rod. Chuck in three-jaw; face, centre deeply, and drill $\frac{3}{16}$-in. for about $\frac{3}{4}$ in. depth. Turn down $\frac{1}{2}$ in. of the outside to $\frac{3}{8}$ in. diameter, and screw $\frac{3}{8}$ in. by 26. Part off $\frac{1}{8}$ in. behind the shoulder. Reverse in chuck, and open out to $\frac{1}{8}$ in. drive fit for $\frac{1}{8}$ in. depth. Chamfer the corners of the hexagon. The union screws for the oil connections are made exactly the same as the nipple in the side of the check valve under the lubricator, so there is no need for repetition of ritual.



Steam and oil connections for "Doris"



Oil check-valve

Directly above the centres of the seatings on top of the steam chests, and approximately $\frac{7}{16}$ in. above the edge of the flange of the smokebox saddle, drill a $\frac{1}{8}$-in. pilot hole each side, and open them out with a $\frac{3}{8}$-in. clearing drill; letter W if you have it, if not, use 25/64 in. Make a couple of $\frac{3}{8}$-in. by 26 locknuts from $\frac{7}{16}$-in. brass rod, $\frac{1}{8}$ in. thick; I don't have to detail that simple job. Poke one of the union screws through the hole in the smokebox, and put the nut temporarily inside; also put the oval flange temporarily in place on the steam-chest. Bend a bit of $\frac{1}{4}$-in. copper tube to the shape shown in the illustration, and of a length that will just enter both the union and the flange; then bend a similar piece for the opposite side. On the inner side of the bend, drill the pipe for the oil nipple (see illustration for approximate location) and fit same. The whole lot, flanges, main unions, and oil nipples, can then be silver-soldered at one heat. Pickle, wash off, and clean up; then drill a $\frac{5}{16}$-in. hole in the side of the smokebox saddle directly below the holes in the smokebox, after which the steam-pipes can be erected. Put a 1/64 in. Hallite or similar gasket between flange and seating on the steam chest, and use $\frac{1}{8}$-in. or 5-B.A. screws to hold down the flange. Any heads will do, as the whole lot is hidden by the casing, when same is fitted later on. A good smear of plumber's jointing, put around the threads of the union screw close to the shoulder, will effectually seal any air leak; a few strands of asbestos may be wound around inside if desired, before tightening the locknut. Before screwing home the union nuts on the pipes coming from the superheater header, wipe off any superfluous jointing. You don't need it on unions, it only makes them hard to undo when required.

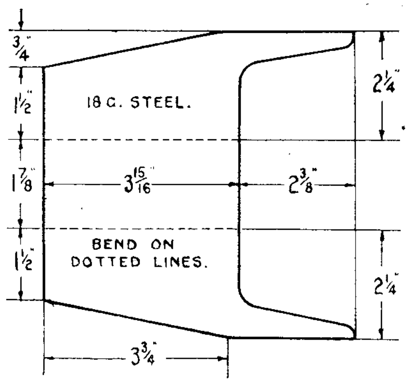
Oil Connections

Make up a small spring-loaded check valve, as shown in the illustration, from $\frac{5}{16}$-in. brass rod. The seating, ball fitting, union end, and cap, are all made as previously described for the clacks under the lubricators; but instead of a screwed fitting, or a union nipple in the side, silver-solder in two pieces of 3/32-in. copper tube, or $\frac{1}{8}$-in. if you have nothing smaller. These should be approximately $2\frac{1}{2}$ in. long. and the outer ends are furnished with union nuts and cones, to match the nipples on the steam-pipes. Note, it is very important that both these pipes should be exactly the same length, otherwise one cylinder will get more oil than the other. The oil will naturally take the path of least resistance. Bend the pipes to the shape shown—you needn't bother to be too exact —wangle the nuts through the $\frac{5}{16}$-in. holes in the saddle, and connect them to their respective nipples on the steam-pipes. The union at the bottom of the check valve is connected to its mate under the lubricator, by a piece of 3/32-in. or $\frac{1}{8}$-in. copper tube, furnished with the necessary union nuts and cones at each end. No separate support is needed for the valve; the pipes will hold it quite well.

Grate and Ashpan

The grate and ashpan for this engine are very similar to those I specified for the "Minx," owing to the presence of the trailing coupled axle under the firebox. On a $2\frac{1}{2}$-in. gauge engine, there would have been no difficulty in using a full-length inverted-channel ashpan, with a couple of slots in the side for allowing the axle to clear; but this type is only suitable for use with a separate grate having extended bearers fitting into nicks in the bottom of the firebox side sheets, and the engine has to be turned over, to reinstate the grate and ashpan after the fire has been dumped. Although "Doris" isn't such a hefty lump as the "Minx," she is still too much of a "two-ton-Tessie" to be turned upside down with impunity. Hence the arrangement shown, which can be replaced with the engine standing over the ash-pit.

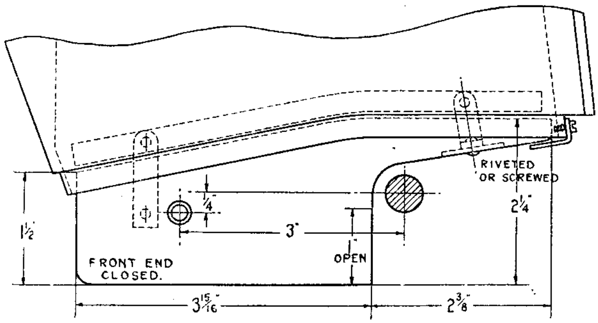
The grate can be either cast, or built up. If the latter, you'll need seven lengths of $\frac{1}{8}$-in. by $\frac{5}{16}$-in. commercial black strip steel, each a full $6\frac{1}{4}$ in. long. These are cut, bent, drilled, and assembled exactly as described for the 5-in. gauge engines. The spacers are made from $\frac{5}{16}$-in. round rod, drilled No. 20 for the 5/32-in. bearers. Incidentally these bearers would be more lasting if made from rustless steel, not for any "fancy" purpose, but simply because it is more resistant to burning than ordinary steel, and also does not rust away when condensation takes place in the firebox after the engine has been standing cold for any length of time.

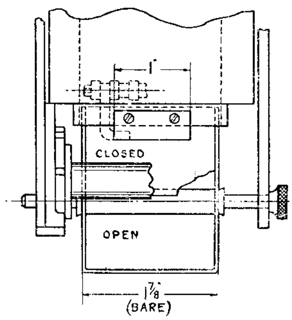


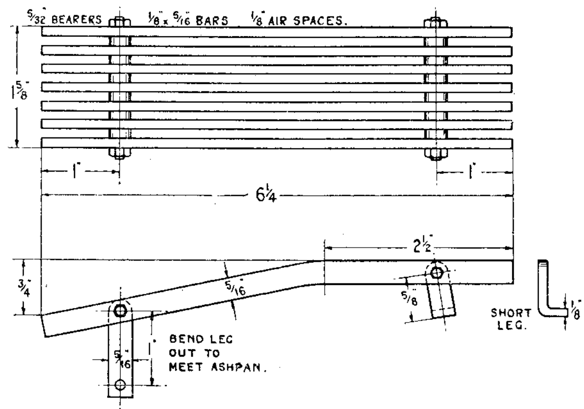
Ashpan "in the flat"

The front legs are splayed out to meet the sides of the ashpan, same as "Minx," but the back legs are made angle-shape, with the angles at the bottom, and pointing toward each other, as they are too short to bend outwards for riveting to the side of the ashpan. Instead, they can be set at an angle to the firebars, as shown in the illustration, so that they will rest on the sloping part of the ashpan, to the rear of the trailing coupled axle. They can be attached either by rivets, or screws put through clearing holes in the ashpan, into tapped holes in the feet.

The ashpan itself is made up exactly as described for the "Minx." Ordinary blue sheet steel of 18-gauge is plenty thick enough. A piece approximately $6\frac{3}{8}$ in. long and $6\frac{3}{8}$ in. wide will be needed, and this is marked out as shown in the diagram. Cut away the unwanted parts, and bend up the residue to a channel shape, which should be a bare $1\frac{7}{8}$ in. wide at the open top so that it will fit easily between the side plates of the firebox. I have shown the front bottom corner rounded, as on the old Brighton engines, but it may be left square if desired. On the full-sized "Class 5's," there is a damper door here, but it isn't advisable to fit one on the little engine, as ashes and grit will blow out of it and get all over the motion. There is a bit of a difference between the distances between ashpan and moving parts, in 4-ft. $8\frac{1}{2}$-in. gauge size, and $3\frac{1}{2}$-in. gauge! Close the front end with a piece of 18-gauge steel brazed into position; or if you prefer, cut the piece wide enough to allow $\frac{1}{4}$ in. or so being bent at right-angles each side, and riveted to the sides of the ashpan. Same applies to the sloping piece over the axle at the rear end. Personally, I prefer brazing or Sifbronzing. A gap 1 in. deep is left between the bottom of the ashpan and the lower edge of the curved piece







Grate and ashpan for "Doris"

over the axle, as shown in the illustrations. This should be all right for Welsh or anthracite coal; but for North Country steam coal it may be necessary to drill a few holes in the curved plate. This, however, will be a matter for actual experiment when the engine takes the road. If the fire burns dull under the door, the holes will be needed.

How to Fix the Grate

The grate is made a permanent fixture in the ashpan, in a manner similar to that of the "Minx"; the bottom edge of the bars should be approximately $\frac{1}{8}$ in. above the upper edge of the ashpan. The front legs of the grate are splayed out and riveted to the sides of the ashpan. The back legs are set back until the angles or feet at the bottom are fair and square with the sloping plate, as shown by the dotted lines in the illustration of the complete assembly, and are secured by screws or rivets as previously mentioned.

The whole bag of tricks can now be erected on the engine. At 3 in. ahead of the trailing axle centre, and $\frac{1}{4}$ in. below level of same in running position, drill a $\frac{3}{16}$-in. clearing hole through the frame at each side of the engine; use No. 11 drill. Bend up a little bracket from a piece of 18-gauge steel 1 in. long, the vertical part being about $\frac{3}{8}$ in. and the horizontal part about $\frac{1}{2}$ in. wide; attach this to the bottom of the firebox door-plate by a couple of $\frac{1}{8}$-in. or 5-B.A. screws. Stand the engine on a piece of line without cross-sleepers (like the pits in the loco. sheds) and insert the back end of the ashpan into the firebox ahead of the rear axle, pushing it over same, until it drops back and rests on the bracket, allowing the front end to just enter the firebox. Prop up the ashpan until level, then poke the No. 11 drill through the holes in the frames, holding the brace level and square, and drill corresponding holes in the ashpan. Remove ashpan, open the holes to $\frac{5}{16}$ in., and fit a tube and pin exactly as described for the "Minx."

You are now ready for your first trial run—*what* a day!—and the same general instructions as given last week, apply to the $3\frac{1}{2}$-in. gauge engine, so go right ahead, good luck, and mind young "Doris" doesn't run away with you; she is quite capable of it! Just one point; she has piston valves, whilst the "Maid" and "Minx" have slides, so don't on any account forget to open the cylinder drain cocks before starting off from cold, and don't close them until the cylinders are thoroughly hot, and water has ceased to issue from the cocks. Give the lubricator wheel a few turns by hand, to ensure that the valves start with lots of oil. Once the oil film between piston-valves and liners is established, the lubricator will maintain it, and the top of the chimney should always show signs of oiliness, an indication that all is well down below. As long as the film *is* maintained, wear will be negligible, as the metal surfaces never actually come in contact; also, as the film forms a seal, wheezing and blowing should be entirely absent.

Passing Thoughts About Tractive Effort

I haven't the foggiest notion who wrote the paragraph about tractive effort, in the "Smoke Rings" columns in the issue for February 24th last, so don't run away with the idea that I am trying to "pull a fast one" on anybody in particular; but certain statements made in it, seem to call for a little analysis and elaboration. Let us therefore expound!

The statement that "theoretically, a locomotive on a straight track with dry rails should be able to move a load equal to one hundred times its drawbar pull" means exactly nothing at all, for it entirely ignores THE vital factors, bearing and flange friction. If you don't believe me, ask any full-sized driver. He will tell you that some coaches run free, and the engine can play with a dozen of them, whilst others run as stiff as—ah, um! I'd better not report that verbatim—and he wonders if the axleboxes have been filled up with golden syrup in mistake for oil Just shut off to stop—you don't need any brakes! The same thing applies in the small size. If your passengers can spread their weight evenly over the cars, so that flange friction is reduced to the minimum, and the cars themselves have perfectly-turned wheels running on self-aligning double-row ball-bearing axles, the engine will pull an amazing load.

Now couple the same engine to a rough car consisting of a bit of plank, with four roughly-turned or worn wheels, with axles running in plain plummer-block bearings, out of alignment; sit your passenger toward one corner, so that about 75 per cent. of the load comes over one wheel, and forces its flange hard against the rail head. See what happens; even if the engine is able to start the load, she will only just crawl with it. Where has the 100 to 1 tractive effort gone? Just mopped up in flange and bearing friction.

A load of twelve times its own weight, on decently-constructed cars, should be a minimum, not a maximum, for any self-respecting little steam locomotive worthy of its name and traditions. The very first time I steamed "Tugboat Annie," during the war period, one afternoon when Jerry wasn't womming around, I put three cars behind her, using old "Ayesha's" tender because she hadn't one of her own. On those cars were five hefty adults; three of them officials of the Coulsdon and Purley U.D. Council, one of the lorry drivers, and myself, which totted up to just over fourteen times her own weight, as she was then in her unfinished state. "Annie" started that little lot without slipping, and rapidly attained a speed which gave my passengers all the excitement they wanted in staying on the cars going around the curves; she was running notched up to kicking point, and a little over half regulator. Had I let her all out, we should have been in the ditch!

My old single-wheeler "Ancient Lights" weighs 18 lb. in working order. On the occasion referred to, in the issue mentioned above, she was doing her best to run away with a load of 11½ times her own weight, with only three-quarters of her power available, owing to the sheared crosshead pin. She makes easy work of myself and a six-stone child, a load equal to fourteen times her own weight, and she would be off the road at the curves if I let her go. This from a poor old cat over 60 years of age!

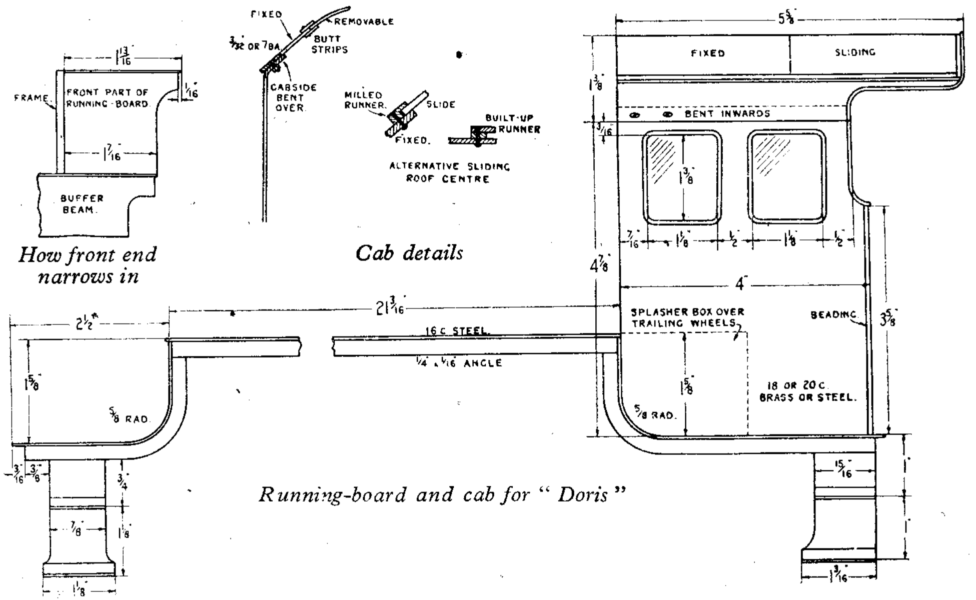
My little 2½-in. gauge Carson "Precursor," weighs 16 lb. only, but will haul two 10-stone adults at a high speed; this is equal to eighteen times its own weight, and it isn't "all-out," at that. True, it has one of my own boilers, and my own valve-gear and setting. Old "Ayesha" weighs 19 lb. and if you had seen what she did with the combined load of our advertisement manager and myself, you would have been excused for wondering if she really had any load or speed limit, despite her 27 odd years of service. Forgive me if I remind beginners that she was the engine that "started it all." I would also remind them that the locomotives referred to above, are simple two-cylinder engines, either single-wheeled or four coupled; *not* three- or four-cylinder jobs with six or more coupled wheels, with large boilers to match. They were not built for super-haulage; merely as representative express passenger engines, whose full-size sisters aim at high speed rather than great power. It is when we come to locomotives that really are intended for "shifting the load," that the haulage capacity becomes astounding. My 2½-in. gauge 2-6-6-4 Mallet "Annabel" thinks nothing at all of starting six heavy adults from a dead stand, on a grade of 1 in 70, and what she can shift on the level, has never yet been ascertained, as so far sufficient cars have not been available. As to the speed she can travel at, well, you had better ask Driver L. A. Earl, late of the L.M.S., about that!

Another engine that loves an outsize in loads is my old "Caterpillar" goods engine, four-cylinder eight-beat 4-12-2, built in 1926 in 43 days. She is only 2½-in. gauge, but at the Model Railway Club Exhibition that year she took her turn with engines twice her size, hauling 10-passenger loads; and once, at a friend's place in Birmingham, she hauled a load of 16 mixed adults and children, seated on a plank supported by two eight-wheel cars. The above instances are not intended as any "hot air," merely statements of fact for which I can vouch, and check weights and figures; but nearly every week I receive letters from delighted builders of locomotives described in these notes, giving details of deeds of prowess. To give just one example, a 2½-in. gauge "Austere Ada" did the whole of the passenger-hauling at a provincial club exhibition, for two days, taking six adults at a time, and finishing as fresh as the proverbial spring daisy. A little engine that won't pull *at least* twelve times its own weight, with cars of reasonably good workmanship, needs a little kind attention!

A $3\frac{1}{2}$-in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

THE running-boards on the little L.M.S. engine are made up in a manner somewhat similar to those of the "Maid of Kent," so there is no need to go into full details. The best way is to make them in three pieces, joined same way as suggested for the "Maid"; but there is one difference. The "Maid's" are the same width full length; "Doris's" are not, owing to the buffer-beam being shorter than the drag-beam. Either 16- or 18-gauge steel, or brass if preferred, may be used, the width bending angle is to solder a piece of square rod in the angle, bend the lot, and then melt out the square rod, leaving the angle bent as required, without kinks; a very good wheeze too, as I found when bending the angle stiffeners for the cab tops of "Jeanie Deans" and "Grosvenor." Incidentally, I made these weeny angles by milling out bits of $\frac{1}{8}$-in. square rod; another Winter specification which proved "the berries," as the resulting angle was cleaner and thinner than the drawn or extruded variety,



How front end narrows in

Cab details

Running-board and cab for "Doris"

of the strip being $1\frac{13}{16}$ in. The curved section ahead of the cylinders needs a piece approximately $3\frac{7}{8}$ in. long. Cut this to the shape shown in the plan view, the front edge being $1\frac{7}{16}$ in. long, curving out to the full width just below the valance on the "high-level" running-board; the end view is shown in the detail illustration. The long straight section, being above the coupled wheels, requires no wheel clearances cut in it, but the left-hand side will need clearance for the reverse-rod and the injector delivery pipe; these can be obtained from the actual engine, far easier than by description and drawing. The curved section at the trailing end is made the same way as that at the front end, but it is the same width all along.

The straight runs of the valances are made from $\frac{1}{4}$-in. by $\frac{1}{16}$-in. angle, riveted to the underside of the running-board by $\frac{1}{16}$-in. rivets, preferably charcoal iron, if steel running-boards are used. The valances should be approximately $\frac{1}{16}$ in. from the edge. If you can bend angle, which isn't difficult, the whole length can be made from it. Dr. J. B. Winter's dodge for and would bring joy to the heart of Inspector Meticulous. If you find that you can't bend angle without kinking it, cut the curved parts of the valances from 16- or 18-gauge sheet, and join them to the straight parts with a butt-strip at the back, same as illustrated for the "Maid." The steps can be fabricated from 16- or 18-gauge sheet steel, same as "Maid" and "Minx," and attached to the running-boards as described for those engines; both dimensions and positions are given in the reproduced drawing. The complete running-boards are attached to the tops of front and rear beams by a couple of countersunk screws in each, 6-B.A. being plenty big enough. They receive support from the guide-yokes or motion-brackets, and the link girders; and sheet-metal brackets, as described for "Maid" and "Minx," can also be used to support them between the driving and trailing axles, and ahead of the cylinders. Making and fitting the brackets is a simple job requiring no detailing. Cast brackets may, of course, be used if desired, but "fabrication" is "all the go" nowadays!

Cab

The front of the cab was shown with the illustration of the backhead fittings; the sides are shown here. They are made from 18- or 20-gauge sheet brass or steel, just as you prefer, and the hints given for "Maid" and "Minx" apply equally to "Doris." All necessary dimensions are given in the illustration. I would strongly advise beginners to cut out a stiff paper or cardboard template first, to the given sizes, and take very great pains to have the curved front bottom edge an exact fit in the curve of the running-board. When you get your template or pattern O.K., cut your piece of metal exactly to the same shape and size, and you don't waste any.

When cutting out the sides, leave a strip about $\frac{3}{8}$ in. wide along the top, over and above the height of the side ($4\frac{7}{8}$ in.) and bend this to line up with the top edge of the cab front. Pieces of angle are needed at the bottom and front edges, to attach the cabside both to the cab front and the running-board; these angles can be of the same kind used for the valances. The windows are fitted same as the "Maid," and edged with $\frac{1}{16}$-in. half-round wire, which is also used for the beading at the back of the cab, and around the edge of the cab roof. It can be soldered to a steel cab, if the metal is cleaned quite bright, and a good liquid flux is used; but wash all the flux off with hot water, after the soldering job is finished, to prevent rusting.

The roof of the cab is made from a sheet of the same metal as used for front and sides, measuring approximately $5\frac{5}{8}$ in. by $7\frac{1}{2}$ in. The corners of this are cut away and radiused off, as shown in the sketch of the roof in the flat. Owing to the overhang which protects the fireman in bad weather (rather different from the Webb cab roofs!) the centre part must be made either completely removable, or arranged to slide forward, like a kind of "sunshine roof." Both methods are shown. To make the back part completely detachable, simply cut out a piece of the roof, as shown; the exact size of this depends on yourself, how much room you need to get at the handles. A thin butt-strip is riveted at top and bottom, at each side, overlapping the edge of the opening; and a piece of metal, same gauge as the cab top, is cut to slide between the open edges of the butt-strips, as shown in the detail illustration. When the engine is in use, this piece is pulled completely out.

For the "sunshine roof" stunt, which I have used on "Tugboat Annie" and "Cock-o'-the-North," the piece is cut out as before; but a little runner is fitted, either by riveting or soldering, at each side of it. This extends to the front edge of the roof. A piece of sheet metal, same gauge as cab roof, is cut, bent to the curve of the roof, and slid between the runners. When the engine is in service, the piece is pushed right up forward, level with the cab front, leaving the gap open. When the engine is out of service, it is pulled back, level with the back edge of the roof, and covers the opening. The runners can be made either by milling a rebate in a piece of $\frac{3}{16}$-in. by 3/32-in. strip, or using two strips, one wide and one narrow, as shown. I used the milled runners on my own locomotives.

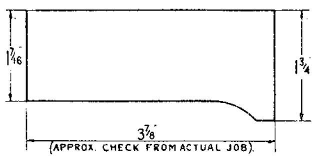
The completed roof is attached to the bent-over portions of the cab sides, by 3/32-in. or 7-B.A. countersunk screws, nutted under the roof as shown in the detail sketch. A rectangular box, of the same kind of metal as the cab, is made and fitted to the inside of the cab on each side, to cover the wheels, as in full-size practice; this can be permanently soldered, or attached by pieces of angle, to the inside of the cab. Make-up pieces of the same kind of steel used for the running-boards, are fitted between the frames ahead of the smokebox, and behind the back-head. The latter piece may be attached to the top of the drag-beam by a couple of 3/32-in. or 7-B.A. countersunk screws; but the front piece must be detachable, for getting at the lubricator. On "Jeannie Deans" I used two 3/32-in. steel pegs, riveted into the piece of plate, and fitting in corresponding holes in the top of the buffer-beam. This did the trick in fine style, rendering the piece instantly detachable, but at the same time the pegs prevented it shifting or jumping out when the engine was running. On the full-size "Jeanie" there was nothing at all between the frames, between buffer-beam and l.p. cylinder cover, but I didn't like the wide open space on the little one, so I covered it over as above, and it looks all right.

"Doris" in 5-in. Gauge

Before proceeding with the rest of the "trimmings," brake gear, and tender, I had better reply collectively to a number of letters which have come to hand regarding the possibility of building a 5-in. gauge "Doris." First of all, I don't want to throw cold water on the idea—don't get running away with that notion for one minute; but I earnestly ask everybody who has written, or who contemplates the idea of building "Doris" (or any other locomotive, if it comes to that) in 5-in. gauge, to consider very carefully whether their equipment will be adequate for the job; how much they can afford to spend on it; and whether they realise how long it is likely to take, and the size and weight of the engine when completed. It is a jolly good "two-man" job to lift the engine alone; and even when building, after you have got the frames erected, and the cylinders and wheels on, it needs a pretty strong person to move it about or turn it over on the bench. I am constrained to call attention to these points, by virtue of letters received from builders of the "Maid of Kent," who light-heartedly started on the job, hit their first lot of trouble in machining the big driving wheels and the cylinder-block on a lathe of 3 in. centre or thereabouts, became alarmed at the size and weight of the chassis as it "grew up," and are now getting worried about the boiler. Many correspondents who asked me to describe a 5-in. gauge engine, wanted a 4-6-0 or "Pacific" (three correspondents at least, asked for the four-cylinder L.M.S. "Sir William Stanier") and nobody at all suggested a small shunting tank of the 0-4-0 or 0-6-0 varieties. I had a "hunch" what was going to happen, having built so many locomotives myself; so I selected the two simplest and smallest tender engines of normal type, the 4-4-0 and 0-6-0. Builders of these engines are, as stated, finding the job just as much as they can manage; there are, I might add, far more "Minxes" being built, than "Maids." Well, with that preliminary warning, here are a few remarks on a 5-in. gauge "Doris" for those who have the equipment, energy, and cash to tackle it.

Existing Drawings Can be Used

The measurements shown on the drawings published in these notes, or the blueprints sold by our advertisers, can be increased in the proportion of 7 to 10 for all general dimensions, such as wheel centres, length of frames, pin centres of valve-gear and so on. Variations may be



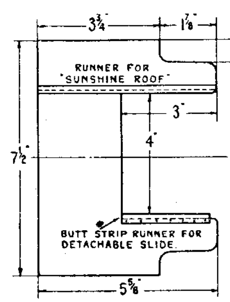
Front part of running-board "in the flat"

made where desirable, to bring the engine more into line with full-size practice; for instance, the cross-section of connecting- and coupling-rods, valve-gear parts and so on, may be a little lighter in proportion. Frames *may* be made from ⅛-in. steel, as specified for "Maid" and "Minx," but it would be better if they were a little thicker, the distance over the outsides being 4⅜ in. Horns and axleboxes same as "Maid." The bogie can also be the same as "Maid," or the specified 3½-in. gauge bogie enlarged; but if this is done, I should advise a proper inverted leaf spring each side, as in full-size practice, instead of the plunger-spring arrangement. The front end of a 5-in. gauge "Doris" is going to be mighty heavy! The bogie wheels would be 3½ in. diameter, and the coupled wheels 6⅝ in. diameter.

The cylinders should be 1 11/16 in. bore by 2½ in. stroke, with ⅞-in. piston valves; these may either be of the plain bobbin type, in which case several fine grooves might be turned in each one, to hold the thick cylinder oil and form a seal (called "labyrinth packing" in full-size practice) or proper rings may be fitted. Cast-iron should not be used for cylinders unless the engine will be running very frequently; despite all that has been said and written, I have never yet come across a case of cast-iron cylinders that did not deteriorate through rust and pitting, when the engine was out of use for any length of time. A variation could be made with advantage, in this size, for getting rid of the exhaust steam; if sufficient readers are interested, I would gladly give a drawing of my recommended ports, valves, etc., for a 5-in. gauge "Doris," by kind permission of our friend the K.B.P., but it isn't worth doing it "on spec." It is as much as I can do, to get out the drawings for the "serial" engines. Incidentally, it is a wonder you got anything at all, these last three weeks or so; my fair lady caught the flu among the Saturday shoppers and passed it on to me. It is the first time I have been "laid out" since the bad air on the "Underground" did it, many years ago. Like "Sophie Tuckshop" on the radio, "I'm all right now" except for a sore throat which makes talking very painful. If this meets the eye of Mr. Clarkson, of New Zealand, he will know why he didn't get the promised telephone message whilst staying at Sydenham. Returning to the job, the valve-gear will be all right if the 3½-in. gauge instructions are followed, enlarging the parts as stated.

Boiler

The shell of the boiler should be made of ⅛-in. copper with 5/32-in. backhead, the dimensions of both barrel and wrapper being enlarged as above; but the inside firebox, tubes, superheater flues, and so on, should be made the same as I described for the 5-in. gauge "Swindon Kettle" in these notes some time ago. Blueprints of this boiler, full size for a 5-in. gauge engine, are available. It will make all the steam needed, and supply it good and hot; by the way, I am pleased to see that high superheat, long-travel valves, big ports and mechanical lubrication, advocated in these notes for so many years, and specified for my own locomotive designs, are now being "boosted" by our more enterprising advertisers; good luck to them! It is high time all the old conventions were cast away for ever. The detailed instructions given for building the "Swindon Kettle" can be applied to the boiler of a 5-in. gauge "Doris," so I need not dilate further on that subject. The boiler fittings can be the same type as described for the "Maid" and "Minx." Concluding this very short summary, all the instructions given for machining and fitting the various components of the "Maid" and "Minx," apply equally to a 5-in. gauge edition of "Doris" and provided that the equipment is available, no particular trouble should be experienced in building it. However, don't forget that I warned you, it is a lengthy, hefty, and fairly expensive job, and rather too much for a beginner to tackle.



Cab roof before bending

Contrary to the above, some followers of these notes who own gauge "1" indoor railways, ask if it is feasible to build a little "Doris" to half the given dimensions, to suit their railway, and could it be fired by oil or spirit? The answer to this is definitely "yes"; but the best thing to do, regarding instructions, would be (if our friend with the blue pencil raises no objection) to devote one week to giving notes plus a few drawings for the job, same as I did with the gauge "1" "Juliet." Two or three sheets of blueprints could be made available. With an oil-fired water-tube boiler, the engine should make easy work of a train of eighteen or twenty coaches on an outdoor "scenic" line, and would have no difficulty in doing a spot of live passenger hauling. A gauge "1" "Dyak" type engine I built for a friend, now, alas! over the Great

Divide, hauled my weight easily, and ran away with a boy of 12.

How Experiences Differ

Three of my fleet of locomotives are provided with working donkey-pumps for auxiliary boiler feed. "Fernanda," a $2\frac{1}{2}$-in. gauge 4-6-2, has a vertical single-cylinder pump of the Weir pattern. The trip rod operating the reversing-valve is worked off the piston-rod. The reversing-valve operates two small shuttle pistons on a single spindle which passes through a slot in the back of the main valve, a simple slide valve of the usual type, the ports being just plain drilled holes. The steam cylinder is $\frac{5}{16}$ in. bore and $\frac{3}{8}$ in. stroke; the piston-rod is 7/32 in. diameter, and prolonged to form the pump ram. The pump cylinder is made the same shape as the steam cylinder; it is separated from it by a turned distance-piece, and the trip rod works between them. Both steam and water valves are at the side. This pump has been fully described and illustrated in these notes, and blue-prints of it are available.

"Annabel" the 2-6-6-4 "Mallet," has a similar pump arranged horizontally. The valve-box on the water pump is located vertically across the end of the pump cylinder, otherwise the "works" are the same.

The 4-12-2 "Caterpillar" has a twin-cylinder duplex pump, made exactly as described for "Fayette," back in 1928 or thereabouts. The cylinders are $\frac{5}{16}$ in. bore, $\frac{3}{8}$ in. stroke, the piston-rods being hollow, and containing trip rods similar to full-size Westinghouse pumps. These trip rods pass through weeny glands on the top cylinder covers, and operate the valve spindles direct by rockers. The ports are crossed, the steam-ways being all drilled in the casting.

Each of the above donkey-pumps is supplied with wet steam from a valve on the backhead of the boiler; both "Annabel" and the "Caterpillar" have several inches of exposed pipe between the steam valve and the pump cylinder. *Each pump is furnished with a little displacement lubricator on the steam pipe*, close to the pump. As the pumps work on wet steam, I do not use the heavy grade of superheater oil, as used in mechanical lubricators, for the pumps, but a more fluid oil, of about the same viscosity as used in the engine of my gasoline cart. The lubricators are always filled before getting up steam. The pumps will start all right when the steam valve is opened, but work erratically until they get rid of all the condensate water; when it has all been blown out, and the cylinders attain working temperature, the pumps work evenly, ticking away like sewing-machines, and maintaining a steady feed. By careful regulation of the steam valve, it is possible to keep a practically constant level in the gauge glass. Now, should one of these pumps quit work when the engine is running, *it is an unfailing sign that the lubricator is empty*, and I immediately stop and refill it, when the pump resumes "business as usual." I could, of course, force the pump to carry on, by giving it more steam, which would easily overcome the extra friction entailed by the failure of the oil supply; but no engine-driver in his right senses would ever force any part of his engine to run without oil! It is a standing joke, that a driver and his oil feeder are inseparable companions; but it happens to be a joke with a solid foundation of truth behind it!

I might add that "Fernanda's" pump worked for nearly thirteen years before the shuttle pistons became worn sufficiently to allow steam to pass and "stop the clock." Had I run it without oil, it wouldn't have lasted the proverbial five minutes. 'Nuff sed!

Constructing a Gear-Cutting Machine

(*Continued from page* 488)

the underside of the bracket. This must be dead square with the bore, and seeing that this bore can now be tightened up, the block can be clamped round a 1-in. bar held truly in the lathe chuck for this facing operation. After the two $\frac{1}{2}$-in. Whitworth tap holes in the back of the block have been drilled and tapped it is ready for fitting to the body casting. The two parts of the slide, which should have been machined a tight fit, are now made a sliding fit by careful scraping and when the keep-plates are screwed down tight, there should be no appreciable play. The keep-plates are merely 5 in. lengths of $\frac{3}{4}$ in. $\times$ $\frac{3}{16}$ in. B.D.M.S. drilled and countersunk where indicated. Their corresponding tap holes in the body castings are spotted through.

Feedscrew. M.S.

This is a straightforward turning and screw-cutting job and calls for no special comment, all the work being done between centres. The B.S.F. Whitworth form thread is quite satisfactory in use and I hardly think it necessary to go to the trouble of cutting square threads. The feedscrew keep-plate is made from $1\frac{1}{2}$ in. $\times$ $\frac{5}{16}$ in. B.D.M.S. drilled $\frac{1}{4}$ in. clear in the positions marked. This is bolted to the top of the body casting by two Allen socket screws in corresponding tap holes. The screw is operated by a knurled knob turned from $1\frac{1}{2}$ in. round steel bar. A taper pin secures this knob in position. For adjusting the depth of cut a graduated collar is fitted immediately under the operating knob. This is a plain steel collar free to revolve on the plain portion of the screw except when locked by the small $\frac{1}{8}$-in. Whitworth knurled headed screw. The graduations can be engraved in the lathe by indexing with a change wheel on the end of the lathe mandrel and scribing with a pointed tool held sideways in the toolpost—an operation often described in these pages. Alternatively, this job can be left till later and done on the machine itself, an operation which will be described fully at a later stage. As the B.S.F. thread is $\frac{1}{16}$ in. pitch, the collar is divided into 62 divisions, each representing 1/1,000 in. of feed.

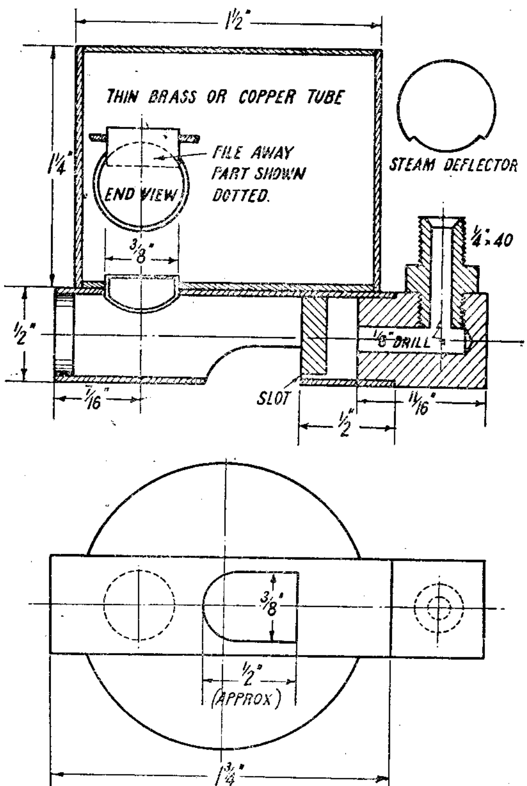
(*To be continued*)

A $3\frac{1}{2}$-in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

HERE, as promised is a description of a simple way of giving little "Doris" a voice that resembles that of her full-size relations. It is possible to get the exact note and timbre by means of a mouth-organ reed in a suitable tube, arranged in a manner somewhat similar to the old motor bulb-horn reeds; but it needs careful manufacture and adjustment, whereas the veriest Billy Muggins can easily make up the gadget shown. At one time, before the nationalisation business, the L.M.S. engines used to come past our hacienda every day, on the through run to Three Bridges; and if I happened to be out on the little railway, they would give me a friendly toot, though the clatter kicked up by the "8Fs" probably drowned the answering call of whatever engine I happened to be running. But I don't see them any more, and it is a far cry from here to the L.M.S.—it is nearly two years since I was anywhere near their home road; but there are plenty of "Austere Ada's" on this section, and they have a similar-sounding whistle, so I tuned up my experimental one to resemble their note.

There is nothing new in the use of a resonator-box to obtain a deep note on a small whistle; Carson's used them on their $3\frac{1}{2}$-in. and 5-in. gauge engines 40 years ago. But there is one difference, which makes all the difference, in a manner of speaking; the Carson whistles were arranged vertically, with the box right on the end of a short tube whistle of the usual pattern. When steam was turned on, any water that went over, or any produced by condensation of the steam in a cold pipe, was blown up into the box, and kept there by the rush of steam, producing a "bobbling" sound. The whistle gave a clear note only when hot, and supplied with dry steam. One was fitted to the 5-in. gauge Carson "Precursor" which I did up for Mr. R. C. Hammett, when he put our air-raid shelter in, during the winter of 1940-41; this had the above characteristics. To get a clear note, you have to keep the water out of the "sound-box"; and the easiest way of doing this, is to use a short horizontal whistle with the sound-box on top of it. There is a simpler way still, and that is to put a short tube in the bottom of the sound-box, and blow a jet of steam straight across the end of it, by means of a "mouthpiece" having a very fine steam slot in it; but while this is certainly simpler "on paper," in actual practice it isn't, as the mouthpiece with the steam slot is rather ticklish to make and adjust. I tried one before making the gadget shown, and it took far longer, with more "messing about," and no better result. Incidentally, the first of this type I made, was for my L.B. & S.C.R. engine "Grosvenor"; and by using a sound-box $1\frac{1}{2}$ in. diameter and $1\frac{1}{8}$ in. long, the little engine has the voice of her big sister. When it first sounded on my road, I shouldn't have been the least surprised bit if the old Coulsdon signal had waved its arm in acknowledgment.



Section and plan of deep-tone whistle

How to Make the Whistle

The sound-box is a piece of $1\frac{1}{2}$-in. diameter brass or copper tube squared off in the lathe to a length of $1\frac{1}{4}$ in. The gauge of tube doesn't matter within reason, but the thinner it is, the better. If a piece of tube this size isn't available, roll up a piece of sheet brass or copper, of about 22-gauge, and solder the joint. It need not be silver-soldered, or even riveted, as there is no heat or pressure to withstand. The two ends are discs of 22-gauge sheet brass or copper, cut to fit tightly, and soldered. At $\frac{3}{8}$ in. from the edge, on one of the ends, drill a $\frac{3}{8}$-in. hole.

The part that makes the noise is made from a piece of $\frac{1}{2}$-in. thin brass or copper tube, the ends being squared off in the lathe, to a length of $1\frac{3}{4}$ in. At $\frac{1}{2}$ in. from one end, file the arch-shaped hole to the dimensions shown. The length of the opening need not be made to "mike" measurements, but the width of it should not be greater than shown; it must be less than the diameter of the tube, to give the best results. Chuck a bit of $\frac{1}{2}$-in. brass rod in the three-jaw, and turn down about $\frac{1}{2}$ in. of it to a drive fit in the tube; part off two $\frac{1}{8}$-in. slices. One is driven into the end of the tube to plug it; and the other has a tiny segment filed away, to the length of the "sound-hole" and a depth of about 1/32 in., so that when it is driven into the tube, with the filed-away portion level with the "sound-hole" (see section) steam issuing from the curved slot between disc and tube, passes right across the hole.

Chuck the $\frac{1}{2}$-in. rod again, and turn down $\frac{3}{16}$ in. of the end, to a drive-fit in the tube. Centre, and drill down to $\frac{5}{8}$ in. depth with $\frac{1}{8}$-in. or No. 32 drill. Part off at $\frac{11}{16}$ in. from the end; reverse in chuck, face off the pip if any, and slightly chamfer the edge. At $\frac{1}{4}$ in. from the blank end, drill a 7/32-in. hole right through into the blind hole, and tap it $\frac{1}{4}$ in. by 40. In this, fit a union screw, as described for pumps and boiler fittings; this is screwed $\frac{1}{4}$ in. by 40 at both ends.

At about $\frac{7}{16}$ in. from the plugged end of the whistle tube, drill a $\frac{3}{8}$-in. hole, diametrically opposite to the arch-shaped hole. In this, fit a short piece of $\frac{3}{8}$-in. tube, same as used for boiler tubes, or a bit of thin brass treblet tube would do. File off the end, with a round file, so that the tube doesn't project into the whistle tube, and cause obstruction. The other end of the tube is fitted into the hole in one end of the sound-box, the whistle tube fitting tightly against the cover or end plate. All the joints can then be soft soldered. Note, there must not be any air leaks, especially around the short bit of tube connecting the whistle tube to the sound-box. Now, if you blow into the open end of the whistle tube, you should get a faint, rather husky, low note. If the whistle blows easily by lung pressure, it is not suitable for high steam pressure. Push in the spigot of the union fitting, then connect a tyre-pump to the union screw. Press on the handle of the pump, bending any part of the connecting hose almost double, to prevent air passing; then suddenly release it when the gauge of the pump indicates 60 lb. or so. The whistle should then give a clear note. If it doesn't, either there is a leak in the soldered joints, or else the disc at the arch-shaped hole needs adjusting. If O.K. the whistle should blow the very deep L.M.S. note, quite clearly, at 60 lb. pressure. It will not be very loud, as the laws of acoustics (I believe that is the "scientific" term!) won't permit a little whistle to give the same volume of sound, at the same pitch, as a big one; but as you don't have to call a signalman's attention a couple of miles away, or anything of a similar nature, on the average little railway, the absence of a great volume of sound doesn't matter a bean. If you want the sound of the whistle to carry a long way, a small whistle must be made to give a shrill tone. You can't have it all ways! I have seen it stated that the proper way to make the opening is to cut it straight across, and not in the form of an arch at all; all I can say to that, is that the great majority of tube whistles, including the American chime whistles, have arch-shaped openings, and I have found this shape very satisfactory on my own engines.

How to Erect the Whistle

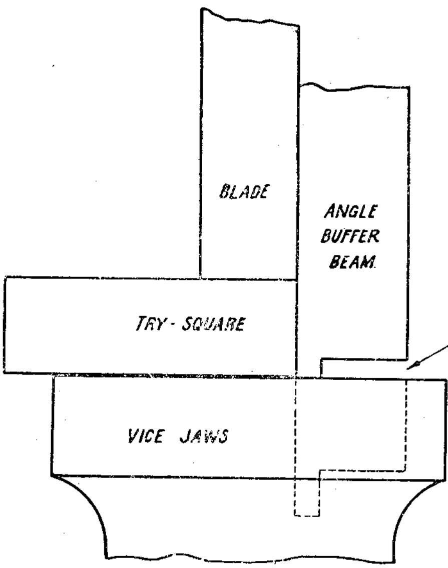
It took only about 15 minutes to erect the whole bag of tricks on "Grosvenor," so it shouldn't take much longer on "Doris." The sound-box was located about halfway between the backhead and drag-beam, with the pipe union pointing to the left. I then took the distance between the union on the whistle and the union on the turret, with a bit of lead fuse wire; cut my pipe, made the two nuts and cones, and silver-soldered the latter to the pipe, softening it at the same time. After pickling, washing off, and rubbing up with a bit of fine steel wool, the pipe was bent to the right contour by finger pressure, and the unions connected up. The pipe held the whistle in place *pro tem.* The piece of footplate between frames, backhead and drag-beam had been temporarily removed, naturally, before locating the whistle; and on this I marked a spot corresponding with the approximate centre of the sound-box, drilled it No. 40 and countersunk it. The footplate was then put in position, and a mark scribed on the top of the sound-box through the hole. The sound-box was then removed, the marked spot drilled No. 48 and tapped 7-B.A.; replaced, union tightened up, footplate replaced "for keeps," and a 7-B.A. countersunk brass screw, with a smear of plumbers' jointing on the thread, put through the hole in the footplate, into the tapped hole in the top of the sound-box.

"Doris's" whistle can be erected in a somewhat similar manner, but you can't put it exactly in the same place, as part of that space will be occupied by the steam-brake cylinder, which is attached to the left-hand frame between the drag-beam and the backhead. The best place to put it, will be as close to the right-hand frame as possible, and about $\frac{1}{4}$ in. ahead of the drag-beam. The sound-box can go partly under the top angle of the drag-beam, and the fixing screw can pass through a hole drilled in same; there is no need for the screw to be exactly in the middle of the sound-box. It has very little weight to support; the steam pipe does the lion's share of the holding up. Beginners note—if thin plate is used for the top and bottom of the sound-box, solder a little disc of brass about $\frac{1}{16}$ in. thick and about $\frac{3}{8}$ in. diameter, at the place where the screwhole is drilled and tapped; otherwise there won't be sufficient hold for the thread. Use $\frac{1}{8}$-in. pipe, to connect the whistle union to the one on the turret.

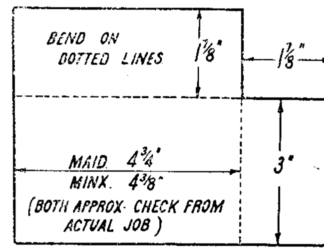
Seat Boxes for "Maid" and "Minx" Cabs

I did not include drawings for the seat boxes in the cabs for the "Maid" and "Minx," because you can get the measurements more easily from the actual job. All you need is a kind of rectangular splasher to cover the trailing wheels where they project into the cab; and these can be made by bending up pieces of sheet metal, cut to the shape shown in the illustration, and bent at right-angles on the dotted lines. They can be permanently attached to the sides of the cab, by small pieces of angle, either riveted or screwed, just as you prefer.

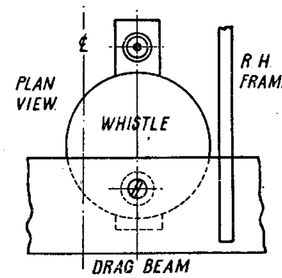
One beginner wanted to know how to get the cab front in place, as the whistle turret prevented it being slid straight into position. If the front is held on the slant, and placed over the whistle turret first, no difficulty should be experienced in getting the lower part over the sides of the firebox, as there are no projecting pipes or other impedimenta, to obstruct its passage; but one of my favourite tricks on my own engines, is to divide the cab front into two pieces, the joint being immediately in front of the whistle turret. Each half is then permanently attached to the corresponding side of the cab, and the seat box also fitted, thus making one unit of the cabside and half the front. The two halves are joined over the boiler by a piece of brass angle, the vertical part of which is riveted to one half, and attached to the other by countersunk screws; the cab roof is screwed down to the horizontal part of the angle. This arrangement was especially suited to "Grosvenor," as the cab front is straight at the top, not curved as usual, and the front part of the cab roof also is flat.



A simple way of cutting true slots in buffer beams



Seat boxes "in the flat"



How to erect the whistle

Beginner's Corner

Many years ago, more than I care to remember, a section of these notes was set aside for the exclusive benefit of raw beginners; I called it the "Tyro's Lobby," and in it described sundry elementary jobs in locomotive-building. These included the construction of a very simple 4-4-0 locomotive in 2½-in. gauge, which I called "Annie Boddie" because anybody could build it. There were a lot of these engines built, and many are still running. Well, from time to time I still receive letters from raw tyros, asking for publication of simple detailed instructions on how to carry out various operations in locomotive construction; so with the kind permission of our friend with the blue pencil, I propose to deal with a few simple jobs, explaining how same can be done without expensive equipment. Remembering the days of my childhood, spent around "Poverty Corner," I have very great sympathy for those whose workshop equipment is of the most primitive kind; but they can take consolation in the fact that it isn't always the owner of the most expensive and elaborate outfit, who turns out the best locomotives!

The Why and Wherefore of Angle Buffer-beams

Now, when your humble servant sets out to design or build a locomotive, the *modus operandi* is exactly the same as that pursued by a full-size Chief Mechanical Engineer. I take into consideration the size of the engine, the work it will be called upon to do, and the probable facilities needed for building it. I aim at making the engine strong, serviceable, easy to build, powerful and efficient; and it is in no sense a "model," a word I hate and detest. Where full-size practice can be copied with advantage, it *is* copied; where better results can be obtained by departing from "orthodox" methods of construction, these are ruthlessly abandoned. What is suitable for 4-ft. 8½-in. gauge, is very frequently quite unsuited for 5-in., 3½-in. or smaller gauges. My designs are not based on the building of one, two, or even half-a-dozen engines, but by scores; I have a whole fleet here now, for operation on my own little railway. In the days gone by, when I had more time and energy, I carried out any amount of rebuilding and overhauling for various friends and other folk, and thereby became acquainted at first-hand with the shortcomings—and they were many!—of various other designers, especially those who did not build themselves; and in my own engines, I have endeavoured to eliminate the faults discovered. New readers may be interested to know that it is now 60 years since I built my first working locomotive—experience teaches!

A weak point in the design of many engines, is the buffer-beam. In full-size practice it used to be a huge wooden plank or beam, attached to the front of the frames, hence the name. In modern engines it is a steel plate secured to the side frames by angles and gussets. Many of the engines I repaired, had the frames out of square, of rhomboidal form, either by having a "biff" on one corner of the beam, or else being put up incorrectly. In every case, the beam was either a casting with lugs on it to receive the frames, or just a plain strip of metal, secured by angles in imitation of full-size practice.

When I started these notes, some 25 years ago come September, I determined that in any design put forward, all defects that I had discovered should be eliminated; and to provide frames that would be easy to erect squarely, and withstand the shocks of collision, derailment, and other happenings, I started to specify buffer-beams made of angle steel, with the horizontal member slotted out to take the frame plates. Now, brother beginners, just try this little experiment. Put a piece of steel, 1 in. wide, and ⅛ in. thick, in the jaws of your vice, letting, say, about 2 in. stick out at the side of the jaws. Now hit the projecting part sideways with a hammer; give it a reasonably hefty clout. Bent it pretty badly, haven't you—ah, I thought so! Well, now put a piece of 1-in. by ⅛-in. angle steel in the vice, gripping by the vertical part of the angle, and letting the horizontal part rest on top of the vice jaws; don't hold that part at all. Now give the end a clout with the hammer, same as you did the flat bar. Doesn't seem to have any effect at all on it, does it? Well, that little experiment will explain, without any words, why I use and specify angle buffer-beams. If an engine with a flat bar beam bumped into anything, even with moderate force, and got all the shock on one corner, or one buffer, the beam would be bent, and the whole frame knocked out of square, no matter how many cross-stays were inserted between the frame plates. Even if the stays were heavy castings, the frame would probably be distorted between the beam and the first and second stays. But if a locomotive with a buffer beam made of angle, hits anything, or even jumps the road and falls cornerwise on a concrete path, the angle withstands all the shock, just the same as the bit of angle in the experiment mentioned above; and the frames remain straight and true.

As an actual example, a locomotive which I built for a friend over 20 years ago, got away with him (he always was a bit of a speed merchant, especially with automobiles) hit the stop-buffers at the end of the track at a speed which he estimated at about 15 miles per hour, completely demolished them, and crashed clean through a feather-board fence. The driver severely bruised his arm and side, as he was sitting on the car the same way as I do; and the smokebox front of the engine was completely stove in, the chimney being knocked backward like the funnel of a destroyer. The angle buffer-beam was undamaged, the frames intact, and the only damage to the cylinders and motion was a bent eccentric-rod. Had the engine been fitted with an ordinary thin plate buffer-beam, she would have probably been so badly knocked "out of plumb" that a complete rebuild with new frames would have been necessary. As it was, a new smokebox put her completely "as-you-were," the bent eccentric-rod being only a couple of minutes' work to correct.

How to Cut True Frame Slots by Hand

Owners of a milling-machine, planer, or shaper, shouldn't have the slightest difficulty in cutting the slots for the frames dead square with the angles. I always clamp mine back-to-back, set them up in the machine-vice on the table of my milling machine, and cut the slots in both beams at one fell swoop. This ensures that the frames are parallel and square with the beams; they would have some difficulty in being anything else! The same process can be applied when using planer or shaper; set up the beams, clamped back-to-back, in the machine-vice, parallel with the table, or if you prefer, clamp them down to the table. Then cut the slots with a parting tool in the clapper-box. Grind the tool to such a width that it cuts a slot which will be a tight fit for the frames.

I didn't always have a miller, and in the days when my equipment was limited, I cut true slots by hand, in the manner illustrated. Any beginner who hasn't any means of machining the slots, should very carefully mark them out on the angle, then clamp same in the bench vice, setting it at right-angles to the jaws by applying a try-square in the manner shown with the slot level with the jaws. Now, by putting two blades in the hack-saw frame, side by side, and pressing same down on the vice jaws as you cut, a rough but true slot can be formed; and then, by judicious application of a thin flat file such as key-cutters use for forming wards, a slot can be formed to take the frame a tight fit. If the vice jaws are used as a guide for the filing, and the angle has been set vertical by means of a try-square as shown, the slots must of necessity be at right-angles to the beam, therefore the frames will also be true. Personally, I wouldn't give a thank'ee for a frame with plate buffer-beams, no matter how well stayed, because I believe in applying the strength where it can best resist shocks. Slots can be cut in the lathe, too, but I will dea with that method in a future note, if all's well.

A $3\frac{1}{2}$-in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

WELL, here we are—all-present-and-correct-sergeant! A nearly-worn-out locomotive can't sprint along the level road at 100 miles per hour, and take banks in its stride; and your humble servant being in the same category, naturally it takes a bit more time than of yore, to get out a drawing and details for a guaranteed job. Still, you know the old saying about everything coming to those who wait! In offering the reproduced drawings, I thought that it would be as well to include enough detail to allow builders of "Doris"—and they are many—to get a good kick-off on the tender job. As I have already given a fair bit of detailed information about the tenders for the "Maid of Kent" and the "Minx," and the tender for "Doris" differs only in size and minor details, it shouldn't be necessary to recapitulate the whole rigmarole; so I will deal briefly with the general construction, and then you can go right ahead and get on with it.

Frames and Beams

Two pieces of ordinary soft blue steel, $17\frac{1}{4}$ in. long, and $2\frac{1}{2}$ in. wide, will be needed for the frames. There is no need to make tender frames as thick as engine frames, as they only have to carry a light load, and there are no traction stresses to withstand, as in the case of engine frames; so 13-gauge (3/32-in.) material will do fine. Mark one out, drill a couple of the screwholes, temporarily rivet the plates together, and get busy with hacksaw and file. Leave a weeny radius at the top of the axlebox openings as shown. An Abrafile will make short work of the arch-shaped openings, only be sure that you keep well within the marked line. These bits of rough wire cut so jolly quickly that you are over the border before you realise it. Incidentally, I tried one in my Driver jig-saw, in place of the usual blade, when I ran out of blades, but it wasn't a success, as the machine ran much too fast for it. The only way to slow it down, would be to install a geared motor, but then it would be too slow for sawing brass and copper, which I mostly use it for.

A 4-in. length of $\frac{1}{4}$-in. by $\frac{1}{16}$-in. angle, either brass or steel, is riveted flush with the top, on the inside of each frame, as shown in the illustration. Since my "Diacro" bending brake came home, I have utilised small bits of 16-gauge steel for making short lengths of steel angle, to be used in place of the extruded brass hitherto specified for these jobs; and as the machine makes perfect angles, equal or unequal, in a few seconds, there is considerable saving both of time and cost, not to mention utilising material otherwise scrap.

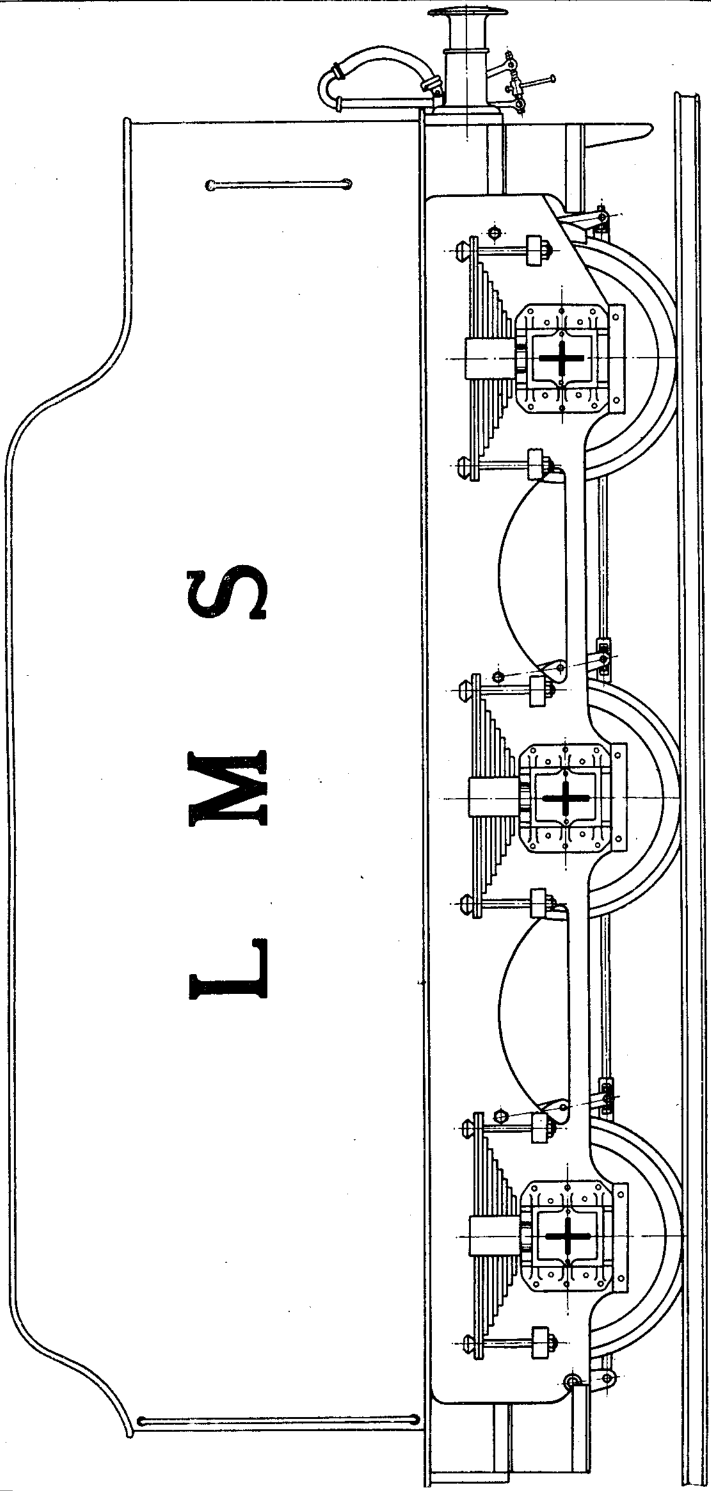
A separate detailed sketch is given, of the horncheeks. Our advertisers who supply "approved" castings, will be able to do the needful, and the horncheeks are machined and fitted, exactly as described for "Maid" and "Minx," so there is no need for repetition. Use $\frac{1}{16}$-in. charcoal-iron rivets, or soft steel rivets if you prefer them, resting their heads in a cupped dolly, made as previously described. Countersink the rivet holes on the inside of frame, and after hammering down the rivet shanks, file off flush.

The beams are made same as the engine beams, from the same kind of material. Note, the frame slots are only 3/32 in. wide, and the inner edges are $4\frac{1}{2}$ in. apart. The drag-beam has square corners, but the buffer-beam has the corners filed off; in full size, this allows the engine to clear lineside obstructions when going around a curve sharp enough to cause considerable overhang. As the holes for the buffer-shanks foul the side frames, nuts cannot be used to fix them; so instead of drilling clearing holes in the beam, tap them $\frac{3}{8}$ in. by 32. The special buffers for these will be described later; let's see to the most important things first. There was once a club member who was always talking about the splendid $3\frac{1}{2}$-in. gauge locomotive he was building, but nobody ever saw any sign of it; and at last he was challenged to prove that he actually *was* building one, by bringing along the pieces. He solemnly produced the front draw-hook at the next meeting!

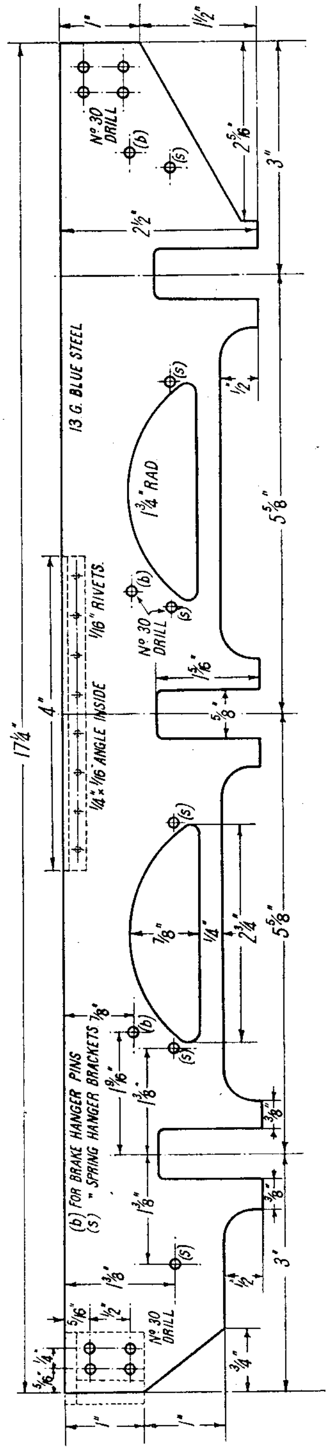
The frames may be attached to the beams either by angles, screws, and rivets, as shown, or by brazing or Sifbronzing the frames into the slots, in which case no angles are needed. I always Sifbronze mine now, with temporary distance-pieces between the frames, and clamps outside, to maintain the whole issue true and square under the heat; the process has been fully described. Many full-sized tender frames are now made up by welding, so once again big practice is following small; yet when I first started in to make brazed or bronze-welded frame assemblies, I was derided by the board of directors of Messrs. Knowitall & Co. Unlimited, on the grounds that this method of construction was "not a real engineering job!!" Well, I guess that time proves all things. Beginners, don't forget, before putting the screws in, or applying the blowlamp or blowpipe, to level up the frames on the lathe bed, or something equally flat, and check the beams to see if they are square with the frames. There must be no suspicion of "chair-with-a-short-leg" effect when the whole lot is permanently assembled.

Axleboxes and Springs

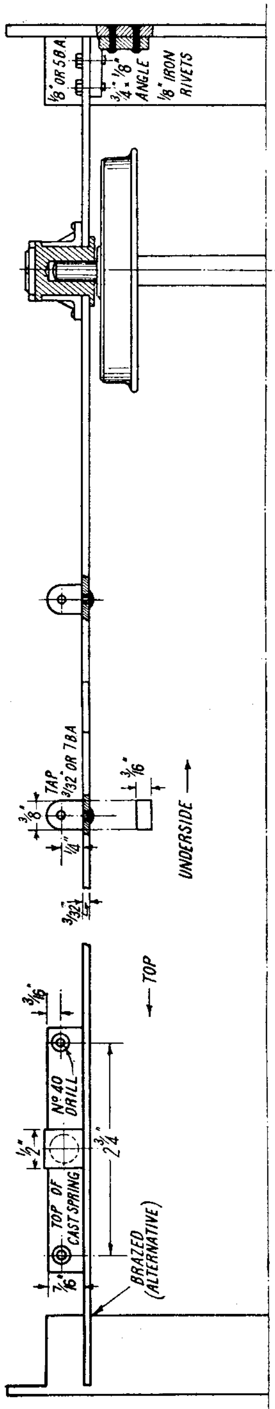
Our "approved" advertisers will probably supply the whole set of axleboxes cast in a stick. This will probably be too long for the side grooves to be milled out at one fell swoop, on the average home-workshop lathe; but if you have



Side elevation of tender for "Doris"

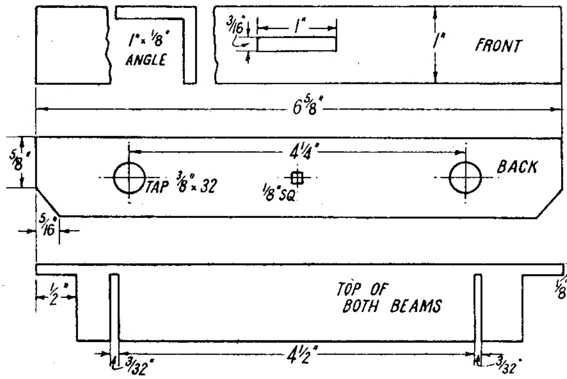


Dimensioned details of the tender frame



Some details of frame assembly

the needful, go right ahead. Otherwise, saw the stick in two, and perform on each half separately, same as described for main boxes, or the tender axleboxes for "Maid" and "Minx." Have them an easy sliding fit in the hornecheeks. Either part the boxes off the stick by holding same in the four-jaw chuck and using an ordinary parting-tool, or saw them off, chuck each in the four-jaw, and face the ends with a round-nose tool set crosswise in the rest. The backs can be smoothed off with a file; cast fronts shouldn't need touching.



Buffer and drag beams

Mark off the axle holes, centre-popping the middle of the back; and if you haven't a machine-vice to hold them whilst drilling, chuck each box in the four-jaw, with the pop-mark running truly, and use a drill in the tailstock chuck. The holes *must* be true and fair with the sides and back of the box. Don't forget the weeny oil holes!

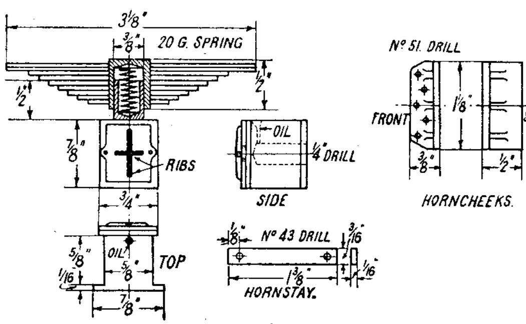
If you can't get castings, use bar material of $\frac{3}{4}$-in. by $\frac{7}{8}$-in. section, and machine it same as the stick of cast boxes. Alternatively, if anybody wants to dodge the milling process, they can, by making the boxes from $\frac{5}{8}$-in. square rod, with separate front face and back flange cut from 16-gauge sheet brass, and either silver-soldered on, or screwed and soft-soldered. The ornamental twiddley-bits can be cut from sheet, and screwed and soldered on likewise. If rod material is used, it should be good-quality brass, bronze or gunmetal, otherwise excessive wear will take place. If only soft stuff like "screw-rod" is available it can be used if the journal holes are bushed with gunmetal or bronze, as specified in similar case for "Maid" and "Minx."

The springs may either be the usual castings with a plunger in the hoop, or real working leaf-springs. In the former case, the plungers and springs are fitted as described for the 5-in. gauge jobs, but to the sizes shown here. If working leaf-springs are desired, they are best made up on Tom Glazebrook's system of "laminated plates," thin spring steel of about 26-gauge being used for the laminations, about three thicknesses being needed for each "plate" in the spring.

A hoop or buckle is easily made, as shown in the detail sketch, from $\frac{1}{2}$-in. square rod; I have shown it tapped 5/32 in. by 40 for a grub screw, to clamp the nest of plates, but if you can get hold of a small Allen screw, use it, and tap the hole to suit. The holes in the top plates, for the spring pins, are punched on a block of lead with an ordinary flat-ended punch, tapered back behind the business end for $\frac{1}{2}$ in. or so. You can make it in a few minutes from 3 in. of $\frac{1}{4}$-in. round silver-steel, by process previously described.

The spring pins for both cast and working springs are merely $1\frac{1}{4}$-in. lengths of 3/32-in. round steel, screwed 3/32 in. or 7-B.A. at both ends. On the upper end of each, screw a $\frac{3}{16}$-in. length of $\frac{1}{4}$-in. round rod; chuck the pin in the three-jaw, and turn the head to the shape shown. The lower ends are screwed into tapped holes in lugs riveted into the holes in the frame, provided for that purpose. To make the lugs chuck a piece of $\frac{3}{8}$-in. by $\frac{3}{16}$-in. mild-steel in four-jaw, set to run truly, and turn a $\frac{1}{8}$-in. pip on the end, $\frac{3}{16}$ in. long; part off at a full $\frac{3}{16}$ in. from the shoulder. Drill a No. 48 hole $\frac{1}{4}$ in. from the shoulder, tap 3/32 in. or 7 B.A., and round off the end. Make a dozen of them, poke the shanks through the holes in the frame marked (s), and rivet over on the inside. When the springs are placed in position over the axleboxes, the spring pins are pushed through the holes in the top leaves, screwed through the lugs, and lock-nutted underneath with ordinary commercial nuts; the assembly can be seen in the general arrangement drawing.

The hornstays are $1\frac{3}{8}$-in. lengths of $\frac{1}{16}$-in. by $\frac{3}{16}$-in. steel strip, with a No. 43 hole drilled $\frac{1}{8}$ in. from each end, and are attached to the frames by

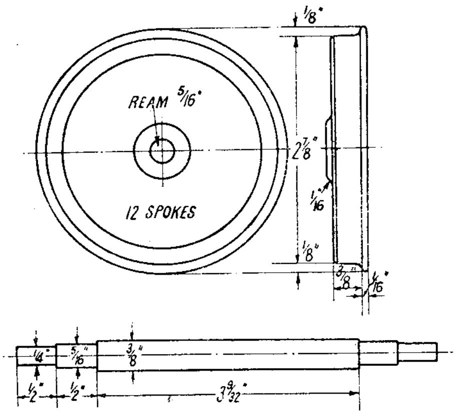


Axlebox and spring details

8-B.A. screws running through the holes in the stays, into tapped holes in the frame. Use No. 51 drill for 8-B.A. tap, and roundhead screws for preference.

Wheels and Axles

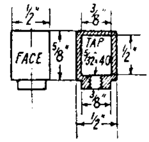
The wheels are finished to $2\frac{7}{8}$ in. diameter on tread, and should have 12 spokes; the hole for the axle is reamed $\frac{5}{16}$ in. They are turned in exactly the same way as the engine wheels, so I needn't waste space by repeating how the operation is done; beginners should be careful to have a nice even radius between tread and flange, and to round off the flange as shown. I have seen an engine which cost a three-figure price, with a sharp angle between tread and flange, and the flange itself not rounded off at all. When running, the sharp edge of the flange bore hard against the outer railhead on the curves, and simply cut slices clean off, the action being exactly the same as the blade of a shear. On my own road, after thirteen years of heavy traffic, the inner edges of the outer rails on both curves show very little sign of wear, the top edge on the inside of the rail just looking as though a smooth roller had been pressed against it. This is how is should be.



Wheels and axles

Three pieces of $\frac{3}{8}$-in. round mild-steel, a full $5\frac{5}{16}$ in. long, are needed for the axles. Chuck in three-jaw, face the end, turn down 1 in. length to a full $\frac{5}{16}$ in. diameter, then further reduce the end for another $\frac{1}{2}$ in. to a bare $\frac{1}{4}$ in. diameter. Use an axlebox for a gauge, and when it slides easily on the end of the axle, the diameter is O.K.

Buckle or hoop for working leaf springs



Take off the sharp edge, or round off the end completely, if you like. Then turn down the $\frac{5}{16}$-in. part to a press-fit in the wheel, or turn until it just won't enter, then ease with a file until it does, whichever your skill will permit. As the journal and wheel seat are both turned at the same setting, the wheel will run truly, even if the chuck should happen to be a few thousandths of an inch out of truth.

All the wheels can be pressed home right away, as the axleboxes are outside the wheels; then put a pair of boxes on the ends of each axle, drop them in place, with the frame assembly upside down on the bench, and put the hornstays on. The wheels should spin freely, and run without any sign of wobble, in any position of the axleboxes; and if the chassis is pushed along the floor, it should run in a straight line, and not go wandering about to right or left. If it *does* wander, the axles are not square across the frame, and you'll get flange friction. Next stage—tender body.

Petrol Engine Topics

(*Continued from page* 758)

latter is very much simplified, and the final result is at least just as satisfactory, providing that accuracy is observed in all the machining operations.

Even so, I anticipate that some constructors will have complaints to make regarding the difficulties in this respect, but I can only say that I have been unable to think of any ways in which the job could have been made easier. If my readers demand designs for tiny engines of intricate type (as they invariably do), they must expect to have to devote care and skill to their construction. Every operation has been carefully planned, and considerable pains taken, both on the drawing board and in the workshop, to reduce procedure to its simplest terms. Innumerable readers, in many cases raw beginners, have succeeded in building successful engines to my designs by following the methods described, and the worst failures have been those produced by contructors who do not observe the necessary care in marking out, setting up and machining, or who try to adopt short cuts in these operations.

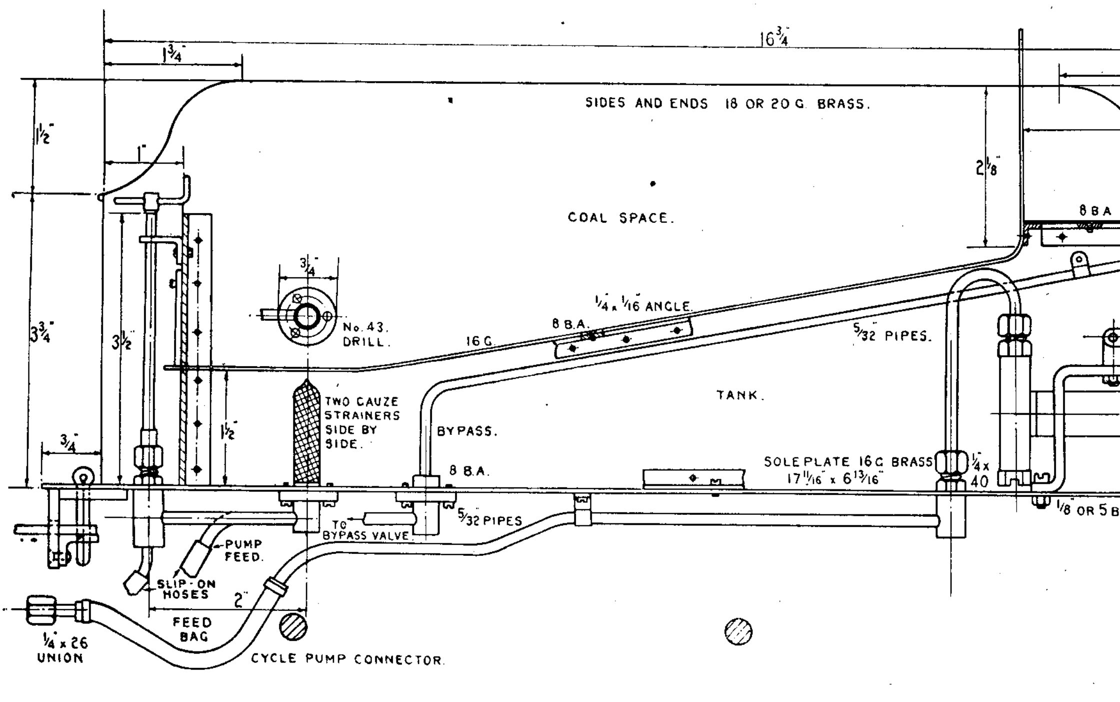
Many readers, including some who are not actively interested in building the particular types of engines described, or even any type of internal combustion engines, have experssed appreciation of the way in which machining problems are dealt with in these articles. Hardly a week passes but one or two letters are received commenting on these "interesting machining jobs," and asking for more; so it is clear that even if nobody ever built engines to the actual designs, the space occupied in describing them in THE MODEL ENGINEER would not be wasted. But I know, on the strength of evidence found when visiting model engineering societies all over the country, that many readers do build the engines, with highly successful results.

(*To be continued*)

A $3\frac{1}{2}$-in. Gauge L.M.S.

by "L.B.S.

When finishing the description of the internal fittings of the tenders for "Maid of Kent" and "Minx" in the issue for June 2nd last, I mentioned that the arrangement for "Doris" would be practically the same, so that no detailed repetition of the instructions would be needed. If you do what our 'Oxton friend Bert Smiff would call "tike a dekko" at the reproduced drawing, you'll see that the layout is practically identical, except for size, and one or two unimportant differences, such as the lengths of the copper pipes. Having more "overhead" room in the front part of the tank, the gauze strainers for the pump and injector feeds can be placed much nearer to the front plate, than on the larger tenders, and the copper pipes kept shorter, which is an advantage. There is a bit of difference in the body itself, apart from its smaller size, as the high sides slope inwards to match the curvature of the cab roof, as shown in the end view. Personally, I don't care overmuch for a high-sided tender on a little engine, and would have preferred the medium one as fitted to the "Princess Royal" when she first came out, and also to some of the older classes of tender engines; but I guess if I specified it for "Doris," Inspector Meticulous would be leading a gang of his followers to our hacienda in double-quick time—and though I would prefer a quick finish, I want it to be peaceful! Incidentally, I fitted a high-sided six-wheeled tender to "Tugboat Annie"; not from choice, but because I wanted her to be able to use existing turntables if reproduced in full size, and naturally had to make up in height, what I lost in length, to get the capacity. "Grosvenor" has a very long tender, nearly as long as the engine, as per big sister. Billy Stroudley's idea in providing the long



Section and front end of ten

tenders, was to get the required capacity without having the tender high enough to risk the chance of a fireman getting scalped, if he happened to be standing on it for any purpose, when the engine passed under a bridge. Firemen frequently stood on the shovel plate, to pull the coal forward, as the coal space was shallow.

Soleplate, sides and back

As with the larger tenders, hard rolled sheet brass is about the best material to use; but the alternatives, such as lead-coated steel or galvanised iron, would do at a pinch. The soleplate should be 16-gauge, and the sides, back, front plate and tank top 18- or 20-gauge. For the soleplate, a piece of 16-gauge metal measuring (when

M.S. Class 5 Locomotive

“ L.B.S.C.”

finished) $17\frac{11}{16}$ in. by $6\frac{13}{16}$ in. will be needed. This is attached to the top of buffer and drag beams, and the side angles, by 6-B.A. brass screws, nutted underneath, as described for the “ Maid ” and “ Minx.”

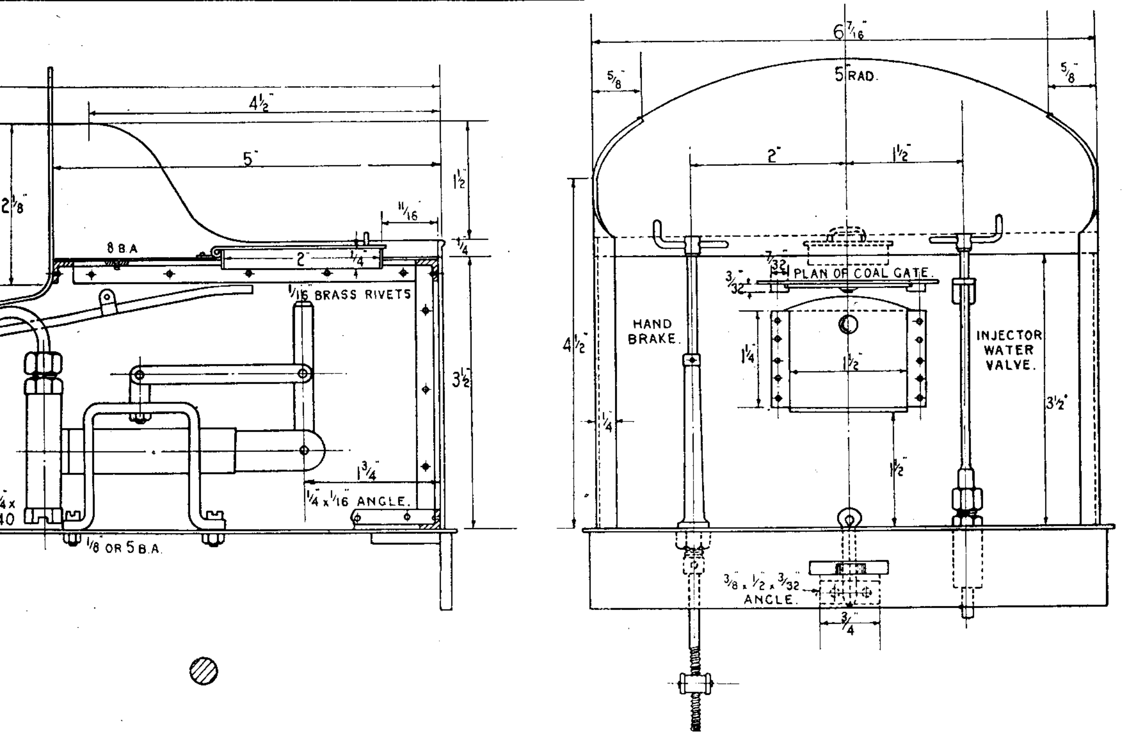
If a piece of sheet metal big enough to make sides and back in one piece, is available, do it that way. If not, use three pieces, two sides and a back. The two sides can be cut together, like frames, which will ensure beginners getting them both alike. If using three-piece construction, rivet on the inside angles to both sides and the back sheet, before erecting the body. This makes the job very easy. The sides and back are joined by pieces of angle riveted into each corner. If you use a toolmaker’s cramp at each end of the angle, to hold it to the body sheet, the riveting is also a cakewalk, and the body should come out nice and square. Take my tip and don’t bother about ornamenting the outside of the body with half-a-million rivet heads. I’ve got nothing whatever against the good folk who delight in that sort of thing ; in fact, I honestly admire their skill and patience ; but, as welding is now in vogue for building up tenders, and some of them haven’t a single rivet in the whole bag of tricks, Inspector Meticulous can’t do a (deleted by censor) thing about it if your tender sides are perfectly smooth.

If the body is bent up from a single sheet, leave the angles until the front plate is fixed, otherwise the sides will try to flap about like wings when you start riveting in the angles. When the front plate is in, it keeps the lot square.

Front plate

On the full-sized tender, the front plate is practically the same height as the top of the cab. That is all right when the driver and fireman ride on the footplate, but entirely out of court when the engine has to be fired and driven from the back of the tender. We therefore fit a low front plate, with a coal-gate like the old Brighton engines had. You can leave out the coal-gate altogether if you so desire, as it is never used ; the only reason I specify it, is because the front plate looks bare without one. Some of the old tenders with a horseshoe-shaped coal space, didn’t even have a front plate at all, let alone a coal-gate. The unfortunate fireman had to shovel up the coal from the footplate or floor level, and a back-breaking job it was, as you may guess.

There is no need to bother about riveting bits



front end of tender body for “ Doris ” of angle to the ends of the front plate, for attachment to the sides of the body. Just cut a piece of metal, same stuff as used for body, $3\frac{1}{2}$ in. wide, and long enough to fit between the sides of the body when same are parallel, plus $\frac{3}{8}$ in. each side. These $\frac{3}{8}$-in. extensions are bent over at right-angles to the plate, in the bench vice, and riveted to the body sides, with the angles pointing to the back of the tender, at 1 in. from the front ends of the body. Fit the coal-gate before riveting in. The opening for it is $1\frac{1}{4}$ in. deep, and $1\frac{1}{2}$ in. wide, the bottom of the gate being $1\frac{1}{2}$ in. from the bottom of the plate. The runners, and the gate itself, are made exactly as described for the 5-in. gauge jobs.

If the sides and back are a one-piece job, the angles inside can now be fitted. Locate them with a cardboard template, as described for "Maid" and "Minx." Then fit the body to the soleplate. The front ends of the body are $\frac{3}{4}$ in. from the end of the soleplate, and the body is set midway between the sides, so that the narrow "gangway," as the Brighton enginemen called it, is the same width each side of the tender. Drill clearing holes in the bottom angles before you locate the body "for keeps," then attach it by 8-B.A. or 3/32-in. brass screws, to the soleplate. Finally, sweat up the joints with a good big soldering bit, all around where the body is attached to the soleplate. Don't forget to cover the rivet and screw heads, and don't use a paste flux.

Internal Fittings

It is advisable, especially for beginners, to install the pump, strainers, by-pass pipe, and injector water valve, before putting on the top plates of the tank, as you can better see what you are doing. The parts named, are made as described for "Maid" and "Minx," and are fitted in exactly the same way, so I needn't go over all that ground again, but only mention the slight differences. One is, that the distance between the centre of the injector water valve, and the strainer attached to it by the 5/32-in. pipe, is only 2 in. The clearing hole in the soleplate for the stem of the injector water valve is drilled $1\frac{1}{2}$ in. from centre line of tender (on your right, if you are looking at the front plate) and $\frac{3}{8}$ in. ahead of the front plate itself. The hole for the strainer is, of course, in line with it, 2 in. to the rear, as the sergeant-major would remark. The strainer for the pump feed is set level with its mate, but about 1 in. on the opposite side of the centre-line. The exact position of the by-pass fitting doesn't matter a Continental, as long as the end of the pipe is led to the filler hole, so that you can see the water squirting out of it when the valve is open. The location shown, $1\frac{1}{2}$ in. behind the strainers, is as good as any, as only a short pipe is needed underneath.

Locate the hand pump with the centre of the operating lever $1\frac{3}{4}$ in. from the back end of the tank, when the handle is vertical. The swan-neck pipe and the union fitting are same as "Maid" and "Minx," and I have shown a "feed-bag," as the enginemen call it, made from a bit of high-pressure hose such as used on cycle-pump connectors, in place of the usual coiled pipe. This is ever so much more flexible than the pipe; a stiff connection is a frequent cause of derailments on curves, as I have found on my own railway when an engine belonging to one of my few personal friends, has come off the road on the south curve for no apparent reason whatever. Disconnecting a stiff feed pipe has completely cured the trouble on more than one occasion.

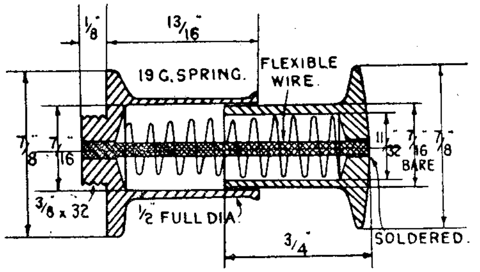
Bending Tip for Beginners

To get a nice clean bend at the top of each side of the tank sheets, without making the metal look as though it had been used for target practice, here is a wheeze which I always used before the "Diacro" bending brake landed in my workshop. Take out the two steel insets from the jaws of your bench vice; and in their place, put a couple of bits of round steel rod about 15 in. long and about $\frac{1}{2}$ in. diameter. Grip the upper edge of the tender sheet between these rods, tighten the vice jaws, and by mere hand pressure on the metal, you can get a lovely even bend without any signs of marking. The front corners of the tender body can be curved inwards by same process, but naturally this will have to be done before the body is screwed down to the soleplate.

Tank Top

It would be advisable to make the fixed part of the tank top from fairly stout plate, say 16- or 18-gauge, as it carries the coal—not so much for reasons of weight, but for shovelling. A piece 14 in. long, and just wide enough to fit nicely between the tank sides, a bare $6\frac{3}{8}$ in., will be needed. The front corners of this are cut away to leave a projecting lip $1\frac{1}{2}$ in. wide and about $\frac{1}{4}$ in. deep, to fit the bottom of the coal-gate opening. The back is cut to a radius of 5 in., and the complete plate bent to the shape shown in the drawing. Try it in position, and mark on the back of the vertical part, the position of the angles at each side of the tender body. Remove the plate, and rivet on a piece of $\frac{1}{4}$ in. by $\frac{1}{16}$-in. angle, to form the front support of the removable part of the tank top. Replace the plate, screw it down to the side angles with 8-B.A. countersunk screws at about 1 in. centres, then solder it all around to make it watertight. Don't forget to solder over all the screwheads, and under the lip where it projects through the gate. The soldering can be carried right up to the top of each side, above the actual tank, as this will help to strengthen the tender body. Note, there are no angles fitted at each side of the coal-gate; none are needed, as the strength of the soldered joint is ample here, the side angles and the bottom of the coal-gate opening providing all the support needed.

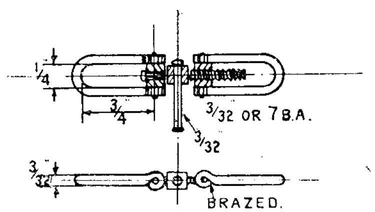
The removable part of the tank top is merely a piece of 18- or 20-gauge sheet metal, cut to an easy fit between the sides, end, and fixed plate; this will measure approximately $6\frac{5}{16}$ in. by $4\frac{7}{8}$ in. Drill No. 43 holes all around, at 5/32 in. from the edge, at about 1 in. centres. Fit a filler and lid, same as described for the 5-in. gauge tenders, but to the sizes given in the illustration. Note, as the filler only projects $\frac{1}{8}$ in. above the tank top, the hinge loop will lie flat on same, and can be attached by a screw as shown, or merely soldered. The plate, with filler attached, is fixed in place by 8-B.A. by $\frac{3}{16}$-in. or $\frac{1}{4}$-in. brass screws, any heads you fancy. They run through the clearing holes in the plate, into tapped holes in the angles. A beading of 3/32-in. half-round wire, soldered all around the top edge of the tender body, and the curved top edge of the fixed plate, completes the bodywork.



Details of tender buffer

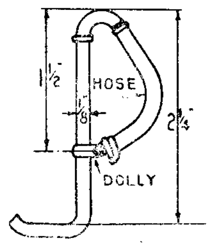
Buffers and Coupling

The fact that the ordinary type of buffer, with a spindle coming through the shank, fouls the side frames of the tender, cannot be helped, as the frame centres are only $\frac{1}{4}$ in. wider than the buffer centres. The way I have hitherto got over this, was by putting a rose cutter, or equivalent, down the hole in the beam, and cutting out a recess. As Inspector Meticulous raised an awful moan about that trick, I give here a sketch of a self-contained buffer which has no spindle, and only needs the support of the $\frac{1}{8}$ in. thickness of the beam, to hold it in place. The socket is turned the same as the engine buffers, except that the stem is only $\frac{1}{8}$ in. long, and has a 3/32-in. hole drilled



Screw coupling

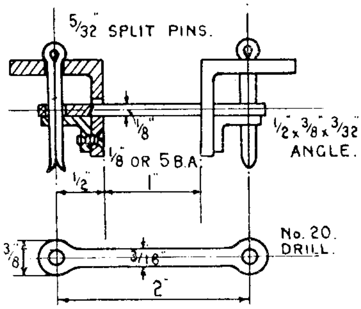
through it, instead of the long stem and bigger spindle hole of the engine buffer. Instead of the head being drilled and tapped for a spindle, it is drilled up with an 11/32-in. drill, to a depth of $\frac{5}{8}$ in., before parting off the rod, and a 3/32-in. hole is drilled in the end. In this hole is soldered a piece of flexible brass or copper wire; picture-wire would do, or a bit of electric flex with the insulation stripped off, doubling and trebling if necessary, to obtain the required thickness. Wind up a spring from 19-gauge tinned steel wire, and put it in the recess in the buffer head; then assemble the buffer, pushing the other end of the flexible wire through the hole in the stem. Enter the head about $\frac{3}{16}$ in. into the socket, then solder the projecting wire where it comes out of the hole in the stem. Solder should run right through the joint in both head and socket. Cut the wire off flush both ends, and smooth over the head end with a file, so that the wire centre is practically invisible. The bit of flexible wire prevents the head coming out, but it doesn't prevent it compressing in the manner usually observed among the buffer fraternity.



Brake pipe

If a casting is used for the socket, it will have a square flange. If turned up from $\frac{7}{8}$-in. rod, make it $\frac{1}{16}$ in. shorter than shown, leave the shank $\frac{1}{16}$ in. longer, cut out a flange $\frac{7}{8}$-in. square, from sheet brass or steel, 16-gauge, and silver-solder it to the socket. Either flange can be drilled No. 51 at the corners; then, when the buffer is screwed home in the beam, a $\frac{1}{16}$-in. or 10-B.A. screw in each corner, running into tapped holes in the beam, will prevent it making an unauthorised exit from the beam when the engine is at work.

The screw coupling is made in exactly the same way as those described for other engines in these notes, the ends of the wire shackles being



Coupling between engine and tender

filed half away, bent into a loop, and brazed or silver-soldered. If you block up the eye, just put a No. 43 drill through. Don't forget to put one end of one shackle through the hole in the drawhook (same as described for the engine part) before bending. Drill a cross hole in the boss in the middle part of the screw, with No. 48 drill; instead of a lever with a ball on the end, as in the other couplings described, fit what on the big engine is really a kind of glorified tommy-bar. This is just a piece of 15-gauge spoke wire, with each end burred over a little, so that it can't fall out of the hole.

Details or Trimmings

The steps at each end of the tender, shown in the general arrangement drawing, are exactly the same as those at the cab end of the engine, and are fixed the same way, so nothing further need be said about the job. The dummy brake-pipe is made from $\frac{1}{8}$-in. copper tube or wire, the hose being a bit of rubber tube slipped over and secured with a weeny clip ; just a thin sliver of copper strip squeezed around with a pair of pliers. The dolly, or dummy coupling plug, is an 0000-gauge edition of a baby's soothing teat ; but instead of being a ring, the handle end is filed flat and attached to the brake-pipe by a strip of thin copper, bent round the pipe and pinned to the shank of the dolly. The free end of the hose is slipped over the teat, and the whole bag of tricks clipped to the buffer beam by a miniature pipe-clip, bent up from strip brass or copper about 5/32-in. wide, and attached to the beam by $\frac{1}{16}$-in. or 10-B.A. screws. Solder the pipe to the clip, to prevent the pipe slipping down.

To couple the engine and tender, drill a No. 20 hole on the centre-line of each drag-beam, $\frac{1}{2}$ in. from the end. Underneath the slot in each beam, rivet or screw a $\frac{3}{4}$-in. length of $\frac{3}{8}$-in. by $\frac{1}{2}$-in. by 3/32-in. angle, brass or steel. If you can't get unequal angle, use $\frac{1}{2}$-in., and file off what part of it projects below the beam. Drill a No. 20 hole in each, using the hole in the beam above it, as a guide for the drill. File up a drawbar, like a weeny coupling-rod, from $\frac{3}{8}$-in. by $\frac{1}{8}$-in. steel, as shown ; or you can simply use a bit of the rod, as it is, with the ends rounded and drilled at 2 in. centres ; use 5/32-in. commercial split pins to hold the drawbar in place, and if you drop one in the grass, don't waste time searching for it, but get another. Time is precious nowadays ! And for that very same reason, it is hardly worth while turning up handrail knobs from rod, and screwing and drilling them, when some of our advertisers can supply them at a reasonable rate. However, for those who prefer to make them, I will give (in the near future, all being well) a sketch of a form-tool and drilling-jig for making them. The location of the knobs, is given in the general arrangement drawings of engine and tender ; they can be screwed direct into tapped holes in the boiler shell, using a smear of plumbers' jointing on the threads, to prevent leakage. Those on the front corners of the tender, and near the back, can be nutted on the inside, as the metal of the tender is too thin to afford a hold, if the knobs were screwed in direct.

The Orpington Regatta

THE Orpington Model Engineering Society is one of the less fortunate clubs as regards suitable water for running power boats, but with the assistance of the Victoria M.S.C. a fine first regatta was held at Victoria Park, London, E. on Sunday, June 19th. One of the highlights was the setting up of a new Class B record (subject to official recognition) by Frank Jutton's flash-steamer *Vesta II* which incidentally is also a record for flash steam in any class.

The day's racing commenced with a Nomination race, combined with a long distance shot at the steering targets. A number of well-known craft showed their faces in this, together with several new boats. The various competitors were very near their nominated times in most cases, the winner being only 0.2 sec. out.

Result :

		per cent. error
1st	Mr. Curtis (Victoria) *Micky*	1.5
2nd	Mr. J. Benson (Blackheath) *Comet* ..	3.4
3rd	Mr. E. Vanner (Victoria) *Leda* ..	4.1

Long Distance Steering Prize : Mr. Curtis (Victoria) *Micky*.

No C Class (restricted) hydroplanes being present the regatta continued with a 500 yd. race for the ordinary Class C boats, and this event showed several new boats in action for the first time in competition, among these were Mr. L. Pinder's new 10 c.c. boat which although not completing the course on either attempt, made a very fine showing. The winner of the event was Mr. B. Miles (Malden), who has long deserved some success in model power boat racing. The runner up was *Defiant III*, Mr. J. Cruickshank's well-known boat.

Result :

1st Mr. B. Miles (Malden) .. 42.25 m.p.h.
2nd Mr. J. Cruickshank (Victoria) *Defiant III* .. .. .. 25.5 m.p.h.

After a lunch interval, racing was resumed with a 500 yd. B Class race, and this race produced some fireworks from Frank Jutton's flash steamer *Vesta II*, although not completing on the first run, it fully atoned for this lapse on the next attempt, recording 47 m.p.h. for the distance, some laps of which were timed at over 50 m.p.h. unofficially !

A very creditable run was made by a new Victoria boat, Mr. Collins's *Pip*, in taking second place just beating Mr. G. Line's *Sparky* (Orpington).

Result :

1st Mr. F. Jutton (Guildford) *Vesta II* .. .. 47 m.p.h.
2nd Mr. Collins (Victoria) *Pip* .. 32.5 m.p.h.

The Class A event which followed proved a disappointment, no competitors being able to get a run. The Class A record holder Mr. Clifford (Victoria) with *Blue Streak* was unlucky when the universal joint was damaged in starting up.

The final event was the steering competition, which, being run over a "slanting" course, proved difficult for most of the steering boats present, but was interesting from the spectators point of view nevertheless. It resulted in a win for the Victoria club, Mr. Mitchel's petrol-driven launch scoring 11 points.

Result :

		Points
1st	Mr. Mitchel (Victoria)	11
2nd	Mr. A. Rayman (Blackheath) *Yvonne*	7
3rd	Mr. W. Gates (Victoria) *Squib* ..	6

A $3\frac{1}{2}$-in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

WE now come to the last chapter in the tale about "Doris"; and though she doesn't get married and live happily ever after, as most heroines do, I have more than a suspicion that she has brought a meed of happiness to the good folk who have followed out the instructions, and will continue to be a source of pleasure all through her working life, which should be long, and trouble-free. Although the tender hand brake is not essential, and makes no difference to the working of the engine, the wheels of the $3\frac{1}{2}$-in. gauge tender look rather bare without the brake gear; and the accompanying illustrations give the shape and dimensions of the necessary fitments. There is no need to go over the whole complete rigmarole, as the making of the parts, and their erection, are carried out precisely as recently described for the "Maid of Kent" and the "Minx," the only difference being that the parts for the $3\frac{1}{2}$-in. gauge engine are naturally smaller. If, therefore, I briefly run through the description, it should enable builders of "Doris" to complete the job easily and satisfactorily, in the minimum of time.

Brake Blocks and Hangers

The brake blocks can be either made up from castings, or cut from $\frac{3}{8}$-in. by $\frac{1}{4}$-in. steel bar, as described for the "Maid." Red fibre can be used by those who prefer it. Several readers ask if there is any objection to using brake blocks cast in brass or gunmetal, saying that these should have no ill-effects on the wheel treads. No objection at all; as I said about fibre blocks, they can be painted, but they are partly obscured by the frames, and not noticeable even if left bare. Besides, non-ferrous blocks would rapidly discolour, and take on the "rusty" appearance which characterises "Doris's" big sisters since the railways developed the economy stunt. It will be noticed that the blocks are very small, but they are correct in size for the type of engine and tender.

The hangers are filed up from $\frac{1}{4}$-in. by $\frac{1}{8}$-in. steel. Note, the holes in the hangers are drilled No. 30, and the holes in the brake blocks No. 32. The hanger pins are plain turning jobs, the material needed being just a bit of $\frac{1}{4}$-in. round mild-steel held in three-jaw. Tip for beginners: when reducing the hanger end for screwing, turn it so that the hanger just slips on without shake; then leave the hanger on, and turn the 3/32-in. part for the screw, letting the turning tool go as close as possible to the hanger without actually touching it. Remove hanger, and screw right up to the shoulder with the die in the tailstock holder; you'll then be able to screw up the nut quite tightly without pinching the hanger, and at the same time the hanger won't have a chance to do any side-stepping. Another tip for the same fraternity—when pinning the brake blocks to the hangers, leave them stiff; not a fixture, but just enough to "stay put" in whatever position you put them with your fingers. The blocks, when erected, will not rub against the wheels all the time, as they would do if left free to flop about.

Brake Beams

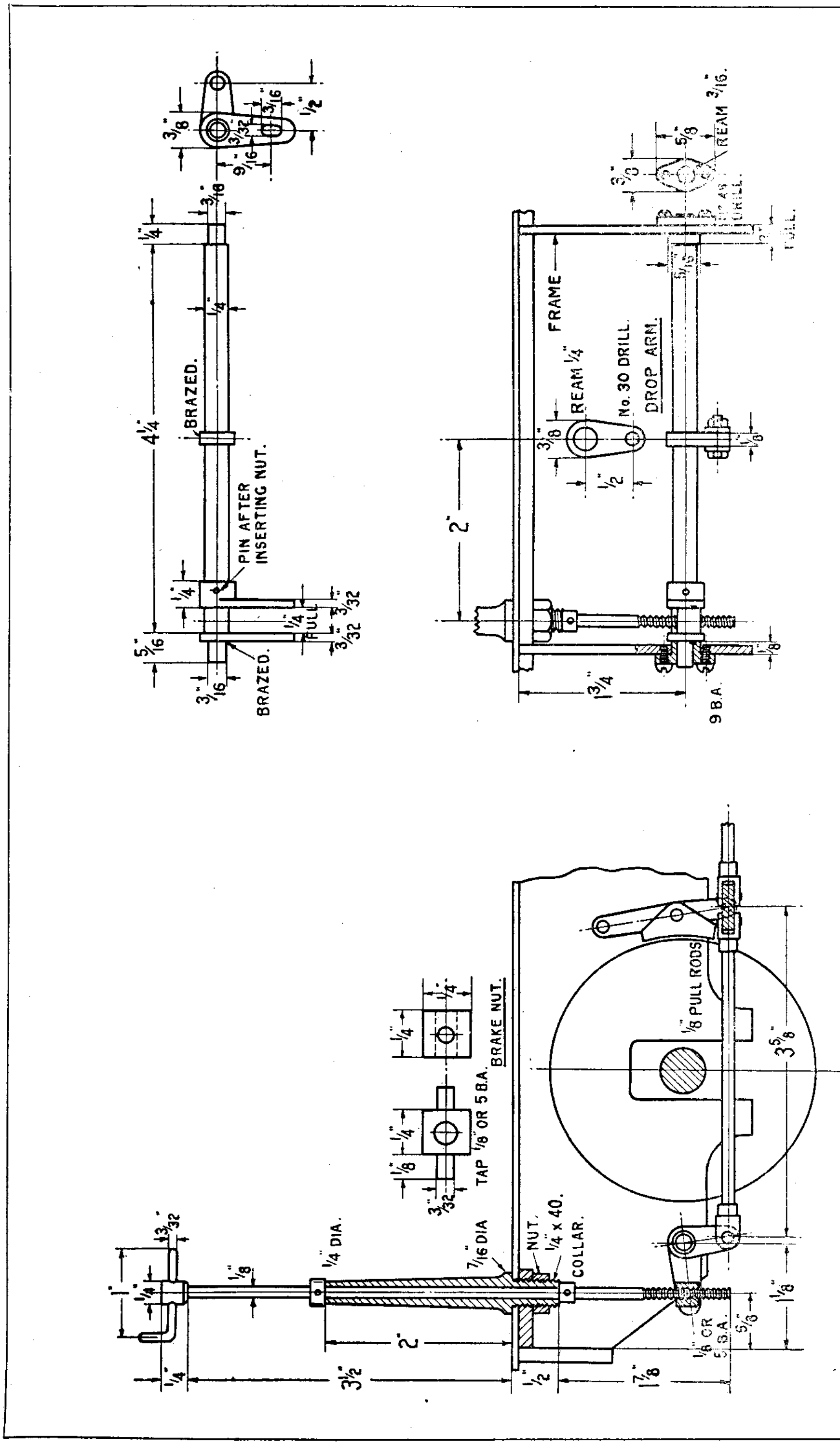
The beams are of the usual flat type, tapered off at each end. They are filed out of $\frac{1}{8}$-in. by $\frac{1}{2}$-in. steel, three pieces being needed, each $4\frac{5}{16}$ in. long. Chuck truly in four-jaw, face the ends, and turn down a full $\frac{1}{4}$ in. of each end to $\frac{1}{8}$ in. diameter, further reducing a bare $\frac{1}{8}$ in. to 3/32 in., and screwing 3/32 in. or 7-B.A. Two of the beams are drilled as shown; the third only needs one hole in it. All three beams can be filed or milled to shape at one fell swoop, by clamping them together in bench vice or machine vice. Hangers (with brake blocks attached) together with beams, can then be erected as described for "Maid" and "Minx," using ordinary commercial nuts on the screws.

Brake Column and Shaft

The brake column requires a piece of $\frac{7}{16}$-in. round brass rod $2\frac{1}{2}$ in. long. Chuck in three-jaw, face the end, centre and drill No. 30 halfway through; reverse in chuck, and repeat operation, letting the drilled holes meet. Turn down $\frac{1}{2}$ in. of the end to $\frac{1}{4}$ in. diameter, screw $\frac{1}{4}$ in. by 40, and face off any burring. Re-chuck in a tapped bush held in three-jaw; bring up the tailstock centre to support the free end, and turn the outside to a taper as shown. Make a $\frac{1}{4}$-in. by 40 nut from a bit of $\frac{3}{8}$-in. hexagon brass rod, to fit the screwed part; another kiddy's practice job needing no detailing.

The brake spindle is a 6-in. length of $\frac{1}{8}$-in. silver-steel or rustless steel. Put an inch of $\frac{1}{8}$-in. or 5-B.A. thread on the lower end. Make two little brass collars 7/32 in. diameter and about $\frac{3}{16}$ in. wide, drilled No. 32. Press one of these on the plain end, pushing it down the spindle until the top of it is $1\frac{7}{8}$ in. from the bottom of the screwed part; then pin it with a bit of 16-gauge wire. Poke the plain end through the column, from the threaded end of same; press on the other collar, so that it bears on top of the column, allowing the spindle to turn freely without end-play, and pin that also. Fit a handle to the top, same as described for the handle of the injector water valve, to enable the fireman to do his daily dozen.

At 2 in. from the centre-line of the tender, and to your left when you are looking at the front end of it, drill a $\frac{1}{4}$-in. clearing hole at $\frac{3}{4}$ in. behind the edge of the drag beam; approximately $\frac{7}{8}$ in. from the edge of the soleplate. This hole goes clean through soleplate and top member of the beam, as shown in the illustration. Put the screwed end of the brake column through it, and secure it with the special nut.



Tender brakes for "Doris"

The brake shaft is a piece of $\frac{1}{4}$-in. round mild-steel $4\frac{13}{16}$ in. long. Turn $\frac{1}{4}$ in. of one end, and $\frac{5}{16}$ in. of the other end, to $\frac{3}{16}$ in. diameter. File up the drop arm from $\frac{1}{8}$-in. by $\frac{3}{8}$-in. steel; I usually make these oddments from bits left over after cutting out frames. Drill and ream as shown, and squeeze it on to the shaft midway between shoulder. Next, file up the two brake arms from 3/32-in. flat steel. The smaller end has a slotted hole 3/32 in. full wide, and $\frac{3}{16}$ in. long; simply drill two No. 40 holes close together and run them into a slot with a rat-tail file or an Abrafile. Drill both the larger ends with No. 14 drill; ream one of them $\frac{3}{16}$ in., but only put the reamer in far enough to make the hole a very tight fit on the end of the brake shaft. Chuck a bit of $\frac{3}{8}$-in. round steel rod in three-jaw, and turn a pip on the other end to a tight fit in the hole in the other arm. Part off $\frac{1}{4}$ in. from the end, squeeze the pip into the hole in the arm, and braze or silver-solder it. Chuck the boss in the three-jaw, and drill letter "C" or 15/64 in., reaming $\frac{1}{4}$ in. to fit the shaft. After cleaning it up, slide it on the shaft, boss first; don't forget it goes on the end with the longer spigot. Then put the plain arm on, set it at right-angles to the drop arm, and braze both brake arm and drop arm at the same heat. Quench in water only, and clean up.

To make the nut, chuck a bit of bronze or gun-metal rod, $\frac{1}{4}$ in. square, in the four jaw. Set to run truly. Some folk, especially beginners, seem to have a dickens of a job to set square or rectangular stuff truly in the four-jaw, whilst actually it is only a matter of seconds. All your humble servant does, is to run up a pointed tool, such as an ordinary knife tool, to the rod, and adjust the jaws until the point scratches all four corners of the rod when the belt is pulled by hand. Face off the end with the knife-tool, then turn down $\frac{1}{8}$ in. length to 3/32 in. diameter. Part off at $\frac{3}{8}$ in. from the shoulder. Reverse in chuck, by slacking jaws Nos. 1 and 2, putting the embryo nut in, and re-tightening same. Turn another 3/32-in. spigot $\frac{1}{8}$ in. long, on the projecting end. Drill a No. 40 hole through the cube, tap $\frac{1}{8}$ in. or 5-B.A., and there is your nut. Put one of the trunnions through the slotted hole in the fixed brake arm; run up the movable one until the other trunnion enters the slot in it, leave the nut just free to turn, and pin the boss to the brake shaft by a piece of 16-gauge steel wire driven through a No. 52 hole drilled through boss and shaft.

How to Erect the Brake Shaft

At $1\frac{1}{8}$ in. from the front end of frames (that is, from back of drag-beam) and $\frac{1}{4}$ in. above the bottom edge at that particular point, drill a $\frac{5}{16}$-in. hole each side. Drill a No. 30 pilot hole each side first, and test with a bit of $\frac{1}{8}$-in. silver-steel through them, to see if they are exactly opposite. Then turn up a couple of flanged bushes from $\frac{3}{8}$-in. round rod; gunmetal or bronze for preference, though brass will do at a pinch. Chuck the rod in three-jaw, face, centre and drill No. 14. Turn down $\frac{3}{16}$ in. length to fit the $\frac{5}{16}$-in. hole, and part off to leave a 3/32-in. full diameter flange. Ditto repeato for bush No. 2, but this only needs to be $\frac{1}{8}$ in. long on the $\frac{5}{16}$-in. section. File the flanges oval, and drill each No. 48 as shown, for the fixing screws. Put a $\frac{3}{16}$-in. parallel reamer through each bush.

Temporarily remove the brake column, then put the brake shaft in place with the nut on the same side of the tender as the column; this is easily done, as the $\frac{5}{16}$-in. holes allow the shaft to be put in, plain end first, from the inside of frame. Hold it in position with the spigots in the middle of the $\frac{5}{16}$-in. holes. Slide the bushes over the spigots, the narrower one going next to the brake arms; then secure each bush with two 9-B.A. screws running through the No. 48 holes in the flanges, into 9-B.A. tapped holes in the frames. Locate, drill, and tap the holes as described for cylinder-cover screws. As you replace the brake column, run the screwed end of the spindle through the brake nut, as shown in the illustrations.

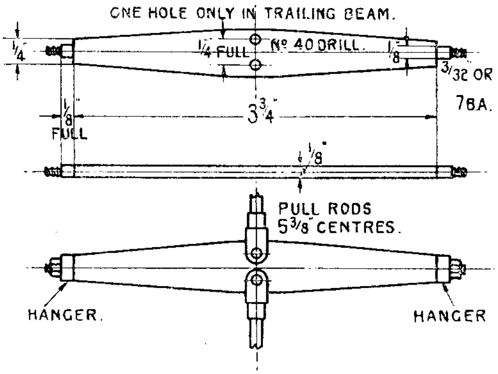
Connecting Up

This is a simple job. Six forks or clevises are needed, made from $\frac{1}{4}$-in. square steel, to dimensions given in the drawing; they are made in the same way as described for valve-gear forks, so I need not repeat the details. The pull rods are made from $\frac{1}{8}$-in. round steel; mild, silver or rustless, doesn't matter which. The front one needs a piece approximately $3\frac{1}{8}$ in. long, and the others 5 in. Put a few threads on each end of each bit, to match the tapped bosses of the forks, and screw on the forks, so that the distance between eye centres on the first one, is $3\frac{7}{16}$ in., and on the other two, $5\frac{3}{8}$ in. The forks are attached to the drop arm, and the brake beams, by pieces of 3/32-in. silver-steel, screwed at both ends and furnished with ordinary commercial nuts. Note, the plain part between the nuts should be approximately 9/32 in. long, so that when the nuts are screwed up tightly to the ends of the threads, they don't pinch the forks, and so cause the brake gear to work stiffly. You should be able to turn the pins with your fingers after the nuts have been tightened. Small split-pins, as used for pinning castellated nuts in automobile work, could be used, if desired, in place of the nutted pins. As the brake gear is not used for service stops, they would be quite satisfactory; and in any event, can be renewed in a very few minutes.

Don't forget, after assembly, to "ile the jints," as one of my old footplate mates used to remark. Then, when the brake handle is turned clockwise, the blocks should touch all the wheels at once, with a perfectly smooth action. If one pair contacts before another, merely disconnect the fork from the beam, and screw or unscrew half a turn or so, as the case may be. It is merely a matter of easy adjustment, to get all the blocks to touch the wheel treads at the same time. There is not the slightest need to go to the trouble of making and fitting a full compensating gear, even if the brakes were intended for service stops; none of our Stroudley engines had any compensating gear, and we always managed to stop all right, the brake blocks wearing very evenly. Many modern engines have no compensating gear on their tender brakes; for example, the full-sized "Hielan' Lassies." No pull-off springs are needed, for the simple movement of turning the brake handle anti-clockwise for a few turns, pushes the brake blocks clear of the wheels.

Epilogue

So we come to the end of the story. As with the "Maid" and "Minx," if builders wish to add all the little blobs, gadgets, decorations and what-have-you, as carried by "Doris's" full-



Brake beams

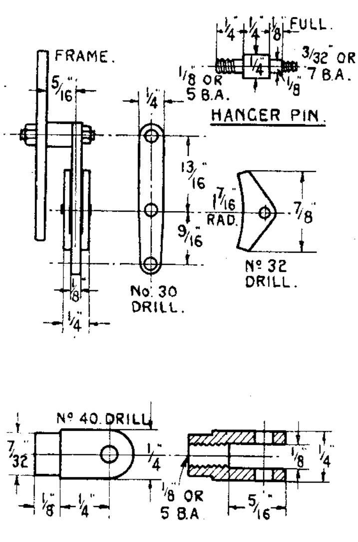
sized relations, they can get close-up photos from any publishers of locomotive pictures or literature, and let themselves go to their hearts' content. Perhaps even our good friend Mr. Hambleton might care to give details of a few embellishments, for those who desire them; though I'm afraid his sympathies, like my own, are along with the old-timers! As regards painting, the full-sized engines are black, and the little one could be painted with any good heat-resisting enamel, such as used for domestic radiators, baths, and hot-water cans. For the benefit of beginners, here is how I get the paint on my boilers, to stand the working temperature without blistering. The engine is first thoroughly cleaned with petrol—it takes very little—a job which is done in the open air. The boiler is filled nearly full of warm water, and the paint (enamel, or synthetic hard gloss) applied with a camel-hair or sable brush, as used by water-colour artists. I don't use any undercoating; if the metal shows through, a second coat applied after the first is dry, is all that is necessary. After being painted, the boiler is kept just below boiling point, by a small home-made Bunsen burner in the firebox, for about twelve hours all told. This need not be continuous. The engine is placed somewhere where there isn't much dust flying around, and the boiler is covered by a sort of tunnel made of stout brown paper. This treatment never fails to "set" the paint or enamel, making it impervious to oil spots, or drops of hot water. If sprayed with oil or water, a few rubs with a soft cloth, or piece of cotton waste, makes it shine, or "bobby-dazzle" as the cleaner-boys used to say. Engine-cleaning can now be classed among the lost arts; the race who practised it, is extinct. Old-timers among our readers who recollect the Brighton engines, the S.E. & C. R. engines of Harry Wainwright, the G.W.R. single-wheelers, and others around the turn of the century, resplendent in shining paint, gleaming brass and copper, and bright steel, will mournfully agree. Such is the state of things to which "money-grubbing," under the fancy names of "rationalisation" (not to mention "nationalisation!") "economics" and so on, has brought one of the greatest benefactors of mankind; incidentally the *only* one that has never been used for purposes of bloodshed and destruction.

Parts of the engine not subjected to heat, can be painted in the usual manner; and if left to dry in air for a day or so, according to the kind of paint or enamel used, will set hard enough for ordinary use. After running an engine, never put her away dirty; drop the fire, and wipe all the superfluous oil and dirt off whilst she is still hot; she will then keep her "new look" for a surprisingly long time.

As promised, I have a short story to tell about a weeny sister to "Doris"; and all being well, and our friend the K.B.P. having no objection, will tell it after we have given the builders of "Tich" a little more information about axle and eccentric turning.

Vision—or Prophecy?

My little bit of "crystal-gazing," as recounted for your amusement in the issue of July 14th last,



Details of brake gear

has had a rather startling sequel, for nearly every correspondent (and they are many) who has referred to it in his letters, has asked the question —how much really *was* "yarn," and how much was actually "advance information"? Well, the only answer I can give to that, is that those who live longest will see most! Others want to know if the locomotives described by their drivers, Bill and Jock, could actually be built and operated thus; and if so, what about describing 3½-in. gauge editions of them, so that "coming events could cast their shadows before," in a manner of speaking.

Well, I'll tell you something that I don't "blow off" about, but what is honest gospel truth. Though I have laid bare, many of the "secrets of success" in these notes, and practically every efficient little locomotive running today, has "a bit of old Curly" in its make-up (even though some owners and builders don't care to admit it!) there are some things I have *not* disclosed, even to my few personal friends; and at present I haven't any intention of doing so. Enginemen on the L.B. & S.C. Ry. always used to try to get a few minutes in hand, so that if delayed by a signal stop, a p-way check, or any other untoward happening, we could still arrive "right on the dot." It is still the same with your humble servant; I always reckon to keep enough "up my sleeve," to enable me to keep a few block sections ahead of anybody who thinks they "know all the answers." I don't know all of them, but I try to learn, by experiment, as many as I possibly can. The few good folk who have seen and driven my own locomotives, often ask about "the little bit of something that the others haven't got," inside the steam chests and hidden in the valve gear.

I have actually tried both the systems mentioned in the "vision of the future," and they both work perfectly. I have incorporated the "Chapelon" part of the L.N.W.R. engine in my "Jeanie Deans." Bill, in the story, said that with 250 lb. in his boiler, the expansion was so perfect that you couldn't hear the exhaust. My "Jeanie" is the same; with 90 lb. on the boiler gauge, she runs silently, with a load equal to 320 tons behind the tender. That is using steam instead of wasting it, if you like! Compare it with the engines seen working on club and exhibition tracks—'nuff sed. The idea of cutting out the main steam supply to one pair of cylinders on a four-cylinder engine with the 135 deg. crank setting, was put forward by Mr. Holcroft himself, many years ago. It works all right in the small size, the power of four big cylinders at starting, giving an acceleration on dry or sanded rails, equal to any electric outfit, and allowing grades to be taken at high speed, exactly as Jock described. Once the speed is attained, the outside cylinders (as big as those of a normal two-cylinder engine) have no difficulty in maintaining it with a very early cut-off. The system really boils down to applying a pair of booster cylinders to the coupled wheels, instead of a separate axle. I originally intended to fit the cut-out valve on "Tugboat Annie"; but she is so economical of steam, when properly handled, that I never bothered about spending the extra time on it. Time is my biggest enemy these days!

Some of our readers were so tickled with the story that they are asking for more, on the same lines—literally! Well, this is a technical journal, not a story magazine; but if our worthy friend who wields the blue pencil (though he is kind to my notes!) raises no objection, I might look into the crystal again, and see what we have on the south side of the Thames, at about the same period. See, for instance, what sort of a locomotive is pulling the Cornish Riviera express—we already know her name and number, 111 "The Great Bear"; and what kind of engine it takes to run from Victoria to Dover with twelve "Golden Arrow" Pullman cars in the level hour. Did I hear somebody murmur "Southern for Sunshine—and for Speed?" Ah, well—you know that famous saying by a long-departed politician—"Wait and see"!

In the Workshop

(*Continued from page* 449)

abutment face of the nut, or by using a washer of the correct thickness. When facing-down the nut, calculate the amount to be removed by estimating what fraction of a circle the nut has to turn to bring it into the correct position; this will likewise represent a fraction of the thread pitch, in this case 50 thousandths of an inch. If, therefore, the nut is required to turn an additional 1/5 of a revolution, then 10 thousandths must be turned off. Should, however, a selection of washers be available, it may then be possible to find one which when fitted brings the handle into the required position. Failing this, a feeler gauge may be used to determine the exact thickness of the washer needed.

What has been said in connection with the present handled-nut will also apply later when the locking handles are fitted to the grinding rests.

Readers may wonder what is the purpose of the four set-screws, seen in Fig. 6, fitted to the bearing bracket of the main pivot of the drilling jig. These screws were fitted to take up any play that might develop in the bearing and, at the same time, to impose a light frictional control during the operation of the jig.

The screws, which are fitted with lock-nuts, are of $\frac{3}{16}$ in. diameter and 40 t.p.i., whilst, to ensure smooth working, fibre pads are fitted between the ends of the screws and the spindle.

In larger and more elaborate commercial grinding jigs, spring-loaded coned bearings are sometimes used to prevent play developing when wear takes place.

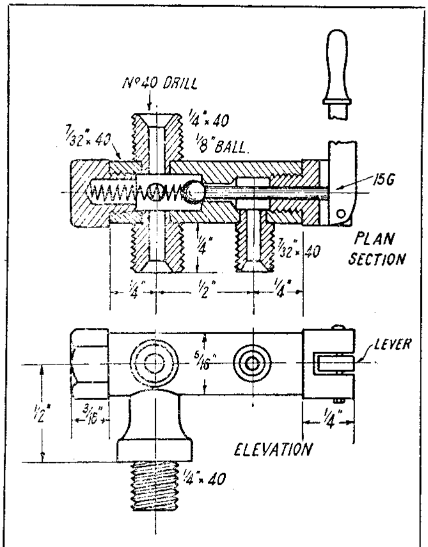
(*To be continued*)

Small Locomotive Boiler Fittings

by "L.B.S.C."

JUDGING from the number of times I have described how to make boiler fittings and mountings, followers of these notes should be able to make them upside down and backwards, in a manner of speaking; but there are so many newcomers to our craft—my correspondence tells a tale—that I had better briefly run through the principal operations once again. Speaking of correspondence reminds me to announce, to all whom it may concern, that what I call the "Curly Correspondence Construction College" has just got to cease operations. If there were such a thing as a Locomotive Construction Writers' Union, your humble servant would have been kicked out long since, for working about three times the "regulation" number of hours every week, with *no* time-and-a-half for Saturday afternoons, and *no* double time for Sundays and holidays. Only last week (time of writing) a new reader wanted detailed information about what tools he needed to start, also instructions on turning. I gave him a brief answer, and recommended him to the late Mr. Marshall's book. By return I got a letter asking for more information about using tools, and as he wanted to build the "Lassie" (first attempt!!) and had only a few back issues, could I supply full instructions. That is only one example. I receive plenty of letters from enthusiastic schoolboys who imagine they can build an engine like the "Maid of Kent" in a matter of weeks, on the kitchen table, with little more than a fretwork outfit. That is no exaggeration. I spent Christmas Day doing twenty-six letters and ten airmails, which took from about 9.30 a.m. till nearly 11 p.m., and was "all in" by the time I'd finished. I just *can't* keep it up any longer.

Some of our advertisers are supplying castings for my boiler fittings; so to save two lots of "how-and-why," they can be machined up in a very similar manner to the built-up pattern. The only difference is in the way they are chucked. For example, the combined whistle-valve and turret casting would have to be chucked in three-jaw by one of the larger union bosses, to turn and screw its opposite mate; then the turned one would be held in a tapped bush in the three-jaw, to turn and screw the first one. To set the small boss true for turning and screwing, the casting would have to be chucked in the four-jaw, the jaws being separately adjusted to grip the sides and ends. Same applies to the bottom fitting of the water-gauge. Personally, I prefer to use rod material for boiler fittings. If "Easyflo" in wire form (commercially obtainable) is used for silver-soldering the joints, the veriest tyro should be able to make neat fittings, with just ordinary care. In passing, I am glad to see that my pet styles of boiler fittings are now being made by our advertisers, and superseding the old museum-pieces, outsize, ugly, and inefficient, which held sway in trade catalogues for so many years.

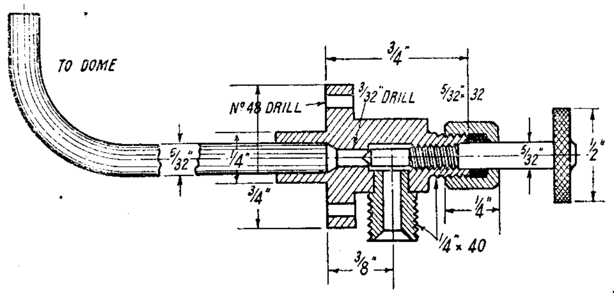


Combined turret and whistle-valve

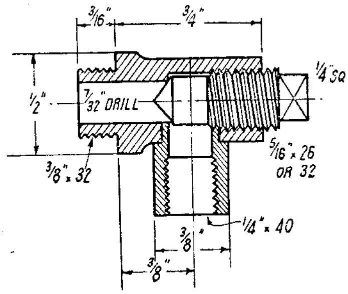
Combined Turret and Whistle-valve

For all built-up fittings, use bronze or gunmetal rod if available; if not, use good-quality brass. For the above fitting, part off 1 in. of $\frac{5}{16}$-in. round rod; chuck in three-jaw, centre, and drill right through with No. 43 drill, open out to $\frac{3}{8}$ in. depth with $\frac{3}{16}$-in. drill, and bottom to $\frac{1}{2}$ in. depth with $\frac{3}{16}$-in. D-bit. Tap the end 7/32 in. by 40, and slightly countersink the end. Reverse in chuck, open out the other end to $\frac{3}{8}$ in. depth with $\frac{3}{16}$-in. drill, tap and countersink as above. Put a 3/32-in. parallel reamer through the remains of the "43" hole. If you haven't one, file off the end of a bit of 3/32-in. silver-steel to a long angle, like slicing a Jerry sausage; harden and temper to dark yellow, rub the flat on an oilstone, and it will ream very well.

At $\frac{1}{4}$ in. from the D-bitted end, drill a 5/32-in. hole right across; drill a similar one between them. At $\frac{1}{4}$ in. from the other end, drill a 5/32-in. hole into the enlarged passageway. The illustration shows which side to drill it. Fit union nipples, made as described for pumps and lubricator clacks, to the three side holes; and in the bottom one, a fitting made like the stem of the oil check-valve, but to the given dimensions. Silver-solder the lot at one heat; pickle, wash and clean up. Seat a $\frac{1}{8}$-in. ball on the hole in the D-bitted end; turn up a little cap from $\frac{1}{4}$-in. hexagon rod, to fit the tapped hole, and drill it No. 30 to take the spring, which is wound up from thin bronze wire, about 30 gauge. A similar cap is needed for the opposite end; but make it from $\frac{3}{8}$-in. hexagon rod, and drill it No. 48 right through. Screw it right home, then file away the top and bottom corners, so as to leave it rectangular. Slot it right across, $\frac{1}{16}$ in. wide, either by milling, planing, or filing. For sake of appearance, I recommend making a weeny edition of the reversing-lever, as shown, from rustless steel or nickel-bronze; but a simple bit of strip metal, pivoted on a bit of a domestic blanket-pin, or a bit of wire of similar thickness (" 56 " drill) will operate the push-rod quite well. The push-rod is a bit of 15-gauge (5/64-in.) bronze, brass or rustless steel wire, of such a length that when pressed in by the lever, it pushes the ball off the seating, and lets steam pass to the union, to which the pipe leading to the whistle is attached.



Injector steam-valve



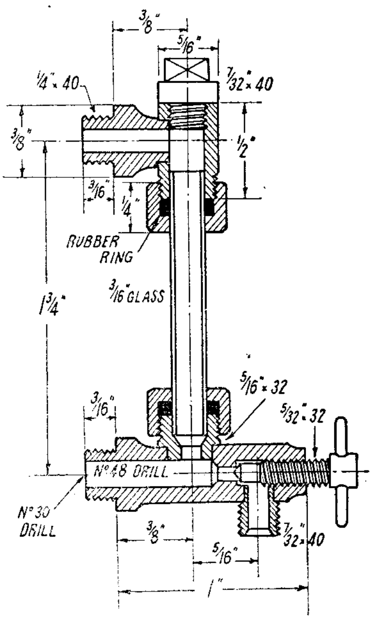
Screw type blowdown-valve

Drill and tap a $\frac{1}{4}$-in. by 40 hole as near the edge of the wrapper-sheet as possible, over the regulator handle, and screw in the fitting with a smear of plumbers' jointing on the threads. The right-hand union is connected to the union on the blower-valve by a $\frac{1}{8}$-in. pipe, and the left to the steam-gauge, as mentioned last week. The whistle is connected up after the boiler is erected.

Injector Steam-Valve

Chuck a piece of $\frac{3}{4}$-in. rod in the three-jaw, and turn down $\frac{1}{2}$ in. of the end to $\frac{1}{4}$ in. diameter; face the end, centre, and drill down $\frac{1}{2}$ in. depth with No. 24 drill. Part off at $\frac{3}{4}$ in. from the shoulder. Reverse in chuck, gripping by the turned part. Turn down a full $\frac{5}{8}$ in. length to $\frac{3}{8}$ in. diameter; further reduce $\frac{1}{4}$ in. of the end to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. by 40. Centre, drill right through with 3/32-in. drill, open up with No. 30 to $\frac{1}{2}$ in. depth, and bottom the hole with a $\frac{1}{8}$-in. D-bit. Further open out for $\frac{1}{8}$ in. depth with No. 21 drill, and tap the remains of the No. 30 hole with 5/32-in. by 32 tap. The slightly coarser thread gives a quicker opening.

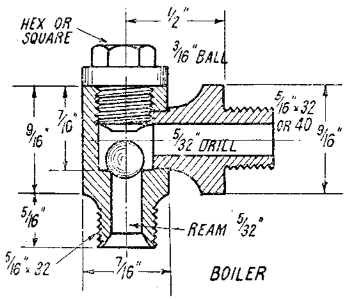
The union-screw, valve-pin, hand-wheel and gland-nut, are all fitted as shown, and as described for the blower-valve. Drill four No. 48 holes through the flange; fit a piece of 5/32-in. copper pipe into the end, long enough to reach up into the dome. You can get the length of this from the actual job; I get all my own pipe lengths by using either a bit of thick lead fuse-wire, or a piece of soft copper wire, as a template. The pipe can be silver-soldered in at the same heat, when doing the union-screw, and softened for easy bending at the same time. The flange is then attached to the backhead, same way as the regulator flange; drill a $\frac{1}{4}$-in. clearing hole at position shown in illustration of backhead complete, insert the pipe, wangle it about until it appears through the dome hole behind the regulator-valve, then drill and tap the screwholes in the backhead, and fix with a 1/64-in. " Hallite " or similar gasket between flange and backhead. Note—the union-screw should hang straight down; recollect this when bending the internal pipe.



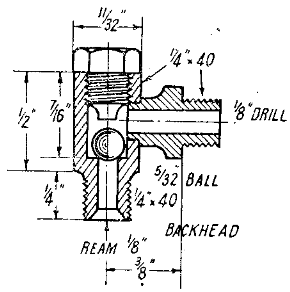
Water-gauge

Water-gauge

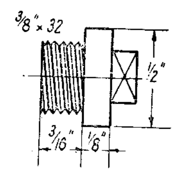
The top fitting of the water-gauge is made in the same way as described for the oil check-valve, but to the given dimensions; and instead of having a ball-seating in it, it is drilled through with $\frac{3}{16}$-in. clearing drill, say No. 11, as the glasses are seldom truly circular, and need plenty of clearance. I have also shown the cap turned from $\frac{5}{16}$-in. round rod, and squared above the flange, for the sake of variety. For the bottom fitting, chuck a bit of $\frac{3}{8}$-in. round rod in the three-jaw. Face, centre, and drill to $\frac{11}{16}$ in. depth with No. 30 drill. Turn down $\frac{3}{16}$ in. of the end to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. by 40. Part off at 1 in. from shoulder; reverse in chuck, holding in a tapped bush in the three-jaw. Centre, and drill through with No. 48 drill; open out to $\frac{5}{16}$ in. depth with No. 30, and bottom to $\frac{3}{8}$ in. depth with $\frac{1}{8}$-in. D-bit. Tap 5/32 in. by 32, and



Boiler clack



Backhead clack



Washout-plug

don't spoil the seating. Turn the outside to outline shown. Drill a 7/32-in. hole in the side, at $\frac{3}{8}$ in. from the shoulder; at $\frac{1}{4}$ in. from the other end, and diametrically opposite, drill a 5/32-in. hole. Fit and silver-solder a $\frac{5}{16}$-in. gauge-glass socket and a 7/32-in. by 40 union-screw as shown. The valve-pin is same as blower-valve pin, but has a cross-handle instead of a wheel, and no gland is required. The gland-nuts are made from $\frac{3}{8}$-in. hexagon rod, same process as union nuts.

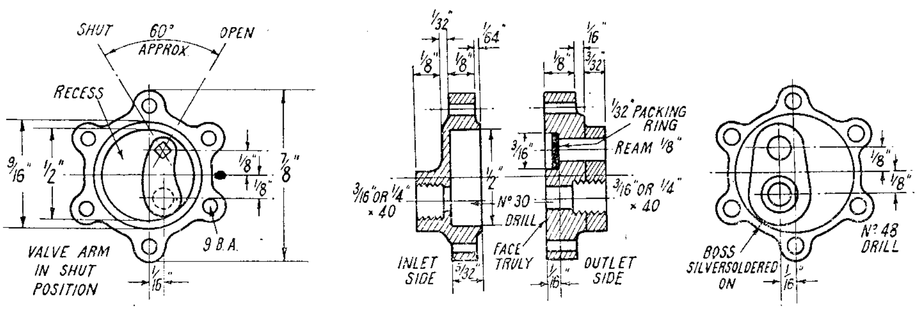
To erect the gauge, drill a 7/32-in. hole in the backhead, between the regulator and blower-valve, in the position shown in the view of the complete outfit, and tap it $\frac{1}{4}$ in. by 40. At $1\frac{3}{4}$ in. below it, on the vertical line, drill and tap a similar hole. Screw in the fittings with a touch of plumbers' jointing on the threads. I always line-up my gauge-glass fittings by putting the shank end of the drill used for drilling the sockets for the glass (No. 11 in this case) through the top fitting, and then adjusting the bottom one until the end of the drill drops into the bottom socket of its own free will and accord. I know then, that the holes are absolutely dead in line, and the glass won't be nipped and broken when tightening-up the gland-nuts. They should not be very tight, as the glass must be free to expand; and rubber rings should be used as packing. Slip a short bit of rubber tube over a piece of $\frac{3}{16}$-in. steel rod, and try a gland-nut on the outside. If the gland-nut won't go over the rubber easily, chuck the rod in the three-jaw, run the lathe as fast as possible, and hold a bit of fine glass-paper to the rubber. A few seconds of this treatment will thin it down sufficiently for it to enter the nut. The rubber tube can be cut into rings by applying a discarded wet safety-razor blade to the rubber as it revolves. When you push the rubber off the rod, it will fall into rings. Wet the glass and rings; insert glass through top fitting, put on first a ring, then the nuts back-to-back, then the other ring. Let the glass drop into place, and screw the nuts home with your fingers, giving them about a quarter-turn with a little spanner; that is all they need. Never clamp a gauge-glass tightly; if you don't believe me, ask any full-size driver or fireman—*they know*!

Boiler Feed Clacks for "Maid" and "Minx"

There is no need to dilate on these, as they are made by the same method described for the oil-clack, the size being given in the illustrations. Two larger ones are needed, and one smaller one. At 2 in. from the smokebox end of barrel on the "Maid," and $2\frac{1}{2}$ in. on the "Minx," drill and tap a hole to suit the thread on the stems of the clackboxes. To get these the same height, beginners should put the boiler temporarily in place on the chassis, mark-off one hole, then set a scribing-block to it, and check the position of the other hole with the scribing-block needle. If anybody sees the engine coming "head-on" and notices one clack higher than the other, you get a blot on your workmanship right away, and I must confess to agreeing with our old pal Inspector Meticulous on that point! Remove caps and balls before screwing the clacks home; set them vertical, then apply a brushful of Baker's fluid or other liquid flux around the flange, a small bead of solder, and a blowlamp flame. The solder will melt, flash around, and form a neat seal. You can, of course, silver-solder in a couple of bushes, when on the final brazing job, if you so desire, and screw the clacks into them; but the 13-gauge boiler shell provides plenty of "hold" for the thread on the stems, the solder seals the joint, and the result is neater than bushing. The backhead clack is screwed into a tapped hole on the horizontal centre-line of the boiler, on the opposite side to the reverse-lever. No soldering is needed here, just a taste of plumbers' jointing. "Doris's" backhead clack is fixed likewise, but there are no side clacks, as she has top feeds, which I will deal with before we erect the boiler.

Blowdown-valve and Washout-plug

At the bottom corners of the backhead, drill two holes with letter R or 11/32-in. drill, and tap them $\frac{3}{8}$ in. by 32, for the blowdown-valve and washout-plug. Both are turned from $\frac{1}{2}$-in. rod, and the plug is just a kiddy's practice job, needing no detailing. The blowdown-valve is precious little more, being merely a glorified edition of the end of the lower water-gauge fitting, as you'll see by the sectional illustration; but instead of the outlet being screwed externally and countersunk, it is squared off at the end, and tapped for a bit of $\frac{1}{4}$-in. pipe, to take the sludge and residue clear of the "works." Anoint the threads with plumbers' jointing before screwing home.



Casing of "Everlasting" valve

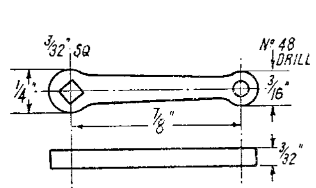
"Everlasting" Blowdown-valve

To those of our fraternity who want a bit of realism combined with a real thunder-and-lightning blowdown, I recommend the type of valve used on big engines, as mentioned last week. The reproduced illustrations and the following particulars are taken from an actual valve, one-sixteenth full-size, made by Mr. F. S. Lovick-Johnson himself; and a dinky little gadget it is, at that. Maybe I'd better explain how it works, first of all, and then you will more readily follow the construction. The body is made in two halves held together by six screws. One half is recessed, and the other truly faced; the recessed half merely has a boss drilled and tapped for the inlet pipe. The faced half has a similar boss drilled and tapped for the outlet pipe; and when the two halves are assembled, both are in line, giving a straight-through "entrance to the way out." Directly above these holes is a reamed and counterbored hole, in which works a spindle, called a "post" by the makers, and a lever is attached to the outer end. The inner end carries a curved arm, which works in the recess. In the lower end of the arm there is a small circular valve, like a round slide-valve, its working face being kept against the faced half of the casing by a weeny spring washer behind it. When the valve covers the lower hole, the outlet is closed; and the higher the pressure, the tighter it closes, because the recess is always full of water under pressure, which keeps the valve on its working face, same as steam pressure keeps the slide-valve in a steam chest against the ports. Moving the lever, turns the spindle, and with it the arm, which slides the valve away from the opening, giving the water a full-bore exit. That is all there is to it; simple, yet effective.

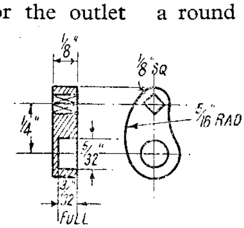
Valve Body

The two halves of the valve body can be made from $\frac{3}{4}$-in. hexagon rod, bronze or gunmetal for preference. Chuck a short bit in three-jaw, face off, and form the recess with a $\frac{1}{2}$-in. D-bit in the tailstock chuck. Cut back with a knife-tool, say 1/64 in., just enough to leave a 1/32-in. ring all around the recess; then part off at $\frac{5}{16}$ in. from the end. Scribe two lines at right angles across the centre of the plain side; then, at $\frac{1}{16}$ in. away from the vertical one, and $\frac{1}{8}$ in. below the horizontal one, make a centre-pop. Chuck in four-jaw with this running truly, and turn the boss. Centre, drill No. 30, open out and tap $\frac{3}{16}$ in. or $\frac{1}{4}$ in. by 40 as required; former for "Doris," latter for "Maid" or "Minx."

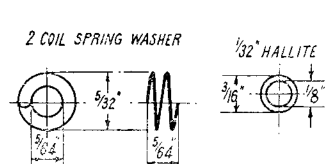
Chuck the rod again, face truly, and part off a $\frac{3}{16}$-in. slice. Rechuck the other way around, and cut back the corners for $\frac{1}{16}$ in., so as to leave a round boss $\frac{5}{8}$ in. diameter, standing up $\frac{1}{16}$ in. File up the oval boss from a bit of 3/32-in. brass sheet, and silver-solder it on in the position shown; this simulates the cast-on boss on the full-sized valves. Maybe our advertisers may supply castings for the weeny gadget. Mark off the position of the two holes on the oval boss, as shown in the illustration. Chuck in four-jaw with the lower one running truly, and drill and tap, same as the recessed one. Rechuck with the upper hole running truly; drill No. 34 right through, and ream $\frac{1}{8}$ in. Counterbore the other end $\frac{3}{16}$ in. diameter and $\frac{1}{16}$ in. deep, with a pin-drill. Drill the six screwholes in the corners



Operating lever

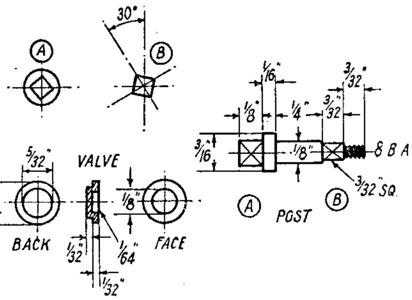


Valve arm



Valve spring and washer

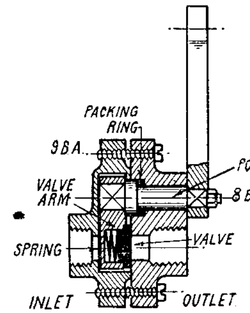
of the hexagon with No. 48 drill, then clamp the two halves together, and locate, drill and tap the screwholes in the other half, same as for a cylinder cover. Put a bit of $\frac{1}{8}$-in. rod through the lower holes, to keep the two halves lined up, whilst doing this.



Spindle or post, and valve

Working Parts

The post, or spindle, is turned up from a bit of $\frac{3}{16}$-in. round rustless steel or bronze rod, to the given dimensions, the lever end being similar to the end of the regulator rod; and you should know how to file squares by this time! The relationship shown between the two squares doesn't matter; it is only given in case any friend or relation of Inspector Meticulous wishes the lever to move the same amount each side of centre. The curved arm is filed up from a bit of $\frac{1}{8}$-in. brass plate, and recessed with a drill and D-bit. The valve is turned from $\frac{1}{4}$-in. round bronze rod. Chuck in three-jaw, face off, recess with a D-bit (just merely relieve the centre, it gives better contact) turn to 7/32 in. full diameter, then with a parting-tool cut in 1/32 in. behind the face, to 5/32 in. diameter, finally parting off $\frac{1}{16}$ in. from the end. Face valve, and the half of the casing, as described for slide-valves and port faces.



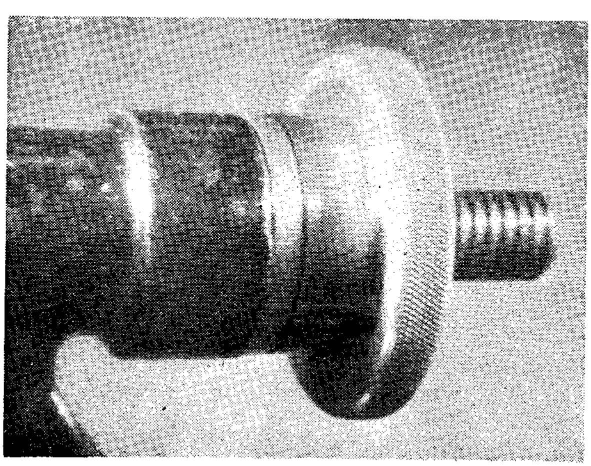
Section of "Everlasting" blowdown-valve

How to Assemble

Fit the curved arm to the end of the spindle. In the recess in the arm, put a tiny double-coil bronze spring washer, as used in radio and similar work, and set the back of the valve against it. Put a 1/32-in. "Hallite" ring in the recess in the spindle hole; carefully insert the post, seeing that the valve is in place when the post is right home; then put on the recessed half of the casing, and screw together by six 9-B.A. screws. The handle is attached, same as the regulator-handle; and for sake of appearance, the casing can be filed up as shown in the illustrations. Piping arrangements to follow later.

A Tailstock Indexing Dial

THE idea of fitting an indexing dial to the tailstock barrel of my lathe occurred to me as being the obvious method to ensure the accuracy essential for many jobs which it was difficult to carry out with the prevailing methods, e.g., the graduating of the barrel, etc. I had not seen or heard of a dial being fitted to the tailstock before, but nevertheless decided to carry out my intention.



I may say that my lathe is a $3\frac{3}{8}$-in. Zyto. I had no trouble in determining a suitable number of divisions, since the thread on the barrel is $\frac{1}{8}$-in. pitch and, consequently, using 125 divisions, I was able to arrive at the graduation of 1 division equal to 1 thou.

From the photograph it will be seen that I have also fitted a new hand-wheel at the same time. Whilst this simplified the fitting of the dial, it was not done with that purpose in mind, but because the thread in the original wheel was a bit worn and the thrust arrangement, being of the split washer type, was not considered satisfactory.

I am convinced that similar dials could be fitted to the majority of hand-wheels without much alteration being made. The dial needs only to be of the fixed type, since it can always be set to zero by moving the tailstock body along the bed. Since using this method, I have found that I can drill holes to a specified depth much quicker than before, at the same time ensuring that they are dead accurate.—R. KEY.