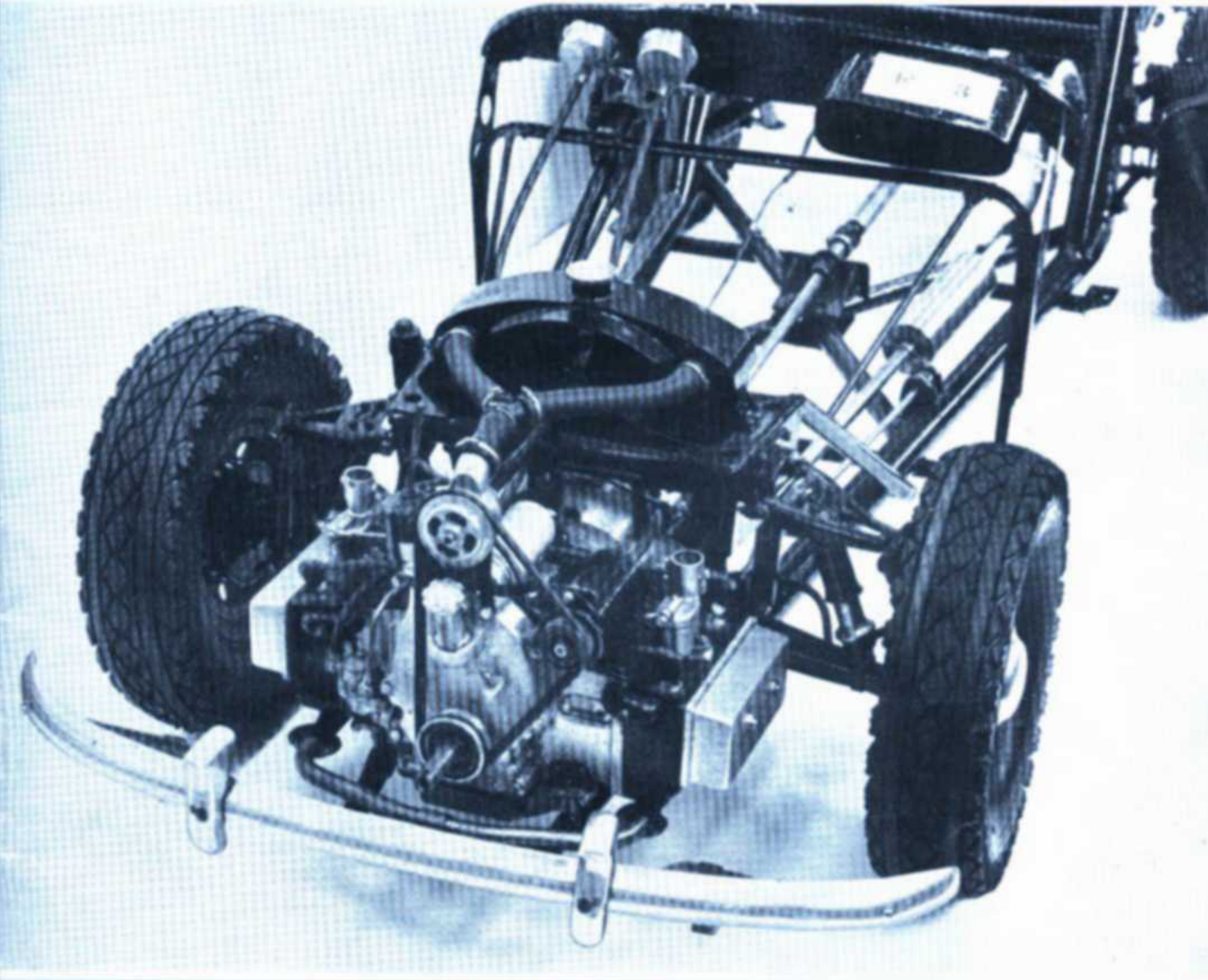
THE MODEL ENGINEER



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THE MODEL ENGINEER

EVERY THURSDAY

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OUR COVER PICTURE

The modern motor car, as a subject for model construction, has become very popular in recent years, and many working models have been built with i.c. engines capable of producing very high performance. The engines employed in these, however, are nearly always far removed, in type and appearance, to those fitted to full-size cars, and it is very rarely indeed that any serious attempt is made to emulate the latter. An exception to this rule is seen in this photograph, which illustrates a unique chassis model of an equally distinctive modern car, the Jowett Jupiter, constructed by Mr. C. D. Sweet, of South Petherton, Somerset. Built to 1/5 scale, the fidelity of the model, and the completeness of detail in the "flat four" engine, will be apparent from the photograph. In view of the many difficulties in producing a working model of a very small multi-cylinder engine, it is no disparagement to state that the scale-size ignition distributor which is fitted for exhibition is found incapable of dealing effectively with the high-tension current, and that it is found necessary to replace it with an "over-scale" distributor for actual working; but with this exception, all parts are built to scale, and work satisfactorily.

SMOKE RINGS

"No Such Animal ?"

SEVERAL READERS have written to us regarding a photograph which appeared recently in *Radio Times*, depicting a student in the International Labour Organisation centre at Tripoli, at work on a lathe. Apparently the latter is of unusual design, having the headstock on the right of the operator's position, and we are asked whether such lathes exist, and why. One reader facetiously suggested that the lathe must be an "Oxley Special" for machining "left-handed thrupple-nuts."

This is not the first time that we have encountered a problem picture of this nature, and while we have no definite information on the matter, we are inclined to the view that the photograph has been printed the wrong way round, either accidentally or deliberately, with the object of improving its composition from the artistic point of view. We can think of no practical reason why a lathe should be made entirely out of conformity with conventional practice in this respect; there are plenty of left-handed lathe operators, but they find no difficulty in operating standard types of lathes. Although we are not prepared to state that lathes with the headstock on the right have *never* been manufactured, our opinion, like that of the farmer who saw a giraffe for the first time, is that "there ain't no such animal !"

From a Jamaican Reader

WE HAVE received a long and most interesting letter from Mr. Harry E. Vendryes, who is proprietor of P. C. Vendryes & Son, Electro-platers and Engravers, 54-56, Johns Lane, Kingston, Jamaica. He and his late father have been subscribing to THE MODEL ENGINEER since Vol. I, and Mr. Vendryes, junior, has done a lot of work on various types of steam engines. But his real interest is in steam locomotives, and during a pre-war visit to England, he met "L.B.S.C.", of whom he appears to be a staunch follower. He has also met several live-steam enthusiasts in the U.S.A. and Canada; but he states that, at home, he is "absolutely alone in this far outpost of Empire, as no one else takes the slightest interest in model engineering, at least as far as I am aware." He inserted an advertisement in a local newspaper for about a week, but without any result.

We would not like to be certain that there is no other reader of THE MODEL ENGINEER in Jamaica; if this note should catch the eye of anyone in that country, or especially in Kingston, he is invited to get in touch with Mr. Vendryes, who, we are sure, would extend a warm welcome and possibly a helping hand.

Calling Gateshead

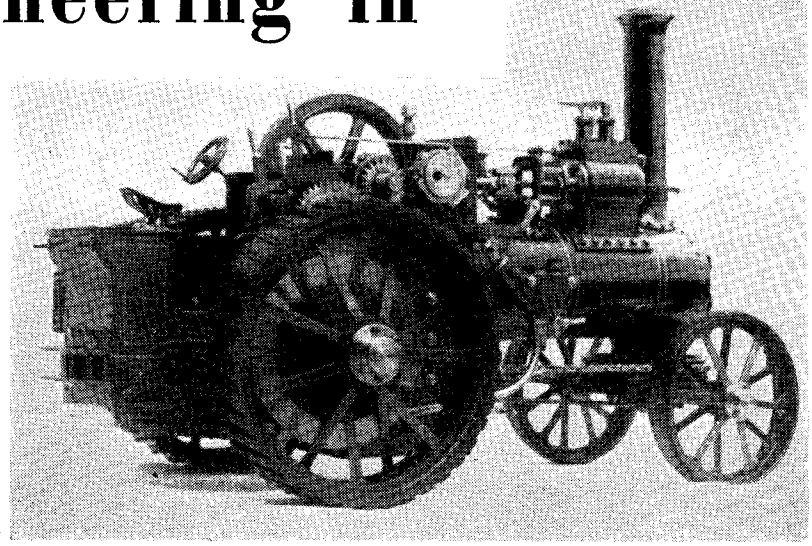
A SOCIETY of model and experimental engineers has been formed in Gateshead, Co. Durham. At present, there are only a few members, but their enthusiasm and confidence is such that they are already building their own workshop. There are probably many readers who would be interested in joining the new club, and they are invited to get in touch with Mr. G. W. Robinson, 30, Rothbury Gardens, Lobley Hill, Gateshead 11, either by calling at his address, or telephoning after 6.30 p.m. His number is Dunston 8-4386.

For Potential Draughtsmen

FROM THE Ministry of Labour and National Service we have received a copy of an informative booklet. It is No. 60 in the "Choice of Careers" series and is entitled "Engineering Draughtsman"; there are 28 pages in which is given an insight into the work of an engineering draughtsman, the kind of technical problems it presents, the opportunities it offers and the qualities and qualifications it demands. It is likely to appeal to boys and young men of quiet temperament and neat hand, with an aptitude for mathematics and the sciences and with a practical way of thinking. Parents and teachers of boys who are about to decide what to do on leaving school will find much useful information and advice in this booklet, copies of which can be obtained, price 1s., from Her Majesty's Stationery Office or through any bookseller.

Model Engineering in Madeira

By W. D. Treadwell



Mr. G. P. Gordon's ½-in. scale "M.E." traction engine

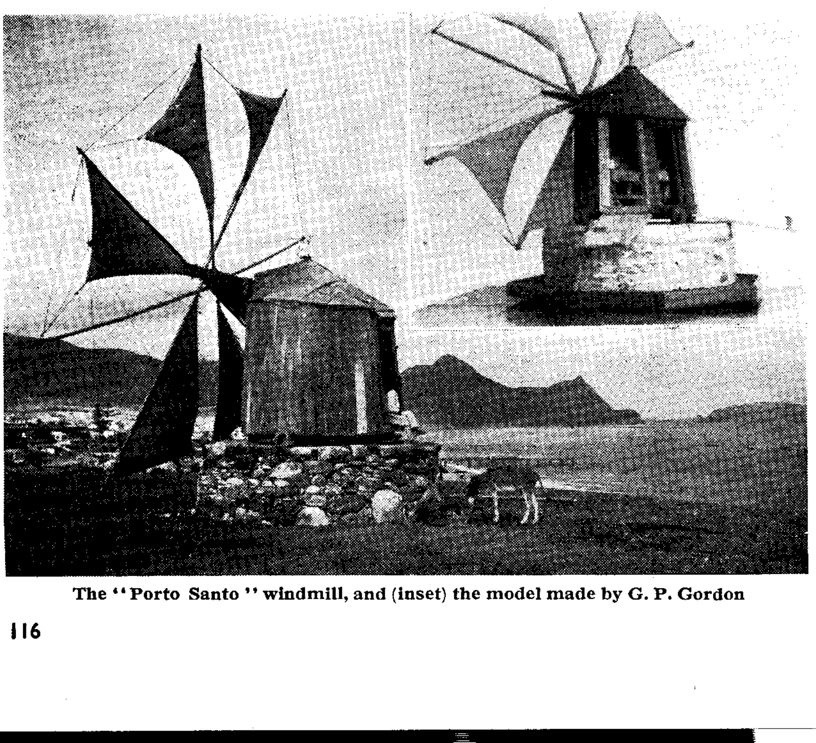
I WROTE to THE MODEL ENGINEER about a year ago to make certain enquiries, and said that I would write again to tell of M.E. activities in Madeira. Unfortunately, since then my time has been very limited, and I have as yet been unable to obtain many decent photographs of the various models which exist here. One of the questions I asked was on behalf of Mr. G. P. Gordon about a suitable colour scheme for his ½-in. scale "M.E." traction engine. The engine is now finished, and the photograph will show what a lovely job it is. As yet, I have not had the pleasure of seeing the model under steam, but if it is anywhere near Mr. Gordon's usual standard, there is no question of its efficiency.

A Prolific Modeller

Mr. Gordon is our most prolific enthusiast, and has many fine models to his credit. Some of his work has been illustrated in THE MODEL ENGINEER, about 1939, when it was described by W. J. Bassett-Lowke, and I think Mr. K. N. Harris has also written about Gordon once. Some of his other models include *Fayette*, a large scale travelling steam-crane, a very nice mill engine, miniature set of carpenters' and engineers' hand tools, Nelson's *Victory*, a working loom, and many others. Some of them, particularly *Fayette*, the traction engine, and the crane are especially remarkable as Mr. Gordon has never left the Madeiras, and so has never seen the prototypes.

The other enthusiast is Mr. E. V. Boddis, who also has several nice models to his credit. These include several small steam engines of various types, to his own designs, a beam engine, 15 c.c. 2-stroke engine, a car chassis for the engine, but not finished yet, and several clocks. Two of the most interesting clocks are a rolling ball clock of the Congreve type, and a Synchronome clock, to Hope-Jones design. I have no photographs of Mr. Boddis' work at present. Mr. Boddis hopes to acquire an M.L.7 shortly, so his workshop is due to become very popular. Equipment between the three of us is very limited, and *very* old !

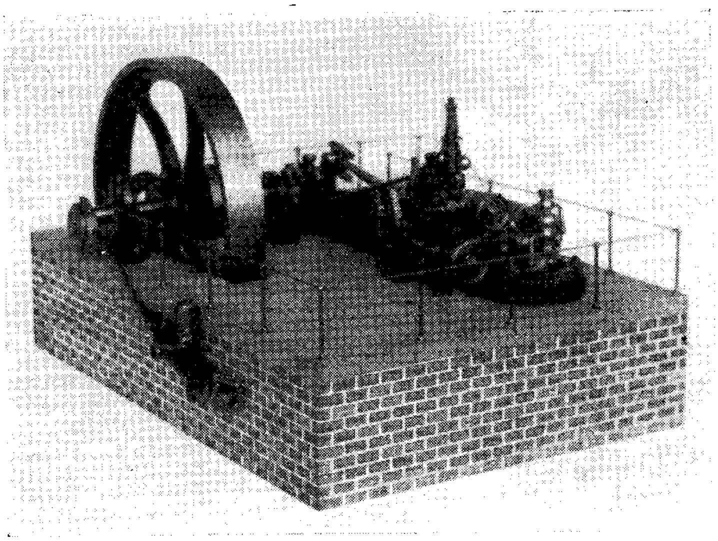
As for myself, I am at present setting up shop, and am working on a 3 in. centre lathe to my own design. So far progress is rather slow, as my time is very fully occupied, but I hope to have it working before long. The headstock and bed are almost finished, and patterns for the tailstock and saddle are under way. The bed is built up of m.s. channel and strip, welded, with cast-iron shears screwed and dowelled in place. The headstock is also built up of channel with ¾ in. thick plates welded in to form the ends. These plates were hacked and filed out, and decided me to get castings next time! The bed shears are the only castings to be obtained from a foundry, all others used to date were made by myself, using an old oildrum lined with fire cement for a furnace, blown by the foot-operated blower of the office forge. With foundry coke, it was surprisingly easy to melt the iron, and so far—touch wood—never a blow-hole. Beginner's luck, I suppose.

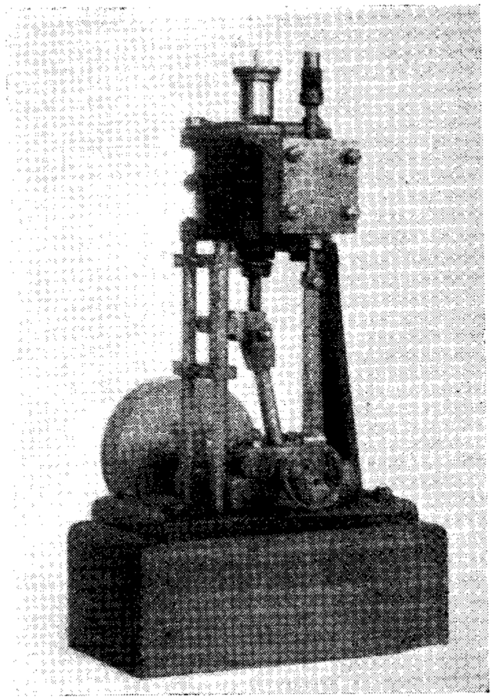


The "Porto Santo" windmill, and (inset) the model made by G. P. Gordon

Lathe Details

A few details of the lathe may be of interest. It is of 3 in. centre height, 11 in. between centres. The mandrel is of 4½ per cent. nickel-steel, and is carried on taper bearings (15 deg. incl.) in cast-iron bushes shrunk into the aforementioned ¾ in. headstock plates ; 9:1





A small horizontal mill engine, and a double-acting vertical steam engine, 1¼ in. bore by 2-in. stroke constructed by Mr. G. P. Gordon

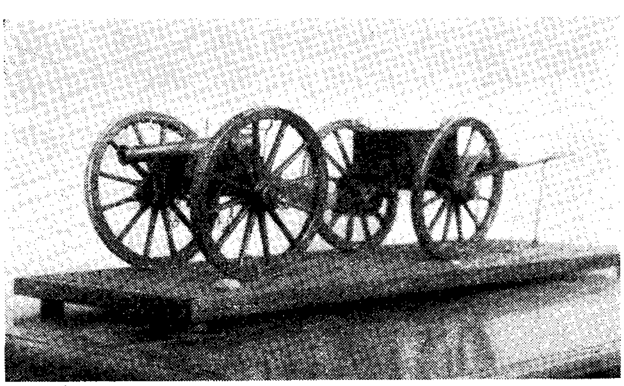
back gear is fitted, and operates with a single lever. As the gears are in constant mesh, changing to back gear is just a matter of moving over the lever. The saddle carries a large T-slotted boring table, and will be equipped, in the first instance, with a 4-way toolpost and 2-tool back toolpost. The fully-swivelling top slide will come later. Feed is by lead-screw or rack, and the self-act will be fitted with a feed gearbox adapted from the design which was published during last year in THE MODEL ENGINEER.

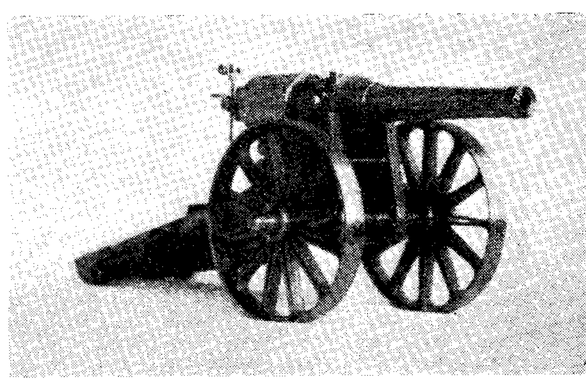
The tailstock is of normal design except that the barrel has rack feed only. Having carefully noted all operations involving the tailstock feed for the last year, I can see nothing that can be done by the screw feed that cannot be equalled, if not bettered, by the rack feed. The only possibility is that of the barrel moving under the influence of heavy cuts between centres, but experiments with the office Holbrook showed that the clamp was sufficient to hold the barrel even when taking heavy eccentric cuts.

The mandrel was quite a job, as the only piece of steel I found was 2½ in. dia. Coupled with the facts that the only tools available were of silver-steel, the Holbrook is treadle-powered, and the main part of the job had to be reduced to 1 in. dia. I lost quite a lot of weight!

Here's an item to amuse "L.B.S.C." The split lead-screw nut started life as a "Dot" cylinder casting. It was just right. My "Dot" is scheduled to have piston-valves and outside Stephenson gear, and it was a slide-valve casting. Now I've got a spare blank available!

I must say now how much I look forward to getting THE MODEL ENGINEER although it is usually three or four weeks old. The first thing looked for is "Duplex," to see if he is offering anything relevant to the job in hand, and then on to "L.B.S.C." Many others, too, have helped, and I must mention Terry Aspin, and thank him for encouraging me to have a go at casting iron. Thanks to all your contributors, and to you for giving us such varied and ever interesting fare.

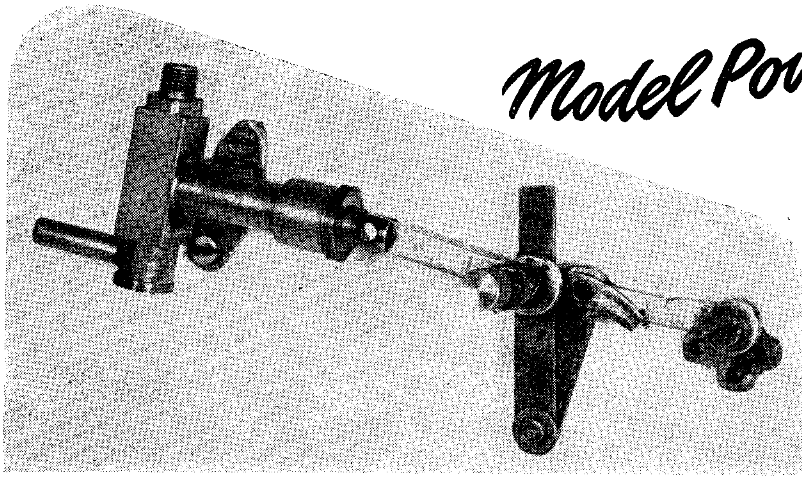




Model field guns and limber made by Mr. G. P. Gordon

Model Power Boat News

BY MERIDIAN



Hand/mechanical pump linkage. The front rocking lever is disengaged by withdrawing the spring-loaded bolt and an extension handle is slipped on the top

FLASH STEAM PROBLEMS —PUMPS

PUMPING against high pressure is just one of the many problems facing the enthusiast who runs a racing flash steam boat. Mr. A. Martin of *Tornado* fame once observed that the water pump was the heart of the flash steam plant and not the engine. Well, provided the engine is efficient, this view is almost certainly a correct one in my experience.

With flash steamers, best performance is often attained just after the water pump has been overhauled, and troubles that may be put down to " cooling off," in fact, are nothing more than the pump failing to do its job.

Oil pumps seem to be relatively free from trouble, so I shall not say much about them beyond a few observations that may be of interest to beginners. Most oil pumps are small in the bore and stroke—$\frac{1}{8}$ in. bore by $\frac{1}{4}$ in. stroke is a common size, and usually they will be around these dimensions. Two pumps are commonly favoured, one to feed the engine and one for bearing lubrication. They are driven at a ratio of anything from 50 to 100 to 1 engine speed, generally by worm gearing. Sometimes the pump rams are actuated by cams, so that the pumps may be operated manually if required. In the latter case, the rams are spring-loaded for the return or suction stroke.

Some exponents favour the use of superheat steam cylinder oil for engine lubrication, but motor oil has been used successfully in one or two examples. Instead of oil pumps, a hydrostatic device actuated from the water end of the boiler may be used, but not all examples have been completely successful. The best known is that installed in F. Jutton's *Vesta II*, which has always worked perfectly.

Now for some of these water pump problems. The biggest trouble is, of course, that the pump may have to work against very high pressures, and under these conditions, the water prefers to go anywhere except into the boiler! The gland is very vulnerable in this respect, and some leakage is almost inevitable, unless it be adjusted so tightly that an enormous amount of power is wasted in overcoming the added friction. Design is an important factor here, and experiment with some of the special types of packing used industrially would probably help.

It is surprising how water will get past even the tiniest path when high pressure is involved. Possible leakage points are the valves of the pump—even the smallest damage or distortion of the seating will result in leakage, and the greatest care must be taken, when making a pump, to see that the valve seatings are truly circular. This sort of leakage is an insidious thing, since although the pump will work, and may appear to deliver well when tested, in actual fact, the whole performance of the plant may be limited by the failure of the pump to deliver properly at more than a moderate pressure. To apply the " big stick " by increasing the stroke of the pump, in the hope that at least some of the water will enter the boiler, does not appear to help much; usually the result is that too much water is pushed into the boiler at the commencement of the run and rapidly cools it off.

Choice of materials is important when making pumps. Stainless-steel is favoured for the ram, and also for the valves. The latter generally take the form of stainless-steel balls, restricted to a lift of about 1/32 in., although mushroom valves have been used with success. Pump bodies can be brass or bronze—aluminium alloys must be avoided, owing to erosion that occurs between the seating and the valve. This sort of erosion is presumably caused by electrolytic action and may even occur with other combinations of metals, but less severely. I have found that the best cure for this trouble was to fit inserts of stainless-steel for the ball valve seats, but it is a tricky job to achieve perfect circularity of the holes. Reamers must be very sharp to cut stainless-steel nicely, owing to its work-hardening properties, and best results may require a lapping process to finish the job.

The water pump in a flash steamer works at very high speed, since the engine/pump ratio seldom exceeds 6: 1 and more often is in the region of 4: 1. This means that with an engine speed of, say, 10,000 r.p.m. (which is moderate by present day standards), the pump is doing 2,500 strokes per minute. Such speed as this demands that the valves are restricted in lift, in order to prevent flutter and consequent loss of pumping efficiency. At the same time, the lift must not be limited too severely, or the water passage is restricted. This is something that must be determined by trial and error—in one case, an adjustment to the amount of lift on the suction valve resulted in a considerable gain in performance.

One wonders how much power is absorbed by the pump in a flash steam plant, but nobody has ever actually measured this; there are too many other things to worry about without making further trouble! Assuming a pump of $\frac{1}{4}$ in. bore by $\frac{1}{2}$ in. stroke, pumping against a pressure of 1,000 p.s.i., a rough calculation would appear to give a figure of $\frac{1}{8}$ B.H.P. absorbed, assuming a speed of 2,500 strokes per minute. This does not take into account mechanical losses due to friction of gears, pump ram, etc., as nothing short of actual tests could determine these figures, which must differ from boat to boat. The total power necessary to drive water pumps must be pretty high, if one judges by the frequency with which pump reduction gearing can be wrecked. I noticed recently that Mr. J. Bamford's *Hero* has a tough looking pair of gears fitted in this department, others having folded up rather rapidly. The present large wheel is a motor-cycle magneto timing gear, of fairly course pitch, and made of tough steel—I gather that this gearing appears to stand up to the job well, and so far shows no signs of stripping.

For starting a flash steamer, a hand pump is necessary, or in lieu of this, some method of actuating the main pump separately from the mechanical drive. The fashions in hand pumps vary somewhat from vertical types operated like the valves of a trumpet, to double-barrelled pumps fitted with isolating cocks or valves. I must say that if one pump only can be used, so much the better, but the disengagement gear must be light, yet sufficiently robust for the job, and this is not too easy to achieve. The most popular type of hand pump is the dual barrelled sort, which uses a common valve chamber. Sometimes the hand pump ram is held back by a catch when not in use, and other examples may have isolating valves, as mentioned above. The benefit of pumps having common valve arrangements is that the mechanical pump is certain to work when the engine starts. It is not exactly unknown, in the case of plants having separate pumps, for the engine to cease running as soon as hand-pumping stops. This failure of the mechanical pump is nearly always due to the valves sticking to the seats, and the time-honoured remedy for this is to smite the valve box with the handiest implement available.

By placing the hand pump in series with the mechanical one, this trouble can be avoided to a certain extent, although the valves might still tend to stick when initially using the hand pump. The latter is placed on the delivery side of the mechanical pump, so that water must be drawn through it when hand-pumping. A disadvantage of this arrangement is the obvious one of leakage past the ram of the hand pump, when the boiler is operating at full pressure; also, the water must pass two extra valves on its way to the boiler. The latter, however, may not be a disadvantage provided that the extra valves do not offer too much obstruction, as they would act as check valves. Incidentally, some exponents fit check valves and others do not. Personally, I favour their use, with the above proviso regarding obstruction.

Cruising Boats

Turning once more to "tamer" flash plants, it can be seen at once that since most of the pump problems are connected with high pressure, they simply do not arise when one considers the plant designed for more moderate performance. This is not to say that slipshod workmanship can be tolerated, but what *can* be said is that, given reasonable design and construction, the troubles that beset the racing boat should not arise to any extent.

One important proviso to this statement is that the choice of materials should be suitable for the job, as indicated earlier on. Brass could be used for the ram instead of stainless-steel, if necessary, but I would say that stainless-steel ball-valves are hard to beat for general use, being much superior to bronze ones.

With a specially designed racing engine, the pumps are usually built into it, and not made as a separate unit. The reasons for this are partly the mechanical advantages offered by such an arrangement, and partly the saving in weight compared with the alternative of separating the pumps from the engine unit.

For the cruising boat, the latter idea is in most cases the best arrangement, since one does not have to work to a weight limit, and the pumps may be situated anywhere that a drive from the engine or propeller shaft can be arranged.

The complete pump unit could contain the reduction gearing (including oil pump gearing), water pump, hand pump, and oil pump, all fitted on a suitable baseplate, and made easily removable from the hull for ease of servicing. If the situation of the pump unit is not convenient for hand pumping the said pump may be situated in any position where it can be operated easily, provided that the piping is arranged in a suitable manner. For the suction side of the piping, plastic tubing can be used, but care must be taken to see that there are no hidden kinks.

Reduction gears need not be especially robust—I have seen Meccano gears used quite successfully in a cruising flash steamer. The gear ratio should be similar to that chosen for racing plants, say 4 : 1 for water, and 60 : 1 for oil pumps.

Water pumps, too, may be of similar dimensions to those used for racing. A pump of $\frac{1}{4}$ in. bore, with a stroke up to $\frac{1}{2}$ in. should provide all the water necessary to make steam for a moderate performance engine. It is usual to drive the pump from a crank disc provided with a screwed-in crankpin. This crankpin may be fitted in any one of a number of tapped holes drilled at different throws, say, $\frac{1}{8}$, $\frac{3}{16}$, and $\frac{1}{4}$ in. from the centre, thus giving pump strokes of twice this distance. The most suitable pump stroke is then found by experiment.

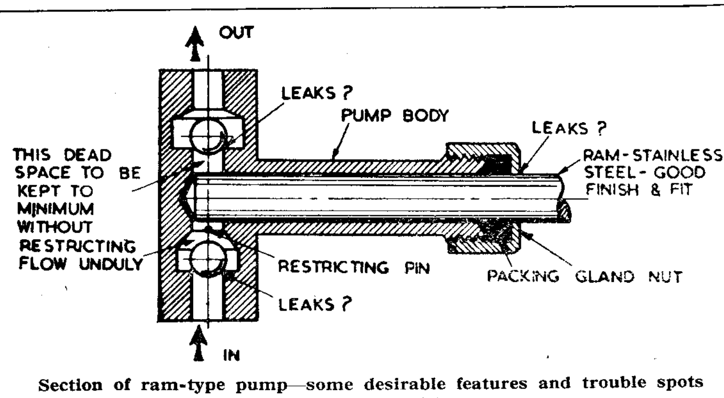
Sometimes a by-pass may also be of use to adjust the amount of water going into the boiler, and this takes the form of a small screw-down valve, situated in the pipeline between the pump and boiler, with the waste pipe ejecting overboard. The adjustment must be a fine one, and the exit orifice should also be small, or trouble may be experienced in regulating the quantity of water to be rejected.

The idea is sometimes put forward of using a double-acting or twin single-acting pumps, the advantages to be gained being a smoother flow of water and a more even load on the engine. Well, I would be the last person to dissuade anyone from making the experiment, but it should be mentioned that it has been tried on one or two boats without much success. A notable exponent to try out this idea was H. Turpin in one of the *Tich* series of flash steamers, and the result was that the two pumps (working at 180 degrees to each other) failed to deliver properly together. The precise reason for this is somewhat of a mystery, and it is quite possible that it could be persuaded to operate satisfactorily if sufficient time was available for experiment. It is just one of the many items of flash steam plants on which further research is required.

An essential component of any flash steam boat is a water filter, for a lot of trouble may be experienced with foreign matter fouling the pump valves if this item is omitted. It must be so constructed that the wire gauze can be removed for cleaning purposes. It is really astonishing how much solid matter can be picked up from some ponds! For the cruising boat, it is advantageous to make the water filter of generous dimensions, since the running time of this type of boat is much longer than a racing boat, and it is undesirable to have to clean out the filter during a regatta.

Beginners sometimes enquire if the oil pumps are really necessary in the case of the moderate performance flash steam plant, and whether the displacement type of lubricator can be used instead.

(*Continued on page* 122)

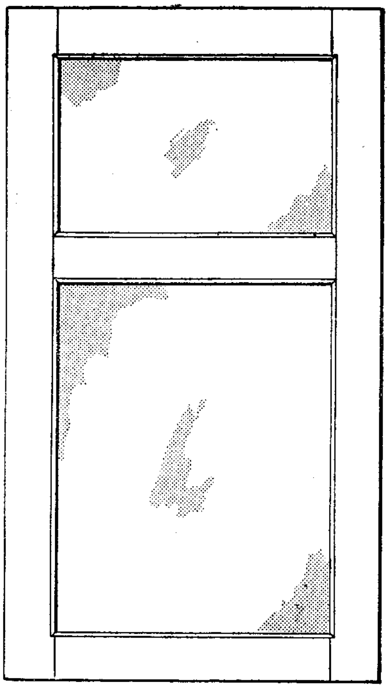


Section of ram-type pump—some desirable features and trouble spots (diagram only)

Woodwork with Metal-working Tools

By "Duplex"

ALTHOUGH the old-time cabinet-maker or coach-builder would have been taken aback by the suggestion that his skilled craftsmanship should be replaced by machine work, at the present day, nevertheless, our doors and window-frames, and even our furniture, are now largely produced by machinery.



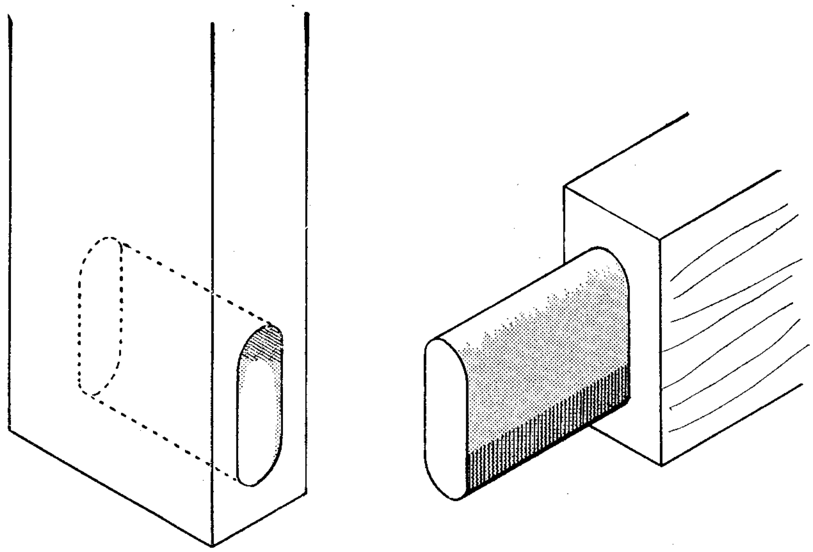


Fig. 2. The mortise and tenon joints of the frame

Left: Fig. 1. The door made for a tool cabinet

Following this example, there are many intricate wood-working jobs that can quite well be done in the small workshop, with the aid of the drilling machine, the lathe, and the shaping machine, by those who have no particular skill or liking for working in wood. When, for example, making a tool cabinet, no difficulty will be found in cutting up and jointing the material forming the main part, but building the glass-panelled door, illustrated in Fig. 1, with accurately fitted joints is not quite so easy.

The type of mortise and tenon joint used for the door frame and for its cross-bar is illustrated in Fig. 2, and it will be seen that, for the sake of appearance, the joints were made with stop-tenons; that is to say, the tenons are not carried right through the side members of the frame and their ends are concealed.

If an inexperienced wood-worker attempts to do this kind of jointing solely with hand tools, in all probability the finished frame will not lie flat and the actual joints will be somewhat unsightly. But in the present instance, ordinary metal-working practice was adopted, and the finished frame was in every way satisfactory and up to good cabinet-making standards.

Before starting work, those who are accustomed only to metal-work should bear in mind that wood stored in a damp atmosphere and then kept at room temperature will shrink; as this may result in making ill-fitting joints, the wood should be allowed to dry out thoroughly before being cut to size.

Marking-out the Work

At the outset, just as in metal-work, it is advisable to mark-out the work from datum surfaces, which in the present instance are the abutment faces of the frame.

This marking-out can be done with the ordinary surface gauge, but it is

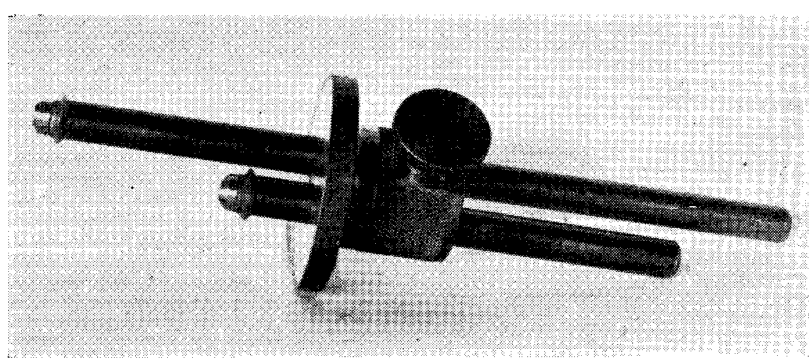


Fig. 3. The adjustable scratch-gauge

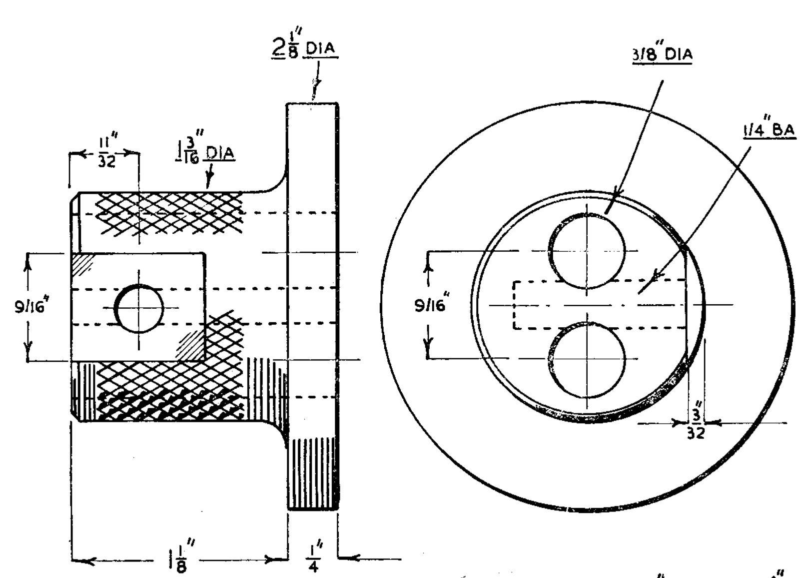


Fig. 4. The scratch-gauge body

usually more convenient to use a scratch gauge, of the kind illustrated in Fig. 3. This gauge, which was made in the workshop, follows the design of the original Starrett gauge.

The body part is machined in the lathe and then drilled with two parallel holes to receive the two scribing arms shown in the photograph. After adjustment, these arms are locked by means of a draw-bolt. Each scribing arm is furnished with a sharpened roller, free to rotate, but held in place with a shouldered screw.

After the five frame members have been finished to size, the gauge is set with its rollers at a distance apart equal to the thickness of the tenon, and so that the two rollers are equidistant from the centre-line of the work.

Both the mortises and the tenons are then marked-out for thickness, and their width is also marked-out by adjusting the scribing arms to correspond. The width of the mortises to receive the cross-member will have to be marked-out with the aid of a rule and a square.

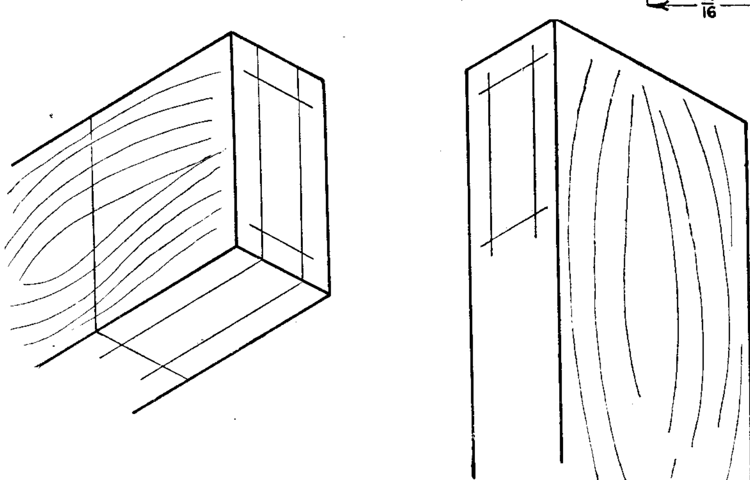


Fig. 6. Marking-out the work

Machining the Mortises

Each side-member is clamped, datum surface downwards, to the lathe top-slide, so that the centre-line is at lathe centre-height, and the part is at right-angles to the lathe axis. After an end-mill of the same diameter as the tenons has been mounted in the lathe chuck, the mortises are machined to the finished length and depth by actuating the corresponding lathe slides. For this work, the lathe should be run at high speed, and the teeth of the cutter may have to be cleared from time to

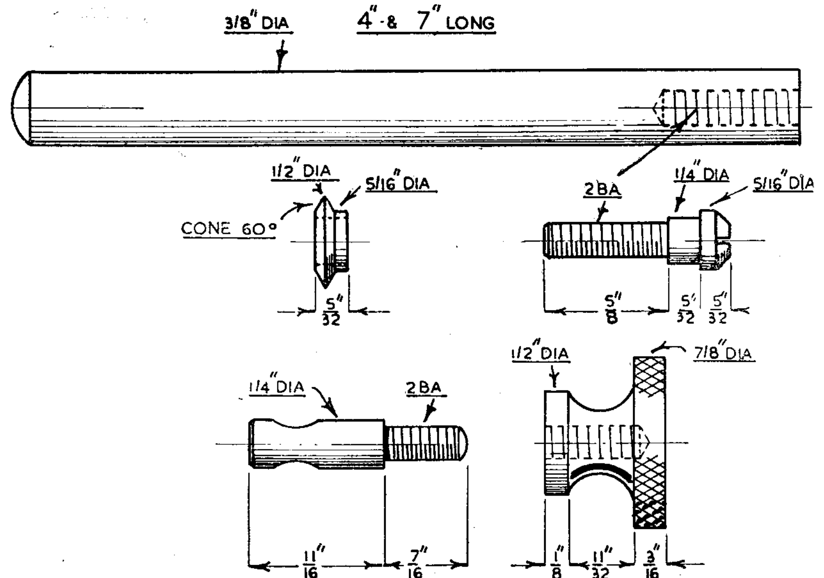


Fig. 5. The scribing arms and locking bolt

time to prevent clogging. The finished mortises will, of course, have rounded ends, terminating at the scribed dimension lines.

Machining the Tenons

The tenons can quite well be cut to size on all four faces, by mounting the work on the vertical-slide and using a sharp fly-cutter driven at high speed by the lathe mandrel.

However, it will usually be found easier to do this work in the shaping machine, with the parts gripped in the machine vice.

For this purpose, it is essential to use a really sharp tool, with a narrow cutting angle, similar to that illustrated in Fig. 7.

The actual tool used was made from a length of square silver-steel, filed to shape and then hardened and tempered to a medium straw-colour. To finish the cutting edge, the tool is first hollow-ground on the periphery of the emery wheel and then honed on an oilstone to a keen edge. The tool illustrated in Fig. 8 can also be used in the shaping machine for work of this kind, and it has the advantage that, in addition, it is suitable for ordinary planing as well as for grooving and forming rabbets. The frame members are gripped in the machine vice with the datum surface upwards, and a series of cuts is taken to remove the surplus wood down to the marked dimension lines. Next, the work is turned over and the tenon is again machined to the full length, but slightly in excess of the finished thickness. Try the corner of the tenon in its mortise and, if necessary, continue the machining until it is judged the parts will go together with light tapping. Do not make the joint a force-fit, as this may split the wood. The tenon can now be machined to the finished width, and the corners are rounded by filing to match the mortise. Time will be saved when machining the remaining tenons if the readings of the slide index collar are noted so that they can be repeated.

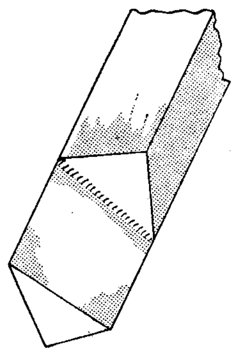


Fig. 7. A shaping machine wood-working tool

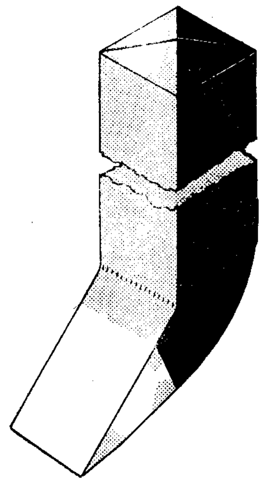


Fig. 8. An alternative form of planing tool

The frame can now be glued and fitted together, with the knowledge that it will lie flat and that very little glass-papering will be needed to make the joint lines almost invisible.

While the glue is setting, it is advisable to secure the frame with cramps; but if these are not available, clamps can be improvised by fixing strips to the bench top, and then bringing pressure to bear on the joints by means of wedges, in the way shown in Fig. 9.

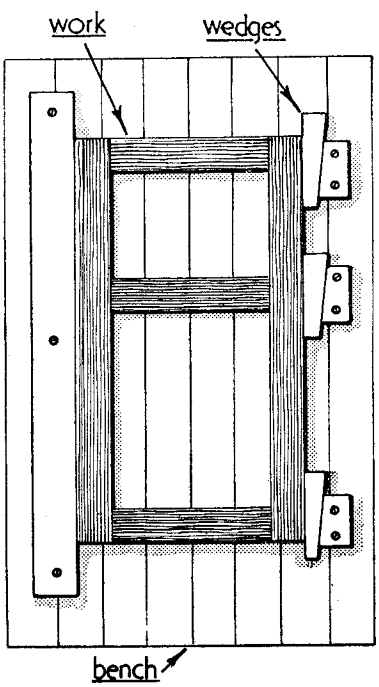


Fig. 9. Showing a method of clamping the door frame

A Useful Hint

To keep the tools in the cabinet from rusting during the winter, it is almost essential to provide some form of heating where sudden changes of temperature occur, as in some out-door workshops. This can be done conveniently, and at small cost, by fitting a 15 W, pigmy, lighting bulb inside the cabinet and supplying it from the 250 V mains.

These bulbs give out quite enough heat to maintain the air within the cabinet well above the dew-point, and the current consumption is negligible.

Model Power Boat News

(*Continued from page* 119)

The answer to this is that it all depends on the particular plant. In any flash plant, working properly, the steam delivered to the engine is likely to be at least mildly superheated, and the possibility always exists that the lubricator may heat up to such an extent that the steam fails to condense, and the lubricator thus cease to work. However, if the lubricator is a large one, this is less likely to happen, owing to the greater surface area losing heat. I would certainly not recommend the usual size of lubricator so commonly seen on small marine engines, as the oil capacity will almost certainly be insufficient, due to the fact that the flash boat should keep running for as long as the lamp will last.

One bad feature of displacement lubricators is "gulping" that occurs when the steam cock is operated—the resulting drop in pressure in the steam chest and the higher pressure still existing in the lubricator forces out large quantities of oil. Since flash steam plants are best without a steam control-valve, this particular snag may not arise but I must say that considering all the points, it is best to fit some sort of oil pump if possible.

The oscillating type of oil pump so ably described by "L.B.S.C." would no doubt be adequate for this duty, as I believe that such pumps have worked quite well against pressures of several hundred p.s.i. In any case, the construction of a valve-type pump is not a difficult task, and provided that due care is paid to the seating of the ball-valves, it should prove to be one of the least troublesome items of the plant.

It has been suggested that in view of recent developments in full-size practice, there might be an alternative to the simple ram pump, which has many disadvantages from the point of view of high-speed pumping. It should be pointed out, however, that the "full-size" jobs are extremely accurately made. The limits on the gear-type pumps employed to pump fuel at high pressure are fantastically small, and the average home constructor would be hard put to reproduce them, especially bearing in mind that the reduction in size would present many problems of its own.

For the flash steam exponent, I am pretty sure that a well-made ram-type pump is the best thing, but if any bold spirit does turn up with an efficient pump of entirely new design, I shall be the first to offer congratulations.

A Gear-cutting Device

For a Potts Milling Attachment

By H. Winton

THE device here described enables a standard Potts type milling attachment to cut gear teeth of the order of 8 d.p. in mild-steel blanks. Gear cutters of the type described in the issue of October 14th, 1954, have been successfully used on this machine, when mounted on a $3\frac{1}{2}$ in. Model M type Drummond lathe.

The main essentials of the design are a back gear giving a gear ratio of about 5 to 1, and a rigid support for the bottom end of the cutter spindle.

The components which obviously call for some comment are the worm and worm wheel. Items 6 and 9. It is very common for model engineers to be put off making worms and worm wheels, due no doubt to the commonly held view that such items require elaborate set-ups and complicated drive arrangements between the cutter and blank spindles.

I would therefore like to say that in my case, they were made with nothing more elaborate than,

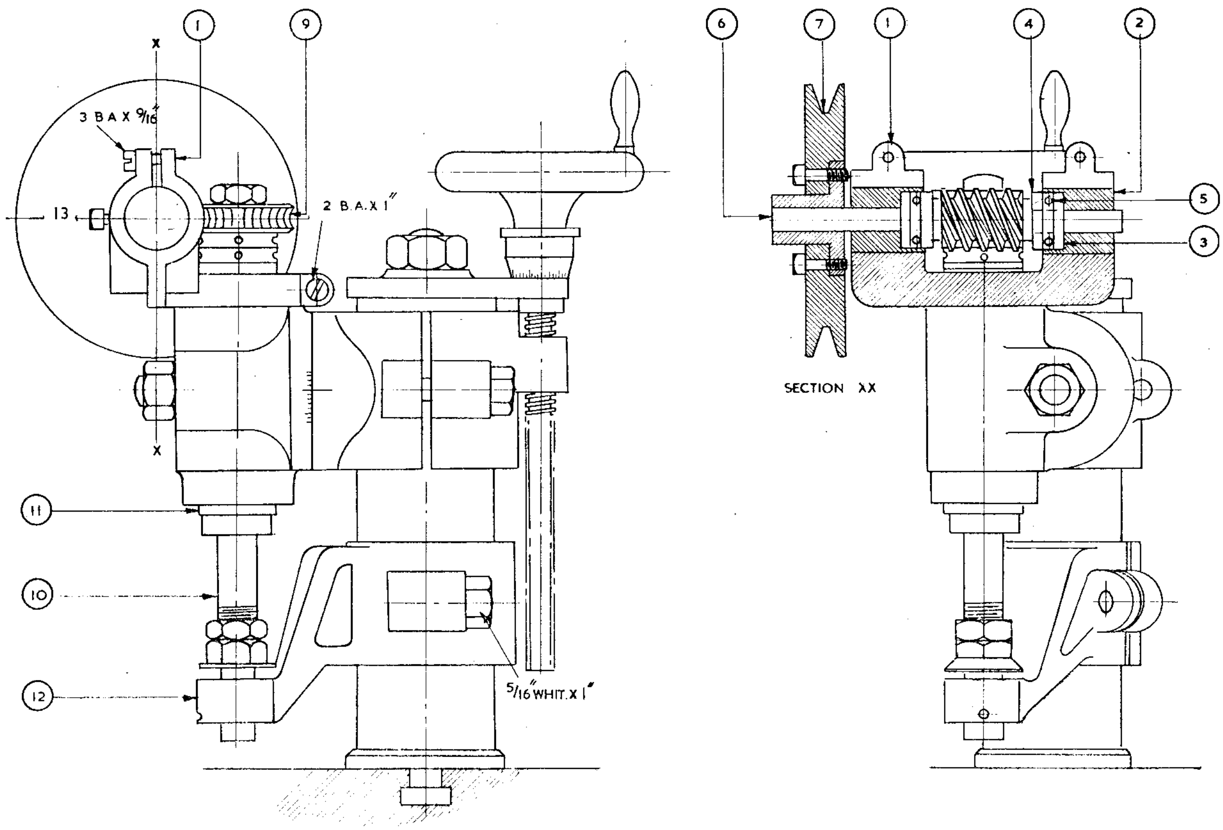
(*a*) A Drummond $3\frac{1}{2}$ in. lathe.
(*b*) A standard Potts milling attachment.
(*c*) Two milling cutters made in the lathe and by hand work in the vice.
(*d*) A home-made dividing head.

To produce the worm, first make up, Items 10 and 11. In making the spindle, Item 10, the $\frac{1}{2}$ in. diameter portion at the left-hand end should be made a close fit in the existing driving pulley, since the latter will be temporarily used to drive the spindle during the machining of the worm, and there is no provision for holding it on, other than tightness of fit.

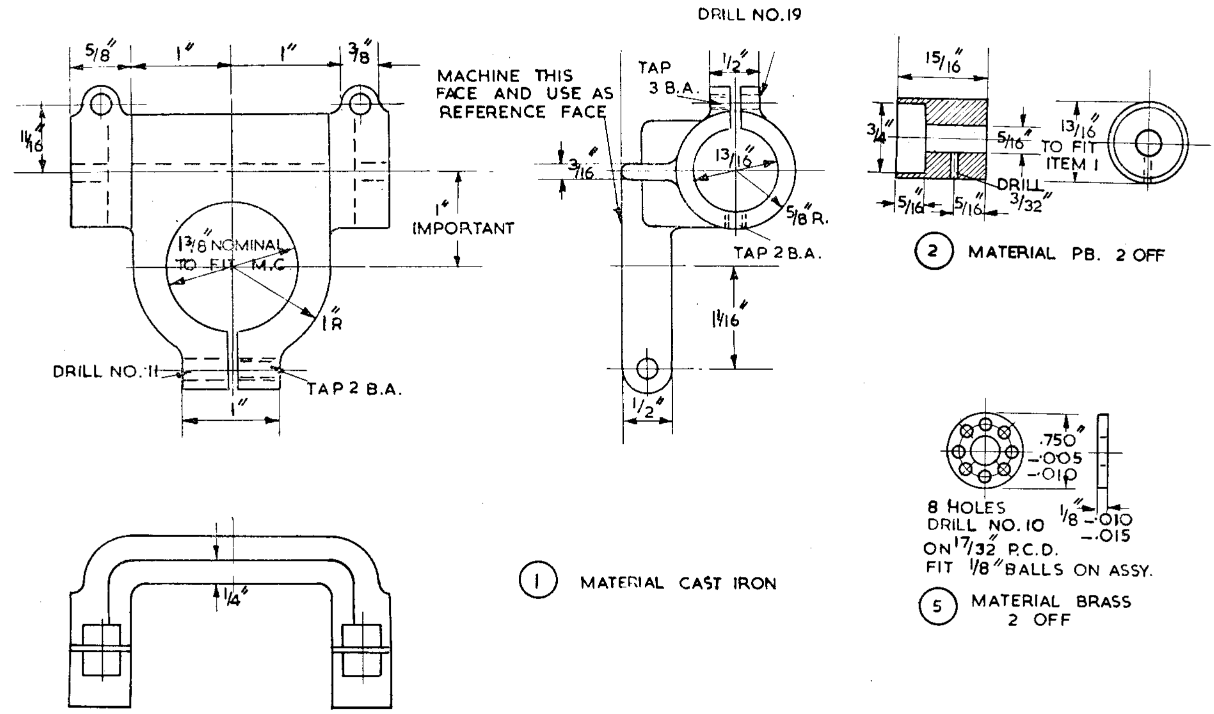
Make up a circular milling cutter $1\frac{3}{16}$ in. dia., having teeth of the shape shown at Item 6, and bored $\frac{1}{2}$ in. to fit the spindle, Item 10.

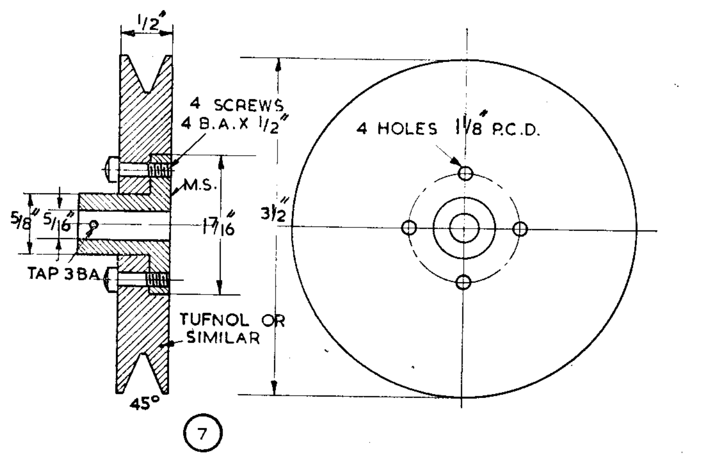
The spindle portion of the worm should not be turned down to $\frac{5}{16}$ in. until after the worm has been cut—in fact it can be left at about $\frac{1}{2}$ in. or just under, in order to lend sufficient rigidity to the work-piece, while the worm-cutting operation is in progress. The left-hand end of the worm proper needs to be about three inches or more from the chuck jaws, in order to leave sufficient room for the milling spindle at the end of the cut. It may also be necessary to allow several inches at the other end, to avoid fouling the tailstock. Check up before cutting off the stock. Mount the cutter on the spindle, Item 10, with two or three spacing washers on either side.

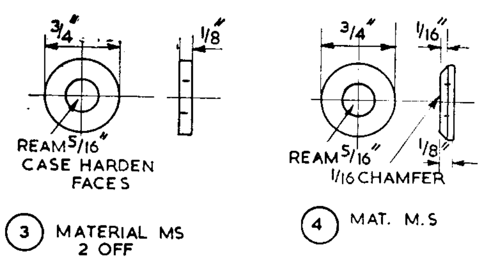
Set the milling spindle to the helix angle of the worm pitch line, i.e., $20\frac{1}{2}$ degrees, make sure the centre of the cutter is at lathe centre height, and proceed to cut one thread of the worm as a normal screwcutting operation, except that the lathe is driven by hand from the leadscrew. Note that the arrangement of change wheels is as given in the drawing for Item 6; it is recommended that the 40-tooth driver be placed on the headstock mandrel. Having cut one

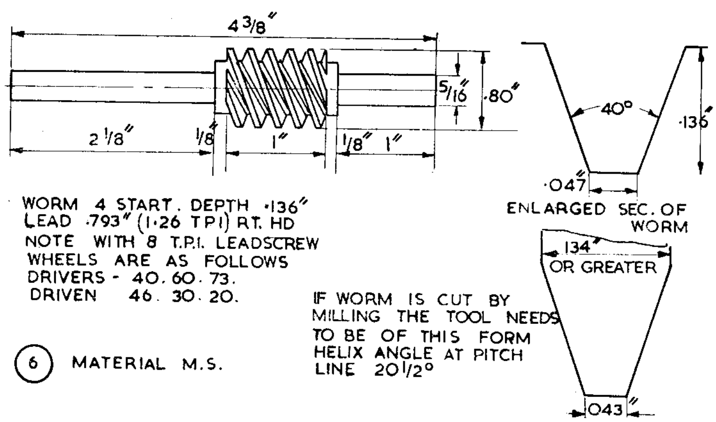


General arrangement views and part section of a gear-cutting device for a Potts milling attachment







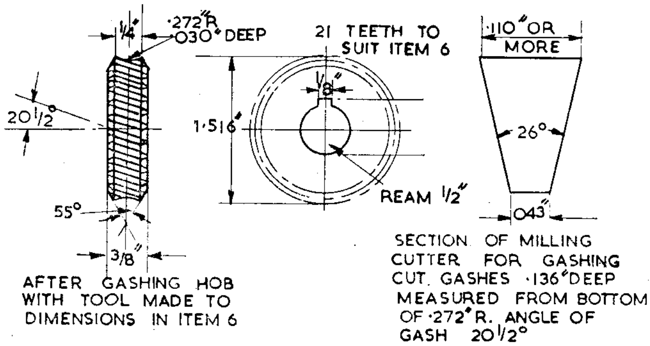


thread, mark off the teeth on the 40-tooth driver with a piece of chalk in four portions of 10-teeth each.

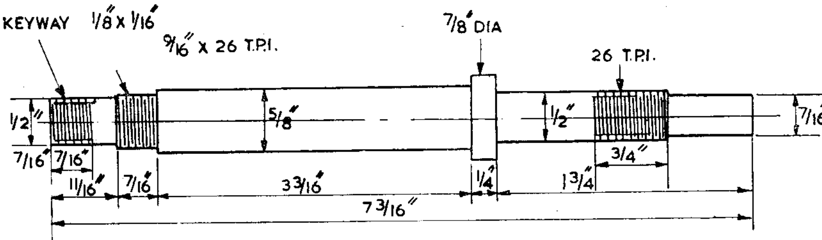
Disengage the gear train and move the headstock spindle round 10 teeth, or quarter of a revolution, re-engage and cut a second thread. Repeat until the four threads are cut.

The gear wheel blank is mounted on a mandrel, one end of which is held in the chuck. A dividing head capable of giving 21 divisions will be required for indexing the teeth. Make up another milling cutter, with teeth of the shape shown to the right of Item 9. A note of warning is here offered to those who feel inclined to use the same cutter as was used for cutting the worm. If you do try to make the one cutter do both jobs, the teeth of the wheel will be misshapen.

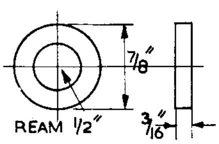
The cutter should be about $1\frac{3}{16}$ in. dia., as before, and bored to fit the spindle, Item 10. Set the milling spindle to an angle of $20\frac{1}{2}$ degrees, the centre of the cutter being at lathe centre height; it should also be in the centre of the



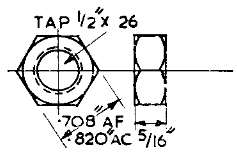
(9) MATERIAL BRASS



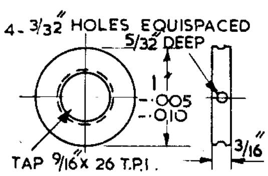
ITEM 10 MATERIAL MS



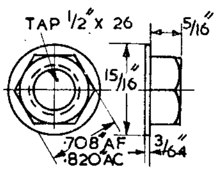
SPACING WASHER 5 OFF



NUTS 2 OFF



LOCKNUT 2 OFF



LOCKNUT 1 OFF

of accuracy judged by high precision standards, the result is perfectly adequate for the present purpose.

The gears on my machine run very smoothly, and remain cool even when taking a heavy cut.

The machining of the bracket, Item 1, was carried out briefly as follows:—

(1) File the bottom face flat, as called for on the drawing and use this as the datum for setting the height of the centres of the two $\frac{13}{16}$ in. bores.

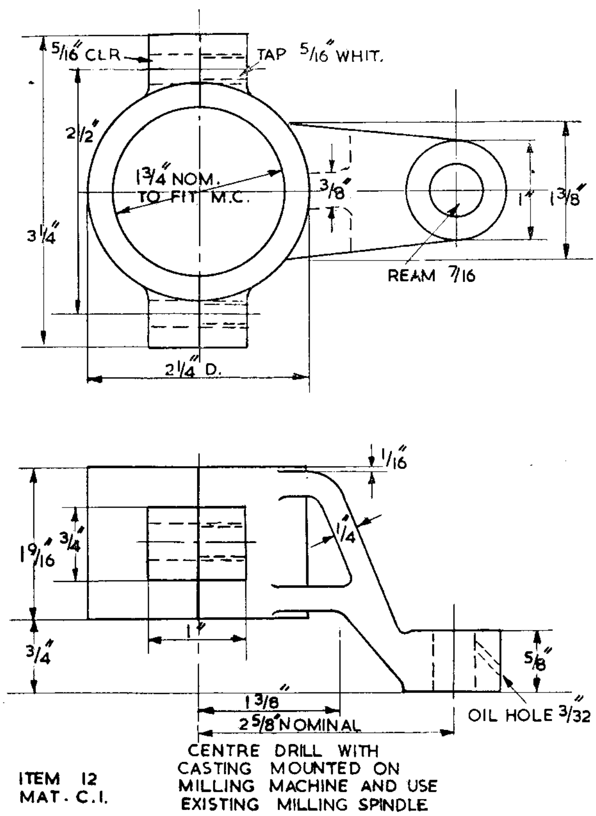
(2) Mount on faceplate, and bore $1\frac{3}{8}$ in. dia., to fit existing milling attachment. Make saw cut and fit screws.

(3) Turn a stub to fit $1\frac{3}{8}$ in. bore, and of a length equal to lathe centre height above boring table, or just over. Drill a centre hole and bolt down to boring table. Mount the Item 1 on the stub, and use a boring bar to bore out the $\frac{13}{16}$ in. bore bearing housings. The 1 in. dimension between spindle centres (see the drawing for Item 1) can be easily measured with calipers between the mounting stub and the boring bar.

The bottom bracket, Item 12, is of course, in two pieces, and the first job is to file the mating surfaces flat. Drill and tap the holes to fit the bolts, true up the upper end, mount on the faceplate and bore to fit the pillar of the existing machine — no keyway is required.

The $\frac{7}{16}$ in. bore is marked off by mounting the bracket, Item 12, on the

(*Continued on page* 136)



ITEM 12 MAT. C.I.

blank in a longitudinal sense. Gash all the tooth spaces to full depth.

From silver-steel, cast-steel, or mild-steel subsequently case-hardened, make a hob to the same dimensions as the worm of Item 6 and make about six vee-shaped grooves along its length, extending to the bottom of the thread. Relieve the tops of the threads behind the cutting edges—do not attempt to relieve the sides. The hob shank needs to be about 4 in. long, and the end of the hob needs countersinking to run on the tailstock centre.

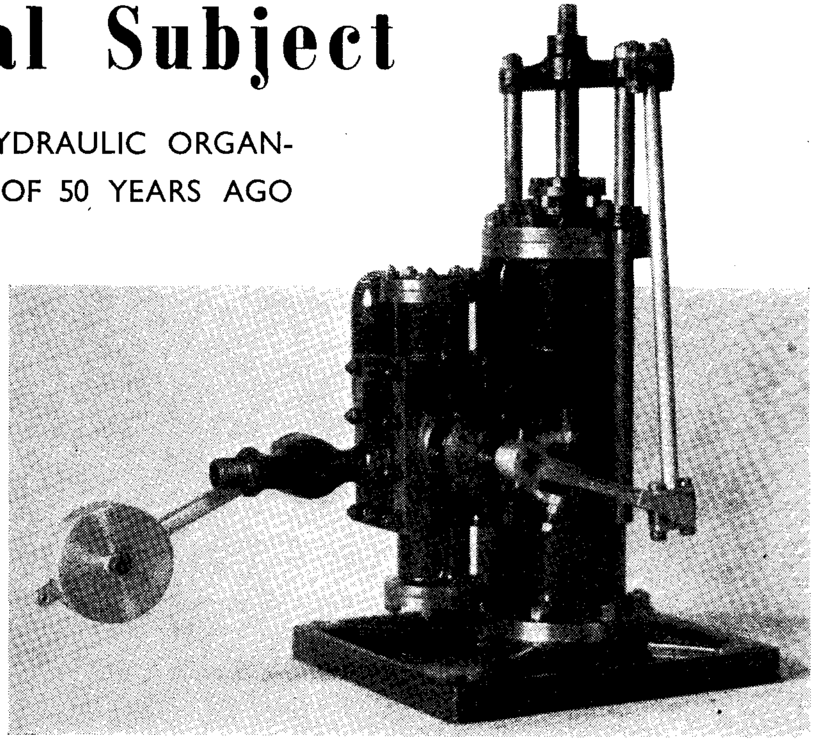
Mount the hob between centres and the worm wheel on the milling spindle —the latter being horizontal, athwart the lathe, below the hob and free to rotate. Make sure the wheel is in the correct position relative to the hob, and then bring the two into engagement by means of the vertical feed on the milling attachment.

Set the lathe running, and continue feeding until the hob has engaged full depth. It will be found that the hob will drive the worm wheel quite satisfactorily, and whilst possibly it may leave something to be desired in the way

An Unusual Subject

A MODEL OF A HYDRAULIC ORGAN-BLOWING ENGINE OF 50 YEARS AGO

By W. U. Hancock



A working model, one fifth full size, of the hydraulic organ-blowing engine

IN these days of super-power stations and the electricity grid, the provision of sufficient air under pressure to meet the demands of a large pipe organ is usually a comparatively simple matter. An electric motor is generally used to drive a fan direct, by belt coupling, or to work a bellows through gearing and linkage. Fifty to sixty years ago, however, electricity was not commonly available, and other sources of power were used. Water power was one, and it was in the late eighteen-nineties, when I was a young schoolboy, that I first made acquaintance with a " Hydraulic Organ-Blowing Engine " that was installed in Bethel Baptist Chapel, Pembroke Dock, and which later became the subject of my first attempt at real model making. It was a very close acquaintance, for my father was the organist, and was responsible for its acquisition and installation, and eventual satisfactory operation; and I was usually his assistant, progressing during the years from candle-holder to chief maintenance engineer.

Hard Work

Hand blowing for this organ was very hard work—I speak from experience—and no organ blower could meet the demand for air when the larger pipes were freely used for sustained notes. Mainly for this reason, and perhaps partly because organ blowers sometimes failed to attend punctually for service or practice, and when present occasionally failed to respond to their cues, it was decided to fit mechanical power operation. Both gas and water mains were available, and water was chosen because it was quieter, safer and simpler than a gas engine—or hot air engine—and the water mains pressure of 80 lb./sq. in. was ample for the power required. A firm in Leeds quoted for a " Hydraulic Organ-Blowing Engine " and after this had been demonstrated running light on the Leeds water pressure of 50 lb./sq. in., it was purchased and delivered. Some months later, the water pipes were connected up—and then began a long period of trouble.

The engine was fundamentally quite simple, and it was surprising that so many things could go wrong and give so much trouble to rectify. The main working cylinder was vertical, and contained a piston controlled by a normal flat slide valve. There was no lap or lead and full water pressure was, of course, maintained during the full working stroke. The slide valve was moved by a cross-piece on a rod connecting two pistons in an auxiliary cylinder, the cross-piece lying in a recess in the back of the slide valve.

Movement of the auxiliary pistons was controlled by a flat rotary valve working on a seating at the side of the auxiliary cylinder. The rotary valve was moved by a lever, operated at or near each end of a working stroke, by projecting arms which were adjustable for position, being held by set-screws on a rod fitted to the crosshead.

Valve Control

The control valve lever carried a heavy weight, which tended to close the valve, and a light chain, running over pulleys to the rising top of the bellows reservoir held the valve open wide enough to keep the reservoir well filled. The chain was long enough to allow the water valve to close when the air reservoir was empty, and the engine was started by depressing a foot pedal which moved one pulley relatively to two others, and, in effect, shortened the chain to its working length.

When water was first turned on, the piston moved to one end of the cylinder and stayed there. It could not be made to reverse, and whichever end it sought when water was " on," it remained until water was turned off. After all attempts had failed, a letter to the makers asking for advice and assistance brought the disturbing news that since the engine had been acquired, the makers had been declared bankrupt and had gone out of business.

Trouble Overcome

For a time it looked as if the engine was a failure, but local resources—and amateurs at that—persisted until the trouble had been diagnosed and overcome. The area of the auxiliary pistons was insufficient, and the total force could not cope with the friction of the slide valve on its working face, plus the friction between the piston cup leathers and the auxiliary cylinder wall. Apparently, the increase in water pressure increased the friction losses disproportionately to the increased force on the piston. The trouble was dealt with by fitting a pad on the port face, the pad having ports smaller on the top permitting a smaller slide valve to be used with less friction. The working piston now reversed smartly at each end, and the engine began its work, but for some time was erratic and unreliable.

The organ and bellows were in the chapel gallery over the main entrance, and the engine was at first installed in the gallery, immediately under the feeder bellows, to which it was connected by the crosshead. As soon as the engine began to work, it was found that this position was most unsatisfactory, for the shock of each reversal at the end of a stroke caused a very heavy thump on the gallery floor, which resounded through the body of the chapel, and was particularly alarming in the vicinity of the main entrance. Fortunately, it was found that the position of the feeder bellows in the gallery was vertically above one end of the fourth stair in a flight leading to the gallery, and below the stairs was a clear space with a solid foundation. So the engine was moved to this position and a long rod made of lengths of water pipe screwed together was used to connect the crosshead to the feeder bellows above. Three or four rough wood guide-blocks were fitted to prevent whip, and a light wooden casing was fitted, to protect the rod from stair level to ceiling. Crude, perhaps—but it gave silent and practically trouble free service for at least 20 years.

Other Defects

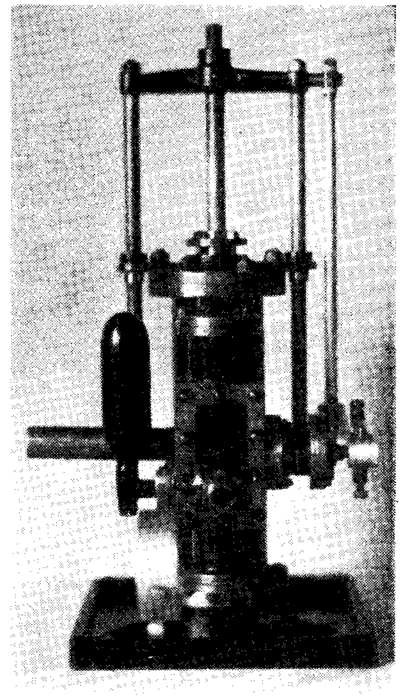
Two further defects had to be dealt with before the engine ceased to be erratic and became the reliable and obedient servant that it was for the last fifteen years of our acquaintance. As originally supplied, an extension of the auxiliary piston worked through a packed gland in the top cover. Its original purpose can only be surmised, but it certainly indicated whether the auxiliary pistons and slide valve were "up" or "down," and one could give the rod a push or a pull when it stuck, —as it so very often did. But, apparently, it stuck only because of friction in the gland, and when the extension was cut away and the gland blanked off, there was no more trouble. A persistently recurring air lock in the valve chest was for a long time the cause of irregular running, and when this was realised, a hole was drilled in a suitable position in the valve chest, the intention being to fit a small bib cock to release air when necessary. As a temporary measure, a short wooden plug was driven in, and, surprisingly, this completely cured the trouble and the plug was left permanently in place. It was quite automatic in action, for when water was in contact with the inner surface of the plug, it swelled, and there was no leakage. When air began to accumulate, the plug dried out, and air escaped *via* the grain of the wood, until water arrived and the plug swelled again. (An "aside"—It is over 50 years ago since that wood plug was fitted, and its functioning was appreciated, yet quite recently I noticed in an engineering periodical that an application had been made by a firm for a patent to be granted for the use of a wood plug for the same purpose in very similar conditions. Progress indeed!)

The Result of Neglect

Some minor troubles were experienced at first, but the only one that persisted was the loosening of the arms that operated the rotary valve lever when the "maintenance engineer" neglected his duties. My association with the engine ceased abruptly when I left the town on the outbreak of war in 1914, and my last news of it was that it was going strong in the early nineteen-twenties, when the organ had been rebuilt and moved to the other end of the chapel still blown by the same old engine. One flashlight photograph (No. 3) was my only record of the engine, when, bitten by the Model Engineer bug, I decided to make a model for old times' sake.

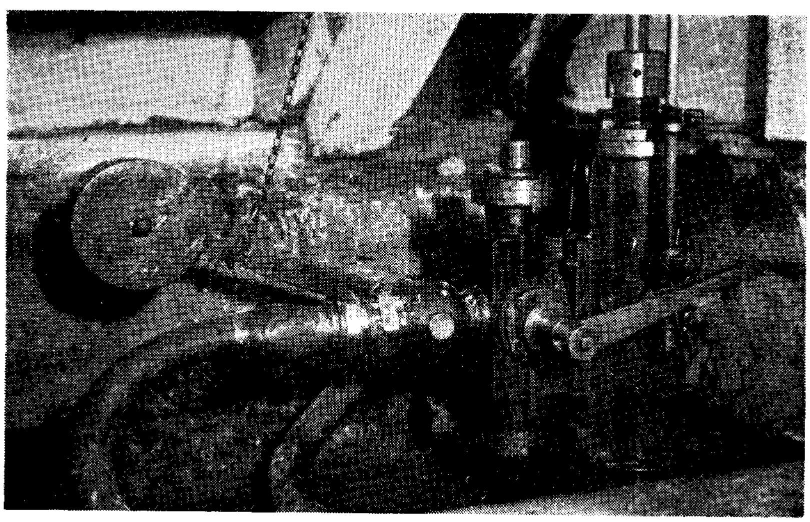
Details of the Model

The model is approximately one-fifth full size, and has a bore of $1\frac{1}{4}$ in. and a stroke of $3\frac{1}{2}$ in. It is fabricated in brass and other non-ferrous scrap, no castings being used, the turning being done on a rather old and well worn $3\frac{1}{2}$ in. Drummond lathe. The model works well on the domestic water supply, and has a maximum speed of 120 strokes per minute.



Another view of the model hydraulic organ-blowing engine

At that time I had limited access to an ancient $3\frac{1}{2}$-in. Drummond lathe, and the freedom of a scrap-metal box. In two respects, the model (No. 1 & No. 2) is intentionally different from the prototype. The extension to the auxiliary piston-rod and the corresponding gland were omitted, and a more reliable and easier-adjusted valve gear was fitted. The main piston, like the prototype, has two cup leathers back to back, with a thick brass disc between, and each of the two auxiliary pistons is similar. An air vessel was added, because when connected by rubber tube to the domestic water tap, the water hammer as the slide valve moved often caused an involuntary shower bath to onlookers—and they can't all take it without using what "L.B.S.C." calls "Esperanto."



A flashlight photograph of the prototype of the hydraulic organ-blowing engine

[*Editorial Note.—This is certainly an unusual model and a very interesting one. It is not very elaborate, but the departure from the prototype must have entailed some logical thinking over the problem of overcoming the rather disturbing fault caused by the water hammer in the model.—Ed.*].

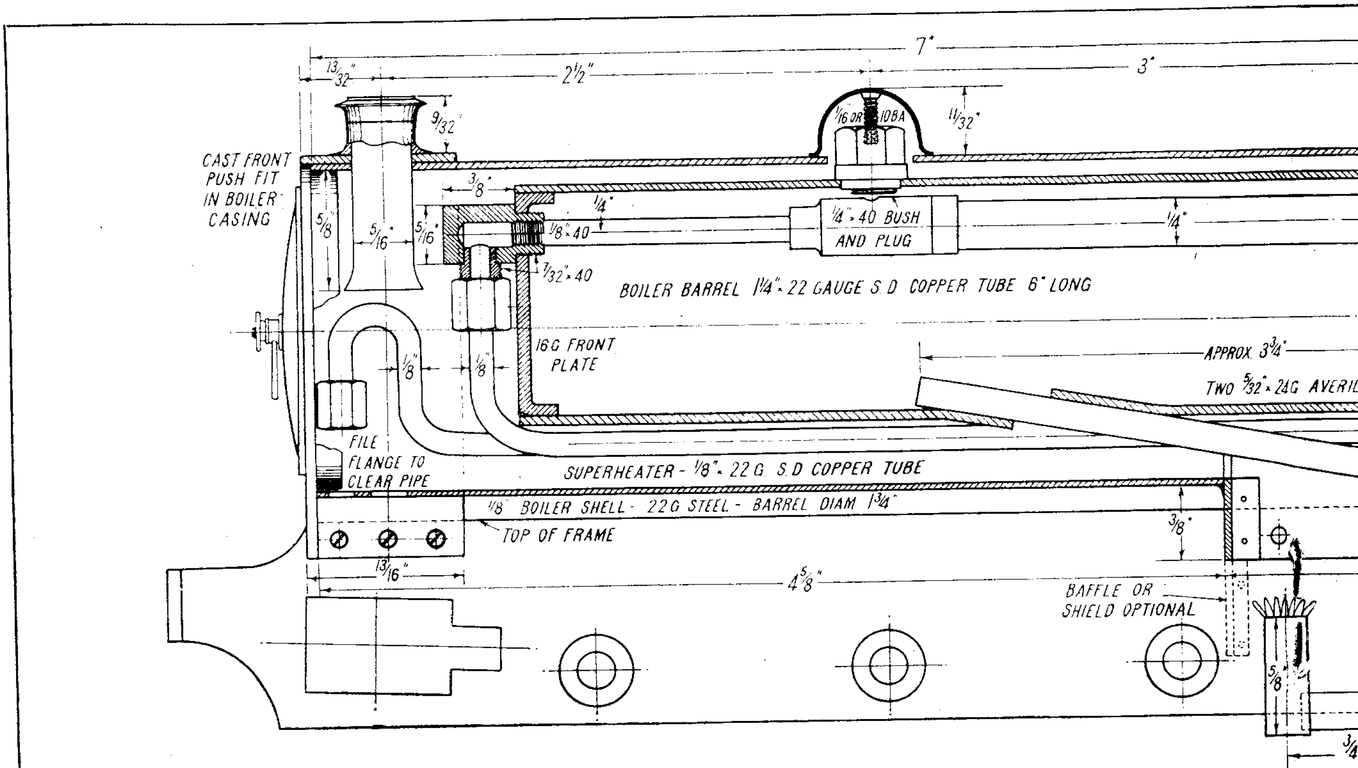
L.B.S.C.'s "Netta"

BOILER FOR THE $1\frac{1}{4}$-in. GAUGE ENGINE

AS it is now about time we gave the builders of the little quins something to get on with, let's turn our attention to the boiler for the baby of the family. Now right here, I'm making a departure from the outline to which the locomotives of class T were originally built, and this is why. If I kept to the " scale " diameter of the original boiler, the barrel would only be $1\frac{3}{8}$ in. diameter in the $1\frac{1}{4}$-in. gauge size; and as I am specifying a water-tube spirit-fired kettle, the dimensions of the barrel that could be got inside of a casing of that size, with allowance for the combustion space required by " essence of poison-gas," if the " fumes " are to be eliminated, would be very nearly microscopic. Don't run away with the idea that it wouldn't steam, because it would, as it would have the same firebox space, and the same set of burners, as on the one shown in the illustrations; but it would be a case of " stop and pump up " far too frequently. Some of the full-size engines were rebuilt with a much larger boiler—if memory serves me rightly, it was of Hull and Barnsley type—and so I propose to follow in the full-size C.M.E's footsteps, and specify a similar size of boiler for the baby quin. This will allow her to run for quite a while before any more water will be needed.

Maybe some folk will want to know why I don't specify a solid-fuel boiler with a barrel of the original size, and firebox and tubes to suit. That could be done quite easily; but such a weeny grate would be tricky to fire, even using charcoal only, or one of the patent fuels used for certain types of slow-combustion stoves. As I surmise that the baby quins will only be needed for hauling a train of wagons on a " scenic " line, and plodding along in realistic fashion for a good time without stopping, without need of attention, then the boiler shown is best for the job.

As to the boiler itself, the outer casing should be made from fairly thin sheet steel, rather than brass or copper. As little heat as possible, should escape through the casing; steel doesn't conduct heat away as rapidly as brass or copper, and if a lining of thin asbestos sheeting is fixed inside the casing, the boiler will get the full benefit of most of the " therms " generated by the burners. There will be plenty of these, as the action of the blast will pull sufficient air through the space between the boiler shell and the inside barrel, to ensure complete combustion of the spirit, " taking the poison out of the gas " in a manner of speaking. The usual trouble with spirit burners is lack of



Longitudinal section of boiler and section at f sufficient ventilation, or induced draught, causing them to give off unburnt vapour, which not only makes your eves water and smart, and smells awful, but is verra wastefu', ye ken.

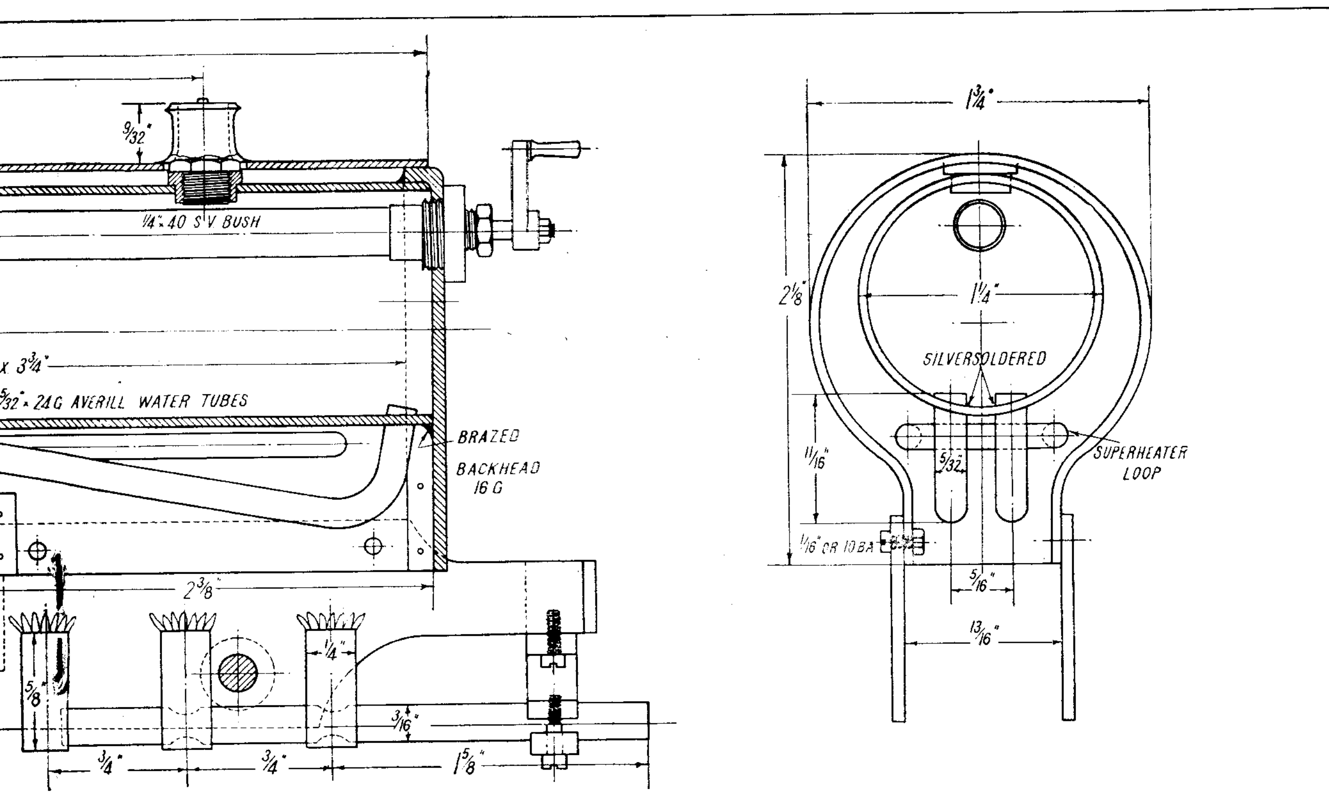
A copper backhead is fitted to the shell, and the inner boiler barrel brazed to it. Note, I said "*brazed*"; the job is intended to be done either with good honest brass wire as a brazing medium, or Sifbronze, or any similar bronze-welding material. The joint has to be a plain butt joint, and must not only be stronger than the parent metals, but must stand the repeated expansion and contraction stresses; no jointing material which is in the least way brittle, or "short" as coppersmiths would call it, should be used. This rules out anything which has a phosphorous content in it. The whole bag of tricks is a comparatively simple job, the methods of construction being the same as I have fully detailed out many times already; so a brief run-through will not only save space, but should enable all average workers to turn out satisfactory "babyquin" boilers.

Casing and Barrel

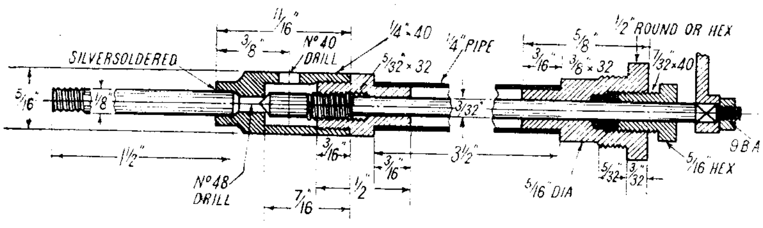
If a piece of $1\frac{3}{4}$ in. by 22 or 24-gauge steel tube is available, to finish to 7 in. length, it can be used for the casing or shell, and will save making a barrel joint. Slit it partly across, at $2\frac{3}{8}$ in. from one end; make a longitudinal cut, parallel to the centre-line, from the end to the slit, and open out the cut portion to the shape shown in the cross section. The casing can also be made from 22-gauge sheet steel, and a sketch of it "in the flat" is included. After cutting out and making the shear slits shown, bend into a tube $1\frac{3}{4}$ in. diameter; the $4\frac{5}{8}$ in. section should overlap about $\frac{1}{4}$ in. Put a couple of $\frac{1}{16}$ in. iron rivets in, to hold the joint, then open out the $2\frac{3}{8}$ in. section as above. Cut a piece of 22-gauge steel to form the throat-plate, and fill in the space between the bottom of barrel and front of firebox; leave enough at each side, to bend over at right-angles, and form a flange about $\frac{3}{16}$ in. wide, which can be attached to the inside of the firebox casing by a couple of rivets at each side. The top should be curved to fit against the boiler bottom. The joints can then be brazed, using brass wire, brazing strip, or Sifbronze; if the casing has been bent up from sheet metal, braze the longitudinal joint at the same heat. A one-pint blowlamp will provide enough heat to do this small casing quite easily. Quench in water only, then mark out and drill the holes at the top, for chimney liner, plug, and safety-valve.

The backhead is made from 16-gauge sheet copper, knocked up over a forming-plate of iron, same shape as back of boiler shell, but $\frac{1}{16}$ in. less in size all around. The hole for regulator is drilled and tapped $\frac{3}{8}$ in. by 32, and the holes for bushes drilled $\frac{1}{4}$ in. The boiler barrel is a piece of $1\frac{1}{4}$ in. by 22-gauge seamless copper tube, squared off to 6 in. length. Lay the backhead, flange up, on a pan of coke or breeze, stand the barrel on it in the position shown, anoint the joint with wet flux (Boron compo for brass wire or brazing strip) blow up to bright red, and apply the wire, strip, or other material. This will melt and flow easily, if the heat is right; feed in enough to form a fillet, then let cool to black, quench in acid pickle, and clean up, by well washing in running water, and scouring with steel wool. Tip : *never* handle very dirty copper, or brass, if you can avoid it.

Put the barrel and backhead temporarily in place in the casing, and mark off the position of the safety-valve and bush holes on the barrel. Remove, drill the holes, and then fit the front plate, which is a flanged disc of 16-gauge sheet copper. Drill the holes for the water-tubes next; those in the middle of the barrel are distorted by putting a piece of 5/32-in. steel rod in each, and forcing it down to the line that the tubes will take. This allows the tubes to be fitted "straight" as shown, which ensures free circulation, and no chance of blocked tubes. After fitting the tubes, fit all the bushes, on top and in the back-head, and silver-solder the lot at one



...d section at firebox for the $1\frac{1}{4}$-in. gauge engine

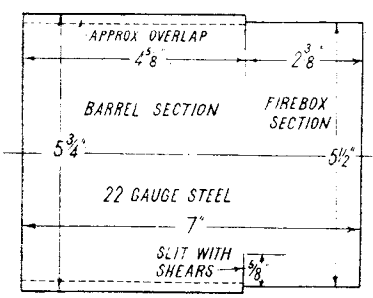


Section of regulator

go; a coarse-grade silver-solder will do quite well for this, such as Johnson-Matthey's B.6 alloy. Make sure that the stuff runs well in around the flange of the front plate, and the distorted tube joints. Pickle, wash off and clean up.

Smokebox

The end of the casing itself really forms the smokebox, but a wrapper is needed around the outside, and this is simply a strip of sheet steel 13/16 in. wide, wrapped around the outside of the casing as shown. It should project $\frac{1}{16}$ in. beyond the casing, as the cast front fits inside it; see longitudinal section. It can be attached at each side, near the bottom, by a couple of $\frac{1}{16}$-in. flush rivets. Drill a $\frac{5}{16}$ in. hole in the top, corresponding to the one in the casing, and fit the chimney liner to it; this is a 1 in. length of $\frac{5}{16}$-in. thin tube, belled out at the bottom as shown. Silver-solder it in position, or attach by a square flange, as



Boiler shell "in-the-flat"

described for larger engines, just as you fancy; " local " silver-soldering is easily done with an ordinary blowlamp on the little steel casing.

Our enterprising approved advertisers will probably supply the front of the smokebox as a casting, with door and hinges in one piece, and a flange which can be turned to a fairly tight push-fit in the end of the shell. A chucking-piece should be provided in the middle of the door, which can be held in the three-jaw while the flange or spigot is being turned, after which it is sawn off, or parted off with the turned flange gripped in three-jaw. Face it truly, centre, drill and tap 3/32 in. or 7 B.A., and fit dummy handle and hand-wheel.

If no casting is available, cut a piece of 16-gauge steel to the shape of the front, and silver-solder a flange to it, made either of tube of suitable diameter, or from a bit of $\frac{3}{16}$-in. square brass rod bent into a circle a wee bit larger than the diameter of the shell. This can be turned to a push-in fit, as described for the casting. The dummy door can be made from a disc of sheet metal, kept in place by the wheel and handle. The chimney, which simply pushes on over the projecting part of the liner, can be turned from a casting, or from a bit of $\frac{5}{8}$-in. brass rod.

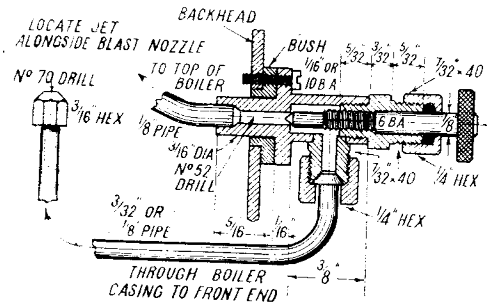
Fittings

The fittings on the baby quin are cut to the minimum required for satisfactory working, owing to lack of space; it's not the slighest use to load up the little engine with a lot of blobs and gadgets which are far too small to operate; incidentally, I've seen plenty of that sort of antic on much larger locomotives. The regulator is just a screw-down valve with an elongated spindle, running through a tube to the gland on the backhead. With the handle fitted in the position shown in the back view, the valve should be shut; a quarter-turn to the left, should pass all the steam required for normal working, thus corresponding to the movements of an ordinary slide or disc regulator.

The valve body is made from $\frac{5}{16}$-in. brass rod. Chuck in three-jaw, face the end, centre, drill to $\frac{3}{4}$ in. depth with No. 48 drill, open out and bottom to 7/16 in. depth with 7/32-in. drill and D-bit, and tap the end $\frac{1}{4}$ in. by 40. Part off at 11/16 in. from the end, reverse in chuck, open out $\frac{1}{8}$ in. of the end with No. 32 drill, and turn the outside as shown. At $\frac{3}{8}$ in. from the end, drill a No. 40 hole into the cavity.

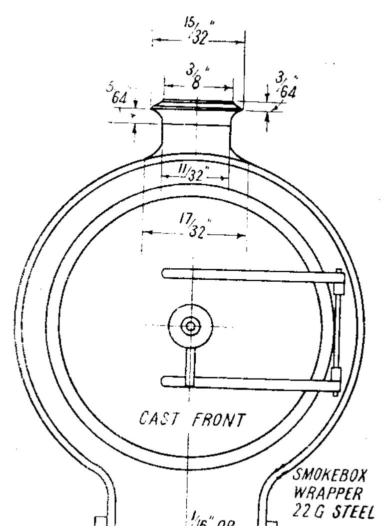
Square off the ends of a piece of $\frac{1}{4}$-in. thin tube, to a length of $3\frac{1}{2}$ in. Chuck the $\frac{5}{16}$ in. rod again, face the end, centre, and drill to $\frac{5}{8}$ in. depth with No. 41 drill. Turn down $\frac{3}{16}$ in. of the end, to a tight fit in the end of the $\frac{1}{4}$-in. tube. Part off at $\frac{1}{2}$ in. from the end, reverse in chuck, turn down $\frac{3}{16}$ in. of the other end to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. by 40. Open out the centre hole to $\frac{1}{4}$ in. depth with No. 30 drill, and tap 5/32 in. by 32. A $1\frac{1}{2}$ in. length of $\frac{1}{8}$-in. copper tube, with a few $\frac{1}{8}$ in. threads on the end, can then be silver-soldered into the end of the body, to form the steam pipe.

The valve can be made from $\frac{3}{16}$-in. drawn bronze or rustless steel. Chuck in three-jaw, and turn down a full $\frac{1}{2}$ in. to 5/32 in. diameter, screw 5/32 in. by

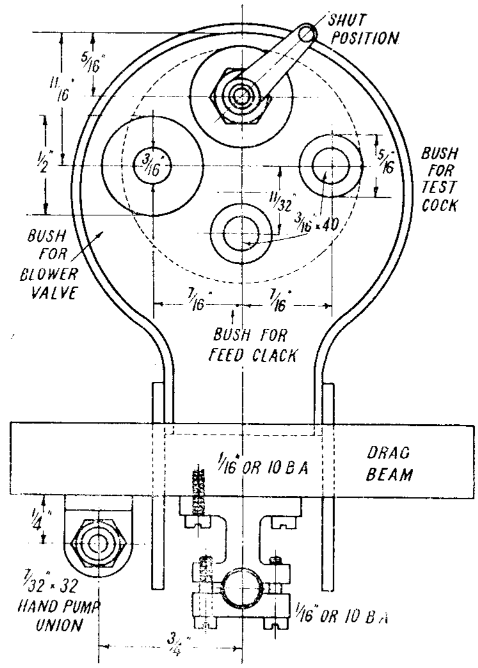


Section of blower valve

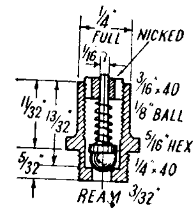
32, turn off the threads for $\frac{1}{4}$ in. length, and form a cone point on the end. Part off at $\frac{1}{2}$ in. from the point, reverse in chuck, centre, and drill No. 48 for about $\frac{1}{8}$ in. depth. The extension spindle can be made from a piece of 3/32-in. round bronze or rustless steel rod, $4\frac{5}{8}$ in. long. Turn down a full $\frac{1}{8}$ in. of one end, to a tight fit in the No. 48 hole in the valve pin; squeeze it in, and silver-solder it. The other end is turned down for $\frac{1}{8}$ in. length and screwed 9 B.A., and squared to fit the handle as shown; but it's a



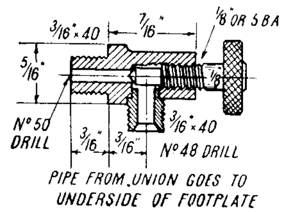
Smokebox front



Rear end of boiler and connections



Safety-valve



Water-level test valve

good wheeze to leave the squaring, until the square hole is punched in the boss of the handle. Push the rod through the regulator plug, from the tapped side, screwing in the pin as far as it will go; the plug can then be screwed tightly into the body, and the tube squeezed on to the boss.

The gland fitting is made from ½-in. round or hexagon brass rod. Chuck in three-jaw, face the end, centre, and drill to about ¾ in. depth with No. 41 drill. Turn down $\frac{3}{16}$ in. of the outside to a tight fit in the regulator tube. Turn down the next $\frac{5}{16}$ in. to ⅜ in. diameter, and screw ⅜ in. by 32; then turn off the threads for 5/32 in. length, as shown. Part off at ⅝ in. from the end, reverse in chuck, open out the centre hole for ¼ in. depth with $\frac{3}{16}$-in. drill, and tap 7/32 in. by 40. Make a gland to suit, from $\frac{5}{16}$-in. hexagon rod.

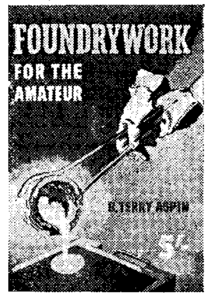
The hole in the backhead is tapped ⅜ in. by 32. At ¼ in. from the top of the front plate, drill a $\frac{3}{16}$ in. hole and tap it 7/32 in. by 40. Insert the assembled regulator through the hole in the backhead, and screw home; the steam pipe should just show through the hole in the front plate. Mark on the gland fitting, which is the top (a pencil mark will do) and take out the regulator again; check the hole for steam entry on the regulator body, and see if it lines up with the mark indicating the top of the gland fitting. If it doesn't, turn the body around until it does, which is easily done, as the connecting tube isn't fixed either to the body or gland fitting; when O.K., solder the tube to the fittings, and the regulator can be replaced "for keeps," with a smear of plumbers' jointing on the threads. Put on the handle, and screw the valve right home; if it isn't in the position shown, when the valve is shut tightly, take it off the squared part, and replace it in as near correct position as possible as the square will allow, securing with a 9-B.A. nut as shown.

The fitting at the front end is merely a built-up elbow, the part which screws into the boiler being turned from $\frac{5}{16}$-in. hexagon brass rod, screwed 7/32 in. by 40 outside, and tapped ⅛ in. by 40 for the steam pipe. A 7/32 in. by 40 union nipple is silver-soldered into the side of it, for attaching the superheater, which is the usual loop of tube, ⅛ in. by 22-gauge being suitable for the 1¼-in. gauge engine. The loop terminates in a swan-neck at the smokebox end, and is furnished with a union nut and cone for connecting to the union at the top of the vertical steam-pipe. The whole doings is clearly shown in the illustration. The boiler is held in place in the casing by a few $\frac{1}{16}$-in. screws at about ½ in. centres, put through clearing holes in the end of the firebox casing, into tapped holes in the backhead flange.

A section of the blower valve is shown separately; and as this is of my usual pattern, except that it is attached by a flange instead of being screwed into the bush on the backhead, it should need no detailed description. The pipe from the union on the body is run through a hole in the backhead (exact spot doesn't matter a bean) and proceeds along the inside of the casing to the smokebox end, where it is turned upwards, and capped with a weeny edition of the blast nozzle. This should be drilled No. 70, and located alongside the blast nozzle so that the jet goes up the liner. Don't forget to set the inside pipe as close to the top of boiler as possible, or the blower will operate with a succession of sneezes, as though it had a dose of flu. This was one of the features of the Jubb engines of not-so-blessed memory! The safety-valve and screwdown test cock are shown in section, and also need no detailing; the erection, spirit burners, and other items will be dealt with, all being well, along with the description of the boiler for the 1¾-in. gauge engine, this being of similar pattern.

For the BOOKSHELF

Foundrywork for the Amateur. By B. Terry Aspin. (London: Percival Marshall & Co. Ltd.). 93 pages, 7¼ in. by 4¾ in., 86 line drawings and 12 photographs. Price 5s.



In pursuance of their policy of self-reliance, many model engineers and home craftsman have been led to explore the possibilities of processes normally outside the usual scope of the home workshop, and one of these, the production of metal castings, has become increasingly popular in recent years. Hitherto, however, little information has been available on the subject of home foundry work, and we are happy to be able to bring to their notice a modest but eminently practical handbook which explains in simple terms all that it is necessary for the amateur to know on this subject. A perusal of its pages will make it clear that the author writes from first-hand experience, having carried out all the operations he describes, including pattern-making, moulding, coremaking, etc., necessary to the production of castings which would do credit to professional moulders. The construction of simple crucible furnaces and cupolas, with methods of firing and provision for forced draught, are described, and the book concludes with helpful advice on where to obtain the appliances and materials necessary for this class of work.

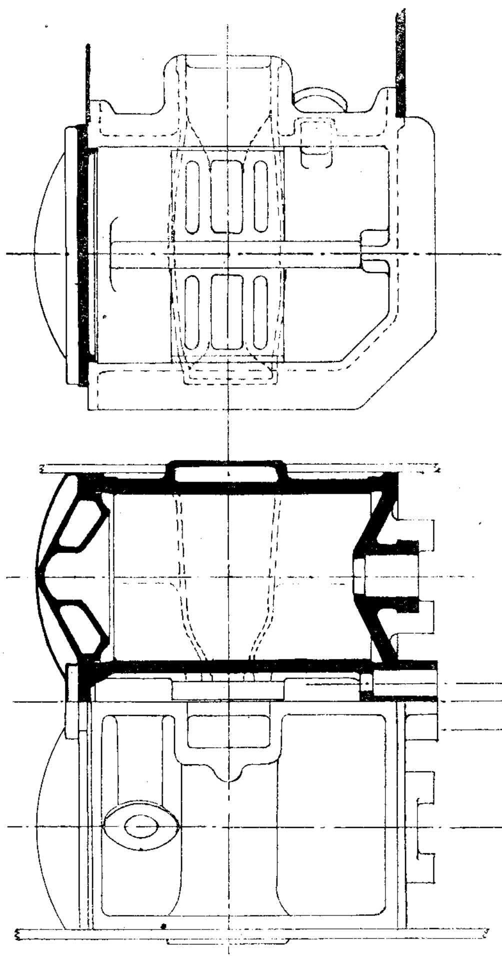
The British Inside Cylinder Loco

By C. M. Keiller

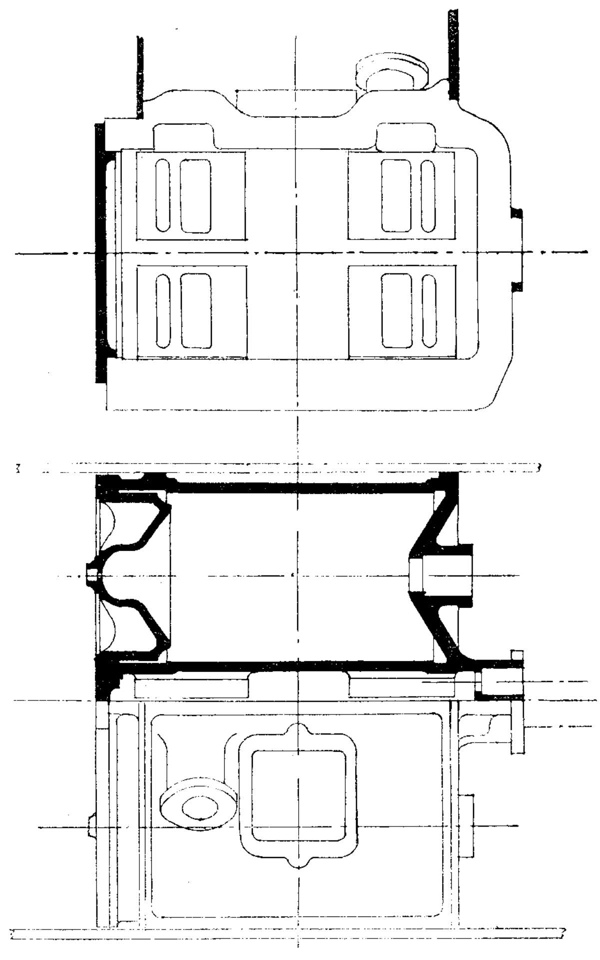
INSIDE cylinders have always been an essentially British feature of locomotive design, and it is hoped that an exploration of a particular phase of their application will be of interest both to model-makers as well as those whose hobby is the full-size machine. And while the writer does not set out to dogmatise on cause and effect, he feels that quite a lot can be learned from this study, and anyway, it is a most engrossing subject for anyone with the locomotive in his blood.

Until the coming of piston-valves, the particular arrangement with a common steamchest between the cylinders, and with the valves back to back and directly driven by Stephenson link-motion, was the most general favourite. It was not the first arrangement; that, curiously enough, was the same as now with the valves on top, but it was introduced pretty early in locomotive history, in 1841 by Robert Stephenson just at the time when link motion had evolved from the various forms of gab motion. The arrangement gained its popularity because of the simplicity, compactness and lightness of the design, but it called for considerable skill to provide adequate and suitably shaped steam and exhaust passages. This can only be said to have become a problem during latter times, when cylinders had to be larger than 17 in. diameter, although McConnell and Ramsbottom did prefer other arrangements for their express engines with 16 in. and 17 in. cylinders, respectively.

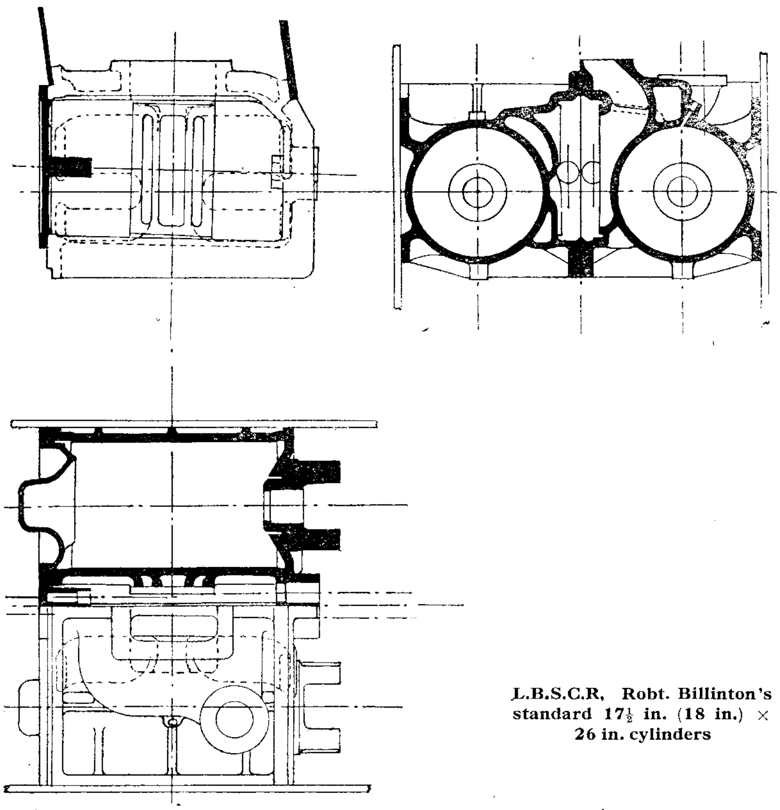
In what may be termed the normal arrangement of this design, the centre-lines of the valve spindles and piston rods are parallel and on the same level, and the scrutiny of a drawing at once shows where the weak point lies. The ports are relatively quite unrestricted, much more so than with the valves on top, and there is plenty of room for the passages from the ports to the cylinder ends; the narrow width of the passage as seen on the usual plan section only applies to the centre-line, there being plenty of width between the port face and the barrel above and below this line. The bottleneck is where the exhaust steam from the lower half of the passage



Cylinder design, Drummond "66" class—1884-86 batch. Drawing dated 1882



Drummond "66" class—1889 batch. Engine Nos. 76-79, 84887

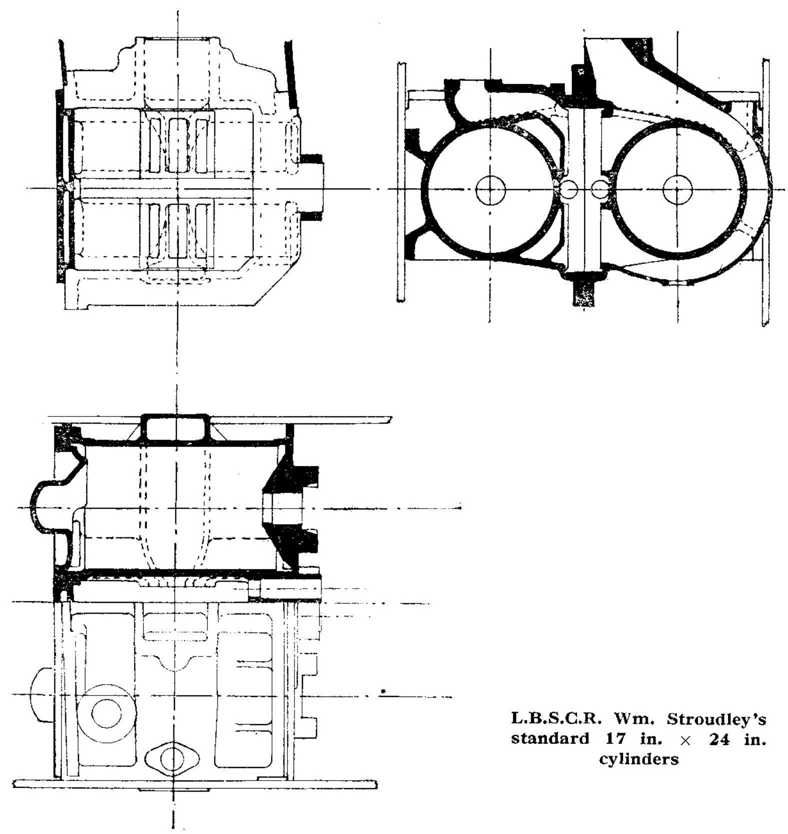


L.B.S.C.R. Robt. Billinton's standard 17½ in. (18 in.) × 26 in. cylinders

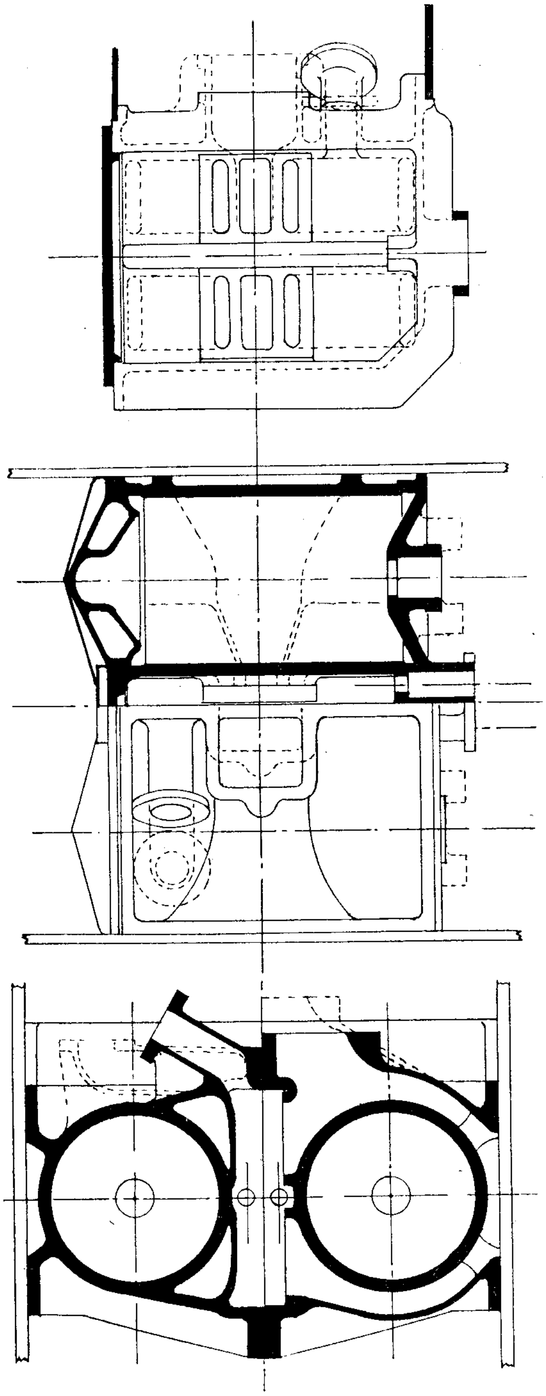
endeavours to get into the blast pipe; it arrives without restriction at the exhaust port but then has to pass upwards through its narrowest part to get into the passage leading to the blast pipe; that is, half of the whole volume of exhaust steam has to pass this point. With cylinders of 17 in. or less, and sufficient cunning, there is not much difficulty in getting sufficient area at this point; but above this size, most designers have thought it necessary to modify the design in some way. One of the most usual was to raise the centre-line of the valve spindles above that of the cylinders, so that most of the passage area is above the cylinder centre-line and can consequently get direct into an adequate exhaust passage. One of the best designs of this type is that of the McIntosh 19 in. cylinders for the C.R.; here, about 90 per cent. of the passage area is above the cylinder centre-line. Another method was originated by Wm. Stroudley; in it, the steam from the lower passage was separated entirely from that of the upper and passed under and outside the cylinder barrel; a further advantage of this arrangement was that the upper and lower ports were quite independent and could be separated sufficiently, in a vertical direction, to allow the cylinders to be brought nearer together and thus allow more room for the crank axle journals. Dugald Drummond, who was Stroudley's works manager at Brighton, also used and developed this method.

As might be expected, the great majority of engines having the "valves between" arrangement were satisfactory without being in any way remarkable; a few were not so good, but there was a fair number that were not only relatively better than others of this type but were brilliant performers by any standards, and these select few were those with the largest possible cylinders for this type, namely, 18 in. to 19 in. diameter. There were, of course, brilliant performers with 17 in. cylinders or less, notably the Stroudley engines with his standard 17 in. by 24 in. cylinders, and the "800" class of the M.R. But there is nothing very remarkable about this, as there is room enough, particularly where double frames are used; the skill of the designer is shown when the exceptional results are obtained with the large cylinders.

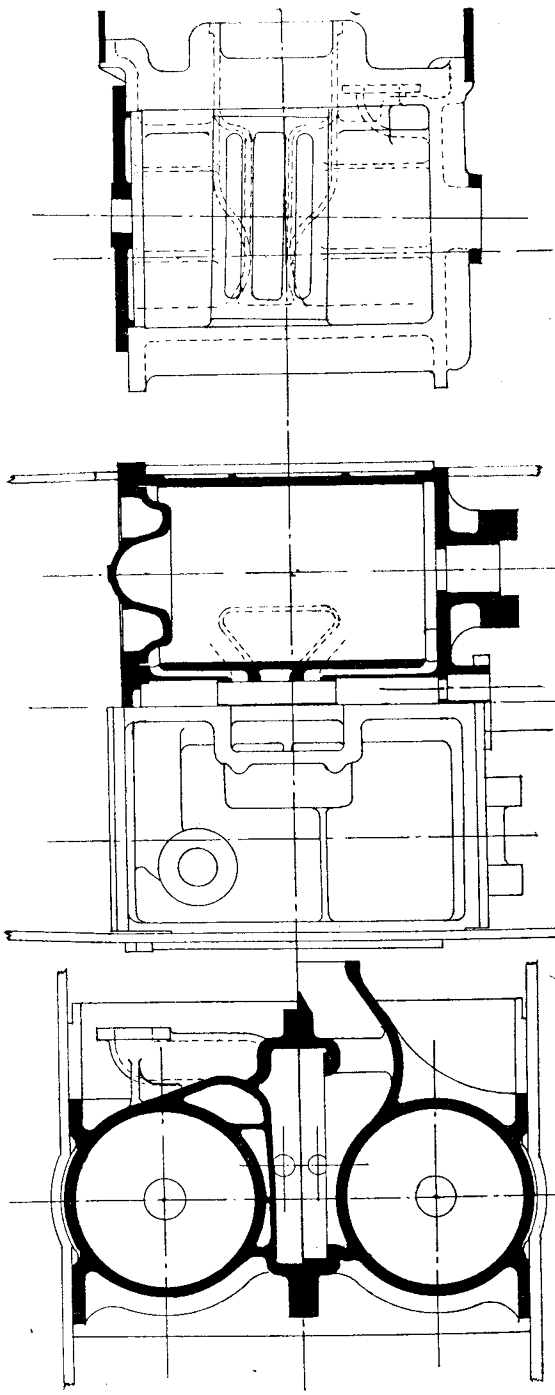
The Stroudley design was the basis of that of Drummond, and it may be interesting to look at the original and follow the subsequent development. Stroudley provided two distinct sets of ports, but each set was only 7½ in. long so the total was quite normal. Only one slide-valve was used, the blank part in the centre being used for the driving buckle, instead of this latter surrounding the valve. The steam ports were 1½ in. wide and the exhaust only 2 in. The



L.B.S.C.R. Wm. Stroudley's standard 17 in. × 24 in. cylinders



Drummond "66" class, 1891 batch, Nos. 83, 88-918103
Lambie "13" class, 1894 batch, Nos. 13-18
McIntosh "721" class, 1896 batch Nos. 721-735



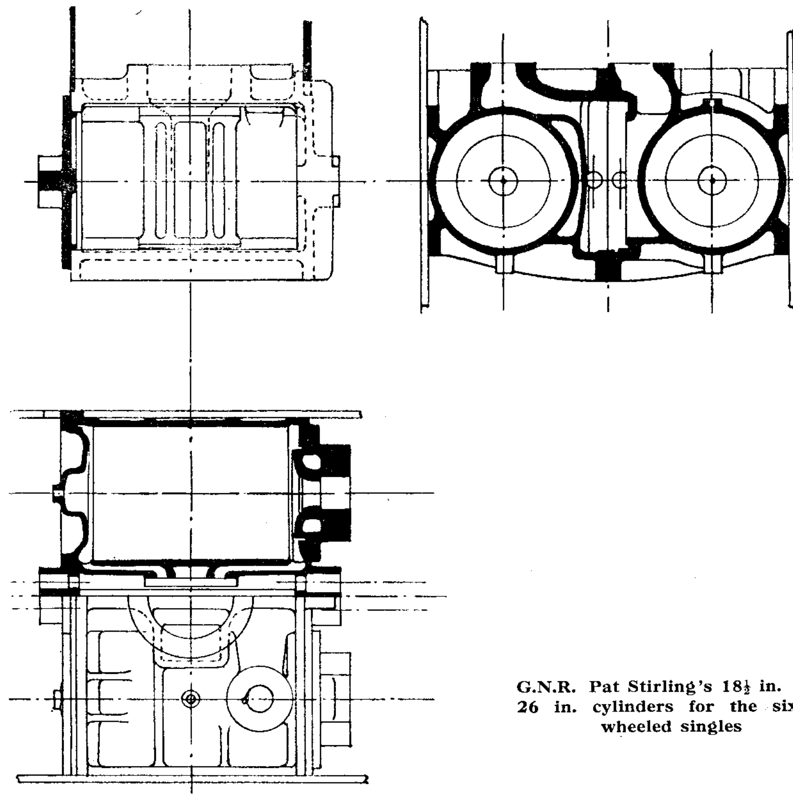
McIntosh 19 in. × 26 in. cylinders for 6 ft. 6 in. passenger engine. Drawing dated 19-2-97

exhaust from the lower port was carried round the cylinder barrel in a cast passage of 24 sq. in. section, which compares with 18½ sq. in. for one exhaust port. Note that, in the Drummond design, this area had to be reduced and was considerably smaller in area than the larger and more normal exhaust ports used by him. One remarkable feature of Stroudley's cylinders, designed as long ago as 1873, is the very large size of the passages from the ports to the cylinder ends; these total no less than 32 sq. in. to serve steam ports of only 22 sq. in. area. The writer cannot help feeling that this passage area was a bit overdone, but one can find no faults with the results; Drummond reproduced this feature exactly in his own design. One inevitable result of these large passages was to give a large cylinder clearance; it was 10 per cent. and 10½ per cent. in the Stroudley cylinders.

The writer has little information about the Drummond design for the N.B.R., but there is little doubt that it was very similar, if not identical, to that of the 1885 design for the C.R. British Railways of Glasgow very kindly searched through their records and gave the writer much valuable and interesting information about the Drummond cylinders for the C.R., and all the following material comes from this source. There is no cylinder drawing extant of the first design, but the reproduced drawing, taken from the existing general arrangement drawing, shows them to be much like the Stroudley original. In the second design, the ports were arranged right at each end of the cylinders, the intention being to reduce the clearance to a minimum. The outside passage for the exhaust extended the whole length of the cylinder barrel, and the main frame plate formed the outside wall of the passage. Again, with this design, only the general arrangement drawing exists; the final design reverted to the original arrangement of ports, but retained the frame plate as one wall of the exhaust passage. The cylinder detail drawing of this is still available, so we have more information of this design: the ports of all three designs were 8 in. by 1⅝ in. by 3¼ in. and the passage area of the last is as much as 39 sq. in. total, as against 25 sq. in., for the two steam ports, directly in the tradition of Stroudley. Also, the clearances are large, 8½ per cent. and 10 per cent.; the exhaust passage was only 22½ sq. in. as against 25½ sq. in. of one port. This design was also used with slight modification by Lambie and McIntosh in the "Dunalastair 1" class, the cylinder and barrel diameters being increased by ¼ in. It hardly needs to be added that all these C.R. locomotives belonged to the select company of brilliant performers. It is interesting to note that Drummond claimed (Proc. I.C.E. 1897) that the outside exhaust passage provided an exhaust jacketed cylinder, while Stroudley on the other hand (Proc. I.C.E. 1885) stated that he adopted the outside exhaust passage to get the cylinders closer together and obtain as strong a crank as possible.

While McIntosh used the Drummond cylinders for his first design, actually the whole locomotive was Drummond except the boiler; his subsequent designs, which were every bit as good, broke away from the Drummond tradition in many ways. His 19 in. cylinders had the normal single set of ports but the centre-lines of the valve spindles were raised 4½ in. above that of the cylinders; the ports were large, 18 in. long—28½ sq. in. area, with passages of 35½ sq. in. area, practically all of which was above the cylinder centre-line. The clearance was a little less than that of Drummond, being 7½ per cent. and 9 per cent.

While the success of the Drummond



G.N.R. Pat Stirling's 18½ in. × 26 in. cylinders for the six-wheeled singles

and McIntosh cylinders is simply explained by their design, the same cannot be said of another class of locomotive with "valve-between" cylinders of large diameter, the Stirling 7 ft. 7 in. single-wheelers of the G.N.R. with 18½ in. by 26 in. cylinders. Certainly, on these machines the cylinders worked under rather easier conditions, owing to the large driving-wheels; but, on the other hand, the engines were worked so hard and responded with such vigour that one cannot criticise the design on the results. These cylinders had neither double ports nor raised centre-lines, and the ports and passages were small compared with the designs already reviewed. The ports were 16 in. long, 1½ in. wide—23½ sq. in., passage area 21 sq. in.; the exhaust port was however 4 in. wide and the upper half opened into a very adequate passage which emerged vertically into the plast pipe. The clearance volumes were small, only 5½ per cent. at each end. These cylinders were undoubtedly good, but just why it is difficult to say. One can only surmise that the arrangement of the exhaust exit must have had something to do with it, and the examination of another design which belongs to the "not-so-good" class seems to support this view; these are the cylinders of Robt. Billinton's design for the L.B.S.C.R., originally 18 in. by 26 in., but now 17½ in. by 26 in. Again, it is very difficult to account for any short comings by the design, compared, of course, with such a masterpiece as the 19 in. McIntosh design the difference is obvious, but, side by side with the G.N.R. design, that of Billinton would seem to promise at least as good results. The ports and passages are on a lesser scale than those of Drummond or McIntosh, but they are practically the same, relatively, as those on the G.N.R. design. The only point that it seems possible to criticise is the actual exit of the exhaust steam from the cylinder block; the passages, although of ample area, meet each other at an angle of greater than 90 per cent., and it might be that the tendency of each passage to interfere with the other would, in fact, cause a bit of choking. The clearances of these cylinders are fairly small, 7 per cent. and 6½ per cent., and any undue back pressure would be reflected in high compression pressures.

A table is appended of the data of all these cylinders, and shows the important ratios more clearly than does letterpress. A certain amount of cause and effect is quite obvious, but other matters are certainly a bit obscure and one should not be in haste to dogmatise.

In connection with these cylinders of a past epoch, it is instructive to turn to some information that is available in respect of present-day piston-valve cylinders. These fall mainly into two classes, those of the W.R. and N.E.R. group, which have clearances of from 5½ per cent. to 8 per cent., and those of

Type of Cylinders	1 Port sizes	2 Piston area as/or 26" stroke	3 Steam port area	4 Col. 3 / Col. 2	5 Steam passage area	6 Col. 5 / Col. 2	7 exhaust port area	8 Col. 7 / Col. 2	9 Outside exhaust passage area	10 Clearance front	11 Clearance back
Stroudley, L.B.S.C.R. 17" x 24"	Two 7½ x 1½" x 2"	sq. in. 209.5	sq. in. 22	$\frac{1}{9.5}$	sq. in. 32	$\frac{1}{6.5}$	sq. in. 37	$\frac{1}{5.7}$	sq. in. 24	% 10	% 10½
Billinton L.B.S.C.R. 17½"x26" originally 18"	15½" x 1⅝" x 3½"	240.5	21	$\frac{1}{11.5}$	23½	$\frac{1}{10.2}$	54	$\frac{1}{4.5}$	—	7	6½
Drummond C.R. 18" x 26" 1891 design	Two 8" x 1⅝" x 3¼"	254.5	25	$\frac{1}{10.2}$	39	$\frac{1}{6.5}$	51	$\frac{1}{5}$	22½	8½	10
McIntosh C.R. 19" x 26"	18" x 1⅝" x 3¼"	283.5	28½	$\frac{1}{9.9}$	35½	$\frac{1}{8}$	58	$\frac{1}{4.9}$	—	7½	9
Stirling G.N.R. 18½" x 26"	16" x 1½" x 4"	268.8	23½	$\frac{1}{11.5}$	21	$\frac{1}{12.8}$	61½	$\frac{1}{4.4}$	—	5½	5½

the L.M.R. group and the new standard locomotives, which latter have much larger clearances varying from 9½ per cent. to 12½ per cent. The former class have small leads of from ⅛ in. to $\frac{3}{16}$ in. and the latter mostly have ¼ in., with one case of $\frac{5}{16}$ in.; the "odd man out," so to speak, is the S.R. "Merchant Navy" and "West Country" classes which have 9.8 per cent. and 10 per cent. clearances respectively, and only $\frac{3}{16}$ in. lead. We know that both Drummond and McIntosh engines on the C.R. were driven on late cut-offs and did use a lot of coal, while the former's engines on the L.S.W.R. with the same design cylinders but driven on short cut-offs were not nearly as extravagant. The same applied to Stroudley's machines on the L.B.S.C.R. The G.N.R. singles were also driven on late cut-offs but were not unreasonable on coal; which, analysed, means that cylinders with large clearances are extravagant with fuel when used on late cut-offs, but quite efficient when they are well notched up, and that those with small clearances are not unduly wasteful, even when driven on late cut-offs. Probably, slide valve cylinders with small clearances could not be satisfactorily run on short cut-offs with the then prevailing short laps and large leads. All the foregoing is what one could expect, as is also the seeming fact that the modern piston - valve cylinders, with small clearances, must necessarily have small leads if they are to be used on short cut-offs, as is also the corollary that modern cylinders with large clearances must have large leads if they are to be efficient, even when notched up. Is this possibly the reason why the "Merchant Navy" and "West Country" locomotives are so wasteful of steam?

Finally, I would add that all the foregoing information in respect of these slide-valve locomotives of the past is authentic, and was obtained from drawings and information very kindly supplied by British Railways at Brighton, Doncaster and St. Rollox, to whom the writer is very greatly indebted. St. Rollox in particular went to a great deal of trouble in searching out information about the Drummond engines of 65 years ago.

A Gear-cutting Device

(*Continued from page* 125)

milling attachment which, with its standard type milling spindle in place, is used to drill a countersink at the centre of the location where the $\frac{7}{16}$ in. bore is required to be made. Boring to size can be carried out on the lathe.

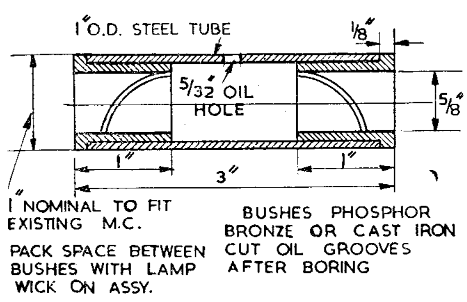
Referring to the drawing of Item 12 again, attention is drawn to the fact that the step-like shape shown in the lower view is to allow the device to be used on the Drummond top slide, such as is necessary if one wishes to produce bevel gears. The oil hole is drilled at the angle shown, to stop swarf being carried into the bearing—a pressure oil gun ensures that the oil goes where it is required.

The "brim" on the lock-nut of Item 10 is intended to act as a cutting lubricant "thrower," but experience indicates that it does little good and can be left off if desired. The whole gadget fairly swims in cutting lubricant when it is doing a tough job of gear cutting.

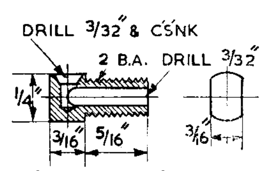
Operating experience prompts me to mention that driving belts are apt to give trouble when cutting gears of 8 and 10 d.p. in steel, i.e., hooks pulling out of leather belts was a common experience and I found that by far the best proposition was a piece of good quality rope which, I believe, the rope merchant called "white Italian hemp." Make a long splice in it so that there is no bump at the join—Boy Scout manuals and the like show how to make a splice of this type.

The jockey weight on my overhead driving gear had to be increased by about 50 per cent. to stop belt slip. Quite a fair amount of power is required for cutting the larger gear teeth, but a ¼ h.p. motor coped quite well.

With a milling cutter of 1¾ in. dia., the worm spindle, Item 6, needs to turn at about 500 or 600 r.p.m. for cutting mild-steel gears. Plenty of suds helps things a lot by washing out the swarf. As regards rate of feed, I found that, primarily because of lack of rigidity in the lathe and milling attachment, the rate of feed could not exceed about 0.002 in. per revolution of the cutter spindle, Item 10. But at this rate I got a good finish and no overheating of the cutter or workpiece or machine. An automatic traverse is strongly recommended. Hand feed on a 70 tooth wheel can be tedious in the extreme.



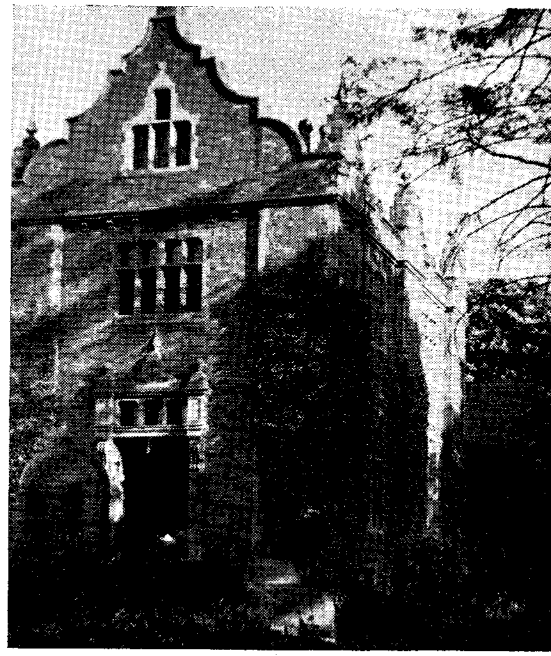
ITEM 11



ITEM 13 MATERIAL BRASS 2 OFF

The Beam Engines at Littlemore

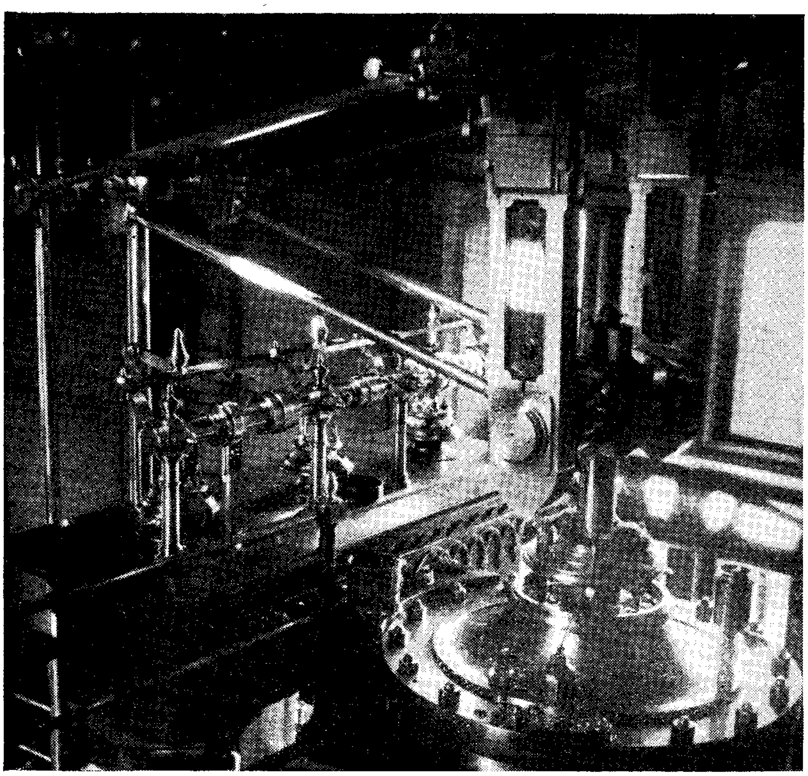
By Ian Bradley



Littlemore pumping station showing the air-bell

IN a previous article, I gave some account of the two beam engines at Crofton in Wiltshire. The Littlemore engines have not the same historic interest as those at Crofton, for they are nearly 80 years younger. Nevertheless, these engines are superb examples of mechanical construction as practised towards the end of the last century. Every part is beautifully finished and certain details, such as the cast-iron arches supporting the beams, together with upper valve chests, have been designed to tone with the architecture of the engine house itself. The buildings have an ecclesiastical appearance; and the interior adds to this impression, for the cast-iron columns that support the beams of the engines form a species of choir screen across the interior of the engine house. It is said that because of some muddle about the boilers, the contractors were bankrupted by the Littlemore undertaking. Apparently, the price put in for the whole plant should have been the figure for the engines alone. The authorities seem to have held those concerned to their contract and this broke them. If indeed this was so, it would seem a poor reward for designing and erecting a set of engines that have proved most efficient in service, as well as being outstanding examples of mechanical beauty.

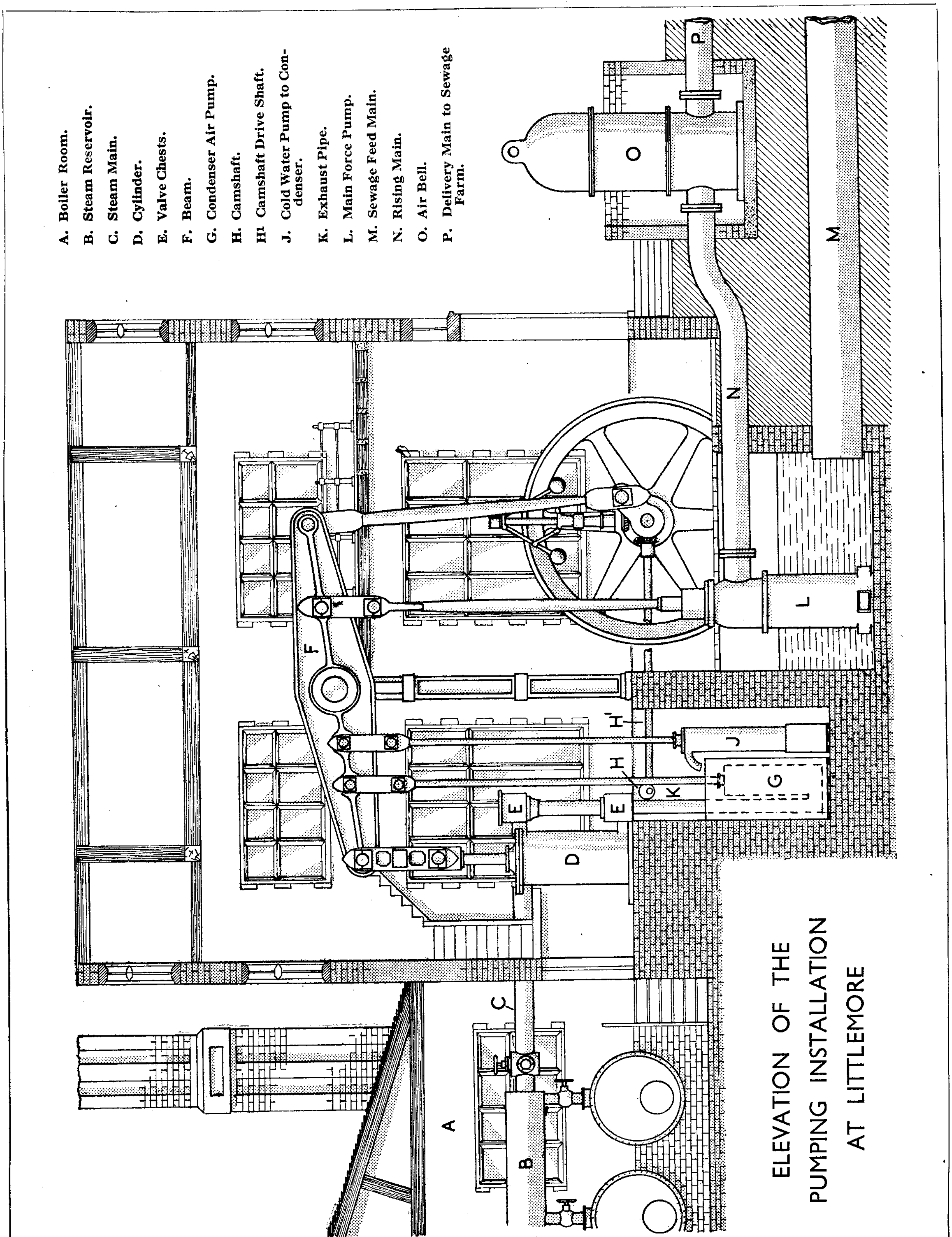
The engines were made by the North Moor Foundry in 1880, and were installed for pumping the sewage in Oxford as well as for handling a certain amount of surface water from some of the college roofs. This water had purposely been allowed to enter the drainage system in order to provide a flow in the sewers.



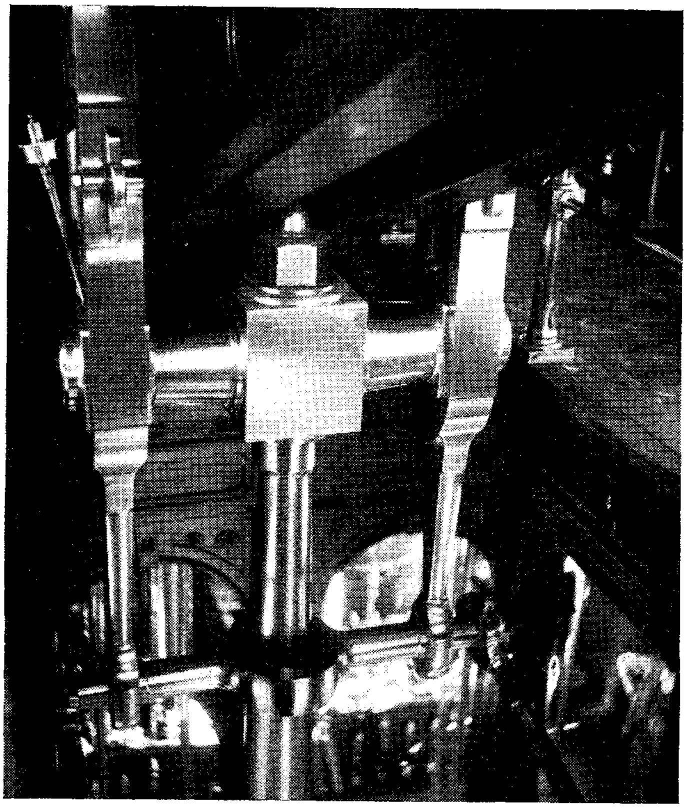
The cylinder-head and upper valve chest of one engine, showing Watt's parallel motion

The rapid expansion and continual growth of the City of Oxford has now rendered the pumping plant almost inadequate; indeed, in a period of considerable rainfall, both engines must be run together in order to carry the load. For this reason, a new pumping station, employing electric motors only, is in course of construction. It is not thought, however, that the beam engines will be withdrawn from service for at least two to three years; but, when they have finished their working life, it is hoped that they may be preserved as an engineering monuments, though it will be a difficult task, in an unheated building, to keep these engines bright and rustless. The cost of doing so, together with the rates on an installation serving no practical purpose, may cause the authorities to scrap the plant.

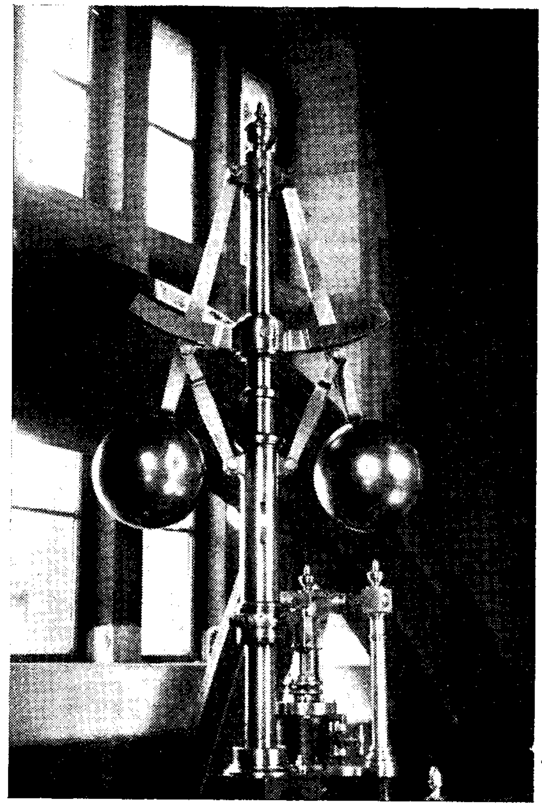
The engines are double-acting, having Watt's parallel motion, and centrifugal governors acting on the throttle valve. The cylinders are steam jacketed and have a bore of 30½ in. They were formerly lagged with mahogany strips, presumably held in place by brass bands. In course of time, this lagging fell to pieces and was replaced by some patent insulating compound that was not supposed to need any covering. Eventually, this claim was discovered to be unfounded, so the present protection of Russian iron was introduced. This form of cylinder covering is often found on small engines; but I do not remember



ELEVATION OF THE PUMPING INSTALLATION AT LITTLEMORE



Top of the pump connecting-rod, showing parts of the parallel motion



Close-up of the governor

having previously seen it used on engines so large as those at Littlemore. The piston stroke is 6 ft. The beams are 24 ft. long as measured between the centres of the piston- and connecting-rods; they are of double construction, similar to those at Crofton, and each pair of beams weighs 14 tons. In order to compensate for the weight of the pump piston and connecting-rod, an extra ½-ton of iron is attached at the cylinder-end of the beam and is shaped to conform with its outlines. It is interesting to observe that it has been necessary to chisel away portions of the beam here and there in order to accommodate the linkage of the parallel motion. Could it be that the draughtsmen failed to lay this out correctly?

A rather interesting form of stroke counter is attached to the shafts supporting the beams. This device makes use of a short pendulum to actuate a counter housed in the top of the attachment. The steam pressure at which the engines operate is 26 p.s.i., and the vacuum in the condenser system is 28 in. Normally, the engines run at 11 r.p.m., but this can be increased to 18 r.p.m. in an emergency. At this speed, however, vibration begins to make itself felt. Our visit to photograph the installation unfortunately coincided with a period of excessive rainfall. Both engines, therefore, were running together; but Mr. Page, the resident engineer, offered to stop one engine so that we might photograph some details. It was then necessary, however, to increase the speed of the other engine in order to handle the sewage flowing to the pumping station; the resulting vibration, though not very great, caused the photographer to make some very caustic comments!

The working of the Littlemore engines is most certainly an impressive affair and greatly enhanced by the 18 ft. diameter, 14-ton flywheels and the large governors, whose flying weights catch the sunlight as it streams in through the windows of the engine room.

Nevertheless, when watching the engines running, it is difficult to appreciate that they are only turning at 11 r.p.m. The crankshafts, however, project through the sides of the engine house, and if the ends of the shafts are watched from outside the building, the impression gained, so long as no other moving parts are visible, is that the engine is turning over at something much less than 11 r.p.m.

The detail finish of all parts is a sight to gladden the eye; with the exception of the flywheels, beams and bearing castings practically every component is machined all over and highly polished, and is kept in this condition.

(To be continued)

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

WORM GEARS

DEAR SIR,—If your enquirer who wanted a 28 or 30 to 1 worm reduction gear (THE MODEL ENGINEER, December 23rd) has been unable to find what he wants, I would suggest that he contacts W. A. Tunstill, Consulting Engineer, Capel, Folkestone.

This gentleman, I understand, makes worm, spiral, bevel and other gears of all ratios from $\frac{1}{16}$ h.p. to 250 h.p.

I have, of course, no interest in his business save as a satisfied client in extremely difficult consultant matters.

Yours faithfully,
Tunbridge Wells. M. L. COKER.

TO MR. FINCH

DEAR SIR,—Some time ago Mr. Finch was in difficulties machining his "Jumbo" valve faces. Up to the moment he has not reported his progress, which should be very interesting. What about it, Bill? I was asked by some of his old machine shop operators how he was going on, so I just remarked: "He is up against a difficult machining job"; whereon one operator yelled in my ear: "What? Bill Finch stuck on a job; I don't believe it!" Now, Mr. Finch, let's be hearing of your progress; I know you have a copy ($1\frac{1}{2}$-in. scale) of the original prints.

Yours faithfully,
Birmingham, 32. "Fireman."

A REVIVED PORTABLE

DEAR SIR,—We have for many years been readers of THE MODEL ENGINEER and we have pleasure in submitting a photograph of our portable engine at work.

The engine No. 20737, built in 1908 by Messrs. Ransomes, Sims & Jeffries Ltd., Ipswich, was shown at the Royal Show, Gloucester, in 1909. We have recently retubed the boiler and the engine is now in excellent condition. We hope to repaint same in the near future.

Yours faithfully,
p.p. G. James & Sons.
Kettering. ERIC JAMES.

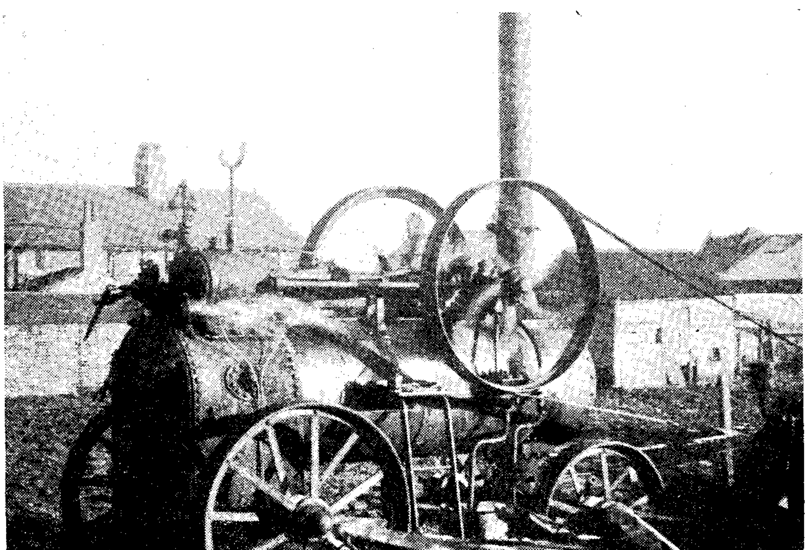
E. W. LATHE ATTACHMENTS

DEAR SIR,—In your issue of November 11th, 1954, Mr. J. J. Constable's article on a self-acting fine feed for a $2\frac{1}{2}$ in. E.W. lathe was read by me with great interest. At the end of his article, Mr. Constable kindly says that he will be pleased to assist any readers and to describe any of the other items which he has made for his lathe.

I am particularly interested as an owner of a $2\frac{1}{2}$ E.W. lathe, in the 4-way toolpost and his reference to the design for holding a $\frac{1}{16}$ in. Eclipse hollow ground parting-off blade. If it be possible for Mr. Constable to submit, and you to publish, the details of this 4-way toolpost and the design for holding the $\frac{1}{16}$ in. Eclipse hollow ground parting-off blade, I am sure that many owners of this fine small lathe would be grateful to both Mr. Constable and THE MODEL ENGINEER—I, for one most certainly should, as I am anxious to make this attachment for my own lathe.

I might say that I have already made a fine feed attachment based on a design from one given in THE MODEL ENGINEER sometime, I think, in the early 1940's. Not having the copy of THE MODEL ENGINEER I had to work from the memory of a similar attachment I built some six years ago for a 3 in. "Grayson" lathe I had at that time. This attachment was an arrangement whereby the leadscrew is driven by worm working on one of the change wheels mounted on the leadscrew, the worm being driven by a small round belt ($\frac{3}{16}$ in.) from a pulley mounted on the end of the mandrel shaft. For my E.W. lathe attachment, I used a 100-1 Bond's worm gearing with a second speed feed by using one of their two-start worms, which actually is the drive normally used for general work. This attachment has an automatic cut-off which can be set as desired to turn to any required length, when a dog clutch is thrown out of gear, and thus avoiding the tool going beyond the length of cut, a great advantage with any fine feed arrangement. It is, too, I think, if anything, simpler than Mr. Constable's design and is, of course, absolutely quiet in operation, as compared with a train of change wheels. Using Bond's worm gears is a great improvement over the design I originally copied using a change wheel with a rather large home-made worm for the drive, and it also enabled me to include the automatic cut-off feed gear.

Yours faithfully,
Tonbridge. H. D. M. HAYWARD.



THE CROSS ROTARY VALVE ENGINE

DEAR SIR,—In my letter which you were good enough to publish in the December 30th issue of THE MODEL ENGINEER, I appear to have made a slip of the pen in describing Mr. Cross's engine as having a sleeve valve. It is, of course, a rotary valve engine of advanced design; please accept my apologies for the mistake.

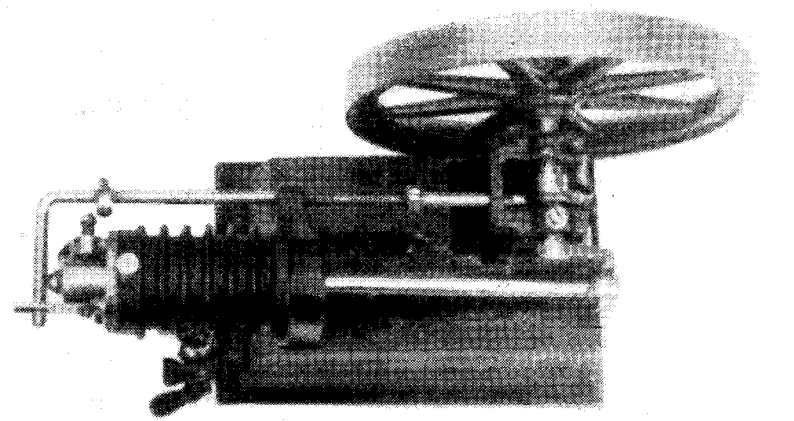
Yours faithfully,
W. L. FEDDEN,
Butleigh. Col. I.A. (retd.)

CHEQUER PLATES

DEAR SIR,—I am a chequer roll turner, working for one of the two firms who manufacture chequer plates of three (3) different patterns, *viz:* "Super Tred," "Super Grip" and "Admiralty Pattern." The "Super Tred" and "Super Grip" are of a type which is known as an interrupted check and the rolls for this are cut by milling cutters. The Admiralty Pattern (which is as drawn by "Steel Merchant" THE MODEL ENGINEER, December 30th) is cut by means of ordinary lathe tools, similar to a Whitworth screw cutting tool. These tools are used in a slide rest and cut six grooves at once. The rolls are chilled iron and have a very hard skin, approx. 1 in. deep.

I have no doubt that a mill could be made to roll model chequer plates using duralumin (in annealed condition), or aluminium, which could be rolled cold. There would, of course, be different chequer rolls, dependent on the scale required.

Yours faithfully,
Blackhill, Co. Durham. J. ORMSTON.



FAIRGROUND ORGANS

DEAR SIR,—Your reader J. L. Middlemiss appeals in the Christmas number of THE MODEL ENGINEER, for information about fair organs and their mechanism. It would take reams of paper to describe fully the workings of the three main types that were about since the "Bioscope" days; but here, briefly, are a few facts for his perusal.

The chief makers were Gavioli, Marenghi, Limonaire, Verbecke, along with other continental makers. The playing mechanisms were divided into three types: barrel; books of cardboard, and rolls of paper.

The barrel type had the barrel made of hardwood, in various lengths depending on the maker's scale of the organ. They were pinned, similar to a musical-box barrel, and one revolution of the barrel completed one tune, whereupon the barrel was moved along its axis a determined distance, for the next turn, a different tune being played.

Great skill was required to "pin" a barrel, because as many as ten tunes were put on a barrel, and apart from the movements of the figures on the front of the organ (these were controlled by the pins in the barrel) allowance had to be made for the different times of marches, waltzes, and other popular tunes. The barrel revolved at a constant speed, and to mark a tune on it, with only a limited number of bars (of music) for the whole tune, required no small amount of knowledge of music. Above the barrel there was fixed the keyframe, from which the keys made contact with the pins on the barrel and, in turn, operated the action to the various pipes via the windchest.

Not all organs had all the pipes that were desired to complete a really full musical scale, and many a "Marker" has had to extemporise and orchestrate, or even transpose from a piano copy, when he was re-pinning a barrel.

The cardboard book music was in the form of a continuous strip of cardboard, made up of separate sheets, glued together to form a pleated book. The keyframe for this type of music was a smaller affair than the one on a barrel organ, but was far more complicated because, apart from the keys, the rest of the frame was operated by pneumatics. The key opened a pneumatic "circuit" which finished at the appropriate pipe, stop, figure, drum, or sleigh-bell. It was possible to have a complete overture on this kind of music, the benefit being that a library of music could be compiled, whereas with the barrels many tunes were lost when the barrel was re-pinned. When the flyleaf of the book was put into the frame, the book would travel through the frame, page by page, to the end when a key would arrest the supply of wind to prevent a "blast" from the organ. On each page was cut the notes of music in the form of different lengths of slots.

Paper music was similar in operation to the cardboard music, except that the paper travelled from the full spool over a tracker-bar to the take-up spool. The tracker-bar can be likened to the keyframe in its operation except in that it was completely pneumatic, atmospheric pressure entering through the holes in the paper to set in operation the primaries and the secondaries of the action, and operating the correct pipes.

The organs were made with reed and flue pipes, drums, sleigh-bells, accordions, etc. The figures on the front—bandmaster, triangle player, bell player—were all operated from the music. It was quite common to see the longer pipes with right-angle bends in them, in order to fit them in the available space.

Some organs were turned by hand, others driven by electric motors getting the current from the "genny" on the traction engine; older ones were originally driven by weights until they were converted. Wind pressure was supplied by several bellows worked by a crankshaft, the bellows in turn supplying the reservoir, which kept the various windchests under pressure.

It would be a rather long letter if I explained the full workings of the "pneumatics," so I would advise your reader to acquire a book on "Player Pianos," wherein he will find the principles explained. Also, the Jubilee number of *The World's Fair* had many pictures of some of the bigger organs in their original settings.

The Gavioli organ that was illustrated in THE MODEL ENGINEER is, by comparison to some, a small one.

It was nothing to have as many as 3,000 pipes in the larger ones, and to hear one during a Sunday concert was an experience never forgotten.

I hope this information is of use to your reader, and that he will not be tempted to make a full working model, as the largest pipe that he could get into his miniature model would, *if he could get it to speak*, have a note in the supersonic frequencies, and certainly not a musical one.

Lastly, all the stops on the organs, for violins, trumpets, saxophones, clarinets, flutes, piccolos, basses, bells, etc., were worked from the keyframe, tracker-bar or barrel, and were allowed for in the making of the music, whatever type it was.

Yours faithfully,
Manchester. "GAVI FAN."

ATMOSPHERIC GAS ENGINES

DEAR SIR,—With reference to the letter from Mr. Hutchison Gall regarding the atmospheric gas engine in my possession, I enclose a further photograph which should answer his query.

The cam does control the gas inlet by means of a rod which opens the valve on front dead centre and closes it again at half stroke; the return movement being effected by a compression spring on the rod itself.

The green transfer on my engine is worded "SYSTEM SCHOENNER" and below this are the words BREVETE PATENT.

Around the transfer are five coats of arms of different countries, including the British one (Lion and the Unicorn).

Incidentally the cylinder bore is 0.916 in., the stroke $1\frac{15}{16}$ in. and the diameter of the flywheel is $5\frac{9}{16}$ in.

Should any other details be required, I will be only too pleased to give them.

Yours faithfully,
Hull. J. M. PROUD.

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:
(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Wire Gauges

I have a catalogue of watchmaker's materials in which brass pin wire is listed in sizes from 42 to 74. Can you please tell me what diameters these numbers refer to, or inform me of the gauge standard that is employed?

E.M.A. (London, S.E.26).

We are advised by suppliers in the clock trade that the "Stubs" steel wire gauge is the standard applied for this material. We show a table for "Stubs" steel wire and drill gauge.

DECIMAL EQUIVALENTS OF "STUBS" STEEL WIRE AND DRILL GAUGE

No. of Wire Gauge	Size in Decimals of an inch	No. of Wire Gauge	Size in Decimals of an inch	No. of Wire Gauge	Size in Decimals of an inch
1	0.227	28	0.139	55	0.050
2	0.219	29	0.134	56	0.045
3	0.212	30	0.127	57	0.042
4	0.207	31	0.120	58	0.041
5	0.204	32	0.115	59	0.040
6	0.201	33	0.112	60	0.039
7	0.199	34	0.110	61	0.038
8	0.197	35	0.108	62	0.037
9	0.194	36	0.106	63	0.036
10	0.191	37	0.103	64	0.035
11	0.188	38	0.101	65	0.033
12	0.185	39	0.099	66	0.032
13	0.182	40	0.097	67	0.031
14	0.180	41	0.095	68	0.030
15	0.178	42	0.092	69	0.029
16	0.175	43	0.088	70	0.027
17	0.172	44	0.085	71	0.026
18	0.168	45	0.081	72	0.024
19	0.164	46	0.079	73	0.023
20	0.161	47	0.077	74	0.022
21	0.157	48	0.075	75	0.020
22	0.155	49	0.072	76	0.018
23	0.153	50	0.069	77	0.016
24	0.151	51	0.066	78	0.015
25	0.148	52	0.063	79	0.014
26	0.146	53	0.058	80	0.013
27	0.143	54	0.055		

"Invar" Steel

I shall be very pleased if you can give me details of the composition and physical properties of "Invar" steel, and more particularly any hints on machining and screwcutting, lubricants, etc., as I am making some "Invar" pendulum-rods for a regulator clock.

E.H. (Leeds, 6).

"Invar" steel is an alloy steel containing a certain proportion of nickel and other elements, but we cannot give you the exact composition.

As a matter of fact, several grades of "Invar" steel have been produced having varying physical properties, the most notable characteristic being a very low coefficient of expansion, in fact, some grades have been made with a negative expansion coefficient. The type known as Grade 1, which has been extensively used for compensated clock pendulums, has a coefficient of expansion of 0.000001, or one-millionth of its length for a temperature rise of 1 deg. F.

We have no definite information on the machining of "Invar" steel, but we have reason to believe that its properties in this respect would be similar to high-tensile stainless-steel, which can be machined fairly satisfactorily with high speed steel tools and normal cutting lubricants.

"Invar" steel can be obtained from the following firms:—Mond Nickel Co. Ltd., Sunderland House, Curzon Street, London, W.1.

Synchronome Co. Ltd., Abbey Works, Mount Pleasant, Alperton, Middlesex.

G. P. Wall, Magneto Steel & Wire Works, Sheffield.

A detailed article on a Compensated Invar Rod Pendulum, by George Gentry, was published in THE MODEL ENGINEER dated December 7th, 1933.

Transformer for ex W.D. Motor

Could you please inform me where I could obtain a static transformer to convert 230 volts to 12 or 24 volts 12/20 amps as stated by "Duplex" for the electric hand drill made from an ex W.D. motor?

C.S. (Peterborough).

Our contributors "Duplex" suggest that you first contact Messrs. K. McGrath of 244, Marton Road, Middlesbrough to see if they still have supplies of the transformer originally supplied for this motor. They will know the particular type. If they have run out of suitable equipment, write to Messrs. Galpins, 408, High Street, Lewisham, London, S.E.13.

C.I. Engine Lubrication

I have recently purchased a 2 c.c. compression-ignition engine, and am running it on fuel consisting of equal parts of ether, paraffin and castor oil. The engine works quite well on this mixture, but there is reason to believe that the proportion of oil is too high, as the engine is always very oily, and oil is discharged from the exhaust as if it is not being used. Could you please tell me the correct proportions to use?

W.K.P. (Liskeard).

Small compression-ignition engines, generally speaking, require a fairly high concentration of oil in order to ensure that an adequate oil film is kept up on all the working parts, but the great majority of the oil is inevitably carried right through the engine and discharged with the exhaust.

Most of these small engines require at least 25 per cent. concentration of oil, and in many cases as high as 33 per cent. is recommended. An attempt is often made to condense and re-collect the oil from the exhaust by the fitting of oil traps, not so much in the interest of economy as cleanliness, but in cases where the exhaust is freely discharged, there is always a good deal of oil deposited on any objects in the vicinity.

We may mention that the makers of small engines nearly always recommend the proportions of oil to fuel which are most suitable for their particular engines, and in all cases, it is advisable to observe these proportions.