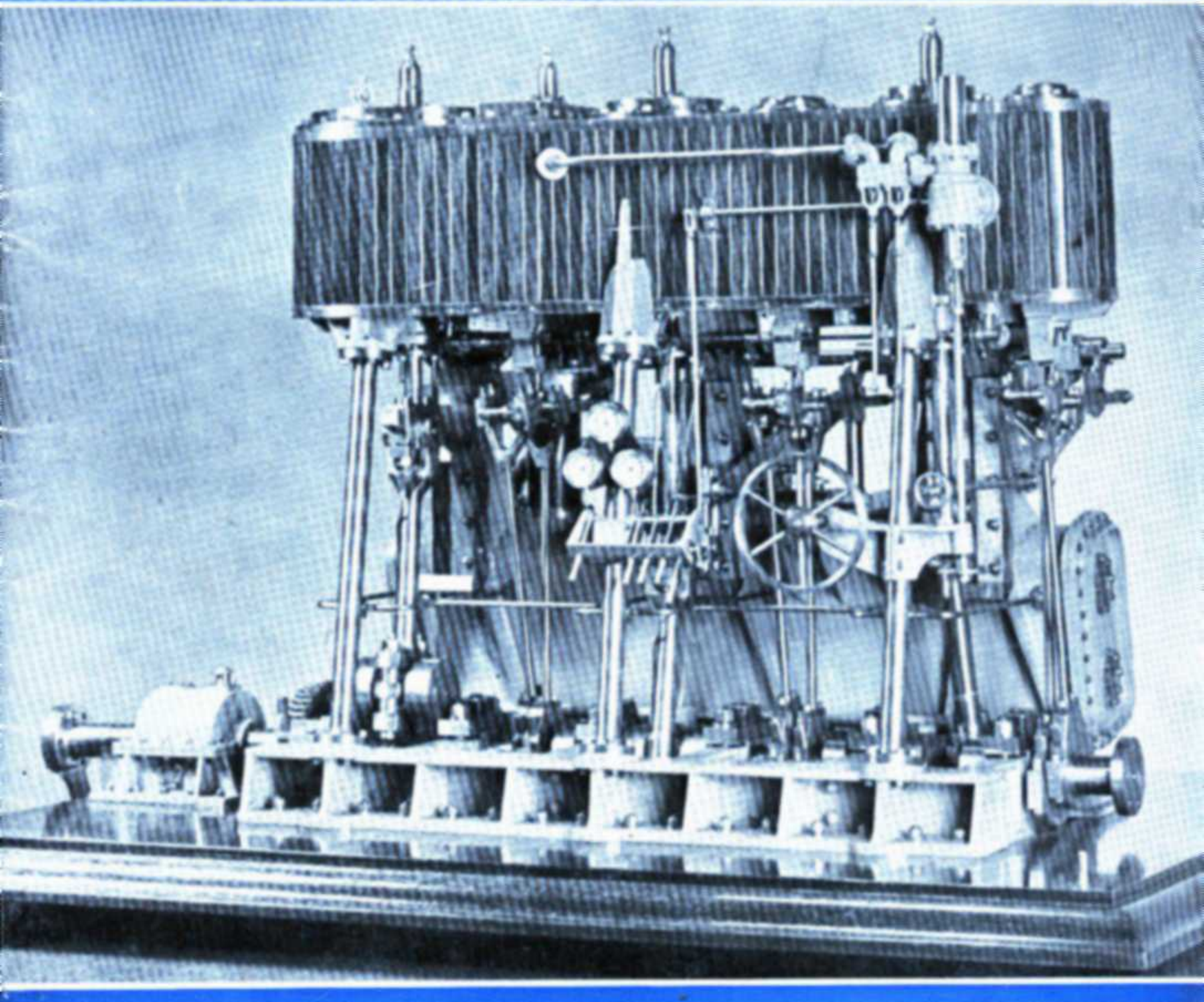
THE MODEL ENGINEER



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THE MODEL ENGINEER

EVERY THURSDAY

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Our Cover Picture

This very fine example of a model triple-expansion marine steam engine was constructed by Mr. E. B. Wilcox, who in this issue describes the methods adopted for fabricating and machining its components. Although some very noteworthy marine engine models have been constructed by our readers, and some of them have appeared at "M.E." Exhibitions in the past, there has been comparatively little information on their construction available. In view of the wide interest displayed in such models, therefore, we feel sure that this description will be welcomed by a large proportion of our readers, especially by reason of the fact that fabricated components are often better than castings for models entailing intricate detail work.

Models intended primarily for working, in which simple construction is desirable, are usually made from castings, but it is often impossible to cast small parts accurately to scale in all details, and alternatives such as fabrication or machining from solid metal are often necessary in the production of authentic scale models.

SMOKE RINGS

The Northern Models Exhibition

THE SIXTH Northern Models Exhibition will be held from March 26th to 28th next, in the Corn Exchange, Hanging Ditch, Manchester; it will be open from 11 a.m. to 9 p.m. each day. The number of entries is, we understand, well up to that of last year, and they are from all parts of the country from the Isle of Wight to Aberdeen.

One of the exhibitors, Peter Holt of Heywood, is showing some "O" gauge locomotives, coaches, wagons, etc., that he has made out of what most people would regard as scrap.

The workshop stand will be under the supervision of the Rochdale Model Engineering Club, and visitors to it will be able to see work actually in progress. The exhibition, as a whole will cover every phase of our hobby and kindred subjects, and we have little doubt that it will attract the usual crowds.

New Gas Council Booklet

THE POSSIBILITIES of "A Career in the Gas Industry" for young men leaving school or university, are outlined in a booklet of that title, just issued by the Gas Council. It emphasises the wide range of openings available, the opportunities for promotion, and the progressive policy of the industry, which offers a satisfying career to those who enter it, whether on the technical, scientific or administrative side. It also stresses that it is the policy of the industry to maintain its reputation as a good employer and to provide for its employees remuneration and conditions of service which are comparable with those offered by any other industry in the country. The various pupilage schemes are outlined, and are available for university graduates and for those leaving secondary or public schools. Advice is given to those with an interest in gas engineering, in a scientific career or in accountancy, the commercial side, or general administration. The booklet, which is illustrated, also describes the general background of the industry, and will be found of the greatest interest by young men and boys looking towards the future. Copies may be obtained from Gas Boards or through the Youth Employment Offices of the Ministry of Labour.

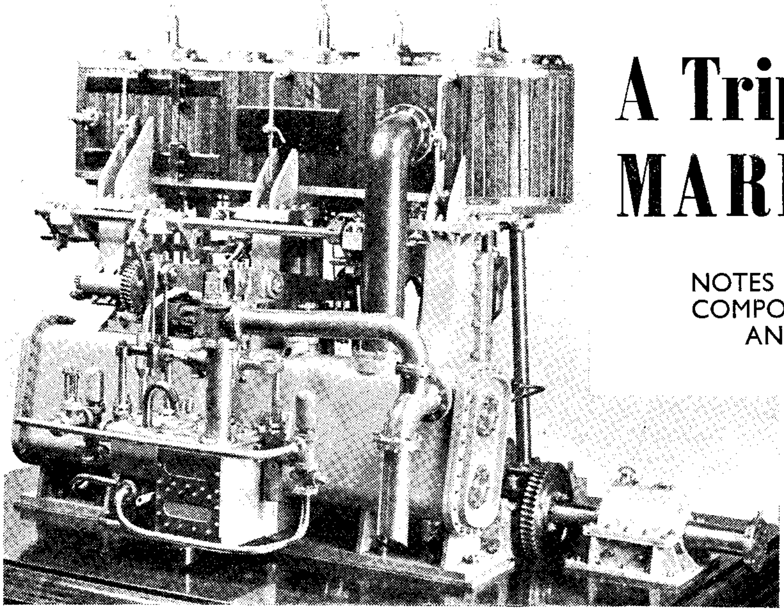
Exhibition of Scientific Instruments

THE 38TH (1954) Annual Exhibition of the Physical Society will be held at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7, from Thursday, April 8th to Tuesday, April 13th next. The Exhibition will be wholly located in the Physics and Chemistry Departments of the College and this should be of great convenience to visitors.

Arrangements for issuing tickets have been greatly simplified and applications for tickets should be made to the Secretary-Editor at the offices of the Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

Extreme pressure on space has made the 38th Exhibition slightly smaller than that of previous years, but this reduction in size is amply compensated by the high standard of the exhibits. Particular care has been taken to ensure that the standard of entries is higher than ever before and a large proportion of new or novel equipment is on show. In an exhibition where there are so many stars it is difficult to highlight individual instruments but it can be said that the craftsmanship and finish of the instruments to be shown at the 1954 Exhibition has reached a new high level.

As in previous years, the comprehensive Handbook of the Exhibition will be available at the Exhibition, and copies can be obtained on application to the Secretary-Editor at the address given above. The price of the publication is 6s. (by post 7s. 3d.).



A Triple-expansion MARINE ENGINE

NOTES ON CONSTRUCTION OF COMPONENTS BY FABRICATION AND SILVER-SOLDERING

By E. B. Wilcox

THE model, to a scale 1 in. to 1 ft., is of fabricated construction throughout, and is surface condensing, the condenser tube plates are drilled for scale-size tubes. "All-round" reversing gear, and locking gear is fitted, the reversing engine is $\frac{3}{8}$ in. bore by $\frac{7}{16}$ in. stroke. The air pump, circulating pump, bilge and feed pumps are operated from the M.P. crosshead, through double levers.

A copy of the designer's original drawings of the prototype, designed for a boiler pressure of 160 lb. per sq. in., and a piston speed of 382.5 ft. per min., was closely worked to, in the construction of the model. The prototype dimensions are H.P. $13\frac{1}{2}$ in., M.P. $22\frac{1}{2}$ in., L.P. 39 in. with a stroke of 27 in.

The photographs were taken by Mr. Lawrence A. Sands.

Tools Used

It may not be out of place, as a preliminary, to describe my modest workshop equipment, which is as follows:

A $3\frac{1}{2}$ in. centre B.G.S.C. lathe, with a gap to clear 12 in. diameter. A 12 in. × 6 in. hand-operated planing machine. A $\frac{1}{4}$ in. capacity, home-made sensitive drilling machine. The usual small tools, including paraffin brazing lamp, and a double-ended tool grinder.

The Crankshaft

With the above equipment, and a certain amount of confidence, a start was made on the crankshaft, which consisted of three coupled sections, the throw being $1\frac{1}{8}$ in., and the diameter of shaft $\frac{5}{8}$ in. Six crank webs were then sawn and cut from $\frac{3}{8}$ in. boiler plate, finished to shape, filed flat, and scraped. After marking-off, each web was bored on the lathe faceplate, with one hole in each web to $\frac{5}{8}$-0.0005 in. diameter, to gauge made previously.

To ensure the six webs being bored with exactly the same throw, a special headed bolt was turned, to a plug fit in the holes already bored. This bolt was fixed on the faceplate to the correct throw, and firmly secured. The second boring in each web was then carried out, and the six identical webs were laid aside for a time. Three pairs of eccentrics, in mild-steel were next tackled, each pair being produced from one piece of steel.

After boring the three pieces of mild-steel, to $\frac{5}{8}$-0.0005 in. to gauges, each piece was pressed on to a specially centred mandrel, one at a time, for turning and finishing to the correct angular relationship to one another. The sections of main shafting, with couplings, was just a plain turning job. The finishing to $\frac{5}{8}$ in. diameter was the important thing; this applies also the crank-pins.

Now comes the pressing of each pair of eccentrics on to its own particular shaft, which was done in the parallel-jaw vice, with the use of appropriate packing. Next in order is one web on each shaft, care being taken to have the angular advance of each eccentric equal on each side of the centre-line of the crank web.

Before the crank web is finally pressed home, one or two trials on the surface plates, with the centre-line of web, set parallel and a try-square against the periphery of the eccentrics, will reveal any error, which can then be rectified. The webs were then dowelled, and each pair pressed on to its crank pin, one or two trials between lathe centres being necessary before pressing home.

The crankshaft couplings were then drilled "off centre," to a specially prepared drilling jig. After turning and fitting the coupling bolts, the three-throw shaft was assembled, tried between lathe centres, and found satisfactory.

The Main Bearing Housings

The housings were fabricated from sheet metal. After pinning and securing the pieces together, silver-soldering was carried out, making a solid job, ready for machining. They were then marked-off, and planed at each end, to a gauge for length, and a separate gauge for the register.

An angle-plate was next prepared with a register planed across it from back to front, this register accommodated each housing in turn, for boring on the faceplate of the lathe. The angle-plate was then set and firmly secured on the faceplate, and each housing bored to $\frac{3}{4}$ in. and faced each side. A piece was then sawn away from each housing, making a U-shaped opening for the main bearing brasses which was carefully finished with a file.

Through the web of each housing beneath the opening for the brasses, two holes were drilled and filed to accommodate square nuts for the main bearing bolts. The brasses were machined from strip brass $\frac{7}{8}$ in. × $\frac{7}{16}$ in. section, sweated together, in convenient lengths to make three pairs of brasses. A prepared piece was then set up in the four-jaw chuck, and bored to $\frac{5}{8}$ in. diameter, it was then turned to $\frac{3}{4}$ in. diameter, length between flanges to suit housings. Three pairs of brasses were parted off from this prepared piece, leaving the flanges $\frac{1}{16}$ in. thick; after unsweating, these were the six bottom brasses. The same process was carried out for the top brasses, but instead of being turned between flanges, they were planed square to suit the housing and bearing keeps.

After carefully fitting each pair of brasses to their respective positions, the "collar" bolts and keeps were prepared; the bolts were turned from mild-steel rod, and screwed at each end. The collar on each bolt was fitted to a pin-drilled recess, to allow it to be level with the top of its housing. After tightening into the square nut, each collar was dowelled "half and half." The bearing keep was cut from bright mild-steel bar. Each complete unit was then re-assembled to its respective position on the finished crankshaft, and put aside for a time.

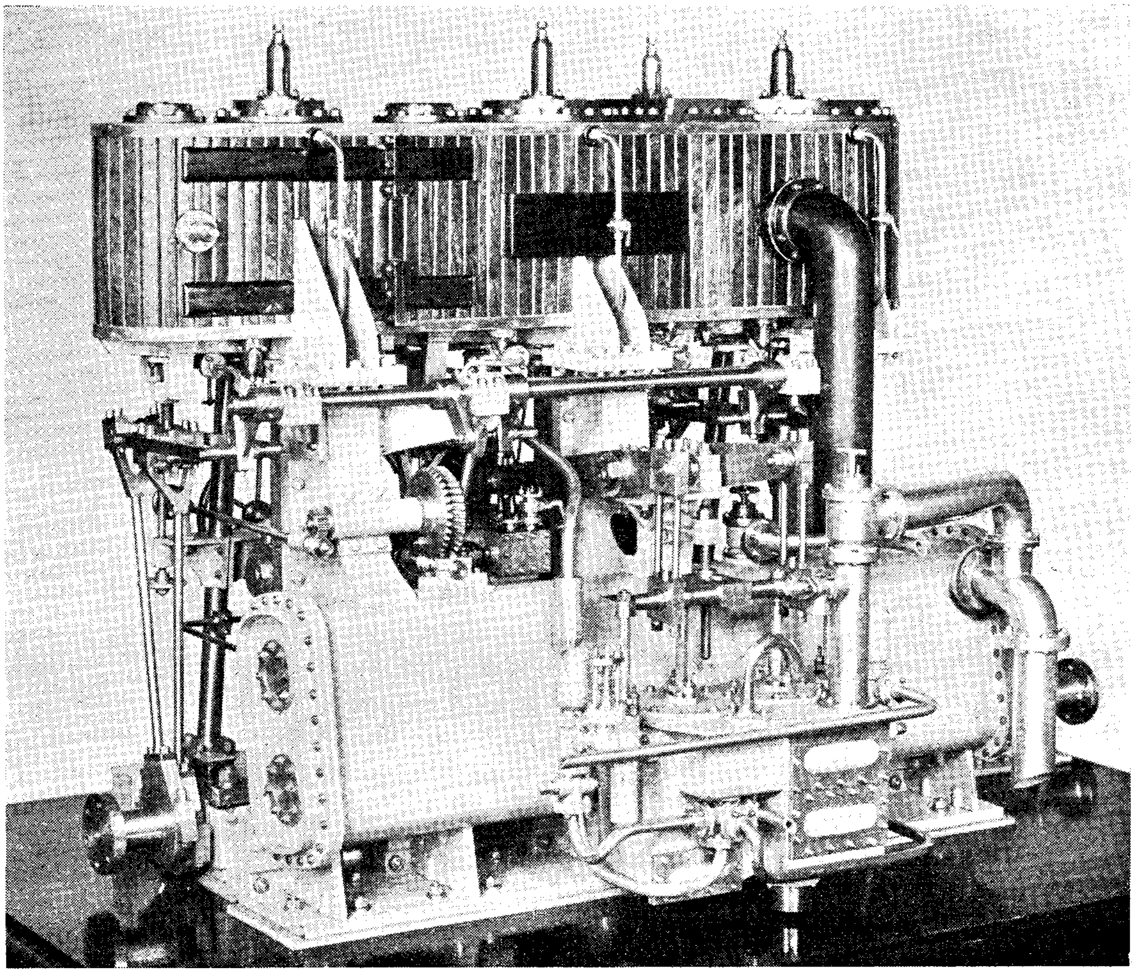
A piece of $2\frac{1}{8}$ in. × $1\frac{1}{2}$ in. × 12 in. angle was next machined all over on the hand-operated planing machine, on the vertical face, a groove was machined along the entire length of the angle; this groove matched the register on the housings, and was very carefully fitted. The entire crankshaft and housings were then offered up, to the machined angle, and cramped together, leaving the crank with a slight amount of end play. After marking-off and drilling in position, the housings were secured with fitted bolts, cramps taken off, leaving the crank-shaft free to swing.

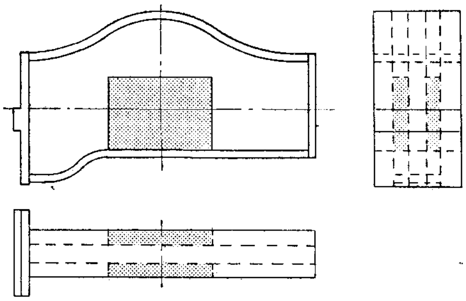
Next in order was the front portion of the engine bed; this was built-up of angle and strip metal, with three pads for the steel columns, stiffened with nine brackets, and of a total length to match the previously mentioned machined angles. This assembly was silver-soldered and finished, then secured to the front of each housing with fitted studs and nuts.

The Condenser

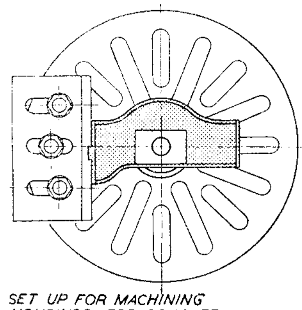
The body of the condenser was fashioned from solid-drawn tube; this had to be the right diameter. Three hard-wood wedges were prepared to assist in shaping the condenser body; these were made to suit the internal shape of the condenser when they were driven home. After annealing the tube, the initial flattening was done between an old book press.

The wedges were then inserted, and with a gradual squeeze by the press, and hammering up on the wedges, the final shape was reached on the tube; furthermore, the tube was perfectly smooth and free from hammer marks. Two flanges were

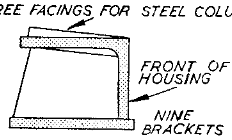




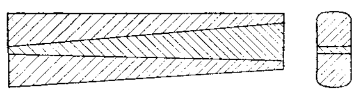
MAIN BEARING HOUSING BEFORE MACHINING.



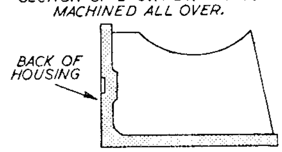
SET UP FOR MACHINING HOUSINGS FOR BRASSES.



SECTION OF ONE PORTION OF ENGINE SOLEPLATE OR BED.



THREE HARDWOOD WEDGES, FINISHED INTERNAL SHAPE OF CONDENSER



BRACKETS FOR THE CONDENSER SEATING.

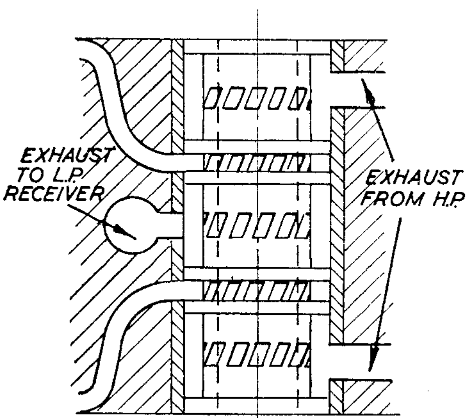
then cut from sheet metal, and carefully fitted and finished to a tight fit on each end of the tube. These were then silver-soldered in position on the tube, which, by the way, had been squared off to length previously.

Three columns were then prepared, the several pieces were cut from sheet metal, the top flanges, and the front plates on the columns were "mortised and tenoned" to hold them in position for silver-soldering. The fore and aft columns are alike, but the centre column is shaped at the back to carry two bearings for the pump levers.

Each column assembly was then silvered-soldered and finished, and finally "bedded" to its approximate position on the condenser body. The three columns were then held at the correct centres (to match the crankshaft), by two perfectly straight strips of bright bar steel, one across the top flanges, and the other across the front plates; this assembly was then further "bedded" to the condenser body. By carefully adjusting the flame of the blow lamp, and shielding adjacent parts, the columns were successfully silver-soldered to the condenser; the centre column was the first to be done, on account of possible "creep," if done any other way.

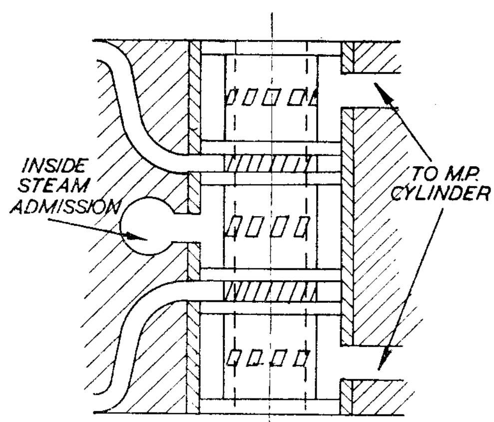
Six brackets were now cut for the condenser seatings, and carefully fitted to the angle-piece which was machined all over. After scribing off, round the flanges of the six bearing housings, the angle was taken away from the rest of the assembly. The six brackets were then secured by temporary screws, each on the same centre-line as the six housings, and finally silver-soldered in position.

Working to the scriber marks on the angle, the unwanted portions of the angle were then cut out, and the openings finished off with a file. The angle was now secured in its original position on the housing



SKETCH OF M.P. OUTSIDE ADMISSION PISTON VALVE LINER.

LINER IS A PRESS FIT IN THE CASING.



SKETCH OF H.P. INSIDE ADMISSION PISTON VALVE LINER.

LINER IS A PRESS FIT IN THE CASING

assembly, and with the condenser, was set up on a surface plate; the condenser was then set in its true position relative to the cranks. A bent scriber was now used to mark off the position of each bracket on the underside of the condenser, six holes were then drilled in the condenser for temporary screws, tapped into each bracket. The condenser was now replaced and the brackets marked off for drilling and tapping.

Finally, the condenser was fixed in position, and held by six set-screws for silver-soldering. The angle was, of course, disconnected from the housings, for this purpose. The opening in the base of the condenser, for the condensate outlets, being already cut out, silver-soldering completed the job.

The various branches were now made; these comprised, main exhaust, main injection, outlet to air-pump foot valve, and a small branch for the jet condensing control valve. After silver-soldering these in position, holes were cut through in the condenser body from each branch. Brackets were also fixed, to carry the reversing engine. The condenser tube plates and stay plate are drilled for scale size tubes, and the complete condenser tube unit may be assembled, separately and fixed in position complete.

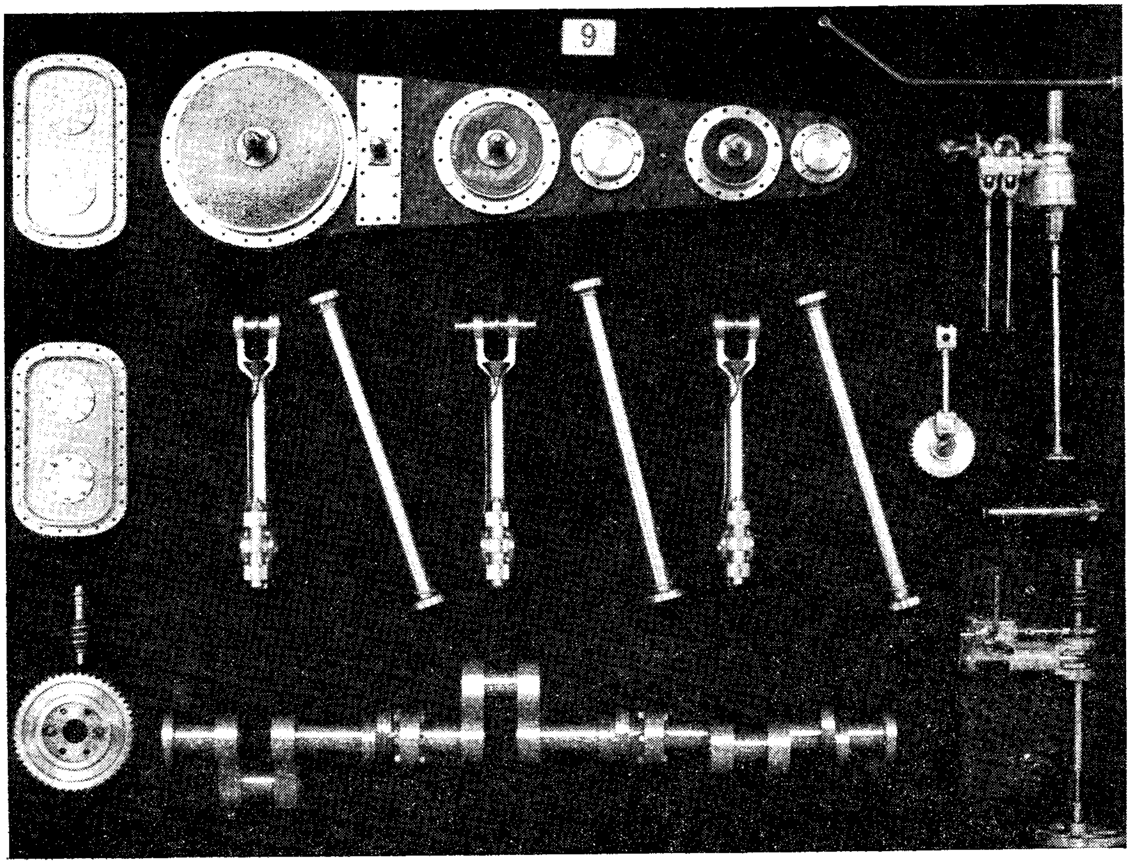
The Cylinders

The three cylinder bottom covers were next cut from sheet metal, flanges prepared and drilled and silver-soldered on. Each cover was then bored, after marking off for stuffing boxes, and after these were machined and fixed each cover in turn was mounted on a mandrel and spot faced for the cylinder. Each cylinder is a piece of specially selected hard drawn No. 10 gauge tube.

To keep each cylinder concentric with the stuffing box, dummy pistons and rods were made and each cylinder, after squaring off in the lathe to length, was silvered-soldered to its own particular cover. This same method was carried out for the cylinders carrying the piston-valve liners. All steam passages between piston-valve casings and steam cylinders are produced from solid drawn copper tube, annealed and flattened to give the same size as the ports in the cylinders.

The L.P. double-ported valve, working face, was now cut and filed with separate pieces for the sides, and pieces to separate the exhaust port from the other ports. This assembly after machining to fit the L.P. cylinder tube, was silver-soldered in position. Top flanges and pieces to fit the front and back of the piston-valve cylinders, to carry the fixing brackets, were next installed, and finally the various facing pads for drain cocks and relief valves, starting valve and impulse pipes.

There is no steam communication between the cylinders, except the steam passages shown in the photographs. All other sources of communciation are blanked off. The H.P. cylinder, and M.P. cylinder are steam jacketed. In the finished condition; the three cylinders were first coated with an approved steam pipe covering. This was allowed to dry thoroughly before lagging with french polished spanish mahogany.



MORE UTILITY STEAM ENGINES

A Double Tangye Type Mill Engine

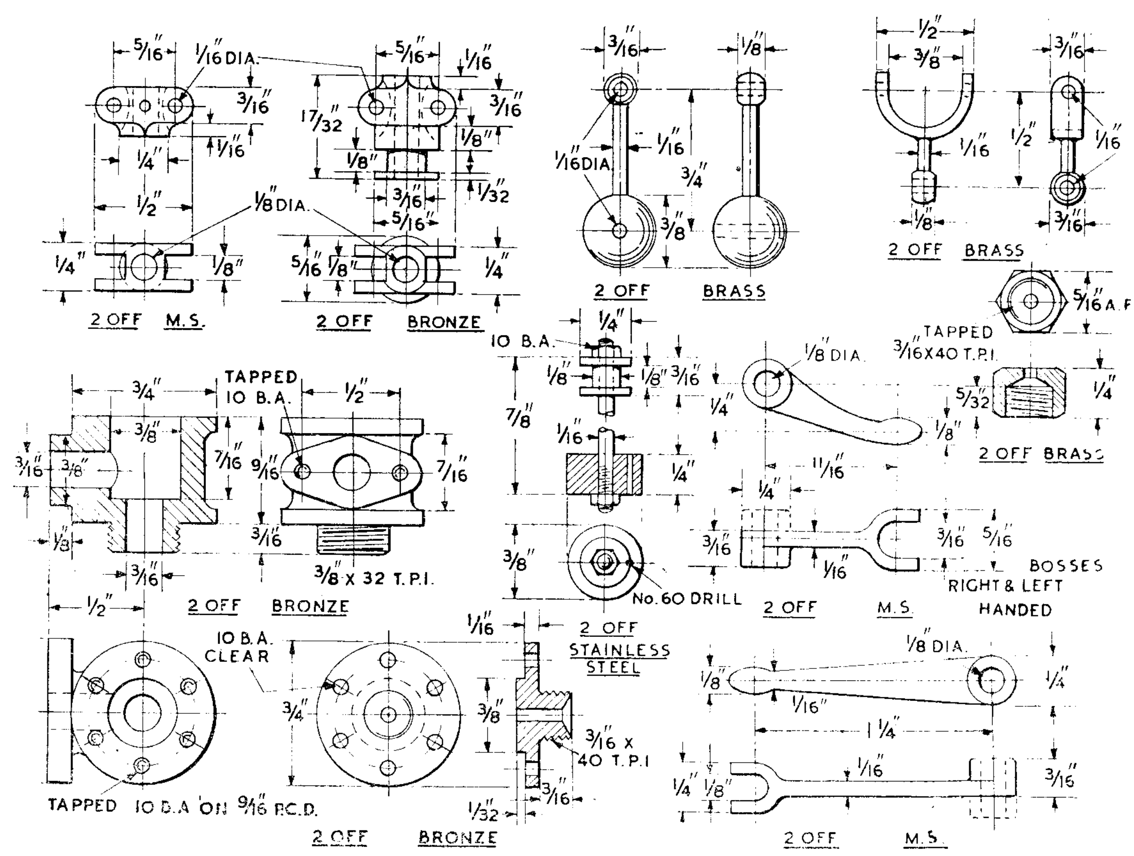
By Edgar T. Westbury

THE components for the governors include a number of very small and somewhat "fiddly" pieces which are illustrated in a group herewith. There are several ways of making these, and all are satisfactory if properly carried out, but the methods I describe will simplify their production and help to ensure the accuracy which is essential to working efficiency.

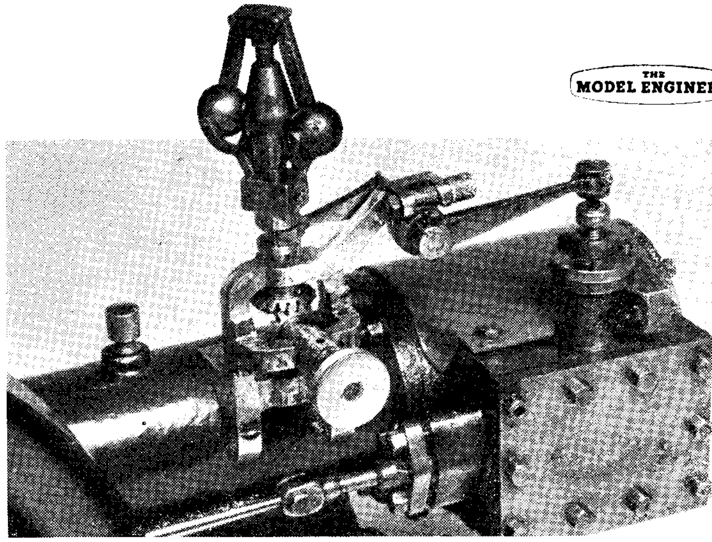
First come the two yokes which are fitted to the vertical governor spindle, the upper one being fixed by pinning thereto, while the other is free to slide, and has a collar which operates the control levers. It is advisable to make the latter in bronze or gunmetal so as to work smoothly on the steel shaft, but mild-steel is more suitable for the upper yoke, and a length of ½ in. by ¼ in. rectangular bar can be used, to reduce the amount of work on the external surfaces. This should be carefully centred in the four-jaw chuck, then faced, centre-drilled, drilled and reamed to fit the shaft; the boss on the underside can also be turned, and the material then necked down with a parting tool at the top, but not completely separated from the bar at this stage, as it will be easier to handle while thus attached.

The holes for the pivot pins may now be marked out and drilled, care being taken to locate them accurately, and also ensure that they pass squarely through the bar; they may be left undersize for the present. Next it is advisable to round off the lugs, concentric with the pivot holes, which is most easily done by filing. The slots may then be formed, preferably by milling, the most suitable tool for this operation being a Woodruff key-seating cutter, and

Continued from page 234, *March* 4, 1954.



GOVERNOR & THROTTLE DETAILS



A close-up of the governor on Mr. G. W. Cooper's engine

the work may be held either in a small machine vice or clamped flat by either face, to a vertical slide or angle plate mounted on the lathe cross-slide. Although vertical movement is very convenient for these operations, it is not absolutely essential, and the "M.E." handbook *Milling in the Lathe* gives several examples of jobs which can be done with the very simplest of lathe attachments. If only an angle plate is available, the work will have to be mounted with its main axis vertical (see the advantage in leaving it temporarily attached to its chucking-piece ?) and with the cross centre-line level with the lathe centres. The cross-slide is then adjusted by the saddle feed so that the slot will be central with the thickness of the yoke (note exact saddle position with the aid of leadscrew index or otherwise) and the cutter run straight in to the required depth from one side; the saddle is then backed away to clear the cutter while the cross-slide is traversed to deal with the other side of the job, after re-locating to centre the slot.

The type of cutter recommended, having a small shank in relation to its outside diameter, enables the cut to be taken to maximum depth with considerable concavity; if a larger cutter, mounted on a shank, is used, the shallower contour will take out an unnecessary amount of metal above and below the pivot centre, and thereby weaken the yoke. In either case it is necessary to run the cutter in as close to the centre hole as one dares, to give sufficient clearance for the working of the arms or links. After completing this operation, the yoke may be parted off in a finished state.

The lower yoke cannot be made from rectangular bar of the same size as the upper one, as it has a collar $\frac{5}{16}$ in. diameter, but it may be made from material of this thickness, by methods identical with the above, and thinned down afterwards by milling or filing; alternatively, round bar, about $\frac{5}{8}$ in. outside diameter, is suitable if some means of indexing can be used in locating the slots and finishing the sides.

Governor Weights

These are shown as made in one piece, but may be built up if desired; Mr. Ballantyne described how he made these from steel balls, annealed to enable them to be drilled two ways, one hole being tapped for attaching the stalk. It is, of course, possible to obtain bronze balls, which are obtainable in standard sizes; this would avoid the need for annealing, and I think that even if such material does not conform to full-size practice, it would not be objected to by anyone except the most meticulous splitters of hairs.

It is, however, quite simple to make the weights, with their stalks, all in one piece, either in steel or other material, and if one is prepared to make or adapt a simple spherical turning fixture, such as has been described several times in THE MODEL ENGINEER; this makes quite an interesting turning exercise. A piece of round bar, a little larger than finished size—or spot-on if it can be truly chucked—with sufficient length projecting to form the complete component, is first turned down at the end, just long enough to enable the $\frac{3}{16}$-in. ball end to be formed; do not turn down the full length of the stalk until this has been done, as it will make it very flimsy, and liable to spring or ride up over the tool. The hollow centre may then be used in the tailstock to steady the end while the stalk is being turned, after which the larger ball may be formed, leaving only a narrow neck to support it while the spherical turning is in progress. After parting off, the part can be re-chucked for trimming the surface not previously accessible, a hand tool being suitable for this operation; do not worry about wobble of the shank when the ball is chucked (using strips of foil to protect the surface, of course), because if it is really and truly spherical, the essential surface will be true, whatever the angle of the running axis.

The cross hole for the pivot-pin can be drilled accurately through the centre of the ball by holding it once again in the three-jaw chuck, but this time with the axis of the stalk exactly at right-angles to the lathe axis, i.e., parallel with the face of the chuck; this should be very carefully checked. A fine centre-drill should be used to start the hole, which is then drilled slightly undersize, with due care to see that it goes through truly, and finished with a sharp $\frac{1}{16}$-in. drill, in the absence of a reamer or parallel broach.

It is hardly practicable to use this method for the hole through the smaller ball end, as the shank will foul the chuck jaws, unless a small chuck with fine jaw faces is available; but it is practicable to do the job in the drilling machine if due care is taken. To ensure that this hole is parallel with that in the larger end, a piece of straight $\frac{1}{16}$-in. steel rod should be inserted through the latter and squared up when the job is mounted for drilling. A convenient method of holding it would be to make a shallow vee-notch in the top of a parallel packing piece, $\frac{1}{2}$-in. wide, and use this to locate the stalk, the lot being clamped to the drill table with a strap or toe clamp. After checking the angle of the rod in the larger end, file or mill a flat on the smaller end to assist in marking and starting the hole truly.

In view of the fact that four of these components have to be made, some constructors may think it worth while to make a drill jig to ensure accuracy and uniformity in these holes. A suitable jig could be made by drilling a piece of $\frac{3}{4}$ in. square mild-steel $\frac{3}{16}$ in. diameter to a depth of slightly over 1 in., and counterboring $\frac{3}{8}$ in. diameter to take the large ball. Some means of locating the component endwise, and holding it securely, would have to be provided, and the positions of the cross holes set out and drilled very accurately; it is questionable whether the trouble taken to make such a jig would be justified for dealing with so small a number of parts.

The sides of the small end will of course have to be faced off and fitted to work freely in the slots of the fixed yoke, but no perceptible end play should be allowed. Plain pivot pins are suitable for all these joints, and may be made from $\frac{1}{16}$-in. silver-steel, the fit in the outer members being sufficiently tight to retain them in position; it is advisable to make them to project very slightly and finish the end faces convex. Needless to say, the joints must all articulate perfectly freely, but without sloppiness.

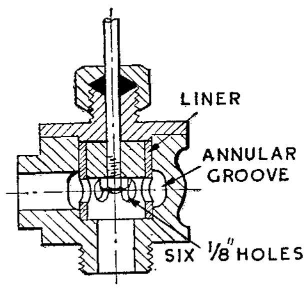
Stirrup Links

These could be made in one piece, by using $\frac{1}{2}$ in. round bar, drilled at the end and the internal contour formed with a round-ended flat cutter, then turned on the outside of the stirrup, prior to cutting away the sides. This would leave the outside surface slightly convex, which if anything would enhance the appearance. But many constructors may prefer to make the stirrup separate, by turning a ring, $\frac{1}{2}$ in. outside by $\frac{3}{8}$ in. inside by $\frac{3}{16}$ in. wide, with three $\frac{1}{16}$ in. cross holes drilled 90 deg. apart in the centre of the width; this may be done accurately by the use of indexing gear, in all four rings, prior to completing the parting off. The unwanted portion of each ring can then be cut away, and the ends rounded off, after which the centre hole is fitted to the turned shank and silver-soldered. In either case, the turning and drilling of the shank follows the methods already described for the previous part.

Again, the links could be filed from flat brass to the shape required, leaving the shank rectangular section, or rounding it off, as considered the more desirable. This is the method employed in the case of the governor on Mr. Cooper's engine, a close-up of which is illustrated on page 287. I also have been sent a book by the late Rev. J. Shores, in which is a photograph of another single engine, purporting to have been made by the Liverpool Castings & Tool Supply Co., in which the stirrups appear to have been built up of two flat strips of metal, joined together at the shank end, and bent outwards to form a fork which embraces the ball at the top.

Control Levers

These are made from mild-steel, and filing from the solid is as good a way as any to make them, though the bosses may be turned and drilled by mounting them in the four-jaw chuck, and while set up, advantage may be taken of the opportunity to machine away a good deal of unwanted material. The inside of the fork may be formed by end milling, or by drilling and filing. Note that these levers are made right- and left-handed to suit the two sides of the engine, by changing the bosses



Alternative form of throttle valve with multiple ports

from one side to the other, as indicated by the dotted lines. This really applies only in the case of the short lever, as the other, being symmetrical top and bottom, only needs to be turned upside down to reverse the boss. I have taken the liberty of putting a "set" or bend in the short lever, so as to offset the fork end $\frac{1}{4}$ in. below the axis level as shown, with the idea of preventing any possibility of jamming the fork at any point in its travel, as might occur if it were in line with the axis. If desired, the lever may be made straight and bent afterwards, though it may not be found as easy as it looks to get a nice shapely bend, without damage to the surfaces.

As with other working parts, the lever forks must be fitted to work quite smoothly, and freely between the collars of the governor and throttle spindles, with no perceptible play. The two levers are pinned to a shaft which works freely in the arm of the governor frame, and before fixing them permanently, it is advisable to ensure that they are in the correct relative positions to operate properly; this will need checking on final assembly.

A rather interesting detail is noticeable on the governor gear of Mr. Cooper's engine, which does not appear to have any precedent in full size practice, so far as I can ascertain, and has probably been devised by the individual constructor. It apparently consists of a means of varying the relative angles of the two levers, with a view to altering the speed while still under governor control, by means of a worm wheel and screw. While this device is undoubtedly ingenious, and would work satisfactorily on a large engine, it would have to be made to a very high degree of precision to work equally effectively in a model. A simpler method of attaining the same end would be to add a variable-tension loading spring on the control arm, and this method is generally used in small industrial i.c. engines, as it avoids complication and eliminates backlash.

Throttle Body

A bronze casting is recommended for this, though it could easily be fabricated by brazing the flange on, or machined from the solid. No special problems arise in machining, but the procedure which I suggest as most convenient will be to face the side flange first and drill the port to a depth not exceeding $\frac{1}{4}$ in., the work being held crosswise in the four-jaw chuck. Next chuck it on its main axis to turn the underside, including the threaded spigot, which may be screwed with a tailstock die-holder, taking the thread as close up to the shoulder as possible, by reversing the die after the initial cut. A piece of metal should then be chucked and faced, drilled and tapped for holding the valve body in the reverse position, ensuring the true running and avoiding risk of damaging it with jaw marks. Face the top surface, drill right through $\frac{3}{16}$ in. diameter, and counter-drill to about 11/32 in. diameter to a depth of $\frac{7}{16}$ in.

The side port should now be drilled into the centre bore, which can be done with the hand-drill, to avoid the need for removing the job from the chuck. Then the counterbore can be opened out to size, and squared out at the bottom with a boring tool, finishing the bore as smoothly as possible. In this way burring or distortion of the bore (which would almost certainly occur if the side port was drilled last), and also the tendency to deflect the drill when forming the main bore (which would occur if it was drilled first), are both avoided.

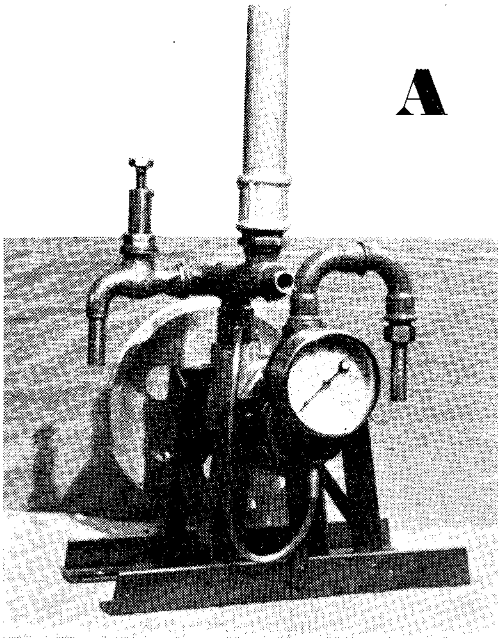
Cover and Gland

The cover may be machined from bar stock, being first turned on the top, including the screwed spigot, taking the usual care to ensure truth of the threads. It may be countersunk on the end to the normal drill point angle, but not drilled through at this setting, and then parted off, with finishing allowance. It is now

(*Continued on page* 290)

A Garden Sprayer

By John D. Elam



Sprayer unit which by replacing the wheel by a crank, can be operated by hand

LET not the illustration of this power-driven sprayer deter any reader who has no portable power at his (or her) command, as I have used the sprayer for one season, man-handled by merely fitting a cycle crank on pump shaft, with a drilled wooden file-handle an easy fit on pedal spindle, and it was found that 50 revs. per min. produced perfect results.

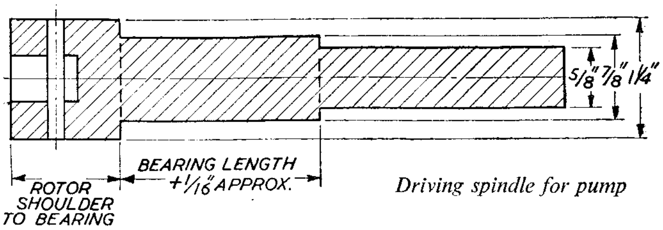
Knowing that I could not always reckon on my friends to assist me, I motorised it and fitted reduction gear which drives the pump at 76 revs. per min. at 40 lb. per sq. in.—really too fast, as the relief-valve is working all the time.

The pump is a surplus A.M. sliding-vane type, mounted on a cradle made from 1 in. $\times$ $\frac{1}{8}$ in. angle-iron. All the pipework is of standard $\frac{1}{2}$ in. iron pipe fittings, but there was one snag; the pump is designed to take $\frac{5}{8}$ in. pipe and I found this is not commercially obtainable, so I had to turn up and screw cut two adaptors from suitable hexagon stock, one end $\frac{5}{8}$ in. and the other for $\frac{1}{2}$ in. fittings.

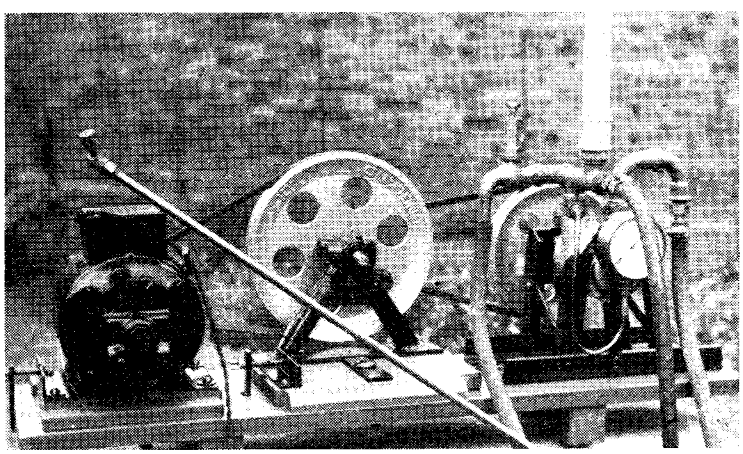
As is well known, these pumps are designed for flange mounting and driven by a universally mounted splined shaft, both of which have to be discarded. In place of original flange I obtained a piece of mild-steel $\frac{1}{2}$ in. thick by 3 in. wide, and cut same so as to be $4\frac{1}{2}$ in. long along top edge and 5 in. long at bottom edge.

For the main bearing, a piece of phosphor-bronze was turned $1\frac{1}{2}$ in. diameter $\times$ 2 in. long, and one end reduced to form a shoulder $1\frac{1}{8}$ in. diameter $\times$ $\frac{1}{2}$ in. long. The former-mentioned steel plate is mounted on the faceplate or independent chuck and its centre located. It is then drilled and bored to fit the spigot formed on bronze bearing, to which it is afterwards brazed, silver-soldered or sweated with soft-solder, according to one's equipment. This having been successfully performed, mount bearing concentrically in chuck, face the mild-steel plate all over, drill and bore out the bearing—finishing, with a reamer if you have the size—to $\frac{7}{8}$ in.; then recess bearing and steel plate to the size of spigot on pump body. This can now be removed from lathe and the four holes drilled for attaching to pump body; using the discarded flange as a register; also those for fixing same to cradle. To finish this part, drill and tap a hole in the bearing to take a screw-down grease cup.

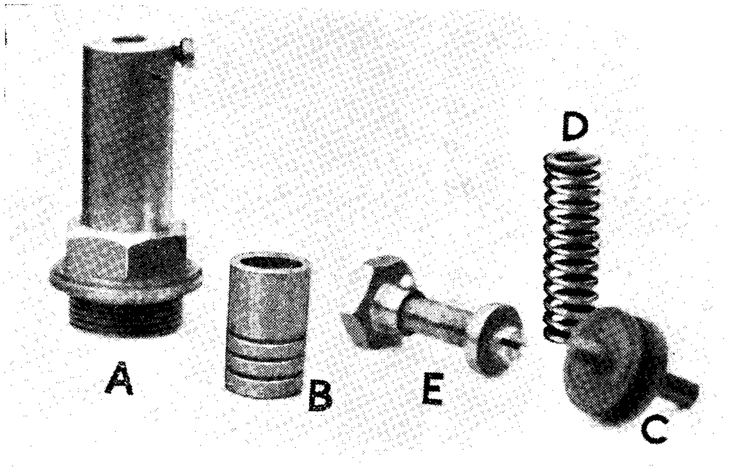
For the driving shaft, procure a length of mild-steel equal in diameter to the universal coupling, reduce one end to $\frac{5}{8}$ in. for a length suitable for the drive you intend to use, then reduce a further portion to $\frac{7}{8}$ in. (i.e. a good running fit in bearing) for a length equal to bearing + $\frac{1}{16}$ in. or thereabouts. That portion of the stock left should be parted off so as to be a running fit between bearing and rotor pump shoulder. This latter portion has to be drilled oversize to the rotor shaft, to offset any slight misalignment that may have crept in, and a hole drilled precisely at right-angles to the axis,



Driving spindle for pump



Motorised sprayer ready for use



Details of the release valve

passing through this hole in such a position that the driving-pin fitted to this engages with driving dog on end of rotor shaft. A stronger job is made if a milled slot is sunk in the end of shaft, and a flat key fitted like that in the universal joint removed.

The back end of the pump is fixed to the cradle by removing two diametrically opposite bolts in back cover of pump, making two distance washers and two long bolts to replace those removed, and drilling the cradle to correspond.

I was at a loss for a time how to arrange a relief-valve which could deal with a reasonable quantity of fluid, when I spotted an old $\frac{1}{2}$ in. bib-tap which had been put to scrap owing to the regulating screw having worn away. This gave me an idea, which I put into practice as follows : I dismantled the head, reserving that portion which screws into body of tap, cutting off all material above hexagon. I then held the threaded portion in s.c. chuck and bored out to take a $2\frac{1}{2}$ in. length $\times \frac{3}{4}$ in. brass tubing which was sweated in; also, sweated in the top was a disc drilled and tapped $\frac{5}{16}$ in. $\times$ 32 t.p.i. with a small air-release hole, also a pinching-screw passing through disc to screwed centre *A* in photograph. Turned a good fit to this tube is a plunger *B*, one end drilled an easy fit to standard tap washer valve *C*, and the other end recessed to take pressure controlling spring *D*.

To control this spring a $\frac{1}{2}$ in. diameter brass rod is reduced to $\frac{5}{16}$ in. and threaded 32 t.p.i., and of such a length as to protrude through top of barrel approximately 1 in., but before removing from chuck, reduce end to form a spigot to take a milled or hexagon disc, which has to be prepared and fixed by the passing through of an 8-B.A. screw. Remove from chuck, saw off, leaving about $\frac{3}{8}$ in. of stock beyond threaded portion. Hold threaded length in chuck and turn down to leave a collar approximately $\frac{1}{8}$ in. thick, and a spigot slightly less than inside diameter of spring. This spigot must have a small slot cut in same to take a screw-driver as it has to be inserted in its thread from the inside of barrel *E*.

After assembling, the release-valve is complete and in practice works perfectly.

If we wish to know the pressure it is working at, one of the many surplus gauges on the market can be fitted.

I have used this sprayer for two seasons and it has given every satisfaction. Using a commercial mist sprayer-head fitted to a lance, one can spray one's fruit trees or flowers in a fraction of the time taken by the old-fashioned hand sprayer.

I was told when I purchased the pump, that the vanes and internal working parts were of stainless-steel; but not to risk any corrosion, I give a good charge of lubricating oil after use and before storing.

The countershaft is nothing more than the crank housing sawn from an old bicycle and welded to a base. Both the countershaft and motor are mounted on separate wood bases which slide between wood guides, the tension to belts being supplied by the bolts and winged-nuts clearly seen in photograph. After adjustment, these individual bases are clamped by bolts passing through the main base.

I trust the photographs and sketch will explain construction, which is very simple.

MORE UTILITY STEAM ENGINES

(*Continued from page* 288)

advisable to make the gland nut, so that it can be used as a screw chuck for the cover before parting it off from the bar. The cover can then be held in it for facing and turning the underside spigot to a neat fit in the bore of the body, also drilling truly for the valve spindle. The six holes for holding down the cover are then indexed or divided out, and drilled, after which they may be spotted through into the body, for drilling and tapping.

Valve and Spindle

These parts are specified as made in stainless-steel, but substitutes may be used if this is not available. The valve must be mounted perfectly true on its spindle, and the time-honoured method of opening out the centre hole to a tight fit on the plain spindle, for about half its length, and tapping the other half, should produce the desired results. The fit of the valve should be on the easy side, as it is not required to seal off the flow of steam, but only to act as a restrictor; it should, however, work perfectly freely in the bore, with no tendency to rub. At the top end of the spindle, a brass or steel collar, to engage the fork of the control lever, is fitted, with some latitude of adjustment up and down, and a lock-nut to secure it. Note the small hole through the valve, to balance the pressure on the upper and lower sides.

It may be observed that I have retained the simple single port piston valve as in Mr. Ballantyne's engine, which presumably served its purpose, but it is quite possible to modify this so as to provide a ring of ports which will avoid any side pressure on the valve, by boring an annular recess and fitting a liner in the body. Another possible and perhaps desirable modification would be to provide a base flange for mounting the valve body on the steam-chest, instead of trusting to providence (and the thickness of the packing washer or grommet) that the flange will come into the right position for connecting up.

(*To be continued*)

L.B.S.C.'s Jitfield Thunderbolt

IN $3\frac{1}{2}$ AND 5 INCH GAUGES

NOW to settle an outstanding item in the construction of the $3\frac{1}{2}$-in. gauge engine, to wit, the mechanical lubricator, the original drawings of which were rendered unusable by the unseemly behaviour of a human snifting-valve. I have made some replacement drawings, and they are reproduced herewith. Although the construction and erection of the cylinder oiler are similar to those already described for the 5-in. gauge engine, the dimensions are different, and these separate illustrations should prevent any confusion. There should, however, be no need to detail out the whole rigmarole again, so here is just a brief synopsis of the how-to-do-it.

The oil tank is made from 20-gauge sheet brass or steel, a piece $4\frac{1}{2}$ in. long and $1\frac{1}{16}$ in. wide being bent into a rectangle measuring $1\frac{1}{2}$ in. $\times$ $\frac{3}{4}$ in. and silver-soldered to a piece of 16-gauge metal cut a wee bit larger than the rectangle. File bottom flush with sides, and make a lid from the 20-gauge stuff; nick the corners, bend over, fit the $\frac{1}{4}$-in. filling tube, and silver-solder. The lid should be a tight fit on the tank. Drill a 7/32-in. hole in the middle of the bottom plate, and a $\frac{3}{16}$-in. hole in the side, at $\frac{3}{16}$ in. from the top.

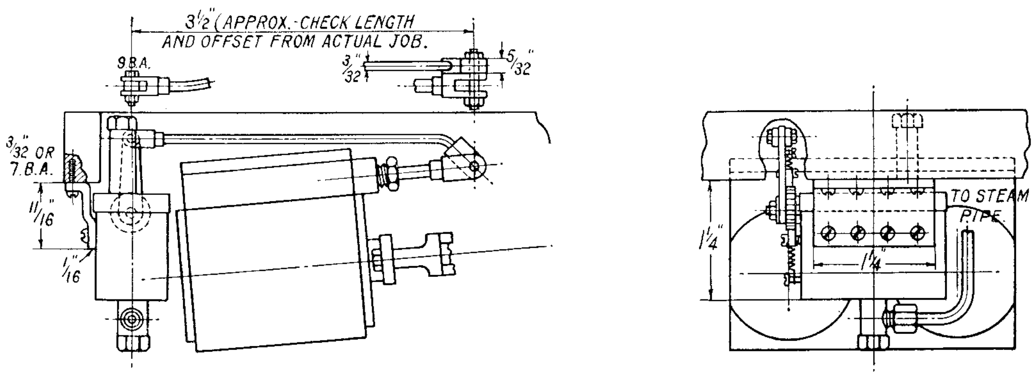
The stand for the pump is made in exactly the same way as for the larger lubricator, but to the given dimensions. Beginners and inexperienced workers please note that great care should be taken in marking out and drilling the ports, as under no circumstances must the distance between their edges be less than $\frac{1}{16}$ in. If it is, then any steam leaking past the check-valve, will enter the tank when the port in the pump cylinder bridges the gap, condense in the oil, and cause it to overflow from the tank. I stress this point because, even since I wrote the last warning, I've seen a lubricator which has failed to deliver oil for this very reason; the maker of it blamed the design, instead of his own bad workmanship.

The pump cylinder is also as specified for the 5-in. job, except that the ram is only 3/32 in. diameter, and the gland is screwed $\frac{3}{16}$ in. $\times$ 40. Only sufficient packing should be put in the stuffing-box to allow the head of the gland to screw right home, on account of the small clearance possible. If you like, a headless gland can be used.

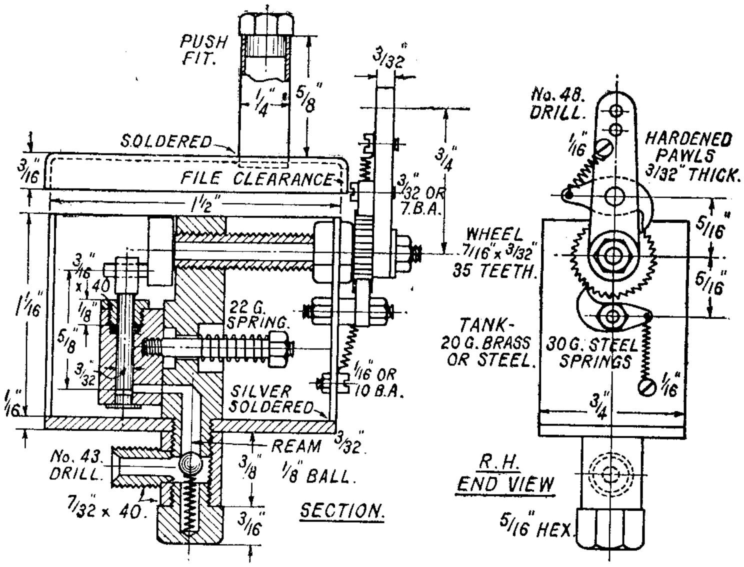
Details and Erection

The bearing for the crankshaft is made from $\frac{5}{16}$-in. hexagon brass rod, turned down to $\frac{3}{16}$ in. diameter for $\frac{7}{8}$ in. length, screwed $\frac{3}{16}$ in. $\times$ 40, and drilled No. 41. Part off to leave a head $\frac{1}{16}$ in. wide, and make a $\frac{1}{8}$-in. locknut to fit. The crankshaft is made from 3/32 in. round silver-steel, to dimensions shown, and screwed at both ends. The crank is a $\frac{1}{8}$-in. slice of $\frac{3}{8}$ in. round rod, drilled and tapped to take the shaft, before parting off in the chuck; otherwise it won't run truly. The crankpin is a bit of 15-gauge spoke wire, screwed into a hole in the crank, drilled a shade under $\frac{1}{8}$ in. from the centre, and tapped 9 B.A.

Here is a check-valve tip which will save time and trouble when assembling the lubricator. Chuck a bit of $\frac{5}{16}$ in. round brass rod in three-jaw, face, centre, drill $\frac{3}{16}$ in. diameter for $\frac{7}{16}$ in. depth, and part off at $\frac{3}{8}$ in. full from the end. Reverse in chuck, skim the face true, slightly countersink, and run a 7/32-in. $\times$ 40 tap through. Attach the pump cylinder to the stand, place in tank, and attach bearing to top of stand, through the hole in the side of the tank, as described for the 5-in. gauge job. Screw the tapped sleeve on to the projecting spigot under the tank; screw bearing home until the head touches the tank side, then tighten the locknut, and tighten the sleeve. On the latter, exactly opposite to the head of the bearing, make a mark in the middle of its length. Remove sleeve, centre-pop the mark and drill 5/32 in. Fit a 7/32-in. $\times$ 40 union nipple in the hole, and silver-solder it. Sleeve will then form the clack body, and when the lot is assembled, the union nipple will come in the right place. All you then have to do, is to seat a $\frac{1}{8}$-in. ball on the hole in the spigot, and fit the bottom cap and spring as shown.



How to erect lubricator—$3\frac{1}{2}$-in. gauge engine



Section and end view of lubricator for the 3$\frac{1}{2}$-in. gauge engine

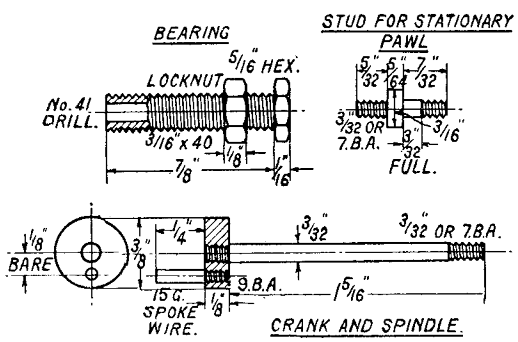
The instructions already given for fitting the crankshaft, ratchet wheel, pawls, and operating lever, all apply to this lubricator, so I need not waste space by repeating them. All sizes are given in the drawings. The lubricator is held in place on the engine, by the same type of bracket, as in the 5-in. job, but it is only 1$\frac{1}{4}$ in. long and $\frac{11}{16}$ in. deep, and made of 16-gauge metal. The drive is arranged in the same way, the operating rod passing over the steam-chest. It is connected to the "waggle-lever" by a fork or clevis made from $\frac{3}{16}$-in. square steel (or brass, just as you fancy) the pin being either a 9-B.A. screw, or a bolt of same size, made from a scrap of 15-gauge spoke wire. One of Pat's famous "little big-ends" is screwed on to the other end of the rod, the end bent over to the requisite amount, and connected to the projecting end of the pin in the right-hand valve-spindle fork. The complete ratchet gear should click one tooth per revolution of the driving wheels.

Haystack Dome

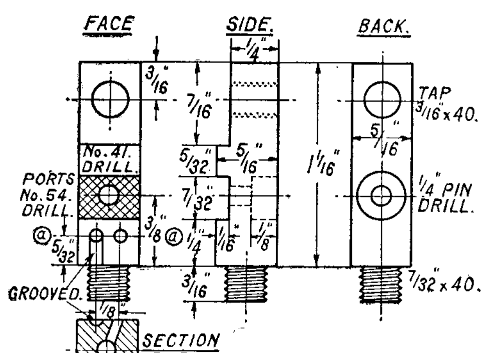
Dang Oi, if we doan' soon get 'aystack top on, rain'll be a-gettin' in, sure-lie; so we'd better see about this job hasta pronto. The procedure is the same for both 3$\frac{1}{2}$-in. and 5-in. gauge engines. First, chuck the casting in the four-jaw, convex side outwards, setting it as true as possible, and face off the flange or seating for the cover which will carry the safety-valves. Next, try the casting on the open top of the firebox shell, and see how much needs to come off, to allow the casting to fit in, to a depth of $\frac{1}{4}$ in. At the time of writing, I don't know if our approved advertisers will supply the castings with the rebate already formed; if they do, it will probably only need cleaning up with a file, to make it fit. Use a second-cut file, and more scratches you make, the better for the silver-soldering job. However, if the casting is the same thickness right to the edge, the rebate will have to be milled.

If a regular milling machine is available, this job is the proverbial "piece of cake," for all that is necessary, is to grip the casting in a machine-vice on the table of the machine, and take out the surplus metal in one cut, by aid of an ordinary side-and-face cutter on the arbor. Don't shift the cross-slide, or the height of the table, when the first cut is made, but simply turn the casting in the vice, to present a fresh side to the cutter, and go ahead. All four rebates should then be of equal width and depth.

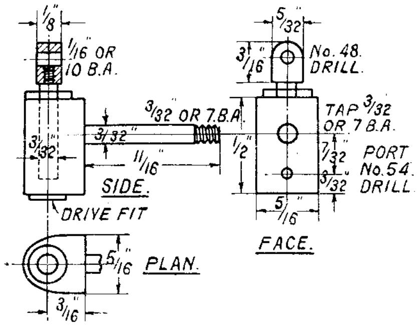
If a vertical-slide and angle-plate are available, the job can be done with equal facility in the lathe. I've just checked that up on my latest acquisition, the "supersonic" Myford. Mount the vertical-slide on the boring-table or cross-slide, with the face of the slide at right-angles to the lathe centres. Bolt the angle-plate to the vertical-slide. Set the casting, right way up, on the angle plate, and secure it either with a plate bearing on the faced seating, with a bolt through the middle, passing right through one of the slots in the angle-plate, or else with a bar across the faced seating, with a bolt at each end. The latter is similar to the way in which I recommend securing cylinder castings to an angle-plate, for boring. Set the casting with one side exactly at right-angles to the lathe centre-line; the easiest way to do that, is to put the faceplate on the mandrel nose, and set the side of the casting parallel with it, either by measuring, or by holding a piece of metal with parallel edges, such as a wide steel



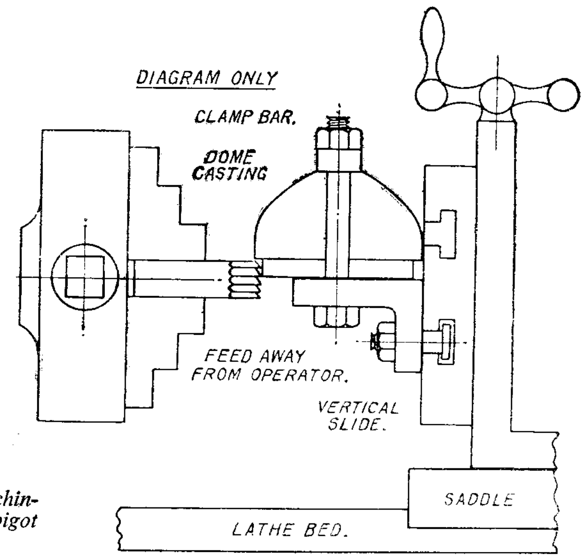
Bearing spindle and crank



Pump stand



Pump cylinder



Easy way of machining the dome spigot

rule, against the faceplate, and running the casting up to it, adjusting so that it touches the metal full length. If the casting isn't square (it should be !), hold the stock of a try-square against the faceplate, and set the casting so that the side of it touches the blade; same as I recommend for setting up cylinder blocks for machining portfaces and bolting-faces.

Replace the chuck, and in it, put an end-mill or slot-drill about ⅜ in. diameter. Run up the casting to the end-mill, and adjust the vertical-slide so that the bottom edge of the casting, which should be overhanging the edge of the angle-plate, is ¼ in. below the upper edge of the cutter. Now, if you feed the casting on to the cutter by turning the top-slide handle, and traverse it across with the cross-slide handle, the cutter will take out the surplus metal, and leave a nice rebate of correct width, in two wags of a dog's tail. After that, all that remains, is to slew the casting around a quarter-turn, reset with the try-square, stock to faceplate (or the face of the chuck) and blade to the machined rebate. Take the next cut, ditto repeato twice more, and Bob's your uncle.

Any unlucky wight who doesn't possess a vertical-slide, could bolt the casting to the top-slide, packing it up until the bottom edge was ¼ in. below the top of the cutter, as before. Slew around on top of the packing, for machining the remaining three sides, resetting with a try-square, as above.

Tip for Shallow Pockets

When I purchased my first Drummond lathe, on the "never-never," over half a century ago, I wanted a vertical-slide, couldn't afford to buy it, and hadn't the cheek to presume on Mr. Arthur Drummond's kindness for any more "tick." By the help of the fitters' "gaffer" at the loco-sheds (pardon, I should write "Motive Power Depot" in this "enlightened" age ! !) I acquired two pieces of angle-iron with a pretty true right-angle. The old Drummond topslide was held to the boring-table by a single bolt; so all I had to do, to up-end it into a nobby swivelling vertical-slide, was to drill two holes in the piece of angle, bolt same to the table by one bolt, and the top-slide to the vertical member of the angle. Another bit of similar angle, bolted to the top of the slide, in place of the tool clamp, did duty as a rising-and-falling table, which sufficed for my modest demands, as I drilled and tapped screw-holes and bolt-holes in it as desired. I also used a piece of similar angle, with a bit of bar and two bolts, as a "universal faceplate chuck."

How to Fix the Dome

In the drawings, you will notice that I showed an imposing array of screwheads all around the joint where the dome fits into the top of the firebox shell. Set out and drill all the holes first. They are all ⅛ in. from the top, and spaced at ⅜ in. centres on both sizes of boiler. Those in the smaller boiler are drilled No. 51, and in the larger, No. 41. File off any burring on the inside, then insert the dome casting, and see that the flange is well home, and the dome set level. Run the drill through all the holes in the shell, and make countersinks on the casting; follow up with No. 55 for the smaller boiler, and No. 48 for the larger, going right through the flange. Tap $\frac{1}{16}$ in. or 10 B.A., or 3/32 in. or 7 B.A., as the case may be, and put in brass round-head screws. Ordinary commercial screws will do quite well for this job, although I personally would make my own, from either drawn phosphor-bronze or good gunmetal.

This joint should be silver-soldered, using either Easyflo, and the special flux sold for use with it, or best quality silver-solder, with powdered borax, mixed to a paste with water, as flux. Better still would be a "jewellers' borax cone" (some of our advertisers sell these) ground to a fine powder, and mixed with water, to form a creamy paste. Anoint the joint well with the flux, laying it on fairly thickly all around, then lay the boiler in the brazing pan with the casting towards you. Blow on the casting with a big diffused flame, as given by a blow-lamp, or an air-gas blowpipe; on no account use a fierce concentrated flame as given by an oxy-acetylene blowpipe, or you'll probably say good-bye to your casting. When the whole issue is dull red, shift the direction of the flame, so that it blows on one corner of the joint; and when the copper and the casting glow dull red together, apply your strip of silver-solder or Easyflo. This will immediately melt and flow in; then work right around the whole four sides, turning the boiler over as required. Don't forget to cover all the screwheads. When through, let the job cool to black, and give

(*Continued on page* 296)

Realism in Apprentice Training

GREENWICH FIRM'S LOGICAL APPROACH

Learning how to operate the shaping machine

A VERY good feature of the apprentice training scheme of G. A. Harvey & Co. (London) Ltd. of Greenwich is the effort made to ensure that the trainees obtain a good idea of current activities in the engineering field as a whole. Thus not only are visits made to other firms and places of interest, such as the National Physical Laboratories and The Model Engineer Exhibition, but two apprentices are each year given an opportunity to change places for three months with two apprentices from German firms.

The firm was founded in Lewisham in 1874 by Mr. G. A. Harvey, father of the present chairman. His business prospered and in 1894 additional premises were acquired in West Greenwich for galvanising and tank making. In 1913 both factories were transferred to the present site in Woolwich Road, Greenwich, where the whole 28-acre site is now covered by buildings.

It is difficult to classify precisely the category in which the firm can be placed, because there are many departments engaging in both light and heavy engineering. To one section of industry, for example, they are best known as makers of large pressure vessels and tanks, but to other sections they are equally well known for their steel-plate work, sheet-metal work, metal perforating, wireworking, wire-weaving, galvanising, and zinc and copper work, in addition to being manufacturers of steel office and factory equipment.

Despite the growth of the firm, it still remains a family concern and takes a close interest in the welfare of its employees. In no respect is this interest more apparent than in its apprentice training scheme, which is administered by an education committee composed of representatives of management, foremen, and shop floor workers. This committee meets at monthly intervals to consider reports on the apprentices' progress, and each apprentice appears before the committee once a year, so that it can discuss his progress with him and take into account any suggestions that he may want to make concerning conditions and training.

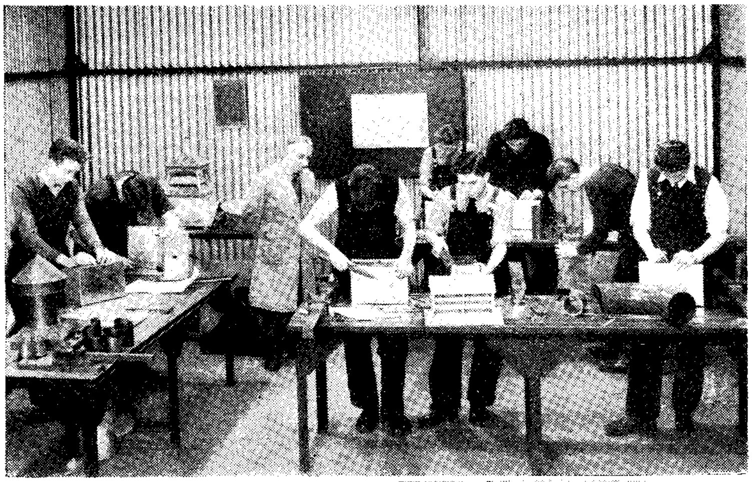
Scope for Selection

A particularly important feature of the scheme is the effort made to ensure that the apprentices obtain a full picture of the various trades open to them in engineering, so that they can be really sure that, within the framework of the current manpower requirements of the various departments of the firm, they have selected the branch to which they are individually suited and in which their interest lies. As it is recognised that the comparatively young age at which apprentices enter the industry may mean that it is difficult for them to make the correct selection at that time, arrangements can be made for them to switch their training to another trade at any time during their apprentice-

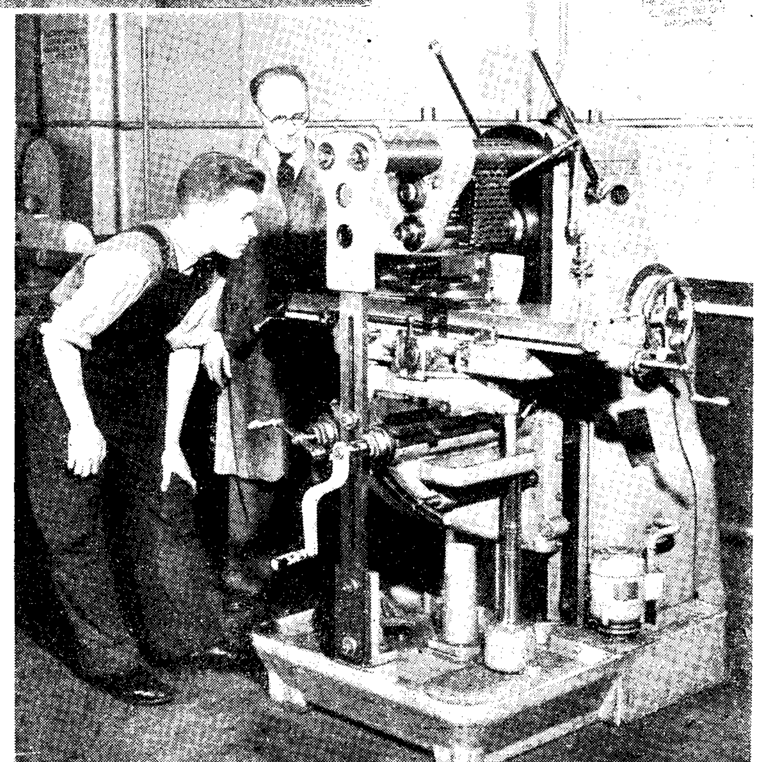
Instruction on reading a drawing

ship, subject to the consent of the education committee and the manpower requirements of the firm, though in practice the number wishing to take advantage of this is small.

The total number of apprentices is 115, of whom 15 are recruited from local secondary technical schools in September each year. A considerable proportion of these boys is generally from Woolwich Polytechnic secondary school. A further 15 entrants are recruited each March from non-technical secondary schools.



General view of sheet-metalwork school



Right: A student receives instruction on a milling machine

For the first six months the boys serve a probationary period in the firm's apprentice training school, during which time their capabilities and aptitudes are assessed. The school is equipped with up-to-date machinery comprising a horizontal milling machine, a shaping machine, a tool cutter and grinder, a surface grinder, a slotting machine, a power saw, two pillar drills, a pedestal drill, and fitting-benches equipped with 18 vices. The school is under the charge of the apprentice supervisor, Mr. S. Moore, who is assisted by one instructor. The age-range of entrants is 15 to 17.

During their period in the school, the apprentices each make a complete set of tools for themselves, which are precision-finished and to drawing. These comprise a set of scrapers, vee-blocks, calipers (inside, outside and odd-leg), squares, a die-holder, tap-wrench, trammels, a scribing block, and tool-makers' clamps. The making of these tools is arranged to involve as many processes as possible and thus give the maximum amount of practice in using the machines available in the workshop.

The last $1\frac{1}{2}$ hours of each day are spent in the lecture room where general subjects are taught—e.g. workshop technology, workshop calculations, science, and technical drawing. Lectures are also given on safety-first precautions and the importance of observing such precautions is strictly inculcated, during the probationary period, in the course of practical work in the workshop. Lectures are given by the senior managers of the company on the products of the firm and the various trades open to apprentices. The lecture room is equipped with a projector for screening technical training films. Visits are made to each department of the firm to give the apprentices an opportunity to watch the various tradesmen at work and thus obtain practical knowledge on which to base their own choice of vocation.

Each week, a $\frac{1}{2}$-day is spent in the sheet metal working school, where two instructors teach sheet metal development. At a later stage apprentices make under their guidance a tool-box to accommodate the tools they have made themselves in the engineering school.

Importance of Indenture

The engineering school was started just 18 months ago, but the indenture scheme was commenced seven years ago. It is noteworthy that at about that time the firm found that the general standard of would-be entrants often left something to be desired. Since the indenture scheme was started, however, there has been a marked improvement and the company is now very satisfied with the type of apprentice coming forward. The labour manager, Mr. J. Hughes, regards this improvement as definite evidence that the kind of entrant sought by the engineering industry can be obtained, provided that he has the security conferred by an indenture scheme during the training period.

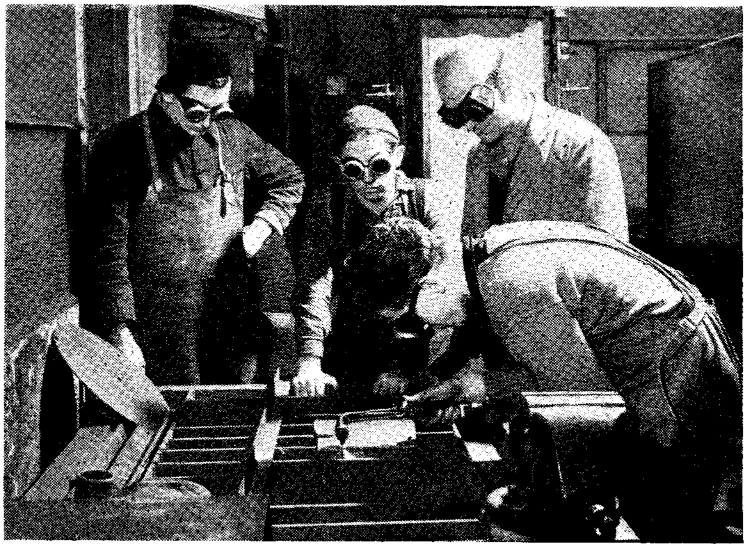
At the completion of his probationary period or at his 16th birthday the apprentice is the subject of a report to the education committee by the apprentice supervisor and is then granted an indenture for a specified trade, taking into account his own choice and any special aptitude he has shown during the probationary period. The choices open to him are fitter, millwright (maintenance fitter), turner, machinist, plater, sheet-metal worker, electrician, blacksmith, tool-maker, pipe-fitter, wire worker, and specialist welder.

A separate curriculum of five years duration is drawn up for each trade. A specialist welder, for example, receives one elementary and two advanced courses in the firm's welding school. Two are on electric arc-welding and one is on gas welding.

A more general idea of the scope of training might be given, however, by outlining the curriculum for apprentice machinists. They spend four years in the machine shop, during which time they would be engaged on drilling, radial drilling, jig-boring, turning, milling, shaping, slotting, grinding (surface and cylindrical), and boring (horizontal and vertical), followed by six months on bench fitting. A similar period is passed in the drawing office and then three months are spent respectively on inspection and in the product planning office. The apprentice supervisor reports to the education committee on the boys' progress at each stage.

Continuation Studies

Until they are 18, apprentices attend a day continuation college, such as Woolwich Polytechnic or the South-East London Technical College, for one day per week at the expense of the firm, and thereafter are expected to attend night school on three evenings per week, the boys taking either the National Certificate course or the City and Guilds course.



Instruction in flame cutting of iron and steel

There is naturally some tendency for the boys to want to become members of the technical staff of the firm and, if vacancies exist, their indenture is endorsed for them to reach the necessary stage of proficiency if they show sufficient school and departmental progress to merit this.

Sectional prizes are awarded yearly to apprentices in the various trades and there is also a shield, which has been donated by the chairman of the company, awarded to the "apprentice of the year." The recipient receives a replica of the shield and a gold watch.

Within recent years an interchange scheme has been operated, whereby two apprentices are exchanged with two apprentices in Germany for three months. The two boys—one a junior trade apprentice and the other a senior technical apprentice—are selected by the managers of different departments each year, so that all trades have their chance to go. The wide range of Harvey's equipment makes it possible to arrange interchanges with a wide variety of German engineering firms. The scheme has proved so satisfactory that it is soon to be expanded, and this should be beneficial not only in engineering training but also in the broader field of international understanding.

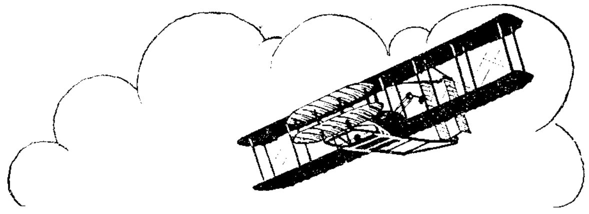
TITFIELD THUNDERBOLT

(*Continued from page* 293)

it about 15 to 20 minutes in the pickle-bath. When it is fished out, you'll probably find that the copper is quite clean, with a matt surface, but the casting has gone black; some cast metals turn black on the surface in the weak acid. This is nothing to worry about, as it resumes its natural beauty under the gentle persuasion of a wire brush.

If any builder is dubious about his ability to silver-solder the joint, it will be quite safe if soft-soldered. There are enough screws specified for the joint, to hold it securely against the working pressure, and the " soft-tommy " would only have to act as a caulking. If this is done, be sure that the copper of the shell is held as tightly as possible to the rebated edges of the casting. Don't use a soldering-bit for the job, but proceed in much the same way as described above for brazing, anointing the joint well with *liquid* flux (not paste on any account) and heating until a strip of plumbers' solder will melt and run in, when applied to the metal. Wash well in running water. Next item, staying.

Tribute to the Wright Brothers



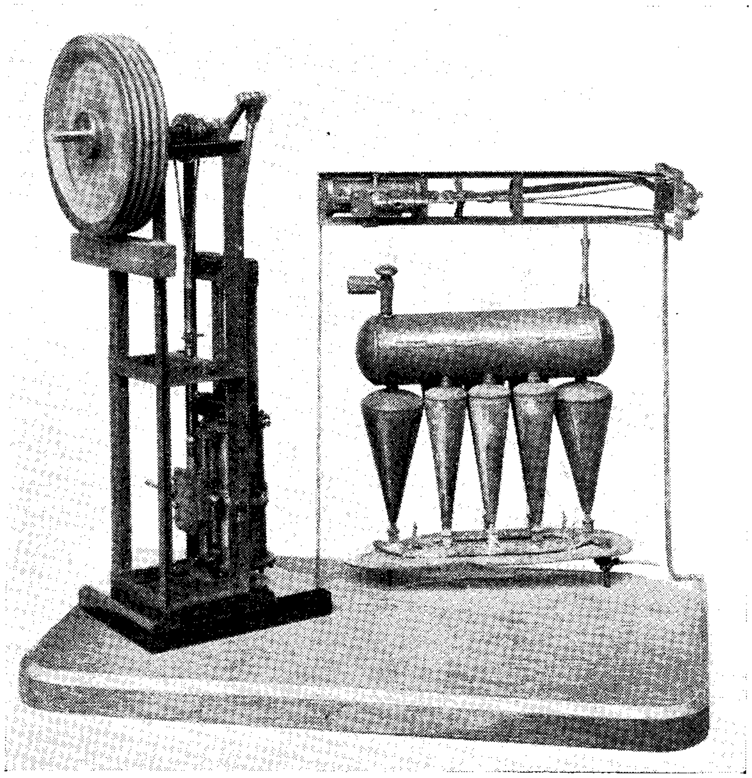
By J. Dewar McLintock

THERE must have been great interest and excitement among nineteenth-century model engineers when, at the Crystal Palace Exhibition of 1867, John Stringfellow's model aeroplane was shown. Here was a beautifully-executed miniature of an object which must then have been little less fantastic than the space ship of tomorrow, and which was propelled by a steam engine made as delicately as a clock.

In this, the Aeronautical Society's section of the exhibition, the visitor would have gazed upon a remarkable scene, in the great glass hall. There was Stringfellow's unearthly triplane, perhaps six or seven feet in wing-span, and with two paddle-like propellers, suspended on a long launching rail near the roof. Around the hall on tables and stands, were other queer aeronautical models—some quite hopeless projects, it would appear, but others with great promise—and among them perhaps the most remarkable, if not the most effective, in the form of a kind of miniature Rocket-type locomotive, having the wings of a bird !

Among the tables strolled elegantly-dressed, top-hatted visitors and their elaborately-gowned ladies, politely jostling one another in their efforts to see these new wonders, and there was great controversy as to whether it was quite proper to think seriously of travelling off the ground.

Nevertheless, by 1894, Sir Hiram Maxim, with his fearsome-looking but surprisingly efficient steam-driven full-scale flying machine, had at least convinced many doubters that a flying age was possible without balloons, and some indication of his status as a practical-minded engineer may be gained from the knowledge that, at the opening of the 1909 " Model Engineer " Exhibition, Mr. Percival Marshall presented to him a beautiful silver scale-model of the machine.

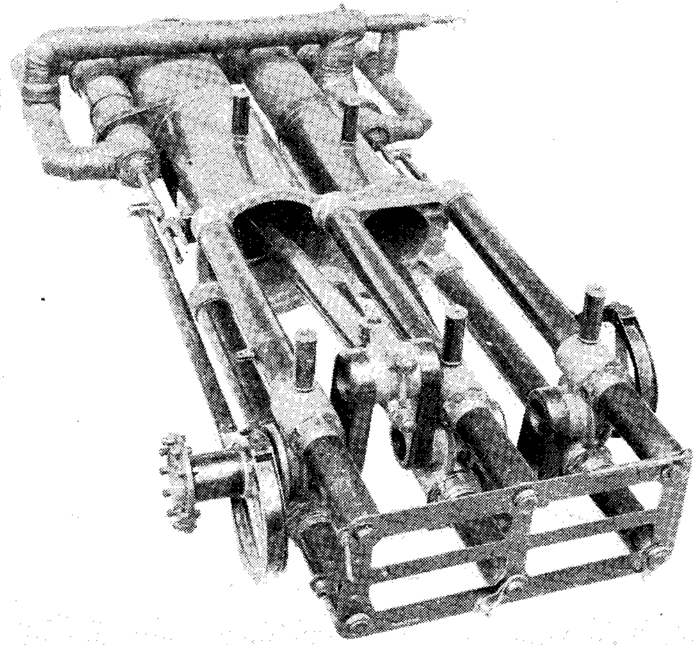


Left : *Steam engine for the Hensan-Stringfellow model*, 1843.
Right : *Stringfellow's model steam engine and boiler*, 1848. (*Photograph Crown copyright. From an exhibit in the Science Museum, South Kensington*).

This silver model and the original Stringfellow steam engine are among numerous fascinating exhibits now in the Wright Brothers' commemorative exhibition at the Science Museum, Kensington, London. The silver model—no bigger than a cigarette packet—is an admirable piece of work from a reproduction point of view, but most of us must inevitably be attracted more by the extraordinary little steam engine with its spindly but strong piston-rod, cross-heads, connecting-rod and eccentric-rods. One is prompted to think that it probably had a first-class power-to-weight ratio ! The connecting-rod is of oval section and of increased section in the middle. The cylinder is of brass or bronze.

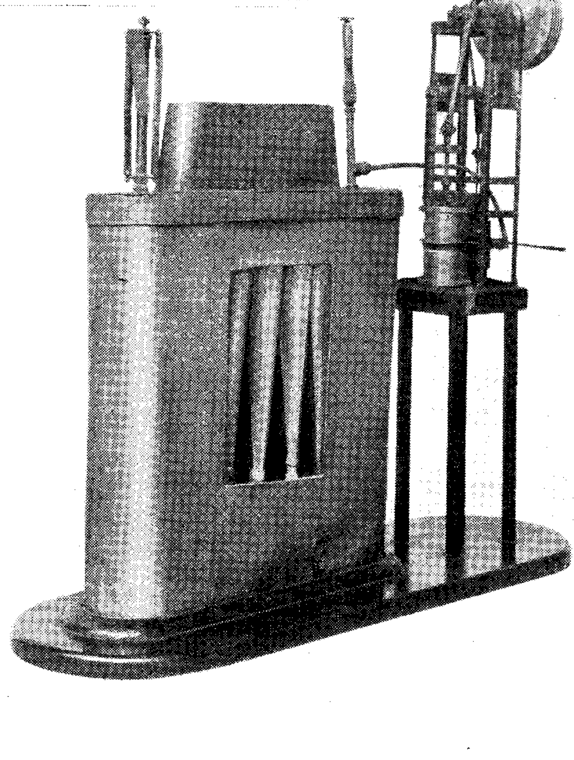
There are many other models and exhibits to delight the eye and the senses, and not least among them are finely-built models of the Wright 1903 biplane (the first aeroplane to make a controlled and sustained flight), the Bleriot 1909 monoplane (first to fly the channel), a 1933 *Hawker Hart*, a Battle of Britain *Spitfire*, and the modern *Canberra* jet bomber.

Apart from models, many items cannot fail to be of interest to model engineers, from a historic viewpoint. Thus, there is a well-worn and slightly battered aerofoil section which was used by F. W. Lanchester in 1894, and was subjected to lift-tests at the National Physical Laboratory. There are interesting



180 *h.p. Compound steam engine of Sir Hiram Maxim's experimental aeroplane,* 1894. *(Photograph—Crown copyright. From an exhibit in the Science Museum, South Kensington).*

Right : *Stringfellow's model steam engine and boiler,* 1868. *(Photograph: by courtesy of the Director of the Science Museum, South Kensington).*



details and drawings of an aeroplane exhibition at the Royal Agricultural Hall in 1907, at which all the exhibits were in model form and occupied 87 stands. Some of these models appear to have been well ahead of their time in respect of design, and notable examples are Cochrane's corrugated aluminium flying machine, the H. A. Chubb ascensional-screw 'plane—a veritable twin-rotor helicopter with the rotors on a common shaft—and an A. V. Roe design which looks remarkably modern.

Many photograph enlargements are seen among the exhibits at Kensington, and include those of the Wright engine with its automatic inlet valves and surface carburettor, a wind tunnel used by the brothers in 1903, and the Maxim flying machine in position on its runway in 1894. It is interesting to note, incidentally, that the Wrights used an ordinary cyclometer as an engine revolution counter on their first flight.

This special section of the museum is likely to be open for a few months and is well worth a visit. And whilst on the subject of the museum, readers may like to keep in mind that the children's section at that fascinating building is of great interest from the modeller's standpoint, for here are to be seen many startling examples of craftsmanship in miniature, as well as expositions of the principles of many scientific and industrial processes.

In the children's section, incidentally, is another Stringfellow steam engine, made for a model aircraft which is reputed to have flown 120 ft. in 1848. A photograph shows a neat-looking monoplane with twin four-bladed airscrews.

IN THE WORKSHOP BY DUPLEX

REDUCING-VALVE for the MINIATURE SPRAY GUN

TO continue with the construction of the reducing-valve, the fitting of the next component, the diaphragm, is perhaps the most important part, for on it depends the proper working of the valve.

The Diaphragm

The diaphragm, which seals off the lower part of the chamber formed in the valve body, is made from brass shim material, 0.005 in. in thickness. This thin brass sheet can be obtained commercially in strips of various thicknesses, and $2\frac{1}{2}$ in. in width. The material is first marked-out in accordance with the drawing and, if the outer diameter is deeply scribed with the dividers, there will be no difficulty in cutting the part neatly to shape with a pair of curved scissors. But an irregular hole is almost certain to result if an attempt is made to drill the central hole in the ordinary way.

Holes in thin sheet material can usually be drilled cleanly by putting a centre-drill of the required diameter right through the work, but the following method, illustrated in Fig. 10, was used with success and a cleanly-cut hole was formed with an easily made press tool. A short length of $\frac{3}{4}$ in. diameter mild-steel rod is gripped in the lathe chuck and, after the end of the material has been faced, a recess, $\frac{5}{16}$ in. in diameter, is bored to a depth of $\frac{1}{8}$ in. to form the die. Next, a length of silver-steel rod, with its end squarely faced, is gripped in the tailstock drill chuck. If the sheet metal is now held centrally against the die, using the inner scribed circle as a guide, the punch can be put through by feeding the tailstock barrel forwards.

As represented in Fig. 9, the diaphragm *Ga* is mounted on the thimble *H* and is held between two heavily chamfered collars *Gb*; the upper collar then serves as a locknut. To ensure making an airtight joint, a thin card washer *Gc* is fitted on either side of the diaphragm and, in addition, a large card washer is placed between the lower surface of the diaphragm and the upper surface of the body.

Continued from page 249, *March* 4, 1954.

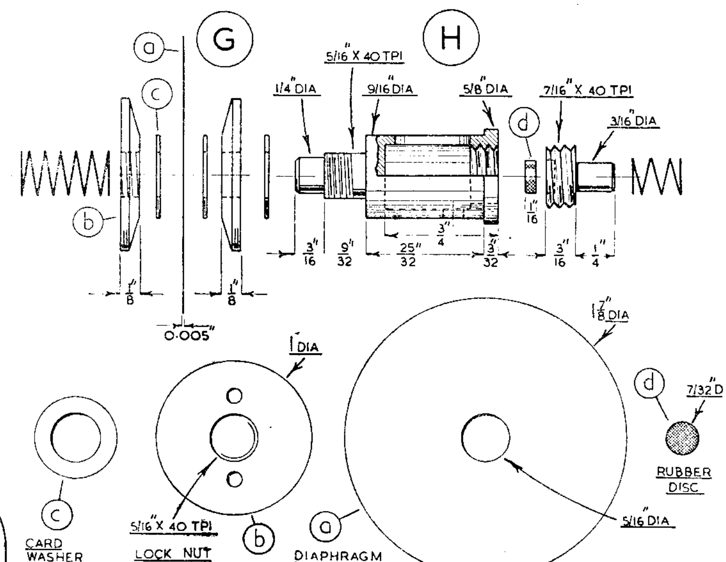


Fig. 9. *G—the diaphragm parts; H—the thimble fittings*

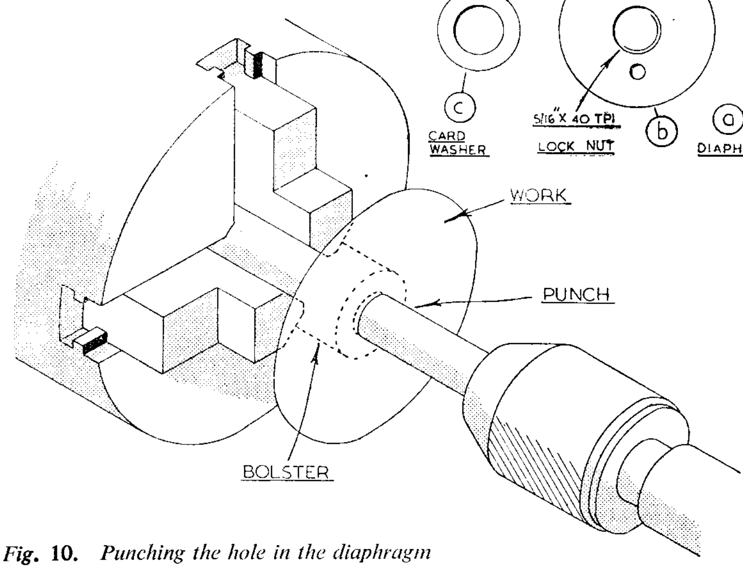


Fig. 10. *Punching the hole in the diaphragm*

The Thimble H

After the thimble has been machined to the dimensions shown, it is cross-drilled with a $\frac{1}{8}$ in. diameter hole after being marked-out when in place in the body, and on the inlet side, a window is opened out from this hole for the passage of the inlet nozzle *J*.

The register shoulder formed at its lower end serves to align the thimble and guide it in the body of the valve.

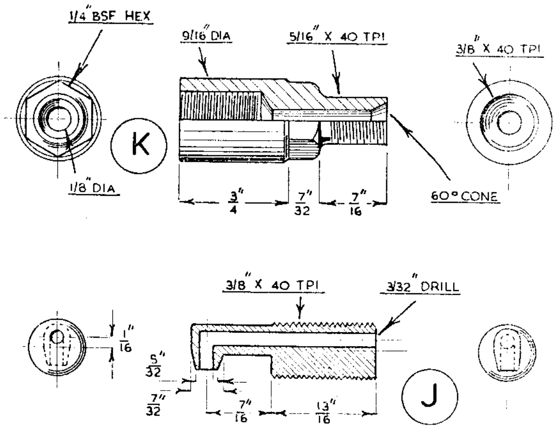


Fig. 11. J—the inlet nozzle; K—the inlet union

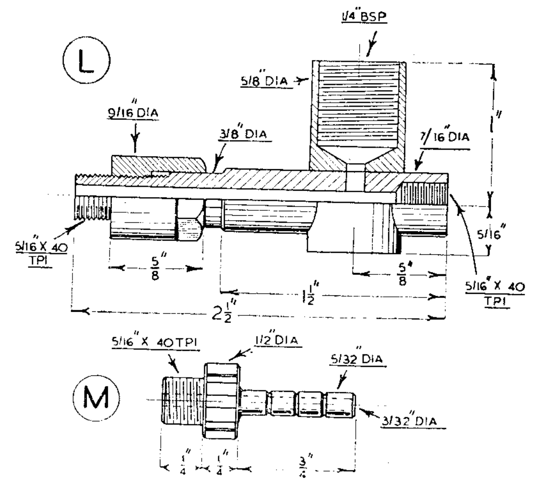


Fig. 12. L—the outlet nozzle and T-piece; M—the alternative outlet union

The threaded spigot screws into the lower end of the thimble, and is recessed on its upper surface to carry a rubber disc *Hd* for shutting off the main air supply.

The Inlet Nozzle J

As shown in Fig. 11, this part is drilled axially with a 3/32 in. diameter hole, located $\frac{1}{16}$ in. above centre.

This hole can be drilled and, at the same time, the neck of the nozzle turned eccentrically by setting the work in the four-jaw chuck, and the thread will not be damaged if the grip is taken on a sleeve of thin card. It is important to turn off the threads on the head of the nozzle as, otherwise, there may be difficulty in screwing the part into place in the body.

The inlet union *K* is formed with a coned end for connecting to the air line, and it also serves to lock the nozzle in place after assembly.

To assemble the valve parts, the base is removed from the body, and the thimble is located by means of a guide-rod passed through the outlet seating. After the nozzle has been screwed in to bring its air passage into the centre of the thimble, the nozzle is held in position by a length of rod inserted in the vertical air passage, and the inlet union is then tightened to secure the parts in place. In order to prevent any leakage of air along the screw threads, the nozzle and its union should be smeared with jointing compound before being screwed into place; for this purpose, we have found that rubber solution forms an effective seal.

The Outlet Union M

This part screws into the seating already machined in the valve body. The grooved end is turned to fit the rubber tubing conveying the air to the gun. Screen-wiper tubing has been found suitable for this purpose, as it is very flexible, but does not tend to kink and shut off the air.

Where a pressure gauge is fitted, the T-piece *L* is made to screw into

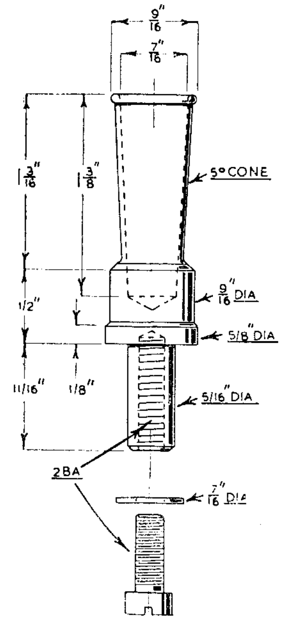


Fig. 13. The gun holder

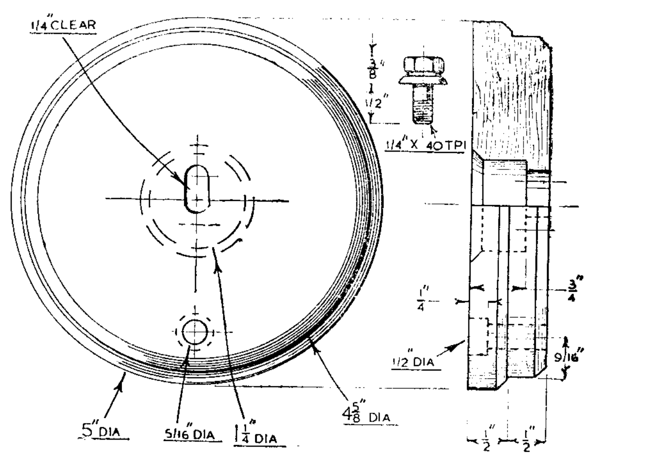


Fig. 14. The base for mounting the components

the valve body, and at the other end it carries the union *M*. To enable the position of the gauge to be adjusted, the threaded end of the T-piece is furnished with a threaded locking collar.

Mounting the Reducing-valve

If the arrangement shown in Fig. 1 of the previous article is adopted, the finished reducing-valve, together with the gun holder, is mounted on a wooden base. The holder shown in Fig. 13 can be turned from duralumin rod, and it serves to hold the gun upright when not in use. The wooden base, Fig. 14, can be easily turned by securing the material to the lathe faceplate with screws inserted from behind. This will also afford an opportunity of glass-papering and french polishing the finished base while it rotates in the lathe. For further effect, a circle of green baize can be glued to the underside of the base.

The Spray Gun in Use

To obtain a good finish on small fittings, instrument parts, and optical work, the cellulose or other paint used for the preliminary coats should be diluted by adding an equal amount of the appropriate thinning agent. For the final coat, the pigment should be further diluted so as to form only a 10 per cent. or a 20 per cent. mixture. This follows the industrial practice of spraying almost pure solvent for the finishing coat. With these diluted pigments it will be found that the gun gives a satisfactory spray with an air pressure of some 10 p.s.i.

It is always advisable to apply several thin coats of paint, rather than to attempt to obtain a good finish with a single thick coat; this practice also prevents the formation of paint runs or the so-called tears. The gun is also useful for shading drawings, and this can be done free-hand; but if the shading has to stop short at a drawn line, then a mask should be used to keep the paint from spreading beyond the required limit.

A piece of thin sheet metal will serve quite well for this purpose, when held in place with the hand at an angle to the surface of the paper, in order to keep the pigment from being sprayed under the edge of the mask.

However, a masking material, known as varnish paper, is made specially for this kind of work. When a strip of the masking paper is pressed down on the drawing, it will adhere to the surface of the drawing paper and, after the required contour has been cut out with a sharp knife, the unwanted portion of the masking is stripped off. Circular outlines can be cut in the masking paper by using a sharp-pointed pair of dividers and, when working free-hand, an ordinary sewing needle mounted in a holder will be found to cut through the varnish paper quite easily.

The shading can now be applied with the gun, and the remaining portion of the mask is afterwards removed. When shading drawings in this way, we have found that good results are obtained by spraying on a pigment made by mixing four or five drops of indian ink with two teaspoonfuls of methylated spirit.

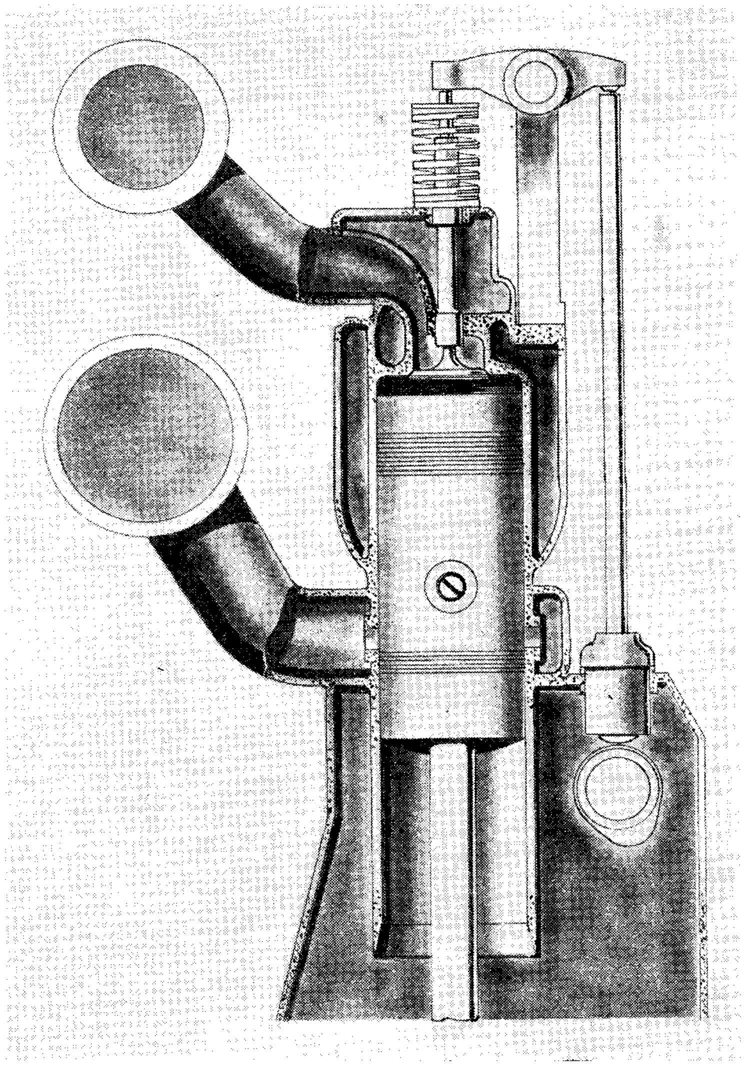


Fig. 15. Example of a drawing shaded with the spray gun

This preparation does not wet the paper and cause cockling and, moreover, it has the advantage of drying quickly. The drawing reproduced in Fig. 15 was shaded by this method, and it will be seen that a realistic appearance has been obtained.

By using the same method, blocking out the background, or other parts of photographs that have to be deleted for reproduction, is easily carried out when the gun is charged with a suitable pigment. Messrs. Winsor & Newton supply a wide range of pigments, specially prepared for photographic retouching when applied with a miniature spray gun of the kind described.

READERS' LETTERS

● Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, 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.

MODEL LOCOMOTIVE BOILER CONSTRUCTION

DEAR SIR,—Recently, two interesting and instructive articles have appeared in THE MODEL ENGINEER, representing two schools of thought, both trying to get around the difficulty of building single-handed such large model boilers. Mr. James Perrier, in the description of his boiler, probably shows the only way for an elderly man to tackle such a job, although I would prefer an *all copper* boiler; by his method of construction, the copper has not been burnt, or partly burnt, rendering the job unsafe, and giving the builder the feeling that, although the boiler had passed all pressure tests, one still has the feeling that all is not well.

Method No. 1

I am of opinion that we owe to Mr. Perrier a great deal for drawing our attention to that soft-solder called "Comsol," made by Messrs. Johnson Matthey, which melts and flows at 300 deg. C. I am sure most elderly men, who must of necessity take care of their health, will welcome such a useful material. I have found in the past that boiler building with a large blow-lamp can give one a nasty cold. I had never heard of "Comsol" before, but it should make a sound joint as a caulking material—provided that the joints are properly flanged and riveted to stand the internal pressure—with the added certainty that *no* part of the boiler had been *burnt*, or partly burnt, by the unskilled use of an oxy-acetylene torch. I congratulate Mr. Perrier on the successful conclusion of his job single-handed.

Method No. 2

I have an oxy-acetylene torch, but have not used it, owing to health reasons. From the Information Sheet No. 422 "The Welding of Sheet Copper Work," supplied by The British Oxygen Co. Ltd., I quote: "A bronze weld is obtained by applying to the joint the welding flame and a bronze filler rod. The metal of the sheets is not fused. The bronze penetrates to the underside of the copper sheets in the line of the weld, and the further deposit of bronze from the filler rod is added to reinforce the joint. Joints made with the bronze weld are stronger than any other type of joint, reliable execution is more readily obtained, and the joint can be made in any position *in situ*.

"It is not essential that deoxidised copper should be used with bronze welded work, since the parent metal is not brought to fusion point when making the weld."

Mr. H. E. White, who is well known to us at Malden for the fine performances of his engines, favours the welding form of construction, but his method is clever on account of the gradual building up of the firebox shell, not too large a mass of metal to be heated up after each operation. However, again we have to face the fact that the copper joints are only butted together. I am sure that Mr. White is able to do the job properly, and I congratulate him on his success—I have seen his engine under steam. Nevertheless, that does not mean that "Mr. Everyman" will, and can, do the same *without* damaging the copper plate by burning or partly burning it.

It, therefore, boils down to the fact that you "pays your money and takes your choice." A 5-in. gauge boiler at 100 lb. pressure can be a potential danger, so as the old song says: "*Beware, Be-ware*!" At Malden we have the same schools of thought. I have assisted to silver-solder with "Easyflow" No. 2 the outside joints of a 5-in. gauge boiler with a gas blowpipe and two blowlamps. I was, at the time, roasted in front and frozen at the rear—rather an appalling experience—it being hard enough to melt "Easyflow" No. 2 on the foundation ring and the backhead; so please drop the word *brazing*, as that may lead someone "up the garden path."

I can see no difficulties which cannot be overcome if an elderly man follows Mr. Perrier's method. A large blowlamp should be able to tackle the inside firebox, and tubes, etc., with the help of a young friend to give a hand with a smaller lamp to play the heat on the other side; "Easyflow" being used to do the job. The reason why Mr. Perrier's method may be recommended is because not many people are prepared to spend the sum of money to buy an oxy-acetylene torch. To see a man demonstrating with a large torch on a small job is, quite frankly, rather funny; but to finish the foundation ring of a large 5 in. gauge boiler and backhead is another matter, and very risky for a beginner on copper with an oxy-acetylene torch.

Yours faithfully,
London, S.W.16. F. WATSON.

SIMPLE STEAM ENGINES

DEAR SIR,—Mr. C. V. Thompson's dissertation on oscillating engines seems rather beside the point in connection with my design to which he refers and calls it an oscillating engine. The sole reason for my design was to *eliminate* the oscillating cylinder. It could be said that it has an oscillating piston, but if semi-rotary movement is oscillation, then every reciprocating part in any engine oscillates and there becomes no distinction in the use of the term.

He thinks my short stroke is a weakness. Short in relation to what? Since a model steam engine can be made of any size, one would think that a stroke could be of any length. If he means that it is short for its size, what is the "size" of a model engine? In any case, why is it a weakness?

Actually, the stroke in an oscillating engine, and in mine, is inseparably connected with port size and spacing, and in my case is exactly what is wanted for this, and could not be altered without altering something else. With spacing of stationary ports and travel of moving port settled, the crank throw (stroke) will be directly proportional to the distance of crankshaft from centre of oscillation compared with the distance of the latter from the line of the ports. In the case of an oscillating cylinder with piston-rod, no doubt a longer stroke is required than with mine where the crank is much closer to the piston.

If the stroke in my design were increased, the angular movement of piston would be increased, and port size and spacing would have to be greater. There would also be the objection of greater friction in piston rotation. Naturally, this semi-rotary movement must be kept to a minimum. Alternatively, the length of the radial arm on piston would have to be increased, and this leads to the only apparent weakness in my design; the fact that the thrust between piston and crank is not in axial alignment with the piston, thus tending to tilt the latter in the cylinder. Hence this radial distance must also be kept as short as possible. Only the extreme length of the piston saves the situation, and this is assisted by the very high surface finish of piston and cylinder bore. I should say that if this radial arm were longer than half the length of the piston there would be strong tendency for the latter to jam in the cylinder, and the greater the power of the engine (load on piston) the greater would be this tendency.

Two other points in Mr. Thompson's letter remain. Double acting "effect" *is* necessary to eliminate idle strokes or dead centres; my design makes a double-acting cylinder simpler than two single-acting ones, contrary to his implication. The spring to keep sliding faces of an oscillating engine in contact will only allow steam to escape if too weak, acting like a safety valve. Since steam tends to force these apart, *something* is necessary to keep them in contact, and a resilient means will keep them more steam-tight, and for longer, with the minimum required pressure than any rigid system, such as the pointed pivot on the other side of the cylinder.

Yours faithfully,
Snaresbrook. C. H. CLARKE.

ANOTHER "BRITANNIA"

DEAR SIR,—It is with great pleasure that I write to congratulate "L.B.S.C." on the excellent job he made of designing "Britannia" in miniature.

From the photograph reproduced herewith, you can see my attempt to bring his design to life, and I have every satisfaction in the way that she performs and her life-like appearance. She has now run approximately fifty hours and has done passenger-hauling continuously for eight hours without losing steam. Her heaviest load was over a ton, consisting of eight hefty men, five twelve-year-old boys and myself driving. This performance was witnessed by a large crowd of people in Sophia Gardens, Cardiff, during the exhibition last November.

Construction was started on Whit Monday, 1952 and due to the usual domestic troubles, was programmed in a rather unorthodox way (I dare not let the better half know that I intended building her, *Dyak* only being completed the week previous, in twelve months). The fabrication went in the following order, pony truck, bogie, rear frames, cylinders (from solid), water pump; then the secret leaked out and so the main frames took shape.

As I had little spare cash, the only castings used were wheels and guide-bar brackets; all the remaining parts were fabricated with the aid of a five-pint lamp, which, incidentally, resulted in my killing a tank of very fine goldfish, thereby bringing on more domestic disturbances!

The boiler is to "L.B.S.C.'s" "words and music," but the copper used was of a much heavier gauge, resulting in a very heavy engine which gives good adhesion and has proved to be a very free steamer. She has to be carefully fired to prevent constant blowing off.

The pony, bogie and tender springs are made from used bandsaw, with the teeth ground off, and give really excellent springing without any heat treatment.

The tender is now completed, and I trust "L.B.S.C." will forgive me for adding the pimples—a few of them can be seen in the photograph—but after seeing the *Rising Star* in Newport Station, I could not resist adorning little sister.

Her first passenger-hauling run in public was on June 20th, 1953, and to date it has not been necessary to make any adjustments, which I think is primarily due to the excellent design. Note that the engine was built in fourteen months, and, therefore, must have been among the first to run.

Yours faithfully,
Cwmbran. JOHN SMITH.

DANGEROUS CHEMICALS

DEAR SIR,—I note in a recent issue of THE MODEL ENGINEER, a letter about carbon tetrachloride as a cutting lubricant and the dangers attending this practice.

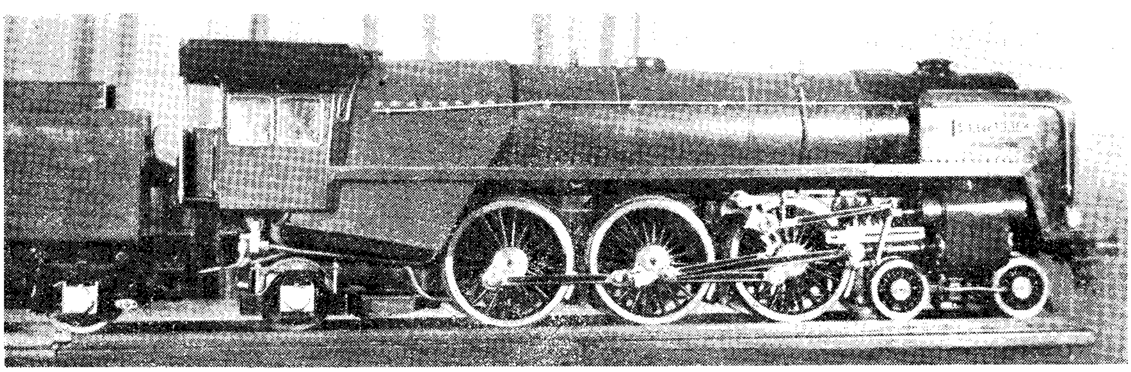
A further danger to those set out by "Arty" is the liberation of phosgene poison gas when C.T.C. is heated, and I would say that a cutting-tool can be a source of very great heat, especially when machining stainless-steel.

The vapour concentration which can be dangerous is very small—some 50 parts in a million of air—thus you will soon see that efficient ventilation is necessary.

Another dangerous substance can be found in metal rectifiers of the selenium type, and where so many of these small d.c. motors which are obtainable ex-Government are used from a rectifier, it is as well to protect the rectifying apparatus with fuses, as any load in excess of its rated current will burn out the rectifier, and apart from a very bad smell, almost like putrid cabbage, the fumes are dangerous.

Don't be tempted to dismantle the rectifier to see if anything can be done about the fault, as handling the burnt selenium can cause a burn very like a caustic burn. If you do have a selenium rectifier burn up on you, pitch it out and replace it with a new one.

The fumes are toxic, and the maximum safe concentration is 0.05 parts in a million of air.



An example of how easy it is to burn up a rectifier was brought to my notice last year, when I was asked, in the course of my work, to repair a small trickle charger which had been in use for one night and the battery, which had its positive to chassis, had been charged backwards, that is, the positive charger lead had been connected to the negative stud. The battery recovered when it was properly charged, but a new rectifier had to be fitted before the trickle charger would work.

The foregoing may be a bit dismal, but forewarned is forearmed, and as a bit of light relief, the gentleman who inquired after a "Popsie" may find that a soft furnishing dept. is a more likely place than a hardware store. He is also likely to find these commodities are an extremely expensive purchase and even more expensive to maintain. My advice is, let well alone, especially if you have a "trouble and strife." !

Yours faithfully,
Aldeburgh. E. C. WRIGHT.

CLEANING PARAFFIN

DEAR SIR,—In the issue of THE MODEL ENGINEER for January 28th, 1954 a reader inquired how to filter used kerosene (paraffin). I have been filtering and reusing my kerosene for a long time, and the saving resulting from this justifies the slight amount of effort involved. I believe my method is easier than the one suggested.

I purchase chemical filter paper, which is surprisingly inexpensive. These sheets are furnished in Circular form. I take one sheet and fold it in half and then half again. The circular edge remaining is then opened, leaving one thickness on one side and three thicknesses on the other. This forms a conical filter which will fit in a funnel. Slight variation in the angle of the last fold will make the filter fit exactly to the funnel. The dirty kerosene containing chips, abrasive, etc., is poured through this filter and the chips and abrasive materials are completely removed. This is a filtering procedure in everyday use in chemical analysis. Oils will pass through, but this does not present much of a problem, since addition of fresh kerosene from time to time is necessary, anyway. The filtering process can be going on while other work is carried out, and requires no time and no power.

Yours faithfully,
WARREN W. LACEY.
New York, U.S.A.

Trade Topics

ROZALEX BARRIER CREAMS

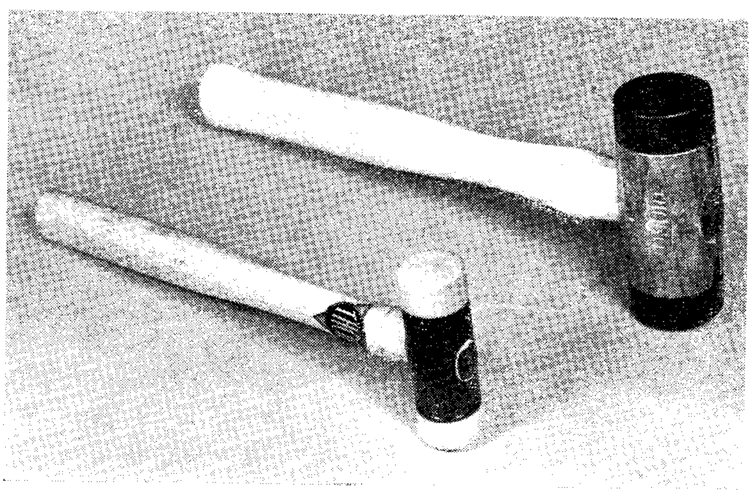
Soiled, grimy and roughened hands are often inevitable in model engineering, and efforts to clean them by the use of abrasives or detergents, apart from being only partially effective, are undesirable because they destroy the natural oils of the skin, and may lay the foundations of dermatitis. For some years now, the problem of safe and effective skin cleansing has been given considerable attention in industry, and the name of Rozalex has become well-known in connection with preparations for this purpose. These now provide a complete service for protecting the hands against all kinds of contaminating substances including irritants, corrosives and stains, which have to be handled industrially.

The Rozalex barrier creams now available comprise the following: *No.* 1, for "dry" work, including coal, soot, metal dust, oils, tar, paint, etc. *No.* 2, for "wet" work, including aqueous solutions, weak acids and alkalis, soluble oils, alcohol-base solutions, and certain types of paint and varnish. *No.* 8, for protection against strong acids, alkalis, and certain organic solvents. All these should be applied before starting work. In addition, preparations for use after work are recommended, including Lanolin cream, to combat skin dryness which might cause cracking or chapping, and ointments Nos. 3 and 4, which are respectively greasy and non-greasy in character, the first for replacing depleted skin oils, and the second for penetrating into the tissues where chafing or irritation has already occurred.

We have given these preparations a prolonged trial and can endorse the claims made for their effectiveness. Further advice on their use, or on any problems connected with skin protection, can be obtained from Rozalex Ltd., 10, Norfolk Street, Manchester.

SOFT-FACED HAMMERS

One of the distinguishing features of the true craftsman is the care he takes to avoid burring, bruising and scratching of finished surfaces in assembly and dismantling of machinery. The use of wooden and soft-metal mallets has long been recommended for such purposes, but the choice of materials available for the contact surfaces of hammers and mallets has now been considerably widened. The range of "Thor" hammers and mallets now includes lead, copper, hardwoods, lignium-vitae, rawhide, semi-hard rubber, etc., to suit all classes of work; the term "mallet" generally implies that the head is made entirely of one material, while a "hammer" usually has a metal head with replaceable inserts of softer material, thereby combining mass and inertia with shock-absorbing properties. A mallet is generally used when the maximum area of contact face, or the minimum weight of blow, is required. "Thor" tools to suit every purpose from light panel-beating to heavy assembly work can be obtained from tool dealers everywhere, or from the makers, Thor Hammer Co., Salop Street, Birmingham.



Notes on LATHE DESIGN

By "G.E.S."

BEFORE proceeding to give an illustration of the use of the formulae already mentioned, a word is desirable about the machining methods.

In each case, the design is worked out to allow of simple operations. In the case of the bed, after machining the underside to a good finish, the whole of the top can be machined without any extra setting, given a small planing machine, with cross-slide, and side tool boxes. If the machining can be done at two separate operations, all the better, as this allows for seasoning.

The headstock is designed to machine on a small milling machine, using a boring bar made as mandrels fitted to the machine. Using "Widia" cutters, a very fine finish can be obtained, and if a batch is being done, it is easy to produce accurate sets. The base is machined by fitting a mandrel to the bored holes. This having two equal bearings, is mounted in vee-blocks on these and planed on a shaper or planer (if planer, both tailstock and headstock can be machined at one setting.)

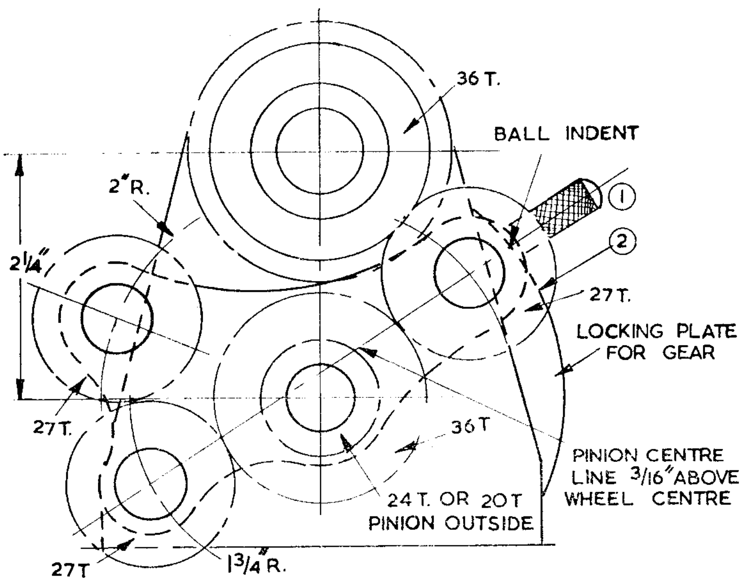
For home production, it is best to machine the base of the headstock, and then work from this by careful measurement. Given care, an error of only a few thou. is possible, which can be easily adjusted by scraping to a proof bar set up in the headstock. A length of 18 in. out of the headstock, with an error of five 10-thou., should be "near enough" for any critic.

The headstock bushes are a two-operation job. First rough all over, leaving 1/64 in. inside, and about the same outside when machined all over. (Note: the pattern for the bush should have double thickness on the collar to give density to the bush; this is machined away first.) Then lay aside in the dark to season, (arrange operations to allow of no lost time). After seasoning, chuck the bushes by the flanges. Set to run true, and proceed to machine bore and outside in turn, using light cuts with finely honed "Widia" tools. Use the highest speed possible; with light cuts, this speed should produce a hard glaze which is the finest surface to lap to fit, and is the finest surface for a bearing, given good clean metal.

The bore should just not enter; an allowance of one thou. is enough if the finish is good. Outside diameter of bush should give a medium interference fit, sufficient to allow of the bush being pressed home with *light* pressure; obviously, any heavy pressing will distort the bore. As suggested, perfectly circular bores are practical. Once both bushes are home, they are lapped to line and to fit, using either lead-filled copper laps or lead laps ("Westbury" type, only two in one bar). This lap is run in between centres while holding the casting in the hands. Lapping is no mysterious process, nor is it an extravagant one. In mass production, quite an ordinary lathe can be fitted with professional laps, and unskilled labour will produce good results under supervision. The mandrel, as already noted, is also lapped until a fine running fit is achieved. Using fine Vitrea lubricating oil, such bearings last indefinitely.

Now let us see how these facts work out in practice. Take as example three popular sections of model engineering: ½ in. scale locomotive work, 6 to 30 c.c. petrol engines, 1-in. scale traction engines. A lathe capable of tackling these should have speeds from 1,200 r.p.m. (for all fine parts and drilling) down to 25 r.p.m. (for cast-iron wheels and parts). The diameters required are up to 7 in. diameter, and down to 1/16 in. in drill sizes, with possibly a No. 78 drill as a lower limit if injectors are made. A 3½-in. lathe made to the proportions above will tackle all these without difficulty. Here are the sizes worked out: Bed—Width 5½ in., depth 4½ in.,

Continued from page 271, March 11, 1954.



THE CENTRES ARE ALL FOR 18 D.P.
REDUCE DISTANCE FOR 20 D.P.

		18 D.P.	20 D.P.
P.D.	36 T.	2.0"	1.8"
	27 T.	1.5"	1.35"
	20 T.	1.111"	1.0"
	24T- 6T.P.I. LEAD SCREW	—	1.3"

Reverse Gear

front strip $1\frac{1}{2}$ in. wide square edge $\frac{7}{16}$ in. thick. Rear shear, 2 in. wide carrying the tailstock. Vees, 60 deg. Headstock—Main bearing, $1\frac{5}{8}$ in. diameter, $1\frac{3}{4}$ in. long and having nose to mandrel $1\frac{1}{2}$ in. diameter and with thread 12 t.p.i., the tail bearing, $1\frac{3}{8}$ in. diameter. The mandrel end diameter is $1\frac{1}{4}$ in. diameter, and the pulley bearing is $1\frac{1}{2}$ in. diameter.

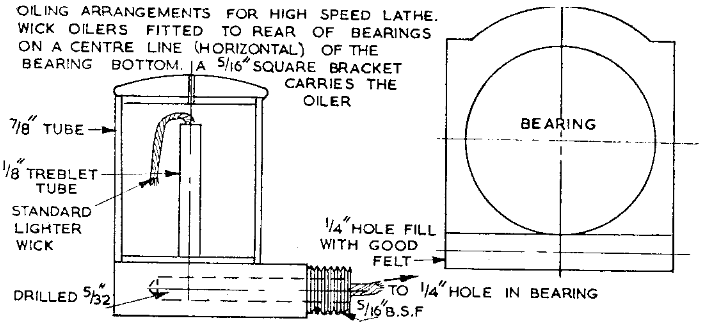
The $1\frac{1}{4}$ in. diameter tail carries a pinion, if gear drive, or $\frac{3}{8}$-in. vee-pulley if belt drive to apron, with a 20 thread $\times$ $1\frac{3}{16}$ in. bore lock-nut, and if desired, either a fibre thrust washer or a light ball thrust race. The drawing gives all other details. (Note sections of castings).

The speeds and the pulley sizes based on them are important, so fuller details are given. It will be found that for the speeds suggested a ratio of 30 per cent. is suitable, i.e. each speed after the first will be 7/10 of the former one. Here are the speeds :—

1200	411	141	48
840	288	92	34
588	201	61	24

These are worked to the nearest whole number.

The four columns give our sets of speeds. Column 1 gives highest direct belt drive. Column 2 gives second direct belt drive. Column 3 is our highest belt speed with back gear in, and Column 4 is slowest belt speed with back gear in. Thus dividing speed one by speed seven gives the ratio of our gears. Checking this by dividing set 8 into set 2 we get our ratio of just over 9. Since fractional numbers are a nuisance in calculating gear ratios, we take the whole number 9. Now note that in working out the speeds, a fraction of 7/10 is used. Our pulleys must comply with this fraction. First the headstock pulley—this has to fit in the space allowed, and provision must be made for belt changing, so our size is limited. Secondly, our smallest pulley must bore out to $1\frac{1}{2}$ in. so again a limit is set; $4\frac{3}{4}$ in. as the largest size will just allow for clearance for a $\frac{3}{8}$-in. vee-belt. From this, using our standard fraction (7/10), we calculate the small pulley size, divide $4\frac{3}{4}$ in. by 10 and multiply by 7 equals 3.325 or say in round figures $3\frac{5}{16}$ in., which is a suitable size to bore to $1\frac{1}{2}$ in., allowing for a vee groove. The middle pulley will be the average between the two. The countershaft pulleys are calculated from the middle speeds in columns 1 and 2,



i.e., 840 and 288. Taking motor speed as 1,440, we get the ratio as 1,440 to 840 and 1,440 to 288; or say 12 to 7 and 5 to 1. Allowing for a 3-in. motor pulley, this means 12/7 of 3 in. for one pulley, and five times 3 in. for the other, or $5\frac{1}{2}$ in. and 15 in. diameters.

The back gear, being epicyclic, has to be worked out from a simple formula. Stated as an equation it is—required two numbers whose squares expressed as a fraction (the lesser over the greater), and taken from *one* gives another fraction which when reversed give a fraction whose proportion is equal to the given ratio.

As in all gear workings, some give and take must be allowed, but by careful estimating, a very close result is possible. Before calculating, one more factor has to be considered: How much room is available for our gear; and from this, what number of teeth per wheel is desirable? In the present case, all the wheels would be classed as pinions, being below 36 teeth; this is our starting point. By trial we can establish that 35 squared and 33 squared used as a fraction, give:— $\frac{1089}{1255}$ deduct from $1 = \frac{136}{1255}$ or $\frac{1}{9}$ approx.

Therefore, our pinions will be 33 teeth and 35 teeth, with 18 d.p. The drawing shows the general layout; the construction of this gear is not difficult, but the workmanship must be very good. Each pinion must be well and accurately cut to fine limits, and the centres for the gears set out by the toolmakers' button method. But given these precautions, the gear will work quietly, and give lasting service. The actual gearbox enclosing the gear should be made oil-tight and have a flange to bolt to the large countershaft pulley. Both these countershaft pulleys should be of best dry hardwood, the larger built in segments on to the smaller, the whole unit dowelled together, and the gearbox bolted to it.

For drive, a $\frac{1}{2}$-in. vee-belt is specified for the motor drive, and a 10 mm. or $\frac{3}{8}$-in. vee belt for the headstock drive. Two belts will be needed for the countershaft, or the smaller pulleys can be worked out to use the same belt (formula according to Rankin).

Should anyone be in doubt, as to the construction of this gear, fuller notes will be given, but the drawing should give all the information required. (If in doubt, make a dummy up from spare pinions.)

The tailstock for this small lathe should have a barrel at least $1\frac{1}{8}$ in. diameter, and a travel of $4\frac{1}{2}$ in. at least.

The locking device for the tailstock need be no more elaborate than a pressure bolt against a gib on the rear shear. Micrometer cross adjustment can easily be fitted, using a $\frac{3}{8}$ in. $\times$ 20 thread screw.

For those fitting screw-cutting gear, an unusual type of reverse is drawn. This requires a fraction of the effort required with the ordinary three wheel gear and is simple to produce. In practice, to save space, 20 d.p. wheels are quite strong when well made in good gear steel. The frame can be made from a plain piece of bright mild-steel, with the handle built on. The setting-out of the centres is easy to do, if buttons are made to pitch diameters of the gears. A relief space of not less than three teeth is desirable between disengaged pairs of gears. Bronze bushes are desirable to all bearings as being simple to renew; Oilite bushes are obtainable in standard sizes. The drawing shows the outline of a larger type.

The general details of this small lathe can be gathered from the drawings, copies of which can be supplied full size for use by model engineers or clubs. Manufacturing rights are strictly limited, and must be applied for, as these notes are the fruits of ten years research plus 30 years experience.

(Continued on next page)

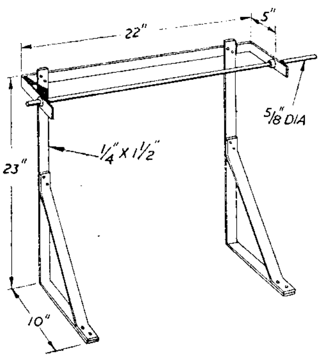
QUERIES AND REPLIES

"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.

Power Shaft for Workshop

Will you please advise me about the layout of power equipment in a small home workshop. I propose to install on one bench against a wall and under a window (a) a small grinder for twist drills and lathe tools; (b) a



$\frac{1}{4}$-in. "M.E." drilling-machine; and (c) a $\frac{3}{8}$-in. Cowell drilling-machine. Is it possible to run all three of these off a single $\frac{1}{2}$-h.p. motor which I have available? I have a small countershaft unit, consisting of a bracket, $\frac{1}{4}$-in. $\times$ $1\frac{1}{2}$-in. steel strip, carrying a $\frac{5}{8}$-in. shaft 30-in. long in bronze bearings placed 22-in. apart, as shown in the sketch.

R.M.H. (Guildford).

This scheme is quite practicable, and many amateur workshops are arranged to use one motor as suggested. In the great majority of cases, no special arrangements are made for disconnecting the machines which are not required for use, as it is a comparatively simple matter to slip the belt on and off as required. It would, however, be practicable to fit friction clutches to the driving pulleys on the countershaft, if it is required to have the machines under instant control.

It is generally advisable to locate the grinder as far away as possible from other power tools, in view of the risk of abrasive dust getting into the bearings, and with the ordinary arrangement of drilling machine drive, it is found convenient to place the drilling machine on the end of the bench to avoid the necessity of an awkward run of the belt.

The countershaft unit shown in your sketch seems to be somewhat flimsy, and we should prefer to see it well braced in both directions; also, the use of self-aligning bearings would be advisable to prevent any possibility of the alignment being affected by deflection of the supports. Apart from this, however, it should be quite suitable for your purpose.

Eureka Clock

I propose to attempt the construction of a Eureka Clock, details of which I understand were published in THE MODEL ENGINEER *a few years ago. Will you please advise me of the dates of issues in which the articles on this clock appeared, or alternatively, whether drawings and instructions can be obtained.*

L.G.A. (London, S.E.9.).

A series of articles on the construction of a "Eureka Clock" appeared in the following issues of THE MODEL ENGINEER: February 3rd and 17th, and March 3rd, 17th and 31st, 1949. Unfortunately these issues are now out of print, and we are, therefore, unable to supply them. You may, however, be able to gain access to these issues through your local model engineering society, and we, therefore, suggest that you get in touch with the Kent Model Engineering Society.

The secretary is: F. H. GRAY, 73, Sangley Road, Catford, S.E.6.

Air Compressor Motor

During the cold weather I have been testing a newly-coupled compressor unit driven by $\frac{1}{4}$ h.p. a.c. electric motor of the repulsion-induction type, having a face commutator with brush gear and a centrifugal starting switch.

The motor often failed to run up to the required speed when on load, and I presumed it was due to low mains voltage. I have endeavoured to improve matters by adjusting the brush position, but this only made it worse.

K. S. (Orpington).

The most likely cause of the motor failing to attain its proper speed is gumming up of the working parts of the compressor, as all oils are bound to become, to some extent, more viscous in very cold weather, and would, therefore, cause considerable oil drag.

This might be improved by using a special low temperature oil for winter use.

Other than this, it is possible that the lowering of the mains voltage would also affect motor speed to some extent. As the motor is of the repulsion-induction type, it is extremely unlikely that alteration of the brush position would be helpful, assuming that this was correct before the trouble was observed.

Notes on Lathe Design

(*Continued from previous page*)

There is nothing startling or unorthodox in the design; all that has been done is to produce a machine which, when once correctly made, will stay so indefinitely.

One more word as to costs. Allowing castings to, say 100 lb. weight, this will cost approx. £12 5s. in best high duty metal. The mandrel will weight 10 lb. and at 1s. 3d. per pound accounts for 12s. 6d. A sound idea is to use modern kiln dried hardwood for the pulleys on the headstock. The screw-cutting gears for the reverse gear would cost 30s. at least, and the gears for the epicyclic back-gear, approx. £2. Much of the mild-steel any engineer will have, but one item will prove expensive today: Allen set-and cap-screws, which are used everywhere as superior to ordinary ones; 10s. will cover these.

Now it is hoped that sufficient has been written to show how a lathe should be built. Anyone wishing further guidance or help may write in, in the usual manner. Patterns can be used at a simple fee, and help given with castings at present according to the economic situation. If any number prefer a certain size of lathe, new patterns would be made and arrangements for the supplies in rota made.