THE MODEL ENGINEER

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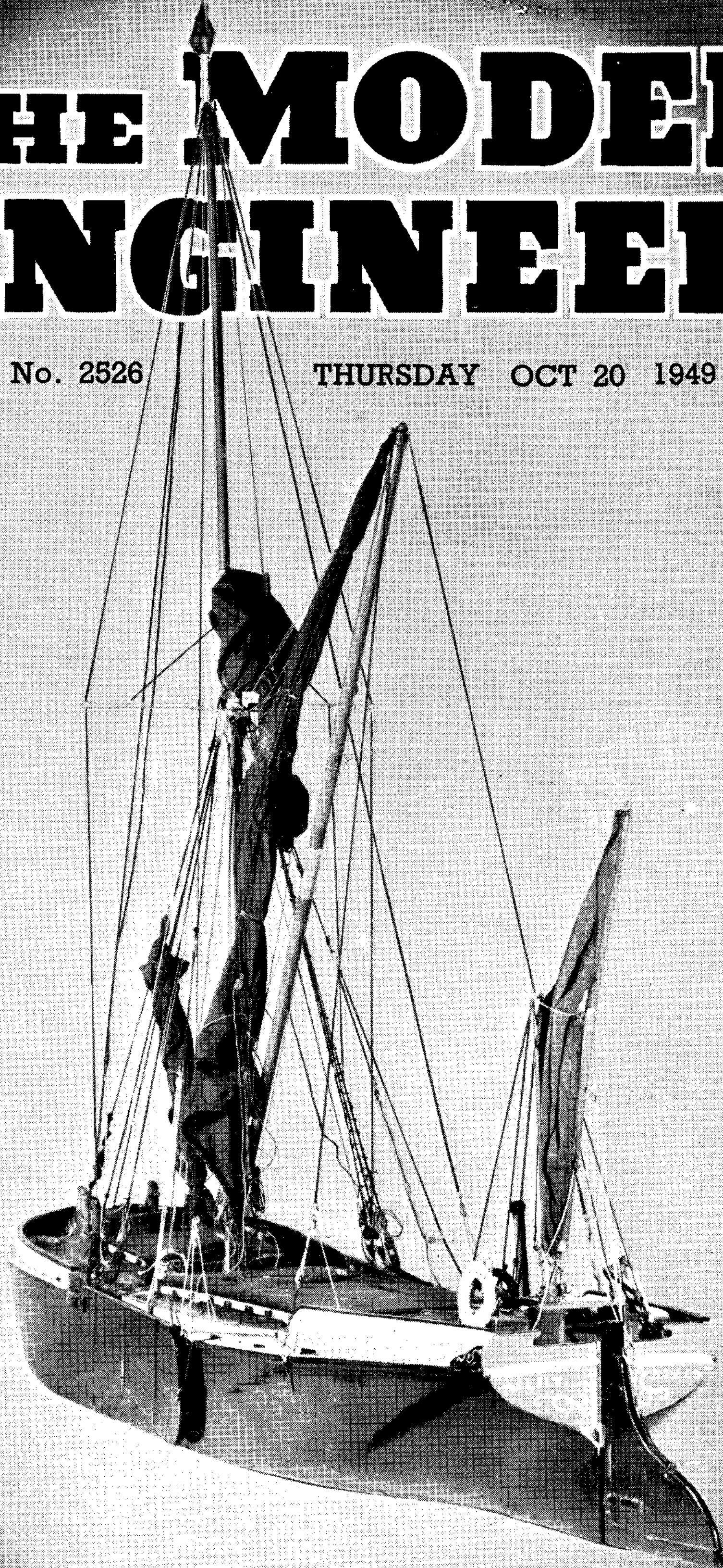


The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

20TH OCTOBER 1949 VOL. 101 NO. 2526

SMOKE RINGS

Our Cover Picture

● FOR OUR cover picture this week we have used a photograph of the working model of a Thames Barge which was entered by Mr. J. J. Starkey, of Southend-on-Sea, in the recent MODEL ENGINEER Exhibition, where it was awarded a Very Highly Commended Diploma. This was a very fine model, finished in the robust style typical of these grand ships, and which is eminently suitable for a model which has to stand the somewhat trying conditions encountered at the pondside. The hull is about 4 ft. long and has a displacement of about 50 lb. When in use she is fitted with a false keel which weighs nearly 40 lb. The interest and pleasure Mr. Starkey gets from his model is shown by the fact that he frequently brings it up to London on Sunday mornings and spends the day sailing it on the Round Pond. The writer has seen it in action and it makes a very fine picture, especially if there is anything of a breeze. Mr. Starkey tells me his only regret is that he built it before he saw Mr. March's recent book on the *Sailing Barges of the Thames and the Medway*. If he had seen this book before he built it he would have been able to make his model even more representative of its prototype.

The Festival of Britain, 1951

● DURING the course of the "M.E." Exhibition, we were approached by the Council of Industrial Design, the official body engaged in the organisation of the forthcoming Festival of Britain, with a view to arranging for representation of model engineering in its various branches at the Festival. We were very pleased to be able to convene a meeting of representative clubs at the Exhibition for discussing the most suitable means of putting this proposal into effect, and advantage was taken of the presence of representatives of the several interested bodies in the model engineering world.

At the outset it should be explained that space on the site of the Festival on the South bank of the Thames will be very limited, and it is not contemplated that any considerable exhibition of models can be staged there. The idea is rather to show a small selection of representative models (which can be changed periodically) to whet the visitors' appetites, and then to furnish details of events such as exhibitions, regattas, flying meetings, track-runs, etc., which might be running in various parts of the country at that time, and to which access could be given. By this means, visitors from overseas would be introduced to the activities of British model engineers, which are somewhat unique, since in no other country is spare-time craftsmanship practised to such an extent as in Britain.

With about eighteen months to go before the opening of the Festival, there is time to plan a comprehensive campaign, in which all can co-operate. Such an opportunity of putting our hobby before such a widely-drawn gathering of people, has surely never previously occurred, and if the thing is handled properly it can only prove to be of considerable benefit to model engineers throughout the country.

It should be clearly understood from the outset that whatever is done will be done on a national scale, and that no sectional or local interest will be allowed to predominate. The way is open for each and every one of us to make the best use of this opportunity, and suggestions as to how best to tackle the matter will be cordially welcomed from societies, clubs, groups and "lone hands." These will be carefully considered, and from them it is hoped to draw up a comprehensive plan for submission to the organisers of the Festival.

This is probably the first occasion upon which our fraternity has been accorded recognition from official quarters and as such it calls for the best effort we can make.

At the moment nothing definite is known as to what facilities will be available at the Festival site, but suggestions have been made as to the possibility of a passenger-carrying track, and a small pool for marine models. Also, it may be possible for part of the Serpentine in Hyde Park to be reserved for boating events.

Please give this matter your earnest consideration and send any suggestions you may care to put forward, together with an intimation of your willingness to participate in this event to the undermentioned :—

For general engineering and passenger-carrying locomotives and tracks : Mr. A. B. Storrar, 67, Station Road, West Wickham, Kent ; For model power boat interests : Mr. E. T. Westbury, 10, Oakhurst Rise, Carshalton Beeches, Surrey ; For miniature railways : Mr. G. P. Keen, Upalong, Cliff Road, Hythe, Kent ; For model aeroplanes : Mr. E. F. H. Cosh, 35, Maple Crescent, Sidcup, Kent ; "Lone hands" : Mr. W. R. Dunn, Halcyon, Rersevoir Road, Elburton, nr. Plymouth ; Model yachts : Lieut.-Commander J. H. Craine, R.N.R. (Retd.), 271, Scott Ellis Gardens, St. John's Wood, N.W.8.

The Craftsman and His Tools

● THE FACT that high-class production in modern industry is very largely dependent on elaborate machine tools and other equipment is sometimes apt to create the impression that a similar state of affairs exists in model engineering, and that expensive tools are absolutely necessary for producing good models. The beginner seeking advice on workshop equipment is often told that it is impossible to do good work on a simple and inexpensive type of lathe—this is a very dangerous and false doctrine. Indeed, if it were true, there would be comparatively few model engineers among what are officially termed "the lower income groups." Without, in any way, deprecating good tools, and good lathes in particular, they are not the most important things in the model engineer's life. The latter, if he is really determined, will make the best of his limited equipment, however inadequate it may appear. Statistics gleaned from the entry forms of several MODEL ENGINEER Exhibitions have proved that by far the majority of models entered are built with the aid of simple, and even primitive, equipment, and this includes many models which have won high awards. It is, in fact, the exception rather than the rule for the worker with a highly elaborate workshop equipment to achieve distinction as a model engineer, and possibly the reason for this is that model engineering can only thrive as a hobby when it presents a constant challenge to the resources, determination and ingenuity of the worker. Many veterans, whose names are now familiar to all our readers, started their model engineering career with little or nothing in the way of equipment, but by improvising and contriving and adding to their stocks of tools as finances allowed, they have acquired the means to progress to better and better models. In all model engineering success stories, we find the spirit of adventure, the urge to overcome obstacles and blaze new trails. The man who waits until all conditions are favourable and the right tools are placed in his hands is hardly likely to become a successful model engineer.

Whose Launch ?

● WE HAVE had a further letter with regard to the above query which was raised in our issue of August 4th. This is in addition to those referred to in "Smoke Rings" in THE MODEL ENGINEER for September 29th, and supports our remark that there appears to be more steam launches on the river than we thought. Here is the letter—which is from Mr. S. P. Clements, of Sunbury-on-Thames :—

"Your reader, Mr. R. Nicholes, of Hayes, may be interested to know that while looking for a sailing dinghy, I chanced to call at a boathouse just below Walton Bridge (Roswells) and there in a secluded backwater behind the boathouse I found a collection of boats that would delight the eyes of any 'steam enthusiast.'

"The attendant told me that until a few weeks ago, they had four 'steamers' tied up there, but the smallest, *Downside*, measuring some 8 ft. overall, had been moved.

"Still moored, and used regularly, the three remaining boats are the *Erg*, 10 ft. long approximately, with an oil-fired burner and Stuart Turner single-cylinder engine—hull painted grey—clinker-built ; *Oxbird*, and 18 ft. mahogany carvel-built launch again oil-fired, with a Stuart Turner two-cylinder compound engine ; and the *Churr*, originally the *Mabs*, about 24-26 ft. long with cabin aft, and oil-fired boiler and beautiful mahogany lagged two-cylinder compound engine amidships.

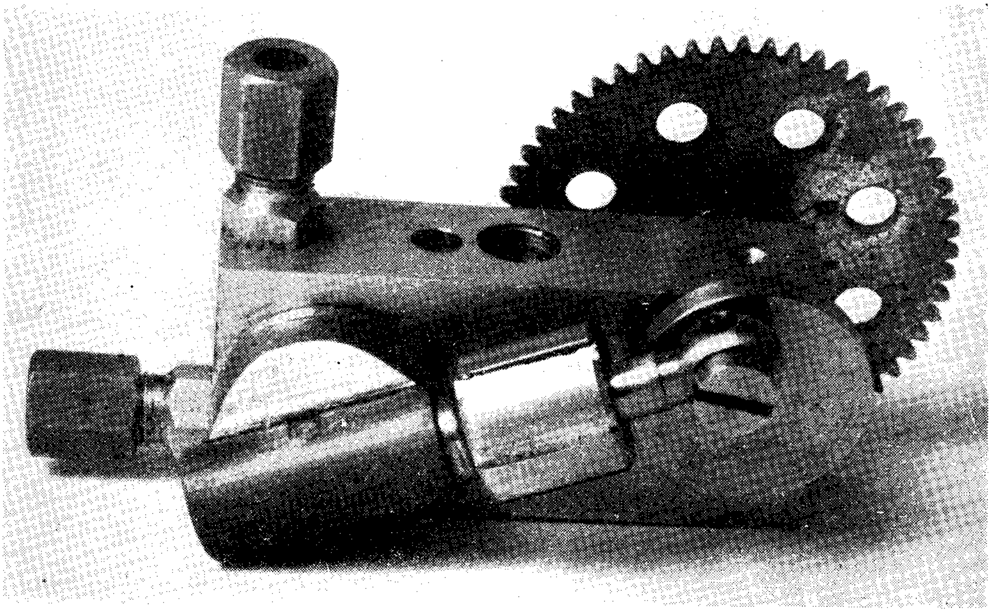
"I feel sure the attendant would be pleased to furnish the owners' names to your reader, if he cares to call, and should it be a Sunday morning, he will see them with steam up, and possibly under way. All launches have brass 'spouts'!"

*UTILITY STEAM ENGINES

by Edgar T. Westbury

I HAVE constructed several types of oscillating pumps for dealing with various fluids, and have found them capable of working quite reliably at pressures well above those likely to be required for feeding water to a small boiler. In the example illustrated, one or two small but important detail modifications have been introduced to make it suitable for pumping water, port block. The most important improvement, however, is one that is not seen from the outside, namely, the provision of a capillary oil seal, which not only ensures continuous lubrication of the face surfaces, but also eliminates leakage at this point.

From the enlarged detail view of the port block, it will be seen that a circular oil groove is



An enlarged view of the experimental oscillating feed pump

for which purpose it has proved entirely satisfactory, despite its small size, $\frac{3}{16}$ in. bore by $\frac{1}{2}$ in. stroke. The most noticeable differences in the design are the abolition of the usual loading spring on the trunnion pivot, and the large circular "trunnion block" integral with the pump barrel, which acts as a pressure sealing face, in contact with the stationary port block.

The spring usually employed to hold these faces in contact is undesirable in this particular case, because having to resist the full delivery pressure of the pump, it would have to be relatively strong, and would therefore create considerable friction except when partially balanced on the delivery stroke. Its place is taken by a positive thrust adjustment, incorporating an accurately faced washer and two locknuts, adjusted to take up all end-play between the faces of the trunnion block and the stationary

machined in the face, concentric with the trunnion bearing, and outside the radius of the ports. An oil well is drilled in the top face of the block, and communicates with the groove by means of a small horizontal hole. The well is kept filled with an oil of fairly high viscosity, and flows around the groove, forming a "moat" which effectively repels water by surface tension.

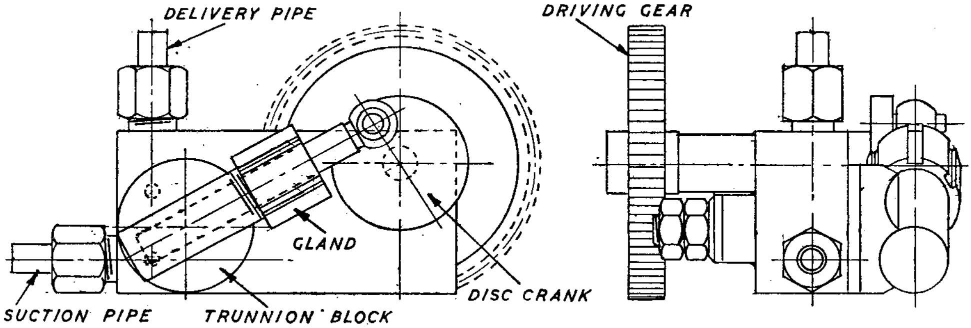
It goes without saying that a pump of this type must be accurately made, and of good materials, to be consistently successful in practice. The barrel and trunnion block should be made of bronze or gunmetal, with a stainless-steel plunger, either having the eye bushed, or running on a hardened crankpin. An aluminium alloy port block has been used successfully in the pump illustrated, but experiments are being made with a block made of "Tufnol" (laminated fabric bonded bakelite board) which has the merit of being self-lubricating where water is present. Perhaps the most satisfactory arrangement would be to use a metal block, for mech-

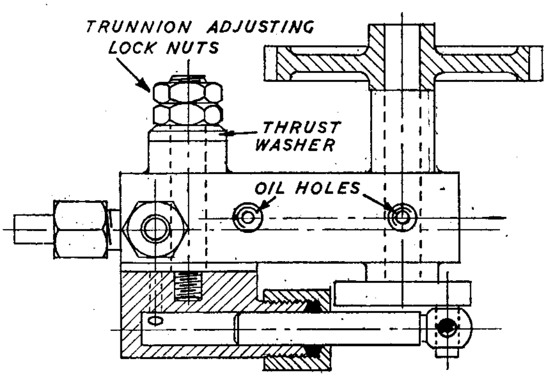
*Continued from page 445, "M.E.," October 6, 1949.

anical strength, having a flanged "Tufnol" bush inserted to form the port face and trunnion bearing; the crank bearings may also be in the form of "Tufnol" bushes.

The flat face of the trunnion block should be apped on a piece of plate glass before inserting the pivot stud, and the same treatment should be applied to the face of the port block, if of metal. It is advisable to tin the small end of the pivot stud before assembly, and sweat it into the trunnion block, as this will eliminate the risk of the stud working loose, or becoming unscrewed when setting the locknuts. The stud must be dead square with the trunnion block, and a check may be made by applying a very small trace of marking colour to the port block face and wringing the parts together. If the colour is not transferred all round the face of the trunnion block, it indicates that the stud is out of truth, and must be corrected. Reasonable care in the machining of the faces, and drilling and tapping, however, will enable faults of this nature to be avoided.

Most oscillating pumps and engines have a single port in the trunnion block, which lines up in turn with each of the ports in the stationary block, at points of maximum swing. This





General arrangement of oscillating feed pump

single port is sometimes difficult to locate accurately, and as the efficiency of the device depends on correct timing of the ports, errors in this respect may account for the poor results obtained in many cases. In this pump, however, two ports are drilled in the trunnion block, entering the barrel at an angle, and they can be exactly located by drilling the holes in the port block right through and using them as a jig to "spot" the holes in the trunnion block, when the crank is set to the point of maximum angularity either way. The ends of the holes in the port block are afterwards plugged. By this method, the pump may be timed to work in either direction, whereas with the single port, it will only work one way, unless the functions of the suction and delivery passages are changed over.

Automatic Control of Feedwater

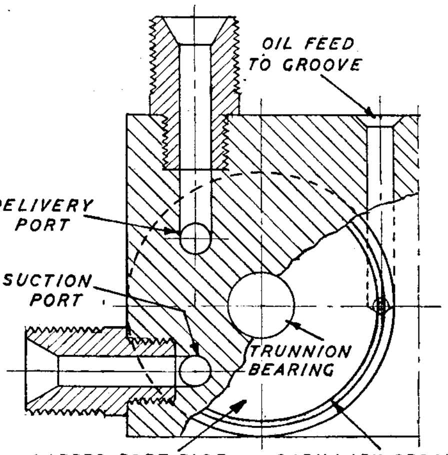
Although many devices for this purpose have been suggested and discussed, very little experimental work seems to have been done in connection with small plants such as those now under consideration. In the case of boilers which have a fairly substantial water capacity, such as centre-flue fire-tube, or normal forms of water-tube boilers, the aim is to keep the water-level fairly constant, and the first device which suggests itself for producing this result automatically is some form of float feed, similar in principle to that of the domestic water cistern or a petrol engine carburettor. This method has been used with complete success in full-size boilers, the float being usually located in a separate chamber adjacent to the boiler, and in communication with it both above and below the water-line; the valve controlled by the float is usually of the "double-beat" or balanced type, so that it works freely and without any tendency to move either under the steam pressure in the boiler, or the water pressure in the feed line.

There are however, several practical difficulties in applying such a device to a small boiler. In the first place, the float chamber might have to be as large as the boiler itself, in order to enable a float having sufficient buoyancy for positive control to be accommodated. The float would have to be made sufficiently strong to avoid risk of collapsing under steam pressure, and there would be some difficulty in balancing a very small check valve. Added to this, the device would inevitably be somewhat delicate, and liable to be deranged by furring up by impurities deposited out of the feedwater. This does not mean, however, that a practical float control system for a model boiler could not be evolved if sufficient intelligent research work were devoted to it.

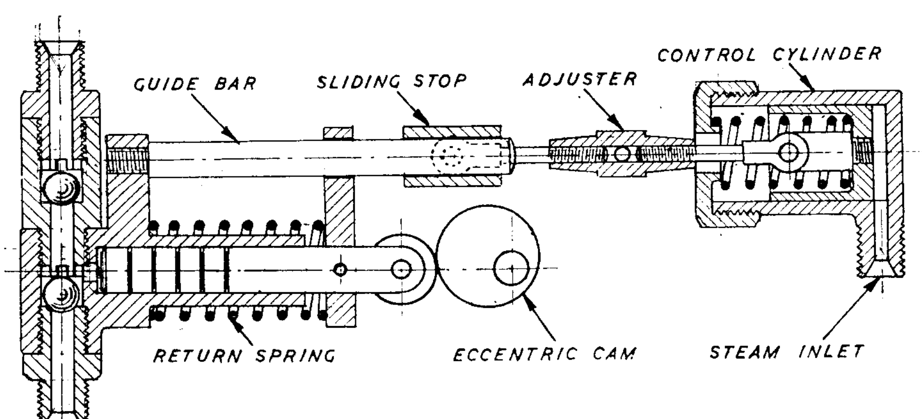
A very ingenious, and, I believe, completely successful automatic feed control system for a model boiler has been evolved by Mr. A. C. Clark, of the Kent Model Engineering Society, and applied to the plant of his model tug *Salvage* (which, incidentally, was stolen some time ago—*see* " Smoke Rings," September 8th issue of THE MODEL ENGINEER). I have no exact particulars of this device, but I believe that the principle is to utilise the weight of the water in the boiler, which is obviously proportional to the height of the water-level, to control the feed check. This is done by mounting the entire boiler on pivots in such a way that it is free to tilt to either side of the horizontal position, through a limited arc. The weight and internal shape of the boiler is so adjusted that when the water is below the working level, it produces a bias which tilts the boiler in one direction, and when it rises above the normal level, the centre of gravity is changed so that it tilts in the opposite direction. (A somewhat similar device, it may be observed, has been used to operate a safety switch in an electric kettle ; the actual switch is of the mercury type, which operates by the tilting motion of the kettle when the water boils away to the danger point.) In this case a normal form of stopcock or pin valve may be used, and pressure balancing is not necessary, as the tilting action of the boiler is positive, and supplies greater mechanical force than can be obtained by means of a float. The only disadvantage of this device is that it necessitates the use of either flexible connections or trunnion joints on both the steam and feedwater supply lines to the boiler.

Feed Control by Steam Pressure

An interesting method of feed control for flash-boilers has been suggested by Mr. J. Houstoun, who is a marine engineer by profession and therefore well qualified to express practical opinions on this subject. There are, I believe, few engineers who know more about steam engines than " they that go down to the sea in ships " (you see, I used to be in this line of business myself, once upon a time !). Mr. Houstoun's idea is to control the amount of feed water delivered, to suit the amount of pressure in the boiler, the principle being essentially the same as that of the " Pressure-stat," which has been used on many full-size steam plants,



Part-sectional enlarged view of port block, showing ports and oil-sealing device



Method of feed control by steam pressure, as proposed by Mr. J. Houstoun including the Doble steam car, though in the latter case it was employed in conjunction with other automatic controls.

Mr. Houstoun's suggestions were illustrated in rough diagrammatic form, and I have taken the liberty of elaborating them, but without, I trust, altering the essential features. It will be seen that steam pressure is used to control the stroke of the pump, so that in the event of a rise of pressure, the amount of water fed to the boiler is reduced ; therefore, assuming that the heat supplied to the engine is constant, the feedwater supply will always be in proportion to the quantity of steam actually consumed by the engine.

The pump is of fairly normal design, except that it is not positively driven by a crank or eccentric in the usual way, but is driven by a cam (which may conveniently be made in the form of an eccentric) on the delivery stroke only, the suction stroke being effected by a return spring. In the example illustrated, the usual gland for sealing the plunger is omitted for the sake of keeping the spring as compact as possible, and a very accurately fitted plunger must be used, unless it is equipped with cup leathers or other form of packing. A cross bar is attached to the plunger behind the cam follower, serving as an abutment for the return spring, and extended upwards, where it is bored to slide freely on a guide bar fixed to the pump body, parallel to the barrel.

In line with and opposite to the guide bar (or in any position where it can conveniently be connected by linkage) is a fixed steam cylinder, having a freely sliding piston and a control spring, adjusted to suit the range of steam pressure over which it is required to work. This range may be made adjustable by shifting the screwed cap which forms the spring abutment. On this side of the piston, the cylinder is open to atmosphere, the other side being connected to the main steam pipe or the steam chest of the engine. It will be clear that under working conditions, the piston will take up a position where the steam pressure is balanced by the compression of the spring, and any alteration of pressure will result in movement of the piston in one direction or the other until balance is restored ; it constitutes, essentially, a mechanical pressure gauge.

The piston is connected, by means of a rod of adjustable length, to a sliding stop on the guide bar of the pump, where it operates to arrest the return motion of the plunger at a point determined by the position of the steam piston. At the minimum pressure, the follower remains in contact with the cam throughout the full stroke, and the maximum amount of feedwater is delivered ; but as the pressure rises, the stroke is correspondingly reduced, and less water fed to the boiler. It will be noted that the plunger always reaches the point of minimum clearance in the barrel at the end of the delivery stroke, so that risk of unreliability under low output conditions is avoided. The adjustment of the stop position may be effected by a " turnbuckle " with right-and left-hand threads, as shown. In its complete form, the device comprises a variable output metering pump, with servo control, and may be found adaptable to other purposes than that specified here.

While Mr. Houstoun's suggestions are ingenious and mechanically sound, I have some doubts as to whether they constitute a complete answer to the problem of automatic feed control, and I foresee some snags in their practical application to model boilers. In the first place feed supply and steam pressure are not necessarily interdependent, and it does not follow that if the steam pressure rises, it is desirable to reduce the feed supply. This may perhaps be the case in a " prototype " boat driven by flash-steam, where the object aimed at is uniform engine performance ; but it is not applicable to a boiler having fairly considerable water capacity, where a rise of steam pressure may be much more effectively counteracted (temporarily, at least) by increasing the rate of feed supply, and thereby cooling the boiler, than by reducing it. Sometimes the steam pressure in a boiler will rise when the water-level is dangerously low, and safety demands the maximum amount of feedwater the pump can supply.

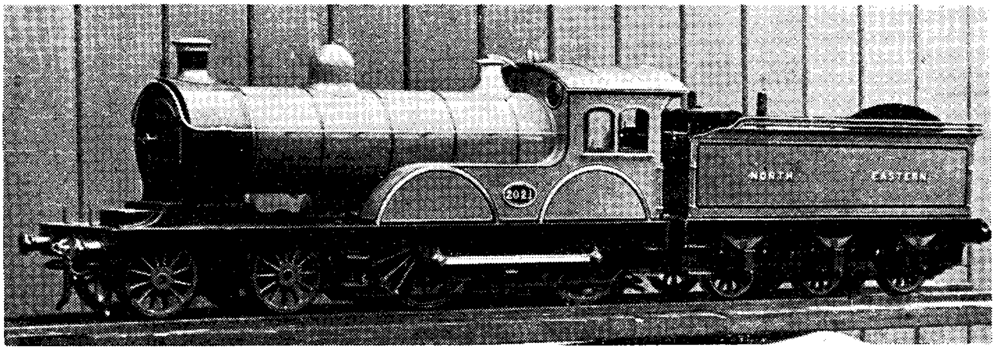
Another point about this device is that it presupposes that the heat supplied to the boiler is entirely consistent and reliable, which, in my opinion, is rather the exception than the rule in model steam plants. The majority of such plants run with the throttle wide open, and steam pressure is dependent on the heat generated by the burner. Should this become reduced by a partially choked burner nipple, a fall of air pressure in the container, or for any other reason, the steam pressure will inevitably drop, but to keep up the optimum performance in these circumstances, it is clear that the water supply must be reduced rather than increased. There is, however, a possibility that the steam control cylinder as suggested by Mr. Houstoun could be utilised not only to control the feedwater, but also the supply of fuel to the burner, such as by operating a needle valve in the fuel pipe, or controlling an engine-driven fuel pump of similar design to the feed pump shown.

Readers may remember that I described, a few years ago, some tentative experiments with a thermostatic method of feed control, the results of which appeared very promising. As I have never since found time to carry out further work of this nature, I do not propose to elaborate on these experiments, though I still believe that a form of thermostat suitable for this purpose is within the productive ability of the average model engineer.

It may be very difficult to devise the ideal automatic boiler control system ; but it is certainly not impossible, and deserves the close consideration of all those who are interested in steam power and wish to see it keep pace with its admittedly formidable rivals in modern power models. Suggestions such as the above, even though they may not give the complete answer to the problem, should never be dismissed lightly ; they at least show some attempt to escape from the rut of conventional thought, and one should remember that, to paraphrase an old proverb, " it is better to have tried and failed, than never to have tried at all ! "

(To be continued)

N.E.R. No. 2021 by H.P.J.



ONE Sunday afternoon, early in 1901, in the North Eastern Railway engine sheds at York, I saw a brand new engine just arrived from Gateshead works. It made a great impression on my youthful mind, and I there and then decided to make a model of No. 2021, one of the 60 Class R engines built between 1899 and 1907. Many years elapsed before this good resolution materialised, and here you see the result.

The model is $3\frac{1}{2}$-in. gauge, with cylinders $1\frac{1}{8}$ in. diameter × $1\frac{5}{8}$ in. stroke. Slide valves below, direct driven, without needing rocking levers, by Stephenson link motion. About 50 per cent. reduction of the steam load on valves is effected by balancing them. Discs, let into the backs of the valves, and bearing on the inside of the valve-chest cover, are held down to the cover by three phosphor-bronze springs. Some careful machining is required here, or live steam blows up the exhaust pipe. Four-bar guides, balanced reverse shaft, strapped and cottered big-ends, and T-ended eccentric rods are fitted, as in the prototype.

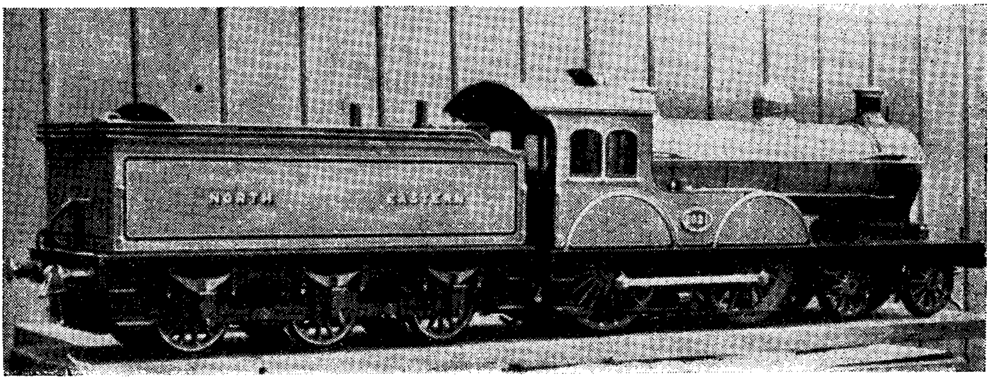
A feed-pump $\frac{5}{16}$ in. diameter × $\frac{13}{16}$ in. stroke is provided. Feed-pumps are usually considered impossible with eccentrics between the cranks. However, as the crank webs are circular, and eccentric to the shaft, it was an easy matter to fit a strap on the extreme left-hand web, giving a stroke of $\frac{13}{16}$ in.—half the length of the cylinder stroke. The pump is screwed to the left-hand frame.

The frames are $\frac{1}{16}$ in. thick, i.e., a scale 1 in. This allows the maximum swing to the bogie, as the frames are not cut away to clear the wheels. The engine will run on a 23 ft. radius curve.

The cylinder lubricator is driven from the left-hand side valve spindle tail-rod, but the usual ratchet wheel drive is not used, owing to the valve travel varying when linking up. The roller and inclined plane method is used, as on the early cycle free-wheel clutches, and ensures that the oil pump delivers at the shortest valve travel, which is 7/32 in.

The boiler is of 14-gauge copper, $3\frac{5}{8}$ in. diameter, the firebox is $5\frac{1}{4}$ in. long. Two $\frac{1}{4}$-in. superheater elements are fitted. The regulator is of my own arrangement, of the disc type, giving a small fitting on the backplate which has a sector with stops. It takes steam from the dome. The blower-valve is also of my own arrangement, with internal collecting-pipe. We all like a neat backplate.

(*Continued on page* 503)



Cotton Bobbins in the Workshop

by "Technician"

MOST readers are familiar with the type of socket on ex-W.D. electrical equipment and will have found difficulty in making secure connections without dismantling the apparatus. The cotton bobbin connector enables any piece of apparatus to be connected up and disconnected pushed into the socket as a normal plug and will make secure contact. If the bobbin has to be removed frequently, the flex or cable can be secured in the centre hole by means of a small wooden plug. The method has been found very successful and has been applied to all types of

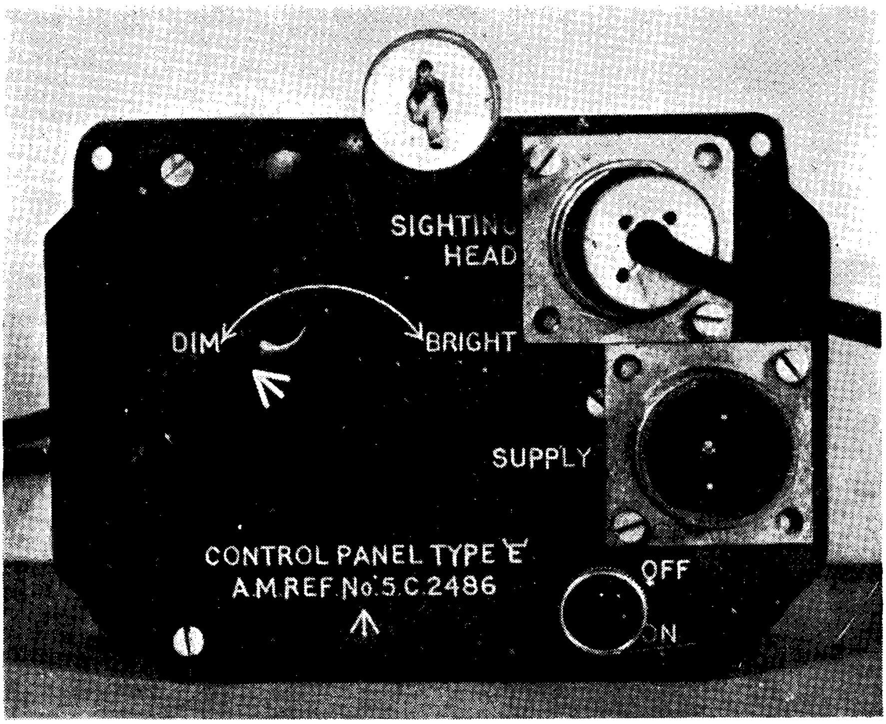


Fig. 1. *A variable resistance connected up as described. The plug for the power supply is shown on the top of the instrument*

with the same ease as if the original plugs were available.

Obtain a number of cotton bobbins of various sizes and remove the flanges from one of the ends, select one which will push easily into the socket on the apparatus to be connected up and give a light tap with the hammer. This marks the position of the pins on the wood. Deepen the impressions with a centre punch and drill each one through the length of the bobbin using a drill about $\frac{1}{16}$ in. larger than the pin. Pass the end of a length of flex or multicore cable through the centre hole of the bobbin from the flange end, bare the ends of the wires for $\frac{1}{2}$ in. and push into appropriate holes. The bobbin may now be apparatus, and is particularly useful in connection with resistances, etc., where circuit changes are frequently made. Fig. 1 shows a useful resistance connected up by this means. Fig. 2 shows a part section of a connector.

Cotton bobbins also make particularly useful drill and tap stands, and the writer always has a supply ready drilled for holding taps, etc., that are required for a particular job. It is much easier to pick up small tools from a stand and there is much less danger of them being lost than when left lying on the bench. The bobbins also make excellent permanent stands for small collections of tools and special drills such as dental burrs, as in Fig. 3.

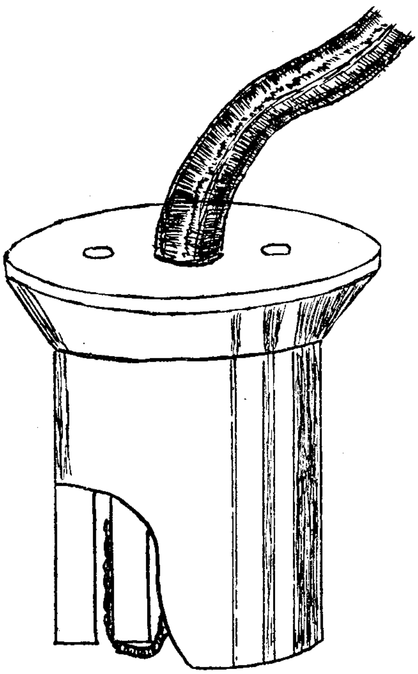


Fig. 2. Part section of connector, showing method of construction

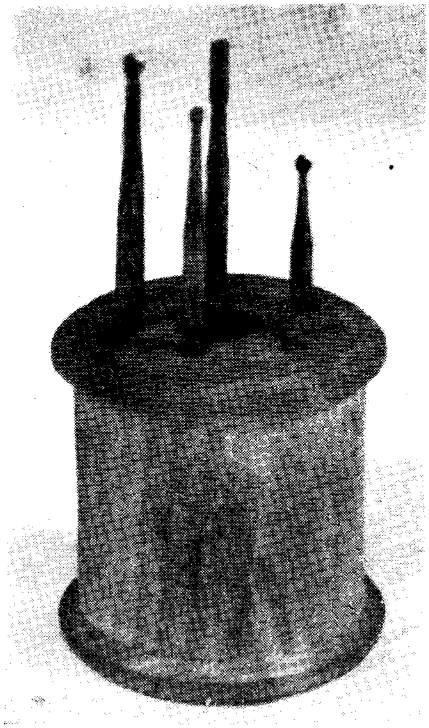


Fig. 3. Cotton bobbin holder containing a selection of dental burrs

N.E.R. No. 2021

(*Continued from page* 501)

The air brakes of the prototype are arranged as steam brakes on the model. The brake pistons have a fixed travel, compressing springs, the strength of which determines the brake load on the wheels. The cylinder sizes and strength of springs are arranged so that the load is constant between 60 and 110 lb. pressure. It is impossible to lock the wheels. Of course, the brake is either full on or off, but as the cylinders are steam jacketed, is very quick acting.

Reverse-screw is $\frac{3}{16}$ in. $\times$ 24 threads, 2-lead, requiring only $5\frac{1}{2}$ turns from full fore to full back gear.

A few other items are : Dummy donkey pump in right-hand splasher, with hinged number plate to give access to the glands, pipes for same, vacuum and exhaust pipes, sliding cab windows, hinged ventilator on cab roof.

The tender is of the usual construction, with working hand brake, and dummy water scoop handle. The hand-pump is fitted transversely. I have found that it is easier to operate than when placed longitudinally. There are about half a gross of 12-B.A. nuts on engine and tender. There seem to be a lot of $\frac{3}{4}$-in. Whitworth nuts on the prototype, and 12-B.A. is just about scale size for $3\frac{1}{2}$-in. gauge. Handrail knobs are of stainless steel, of varying lengths. The whole job is as near to scale as possible in a working model.

I have made a fair number of "free-lance" locomotives, but never seem to get the same satisfaction as when contemplating a prototype model. You can do what you like as regards construction and details with a "free-lance," not so with a prototype. This, of course, means that a prototype model is far more difficult to make, particularly if it is a working job.

This is the second N.E.R. 2021 I have made. The first did about 150 miles hauling youngsters during the "Holidays at Home" movement, before a friend took a fancy to it, and eventually acquired it.

A Small Compressor from Scrap

by J. Dacombe

IT all started with a desire to spray the car, or was it the urge to start making something else? Anyway the car got the blame.

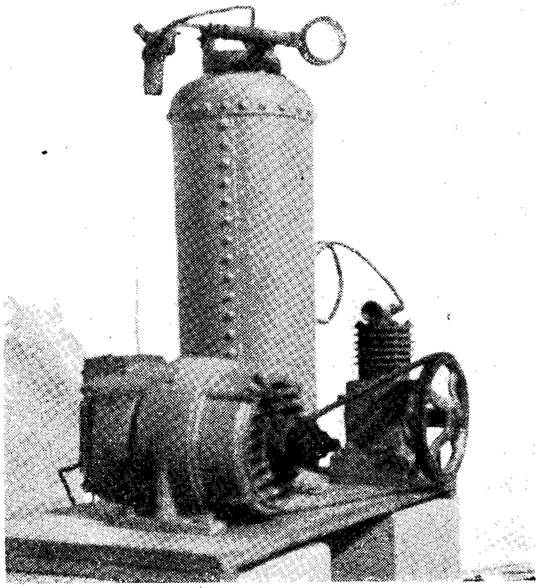
The size of the machine was limited by what I could find in the way of material, and consideration for my ¼-h.p. motor. This was "borrowed" from the lathe and presented with the job of pulling the compressor, which is 1⅞ in. bore by 1¼ in. stroke, at 700 r.p.m. with 35 lb. pressure. I managed to spray the car quite well for a first attempt, putting about eight coats on, and for this job alone I think the machine has well repaid me for my efforts.

Cylinder

This seemed to me to be the first thing to look for, so, after much raking about on the scrapheap, I dug out a clutch operating collar from a concrete mixer. This proved to be a nice piece of cast-iron. A few light cuts through the bore, a polish with fine emery cloth, and it was all ready for a piston. I should mention that the shape of this collar allowed for three cooling fins to be turned. The outside edge of the cylinder-head was thinned down to form another, two more were cut from ⅛-in. mild-steel plate, and fitted to the cylinder, more for appearance than the effect they may have on the working temperature. I must say the machine keeps nice and cool, even when used in hot weather for long spells.

The Crankcase

This was built up from 3-in. × 1½-in. channel iron and steel plate. I was lucky in having the use of an arc welding outfit. This made short work of the joints which were bevelled before welding, and dressed on the grinder afterwards. A crankcase made in this way is difficult to distinguish from a casting. Two pieces of channel were cut and squared up to length and a 2-in. hole was bored in each, one for the main bearing housing, the other for inspection cover. The top of the crankcase is ⅜-in. mild-steel plate cut 3 in. square and has a 2-in. diameter hole, counterbored to take the outside of the cylinder end. The base is simply a piece of ¼-in. plate with a hole in each corner for holding-down bolts. The whole lot was carefully clamped together before welding.



All ready for that flat tyre!

Main Bearing Housing

Next followed another rake over the junk-heap. I was rewarded with two steel blanks 3¼ in. diameter × ⅝ in. thick and a piece of hydraulic tube. One of the blanks was drilled to take the tube, and a good fillet of welding was run round both sides of the blank and tube. It was then put in the lathe and faced, spigot formed and bored for bronze bushes, all in one setting. It is fixed to the crankcase with four ¼-in. Whit. set-bolts.

Crankshaft

I was again fortunate in having the use of a 6-in. lathe. My own, by the way, is only a 2-in., so the crankshaft was turned from the solid and case-hardened. Having in mind the horrible shape a crankpin develops after a lot of hard work, this was press fitted with a steel sleeve, which can be renewed should it become badly worn.

Cylinder-Head

My other steel blank was used for this. It was faced off both sides in the lathe and the edge reduced to form the cooling fin. Two holes were drilled and counterbored to house the valves and the remainder of one of these holes tapped ⅛-in. gas for the delivery pipe. The holes for the cylinder-head studs were drilled next, and the head used as a jig to drill cylinder fins and top of crankcase. The studs are ¼-in. Whitworth in crankcase, they pass through clearance holes in the fins, and are fitted with ¼-in. B.S.F. nuts to secure the head and cylinder.

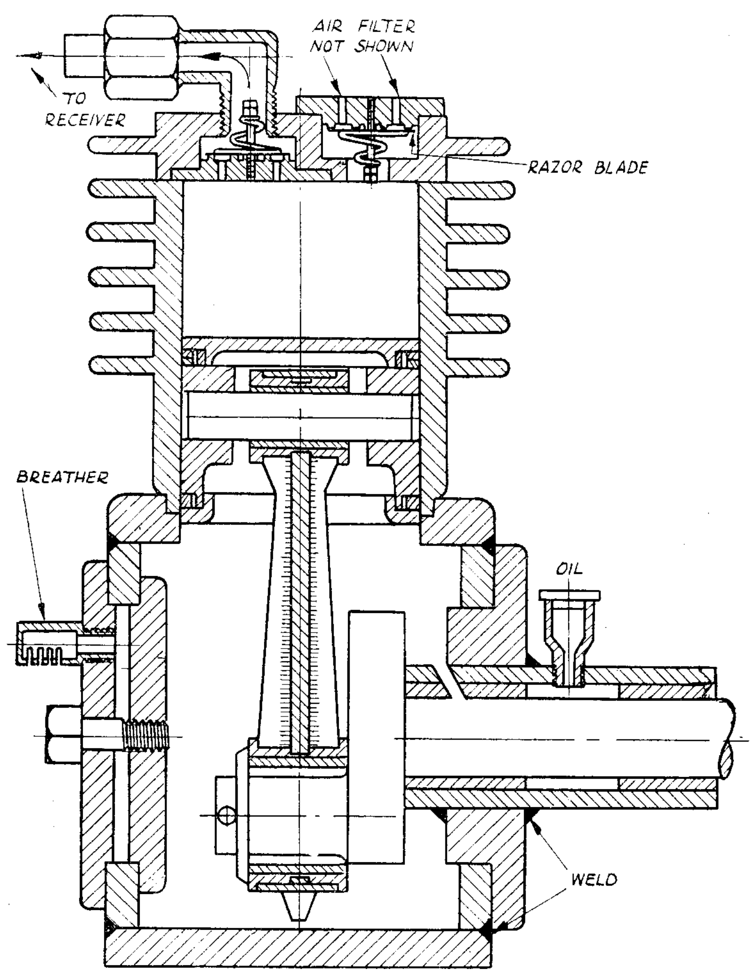
Valves

These were turned up from short ends of bronze and have a double seating. The metal between the seats was perforated with a 3/32-in. drill, care being taken not to damage them. They were then given a few rubs on a piece of plate-glass, using fine emery paste.

The plates or discs were carefully ground from razor blades of the three-hole pattern, thus the problem of drilling or punching holes in thin steel plate without buckling same was solved, or shall we say avoided. Each valve is fitted with a centre pin screwed 7 B.A. and a light conical coil spring, just strong enough to hold the razor blade snugly on the seatings. They were put into the cylinder-head with paper joints and secured by four 7-B.A. countersunk screws.

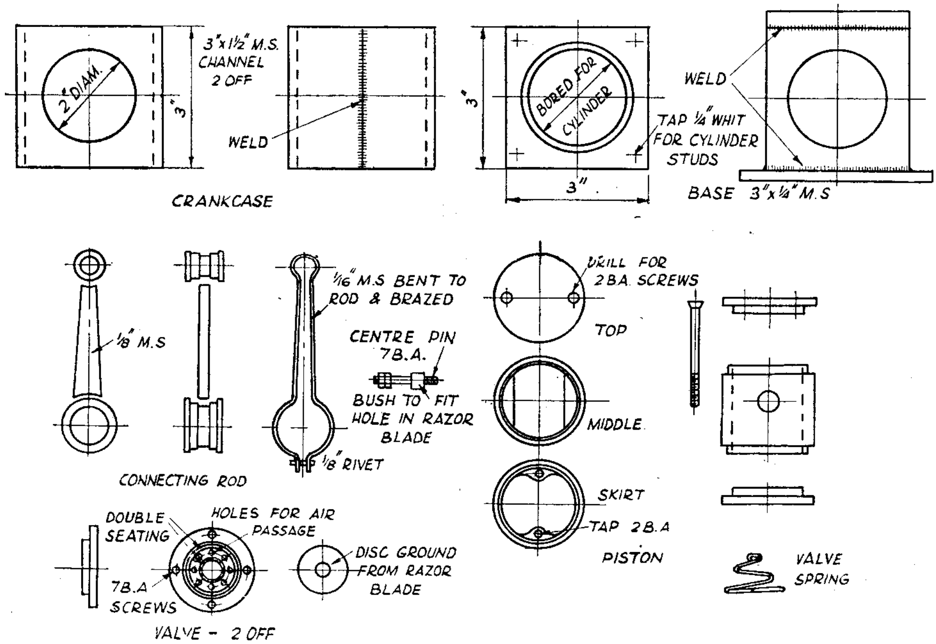
Piston

This was rather a problem. I wanted a cast-iron piston with plenty of metal for the small end pin, yet not too thick and heavy. It was decided to make it in three pieces, so the centre portion was tackled first. It was turned very slightly oversize, stepped both ends for $\frac{1}{8}$-in. piston rings, and the inside bored for the spigot on top and skirt of piston. The position for the small end pin hole was carefully marked out and drilled undersize from both sides, being opened out later with a reamer made from a piece of $\frac{3}{8}$-in. silver steel. It was tested by standing on a surface plate with a long piece of silver-steel in the hole and passed out O.K. The surplus metal on the inside of piston was then carved away by drilling and filing.



A "look into" the compressor

The top and skirt have a spigot, turned a neat fit for the inside of piston. Two holes were drilled in the top for 2-B.A. countersunk bolts which pass right through the piston into tapped holes in two lugs left on the inside of the skirt. After putting the piston together it was polished with fine emery cloth, until it just slid through the cylinder bore. The piston rings were turned from cast-iron, two compression $\frac{1}{16}$ in. wide for the top groove, and a $\frac{1}{8}$-in. scraper for the bottom. They were turned oversize, parted off, gaps cut out, closed in and returned on a short end of mild-steel fitted with a centre stud and plate. One edge of the scraper ring is bevelled and was sprung into the groove, with bevel looking towards top of piston.



Details of valve and built-up connecting-rod, crankcase and piston

Connecting-rod

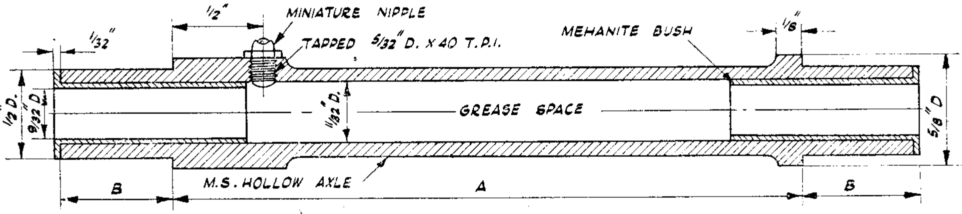
This was built up from mild steel and brazed. Two steel bushes were turned up and a $\frac{1}{8}$-in. groove cut with a parting tool in each. They were joined together with a piece of $\frac{1}{8}$-in. plate, cut to shape and wedged tightly in the grooves. Then a piece of $\frac{1}{16}$-in. strip was bent round the lot, terminating at the big-end, where a single $\frac{1}{8}$-in. rivet was put in to hold the job together while it was brazed. Two old clamps that I keep for these jobs were put on the middle of the rod to stop the joints from opening under heat. After brazing, it was cleaned up with a file, big- and little-ends bushed, and tested for twist or bend, with two long silver-steel rods in the bushes.

The inspection cover is the top cut from a discarded piston and is secured to the crankcase by a single $\frac{1}{4}$-in. Whitworth screw and crossbar, smoke-box door fashion. It is fitted with a breather made up from a short length of brass tube. The driving wheel, 7 in. diameter, was found in the workshop. It just needed the rim turning for $\frac{3}{8}$-in. V-belt, and is fixed to the crankshaft by a $\frac{1}{4}$-in. Allen screw. The air cleaner was made up from bits of brass found in the junk box. It is packed with fine gauze and cotton wool and is fixed to the inlet valve by two 7-B.A. countersunk screws. I think that just about covers the construction. The rest of the plant was almost ready made. A large fire-extinguisher makes an ideal receiver, being fitted with pressure gauge, safety valve, stop cock and drain tap. One item we must *not* forget; the crankcase is fitted with a $\frac{1}{8}$-in. gas elbow and plug for checking the oil level. If any reader is interested and would like any further details I will be pleased to furnish them. I have promised myself one of our friend "L.B.S.C.'s" locomotives for years, so I think it is time I put my motor back on the lathe and "had a go."

A Modified Trailing Axle

by G. Fletcher

THE following modification was carried out by me on my father's $3\frac{1}{2}$-in. gauge "Pacific" locomotive *Caledonia* (described by him in THE MODEL ENGINEER, April 18th, 1946).



As originally built, the locomotive had the normal type of radial axle-boxes with overhung bearings and leaf springs on the trailing axle. This arrangement gave good results when first built but, in spite of a special "tailor-made" ashpan which could be emptied from the side of the locomotive, forward of the trailing wheels, a considerable amount of fine ash found its way into the bearings and became embedded in the split bronze axle-boxes, thus causing an alarming amount of wear. This was taken up several times, but it was obvious that some remedy was called for.

After careful consideration, enclosed ball-races were ruled out as being just as easily damaged by grit as plain bearings and much more likely to "seize" in the event of becoming "gritted up"; so the following method was decided upon :—

First, the axle-boxes and axle were removed and the axle-boxes cleaned and re-reamed to original size, which was 9/32 in. The wheels were then carefully removed from the old axle and were bored and reamed out to $\frac{1}{2}$ in. after being very carefully mounted in the four-jaw chuck. The reaming was done in the lathe, to ensure accuracy of alignment.

A hollow axle was then turned out of mild-steel to the dimensions shown in the sketch, length *A* being the gauge of the engine minus the width of the flanges, and length *B* the width of the wheel bosses.

The method of machining the hollow axle may be of interest, as it required to be very carefully done. A length of $\frac{11}{16}$-in. B.M.S. bar was put in the three-jaw chuck and the ends squared off to a length (A + 2B).

It was then put in the four-jaw chuck and carefully trued up. One end was centre-drilled and a pilot hole $\frac{1}{8}$ in. in diameter drilled for just over half the length of the shaft (it was impossible to drill the whole way owing to the length of a standard $\frac{1}{8}$-in. drill being only just over 3 in.).

It was then drilled out 9/32 in. for the same distance. This was repeated from the other end. As a result of the care taken in setting-up, there was practically no error in alignment of the two holes. A 21/64-in. drill was then put through the entire length of the shaft, and finally it was reamed out to 11/32 in.

Two "buttons" were then made a push-fit in the ends of the shaft. These buttons were shouldered and centre-drilled. The hollow shaft with buttons in place was put between centres, the ends being machined to $\frac{1}{2}$ in. + 0.001 in. to give a press-fit for the wheels. The shaft was then removed from the lathe, the buttons removed and the hole for the oil nipple drilled in the vee-block and tapped 5/32 in. × 40 t.p.i. This was off-centre to clear the "plumbing" under the centre of the ashpan.

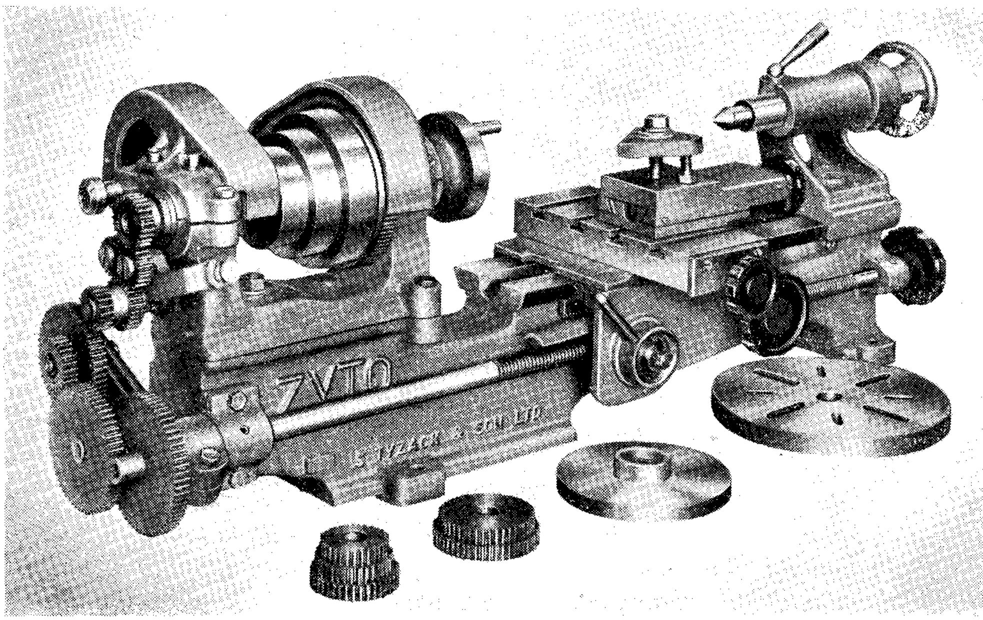
The bushes for the ends of the shaft were then turned from a piece of Meehanite, their dimensions being as shown. They were, of course, bored out with a boring-tool 0.01 in. small and reamed after being pressed into the axle, the interference for this being 0.001 in. The wheels were then pressed on and the whole assembly checked for true running.

The oil nipple was a straightforward piece of turning, being fitted with a $\frac{1}{16}$-in. ball and spring, the size of the hexagon part of it being 7/32 in. across flats.

A "dead" axle was then made from 9/32-in. silver-steel, with $\frac{1}{16}$-in. diameter pins through it, about $\frac{1}{4}$ in. from the ends, to locate it in grooves in the axle-boxes which originally housed collars to prevent end-float of the revolving axle. The axle-boxes were then "taken up" until, when they were screwed up, they gripped the dead axle firmly. The whole assembly, axle, axle-boxes and dead axle, was then put together and filled with light gear oil from an ordinary grease-gun by means of the nipple.

It will be seen that both bearing surfaces are now fairly hard; thus grit is not very likely to embed itself in the bearings, and any which does find its way in will be forced out by the oil under pressure from the gun. The assembly is also very much more rigid than originally and runs very smoothly.

I hope that this may be of interest to readers and that it might help to solve a similar problem for some other locomotive builder, as it would seem to be applicable to any axle including coupled axles, and certainly provides a much larger bearing surface than the conventional axle.



The New "Zyto" $3\frac{3}{8}$-in. Lathe

MESSRS. S. TYZACK & SON LTD. of 341-345, Old Street, London E.C.1. are well known to our readers, and have a very solidly established reputation in the tool and workshop equipment trade. They were among the earliest advertisers in THE MODEL ENGINEER and have been represented at many "M.E." Exhibitions, including the latest, held this year. Before the war, their "Zyto" lathe was one of the most popular in the light inexpensive class of machine tools, designed primarily for use in the amateur workshop; but due to inevitable difficulties experienced during the war, its manufacture was suspended, and there have been unavoidable and understandable delays in getting it back into production. This has now been accomplished, however, and many of our readers will welcome the return of the "Zyto" screwcutting lathe in an improved and fully up-to-date form, yet retaining most of its original characteristics, and holding its place as one of the cheapest machines in its class. The general specification remains much the same as in the pre-war design, but many detail improvements have been introduced, and the structural materials and accuracy have been considerably improved.

The main dimensions are as follows: Height of centres $3\frac{3}{8}$ in., over saddle 2 in., over gap $4\frac{1}{4}$ in., overall length of lathe 30 in., standard faceplate 6 in. diameter. The bed is of box section, with internal stiffening webs, having its main support under the headstock and gap, with a further support in the form of a foot at the tail end. It is machined flat across the guide-ways and headstock seating, with wide angular shears to guide the saddle and tailstock. An adjustable headstock casting is secured to the bed with three bolts, allowing of adjustment for parallelism; it has long and sturdy bearing housings of the "half-split" type to enable bearing clearances to be adjusted. The mandrel is precision ground, 1 in. diameter over the journals, which run in "Glacier" metal bushes, and a ball thrust-race is fitted, end play being adjustable by the usual screwed collar. A $\frac{3}{8}$-in. clearance hole is drilled right through the mandrel, and opened out to No. 1 Morse taper at the nose end.

The back-gear shaft is engaged by endwise sliding movement, controlled by a hand knob with a spring plunger locking device; the back gear reduction is 6-1. Steel pinions are fitted, and a slip-bolt is provided for locking the pulley to the mandrel for direct engagement. The drive is by a flat belt, giving three direct mandrel speeds, and cast aluminium guards are provided over the reduction gearing. A tumbler gear with steel pinions, giving forward, neutral and reverse movements of the screwcutting gear train, is provided.

A rather unusual feature of the tailstock is that the barrel is bored to a larger diameter than the headstock mandrel, being $\frac{1}{2}$ in. in the bore, and tapered at the front end to take No. 2 Morse taper centres. The tailstock casting is mounted on a separate base, providing for parallel set-over adjustment, and the assembly is clamped to the shears of the bed by a quick-acting lever clamp.

(*Continued on page* 513)

Bringing "Maisie" Up to Date

by "L.B.S.C."

SINCE the announcement first appeared, that it was proposed to publish a selection of my locomotive "serial stories" in book form, many correspondents have written me on this subject, and various suggestions have been made. One of the most frequent was, that followers of these notes realise that many improvements have been made in the later locomotives I have described; and they suggest that, wherever possible, such improvements might be incorporated in the reprinted instructions, and the sets of blueprints, for the older locomotives. This is really only following full-size practice; as an example, I might quote the old "D" and "E" classes of 4-4-0's on the Southern Railway (direct predecessors of the "Maids of Kent") which were rebuilt at Ashford to the late Mr. Maunsell's instructions. They were good before—but by the time that worthy and clever locomotive engineer had finished with them, they were indeed the "cat's whiskers." Some of our readers have already incorporated my later improvements when building or rebuilding locomotives of your humble servant's design; and in giving one instance, I can, at the same time, clear up a misunderstanding in a few words.

In the issue of July 28th an advertiser announced that "Maisie" was *the best* of all my locomotives, and that *he had improved on the original design.* Several readers, in calling my attention to this, jocularly added that if such were the case, it was time I handed over this job to the party in question! The fact was simply that the wording was just—shall we say—a wee bit unfortunate. What that particular advertiser meant to imply was (as he had told me many times), that in his opinion, "Maisie" was one of my most popular engines, which, in fact, it was; easy to build, not too expensive, and could do the job in grand style. He built one; and in the very commendable job of running kiddies around on bomb-site and other tracks during the "holidays-at-home" stunt during the war, she naturally became badly worn. Both the advertiser and his assistant were fairly frequent visitors to my workshop and railway; they had seen "Jeanie Deans" grow up from a pair of frame plates, to a finished locomotive which they had both driven; they knew actually more about my own ideas and practices than I had ever put into these notes; so what was more natural than that they should have made use of such knowledge, when rebuilding the badly-worn "Maisie"? I hope that explanation makes everything clear.

A New High-efficiency Boiler

For quite a number of years past, I have been experimenting with boilers having a high superheating capacity, with a view both to getting the utmost efficiency, and noting what effect the "redhot" steam had on cylinders made of non-ferrous metal. My own idea was, that provided the lubrication was adequate, you couldn't have the steam too hot, within reason, of course; and my experiments proved this to be an actual fact. One experiment I carried out, was to put a coil of tube right in the flame of a powerful oil-burner, firing a water-tube boiler on a $2\frac{1}{2}$-in. gauge engine, so that the coil became bright red when the engine was at work. The steam was so hot that it melted a temporary soft-soldered joint on the *exhaust* side! Anyway, using a mechanical lubricator of my oscillating-cylinder type, with a 3/32-in. ram delivering one bead of heavy black superheater oil every 35 turns of the driving wheels, the little locomotive hauled my weight for no less than $3\frac{1}{4}$ miles without a stop, on the contents of one tenderful of water, a little over $1\frac{1}{2}$ pints. Did I hear somebody ask if she belonged to the "Camel" class? Well, as it was obvious that such a temperature could not be attained with the ordinary type of fire-tube superheater, the elements of which cannot become redhot, I decided that on all future locomotive boiler designs, as many flues and elements as possible, would be incorporated. You have seen the results in all my later boiler specifications. Rather different to the antiquated idea once prevalent of a "gridiron" in the smokebox!

"Maisie's" original boiler contained two superheater flues only, with two spearhead elements. There were also 18 ordinary tubes of $\frac{7}{16}$ in. diameter, all 13 in. long. This boiler steamed well, and the original engine has never been short of steam under ordinary working conditions, since the day she left my workshop; but in cold weather she had a wet and visible exhaust. Some folk like to see this, as they say it adds a touch of reality; but it is usually an indication of low superheat. In the case of "Maisie," it also indicated something else, viz. that the proportion between length of tubes, and length of firebox, could be improved upon; the smokebox ends of the tubes weren't doing much towards steam generation. In the new boiler I have corrected all these matters, as you will see by the reproduced drawing.

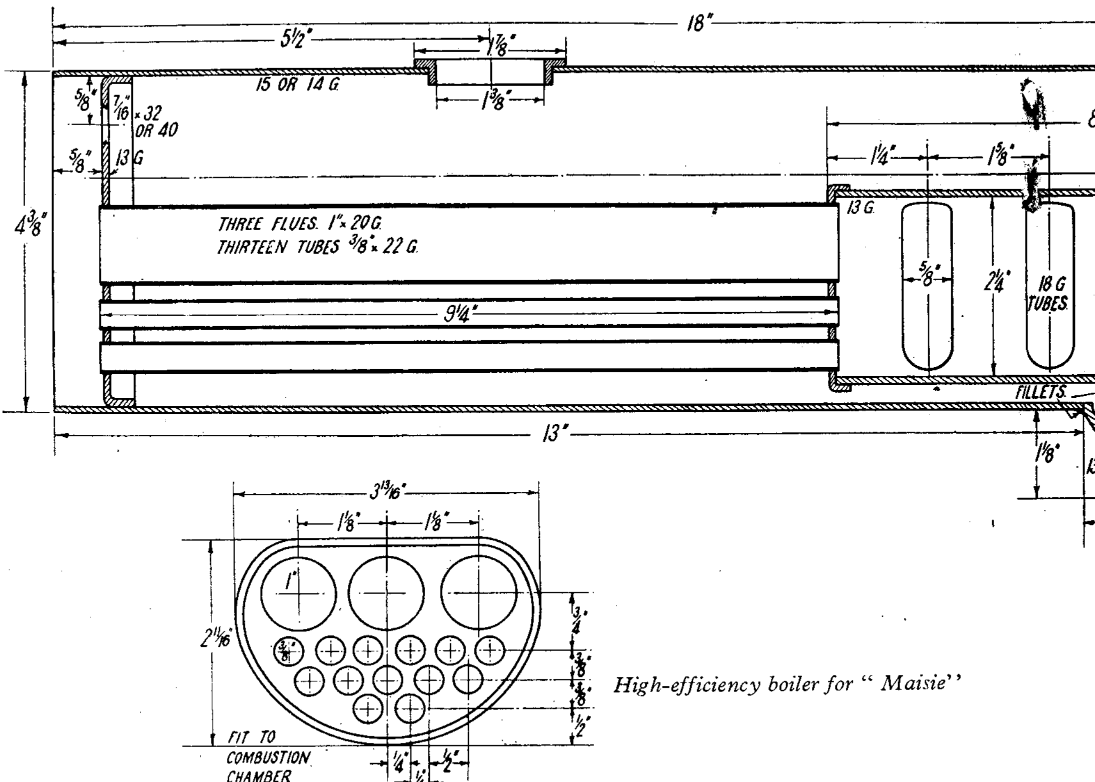
The boiler is exactly the same externally, as the original boiler, so that no alterations whatever are needed to the chassis. It is in the internal arrangements that the difference lies. First of all, the inside firebox is of a different shape, the sides having a greater slope than the sides of the wrapper; this enables the water space gradually to get wider between the foundation ring and the crown sheet, allowing steam to come away more freely, and is in accordance with full-size practice. A combustion chamber 4 in. long is added; this is formed in one piece with the firebox. It contains four $\frac{5}{8}$-in. water-tubes; and the combustion chamber and water-tubes provide a great increase in the firebox heating surface, which is the most effective part of the boiler.

The distance between the tubeplate on the end of the combustion chamber, and the smokebox tubeplate, is approximately 9 in. and this allows the use of ⅜-in. fire-tubes instead of the original $\frac{7}{16}$ in., so there is no core of hot gases escaping through the middle. The superheater is one which I have tried out and found champion ; the first of this type was fitted to the commercially-built " Cock-o'-the-North " when I rebuilt her, and the way it delivers hot steam is just nobody's business. In the present case, there are three 1-in. superheater flues, each containing two ¼-in. elements with block return bends extending right to the combustion chamber ; this gives approximately three times the amount of superheating surface provided in the original boiler. On top of that, it is ever so much more effective, because the heat will travel better along the 1-in. flues, and at the same time be split up more effectively between the four ¼-in. pipes in each. The ends of the six elements are attached to two headers in the smokebox ; details of the superheater will appear next week, all being well.

How to Build the Boiler

The boiler barrel and wrapper sheet is made exactly as described for the original " Maisie " boiler, a piece of 4⅜-in. seamless copper tube being split and opened out to form the firebox wrapper ; but if possible use a little thicker gauge metal, 15- or preferably 14-gauge. A higher working pressure may then be used if desired. The inside firebox and combustion chamber are made from a single sheet of 14-gauge copper, 11 in. long and 8 in. wide. At 3⅞ in. from one end, on each of the 8 in. sides, make a saw-cut 3⅜ in. long ; then bend the whole lot to the shape of the firebox, as shown in the cross-section. Leave the 4⅛ in. part thus, then continue bending the 3⅞ in. bit around, until the ends overlap, leaving a flat-topped extension to the firebox, of the shape shown in the illustration. Put a few 3/32-in. copper rivets through the overlap, to hold it whilst brazing. Fit a throatplate under the semi-circular part, exactly the same as the one fitted to the boiler shell ; turn over each side to form a flange, which is riveted to the sides of the firebox sheets, and see that the front butts up close to the underside of the chamber.

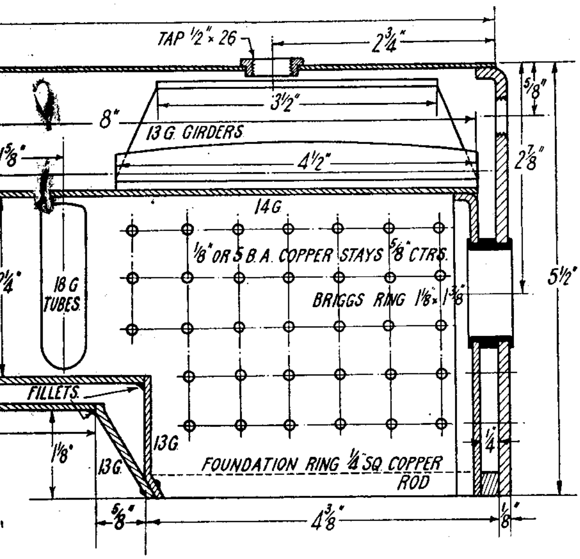
The door-plate is fitted exactly the same as on the original boiler. Turn up the firehole ring from a piece of tube as given in the original instructions, squeeze it oval, and fit it into an oval hole cut in the door-plate ; put enough rivets through the firebox side sheets, and the flange, to hold the door-plate in place whilst brazing. Drill four ⅝-in. holes in the combustion chamber, top and bottom, as shown in the

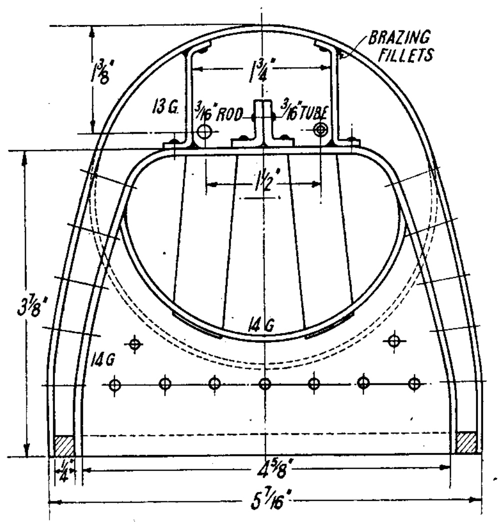


High-efficiency boiler for " Maisie "

illustrations. Those in the roof are $1\frac{1}{4}$ in. apart, and those in the base are $1\frac{5}{8}$ in. apart, giving the tubes a slight slope, and letting them act as substantial stays to the chamber. Note: when fitting the water-tubes, which should be $\frac{5}{8}$ in. outside diameter, and 18- or even 16-gauge, leave them plenty long, projecting $\frac{1}{8}$ in. or so beyond the holes. This makes the brazing much easier, and they are filed off flush when the job is complete.

The combustion chamber tubeplate is flanged up over an iron former, made exactly the same size as the end of the combustion chamber. This allows the tubeplate to fit over the end of the chamber like the lid of a cocoa tin, and there is no chance of a leak or failure of any other kind, developing there. One or two of those misguided folk who "know all the answers," have tried brazing on a flat plate instead of flanging as per "words and music"; and they have literally "come unstuck," as the kiddies would say, the plates failing on test, and rendering the whole boiler utterly useless.





The former should be about $\frac{1}{4}$ in. thick; it is easily sawn, if the saw is anointed with a little cutting oil. Set out all the tube holes, and drill a $\frac{1}{8}$ in. or No. 30 hole at each location, so that it may be used as a jig to drill both the combustion chamber tubeplate and the smokebox tubeplate. Cut out a piece of 13-gauge copper sheet, $\frac{1}{4}$ in. bigger all around than the former; place them together in the bench vice, and hammer down the projecting edge of the copper over the former. Run the drill through all the holes in the former, carrying on through the copper plate; then, when the latter is removed, drill the smaller ones 23/64 in. and the bigger ones 63/64 in. finishing to size with a reamer. If you haven't a 1-in. reamer, use a file, opening out the hole until the end of a piece of 1-in. copper tube is a good tight fit. Clean the inside of the flange before "putting the lid on."

The crown stays can then be fitted; these are very simple, being simply two "Z" girders cut from 13-gauge copper and riveted to the crown sheet at each side, and two "L" girders riveted back to back, and then attached to the middle of the crown sheet. The whole bag of tricks can then be brazed or Sifbronzed. A $2\frac{1}{2}$-pint blowlamp will do the job fairly easily, with plenty of coke packing, but a 5-pint is preferable, if you can beg, borrow, or—ah, um! otherwise acquire one. An air-gas blowpipe with a fan or bellows, about 2 in. nozzle, would also make short work of the job. I find Boron compo still the best flux for general brazing, although I very seldom do any now, much preferring my old friend Mr. Sifbronze, which when used with an oxy-acetylene blowpipe, makes the job easier than using "soft tommy." Easy-running brazing strip can be obtained from all metal merchants, most tool stores, and some of our advertisers. The Sifbronze people themselves make a brazing strip, which they call "Sifbrass," and it works fine with a blowlamp. Warning—some folk advocate silver-solder for the whole boiler. I don't, and I'll tell you why. I have seen some all-silver-soldered boilers sprouting Welsh vegetables in firebox and combustion chamber after two or three runs; the reason being that the heat of the final operation starts cracks in the earlier ones, which are unable to stand the final heating without fracture. If you use a fairly high-melting-point alloy for your internal joints, you can make the boiler hot enough to almost see the tubes through the barrel, when doing the final braze-up, and nothing will "give" inside. Don't forget I passed the three-figure mark with my personal boilermaking, some years before Adolf started his shindy, so can speak from experience. The only brazing material in the nature of silver-solder that I would recommend for firebox joints, is Johnson-Matthey's B6 alloy, which has a low silver content, just enough to make it run freely at a fairly low temperature. This may be used without fear of cracking afterwards, but it is much more expensive than easy-running strip, which contains zinc instead of silver.

Cover all the joints with wet flux, up-end the assembly in the pan, and go to work just as I described for the " Lassie," doing the doorplate and firehole ring first. After a preliminary warm-up, start on the bottom corner, blow up to bright red, feed in a little of the strip, and work right around, taking the firehole ring " in your stride," so to speak. Then, as the combustion chamber tubeplate is resting on the coke, run a fillet of brazing material all around the flange. Next turn the assembly the other way up and attend to the throatplate under the combustion chamber; after which, lay the whole issue in the coke upside down, and do the seam on the underside, and the bits of tube sticking through the bottom of the combustion chamber. Finally stand the assembly right way up, go around the upper ends of the water-tubes, and then see to the crown-stay flanges. Very important this—run a little silver-solder in first, which will " sweat " in under the flanges, and seal the rivets; then pile on sufficient brazing strip at each side, to leave fillets as shown by the black triangles in the illustrations. This will entirely prevent any tendency of the stays to try and tear away from the crown of the firebox. Have a jolly good quiz all over the assembly, make quite certain that no places have been missed, before putting it in the pickle bath. File the projecting ends of the water-tubes flush with the combustion chamber.

Smokebox Tubeplate and Tubes

The smokebox tubeplate is made exactly as described for the original boiler, using 13-gauge sheet copper, but the tube holes are set out and drilled to correspond with those in the combustion chamber tubeplate; simply clamp the iron former to the smokebox tubeplate, drill the holes, then open out same way as described above. Thirteen $\frac{3}{8}$ in. by 22-gauge, and three 1 in. by 20-gauge pieces of tube are needed; the ends should be squared off, and then cleaned up with emery-cloth, before inserting into the tubeplate. They should project through about 1/32 in. into the combustion chamber. Put the smokebox tubeplate on, to act as a spacer and " holder-up "; line up the nest of tubes with the combustion chamber, then up-end the lot in the brazing pan, and silver-solder the tubes to the tubeplate. If wet flux is smeared all over the tubeplate before the tubes are inserted, and the tube ends served likewise, there won't be any missed places. Little bits of silver-solder can be dropped all among the tube ends, or a ring of silver-solder wire (commercial article) can be placed around each tube, in contact with the tubeplate. A coarse grade silver-solder is advisable. If the whole issue is then blown up to medium red, the silver-solder should melt and form a fillet around each tube. Before putting the assembly in the acid pickle, pull off the smokebox tubeplate and heat all the tube ends to a bright red. This will soften them ready for expanding into the holes in the smokebox tubeplate when finally fitted.

The assembly is then inserted in the boiler shell, and fixed in precisely the same way as the original boiler, the crown-stay upper flanges being riveted to the top of the wrapper, and the throatplate under the combustion chamber being riveted to the throatplate under the boiler barrel, without the intervention of any foundation ring; see longitudinal section. The smokebox tubeplate may then be inserted, and carefully driven down until the tubes are projecting 1/32 in. or so. Clean the flange and the inside of the end of the barrel, before inserting. If the tubes fit tightly in the holes in the smokebox tubeplate, they won't need expanding; but if they are at all slack, drive a greased taper drift into each, which will force the tube into close contact with the surrounding metal. The whole lot can then be silver-soldered, and the smokebox tubeplate fixed, same as described for the original boiler, or for " Hielan' Lassie "; the tops of the crown-stay girders can be attended to at the same time. Don't forget to put a fillet of brazing material, or coarse grade silver-solder, alongside each crown-stay girder.

Foundation Ring and Backhead

The foundation ring is composed of three pieces of $\frac{1}{4}$-in. square soft copper rod, as in the original boiler, so there is no need to dilate on that subject. The backhead in this boiler is made from $\frac{1}{8}$-in. sheet copper, in place of the thinner material originally specified, and will need no bushes, as this thickness is sufficient to provide enough hold for the threads of the fittings when screwed directly in. The backhead former will be 1/32 in. less all around, than the original given size, so that the flanges of the backhead will be of the same overall dimensions.

The backhead is fitted, same as described for the " Lassie." Measure from top and sides of wrapper to the firehole ring, transfer measurements to the backhead, cut the hole, and fit the backhead in place, beating down the projecting lip of the ring into close contact with the backhead. Then close the sides of the wrapper into contact; if they don't want to " stay put," a few screwed stubs of 3/32-in. copper wire through both wrapper and backhead flange, will teach them manners. Then fit the three pieces of ring (says Pat) around the bottom of the firebox, and put a few rivets through each, to hold them in position whilst brazing. The pieces of rod can either be let in, so that they are $\frac{1}{16}$ in. from the edges of the plates, or they can be bevelled off at the edges; either method will provide a channel for the brazing material to flow into, and make a good joint. The dome and safety-valve bushes may also be fitted, as shown in the drawing.

The final braze-up is done in the same way as described for all the other boilers previously described; cover all the joints with wet flux, lay the boiler upside down in the pan, pile coke around, put some asbestos cubes or pieces of millboard in the firebox to prevent the flame of the blowlamp going into the combustion chamber, and go ahead. Warm up the whole lot evenly, then concentrate on one corner of the foundation ring, and work right around, feeding in the brazing material as you go. This being the " final heat," in more senses than one, you can, if you wish, use a good grade of silver-solder, such as "Easy-flo," and the special flux sold for same; and the dull red heat needed to make this run won't have any effect on the previously-brazed joints, so the boiler should emerge from the ordeal, as tight as the proverbial bottle. When the ring is done, up-end the boiler and go all around the joint between backhead and wrapper, and around the firehole ring; then stand the boiler right way up, and do the dome and safety-valve bushes. If "Easyflo" or best grade silver-solder is used for these, they can be done merely by directing the flame of the blowlamp straight on them, so that the bushes and the surrounding metal are heated to dull red, enough to melt the silver-solder. Let the boiler cool to black before you put it in the acid pickle, and don't forget to hold something (like a rubber mat, for example) between yourself and the pickle-bath, as there is usually a miniature volcanic eruption when the pickle goes inside the boiler and makes contact with the tubes and combustion chamber. Let it soak, anything up to half-an-hour, before fishing it out, draining, washing out and cleaning up. Give a preliminary "pinhole test," as described for the "Lassie."

Staying

The solid and hollow longitudinal stays are the same as on the original boiler; but in place of the few 5/32-in. side and end firebox stays originally specified, substitute the $\frac{1}{8}$-in. stays at closer spacing, as indicated in the drawing. These are not only more efficient, but are easier to fit, the smaller holes being easier to drill and tap, and also they are much less liable to start a leak. Three of them at each side, come just inside the combustion chamber, the reason being that if omitted, a rather large flat place would be left unstayed on the outer wrapper between firebox and barrel. These stays will be longer than the ordinary firebox stays, and should be inclined so that they are at right-angles to the combustion chamber at the point where they enter, so that the nuts will bed down properly. As the outer ends are headed over with a hammer, the angle at which they will emerge, doesn't matter a continental. The head will be just the same shape and size.

When all the stays are in, sweat over all the heads and nuts, using soldering bit and blowlamp in a "combined operation" as previously described, or brush the liquid solder all over the heads and nuts with a wire brush, made by driving a bunch of iron wires into the end of a bit of copper tube, and flattening it. Don't forget to fit a wooden handle; if you do, I'm open to bet you won't forget it a second time! After the sweating job is finished, well wash the boiler in running water, and scrub with an old nailbrush or some steel wool. If the operator is sweating, too, you'll know exactly what to do, without any instruction from your humble servant. Here's luck! All that remains, is to test the boiler to 160 lb. water pressure, same as described for "Maid," "Minx," "Doris" and so on; and if all O.K. fit the new six-element superheater to be described in the following instalment.

Anybody who owns an oxy-acetylene blowpipe outfit, use Sifbronze for all the joints except the tubes. Do those with Johnson-Matthey's B6 or a coarse grade of silver-solder, and DON'T use the oxy-acet. flame for that job. It is too hot, burns the silver-solder, and makes it go all spongy. For silver-soldering, the hottest advisable flame is oxy-coal-gas; but an ordinary air-gas blowpipe, or paraffin blowlamp, is far safer, especially for inexperienced coppersmiths.

Note to prospective purchasers of the "Maisie" handbook—this will contain amended notes on the above boiler, in place of the original, and full-size blueprints of it will be included in the set, although prints of the old original boiler will still be available for those who prefer that type.

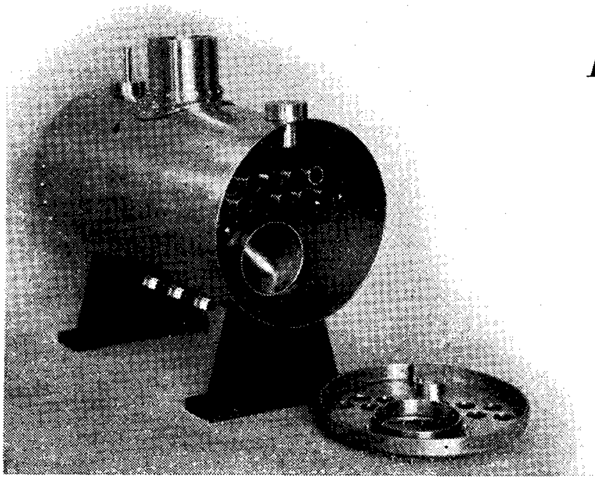
The New "Zyto" $3\frac{3}{8}$-in. Lathe

(*Continued from page* 508)

The saddle has long sliding ways to facilitate accuracy and smooth movement, and the adjusting gib-screws are provided with lock-nuts. It incorporates an apron with a double clasp nut, fitted in adjustable vee-guides, for the engagement of the leadscrew, and a pinion engaging a rack attached to the bed for quick traverse. The slide-rest is fully compound, comprising a cross-slide with four tee-slots, which has a long traverse, and a top-slide of sturdy design, with standard openside form of toolpost, enabling any type of tool to be held. All slides have adjustable gib-strips, and Acme thread feedscrews, with end-play adjustment. Ball handles have now superseded the disc handles seen in the photograph. An 8 t.p.i. leadscrew is fitted, and ten machine-cut change-wheels are provided, covering practically all British standard screw pitches, in addition to self-acting feeds. The standard equipment includes set up change-wheels, gear guards, faceplate, catchplate and one finished chuck backplate.

The lathe can be supplied either for bench mounting, or mounted on a cast-iron stand. A power countershaft for wall or bench mounting can be provided to drive either the bench or stand type of lathe, or the latter can be completely motorised by the fitting of a self-contained driving unit, incorporating a $\frac{1}{4}$ h.p. motor, adjustably attached to the underside of the chip tray. A full range of accessories, including chucks, centres, angle-plates, vertical slides, tools and tool-holders is also available.

A Successful Joint Exhibition



THE exhibition organised by the Bristol Joint Model Clubs Committee, which was held recently, was an unqualified success. In spite of the somewhat inconvenient location of the hall the attendance was very satisfactory and the cost of the exhibition was more than met some days before its close. The exhibition was held in two of the larger halls of one of the secondary schools. A multi-gauge track was erected in the playground by the Bristol Society of Model and Experimental Engineers and proved a great attraction. Another feature, also in the playground, was a demonstration of model race cars by the Bristol and West Model Car Club. The weather throughout the period of the exhibition was fine and these outdoor activities were seen at their best.

The models were very well displayed in the spacious rooms provided, an unusual feature being the method adopted in arranging barriers around the stands. These were of light alloy tubing, as used for scaffolding, and which was hired from local builders and proved very efficient in use.

The number of exhibits by the participating clubs exceeded 250, and the standard of workmanship was very high and considerably better than that at the previous exhibition held in 1946. The many models working under compressed air on the stand of the Bristol Society of Model and Experimental Engineers created special interest. In the lower hall, the Bristol 7-4-2 club displayed a 36 ft. portable 16.5 mm. gauge model railway, which was a great attraction, and ensured that the other displays in this hall were not neglected.

The following were the principal items of interest on the stands of the various clubs represented.

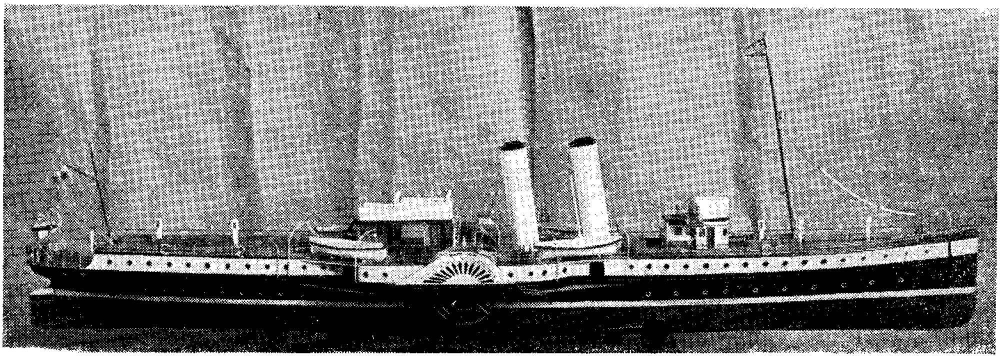
Bristol Society of Model and Experimental Engineers

3½-in. gauge L.M.S. "Princess Royal" by Mr. R. Phillips. Unit showing stages in construction of an L.M.S. Class V loco in 3½-in. gauge by Messrs. Hodges, Jermyn and Penty. 9.5 mm. talkie projector, by Mr. Newcombe. Large mill type horizontal engine and boiler in construction, by Mr. H. M. Webb; a photograph of Mr. Webb's boiler showing its excellent workmanship is reproduced on this page. Radio-controlled battleship and radio gear, by Mr. Chantrell. 1½-in. scale compound traction engine, by Mr. Price.

Bristol Ship Model Club

Steam yacht *Lady Lisa*, by Mr. Dorrington. Paddle steamer *Glen Gower*, by Mr. Dorrington (see photograph reproduced on this page.) Paddle steamer *Glen Sannox*, by Mr. A. S. Miller. Revenue cutter and ketch, by Mr. Tilley. Case of waterline models, by Mr. Poole, to scale 1 mm. to 1 foot.

(*Continued on page* 518)



IN THE WORKSHOP

by "Duplex"

*48—Fitting Angular Rests and a Twist Drill Jig to a Grinding Machine

IN the previous article the addition of the twist drill grinding jig was dealt with, and it now remains to describe the making and fitting of the two angular grinding rests which are mounted at either end of the machine.

As the right-hand rest fits into the standard bracket supplied with the Potts grinding jig, its construction differs from that of the left-hand rest, as will be seen on reference to the photographs which appeared in the previous article.

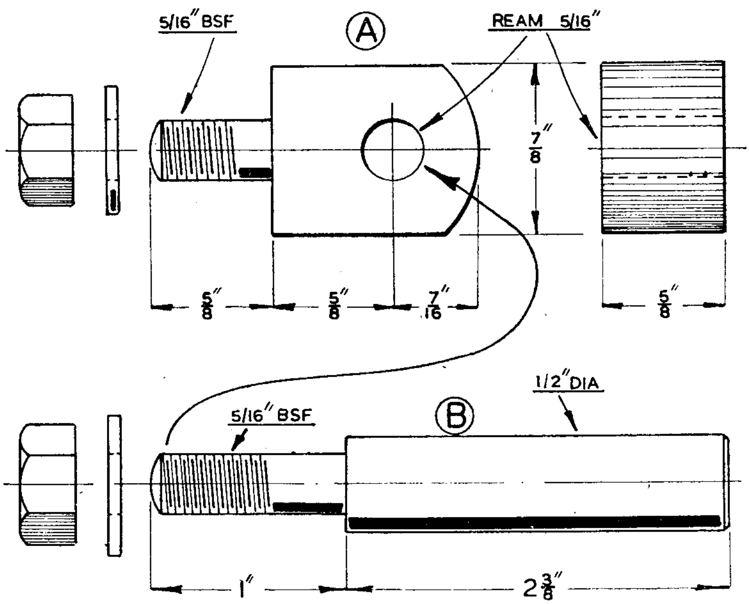


Fig 8. *Bracket for right-hand rest arm*

The component which fits into the bracket and also carries the rest arm will be seen in Fig. 4, and the working drawings of its parts are given in Fig. 8. The banjo (*A*) is made from a piece of mild-steel, and before being cut to length it should be drilled and reamed to receive the reduced end of the bracket spindle (*B*). The reaming size drill for $\frac{5}{16}$ in. in common use is Letter "N" which, as it leaves $10\frac{1}{2}$ thousandths of an inch to be removed by the reamer, is hardly satisfactory for this purpose, and its use may well result in the formation of a bell-mouthed hole. It is, therefore, better practice to employ a special size of Dormer drill for this operation ; the 7.8 mm. drill leaves $5\frac{1}{2}$ thousandths and the 7.9 mm. drill only $1\frac{1}{2}$ thousandths for the reamer to remove.

The next operation is to form the threaded shank on the banjo to carry the rest arm. For this purpose, the material, after being cut to length and having the position of the shoulder marked-out, is gripped in the four-jaw chuck, where it can be readily centred with the aid of the test indicator by first setting one pair of opposite sides central and then setting the remaining pair in a similar manner.

Should the work not project sufficiently to allow the test indicator to make contact with its surfaces, the setting can then quite well be made from the outer faces of the jaws, for the inner and outer

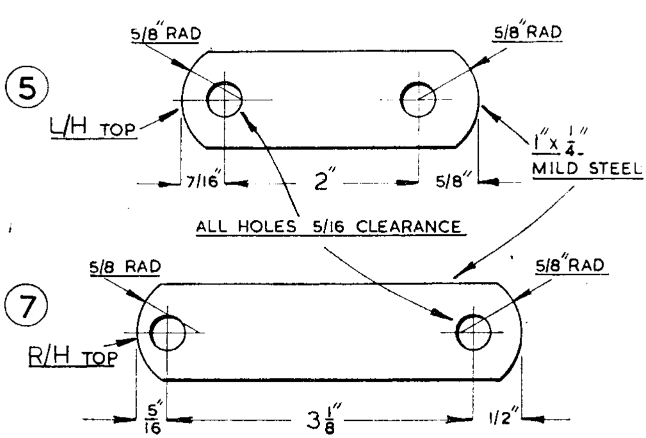


Fig. 9. *Rest arms*

*Continued from page 454, "*M.E.*," *October* 6, 1949.

surfaces of the chuck jaws are ground concentrically during manufacture. When the shank of the banjo has been reduced to its finished diameter, the threaded portion is either screw-cut or is formed by using the tailstock dieholder.

The bracket spindle (*B*) is best turned to size between the lathe centres, for ordinary mild-steel rod of the nominal diameter is usually not sufficiently accurate for this purpose and, moreover, it is essential that the spindle should be a good sliding fit in the bracket to save having to tighten the clamping-screw unduly in an attempt to secure a firm hold.

The Rest Arms

Working upwards, the next part required is the rest arm, No. 7, Fig. 9 ; and it will probably save time and unnecessary work if part No. 5, that is to say the arm for the left-hand rest, is marked-out and drilled at the same time. Advantage can then be taken of the full length of the material to gain a safe hold while drilling ; otherwise, a short piece of material should always be gripped in the machine vice to avoid the danger of the work spinning and damaging the fingers when the drill breaks through.

The two sides of the rest arms should next be filed flat, and although some workers maintain that they cannot file flat, there is really no difficulty in doing this if a little care is taken and ordinary skill is used. Grip the material in the vice so that it rests on a block to raise it above the level of the jaws and to prevent it tipping when the filing pressure is applied. Swivel the vice to bring the long axis of the work pointing towards the body. Select a smooth file with a blade about twice as long as the material. Lay the file on the work and hold it there with the tips of the fingers of the left hand only. Now take hold of the file handle with the tips of the fingers and thumb of the right hand. As the file is moved to and fro along the work, the left hand keeps it in level contact with the work, and the right hand merely actuates the file without exerting any upward or downward pressure which would tend to tip the file on the work. The action of the right hand and arm is very similar to that employed when using a billiard cue, that is to say the object is to maintain a straight line motion. In time, these movements become automatic, and the pressure exerted by the fingers of the left hand is transferred from finger to finger so that it is maintained towards the centre of the work and there is thus no danger of the file tipping.

In this manner, it will be found that, if required, the work can be filed slightly concave in relation to both its long and its transverse axis. Clearly, this method of filing is intended for producing accurate work and not for removing a large amount of material in a short time.

Pinning of the file teeth with metal particles will cause scoring of the work surface and must be avoided at all costs.

Some files, it will be found, tend to pin less readily than others, particularly those which have had a little wear ; the use of only light pressure when filing is also a safeguard. Tap the file against the bench from time to time to dislodge the filings from between the teeth, and immediately any scoring action is felt, examine the file and remove the offending metal particle with the point of an old scriber before any further damage is done to the work.

With a little practice, it should be possible to file all the long flat surfaces, here encountered, to a good and accurate finish ; in addition, this will serve to protect the worker from the temptation to use emery-paper in an attempt to obtain this result. The edges of the arms can be finished by draw-filing, for in this case it does not matter if these are made slightly rounded by the file being inadvertently tipped from side to side owing to unequal pressure being applied by the two hands. The radiused ends of the arms can be filed to the marking-out lines, but it may help, if these lines cannot be clearly seen, to bolt a washer to the face of the work to act as a filing guide. Finally, these surfaces can be given a good finish by draw-filing and, at the same time, keeping the file moving along a curved path.

Making the Grinding Tables. Part 2.

The dimensions of the two grinding tables are given in Fig. 10, and it will be seen that they are similar except for the location of the threaded holes for the attachment screws. These two parts can, therefore, be conveniently marked-out on a single piece of material and the holes drilled and tapped $\frac{1}{4}$-in. B.S.F. before the tables are cut to size. The wheel gaps are cut out with the hacksaw and then filed to the dimensions given, but it should be noted that the sides of the gaps are filed to a bevelled edge on their underside so that they will clear the wheel when the table is set tilted.

The work surface of the table should not be finished by filing until after the attachment brackets have been secured in place, for the projecting screw ends can then be filed flush at a single operation. Nevertheless, all the edges of the table can be finished at this stage by draw-filing.

Mild-steel is not, of course, the ideal material for making grinding rests, as it is so readily scored by the abrasive dust which collects on the table surface. This objection can be overcome either by using an iron casting, and so abandoning the built-up form of construction, or by case-hardening the table ; but, in this event, it will almost certainly be found necessary to have the work surface-ground to correct the distortion resulting from the hardening process.

The two brackets shown in Fig. 10 for attaching the tables to the rest arms are of similar construction, except that the right-hand part is drilled, and tapped $\frac{5}{16}$ in. B.S.F., 11/32 in. from its upper surface, instead of on the centre-line as in the case of the left-hand bracket. These parts are made from $\frac{5}{8}$ in. square mild-steel, and their upper and front abutment surfaces are filed flat and square to ensure accurate fitting. After the brackets have been secured in place by means of the $\frac{1}{4}$ in. B.S.F. attachment screws, the bracket itself is gripped in the vice to allow the table surface to be filed flat, in accordance with the suggestions already offered for carrying out this work without danger of forming a convex surface ; for, if the table surface has the latter form, the tool may rock while being

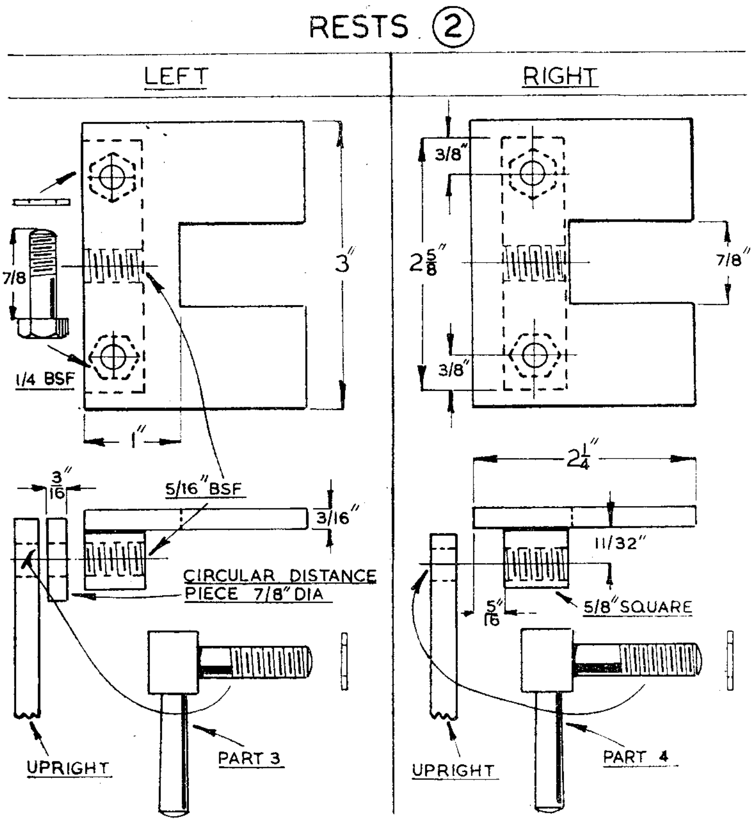


Fig. 10

sharpened and the ground surfaces will not then be flat.

The Clamp Handles

The next operation is to make the three, handled, clamping screws denoted as parts 3, 4 and 6 and of which the detailed dimensions are given in Fig. 11.

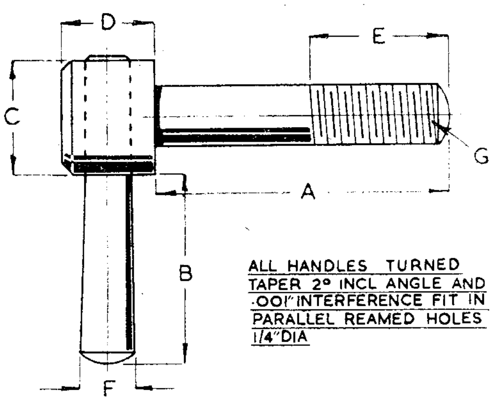
When making the screw itself, it is advisable in the first instance to cross-drill the $\frac{5}{8}$ in. diameter rod used, by securing it in a cross-drilling jig of the type previously described. After these holes have been located and drilled, the material is gripped in the chuck and the screws are machined and threaded in the ordinary way. To give a good appearance, the heads of the screws should be turned, and their ends faced and chamfered after the work has been reversed in the chuck.

The handles are turned to a taper of approximately 2 deg. included angle by setting over the top slide, but the diameter of the parallel end portion of the handle is made one thousandth of an inch in excess of $\frac{1}{4}$ in. to make it a secure press fit in the reamed hole in the screw head. These handles should be given a good finish by gripping them by their parallel portion in the chuck of a drilling machine running at high speed.

A piece of worn abrasive cloth, folded over the handle, is then worked up and down with the fingers, and, if a little oil is applied to the work, a smooth, even finish will be obtained which, here, gives a better appearance than a highly polished surface.

The right-hand rest can now be assembled and is then ready for use, but the left-hand rest, as shown in Fig. 10 and in the photograph in Fig. 12, requires a distance collar $\frac{3}{16}$ in. thick to bring the table into the correct position in relation to the grinding wheel.

It will be seen that the three rest clamping-screws have washers beneath their heads, and all have been fitted so that their handles lie vertically when fully tightened; this is done partly for the sake of appearance, but also to locate the handles in



PART No	A	B	C	D	E	F	G
(3)	1 1/8"	1 1/4"	5/8"	1/2"	3/4"	5/16"	5/16" BSF
(4)	1 5/16"	1 1/4"	5/8"	1/2"	3/4"	5/16"	5/16" BSF
(6)	7/8"	2"	5/8"	1/2"	1/2"	5/16"	5/16" BSF

Fig. 11. *Details of the clamping-screw* a convenient working position.

As already described the handles can be correctly positioned either by fitting them with washers of suitable thickness or by facing down the shoulders of the screws, but in the case of the upper screw of the left-hand rest, part 3, this is, perhaps, best done by using a pile of washers instead of the distance collar, and then making this collar to a thickness equal to that of the trial washers as measured with the micrometer.

Adjusting the Rests

When adjusting the rests for use, the gap in the table of the left-hand rest is set to the wheel by swinging the rest arm, but the gap of the right-hand table is set by sliding the rest as a whole in its bracket mounting.

It should, perhaps, be mentioned that, in the actual grinding machine worked on, the hexagon rods carrying the bar, part 1, were set to project $3\frac{5}{16}$ in. from the main casting, but this distance can, of course, be varied if required to facilitate mounting the grinding rests.

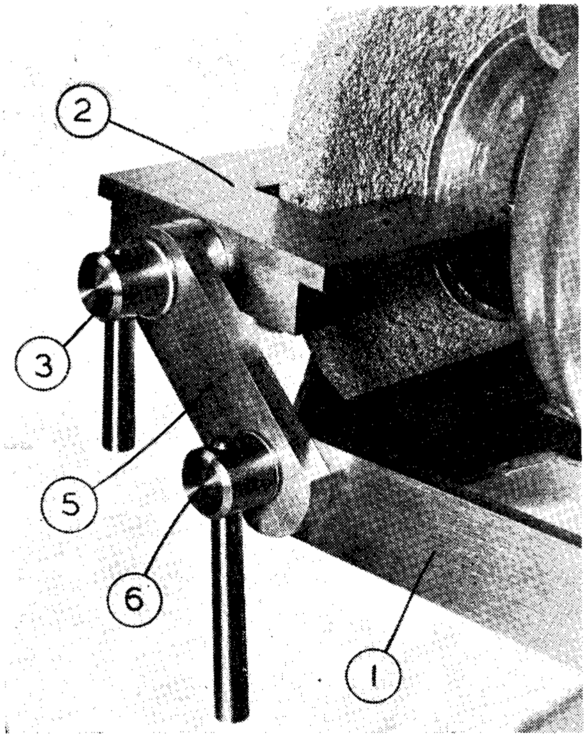


Fig. 12. The left-hand grinding-rest in position

When the work has been completed and the rests are in place, it will be found that they are very rigidly mounted and can be used for all ordinary tool-grinding operations; furthermore, it is the work of a few seconds only to remove the right-hand rest and replace it by the twist drill grinding jig.

Although the description here given applies to the Wolf grinding machine, there should be no great difficulty in equipping machines of other makes in a similar manner, and thereby gaining the many advantages offered by adjustable grinding rests as well as a sure means of sharpening twist drills correctly.

A Successful Joint Exhibition

(*Continued from page* 514)

Bristol and West Model Aero Club

Two "Thermalist" $11\frac{1}{2}$-ft. sailplanes, by Messrs. K. W. and R. J. Moon. 52-in. span tailless push-pull monoplane framework, by Mr. R. T. Howse. 4 ft. span nylon covered duration model with 5 c.c. "Vulture" engine, by Mr. C. H. Middleton.

Bristol 7-4-2 Club

Three 4 mm. fully-scaled G.W.R. locos, by Mr. F. H. Bigg. Specimen pieces of 16.5 mm. trackwork, by Messrs. W. and G. Faulkner. Four T.P.O. mail vans, 4 mm., by Mr. J. T. Fraser.

Bristol and West Model Race Car Club

Hydraulic brake h.p. tester, by Mr. B. Harris. 10 c.c. prototype race car, by Mr. B. Harris.

Bristol Model Power Boat Club

Metre hydroplane *Bullrush*, by Mr. G. Noble. Jet unit (U.S.A. manufacture), by Mr. Kerswell. A very fine model tug, by Mr. Dickson.

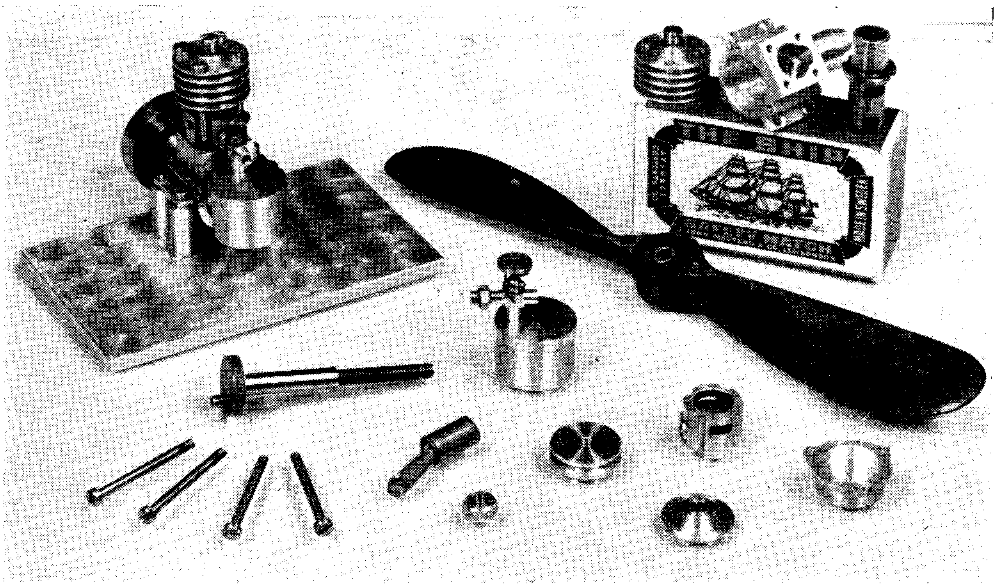
Bristol Model Yacht Club

Although not participating officially, owing to present complete lack of a sailing water, this club loaned a number of fine model yachts including a new Marblehead designed and built by Capt. Watkins of Portishead.

A 0.3 c.c. Compression-Ignition Engine

by A. G. Boulting

THE following is a description of and instructions how to make a small diesel, or more correctly, compression-ignition engine. The bore is ¼ in. and stroke ⅜ in.; this is equivalent to about 0.3 c.c. No soldering or screwcutting is necessary, and all the work, consisting of turning, drilling and boring, with the use of 5-, 8- and 10-B.A. taps and dies only, can be done on a 2½-in. plain lathe.



An engine complete, along with a dismantled engine, showing the component parts

The crankshaft is $\frac{3}{16}$ in. diameter, which is extremely large compared with the bore of ¼ in., but is very strong and has long-wearing qualities; for this reason no bushes are fitted to the dural crankcase. This will prove quite satisfactory.

A small drilling-jig will save a great deal of time marking out, and can be used to drill the four 8-B.A. holes in the crankcase, the four clearance holes in the port sleeve, and also in the cylinder-head.

Four of these engines have been made without any trouble, and one proved very satisfactory in a small 'plane of 30 in. span. They should be quite suitable for a small car or boat.

Mild-steel is used for the cylinder, piston, contra-piston, connecting-rod and crankshaft. All these are case-hardened and finished by lapping.

Crankcase

Make this from a suitable piece of dural about 1 in. long. Mark out and turn a ⅝ in. diameter boss ½ in. long and leave this parallel for the present, to hold in the chuck, for the rest of the turning. When the crankcase is finished the boss can be turned to a taper on a $\frac{3}{16}$ in. spigot. Hold boss in chuck, face off, drill 11/64 in. right through, bore out to $\frac{9}{16}$ in. diameter, 13/32 in. deep and finish bearing with a $\frac{3}{16}$ in. reamer.

Remove from chuck, and mark out position for the cylinder. The quickest way to machine this is to set it up in a four-jaw chuck, with a piece of silver-steel through the main bearing to centre up. Drill and bore out to $\frac{5}{16}$ in. for cylinder, then set the crankcase over ⅛ in. and cut out transfer port with a 5/32 in. diameter drill.

Cylinder

Make this from mild-steel; drill out carefully, and bore out, leaving three or four thou. to finish with a ¼ in. reamer. Mark out and drill ports, clean up with files, taking care not to mark the cylinder bore opposite the transfer port, as scratches take a lot of lapping out. A piece of shim-steel in the bore will save this. File a flat about ⅛ in. wide from the lower edge of the transfer port to base of cylinder, to increase transfer port area. Case-harden, clean up and remove any scale from ports. Lap out to a good finish, make up a new lap and keep this for finishing only, use fine paste or jeweller's rouge only. Several articles in THE MODEL ENGINEER have given full particulars of the best way of doing this.

Piston and Contra-Piston

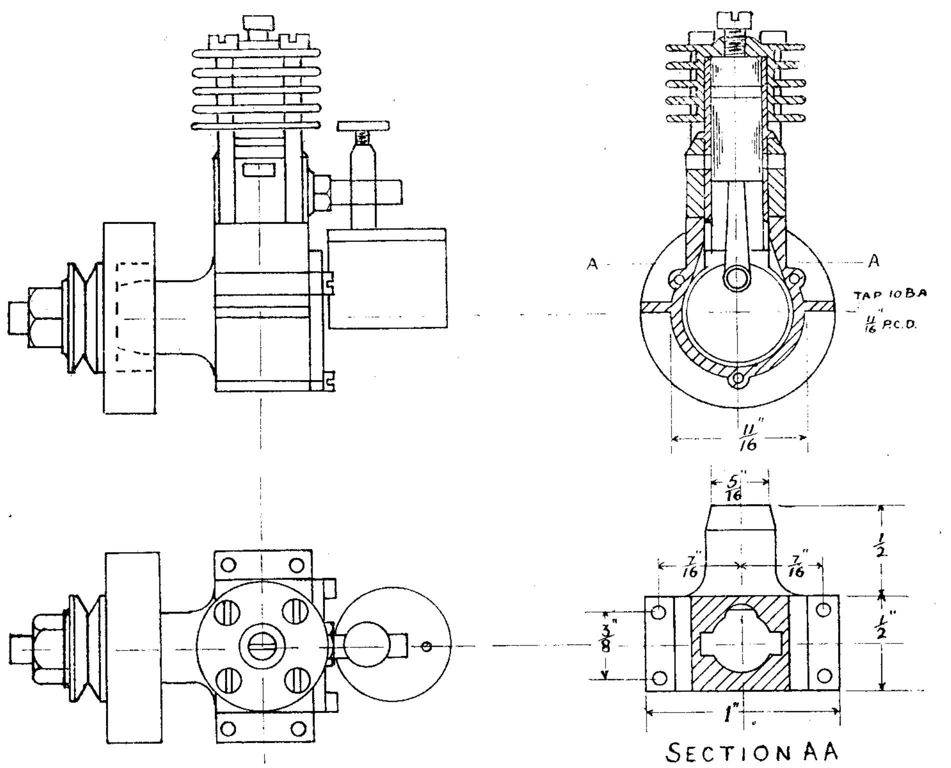
Make the piston and contra-piston together from a piece of mild-steel $1\frac{1}{2}$ in. long. Turn $\frac{3}{4}$ in. to 7/32 in. diameter, this will allow the lap to run clear. Reverse in chuck and finish to 0.002 in. over the finished size of the cylinder bore, finish the inside of the piston to 0.210 in. diameter. With a thin parting tool cut about half-way through, $\frac{7}{16}$ in. long for the piston, and again at 5/32 in. for the contra-piston. This will leave about 3/32 in. to keep the lap steady and prevent the head of the contra-piston being rounded.

Case-harden, then lap to a tight fit in the cylinder. When the piston just enters the cylinder, leave it at this, and saw it off. It will be found that the metal at the bottom of the parting groove will not be too hard to be cut with a small Eclipse saw. Drill out the contra-piston, and saw off.

Bore out a piece of dural about $\frac{1}{2}$ in. long to fit the piston, cut through lengthways. Hold the contra-piston and piston in this to face off. In the piston, drill a 10-B.A. clearance hole, and countersink with a centre-drill.

The contra-piston should be a tight fit, but the piston may want easing very slightly. Turn a piece of rod to 0.210 in. diameter, drill and tap 10 B.A., secure the piston with a screw, and polish with a lap, nearly dry, and a little rouge. Work on the piston until it is a perfect fit.

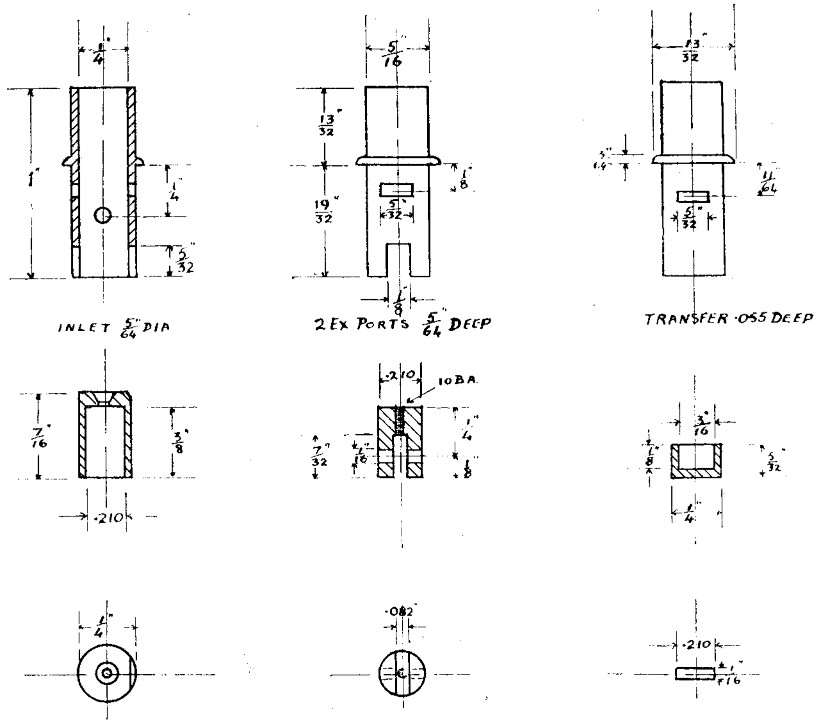
An alternative method of making the piston and contra-piston is to finish the outside diameter as before, bore out the piston; then give it a good soaking in case-hardening compound, and allow it to cool out. Replace in the chuck, and part half-way through as before. Heat up again and quench out. This will leave only the working faces hard.



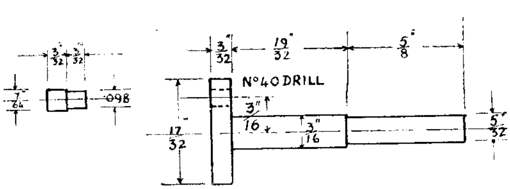
General arrangement of the engine

Carburettor

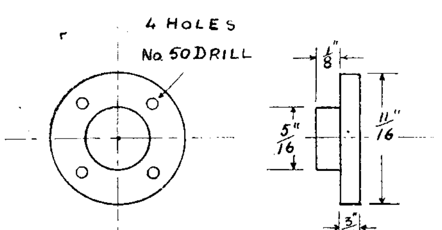
This can be sawn out to shape from $\frac{1}{8}$ in. dural plate. Hold in a four-jaw chuck, and turn a boss $\frac{1}{8}$ in. diameter, and $\frac{5}{16}$ in. long. Die this 5 B.A., and after finishing the thread, drill through 5/64 in. Then for the boss for the jet, set up in a four-jaw chuck, use a drill, or piece of 5/64 in. silver-steel through the carburettor body, to set up to. Turn a boss $\frac{1}{8}$ in. diameter. Drill right through with a No. 55 drill, for the 10-B.A. thread. Open out front boss with a No. 51 drill, and using this as a guide, tap out 10 B.A., in position. Both threads will then be in line. Finish the other two bosses on the outside in a three-jaw chuck, and taper the inlet with a centre-drill.



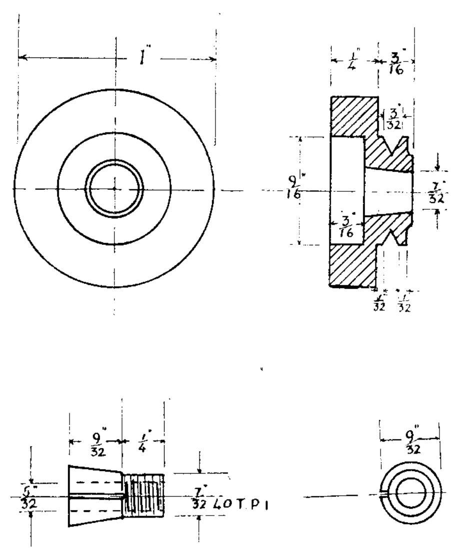
Cylinder, piston and contra-piston assembly



Crankshaft



Drilling jig



Details of the flywheel

Port Sleeve

Dural is the best metal for this. It is an advantage to leave the sleeve about 1/64 in. long, and any errors in the connecting-rod centres, crank throw, or piston, can be allowed for by turning a little off the lower end. Start with the outside diameter $\frac{11}{16}$ in., and bore through $\frac{5}{16}$ in.; make this a good fit on the cylinder. Then set over $\frac{1}{8}$ in. and mill out transfer port. Remove from chuck, and with the drilling jig, drill the four holes for the cylinder-bolts; open these out with a No. 42 drill, for 8-B.A. clearance. Drill a No. 37 hole for the carburettor, $\frac{1}{4}$ in. from the top; also, holes for the exhaust ports. Make certain all these holes are in correct relation to the transfer port.

With the sleeve on a $\frac{5}{16}$-in. spigot, turn each end to $\frac{1}{2}$ in. diameter, leaving $\frac{3}{16}$ in. for the induction pipe boss, and then chamfer the top end. Set up in a four-jaw chuck to the No. 37 hole, and a boss $\frac{3}{16}$ in. diameter is then turned; face off and tap 5 B.A. File all spare metal away.

Crankshaft

A mild-steel bolt can be used for this, and will save a lot of hard work on a small lathe. Leave about 0.002 in. on the bearing diameter for

Carefully drill the big- and little-end holes The big-end boss can be turned in a four-jaw chuck, and then file rod to shape. Case-harden, and lap out the big-end to fit the crank pin.

The Jet

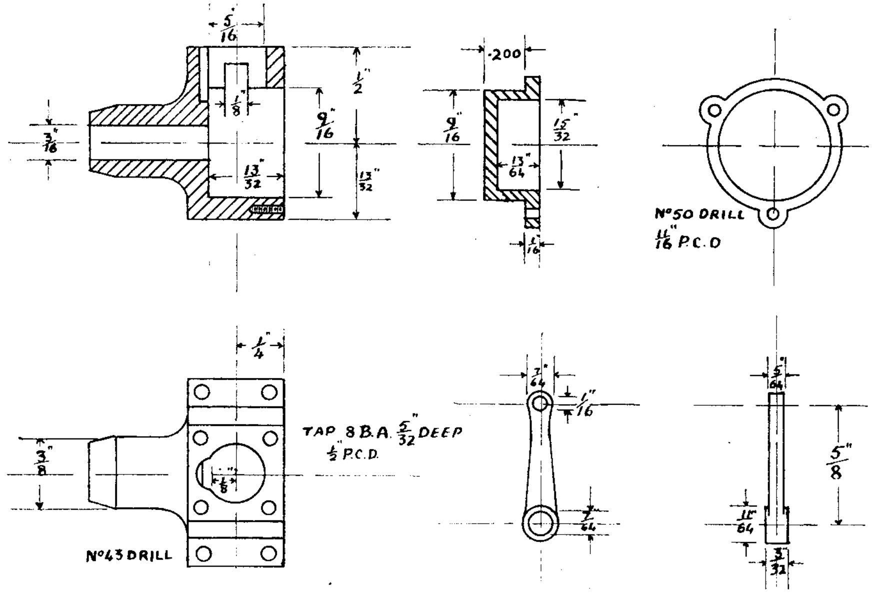
This is turned from brass. Turn to 0.086 in. diameter, $\frac{11}{16}$ in. long, die 8 B.A. for $\frac{3}{8}$ in. Centre with a small drill, reverse in the chuck, and drill with a No. 58 drill, leave about 1/32 in., to drill through for the jet. This is drilled 0.010 in., a No. 80 drill will do.

The needle valve is turned from $\frac{1}{4}$-in. mild-steel. Finish the point to a fine taper. A wire extension soldered on the head will give better control. A coil spring of three or four turns will keep the needle in position.

Piston Yoke

This is made from dural. Make it a good fit in the piston. Drill gudgeon-pin hole, and cut a slot for connecting-rod clearance. Drill and tap the other end 10 B.A. The gudgeon-pin is of silver-steel, hardened and tempered.

The cylinder-head, and crankcase cover are both turned from dural, they are straightforward turning jobs, and no instructions are required.



Details of crankcase, end-cover and connecting-rod

lapping; this is quite sufficient, provided a good finish is left after turning, and the metal is not over heated when hardening. Finish the crank-pin hole with a No. 40 drill. Case-harden, and clean up crankshaft with a $\frac{3}{16}$-in. dural lap to fit crankcase. Turn the crank pin from mild-steel and case-harden, or from silver-steel, hardened and tempered, and leave about 0.001 in. on each diameter. Polish with a fine oilstone, and leave about 0.0005 for a drive fit in crank disc.

The connecting-rod is also of mild-steel. Use the drilling jig again for the bolt holes, and open out with a No. 42 drill for 8 B.A. clearance.

The fuel tank is also made from dural, and can be any convenient size. A spring clip can be used to hold it together.

Four cylinder-head bolts, 8 B.A., and 1 in. under the head are required. Aeroplane surplus bolts are suitable for these. They are tough, but will take a good thread.

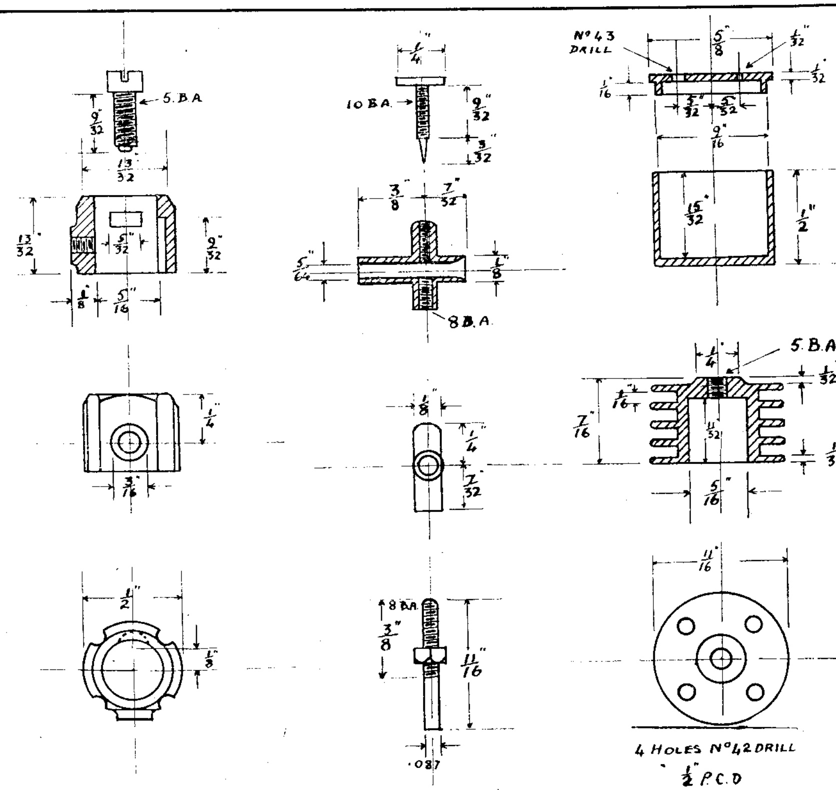
Three 10-B.A screws are also required for the crankcase.

If it is desired to make the engine as light as possible, before assembling the crankshaft, fit the end cover, and with a hacksaw and files, cut as much metal away as possible.

Assembly Notes

From a piece of phosphor bronze, turn a thrust washer 9/32 in. diameter, drill $\frac{3}{16}$ in., and part off 0.015 in. wide. Fit this on the crankshaft, oil and assemble in the crankcase. Turn port at B.D.C. Inlet should be fully open at T.D.C. Check the length of the port sleeve, and if necessary, place on a $\frac{5}{16}$ in. spigot, and face from the bottom end until correct. If a cardboard disc is made, and marked in degrees, the port opening can be checked. Exhaust opens 130 deg., inlet and transfer ports 100 deg.

Note the position for the deflector on the piston, remove it and stone the deflector about



Details of port sleeve, carburettor, tank and cylinder-head

another thrust washer 9/32 in. diameter, drill 5/32 in., and part off 1/32 in. wide. Place this on the shaft, press the flywheel assembly on and take up all end play. Lock the flywheel on the taper. Make a 10 B.A. screw 5/32 in. long, with a 60 deg. on the head. Do not cut it off from the rod, use this to screw it in position.

Place the piston in the dural holder and lightly grind the screw-head into the piston, with a little fine paste. Clean out any grinding paste, place the connecting-rod assembly inside the piston, and with the piston in the dural holder, grip lightly in a chuck. Screw the 10 B.A. screw in tightly ; a little jointing can be used here. Saw the rod off, face off, and finish smooth with an oil stone. At this stage the deflector has not been cut on the piston. With the crank pin at the top, the connecting-rod and piston can be fitted. Fit cylinder in position, without the port sleeve in place, and set it so that the top of the piston is level with the bottom of the exhaust 1/32 in. deep. Replace and check the opening, which should be about 15 deg. after the exhaust. Should the opening be less, dismantle and stone a little more off the piston, until correct.

Thoroughly wash and clean all the parts. Assemble the engine with a little oil. No jointing compound is necessary, as it only makes the engine difficult to take down. A little oil on all the joints proves satisfactory. Lock the carburettor in position with a 5-B.A. nut. Set the jet with about one turn showing in the induction pipe.

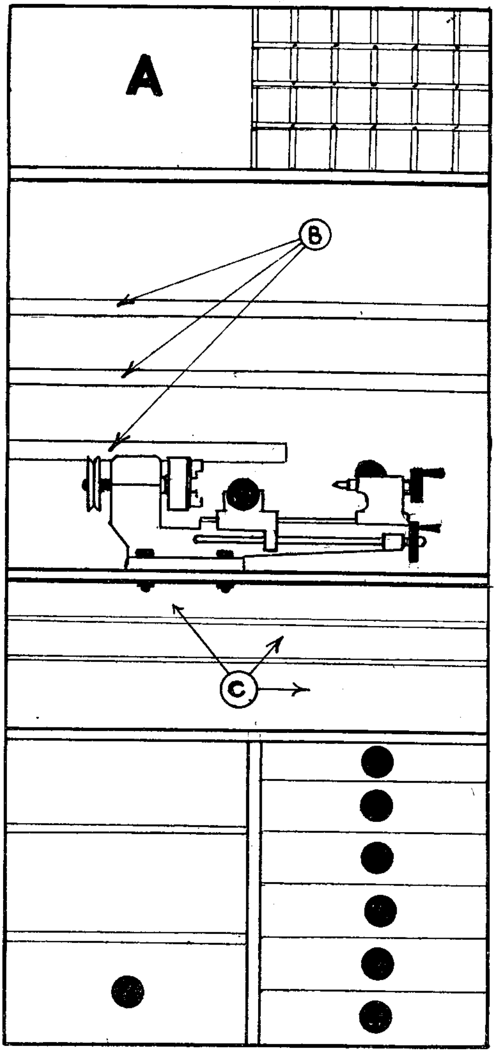
The engine is now ready for a test run. A fuel made up of two parts paraffin, two parts ether, and one part castor oil will give good results. Any standard fuel mixed with an equal measure of ether will do, or ready mixed fuels. They are probably less harmful to the engine than the paraffin mixture.

Try the carburettor needle one turn open. Choke the carburettor and turn the engine over

(*Continued on next page*)

A Cupboard Workshop

by J. H. MacPhee



MANY articles have been written for THE MODEL ENGINEER on workshops, ranging from small portable shops to the more elaborate miniature factories. I trust I may be excused if I present yet another variation on an old theme. As my interest lies in ship modelling, my only machine tool is a small 2¼-in. Rollo lathe. The workshop, if one can term it so, is used only for operating the lathe, and storing tools.

The workshop [?] is sited in a cupboard, approximately 6 ft. 6 in. × 2 ft. 9 in. × 12 in. deep, and the sketch shows the principal features. The top shelf (A) has a rack for bar stock, and also accommodates some of the useful woods, such as elm, boxwood, etc.

The lathe is bolted to a bench built up from scrap wood, the top being of ⅞-in. pine. This proved rather noisy, so a sheet of ⅛-in. steel was bolted over the entire top. This effectively stiffened the bench and cut down the noise. The back of the cupboard was panelled in some old 5-ply, which was handy, and racked (B) to hold drills, cutters, etc. Space not occupied with racks was fitted to hold calipers, pliers, etc. The space (C) immediately under the bench contains the paint store. A series of drawers is fitted on one side below this, and holds in addition to small tools, the assortment of scrap and junk which everyone seems to collect. Two shelves are fitted on the other side, for the larger lathe accessories, and beneath them a deep drawer contains a portable ropewalk and store. Electric lighting is installed above the bench.

Although this arrangement will not appeal to model engineers, it may be of use to ship-modellers and model railwaymen, who possess some of the smaller lathes on the market, and who, like myself, cannot obtain the space for a shed workshop.

A 0.3 c.c. Compression-Ignition Engine

(*Continued from previous page*)

once or twice, then with the compression screw slack, give it a sharp pull over with the cord. If it does not fire and becomes stiff in turning over, do not force it. With the piston at the bottom, blow through the exhaust ports to clear the oil away. If the engine will not run smoothly, and unscrewing the jet has no effect, the choke is probably too large, screw the jet in another turn and try again. If the jet is screwed in too far, it will have the effect of a very small choke; and the needle control will be extremely sensitive.

Once the correct setting for the jet needle and contra-piston is found, the engine should always start without any trouble. The engine will run in either direction. Running light with the flywheel, the engine can be made to run well past the 15,000 r.p.m. mark on a Dekko rev. counter, but no useful purpose can be served by doing this.

Crankshaft for Propeller

Make the $\frac{3}{16}$ in. diameter ⅝ in. long, and ¾ in. of 4-B.A. thread. Use a 0.015-in. thrust washer behind the crank disc only. Screw a dural pulley $\frac{9}{16}$ in. diameter, and 5/32 in. wide, with a groove for starting; on the 4-B.A. thread. If the engine is stiff, a plain flywheel with a 4-B.A. clearance hole can be clamped against the pulley, and used for testing and running in. When the engine is free, a 6 in. diameter propeller can be fitted.

The weight of the complete engine with fuel tank and propeller should be just under 2 oz.

PRACTICAL LETTERS

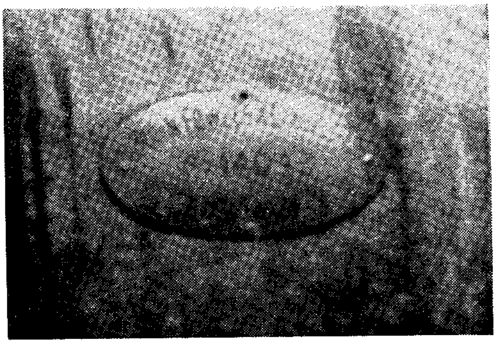
Re Fowler Plough Engine—14049

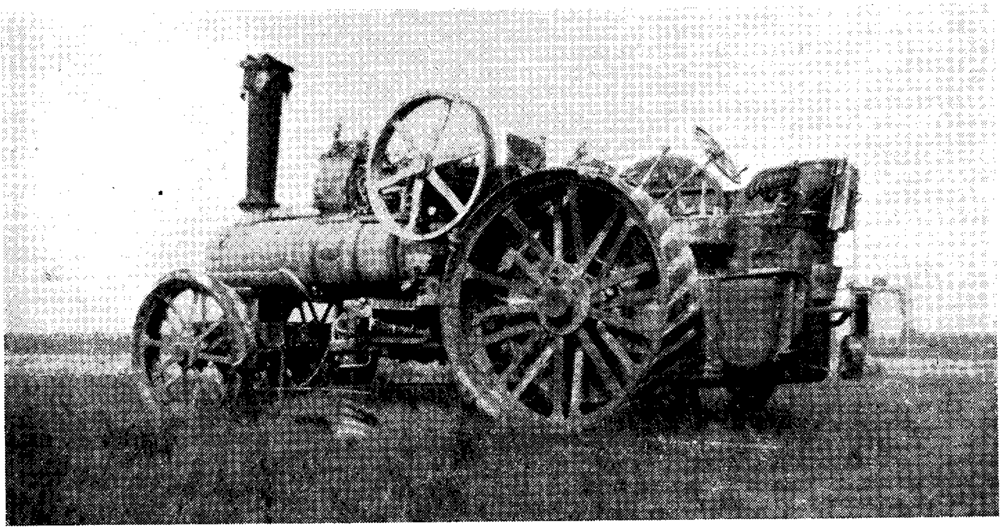
DEAR SIR,—When passing Beeding Cement Works near Shoreham some weeks ago I saw standing in a siding a Fowler engine in fair condition, but did not have time to stay and examine it.

However, on a later Saturday, I again visited the site, where major extensions are in progress, to see if the engine was still there and to obtain a few snaps. To my dismay it was not in the same position as before; I looked about, but could find no trace of it, until I inquired from the workmen and was informed that it was near the top of the hill.

I climbed to the top, approximately 200 ft. above, and there I found her, where she has apparently recently been at work with a scraper clearing top soil to enable the chalk to be exposed.

I sincerely trust the enclosed snaps will be of interest, particularly that of the plate on the side of the barrel where the number of the engine 14049 can be seen. The registered road number is CE 7749.





It is a compound type with a working pressure of 200 lb. per sq. in. The photographs do not really do it justice, as it now stands in a very exposed condition, and is covered in cement and chalk dust. When I first saw it, it was much cleaner than now.

Yours faithfully,

Brighton. S. R. BOSTEL.

Balance Wheel Adjustments

DEAR SIR,—I feel that I must reply to the letter from Mr. G. H. Thomas (September 15th) as I feel that he has overlooked one or two important points.

I am quite aware that it would be bad practice to carry out the adjustment suggested on watch or *normal* clock balances, nor do I think that anyone with any practical knowledge would attempt to do so.

If Mr. Thomas will refer to my original letter he will find that I stated that this method of adjustment could be used *in the case of the Eureka clock.*

It must be remembered that the maker of these clocks provided poise screws with very long threads to allow for adjustment. How, therefore, can it be bad practice to use this adjustment?

Furthermore, as it is usual to start adjustment of these clocks with all screws half out, his objection that it is not possible to move screws inwards does not apply.

Yours faithfully,

WATCHMAKER.