A Design for a Model Compound Condensing Steam Engine.

By "AXLE."

NO model looks better, I think, than a well-made compound steam engine. The following is the result of an attempt made by the writer to furnish himself with working drawings from which to make a model condensing engine. In designing the model, drawings of a set of compound marine engines (with H.P. and L.P. cylinder bore, of 13 ins. and 26 ins. diameter, and a stroke of 20 ins.) of a kind usually installed in small coasting steamers were kept in view as a type upon which to base the design. Although not an exact copy of such a class of engine, an attempt has been made to retain the same general appearance. A good working model is essentially a compromise, simplicity of design and appearance being of first importance. Also a reasonable efficiency is expected of an engine built to be one that will do something more than merely " go."

The H.P. cylinder bore is 1 3/4 ins. and the L.P. cylinder 3 ins., giving a cylinder area ratio of 2.9: 1. In order to keep down the overall height of the engine a rather short stroke of 2 ins. is used. A working pressure of 100 lbs. per square inch, giving 500 as the maximum revolutions per minute, has been assumed. The engine is fitted with the usual pumps driven by levers operated by the L.P. engine. Liberal bearing surface has been given to the working parts and means of adjusting them provided wherever thought necessary.

The valve gear is of the overhung type, with all-round reversing gear. The H.P. engine is fitted with a plain piston valve and the L.P. with a Rat valve. The condenser is fitted with 83 tubes 1/4 in. diameter. The bedplate is cored out to form a chamber connecting the condenser and air pump. The circulating pump is double-acting and forces water into the condenser at the L.P. end and discharges at the other, as it was not thought necessary to fit a partition in the condenser cover to obtain a return flow of the cooling water. Figs. 1 and 2 show the general arrangement of the model.

In describing the details of the engine, I will consider the parts requiring castings first, commencing with the bedplate, which is shown in Fig. 3. The patterns should not be difficult to make. The several facings on the upper surface are all in the same plane. The bedplate has an extension which carries the air-pump. A chamber is cast in this extension, which connects the air pump and condenser. A core box will be required to form the core in moulding this chamber. The pockets for the main bearings and the recesses at the front and back should also be cored out. The mould should be arranged to part at the underside of the top flanges of the casting.

The bedplate should be cast in good cast-iron, allowing 1/16th in. on all the surfaces to be machined. The casting should be free from blowholes and spongy metal. Having obtained a suitable casting, mark it off carefully to the dimensions given in the drawing in the following manner. Set the casting up on an angle-plate so that the upper surface of casting stands in the vertical plane with the underside towards the angle plate and with the front of the casting horizontal. The casting having been. previously whitened should have the centre lines corresponding with the front columns, main bearings, condenser, and air pump plainly marked with the scribing block sliding on the marking off table. As these centre lines will be required as guides in erecting the engine they should be permanently marked in with a fine centre punch. The centre lines at right angles to the above-mentioned centre lines may now be marked in, applying a square for this purpose. Having obtained the chief centre lines the other machining marks can be located by compasses. The holes for the front columns, main bearing bolts and condenser fixing bolts can now be marked in. To form a centre for the hole corresponding with air pump barrel, a wooden plug upon which is attached a piece of tinplate can be fixed in the casting. The machining marks for the upper surface and depth of pockets can be marked on the casting if the scribing block is applied to the angle plate.

The first machining operation should be the planing of the underside of the casting, which should be bolted upside down on the table of the shaping machine. A cut should be taken across the bottom to form a flat surface for the heads of the main bearing bolts. The bottom flange of the casting through which the holding bolts arc drilled should be just cleaned up. The casting should now be turned over in order to machine the top and the pockets. As before-mentioned, the upper facings being all in one plane, they can be machined all together. The casting should be secured to the shaping machine table so that the sides of the pockets can be machined at the same setting. The table should now be turned through 90 degs. so that the pockets can be machined along the bottom and other sides. The seating for the air pump barrel can be bored out with a cutter bar after mounting the work on an angle plate attached to the lathe saddle. The casting should now be drilled

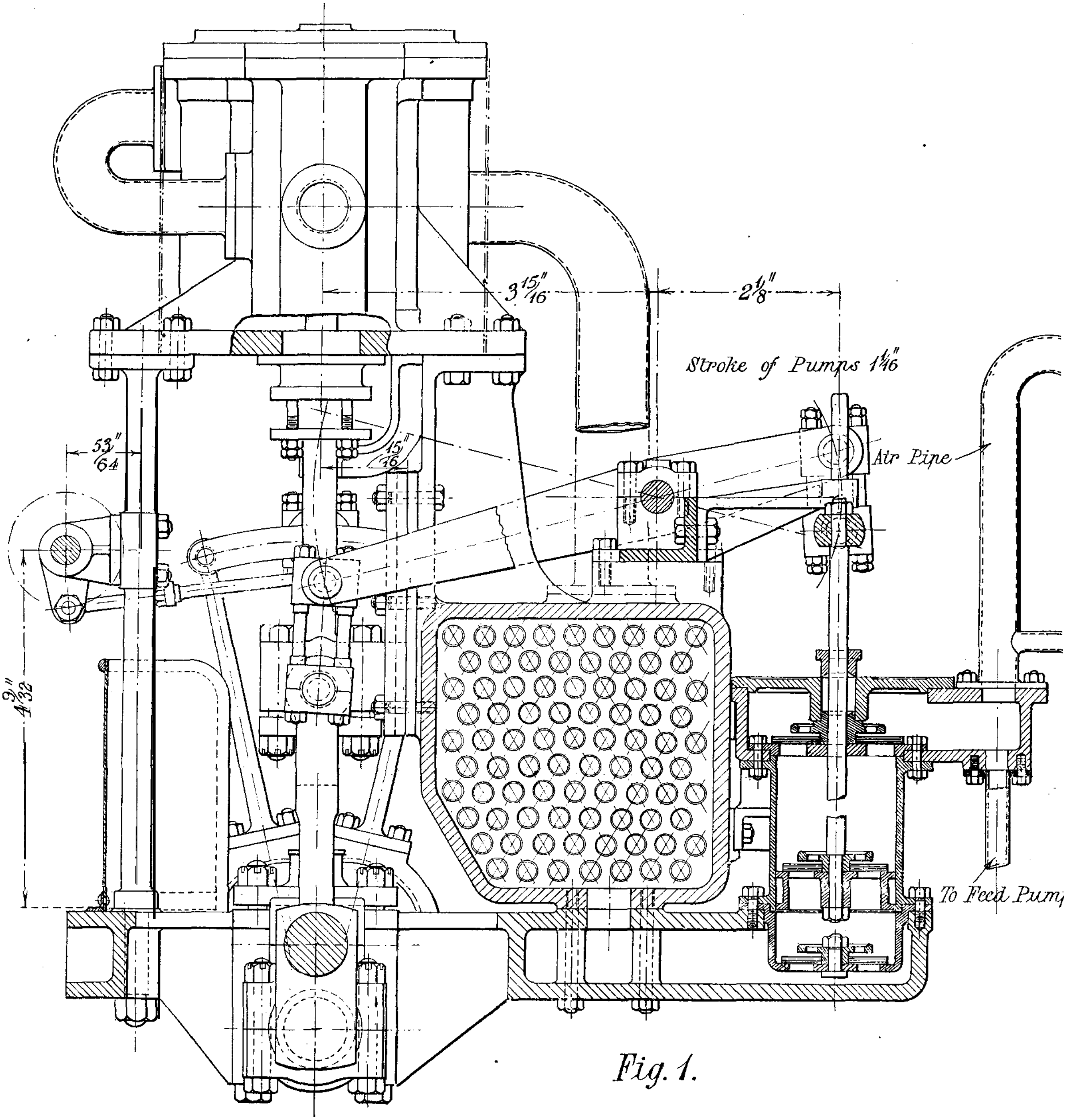
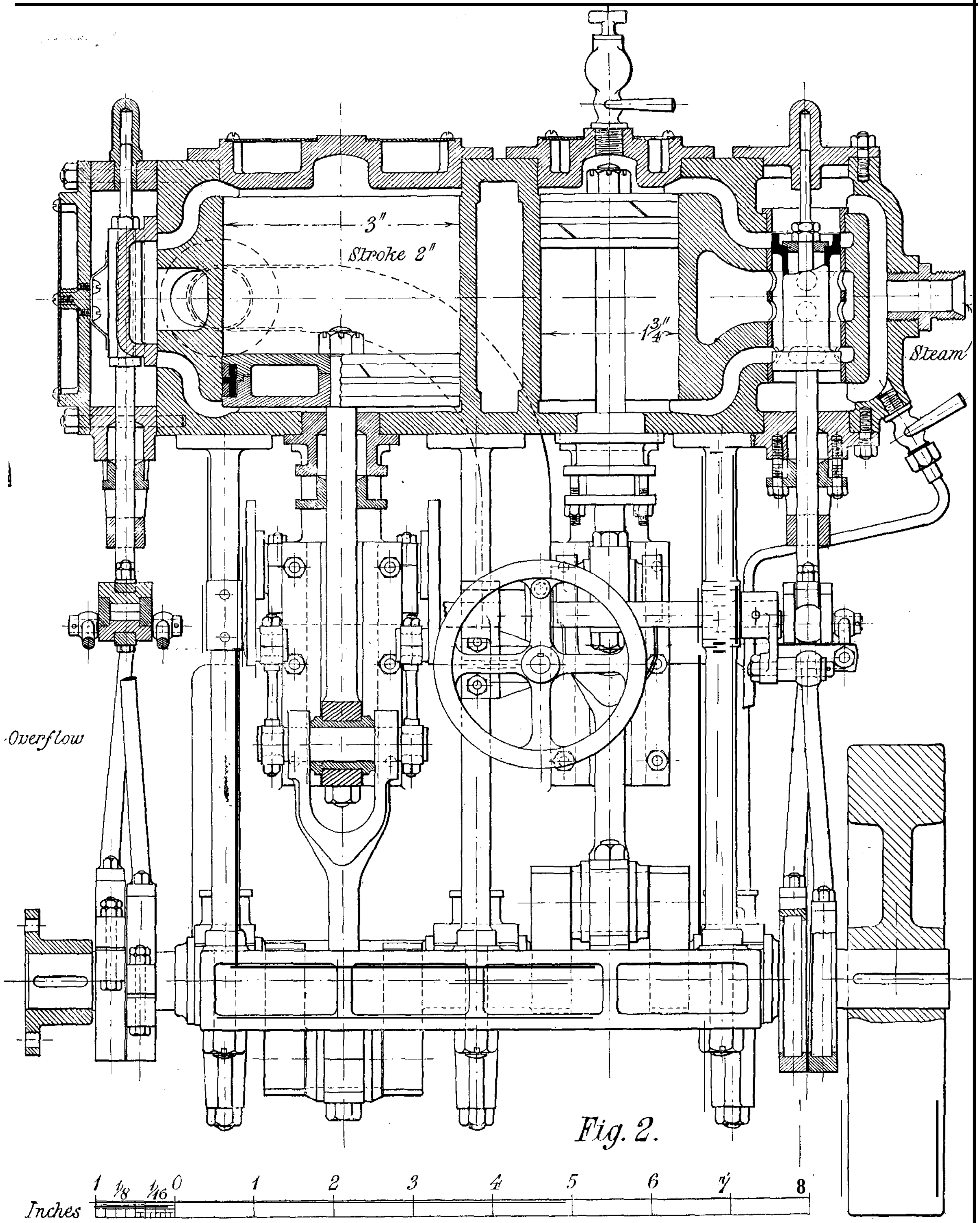


Fig. 1.

GENERAL ARRANGEMENT DRAWINGS OF A MODEL COMPOUND CONDENSI



STEAM ENGINE WITH CYLINDERS 1-3/4-IN. AND 3-IN. BY 2-IN. STROKE.

and tapped. The holes for the main bearing bolts are 15/64th in. diameter drilled right through the casting. Studs can, of course, be used, holes tapped 7/32nd in. diameter and 1/2 in.deep being provided for this purpose. The holes for the front columns are 5/16th in. diameter and should be drilled perfectly square with the upper surface. 8 holes 9/64th in. diameter are drilled for the studs holding the condenser to the bedplate. The four centre holes are drilled right through the casting, and should be faced on the underside with a 5/16th-in. pin drill, to give a flat surface for the nuts. The air pump barrel is secured to the bcdplate with six No. 5 BA studs, and the facing should be drilled and tapped for the studs at least 7/32nd-in. deep The holes for the holding-down bolts are 13/64th in. diameter to suit No. 2 B.A. bolts, four holes being drilled at the front and three at the back of the casting. The casting should be filed up along the edges of the flanges and .the crank races. The port leading to the air pump should be filed up to size if necessary, and the sharp corners should be taken off the pockets for the main bearings.

The H.P. and L.P. cylinders are cast together. To facilitate the machining of the L.P. valve face. and to simplify the casting, the L.P. steam-chest is attached as a separate casting to the main portion of the cylinders by means of studs. Core boxes will be required for forming the ports which are cast in the cylinders. The bottom of the casting is perfectly flat. The feet for securing the cylinders to the front columns and condenser are extensions of the bottom flange and have been arranged to give the least trouble in moulding. The piston-rod stuffing boxes are separate from the cylinder casting, so that the cores for the cylinder boxes can be supported at hoth ends. With the exception of the core boxes little difficulty should be encountered in the making of the patterns for the cylinders.

The cylinders should be made of close-grained cast-iron, care being taken to obtain a clean, sound casting. The casting should be accurately marked off to the dimensions given in Fig. 4.

The casting should be mounted on the faceplate in the lathe and the bottom surface machined right across. This machined face will then form a flat true surface for setting up the casting for further machining.

It is probable that a lathe large enough to swing the casting when boring the cylinders will not be available, so that the boring out will be done with a boring bar. If a lathe big enough to take the casting set up on a faceplate is available (a gap-bed lathe of 5-in. to 6-in. centres at the least will be required), then the casting should be attached with the machined side towards the faceplate and resting upon two parallel strips, so that the faceplate will clear the tool when the holes for the stuffing boxes are being bored out.

The casting should be set up for boring out the H.P. steam-chest first. As the casting will be considerablv out of balance when rotating in the lathe a suitable balance weight should be placed on the faceplate opposite the casting.

The rough surface of the hole should first be removed with a stiff flat drill, say 7/8 in. diameter, which could be followed up with a 15/16th-in. diameter twist drill. The finishing cut should be done with a hooked boring tool, and care should be taken to ensure a smooth and parallel hole. If a 1 in. diameter parallel reamer- is available the bore should be finished off with it, but reamering is not essential. The top and bottom of the steam-chest should be counter-bored to suit the steam-chest covers. The sharp corners should be removed by chamfering at 45 degs. to say 1/64th in. to I/32nd in. deep.

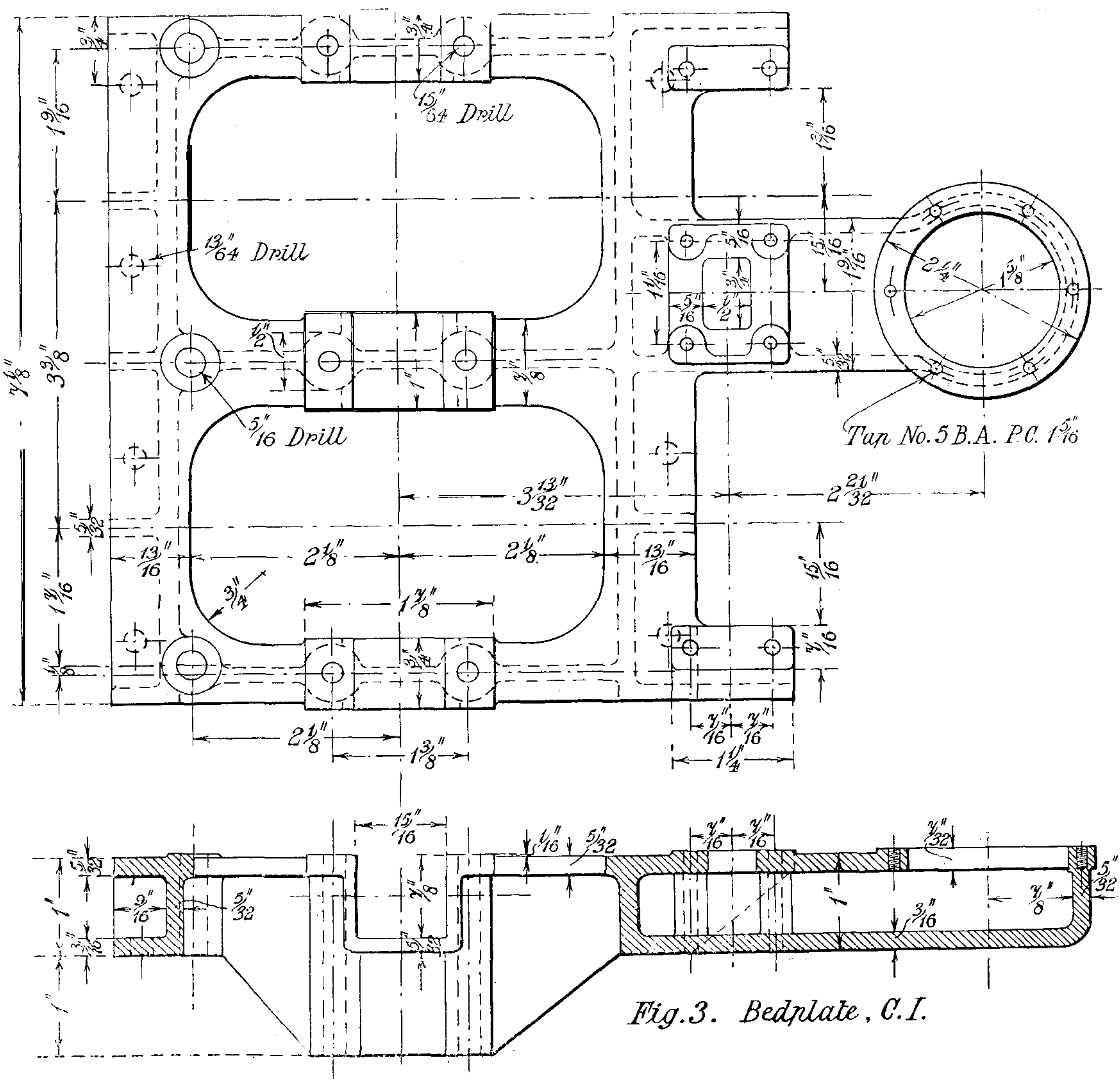
The casting shouid now be moved on the face. plate and set true for boring out the H.P. cylinder. A fairly heavy cut should be taken as a first cut so as to get well below the hard surface, and using as stiff a boring bar as possible. The cutting speed should not be too high and fairly light cuts should be taken after the first cut. The finishing cut should be done with a broad, well-rounded tool. A hooked tool will be required for counter-boring the bottom of the cylinder to 1/16th in. larger in diameter. A cut can be also taken across the bottom, but it is not necessary if the casting is clean and cast to the correct dimensions. The top of the cylinder is counter-bored 1/16th in. larger in diameter to suit the H.P. cylinder cover. The bore can of course be ground to size, but as high a degree of precision as necessary should be obtained without grinding. The hole for the stuffing box should be bored out at this setting. A similar procedure should be followed in boring out the L.P. cylinder. The top of the casting should be machined right across at the same setting.

The L.P. valve face can be machined either in the lathe or in the shaping machine, or if the maker is skilful with the file and scraper, then these tools may be used. In any case the scraper will probably be used in bedding the slide valve down to its face. This, however, will be discussed later.

Should one's lathe he too small to carry the casting on the faceplate, then the casting should be bolted to the lathe saddle. The casting is 2 3/8 ins. wide from the centre on one side, so that it should be easily set up on a 3 1/2-in. centre lathe.

The casting should be bored out with a 3/4-in. diameter boring bar held between the lathe centres and passing through the bottom of the cylinder to be bored. Should the lathe not be one possessing a sliding saddle, then the casting should he bolted directly on to the lathe bed, and the traverse of the tool obtained by arranging the tool holder to slide along the boring bar. This can be done in the following way. The circular toolholder is bored out a good sliding fit on the boring bar and is tapped to suit a lead-screw passing through it, and which runs one tooth every revolution of the bar by means of a tripping device fixed to the lathe bed.

The steam inlet boss is tapped 3/8-in. B.S. pipe, to suit the steam-pipe union. The boss should be faced with a 1-in. diameter pin drill before tapping. The exhaust passage from the H.P. cylinder is a 1/2-in. diameter drilled hole. Thc



Plan and Sectional Elevation of the Engine Bedplate.

parallel to the boring bar. The lead-screw is held at the front end by means of a collar, in which the lead-screw can rotate but not move endways. Bv rotating the lead-screw (which has, say a 3/8-in. Whitworth thread), the tool-holder is moved along the boring bar. To cause rotation of the lead-screw a small star wheel is mounted at the front end and which is moved

boss for the H.P. exhaust pipe should be faced either in the lathe or with a pin drill, and also be tapped for the studs securing the exhaust pipe. The exhaust passage from the L.P. cylinder is a 5/8-in. diameter hole drilled obliquely through into the exhaust port. The exhaust pipe boss should be faced and tapped for the studs securing the exhaust pipe.

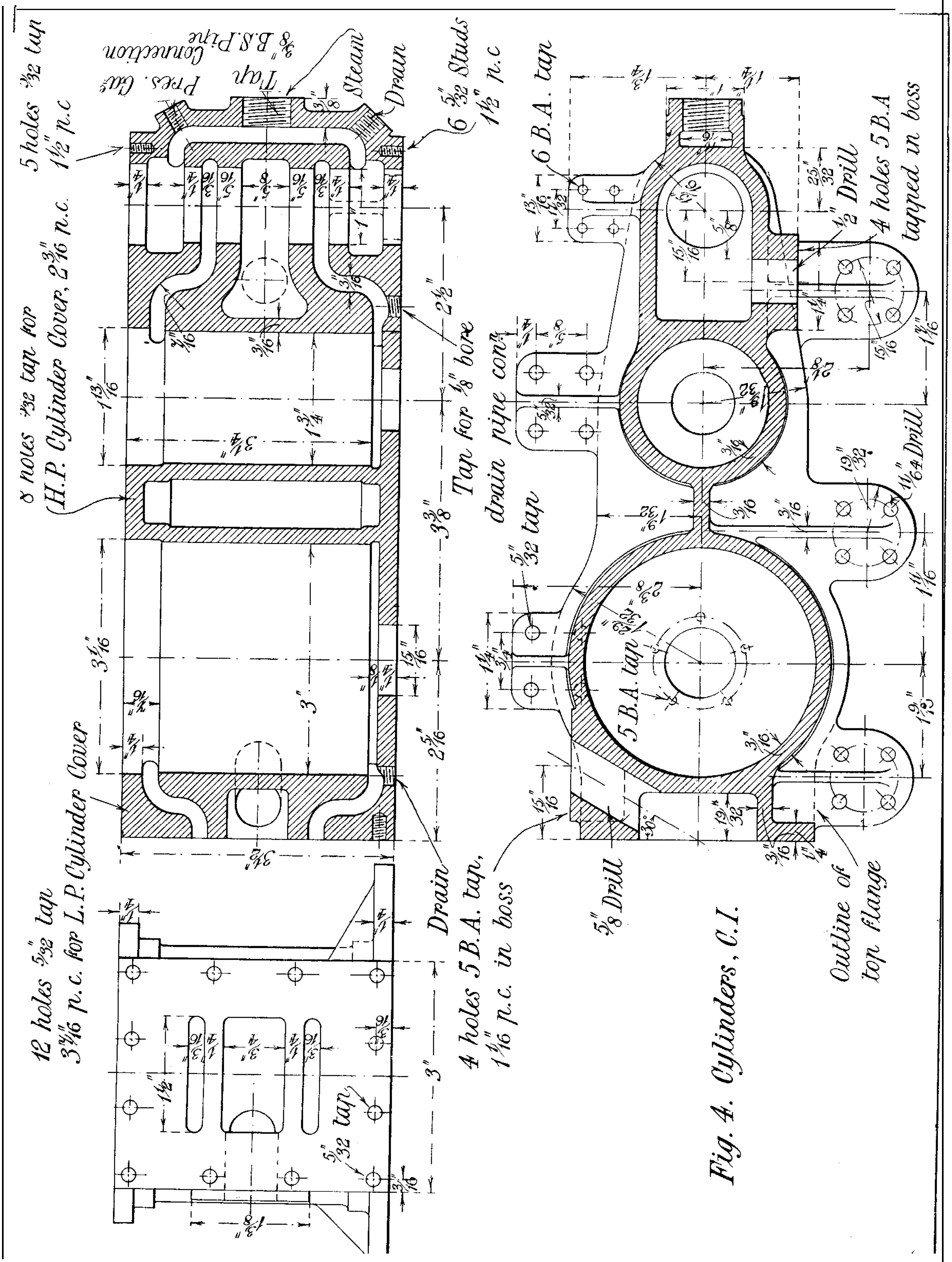


Fig. 4. Cylinders, C.I.

The tapped holes for the H.P. and L.P. cylinder covers and steam-chests will be dealt with later, as they should not be drilled until the parts to be attached to the cylinder are ready for fitting.

Three holes for the drains are tapped 1/4 in. diameter and 30 t.p.i. in the cylinders at the bottom of the steam ports, as shown on the drawing. The holes for the screws securing the lagging are tapped No. 8 B.A. and 1/4 in. deep, and are situated 1/8 in. from the edges of the casting and spaced about 1 5/8ins. apart as symmetrically as possible around the flanges.

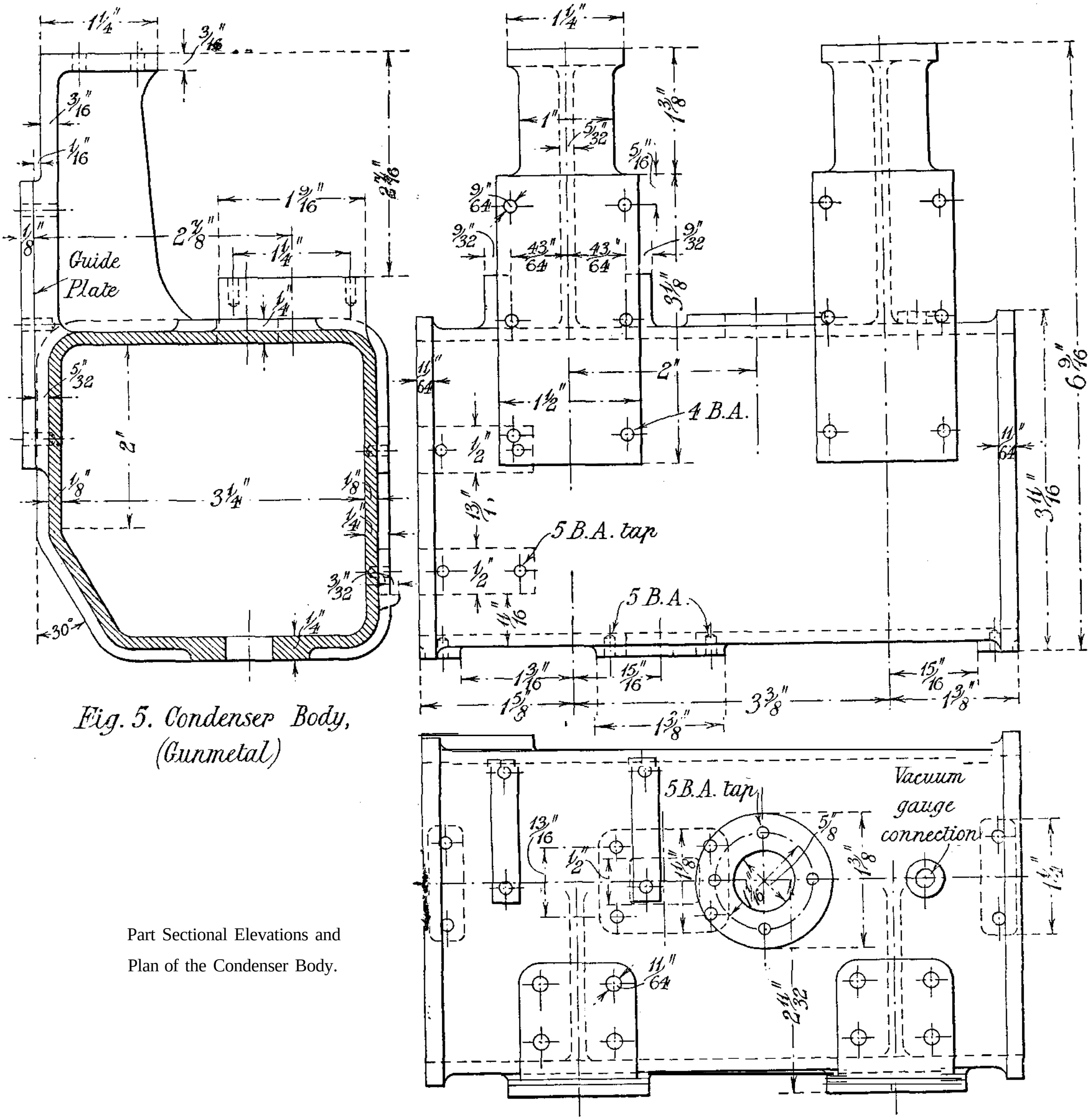


Fig. 5. Condenser Body, (Gunmetal)

Part Sectional Elevations and Plan of the Condenser Body.

The body of the condenser is shown in Fig. 5. It is made of gun-metal, and the interior is cored out. Having obtained a good casting, it should be prepared for marking off. First lightly machine the two faces of the columns upon which the guide plates fit, machining the two faces at the same time if possible to ensure that they are parallel and in the same plane. The casting can now be set up on the surface plate and marked off from these accurate surfaces very carefully.

The facings for the guide plates may now be machined down to the right depth. The ends of the casting should be faced next. This may be done in the lathe. Secure the casting on an angle plate with guide faces downwards and with one end towards the faceplate. The outer end may then be faced across. The casting may now be turned end for end and again machined. The tops of the columns, the feet carrying the bearings for the pump levers, and the facings at the back and bottom of the castings, can be machined at one setting in the shaping machine. This, of course, depends entirely upon the tools at the maker's disposal, and many of the parts which would be usually machined can be finished with the file and scraper when in skilful hands. The guide plates are secured to the columns with four No. 4 B.A. studs and two No. 4 B.A. bolts in each, and the columns should be drilled and tapped accordingly.

The holes for the screws holding the bearings for the pump levers and the bolts holding the cylinders should be left undrilled until the time comes for fitting up these parts.

The condenser body should now temporarily be clamped to the bedplate, so that the holes in the bottom may be marked off for drilling and tapping. The centre lines on the condenser should register accurately with those on the bedplate, and the guide surfaces should be perfectly parallel and square to the main bearing pockets before the holes are marked off. Eight No. 4 B.A. studs secure the condenser to the bedplate. The boss on the top of the condenser to which the exhaust pipe is attached is drilled 5/8 in. and also tapped No. 5 B.A. for the four screws securing the exhaust pipe. A small boss is provided which is drilled and tapped to suit the connections for attaching a vacuum gauge

(To be continued.)

Watt Colliery Engines.

AN interesting correspondence between Boulton & Watt and a Swansea firm, written between the years 1779 and 1781, has recently been published in South Wales. It relates to proposals for the erection of a colliery engine, and James Watt informs his correspondent that he proposed to install an engine with a cylinder 52 ins in diameter with an 8 ft. stroke, making 8 strokes per minute. He estimated that this would require about 64 bushels of coal per 24 hours, provided that a proper " boyler, such as are used in Cornwall " were employed. It has been estimated that this engine would have an output of about 30 b.h.p., with a coal consumption of something less than 7 lbs. per b.h.p. hour. Now, Watts' engines were erected on a profit-sharing basis under which his firm received the value of one-third of all the coal saved, and as a Newcomen engine of the period would consume nearly 18 lbs. of coal per b.h.p. hour, it wili be seen that his profits would bc very considerable.

Radio Engineering.

The Licence Difficulty : A Suggestion.

In view of the apparent deadlock at present existing concerning the issue of licences for the 'reception of wireless to those amateurs who desire to construct their own apparatus, the following suggestions are put forward as a possible solution of the difficulty which undoubtedly exists.

There are at the moment three distinct classes of wireless amateurs :-

(1) Those who desire simply to receive broadcast telephony and are content to purchase complete sets bearing the B.B.C. mark of approval.

(2) Those who desire to receive broadcast telephony, but who prefer to construct their own apparatus of more or less stereotyped design and from components of what are practically standard pattern.

(3) Those who wish to construct, or assemble, their own apparatus for experimental work of greater or lesser elaboration, and to whom broadcast telephony is probably a secondary consideration.

As matters stand, those in the first group are easily and simply catered for by the issue of broadcast licences from all post-offices. The P.M.G. and the B.B.Co. each receive their due share of the fees paid and the licencee can set to work. At the same time, there is a growing feeling that in some instances the manufacturers forming the B.B.Co. are charging prices for their products which smack of " profiteering."

Those in the second group form the difficulty. They are not true " experimenters "-though many of them mav later become such-and the paragraph in Form 43a requiring them to state previous experience in the use of wireless apparatus hits them badly. So also does the paragraph requiring them to state the nature of the experimcntal work they desire to conduct. Many of them have no wish to be classed as experimenters, and the real earnest experimentcr is rather put about that such individuals are placed upon the same plane as himself.

And this brings us to the third group, the members of which are suffering most of all, as until the difficulty concerning the second is settled, those in the third must wait.

It must have been foreseen that some such position would arise, and the blame for the present deadlock must be placed largely upon those who circulated such glowing pictures of the future of wireless-more particularly of broadcasting-without, at the same time, giving the general public a statement of exactly what they might and might not do. Con.. sequently thousands, from schoolboy to grey-

A Design for a Model Compound Condensing Steam Engine-II.

BY " Axle."

(Continued from page 254.)

We will now deal with the condenser tube plates, Fig. 6. They are made from sheet brass and filed up to shape, and are drilled to suit 1/4-in. diameter brass tubes. These holes should be very carefully drilled to secure accurate spacing of the tubes. The tube plates should be lightly covered nith solder or tinned on both sides to obtain a good joint mhen the tubes are finally sweated in.

Fourteen holes 9/64_th in. diameter are drilled round the tube plates through which pass the studs holding the condenser covers.

The tube plates are held to the hody of the condenser with six No. 5 countersunk head screws. It should be observed that the countersinking of the tube plates make them R.H. and L.H. The tube plates may now be used as gauges from which to mark off the holes in the end of the condenser. Twenty holes are drilled and tapped No.5 B.A. in each end and 14 studs fitted for attaching the covers. The ends of the condenser should be covered with a very thin

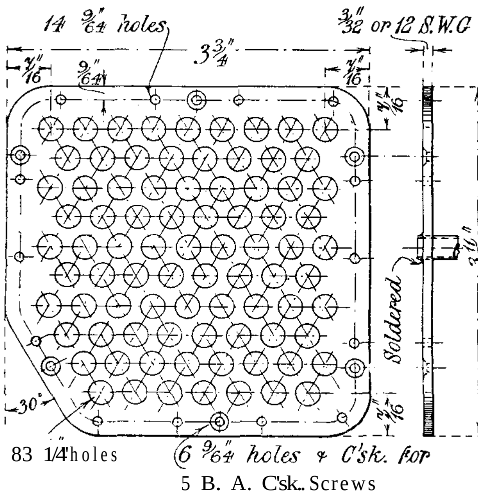


Fig. 6. Tube Plates.

Setting Out for Condenser Tube:.

layer of solder, so that when the tube plates and covers are finally fixed in position, a soldering-iron can be run round the joints to make them perfectly tight.

Little further can be said about the condenser until several of the other castings have been described. Firstly, We will deal with the air pump barrel, Fig. 7. This part is made from a, gun-metal casting, and is turned all over in the lathe. The casting should be made I in. longer than the finished length for chucking. The barrel has a spigot at each end, one which registers with the bedplate, and the other with the hotwell casting. The spigots should be a push-fit into the parts with which they register, and the bore should be smooth and parallel. It

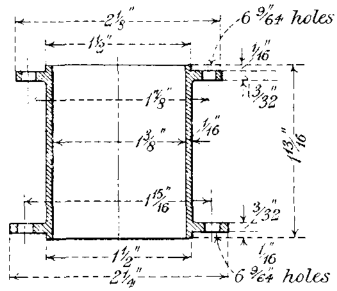


Fig. 7. Air Pump Barrel

Section of the Air Pump Barrel.

may be mentioned that on dimensioning the drawings no allowance has been made with regard to the limiting dimensions required to obtain the various fits, because the engine being dealt with is not one in which interchangeability is required,and the fit will be obtained in

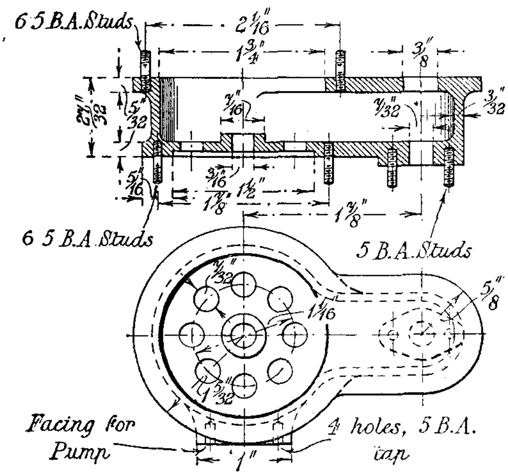


Fig. 8 Hotwell

Section and Plan of the Hotwell.

practically all cases by trying the parts together in position, or with the skilful use of callipers, Yet there is. no reason why the fitting parts should not be machined to definite limits. such as are given in Newall's tables and to be found in the majority of mechanical engineering pocket books. This method of obtaining precision will necessitate the skilful use of the micrometer.

The flanges of the air pump barrel are drilled with six 9/64th-in. holes in each, to suit the studs in bedplate and hotwell.

The casting for the hotwell is of gun-metal, Fig. 8. In Fig. 2 the head valve is shown as a separate part, but there is little reason why the head valve should not be in one piece with the hotwell. In any case, details of design such as this are left to the choice of the builder.

The casting should first be bored out for the cover, faced across the top and the valve sent. It can then be turned over and the recess machined to suit the barrel. Six No. 5 B..A. studs secure the air pump cover and six similar studs secure the hotwell to the barrel. The oval flange on the underside is drilled 1/4 in. and is also filled with two No. 6 B.A. screws for attaching the suction pipe to the feed pumps. Instead of an oval flange a screwed union may be used. (It is the opinion of the writer that the B.S.P. connections are rather bulky for small work, and special connections, which can be obtained from any firm of model engineers, should be used in all cases where a screwed pipe connection is required.) The valve seat has eight holes 7/32nd in. diameter drilled in it.

The circulating pump is double acting. The body of the pump is shown in Fig. 1). It is made from a gun-metal casting. The making of the patterns should be fairly simple. The barrel of the pump can be cast solid if desired. The valve box of the pump is separate from the body. Having obtained a suitable casting, it should be machined across the face upon which the valve box rests. This face will then form a flat surface upon which the casting can be attached to an angle-plate fixed to the faceplate of the lathe,

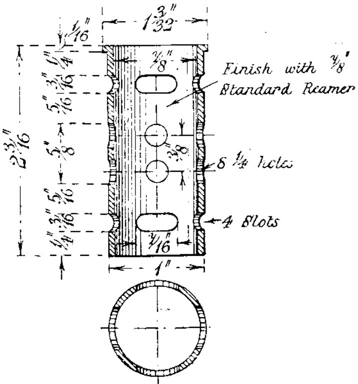
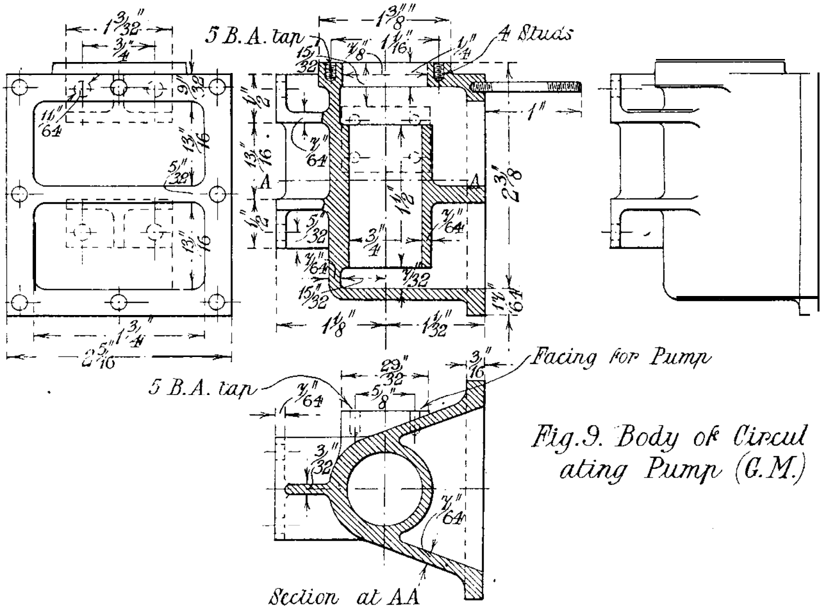


Fig. 10. H.P. Valve Liner, (C.I.)

Section of the High-pressure Valve Liner

to enable the barrel to be bored out. The top and bottom of the barrel should be slightly chamfered. The top of the casting can be bored and faced for the cover at the same time. The brackets holding the pump to the condenser should be machined parallel to the bore. The lower edge of the bottom bracket should be machined and filed up parallel with the cover face. This edge registers with the lip machined



Part Sectional Elevations and Plan of Circulating Pump Body Casting.

on the back of the condenser, which takes some of the load from the studs and also forms a means of alignment when fitting up the pump to the condenser.

The cover is held on with four No. 5 B.A. studs, and the casting should be drilled and tapped to suit. Eight No. 5 B.A. studs I in. long secure the valve box and the cover.

On one side of the pump there is a facing, upon which is attached the feed pump. This facing is drilled and tapped for the four NO. 5 B.A. screws which hold the feed in position.

Having now somewhat briefly described the making of the chief parts of the model, we will

I3/16th in. diameter by 2 1/2 ins. deep. The outside should then be rough turned down to slightly over size. The inside can now be bored out to size and lapped to obtain a smooth, parallel bore. The liner should be turned to a light force fit into the cylinder. Before parting off the liner, the position of the steam ports should be marked on with the point of a screw-cutting tool. The liner may now be parted off to length. The slots forming the steam ports can now be drilled out and finished off with the file. Eight 1/4-in. holes spaced as shown on the drawing form the exhaust ports. The liner can now be fitted into the cylinder, being drawn into

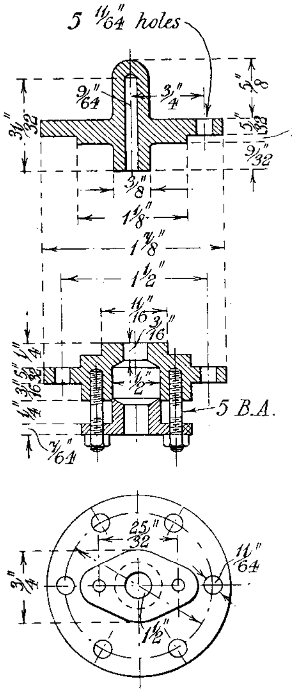


Fig. 11. H.P. Steam Chest Covers, G.M.

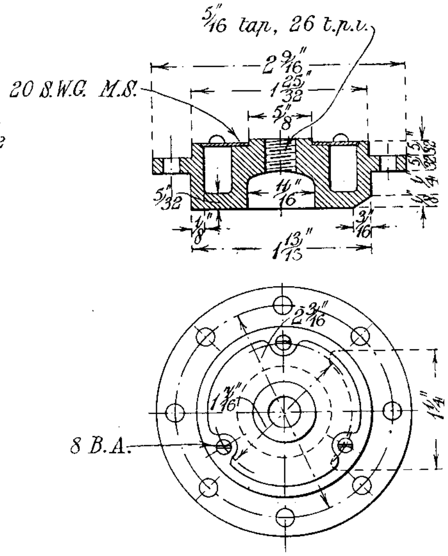


Fig. 12. H.P. Cylinder Cover, C.I.

Details of the H.P. Cylinder Cover and Steam Chest Cover.

deal with some of the minor parts required to complete the cylinders. Referring to Fig. 2, it will be observed that the H.P. steam-chest is fitted with a liner in which the slide valve works. The liner is shown in Fig. 10. It may be made of cast-iron or mild steel. A piece of mild steel solid drawn tube I in. outside diameter by 16 S.W.G. thick would probable be suitable. If the liner is made of cast-iron it should be made I I-16th in. outside diameter, thus making the thickness 3-32nd in. Suppose the builder decides to make the liner of cast-iron, a suitable piece of metal should be fixed in the lathe chuck and a hole drilled down the centre, say,

place with a 1/4-in. bolt and washers. If the liner seems too tight,it should be withdrawn and eased slightly on the hard places. The liner should draw in with a moderate pressure on the spanner. No attempt should be made to drive it in with a hammer. If necessary the bore of the liner can be lapped out with a suitable parallel cast-iron plug and emery powder.

The top H.P. steam-chest cover, Fig. 11, is made from a gun-metal casting. It should be placed in the chuck and the dome and outside turned up to size and polished. It should now be reversed end for end in th- chuck and set true for drilling the 9/64th-in. hole up the centre.

This hole forms the guide for the top end of the valve spindle. The cover has a spigot which should be turned to a push-fit into the cylinder. Five 11/64th-in. diameter holes are drilled in the cover. The bottom cover is also made of gun-metal, and has a stuffing box, into which is fitted an oval-flanged gland. The gland should be an easy push-fit into the cover. Both gland and cover are bored 1/4 in. diameter to suit the valve spindle. The gland is adjusted with two No. 5 B.-A. studs and nuts. The gland mag be turned from bar or from a casting. The cover has six II/64th-in. diameter holes drilled in it. The H.P. cylinder cover, Fig. 12, is made of cast-iron. provided three bosses to be drilled and tapped for the screws securing the lagging, and has twelve holes 11/64th in. diameter drilled in the flange.

The L.P. steam-chest, Fig. 14, is made of cast-iron. The steam inlet is on one side near the top. Both sides of the casting should be machined in the lathe, after which operations it should be set up on an angle plate in the iathe and bored out for the gland and valve spindle. The hole for the valve spindle should be bored right through the top of the casting, afterwards opening the top hole out to 5/16th in. diameter to suit the valve spindle guide. The facing for the valve spindle guide bracket should be

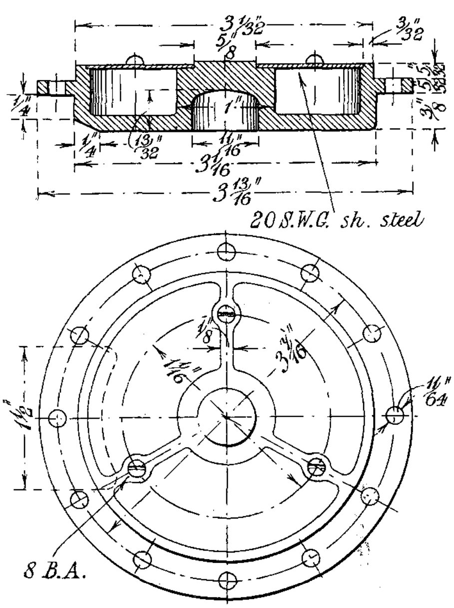


Fig. 13. L.P. Cylinder Cover, C.I.

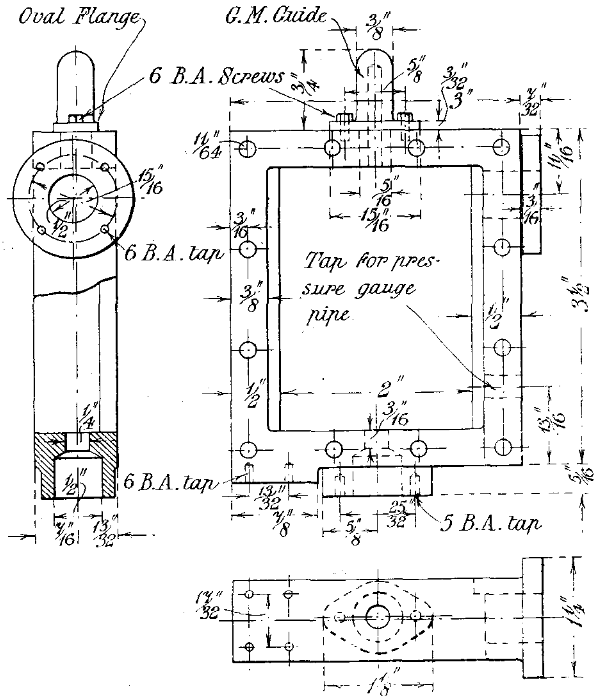


Fig. 14. L.P. Steam Chest CI.

Details of L.P. Cylinder Cover and Steam Chest.

It should first be turned up and polished on the outside and recessed. The cover should be drilled, tapped, and faced for a suitable lubricator. The underside of cover should be turned to a push-fit into the cylinder. The cover is bevelled on the side which comes opposite the steam port and is recessed for the piston nut. This recess and the underside should be cleaned up while the cover is in the lathe. A piece of sheet steel should be cut to fit the cover and fixed with three No. 8 B..4. screws. Eight holes 11/64th in. are drilled in the flange of the cover to suit the securing studs.

Fig. 13 shows the L.P. cylinder cover. The above remarks on the H.P. cover also apply to the L.P. cover. It has three ribs in which are machined when the stuffing-box is being faced across. The valve box should now be reset for facing up the steam inlet flange. Two narrow strips are cast on the inside of the valve box, which should be machined or filed up parallel to each other to form a guide for the slide valve. The casting must now have twelve II/64th-in. diameter holes drilled to suit the securing studs and ten No. 6 B.A. tapped holes, four in the steam inlet flange, four in the facing for the guide bracket and two for top valve spindle guide. It is tapped for two No. 5 B.A. studs for adjusting the gland. The H.P. and L.P. glands are of the same dimensions.

(To be continued.)

are introduced, thus making it possible for one piston valve to cantrol the steam of both cylinders at one side. The front piston valve head serves the front port of the inside cylinder, and also the back port of the outside cylinders, and vice versa, and by this means the rocking shaft with valve, valve spindle and valve connecting rod of the earlier locomotives are eliminated. The outside cylinders are identical in every respect, thus obviating the necessity for right and left-hand patterns. The piston valves have a diameter of 10 ins They were supplied by Allen and Simmonds, of Reading, in accordance with their patented design. The valves are arranged for inside admission and are actuated by Stephenson link motion as in the earlier type. Reversing is effected by meams of steam reversing gear fixed to the right-hand frame close to the reversing shaft, and operated from the footplate, the cut-off in fsll gear being 77 per cent.

The reconstructed engine is, as seen, provided with a large and comfortable cab of the standard type now adopted on the Glasgow and South Western section of the London, Midland and Scottish Railway. The tender, which is of the self-trimming or hopper type, has a water capacity of 3,260 gallons, and coal capacitv of 5 tons, whereas the original engine had a water capacity of only 2,500 gallons and carried 4 tons of coal.

In the original engine the rigid wheelbase was 8 ft. 9 in. This has been lengthened to 10 ft. in the reconstructed one, the total whcel-base, engine and tender being now 45 ft. 9 7/8 ins. as compared with 42 ft. 6 1/2 ins. In its original form the engine weighed in working order, without tender, 48 tons 14 cwt., the weight being now increased to 61 tons 9 cwt. Similarly, the tender, which weighed 32 tons 5 cwt., now turns the scale at 37 tons 7 cwt. The diameter of the wheels remains as before namely, 6 ft. 9 1/2 ins., for the coupled wheels, and 3 ft. 7 1/2 ins.for the bogie wheels. The bogie wheelbase has been increased from 6 ft. to 6 ft. 6 ins. The engine as originally constructed developed a tractive effort of 15,832 lb. In its altered condition it develops 18,390 ib. at 85 per cent. of the boiler pressure.

This is one of those cases in which a locomotive, though having become obsolete where first-grade main line traffic is concerned, still offered a sufficient opportunitv for conversion. .4s now running, it is practically a new engine and should rank among the most efficient 4-4-0 passenger locomotives in the country. .4lthou;;h the engine has been engaged in fast passenger traffic for a very short period it has, we are informed, already shown remarkable features of power output, acceleration and steady running at high speeds.

A Design for a Model Compound Condensing Steam Engine-III.

BY " AXLE."

(Continued from page 277.)

The piston rod stuffing boxes shown in Fig. 13 are made eithelr from gun-metal castings or from bar. They should be machined all over. They are a push-fit into the cylinders and should be bored out 3/8 in. diameter to suit the piston rods. Five 9/64th-in. holes are drilled in the top flange and the bottom flange is tapped for three No. 5 B.A. studs. The studs should stand out 5/8 in. The piston-rod gland is made of gun-metal and should be turned on the outside to an easy push-fit into the stuffing box, and bored to suit the piston rod. The flange is drilled to, suit the studs in the stuffing box.

The cylinder covers, valve box, and stuffing boxes can now be used as template for marking off the position of the studs required in the

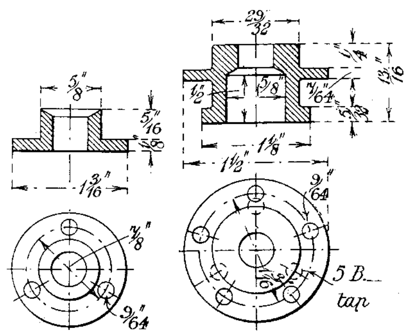


Fig. 15. Piston Gland, G.M

Section and Plan of the Piston Glands.

cylinder casting, care being taken to see tha: the bevelled portions of the cylinder covers are opposite the steam ports. In temporarily clamping up the L.P. valve box care should also be taken to get the centre lines marked on the castings registering exactly, and slide valve guides parallel to the cylinder bore. The studs securing the covers and valve box are 5/32nd-in. Whitworth, screwed about 1/4 in. into the casting and standing out at least 1/32nd in. longer than the length required to take a full nut with the various covers jointed in positiotn. The stuffing boxes are secured with five No.5 B.A. studs and nuts, and can now be attached to the cylinders permanently. No jointing will be required for the stuffing boxes, except, perhaps, a little red lead paste.

Fig. 16 shows the L.P. steam chest cover. It is made of cast-iron. If possible the lip or recess in the back of the casting into which fits the lagging should be cast in, otherwise the lip may be dispensed with and the lagging allowed co be flush with the sides

The cover should be machined on the plain side, and filed up to size on the edges and polished. The lagging is secured with five No. 8 B.A. screws.

To keep the slide valve on its face a spring is fitted to the steam-chest cover. This spring is bent from a piece of spring steel 5/16th in. wide and 22 S.W.G. thick, and is secured to the cover with two No. 6 B.A. screws. The flange of the cover is drilled 11/64th in. diameter to suit the valve box.

Fig. 17 shows the H.P. piston, which is fitted with a block ring and two split rings. A plain piston with two grooves turned in for the rings can be used if desired, or the block ring mav be dispensed with. The body of the piston is made

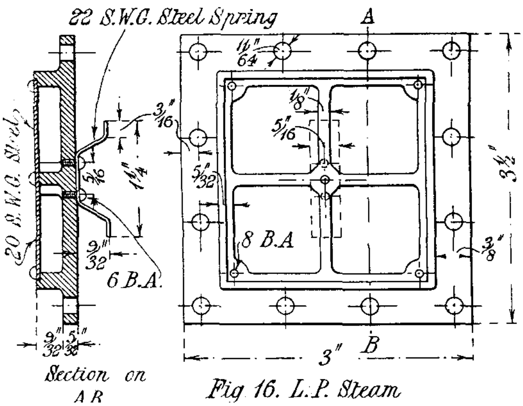


Fig 16. L.P. Steam Chest Cover C.I.

Elevation and Plan al the L.P. Steam Chest Oover.

in two pieces and each should have an extension cast on for holding the casting in the lathe.

Each casting should first be bored out 9/32nd in. diameter, faced at the joint, and rough turned to, say, 1/64th in oversize on the outside. The two pieces can then be mounted on a mandrel and turned to size. The body of the piston should be a good sliding fit in the cylinder, say, from ,005 in. to .008 in. stock. The block ring is machined all over and should float between the flanges of the piston when assembled. It should be bored out to an easy fit on the: piston body and should be the same diameter as the piston flanges. The piston rings can be turned from the casting used for the block ring. The rings should first be turned up to I 13/16th ins. diameter on the outside and 1 1/2 ins. inside and parted off to thickness. A piece should then be sawn out, say, 1/8 in. wide at 45', and the joint filed up true. The ring should now be mounted on a faceplate, being held in place with a washer big enough in diameter to grip the ring all round, but leaving enough room to allow the tool to work on the outside of the ring. To close the joint of the ring while it is being set up a piece of wire can be placed round it and the ends twisted. Having set the ring to run as true as possible, it should be again turned to the same size as the bore of the cylinder. Without

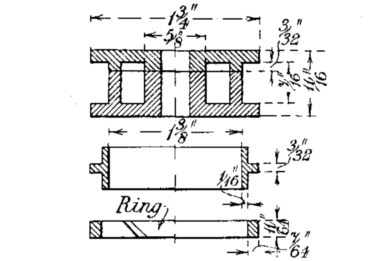


Fig. 17 H.P. Piston, C.I.

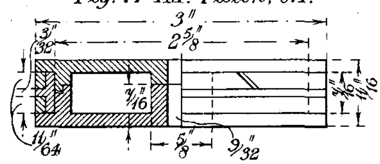


Fig. 18. L.P. Piston, C.I.

Details of the H.P. and L.P. Pistons.

removing the washer holding the ring, it should be gripped with small U plates, and bolts on the outside. Then the inner fixings can be removed and the ring bored out to its finished size, which is I I7/32nd ins. diameter. The rings should be tried in the cylinder and the joint filed to obtain

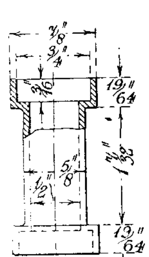


Fig. 19. H.P. Slide Valve. C.I.

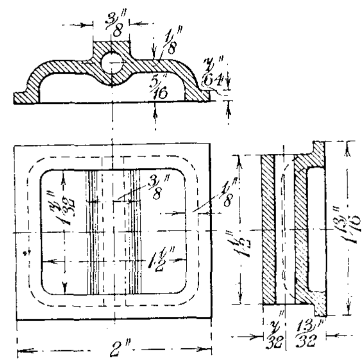


Fig. 20. L.P. Slide Valve, C.I.

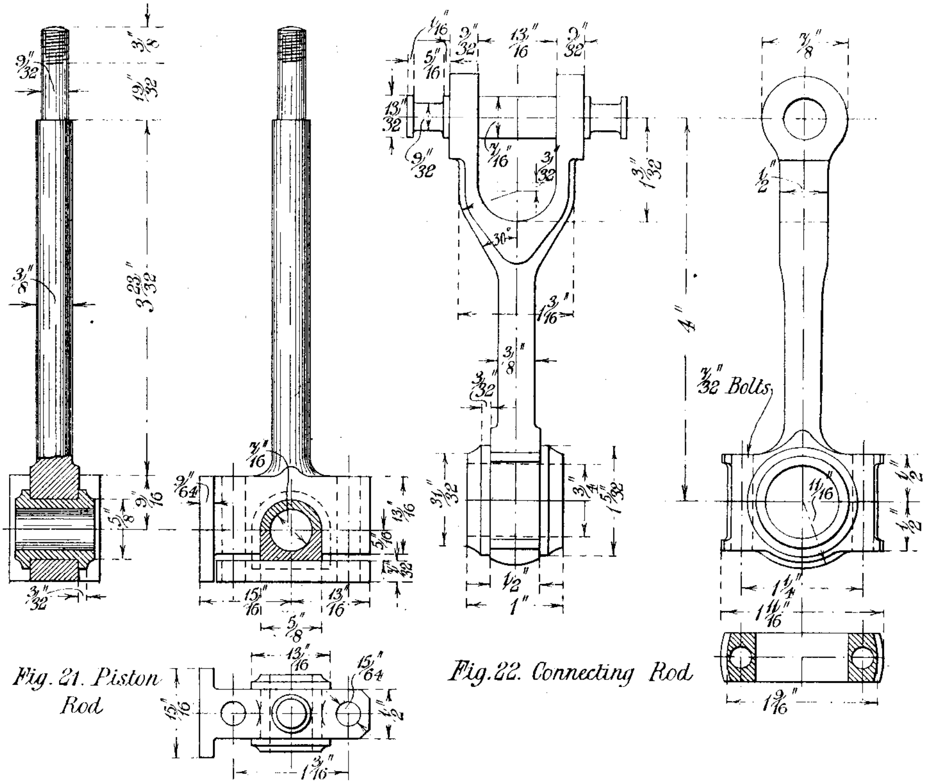
Details of the L.P. and H.P. Slide Valves.

not more than .01 in. opening when the ring is placed square in the cylinder in any position up and down the bore. The complete piston should now be assembled, and care should be taken to see that the rings are free to move when the piston is tightened up. The L.P. piston, Fig. 18, is similar in construction to the H.P. piston. The rings should be turned up to

3 3-32nd ins. diameter outside and 2 3/4 ins. diameter inside, after which 1/4 in. should be cut at 45 before turning the ring up to size. Much that has been said regarding the H.P. piston also applies to the L.P. piston. The two pieces forming the body of the L.P. piston are registered together at the outer joint; the spigot on the lower portion being a push-fit into the upper portion.

The piston valve, Fig. 19, can be made of either gun-metal or cast-iron. No rings are fitted, as a plain piston valve is easily replaced when leakage occurs. It should be turned to a push-fit scraper.The sides of the valve should be parallel and a sliding fit between guides provided on the L.P. steam-chest.

The piston rods are made from mild strel forgings. The first operation is to machine the crosshead to size in the shaping machine, and rough turn the shank. The pocket for the top end brasses can be formed by drilling a suitable hole with a twist drill and cutting out the piece of metal not required with a saw, after which the sides of the pocket can be filed to shape. The bolt holes can now be drilled and a plate temporarily fitted across the end of the rod to form



Details of the Piston Rod and Connecting Rod.

into the liner. It can be ground in with a little oil and fine emery. The over-all length should be left a little over-size to allow for adjustment of the steam edges when the valve is set near the completion of the model. The valve is machined all over and forms a piece of simple turning. The L.P. slide valve is made of cast-iron, Fig. 20. It should be faced on bsth sides either in the lathe or shaping machine, and the edges filed up square to size. It is bored out 7/32nd in. diameter and faced at the ends to suit the valve washer and securing nuts on valve spindle. The face of the valve should be tested on a good surface-plate and the high places removed with a centre upon which to finish turning up the rod. The rod should now be turned to size and the end screwed to suit a 9-32nd-in. slotted nut. The cap for the brasses should be made from mild steel bar. It is drilled to suit the bolts and the front corners are bevelled off at 45‘, as shown in the drawing, Fig. 21. The top of the holes in the piston-rod are knifed to suit the bolt heads. The top end brasses are made from gun-metal castings. To machine a pair of top end brasses they should first be filed up flat at the joint and soldered together for boring out. Two top and two bottom pieces should be soldered together. The sides can be faced if the brasses are mounted on a mandrel. The brasses should be a good fit in the pockets. The pistons can be fitted on to the rod and the nut tightened up. The top of the rod can then be drilled for a 1/16th-in. diameter split pin. In machining the rod care should be taken to get the back and sides of the crosshead parallel to the shank and the hole through the top end brasses perfectly at right angles to the axis of the rod. Two bolts 7/32nd in. diameter by I 5/16th ins. long are required for both piston rods. ln Fig. 21, the portion of the rod which fits into the piston is shown parallel. The piston thus bears on a shoulder with a rather small bearing surface. If desired a cone may be provided on the piston rod 3/8 in. long, tapering from 3/8 in. diameter to 9/32nd in. diameter.

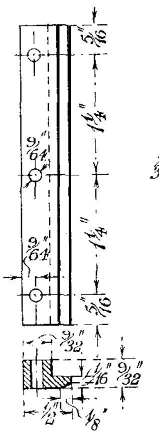


Fig. 23. Guide Bar, M.S.

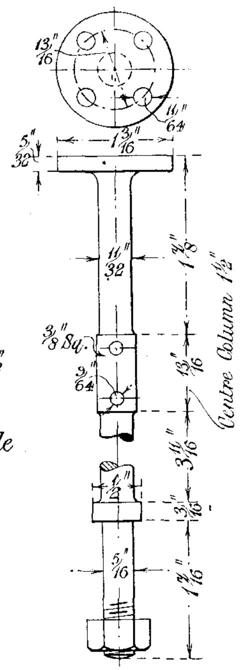


Fig. 24. Column

The Front Column and Guide Bar.

The connecting-rods, Fig. 22, are also made from mild steel forgings. The H.P. and L.P. rods are the same, except that the L.P. crosshead pin is extended to form gudgcons for the pump levers. The forgings should first be turned all over. The big end should be drilled 31/32nd in. and then split with a fine saw and the joint filed up true The pieces can be drilled and bolted together and the sides faced up in the lathe. The hole for the crosshead pin should be now drilled and the fork formed by drilling a I3/I6th-in diameter hole, and sawing away the metal between the jaws. The jaws should be shaped to width and the eyes filed up to size.

The bolt holes are knifed at both ends. Little need be said about the crosshead pins. They are turned smooth and parallel, and should be a light drive fit into the connecting-rod. The pin for the H.P. rod should stand through about I/32nd in. at each side of the jaws. The pin and bore of the bottom end should be parallel to each other. The bottom end bearings are turned up from, gun-metal castings. Two half-castings should be filed up at the joint and soldered together. They should first be bored out to 3/4 in. diameter, and then turned up on the outside and parted off. The bearings should then be lightly driven on short piece of bar that has been turned up to 3/4 in. diameter, and the edges of the bearings radiused to suit the fillets on the crankpins. The bearings may then be un-soldered and the joint cleaned up.

The guide bars are made of mild steel, and should be machined all over in the milling or shaping machine. The front inner edge of the lip is bevelled (Fig. 23). They are drilled, three 5/32nd-in. holes in each, for 4 B.A. bolts.

The front columns, Fig. 24, are turned from mild steel bar and finished bright all over. The top flange has four 11/64th-in. holes drilled in it. The holes should be knifed on the underside with a 3/8-in. cutter. The lower end of the columns is turned to a push-fit into the bedplate, and screwed for a 9/32nd-in. diameter nut. The square portion on the centre column is longer than that on the outer columns. Care should be taken to obtain the *correct* relation between the sides of the squatre and the centre lines of the holes in the flange. The square portion of the centre column has three 9/64th-in.holes drilled in it, which can be marked off from the bracket carrying tha reversing gear.

Loose guide plates are fitted to the condenser. They are made of mild steel sheet and should be filed up true all over to 3 1/8 ins. by1/2 ins. by 1/8 in. thick. Six 5/32nd-in. holes are drilled in each to suit the holes in the guide bars and condenser columns. As no bending load comes on these guide plates they may be made of cast-iron.

We will now deal with the crankshaft, which is perhaps the most difficult piece of the engine to make. The crankshaft is shown in Fig. 25. It is made of mild steel and has two cranks set at 180°. It is the usual practice in two-cylinder marine engines to have cranks at 90, and has the advantages of considerably reducing the range of twisting stress and of making the engine comparatively easy to start, for when one crank is on the dead centre, the other is in the position of maximum turning moment. But in a model these points are not of much importance, and with the idea of obtaining a better balance cranks at 180' have been adopted. The crank-shaft shown has the eccentric sheaves solid with the shaft, and is made from a forging. To simplify the making, the eccentric sheaves can be made of cast-iron and keyed on. Having obtained a forging for the crankshaft, the first thing to do is to remove some of the metal between the webs. This metal can be drilled and sawn out. The shaft should now be centred and the ends turned down to 7/8 in. diameter, upon which should be fixed cast-iron throw-pins and journals. The crank-pins can be finished to size. The eccentric sheaves should also be finished to size. The throw-plates ran then be removed and the shaft put in the shaping machine to machine the sides of the webs, after which operation the shaft can be put back in the lathe and the main journals

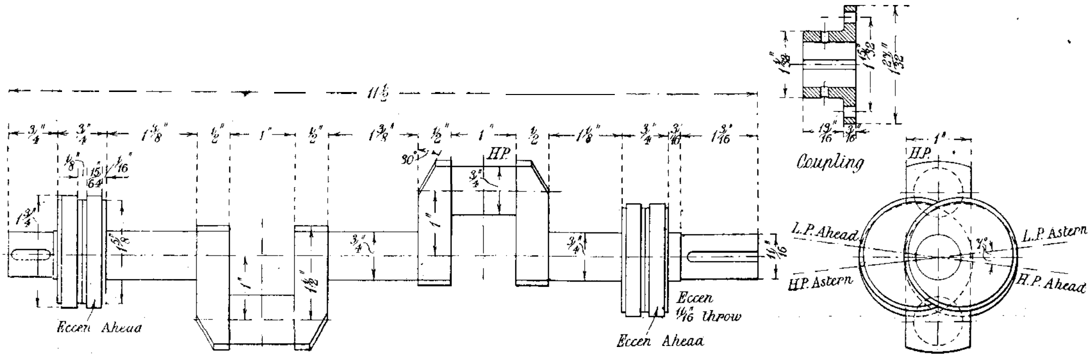


Fig. 25 Crankshaft

The Crankshaft and Diagram of Position of Eccentrics.

plates, large enough in diameter to carry the centres required for turning the crankpins and sheaves, say 2 3/4 ins. diameter by 3/4 in. wide. The throw-plates should be a driving fit on the shaft and secured with setscrews. The centres should be marked off on the throw-plates, and small holes drilled and countersunk for swinging the

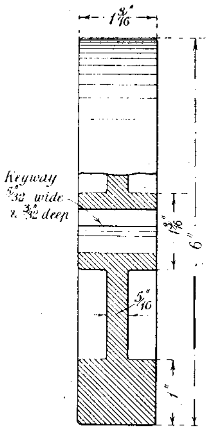


Fig. 26. Flywheel C.I.

Part Sectional Elevation of the Flywheel.

shaft in the lathe. The shaft should first be rough turned to 7/8 in. diameter, and the eccentric sheaves also rough turned nearly to size. The outside edges of the webs should then be machined and bevelled, as shown on the drawing. The crankpins should now be turned and the inner edges of the webs faced. A fillet I/16th in. radius should be provided on crank-finished off. The shaft should be machined smooth all over. The keyways at the ends of the shaft may now be cut 5/32nd in. wide by 3/32nd in. deep to suit the loose coupling and the flywheel. If desired. the coupling may be solid with the shaft, making it 1 5/8 ins. diameter by 3/16th in. wide, and drilled to take four 3/16th-in. bolts. The loose coupling may be turned from 1 7/8-in. diameter bar, and is bored a light driving fit on the shaft. It is turned up smooth all over. The flange is drilled for four 3/16th-in. diameter coupling bolts and the holes knifed with a 3/8-in. diameter cutter. The coupling is drilled for a 3/32nd-in. diameter taper pin, which secures it to the shaft. The keyway is 5/32nd in. by 3/32nd in. deep. The flywheel is made of cast-iron, Fig. 26, and is turned all over. The face and edges should be turned smooth and polished. The wheel should be bored out to suit the shaft upon which it should be a light driving fit. A key 5/32nd in. wide which is sunk 3/32nd in. deep into the shaft secures the flywheel. As a safeguard against the flywheel coming off it may be further secured by a 2 B.A. screw tapped centrally into the end of the shaft and a 1-in. diameter turned washer. If the flywheel is required for a belt drive then the face of wheel should be slightly cambered.

(To be continued.)

S. A. F.--We do not quite grasp n-hat your difficulty is, but possiblv you will find a perusal of our handbooks Electric Batteries " and " Induction Coils," 10 1/2d. post free, from our Publishing Department, would put you on the right track.

A Design for a Model Compound Condensing Steam Engine-IV.

By " AXLE."

(*Continued from page* 299.)

The main hearings. Fig. 27, are made from castings of gun-metal. The end bearings are the same, but the centre one is wider. The half-castings should first be machined and soldered at the joint, then bored out to suit the shaft and the sides faced. The square flanges can be filed up to size and the bearings fitted into the pockets of the bedplate. Care should be taken to get the bottom of the bearings bedded evenly on the bottom of the pockets and also the thick ness of metal under the shaft the same in all the bearings.

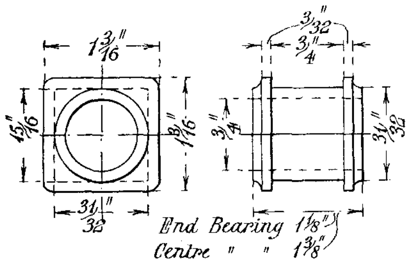


Fig. 27. Main Bearings, G.M.

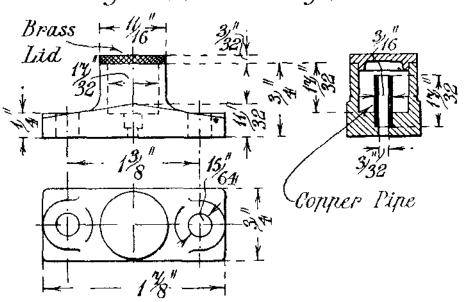


Fig. 28. Main Bearing Caps, C.I.

Details of the Main Bearings and Bearing Caps.

Each half bearing should be bedded on to its corresponding journal. If a little paint is lightly smeared on the shaft it will show the places wherc the shaft is bearing on the brasses. The shaft should bear evenly along the crown of each half-bearing, the sides of the bearings being eased if necessary.

The main bearing cups are made of cast-iron Each is provided with an oil cup, as shown in Fig. 28. The castings should first be faced up Ievel on the underside and the oil hox turned and bored out. The oil chamber is fitted with a piece of copper pipe to form a siphon. A brass lid turned from brass bar and knurled on the flange is fitted to each cap. The caps should be filed up to width to suit the bearings and drilled for the main bearing bolts.

The valve gear is overhung, so that the travel of the eccentrics is greater than the travel of the valve. The reason for using overhung gear is to dispense with the gudgeons and forked eccentric rods required with direct valve gear with double link bars, and using plain eyes on the eccentric rods instead. Of course, should the builder desire direct valve gear, the design can be casily modified.

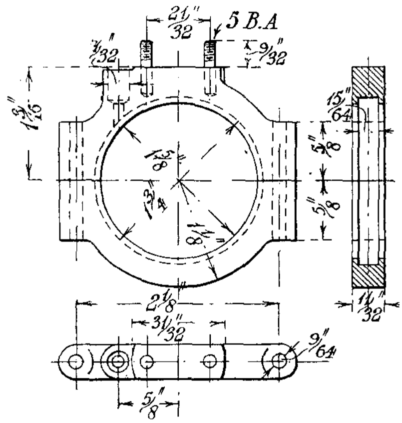


Fig. 29. Eccentric Straps, G.M

Elevations and Plan of the Eccentric Straps.

The eccentric straps, Fig. 29, are made from gun-meta1 castings. Having obtained the castings they should be filed up at the joints and soldered together in pairs. Each strap should then be marked off and bored out and faced across the side. The groove in the strap should be slightly wider than the eccentric sheavc to obtain a running fit. The strap can then be turncd over and the other side faced. Each is drilled to suit two No.5 B.A. bolts and tapped for two No. 5 B.A. studs for securing the eccentric rods. The oil chamber should be drilled 3/32nd in. and counterbored to 3-16th in. diameter. The eccentric straps should be filed up and polished wherc not machined.

The eccentric rods, Fig. 30. may be made either from bar or forgings. They are turned up bright all over. The eye end is first turned spherical and then drilled, and the sides faced. The foot is drilled to suit the straps. Before bending the rods to obtain the set they should be heated locally with a Bunsen flame or blow-lamp.

The link bars, Fig. 31, are made of mild steel bar bent and filed up to size The fours bars should first be bent to the correct radius and the holes drilled near the ends with the four pieces clamped together. The pieces can then be bolted together with fit bolts and filed up to size. Two gauges for the inner and outer radii should be made from sheet steel as a guide in filing the bars. The eccentric rod pins are turned up from mild steel bar and are a tight fit into the radius bars, and are secured by 3/64th-in. diameter taper pins, as shown The rear pin carries the drag links shown in Fig. 32 which are held in position with a washer and taper pin at each end. A small forging can be made for the T end of the drag links, one end of which is turned spherical, drilled and faced, and the other end turned and drilled for the connecting links whtch are turned

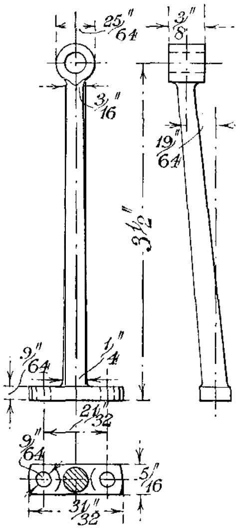


Fig. 30. Eccentric Rods, M.S.

Showing Off-set of the Eccentric Rods.

from 3/8-in. bar. The reversing shaft is 5/16th in. diameter and 7 15/16th ins. long. At the ends are mounted the reversing levers and near the centre is mounted the wormwheel. The reversing levers, Fig. 33, are made of mild steel and have two bosses turned on them, one of which is bored to a tight fit on the reversing shaft, and the other drilled to suit the pin, Fig. 34, upon which are attached the drag links. The levers are finished bright all over. The pins are turned from 3/8-in. bar and have a washer secured with a split pin at one end and a 5-32nd-in. nut at the other.

Two forgings will be required for the valve spindles shown in Fig. 35. The forging should first be rough turned on the shank to slightly over size. The end which carries the link block should then be turned, drilled and split with a fine saw. The joint thus formed should be filed up, and liners of a thickness equal to the depth of metal removed with the saw fitted. The cap should then be bolted in position and the spindle cleaned out with a 1/2-in. diameter reamer. The shank can now be finished off to size and screw-cut for a 2 B.A. nut which secures the valve.

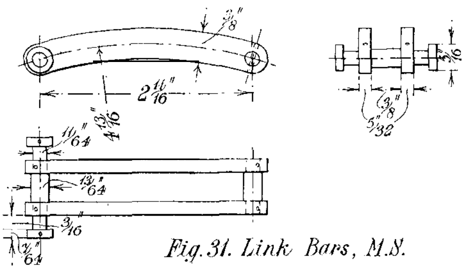


Fig. 31. Link Bars, M.S.

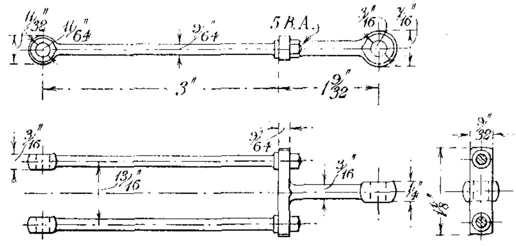


Fig. 32. Drag Links.

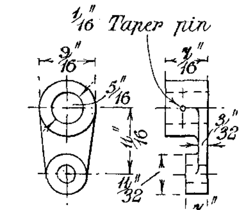


Fig. 33. Reversing Lever, M.S.

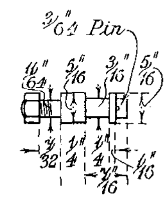


Fig. 34. Pin for Reversing Lever, M.S.

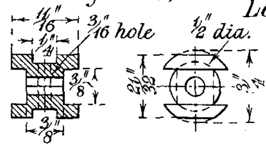
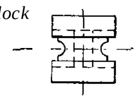


Fig.36. Link Block



Details of Reversing Gear Components.

The top of the rod should be a good working fit into the top guides, and the largest diameter of the shank should be a good sliding fit into the bottom cover, gland, and gutde bracket. The H.P. valve spindle is fitted with two loose washers, which are a push fit into the piston valve and a sliding fit on the valve spindle. The L.P. valve spindle is fitted with a plain washer. the exaot thickness of which should be found when setting the valves. The link blocks, Fig. 36, arc made of gun-metal and are in halves. The half-castings should be filed up flat at the joint-, and soldered together for turning. They should first be drilled with a 3/16th-in. diameter drill and then ‘turned up on the outside and faced at the sides. They should now be unsweated and the slots filed to suit the radius bars. Careful fitting will be required at this point. When the link block is fitted into the valve spindle on assembling the valve gear, it should be a working fit therein and at the same time, the joint

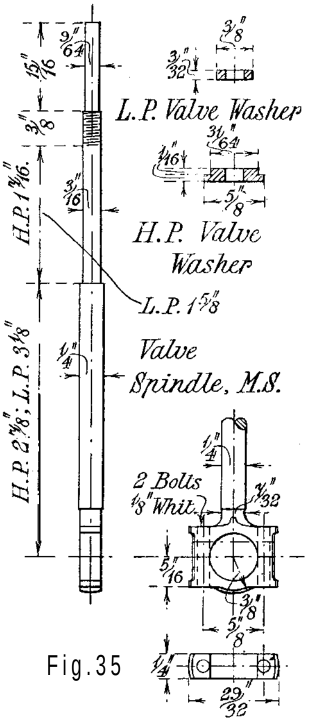


Fig.35

The H.P. and L.P. Valve Spindles and Washers.

of the link block should be quite close, so as not to grip the radius bars. This means that the joint of the link block should be adjusted so as to give a good fit on the radius bars and at the same time give a good fit in the valve spindle. Of course, the usual practice in link block design is to fit loose adjusting pieces on the top side of the radius bar, so that the link block can be adjusted on the radius bars without disturbing the fit between the block and the spindle.

The reversing shaft is carried in brackets attached to the from columns. The end brackets are shown in Fig. 37. They are made of gun-metal and bored 5/16th in. diameter and faced to suit the reversing shaft and are tapped No. 5 B.A. for the securing studs. The centre bracket, Fig. 38, carries the reversing shaft and also the worm and worm shaft. The foot is drilled for two No. 5 B.A. bolts and tapped for one No.5 B.A. stud. The lugs are drilled to suit the worm

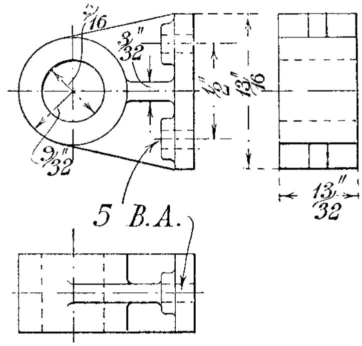


Fig. 37. Reversing Shaft Brackets, G.M.

Elevation and Plan of Reversing Shaft Brackets.

shaft and the sides faced. The boss is drilled 5/16th in. diameter and sides faced.

The reversing gear is shown in Fig. 39. The worm wheel is made from a gun-metal casting, and has twenty teeth No. 20 D.P. It should be first bored out 5/16th in. diameter to suit the reversing shaft and turned up to 15/32nd in.

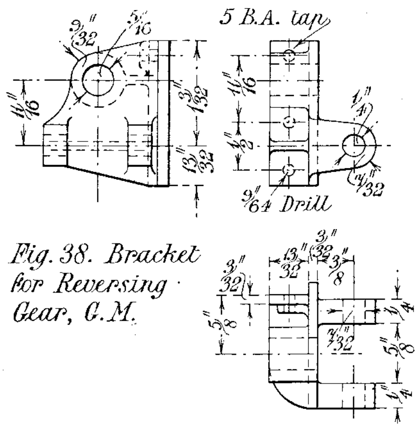
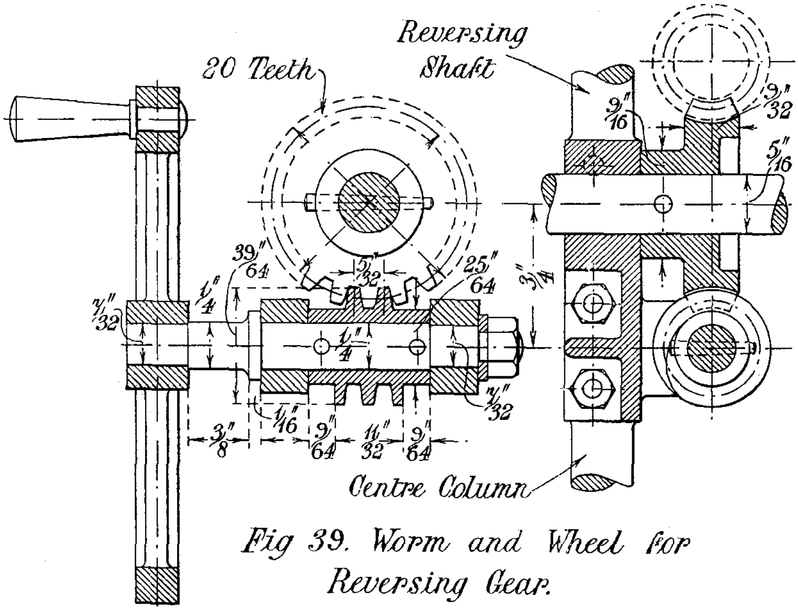


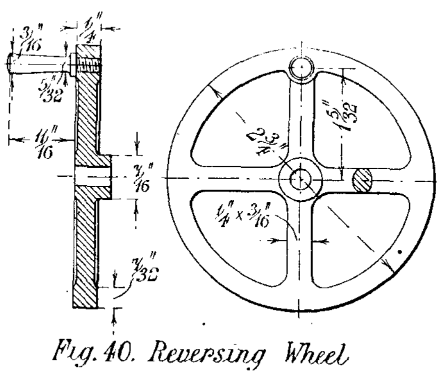
Fig. 38. Bracket for Reversing Gear, G.M.

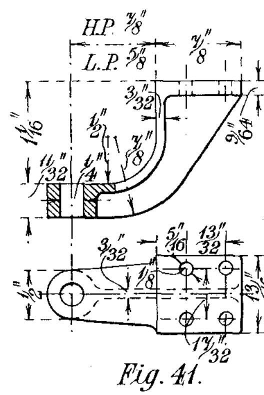
Details of the Reversing Gear Brackets,

diameter to form the blank upon which to cut the teeth. The blank may be fixed on an arbor and held in the chuck for gashing the teeth with a cutter operated from the slide-rest. Alternatively the blank can be held on a fixed arbor attached to the slides-rest and the cutter mounted between the lathe centres. An index plate should be used to obtain accurate spacing of the teeth. (I notice a similar machining job is described in the June 3rd issue of the M.E., Vol. XLII, page 520.) The diameter of the cutter should be ,608 in.,and inclined to the axis of the worm wheel 5 3/4 deg. The worm is made from mild steel bar. It has a single thread of .157-in. pitch and a mean pitch diameter of .5 in. If a thread is cut either of 6 1/2 t.p.i. or 4 mm. pitch it will be sufficiently correct. Ihe wheel is bored to suit the spindle and is drilled for two small taper pins. The spindle should be turned to a working fit into the bracket and a tight fit into the worm. It is located in the bracket with a collar at one end and a nut and washer at the other end. The from end is turned to fit the reversing wheel shown in Fig. 40. The wheel is a gun-metal casting and has four arms of elliptical section. The rim should be turned up and polished, and the boss bored out and faced The handle is made of steel, and may be either screwed into the wheel and riveted over, or it may be driven in and secured with a nut. The wheel should be sccured on the shaft with either a taper pin or a key 1/16th in. square.



Part Sectional Side and End Elevation of Worm Wheel for Reversing Gear.





The Reversing Hand Wheel and Valve Spindle. Guide Brackets.

The valve spindle guide brackets, shown in Fig. 41, are gun-metal castings. The foot should first be machined level, which will then allow the casting to be set up true on the faceplate for boring out. The foot has four 1/8-in. holes drilled in it, which should be marked off in position. It should be noticed that the dimensions of the H.P. and L.P. brackets differ.

Having briefly described the parts required for the valve motion, let us revert back to the condenser. The condenser has 83 brass tubes, 6 11/16th ins. long by 1/4 in. diameter by 26 S.W.G. thick. The tube plates should be attached to the condenser with six No. 5 B.A. countersunk screws in each. The tubes should be lightly covered with solder for a distance of about 1/4 in. from each end and placed in position. The holes in the tube plate can be reamered out slightlv larger if the tubes are difficult to thread into place. When all the tubes have been fitted the tube ends should be permanently fixed by heating with a gas blowpipe and causing the molten solder to fill the joints round the tubes.

The condenser covers are shown in Fig. 42. They are made of brass. The shape of the covers is the same as the tube plates. The cover at the L.P. end of the condenser is provided with an oval flange near the bottom, but the cover at the other end is provided with a similar flange near the top. The cover is drilled to suit the studs in the condenser and should be marked off from the tube plate. Fourteen small bosses are provided on the outside radiused edge to suit the nuts and which should be faced with 9/32nd-in. diameter pin-drill. The covers should be faced at the joints and then turned over and the flanges faced. A 5/16th-in. drilled hole forms the inlet and discharge for the cooling water. Each flange is provided with two No. 5 B.A. studs for securing the inlet and discharge pipes. The covers can now be jointed to the condenser and secured with No. 5 B.A. nuts. Fig, 43 shows the cover for the circulating pump. It should be turned all over. It is a push fit into the body of the circulating pump and is bored out for the gland and rod. The gland is turned to a push fit into the stuffing box, and is also bored out to suit the pump rod. The oval flange is drilled 9/64th in. to suit the adjusting studs, which are screwed into the cover.

(To be continued.)

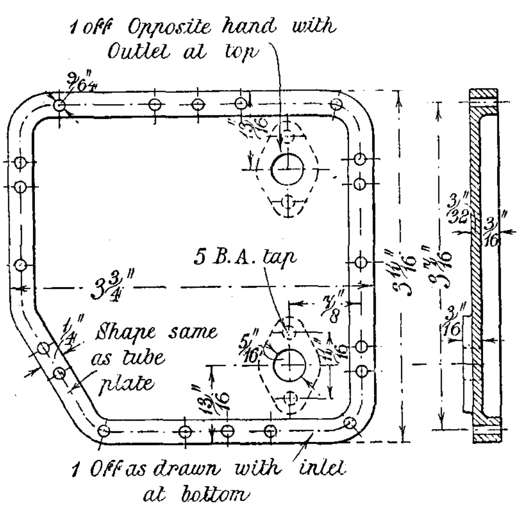


Fig. 42

The Condenser covers.

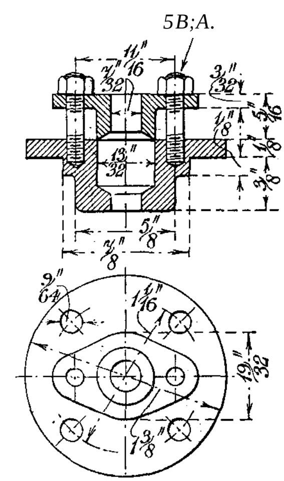


Fig.43. Circulating Pump, Cover G.M.

Section and Plan of Circulating Pump Cover.

The Horse-Power of Boilers.

The following note on this subject is prompted by the inquiry: On what basis is the h.p. of steam boilers calculated ? I am given that a Vertical boiler 6 ft. 6 ins. long by 3 ft. diameter will evaporate 480 lbs of water per hour from :tnd at 212 deg. F. This is called a 4 h.p. boiler (approximattcly). I cannot understand this being ;I 4 h.p. boiler as :-

280 lbs. per hour $= \frac{280}{60}$ lbs. per min.

As B.T.U.'s to evaporate 1 lb. of water from and at 212 deg. F.=966 and I B.T.U.=778 ft. Ibs.

$\frac{280}{60} \times \frac{966}{1} \times \frac{778}{1} = 3,507,224$ ft. lbs. per min. and ho

3,507,224/33,000= 106 h.p. (approx.).

Can you explain to me why the horse-power calculated from the B.T.U.s generated by the boiler is 106 h.p. (or in what respect the calculation given is not correct) while the boiler is given as 4 h.p. ?

machine-tool making, there was the general run of local engineering work, and the making of motor parts. We also designed and made numerous special machines for various purposes. Of ornamental turning apparatus for some years we made a considerable amount, including ‘rectilinear, oval, eccentric, and dome chucks, spherical and ordinary slide-rests, besides many other things which I cannot call to mind just now. The illustrations will give an idea of the class of work. To make an epicycloidal cutter without having seen one is a rather formidable job, as anyone trying it will find. I am referring not so much to the high grade of workmanship required, but to the amount of preliminary work and study which such a job entails. In this matter I was assisted by the late Rev. C. C. Ellison and other experts. Nearly sixty special tools, jigs, mandrels, taps, broaches, etc., were made in order to produce this one instrument. The matter of making small multiple-thread screws and taps (also referred to by Mr. Westmoreland) is dealt with in my book " General Work in the Small Shop,"

All this, however, is, with me, a thing of the past. I recollect that the late Mr. Massey once said, in effect, that there was no fortune to be made by following in his footsteps. And I fear that to-day high craftsmanship is still more at a discount. Those who want to " get on " must cultivate, brains rather than hand skill. Of course, I do not mean that all-round mechanical ability is not a' great asset. But when a manufacturer comes and asks one to design and make a special machine, he does not enter into all that, nor does he care about nhat the machine is going to be like-he doesn't want an ornament. What he says is : " Can you make a machine that will do twice as much work as this one does, and keep on doing it? " The reward for the use of brains, however, is none too great. The engineer cannot afford to bring out a failure,his reputation is at stake. He sows; others reap. My experience shows that the people who " get on " are those who possess the kind of brain which enables them to pick the brains of others. But I had better not enlarge on this subject. The engineer, whether professional or amateur, who takes an interest in his work finds that it has. like virtue, its awn reward. There is this to be said : an all-round experience, such as the " old shop " could, and did, afford, is a very good foundation for a young man to build on. The ability to start with a sheet of paper, work the thing out, and, if necessary, to carry the whole job through single-handed, is almost certain to be advantageous to him at some time or other, whatever may be his ultimate aims and achievements.

A Design for a Model Compound Condensing Steam Engine-V.

BY " AXLE."

(Continued from page 377.)

The valve box of the circulating pump is shown in Fig. 44. It has a vertical partition, which: separates the delivery valves from the suction valves. The inlet flange is on the bottom and' the delivery is on the side of the valve box. The casting should be machined at the joints, which register with the body and cover. The seats for the, delivery valves can be faced with a 3/4-in. diameter centre drill. Each seat has six 1/8-in. holes drilled in it, and the centre drilled and

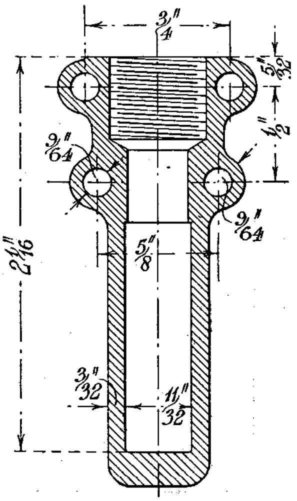


Fig. 46. Feed Pump Body, G.M.

Section of Feed Pump Body.

tapped No. 5 B.A., into which is screwed the valve guards. The valve guards are turned from bar, one end being a countersunk head with a screwdriver slot, and the other screwed to take a No. 5 B.A. nut. The valves may be made either-of leather or rubber. They are 11-16th in. diameter and about 3-32nd in. thick, and have. a 3-16th-in. hole cut in the centre. The valve box is drilled to suit the studs on the body. and the centre partition is drilled and tapped No. 5. B.A. at the centre, thus making provision for an extra stud for securing the valve box cover.

The inlet and outlet flanges are drilled: 5-16th in. and are provided with two No. 5 B.A. studs in each for securing the cooling water pipes. The top of the valve box is drilled and tapped to suit the air vessel (Fig. 45). The cover is made-from a casting and has nine 9-64th-in. holes drilled in it. It should be faced on both sides and the edges filed up to size.

The air vessel is made from gun-metal bar. A piece of bar is drilled 1/2 in. down the centre to a suitable depth and counter-drilled 3-16th in. One end is screwed to suit the valve box. A turned cap is either screwed or silver-soldered into the top, after which the complete vessel can be turned and polished smooth on the outside.

The feed and bilge pumps are shown in Figs. 46 and 47. They are of the same dimensions, except that the bosses for the fixing studs are higher on the feed pump than on the bilge pump. The bilge pump is attached to the side push fit into the pump crosshead and screwed to take a 5-32nd-in. nut.

All the pump rods are shown in Fig. 48. The circulating pump rod and bucket forms one piece. The piston is turned to a good sliding tit into the circulating pump body. It has two grooves turned on the outside. The guide rod is made of mild steel, and is turned to a sliding fit into the pump guide bracket. Fig. 49 shows the air pump bucket or piston. It is made from a casting and is turned on the outside to a sliding fit into the air pump barrel. It should be machined all over. The seat is drilled with eight 13-64th-in. diameter holes. The air pump foot valve, Fig. 50, is also made from a casting

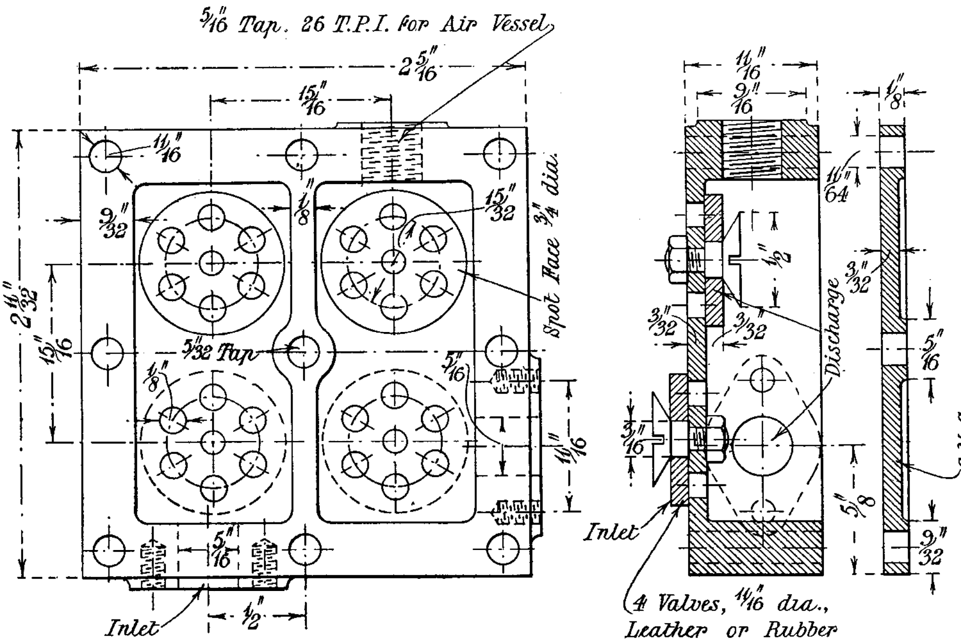


Fig. 44. Valve Chamber of Circulating Pump

Elevation and Section of Circulating Pump Valve Box.

of the circulating pump and the feed pump is attached to the side of the hotwell. A casting mill be required for the pump body. It should first be machined across the faces of the bosses, and then attached to an angle plate fixed to the faceplate and a 5-16th in diameter drill put down the centre. The lower portion can then be opened out with a hooked tool to 11-32nd in. diameter to form a clearance for the plunger. The stuffing box is screwed with a fine thread 1/2 in. diameter and the end of pump faced. The boss at the bottom of the pump is drilled and tapped 1/8-in. gas. The plungers are made of gun-metal and should be turned up smooth and parallel. The top end is turned to a and is turned up all over in the lathe. The upper side is recessed to suit the spigot on the air pump barrel, and the portion under the flange is turned to a push fit into the bedplate. The seat has eight 13-64th-in. holes drilled in it and the flange is drilled to suit the studs in the bedplate.

The valve guards, Fig. 51, are turned from bar. Thc head valve guard is turned to a push fit into the air pump cover and forms the bottom of the stuffing box. There are six 1/8-in. holes drilled in the flange of the head valve guard and four 1/8-in. holes in the bucket valve guard.

The air pump cover shown in Fig. 52 is made of gun-metal. It is bored out to suit the gland, which is identical with the gland fitted to the circulating pump cover. The spigot under the flange is turned to a push fit into the hotwell casting. The cover is turned all over. The flange should be drilled with six 9-64th-in. diameter holes to suit the studs in the hotwell.

The top is drilled and tapped for the two gland adjusting studs.

The valves boxes for the feed and bilge pumps, Fig. 53, are machined from gun-metal castings. The ports are drilled out 3-16th in. diameter. All the threaded portions are 1/8-in. gas. The valves are steel balls 15-64th in. diameter. The spigot on the plugs should allow the balls to lift not more than 3-64th in. The suction and delivery ends are chamfered to suit the nipples on the pipes. The valve box should be screwed into the pump body and should stand vertical when tightened up in position. Instead of the plug over the delivery valve, an air vessel, similar to the one fitted to the circulating pump, may be fitted to the valve boxes if desired. The bearings for the pump levers shown in Fig. 54 are made of gun-metal. The base should first be shaped flat. The casting can then he bored out 3/8-in. diamater and the ends faced, the caps being soldered in position for this purpose. The lower portion should be drilled and tapped for the screws securing the caps. The feet are drilled 9-64th in. diameter. The rear of the casting is drilled and tapped for the bolts and screws holding the guide bracket. The rear face should be filed up perfectly square to the base. The caps are provided with lubricating cups, which are drilled I-16th in. and countersunk with a 90° drill. The caps should be pin-drilled to suit the heads of the screws.

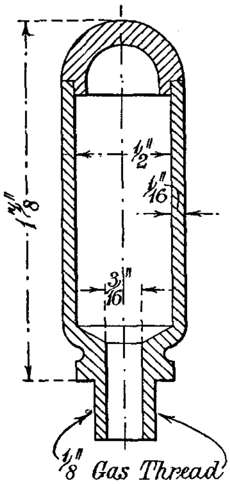


Fig. 45. Air Vessel, G.M.

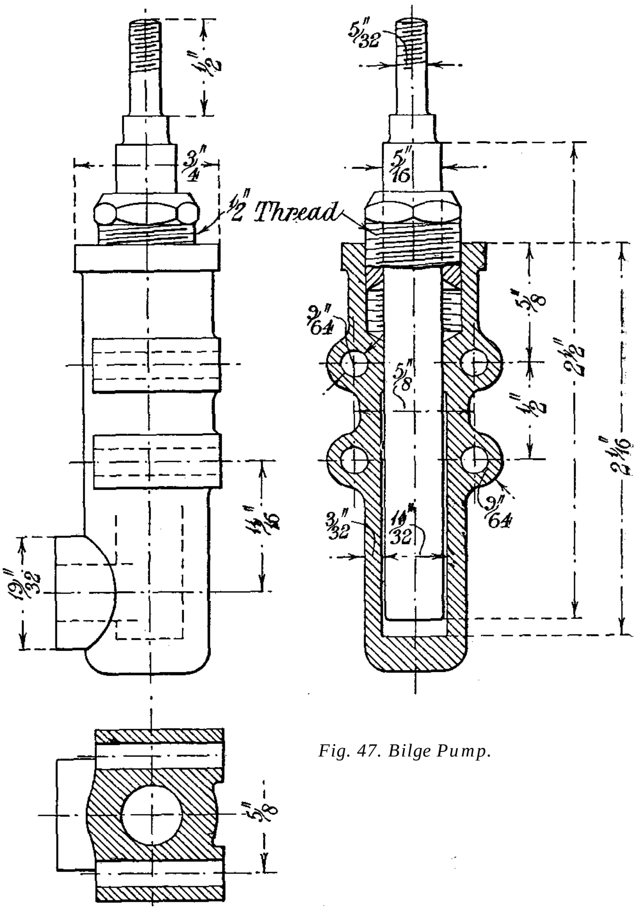


Fig. 47. Bilge Pump.

Section of Air Vessel and Views of the Bilge Pump.

The pump levers are made of steel, Fig. 55, The side plates should be cut from steel plate 1/8 in. thick. The two pieces should be clamped together and drilled 9-32nd in. diameter at the ends for the gudgeon pins, and 5-16th in. in the centre for the fulcrum shaft. The levers can then be bolted together with fit bolts and filed up to size. The gudgeon pins are turned from bar and should be tight fit into the levers, the ends being left long enough for riveting over. The holes in the levers should be slightly countersunk on the riveted side, for riveting. The centre shaft is turned from bar. It has two flanges turned on it to which are attached the side plates. In assembling the parts care should be taken to get the axis of the centre shaft in the same plane as the axes of the gudgeons. The flanges of the centre shaft should first be drilled for the rivets and one side plate marked off from it, drilled, and riveted on. The shaft and side plate should now be placed in two vee-blocks and the centres of the gudgeons adjusted to the same height above the marking off table. The other side plate should be tapped on set parallel to the marking off table. The scribing block should now be applied to the centre of each gudgeon, and, having adjusted them all to the same height, the rivet holes can be marked off on the loose side plate for drilling. After drilling the plate Should be placed in position again and four pegs light driven into the rivet holes. The levers should be tested again for alignment, and, if correct,

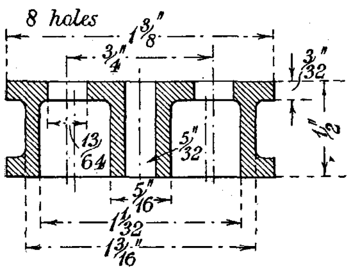


Fig. 49. Air Pump Bucket

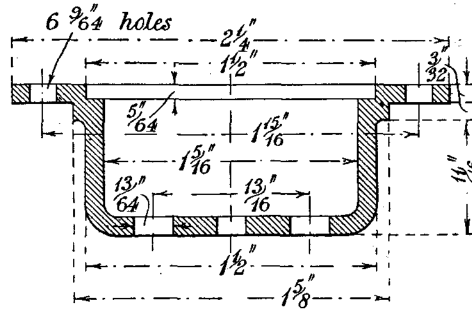


Fig. 50 Air Pump Foot Valve

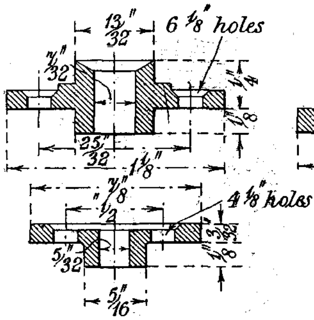


Fig. 51. H.V. Guard, G.M. & F.V. Guard.

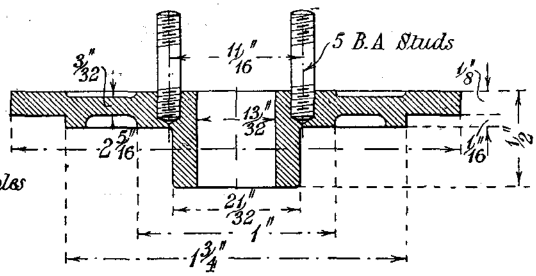


Fig. 52. Air Pump Cover

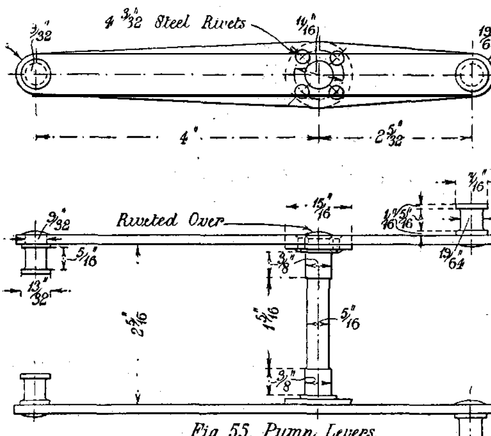


Fig. 55. Pump Levers.

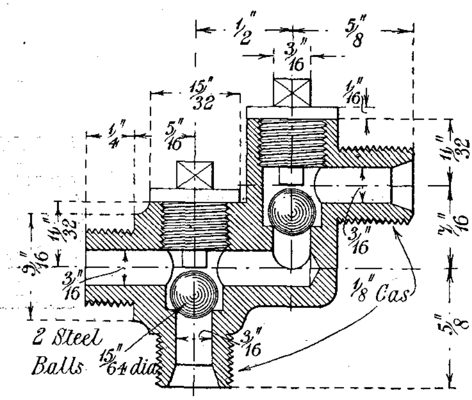


Fig. 53. Feed Pump Valve Box, G.M.

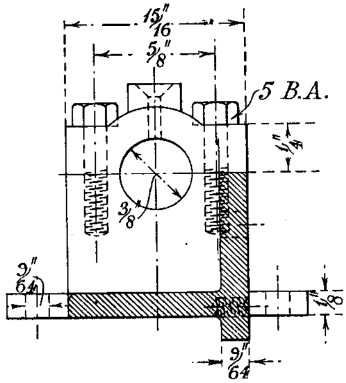
Details of Air Pump Components and Section of Feed Pump Valve Box.

the plate can be riveted up. If the plate should require a little adjustment then the rivet holes can be reamered out to suit.

Fig. 56 shows the crosshead for the pumps. It is made from mild steel bar. The ends are first turned spherical, then drilled, and faced. The centre portion is turned to 7-16th in. diameter and the flats are filed or planed on. It should be turned bright all over. Five 5-32nd-in. holes are drilled in the crosshead to suit the pump rod centres, care being taken to get the holes parallel to each other.

The links shown in Fig. 57 connect the levers to the piston rod at one end, and to the crosshead at the other ends. The bearings of the links are made of gun-metal and are connected together with a pair of collar bolts. The bearings should be bored out and faced to suit the gudgeons. It will be noticed that the front links differ from the rear links in bore and length.

The crosshead guide bracket shown in Fig. 58 is made from a gun-metal casting. The foot should first be machined and then the hole should be bored out parallel to the foot. The foot



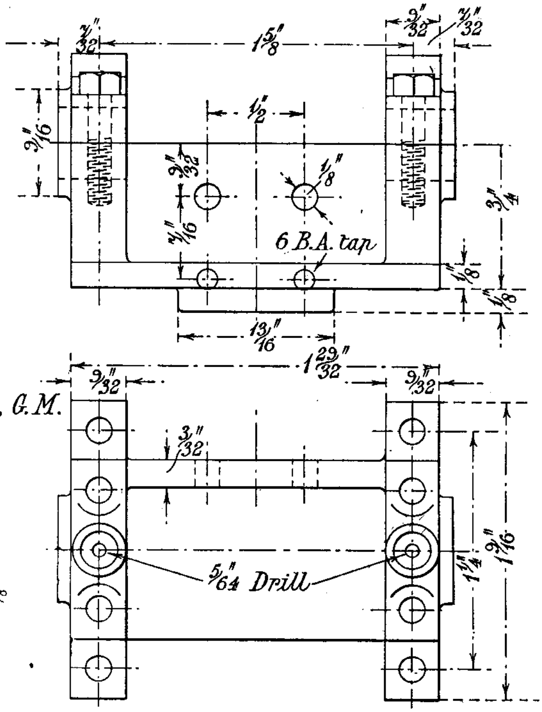


Fig. 54. Bearing for Pump Levers, G.M.

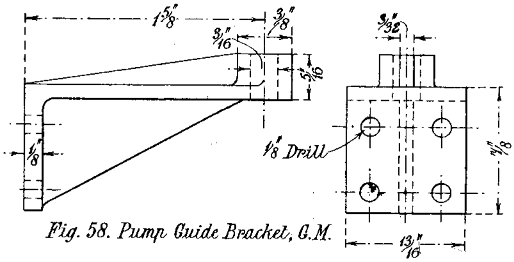


Fig. 58. Pump Guide Bracket, G.M.

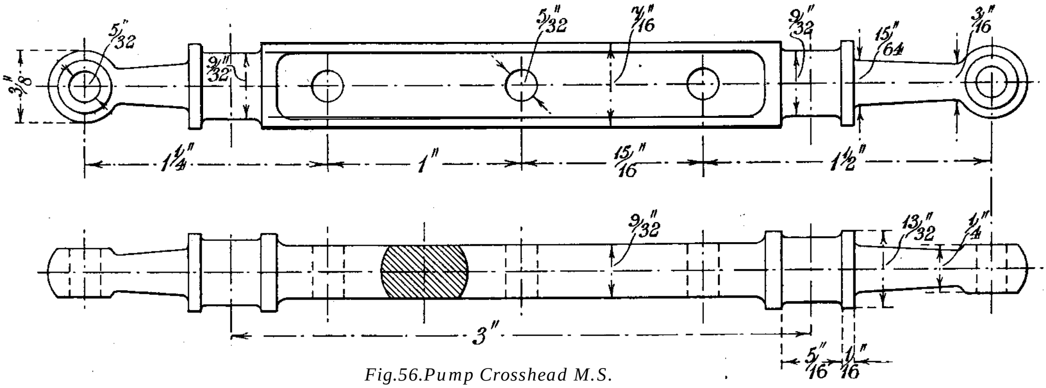


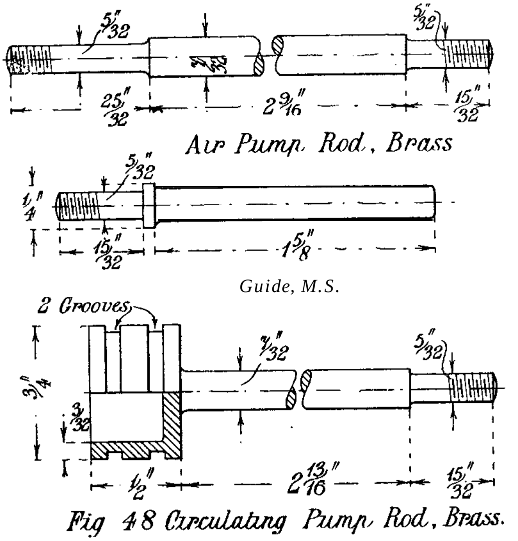
Fig. 56. Pump Crosshead M.S.

Details of Pump Lever Bearing and Brackets and Pump Crosshead.

should be marked off and drilled to suit the holes in the bearing of the pump levers.

Having briefly touched upon the making of the several parts of the engine, with the exception of the pipes, lagging, etc., we will deal with the assembling of the parts.

The bedplate should be bolted to a level rigid foundation. Two pieces of square bar would make a suitable seating. The bottom halves of the main bearings should then be fitted into the pockets and the crankshaft put into place. Each



Air and Circulating Pump Rods and Guide Bar.

top half main bearing should be fitted separately and tried for clearance whcn tightly screwed up. The shaft should bc free to rotate, without shake, in all the bearings. The condenser should non be bolted in position with the guide faces parallel to the axis of the shaft. The front columns should then be erected and tested to see if they are all of the same height by laying a straight edge across the top of the flanges.

The top of the condenser columns and the tops of the front columns should all lie in the same plane.

The cylinders can now be placed on the columns for marking off the holes in the feet. The position of the cylinders should be adjusted to get the centre line passing through the centres of the cylinders parallel to the axis of the shaft, and the vertical centre line of the cylinders passing through the centre of the shaft.

A gauge of thin sheet steel made to register with the main bearing pockets, face of rear columns, and the central hole in the bottom of the cylinder would be useful in aligning the cylinders.

After marking off the holes in the feet the cylinder should be drilled and bolted up in position,

The pistons and piston rods can now be fitted and the back of the slipper eased if necessary to obtain a smooth not-king fit on the guide plate. Any further adjustment of the guides due to wear can be made by inserting thin liners behind the guide plate. The connecting rods should be fitted up next. They should be free owing to swing in the top end bearings when tightened up, and they should be free to rotate about the crankpin when the bottom ends are tightened up. It is perhaps superfluous to mention that neither the crankpin nor the gudgeon-pin should be eased to obtain the correct working fit, and all adjustment should he made on the gun-metal bearings.

The valve gear can now be erected. The brackets should be placed on the reversing shaft and the shaft clamped up into position for marking off the holes in the brackets, which after being drilled and tapped can be bolted to the columns. The eccentric straps should be adjusted to their respective sheaves. The valve spindles should be fitted with the L.P. steam-chest, H.P. steam-chest covers, and guide brackets temporarily placed in position. The guide brackets can then be marked off, drilled,

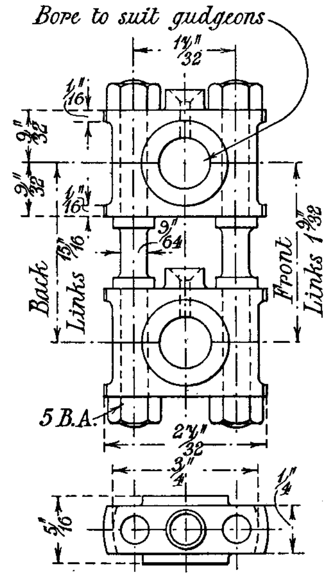


Fig. 57. Pump Links

Elevation and Plan of Pump Links.

and permanently fitted up: The radius links, link blocks, and drag links can now Le assembled.

The worm wheel and reversing shaft should be fixed on the weigh shaft, and after connecting up the drag links to determine the exact position of the reversing levers they should be drilled and pinned to the weigh shaft.

(To be concluded.)

A Design for a Model Compound Condensing Steam Engine-VI.

BY " AXLE."

(Concluded from page 346.)

The valves can now be set to their proper positions on the valve spindle. It will be observed that the valve spindle is not in line with the eccentric-rod when in full gear. The travel of the valve is thus considerably less than the travel of the eccentric. The motion of the valve will be the same as that due to linking up when direct gear is fitted. The movement of the valve can be approximately determined graphically in The following manner.

In Fig. 59, let o.f. and o.b. = radius of eccentric and 0 the angle of advance.

Set back from ***o.f.*** and o.b. angle φ in the direction of rotation, making

D.O.S. = x.o.e. Then D is the position of the crank when the valve is in mid position. Draw S.S1 paraliel to D.D1 and at a distance from it equal to the lap. Similarly draw E.E1 at a distance from it equal to the exhaust lap. Then S is the point of admission, S1 is point of cut-off, E is point of compression and E1 is point of release. The perpendicular from A on to S.S1 = steam lead.

From these diagrams it will be easy for the builder to find the setting of the eccentrics and laps required for various points of cut off.

The diagrams should be drawn, say, four times full size.

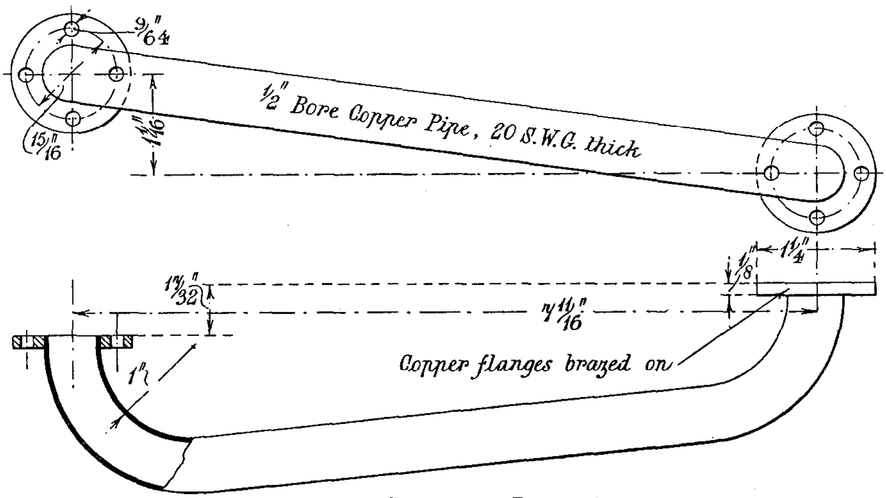


Fig. 61. Receiver Pipe, Copper.

The Receiver Pipe connecting the H.P. Exhaust and L.P. Steam Chest.

$$\text{sine } \varphi = \frac{\tfrac{1}{2}\text{ length of link}}{\text{length of eccentric-rod}}$$

draw f.c. and *b.d.* at right angles to o.f. and ***o.b.*** Join ***c.d.*** and bisect at ***k.***

Draw an arc of a circle passing through ***f,k,b.*** Divide the arc ***f.k.b*** at e such that f.e. : ***e.b.*** as F.E. : E.B. (E is the position of the link block in full gear.)

Then o.e. is the half travel of valve and x.o.e. is the relative angle of advance.

A Reuleux diagram, Fig. 60, can now be drawn as follows :-Draw a circle with radius = o.e. Draw_ diameter D.D1 making angle

The dimensions of the valves given in Figs. 19 and 20 should give about the correct laps, and with the eccentrics shown in Fig. 25 the lead should be about I-64th in. for both valves in full gear. It should be noticed that the construction shown in Fig. 59 only holds good for open rods. If the rods are crossed angle φ should be set back in the opposite direotion from o.f. and ***o.b.***

Having set the valves to the correct lead, the crank should be rotated and the positions of the pistons measured from the tops of their stroke at cut off, and if the valves require lifting or lowering a little then the adjustment can be made by altering the thickness of the washer under the valves. In full gear the steam should be cut off at about 3/4 in. of the stroke. The pumps can now be assembled. The air pump valves should be made of fibre about 3-32nd in. thick and large enough in diameter to overlap at least I-16th in. all round the holes in the valve seats. As an experiment thin sheet brass valves could be tried. The lift of the valves should not be more than I-16th in., but the finding of the correct lift is probably a matter of trial.

The air pump piston should be packed with as many turns of cotton string as it will hold. It should be wound on evenly and the ends tucked under the adjoining turns. The packing should be greased and should make the piston a good tight fit into the barrel.

After jointing on the various pump covers the pump rods can be connected up to the pump crossshead after slipping on the glands. The pump levers should be placed in their bearings and temporarily fitted in position. After setting the levers symmetrically about the centre line of the L.P. engine, with the centre of the bearing the correct distance back from the centre of the piston rod, the holes can be marked through the feet of the bearings on to the rectangular bosses on the condensor. The bosses should be drilled and tapped and the bearing screwed into position.

The pumps can now be connected up to the engine. Each pump link bearing should first be tried on to their respective gudgeons to obtain the

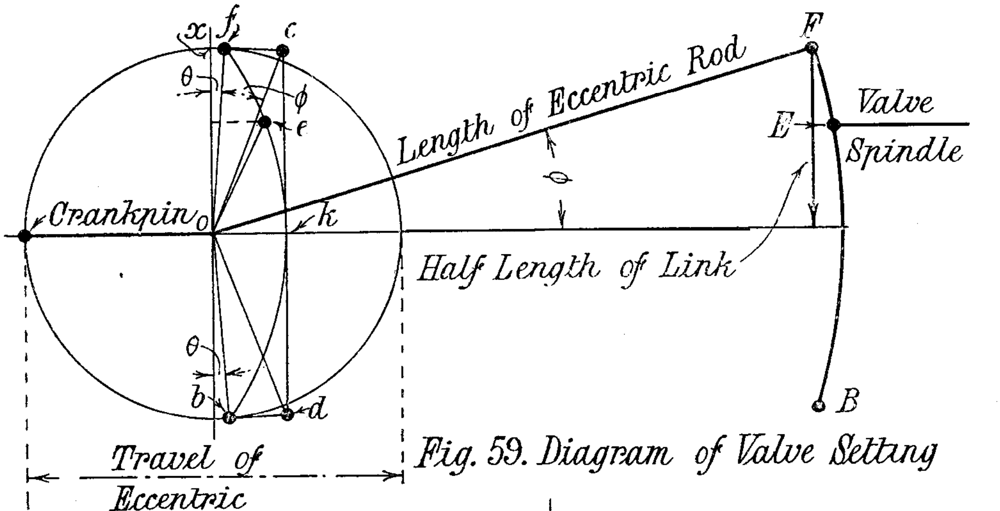


Fig. 59. Diagram of Valve Setting

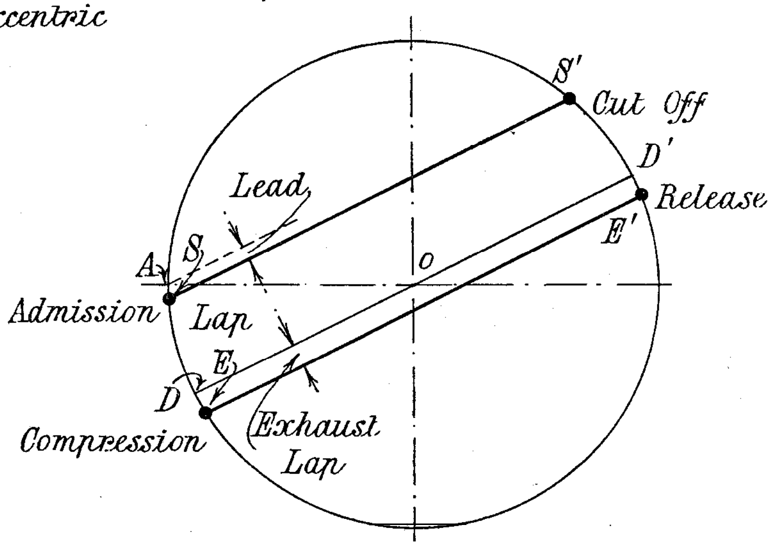


Fig. 60. Reuleux Diagram.

Diagrams showing the Method of Setting Out the Valves in their Correct Positions.

correct working fit. The pump covers should be removed when connecting up the pumps for the first time, so that the clearance of the pump buckets may be observed. The pump crosshead guide should be drilled and tapped after marking off in position, and bolted to the back of the pump lever bearing.

I will now very briefly describe the pipes, lagging, drains, etc., required to complete thn model. The receiver pipe connecting the H.P. exhaust and L.P. steam-chest is shown in

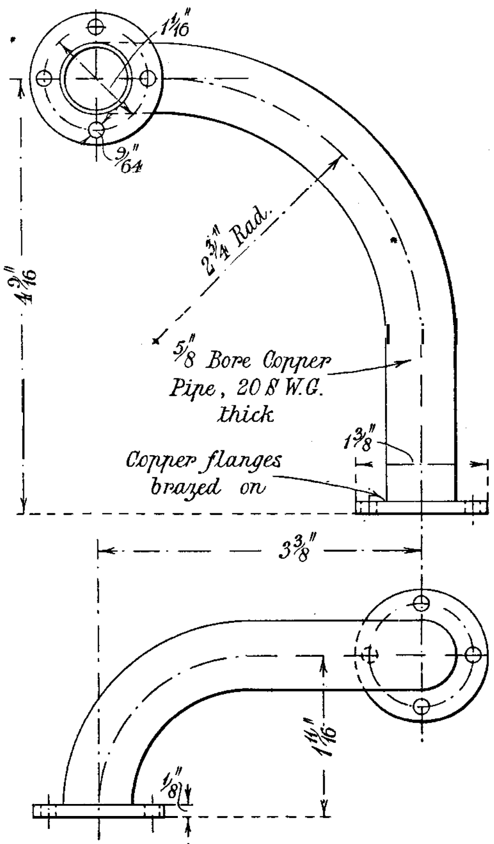


Fig. 62. Exhaust Pipe, Copper.

The Exhaust Pipe from the L.P. Cylinder to the Condenser.

Fig. 61. After bending the pipe, it should be cut to length and flanges cut from sheet copper, brazed, or silver soldered on. The flanges should be drilled to suit the studs on the cylinders, and after filing up the faces of the flanges be jointed up.

Fig. 62 shows the exhaust pipe from the L.P. cylinder to the condenser.

A steam stop valve will be required for the H.P. cylinder. This valve would probably be purchased from a firm specialising in fittings for models. It should be about 5-16th in. or 3/8 in. box, and may be screwed direct into the buss provided on the cylinder.

A pipe 5-16th in. bore by 20 S.W.G. should be fitted to the condenser from the circulating pump. It may be bent, as shown in Fig. 63, and secured to the pump and condenser cover with screws or studs and nuts. The cooling water discharge pipe from the condenser n-ill be made according to the method of disposing of the cooling water discharge. A suitable connection would be a short piece of pipe with the Range brazed on one end, and the other end swelled out to take a piece of rubber pipe.

The pump connecting the feed pump to the hotwell is bent from 3-16th in. hore copper pipe, 20 S.W.G. thick. The pipe is fitted with nipple and union nut at one end and a flange is brazed on the other end. The delivery side of the feed pump is, of course, connected to the clack valve on the boiler.

The bilge pump can be used as an auxiliary feed pump. The air discharge pipe should be bent something like that shown in Fig. 1. It should be a 3/8 in. Inside diameter. On the side a piece of 3-16th-in. copper pipe is brazed, which serves as an overflow from the hotwell.

Three drain pipes are required for the cylinders. They should be 3-32nd in. bore. The drain pipes may be led donn the front columns and fixed with small clips. The condenser should have a small vacuum gauge connected to it.

A steam pressure gauge may be fitted to the H.P. and L.P. steam-chests. The three gauges could suitablv be fitted at the front of the engine somewhere near the top of the centre column.

The lagging for the cylinders should be cut from 24 S.W.G. sheet steel, and is secured to the top and bottom flanges with No. 8 B.A. screws. The space between the cylinders and lagging should be filled with asbestos pulp. The receiver pipe map be wrapped with asbestos cord.

A guard should be fitted round the bottom of the front columns, as shown in Fig. I. It should be cut from No. 22 S.W.G. sheet steel and bent to fit up as closely as possible to the columns, to which it may be attached nith suitable clips. A beading of 1/8-in. half-round brass should be riveted to the edge. A brass angle 3-16th it:. bv 3-16th in. should be riveted to the bottom of the guard and drilled for the No. 8 Ii..\. screws securing it to the bedplate.

A double cock lubricator should be fitted to the H.P. cylinder cover. One may he fitted to the 2.P. cylinder cover, but it is perhaps an unnecessary fitting. Provision should be made for lubricating the top and bottom ends. Small pipes attached to a small oil cup can be led from the top of the connecting rod to the bottom ends in the usual manner.

The cylinder glands can be packed with asbestos cord smeared with oil and graphite, and the pump glands with greased lamp cotton.

The following is a rough calculation of the hoarse-power expected from the engine, assuming that it is capable of being run at 500 revolutions per minute. (It is doubtful to assume that the air and circulating pumps will work efficiently at this number of revolutions per minute.)

Area of H.P. cylinder = 2.4 sq. ins.
Area of L.P. cylinder = 7.06 sq. ins.
Neglecting clearance and area of piston rod.

Volume of H.P. cylinder = 4.8 cub. ins.
Volume of L.P. cylinder = 14.1 cub. ins.
Volume of steam at cut Off = 4.8 x .75.
Volume of steam used per minute =

$$\frac{4.8 \times .75 \times 1{,}000}{1{,}728} = 2 \text{ cub. feet.}$$

∴ Weight of steam used = .54 lbs. per min.
= 32.4 lbs. per hour.

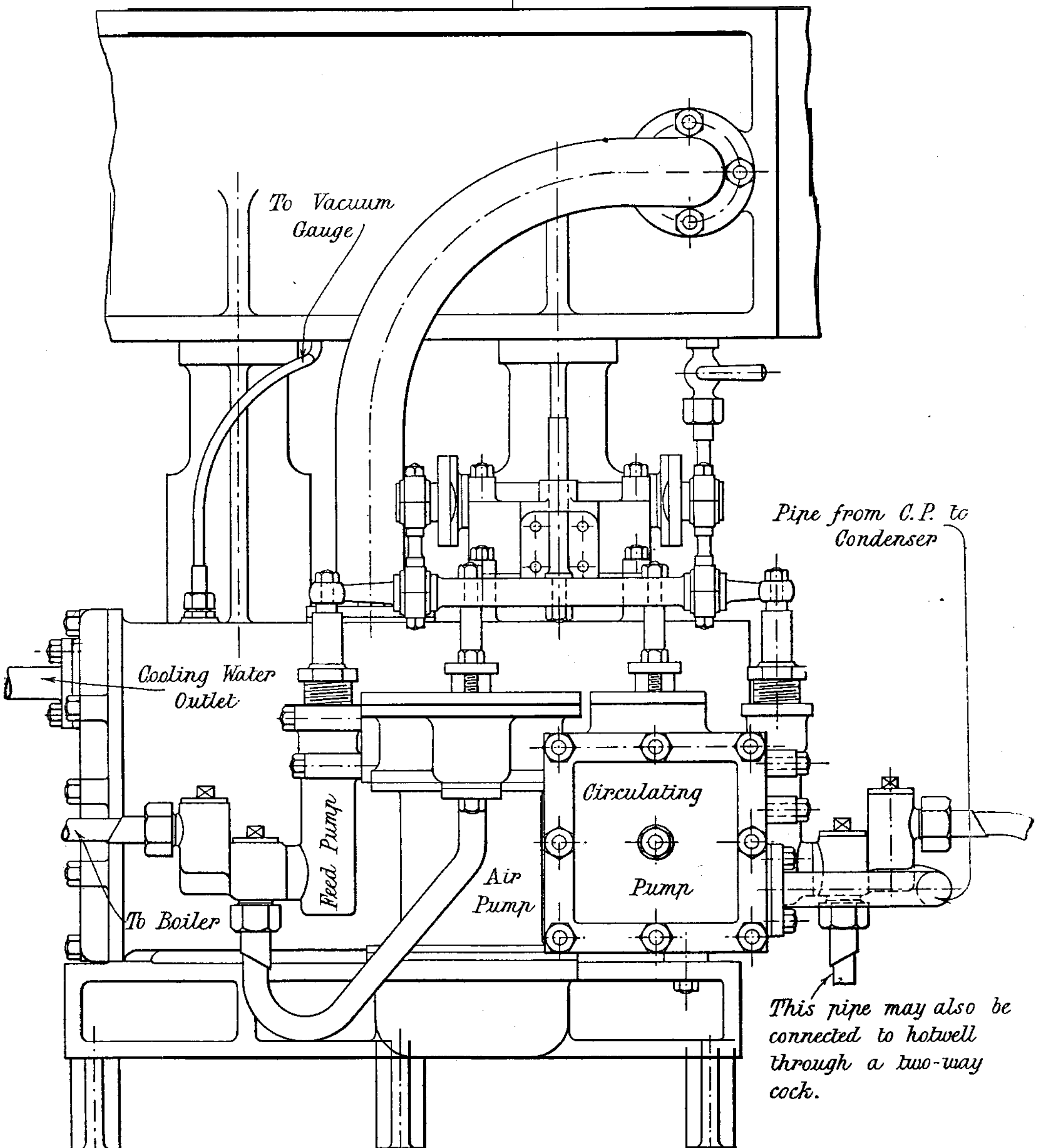


Fig. 63. Rear View of Pumps.

Part Elevation of Steam Engine showing Rear of Pumps

Assuming that the steam consumption for a small engine=40 lbs. per horse-power hour,

$$\text{then expected h.p.} = \frac{32.4}{40} = .81,$$

or assuming the total expansion to take place- in the L.P. cylinder, and a mean effective pressure of 25 lbs.,

$$\text{then h.p.} = \frac{7.06 \times 25 \times 166}{33{,}000} = .80.$$

Cooling surface of condenser =

$$\frac{.78 \times 6.37 \times 83}{I44} = 2.8 \text{ sq. feet.}$$

The cooling surface is probably too small for full power, but should be fairly efficient, especially if the flow of the cooling water is augmented by connecting the inlet side of the circulating pump to a good head of water, such as a water main.

As a guide in designing a suitable boiler for the engine, the following figures' will perhaps be found useful.

Assuming 1sq ft. of heating surface will evaporate 4 Ibs. of water per hour, the heating surface required =

$$\frac{32.4}{4} = 8.1 \text{ sq. ft., with a ratio } \frac{HS}{GA} = IO,$$

grate area required = **.81** sq. feet.

In conclusion, I should like to add a word of advice. Intending builders should not attempt to build the model without first laying cut the general arrangment fos themselves, because in preparing an article such as this, requiring so many more or less fully dimensioned sketches, discrepancies in measurements are liable to creep in, so that as a check upon the drawings which have been given here, it is perhaps essential that the parts should be first put together on paper. Many of the parts may have been described somewhat too briefly, but I should be delighted to give, with the permission of the Editor, any further information about the model to any reader who is interested. Also, I should be pleased to hear, through the Editor, from anyone completing it.

E. B. (Hunslet):-We are unable to give you particulars and details for making a 1 h.p. alternative current induction motor and doubt if you would be able to obtain the stampings necessary for construction of the stator and rotor. These machines require very careful workmanship as the clearance between stator and rotor must be extremely small. We do not know of any firm supplying designs and sets of parts for making induction motors.

Workshop Topics.

The principal items appearing under this heading relate to work done and other matters dealt with in THE MODEL ENGINEER *Workshop at 66, Farringdon Street, London, E.C.4.*

The Setting for Slot-Milling a Model Connecting-Rod End.

Fig. I, with this note, shows a method of accurately slotting the knuckle, or forked small end, of a connecting-rod. The rod is of the short marine type, as supplied with the " Stuart " vsrticai engine parts, and is of cast brass.

The setting involves the use of the "Wheeler" milling attachment, the vertical slide, table and machine vice of which are the portions set up.

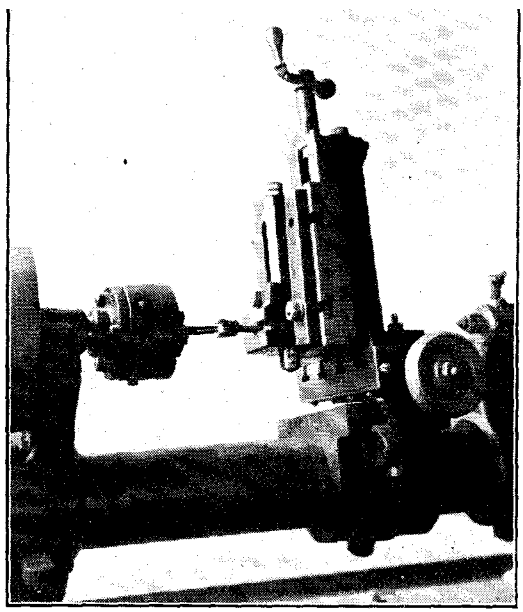


Fig. I.-Setting a Model Connecting-Rod for Slot Milling the Knuckle End.

The vice is aligned with the table accurately, and the rod set deeply in the jaws, using the fixed half of the big end as the holding piece. As the jaws are square with the table, they are, therefore, parallel with the boring table, upon which the vertical slide is mounted. This ensures the slot milling coming out accurately parallel with the big end.

The boring table had to be tilted a little to bring the job opposite the lathe centre, allowing for cross traverse, but not in the matter of height, because this could be adjusted by the vertical slide.

The slotting is done by means of a correct size end mill, duly clearanced upon its side cutting edges and mounted in a chuck. The