ENGINES FOR A STERN-WHEELER

Power units that propel model boats ought to have a relevance to their craft, says Edgar T. Westbury. In this serial article he will write about the kind of plant that is suited to the famous river boats

WHEN steam power was first applied to marine navigation in the early years of last century, its possibilities and practical problems presented an inspiration and a challenge to engineers.

In the development of the steamship many ingenious engines have been produced, including side-lever, oscillating, diagonal. and walking beam engines for driving paddle wheels; and direct-acting horizontal and vertical engines for driving propellers. Even at the present day, when the design of reciprocating marine engines has attained certain conventional features, they still offer a great deal of scope to the model engineer. Although some tine models of marine engines have been exhibited at various times, they have mostly been isolated from their environment, and rarely indeed have they been used to propel model steamships.

In view of the complexity of the modern marine engine, it would be difficult to build a true scale version that could be installed in a model of reasonable size. Most model liners, if propelled by steam at all, have a simplified engine and boiler which is practical but not realistic. But models of small craft offer possibilities for engines which are realistic in character, if not in detail. The primitive engines of early steamships are relatively easy to build to scale in a convenient size, but they have been sadly neglected, in comparison with other " period pieces," such as locomotives or stationary engines.

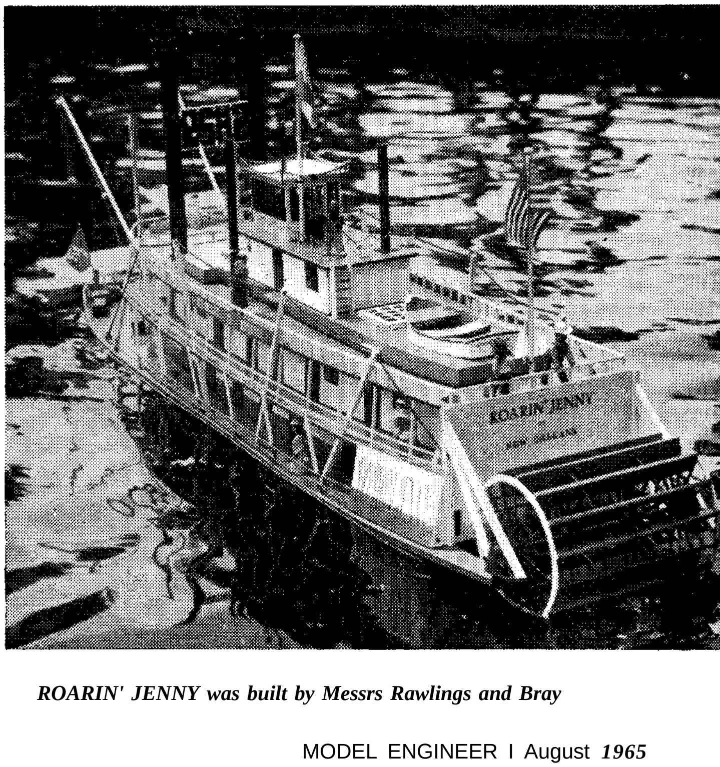
The fact that the engines of ships are not usually visible from outside may account for the lack of interest in making models of them. Compared with the number of people who are familiar with the working details of locomotives, very few have seen the inside of a ship's engine room, and even those who have, cannot well appreciate the beauty and dignity of the machines in the small space available for viewing them. Those who claim to be shiplovers concentrate their attention on external appearance, no matter whether the vessel is driven by sail or power; and the former, being the more spectacular, generally has the advantage. Speaking for myself, all ships are beautiful, not only with skin-deep glamour, but in their innermost parts.

Up to the middle of the 19th century, steamships were almost universally fitted with paddles for propulsion. Long after the introduction of the screw propeller, many ships such as ferries, pleasure boats and harbour tugs were still built with paddles. With paddles there was a great advantage in manoevreing by driving the two wheels independently, and this was probably the reason for their existence. In shallow or weed-infested waters, paddles had a still longer lease of life, because they were less likely to become fouled, and they were easier to clear if they did. One of the most popular and long enduring types of paddle steamer was the " stern-wheeler," and it is with the object of encouraging the modelling of this type of craft that the design illustrated has been prepared.

Some of the earliest experiments in the steam propulsion of ships involved the use of a single paddle wheel at the stern, including the abortive attempt by Jonathan Hulls in 1736 the failure of which was the subject of much satirical comment from those who said " it couldn't be done."

Hull's boat had an "atmospheric" engine of the Newcomen type, without a rotating crankshaft, and it drove the paddle through ratchet wheels, ropes and counterweights. One of the first successful steamboats, Robert Fulton's Clermont, (1807) had a stern paddle wheel driven through gearing from a vertical-cylinder inverted-beam or " side lever " engine.

The development of stern and side wheeled paddle steamers ran neck and neck for many years, but in the smaller, shallow-draught vessels, the stern-wheel was predominant. In the form which has been romanticised in



ROARIN' JENNY was built by Messrs Rawlings and Bray

story, song and film, its normal habitat was the Mississippi River, where it was extremely popular for many years, not only for passenger and freight carrying, but also as a mobile saloon, music hall and gambling casino. Similar steamers were used for river and lake transport in many other parts of the world, including Asia, Africa and central Europe, but the American ones were noted for their elaborate furnishings, often rivalling those of a luxury hotel.

Many readers of the ME have expressed an interest in constructing models of stern-wheelers, and a few interesting models have materialised, including the steam-driven ***Roarin' Jenny*** by Messrs Rawlings and Bray, of Southampton SME. This was elaborately equipped in the true Mississippi tradition; the more austere version by Mr E. J. Crossley of Leicester SME was, I believe, electrically driven. Either type is satisfactory as a working model, and looks well when under way. As free-running boats, they do not navigate as well as other kinds of craft, but they could easily be adapted to radio control, which would eliminate this disadvantage.

I have often been asked for information on the design of engines suitable for model stern-wheelers, but authentic details are difficult to obtain. Some years ago I did some serious research in this matter, but though I made contact with several people in America who had experience with these vessels they were unable to furnish me with sufficient technical information. The available illustrations of the steamers left a good deal to the imagination, as readers who have tried to build models from the limited ***views*** shown in photographs or artists's drawings will no doubt understand.

Spectacular type

The earlier types of stern-wheeler were often fitted with direct-acting engines driving cranks on either end of the paddle shaft, and this is the type which is most likely to interest model engineers, from the spectacular aspect. Later types had enclosed engine rooms, and drove the paddles through chain and sprocket, or other gearing. Some modern stem-wheelers have had diesel engines with worm-geared transmission. These give plenty of scope for constructors who are only interested in the propulsion unit as a means to an end, but there must be readers who think that an engine with its working parts on deck and fully visible has a special appeal.

It is a pity that the modern development of engineering often reduces or even destroys the attractiveness of machines. Working parts move too fast to allow their rhythm to be observed, and mostly their high speed requires them to be enclosed for lubrication and protection. From the utility aspect, there are. obvious disadvantages in slow-moving open engines. In early stern-wheelers, engines often became damaged because of their vulnerable position; this may explain why they were usually brought head-on to the jetties (should I have said " levees "?) instead of coming alongside.

I have devoted a good deal of space to the preamble because I think that in introducing a special design, it is important to explain the reason for its existence. To get down to the actual design, the set of engines shown is intended to serve for a model of ***a*** steamer which in full size would be about 120 ft long, with a 16 ft beam, and 6 ft 6 in. mean depth; draught when empty 19-3/4 in. aft and 4 in. forward. Such a boat would carry 10 tons dead weight with a mean draught of 2 ft and 100 tons (maximum) with a draught of 3 ft 6 in. The boiler, of locomotive type, would have about.

Mr E. J. Crossley, of Leicester, constructed this electrically-driven model of a stern-wheeler

400 sq. ft of heating surface, and work at a pressure of 150 p.s.i.

I have not undertaken the design of a hull, as that is not my speciality; but I consider that it should be scaled at 1/2 in. to the foot, that is, 5 ft long by 7-1/2 beam, and 3-1/4 in. depth.

Many kinds of marine engine cannot be rigidly standardised, but have to be " tailored" to fit the particular hull, or vice versa. In no case is this more evident than in direct-acting paddle engines, where the camber of the deck, either in plan or sheer, has an influence on the attitude of the engine and the immersion of the paddle wheel.

From illustrations examined, it appears that the hull design of stern-wheelers varied widely; some boats have an almost flat deck, others a concave sheer line, while in a few cases the stern " tumbles home" to the extent of nearly 10 deg. Similarly some hulls are almost parallel aft of the mid-line, while others taper sharply toward the stern. These factors must be taken into account, not only in the installation but often in the structural design of the engine. Obviously the immersion depth of the paddles must be under control; in some cases it has been made adjustable, but this introduces mechanical complication.

To cope with these varying requirements, some flexibility in the basic design of the engine is essential. I consider it best to avoid the use of castings for the main frames, in favour of fabricated construction; and such other castings as are necessary are of a simple and straightforward nature, for easy production and machining. In many respects the constructional work on the parts is similar to that on locomotives, and therefore familiar to most ME readers; but other features are very different and call for special treatment.

The cylinders are 5/8 in. bore by 1-1/4 in. stroke, these proportions being conducive to high torque at low speed, and a typical feature of the stern-wheel engines is the long connecting rod, the reach of which keeps the motion work well clear of the paddle sweep. Often these rods were made of wood, but in small size, this feature makes the attachment of the little end and crankhead bearings rather difficult, and I have not followed it. To avoid excessive weight in these

Continued on page 573.

stood sentinel over the Antwerp of the sixteenth century, when long trains of packhorses lumbered in with silks and spices from Constantinople and furs from the Black Sea, luxuries to be exchanged for good cloth woven from the wool of English sheep. Even then Antwerp was a busy port : it is recorded that in 1569 five hundred ships entered the harbour in a single day.

To be continued.

WITTON LAKES *Continued from page 559*

went to Mr D. Bowman of Heaton with 0.1 error and third went to Mr D. Shawcross of Tynemouth with 0.7 error.

After this competition there was a break for lunch, when an unsuccessful attempt was made to run the hydroplanes. With temperamental engines and the water roughened by the wind, it was an occasion when nothing seemed to go right. Eventually it was decided to run it later in the afternoon to allow the steering competitions to start.

The course, a little over fifty yards, was the same as that used for the nomination competition, and not surprisingly we had the same competitors. Unlike the course for the radio control boats, which was exposed to the wind, the water for the steering event was sheltered for about two thirds of its length by the high bank which separates the two reservoirs.

It was the last part of the course which was disturbed by the wind and it was interesting to watch the effect on various boats, and to hear the excuses from the owners when their boats were well wide of the marker buoys !

Two craft in particular caused much amusement to the onlookers, but sheer frustration to their owners, Mr J. Lindstrom of Bradford and Charles Coleman of the St. Albans Club. On being released straight and true Mr Lindstrom's boat decided that it liked the open water and so it turned at least go degrees to starboard. Pity to waste such a lovely day on running a mere fifty yards, seemed to be its attitude as it lifted its bow and headed away from the crowds. It was then a question of whether the engine would run out of fuel before it reached the far bank.

The climax to these voluntary performances came to Charles Coleman's launch. After a reasonable straight run, it was despatched on its return by one of the " catchers." It took a turn to port and headed out into open water again. Unfortunately for Charles his boat chose to test the hardness of the bank and came off second best. With its bows split wide open and its engine still roaring it made a graceful imitation of a submarine as it vanished below the surface.

When it was salvaged and returned to is owner, a survey of the damage proved that it would be running again in a short time.

While these two boats were spending the afternoon in trips round the lake, the remainder were engaged in the serious business of sailing for the target. The eventual winner was Mr P. Gladstone of Heaton. He was hard pressed by young Johnnie Blacknell who took second place and Mr D. Leach, also of Heaton, who came third.

This was my first visit to Witton Lakes and I was most impressed by the facilities. No doubt this venue will be seriously considered as a possible site when our Belgian friends visit us next year. Having a love for the steam engine, I was more than pleased to see the entries from the North East. To those of you who share this interest, but were absent at Witton Lakes, I would suggest that you make a point of attending next year.

STERN-WHEELER

Continued from page 563

cumbersome rods, light alloy castings are specified for them.

A set of marine engines cannot be considered really complete without a fully operative reversing gear, though it is true that in working model steamers, reversible engines are the exception rather than the rule. It can rightly be argued that if boats are only run in the forward direction, reversing gear is superfluous, but it certainly enhances realism, not only in the appearance of engines but also in facility of control. If the reversing gear shown is thought to be an unnecessary complication, simpler alternatives, such as slip eccentrics, may be used, or the engines may be non-reversible by fixing the eccentrics. The conversion from one form to the other entails no alteration to the general design of the engine.

The frame design at first sight appears simple, but because of the special conditions which have to be met-in maintaining rigidity of structure and alignment of the paddle shaft bearings- it is not without a few practical problems. It is necessary to keep the engines as low as possible, not only to obtain correct paddle immersion, but also to obtain a low centre of gravity.

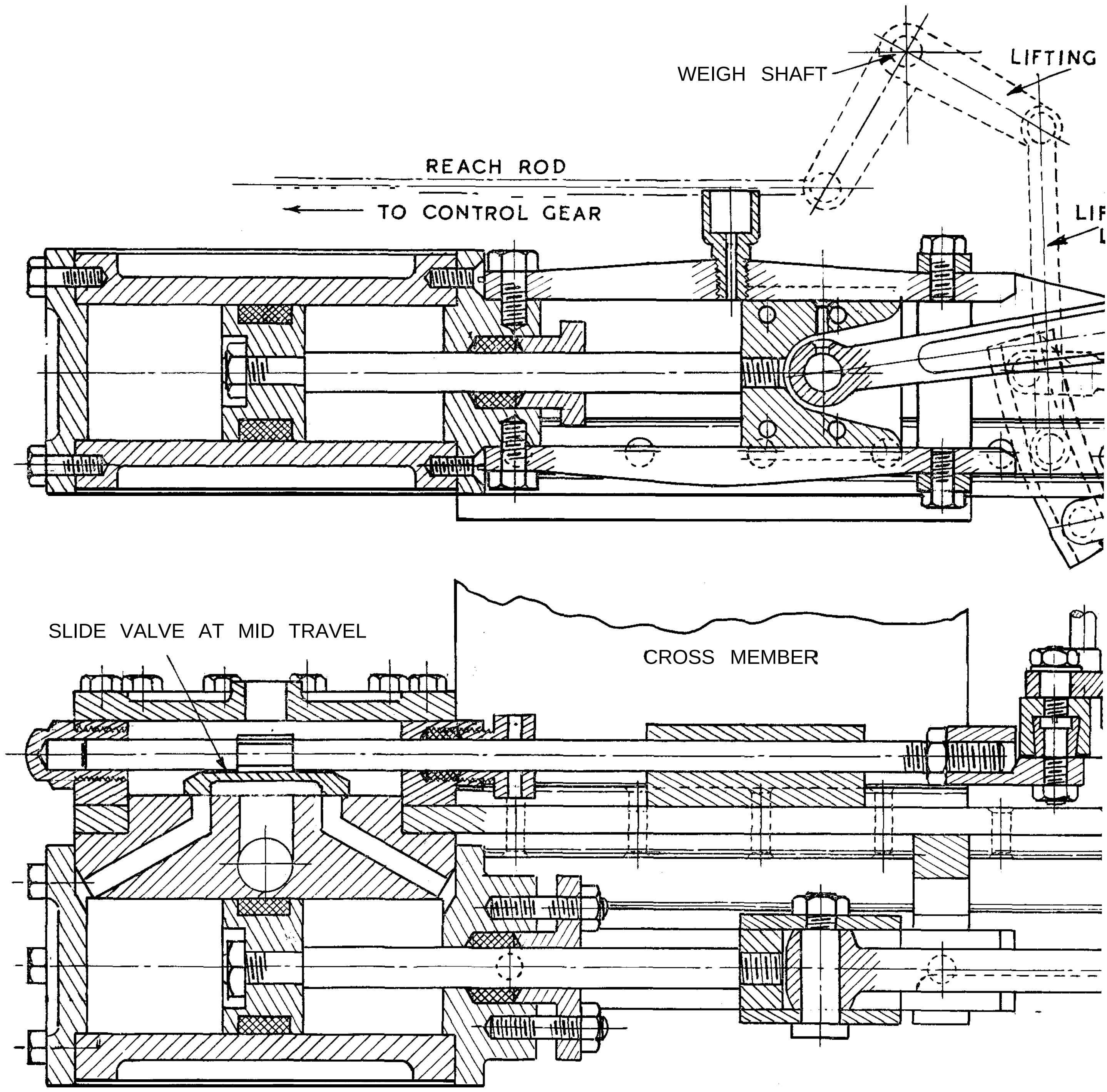
Paddle steamers of all kinds are liable to top-heaviness, especially stern-wheelers with elaborate superstructure. The overhang of the paddle shaft makes support at the after end rather precarious, though it may be possible to extend side timbers of the hull, or provide oblique struts to give additional supports. Some boats have had further extension of the timbers, with a cross beam aft of the paddles. The frame structures may be regarded as cantilevers, cross-connected by a member under the slide bars, which may be let in flush with the deck, or inclined to control the depth of paddle immersion.

Steel plate 1/8 in. thick, reinforced by 3/8 in. angle strips on both sides, is used for fabrication of the frames. It is essential that the material be straight and true; the angular truth of the angle strip should also be checked to ensure that when attached, the strips present a flat face to make good contact with the cross member. The steel need not be bright-rolled; hot-rolled or black steel is in some respects better, as it is less liable to distortion, but it must be free from mill scale or rust.

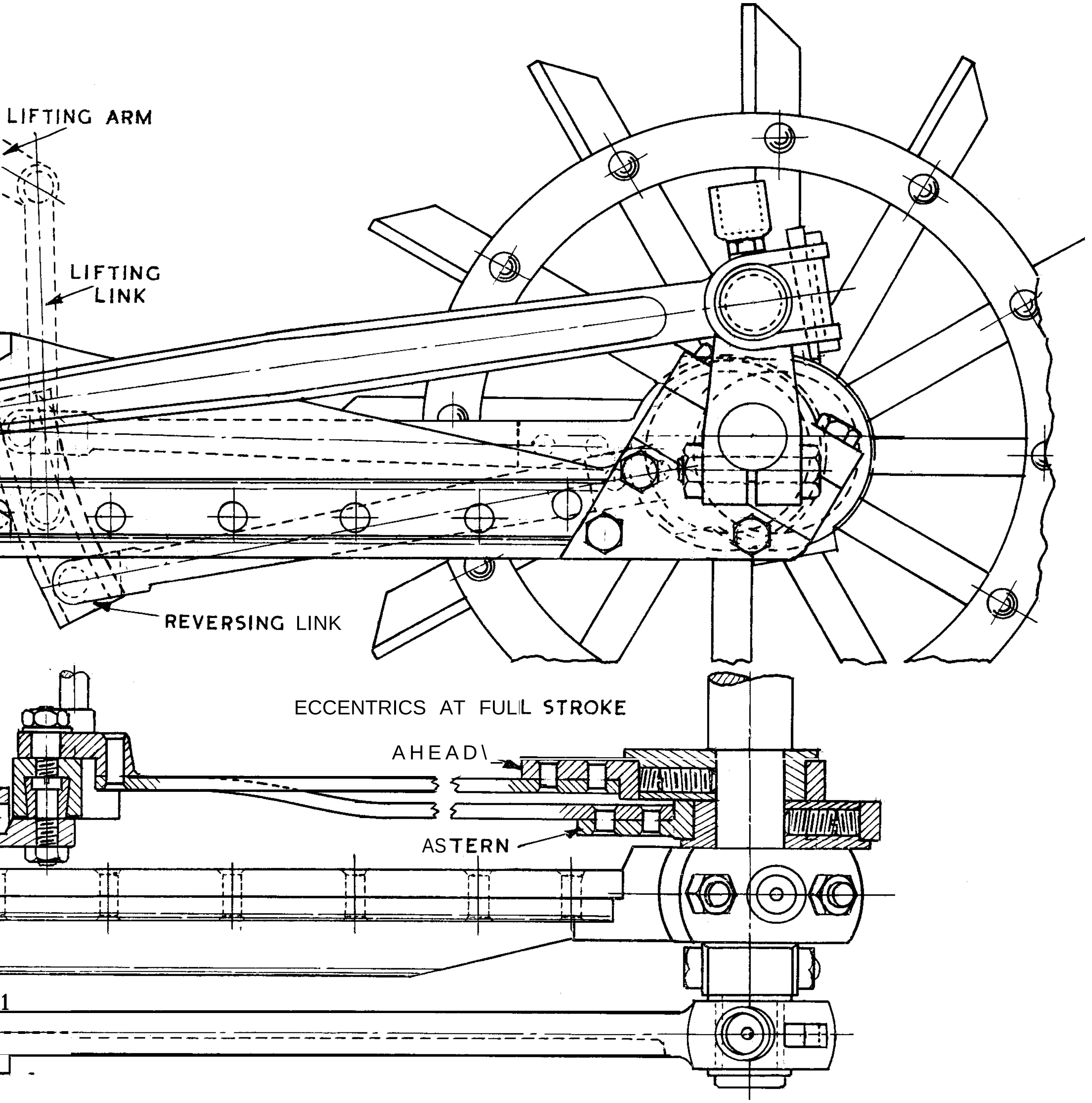
Rolled angle section steel of the specified size may not readily be obtainable, but larger angle steel may be cut down to the required width, or folded angle strips may be used. For preliminary operations, the strips may be temporarily attached by screws or bolts, until other parts have been located and fitted. When finally riveted, the heads should be filed flush, or at least project as little as possible, so that they cannot interfere with the fitting of the other parts. The aperture for fitting the cylinder, and the holes for bolting it in position, are obviously related to the mating parts. Do not forget that the frames and certain other parts, are in pairs, and mirror-inverted to each other.

The cross member is simply a flat steel plate, sufficiently wide to brace the complete engine structure and attached to the frame angles by countersunk screws from the underside. Its width cannot be definitely fixed as it must be related to the beam of the hull at the particular point and the overhang (if any) of the engine cylinders.

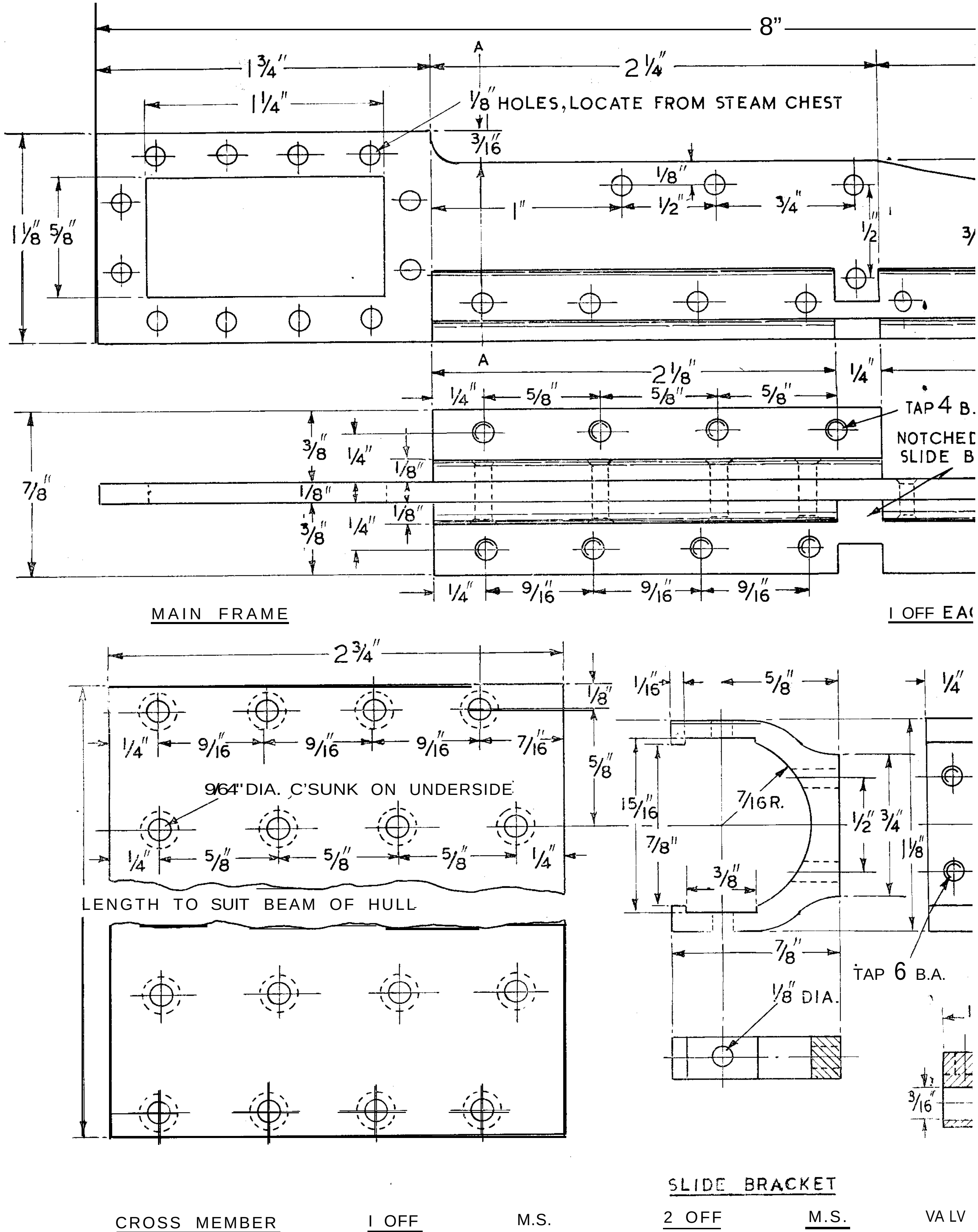
(To be continued)

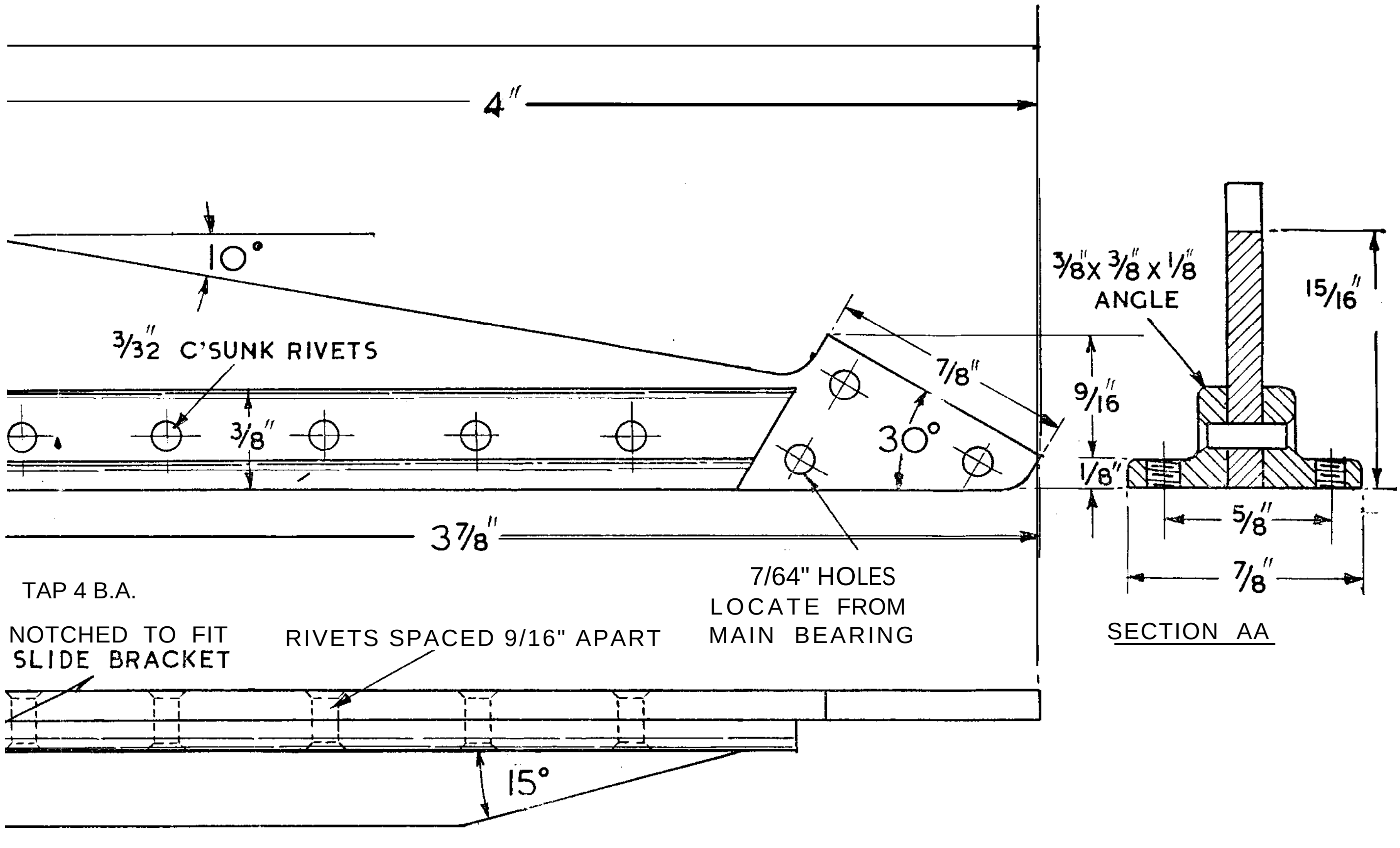


GENERAL ARRANGEMENT ENGINES FOR STERN WHEELER

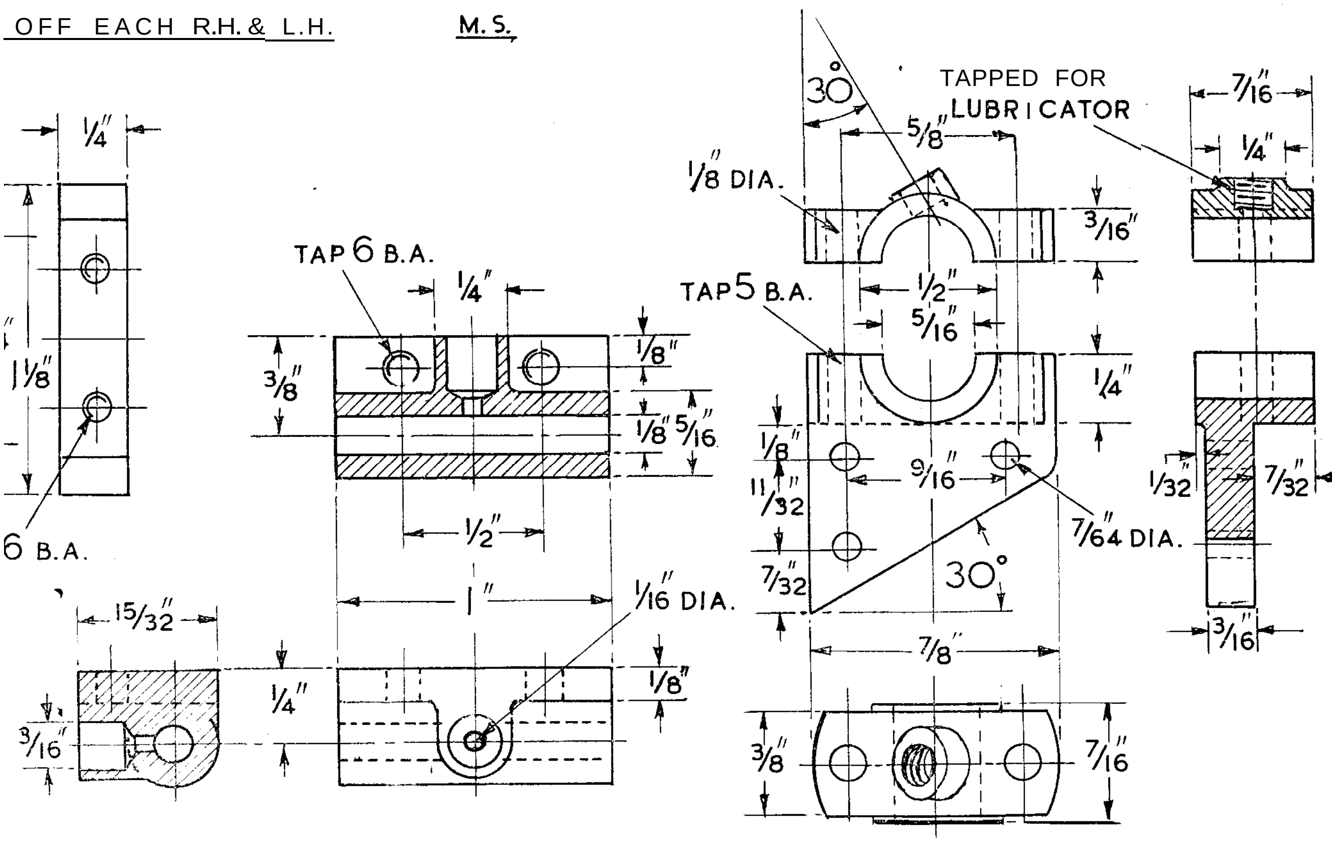


PORT ENGINE ONLY SHOWN


8"
1¾"
2¼"
1¼"
A
⅛" HOLES, LOCATE FROM STEAM CHEST
3/16"
⅛"
1"
½"
¾"
½
1⅛"
⅝"
2⅛"
¼"
⅝"
⅝"
⅝"
TAP 4 B.
NOTCHED
SLIDE B
⅜"
¼"
⅛"
⅞"
⅛"
⅛"
⅜"
¼"
⅛"
¼"
9/16"
9/16"
9/16"
MAIN FRAME
I OFF EA
2¾"
⅛"
¼"
9/16"
9/16"
9/16"
7/16"
⅝"
9/64" DIA. C'SUNK ON UNDERSIDE
¼"
⅝"
⅝"
⅝"
¼"
LENGTH TO SUIT BEAM OF HULL
1/16"
⅝"
¼"
15/16"
7/16 R.
½"
¾"
1⅛"
⅞"
⅜"
⅞"
TAP 6 B.A.
⅛" DIA.
3/16"
SLIDE BRACKET
CROSS MEMBER
I OFF
M.S.
2 OFF
M.S.
VA LV



OFF EACH R.H. & L.H. M.S.



BRONZE

VALVE ROD GUIDE 2 OFF BRONZE MAIN BEARING 1 OFF EACH R.H. & L.H.

Continued from August I

by Edgar T. Westbury

IN a hull of 7-1/2 in. beam, the cross member may be 6 to 6-1/2 in., but obviously it must be fitted so that the frames are exactly parallel with each other to allow the main bearings to be lined up with each other. The cross member may be used as a platform for mounting the control gear, including supports for the weighshaft, between the port and starboard engines. It is permissible to substitute two narrow strips for the wide cross member, but they must be braced by diagonal struts or otherwise prevented from shifting out of square with the frames.

The longer of the two angle strips attached to each of the frames has a gap cut in its horizontal and vertical faces to fit the slide-bar bracket. As its position must be located in relation to the cylinder axis, to ensure true alignment of the slide-bars, the bracket's dimensions and fixing holes may be subject to slight modification, so it is best not to fix them at the present stage.

Slide brackets

The simplest way to make the slide brackets is to cut rectangular pieces of flat steel bar or sheet, I0 in. wide X 1-1/4 in. long, with allowance for any external trimming which may be necessary. A hole 7/8 in. dia. is drilled and bored in the centre of each piece, and the two pieces may then be clamped or soft-soldered together for further operations. Some fitting on the seatings for the slide-bars will be necessary when lining up the parts to compensate not only for any possible errors in their dimensions, but also for the thickness of any packing used in the joints of the cylinder assembly.

For the same reason, the distance between the seating faces and the bores of the valve-rod guides cannot be positively determined. They can be drilled and reamed, and the faces milled or filed parallel to the bores, but it is advisable to leave something on them for final fitting. Fixing holes in the guides and the slide-brackets should also be left until the various parts can be assembled and lined up.

The main bearings can best be made from bronze or gunmetal castings. Although it is not necessary that they should be split, it will facilitate assembly and alignment, besides being in conformity with good practice, if they are made as shown in the drawings.

There must be an allowance for cutting and facing if the caps are cast in one with the lower part, and it is best to drill and tap the holes for the fixing studs before cutting. After facing the joint surfaces and securing the caps with temporary screws, the castings may be mounted either in the four-jaw chuck or on the faceplate for boring and facing on one side; the reverse side of the bore can be faced by clamping the bearing on a mandrel.

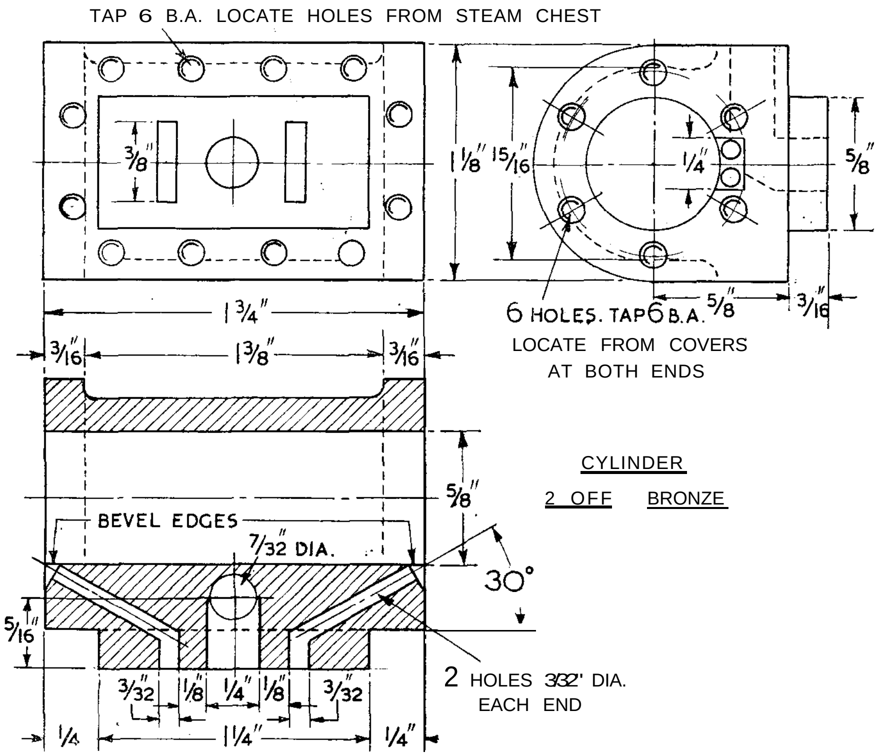
At this setting, a facing cut can also be taken over the mounting flange of the bearing, as far as possible without fouling the corners, to serve as a witness when milling or filing this face, which must obviously be exactly square with the bearing axis. The shoulder of the flange should bed firmly against the edge of the frameplate.

Either bolts or setscrews may be used to attach the bearings to the frames; with bolts, the holes in both parts should be a close fit for 6 BA, to serve as dowels and prevent any side movement. With the bearings mounted on the frameplates, and these held in their correct relative positions by assembling the cross member, the alignment of the bearings should now be checked by fitting a 5/16 in. test bar through both of them. To correct errors, the faces of the bearing flanges may be filed or scraped as required, but this should not be necessary unless they have been incorrectly machined, or the frame plates are out of truth.

Main frame

When properly aligned, the test bar should pass freely through both bearings and make contact over the full length of their bores.

The cylinder group of components have a general resemblance to those used in locomotive practice, and most ME readers will be familiar with the methods of machining and fitting them. To constructors who have no



and cylinder construction

previous experience with this work, it may be explained that the cylinder, steam chest and covers are generally made from bronze or gunmetal castings, though they can be machined from solid metal, or fabricated, if this is more convenient.

The cylinder can be held in the four-jaw chuck for boring, and for facing the flange at one end. A smooth and parallel bore is most essential, and although minor errors in both respects can be corrected by lapping-preferably at a later stage of operations-it is sound policy to produce as good a tool finish as possible in the first place. The flange face which, when fitted, will be adjacent to the piston rod gland, must be exactly square with the cylinder axis, so it should be machined at the same setting as the boring operation. At the other end, accuracy of the flange face is somewhat less important, so it may be machined either by reversing the casting in the chuck and bedding the finished flange face firmly against the chuck face, or by mounting on a mandrel. Identification marks should be made to show relative assembly positions of mating parts.

Port face

To machine the port face truly parallel with the cylinder axis, the most convenient method is to mount the component on an angleplate, using a single bolt through the bore and a plate or disc to bear on the flange. The machined surfaces should be protected from burring or bruising by interposing tough paper. After setting up the angleplate on the lathe, so that the port face is fairly central, and offset weight has been balanced by attaching odd pieces of metal to the faceplate, the port face can be machined flat and true. The distance of the face from the cylinder axis should be exactly 1/2 in.

It is necessary to produce a true surface on the rebated joint face which surrounds the port face. There are several ways of doing this including milling, shaping, or hand filing, but if a rotary-spindle milling attachment with a vertical slide is available, it is a very simple matter to end-mill it while the work is still set up for dealing with the port face. The lathe mandrel should be locked with the cylinder axis horizontal; this can be done sometimes by engaging the back gear, but a more positive method is to tie the faceplate, by a bar or bracket engaging with the channel of the lathe bed or other stationary part. The cylinder must be prevented from any movement while milling the four sides of the rebate, and the depth of cut must be the same all round to produce a flat surface.

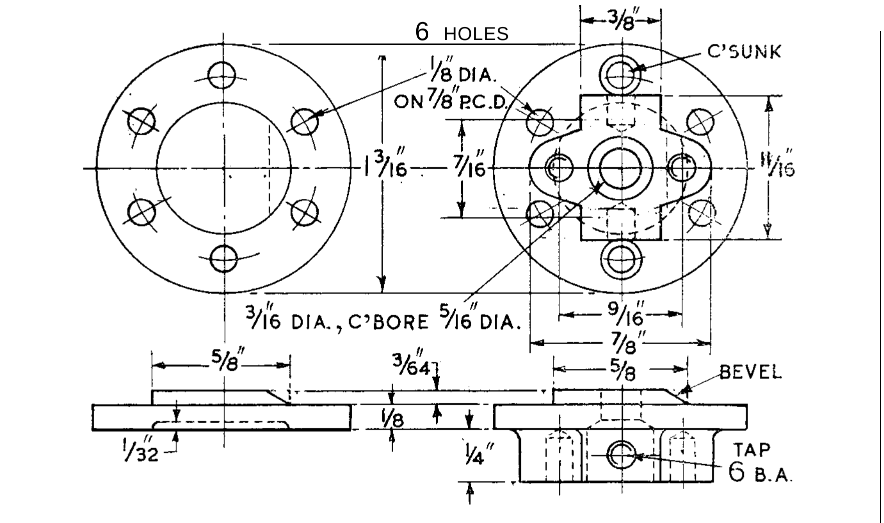
An alternative method is to mount the cylinder on a vertical slide, with the port face square with the lathe axis, and use an end mill running in the lathe chuck. In either case the rebate should be 3/16 in. back from the port face, and the projecting rectangle of the latter should measure 5/8 in. X 1-1/4 in. This fits the aperture in the main frame, and the port face projects 1/16 in. on the other side, less the thickness of any jointing material used between the surfaces.

Methods of cutting ports in cylinders have always been the subject of discussion. The most popular method is by end milling, with the cylinder mounted on a vertical slide and the cutter running in the lathe chuck. This produces round-ended ports instead of the square-ended ports as shown in the drawings, though this is not important so long as the required port area is obtained. The method is generally considered satisfactory, given care and patience, for it allows ports of ample depth to be produced, but the limited speed of most lathes is not suited to running small cutters at their best efficiency. A method of side milling, by using cutters of small diameter on shanks of minimum permissible size, has been described in some of my articles on steam engines. It produces ports of high accuracy, but limited depth, and dispenses with the need for a vertical slide. A full description of the various methods of port cutting can be found in the PM handbook ***Milling in the Lathe.***

Some of the older craftsmen, in the days when machine tool facilities were practically non-existent, produced ports by drilling a row of holes and joining them up with a small cross-cut chisel, but such methods are unnecessarily tedious nowadays. Again, skilled moulders in the old days could produce castings with ports and passages accurately cored in, but this is not now considered practicable except in cylinders of comparatively large size. But whatever method is employed, the important thing is that the ports should be in the right place and cleanly cut so that they can be properly controlled by the slide-valve.

A rather unusual feature of the cylinder ports is that the central port, which leads to the exhaust outlet, is

Continued on page 608



CYLINDER COVERS 2 OFF EACH BRONZE

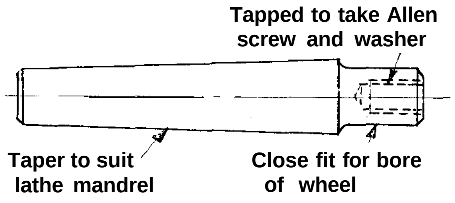


FIG.2 LOCATING SPIGOT FOR WHEEL TURNING

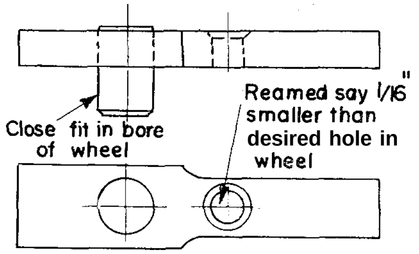


FIG3 CRANKPIN DRILLING JIG
Silver steel or M S case hardened

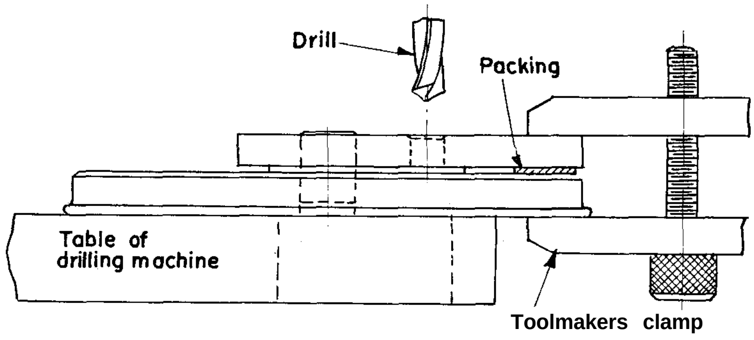


FIG 4 CRANKPIN DRILLING JIG IN USE

articulated suburban stock, Atlantics, Pacifies and occasionally a GC engine stormed or coasted by (depending on its direction) with an express. And, of course, there were the three-cylinder Moguls, on the fast goods. Now the path is closed, and diesel has replaced steam.

But to get back to wheel coning, as model tracks do not normally bother to cant their rails, the coning of the wheels is hardly worth while.

Bogie, trailing and tender wheels will now be ready for their axles, but driving and coupled wheels must have their crankpins fitted before proceeding further with the assembly.

Small diameter axles may be turned in collets, but the three-jaw can be used. If it is insufficiently accurate, the old dodge of packing out the offending jaw or jaws with strips of paper can be tried. This is where the d.t.i. comes in so useful. The axle must be running really true before an attempt is made to turn the wheel seat. Some workers get by with a piece of white chalk; others make trial cuts with the tip of a lathe tool (a knife tool is the one to use here) but give me a d.t.i. every time!

There is, incidentally no need to use silver steel for locomotive axles. Ground mild steel is the stuff we want, and it is generally obtainable in sizes suitable for scales up to 1 in. Above this size, axles will probably have to be turned between centres anyway, but if they are not, proper centres should always be put in, if only for their realistic appearance. A final small point-axle wheel seats should be made a few thou longer than the thickness of the wheel at its boss; thus after pressing home, the axle will protrude very slightly.

A simple jig must be made up for drilling the driving and coupled wheels for their crankpins. My sketch shows a suitable one, and you will notice that it is made long enough to enable the builder to clamp it to the wheel. It is shaped so that it can be located fair and square with the crank boss. When clamping, care must be taken to prevent the jig from being tilted.

To be continued.

ENGINES FOR A STERN-WHEELER *Continued from page* 595

in the form of a round hole instead of rectangular. It has always struck me as rather strange that most designers should insist on orthodox practice in the shape of this port, since it plays no essential function in the scheme of valve events and is not opened and closed by the slide-valve. Therefore it does not matter what shape this port is, neither need its location be precise, so long as it is large enough to give adequate passage to exhaust.

It may be mentioned that all the port and passage areas of this cylinder are well on the large side for the slow speed at which the engines are intended to be run. Despite the many arguments which have been put up in favour of large ports, I have found by experience that they are not ***invariably*** essential to efficiency. But they facilitate control of valve events and give rapid opening and closing, which is all to the good. Wiredrawing of steam is not always an evil, and may sometimes be used to advantage; but it should not ***occur in*** the cylinder ports.

The passages from the ends of the cylinder to the ports are in the form of holes drilled at an angle of 30 deg. to the cylinder axis. To start the drill accurately, a local chamfer should be milled or filed in the mouth of the cylinder at an angle approximately perpendicular to that of the passages. A simple method of ensuring that the holes are drilled at the correct angle is to make a hardwood or metal block with a flat base, and a top surface at 30 deg., equipped with a long stud or setscrew for securing the cylinder in position. A small centre-drill may with advantage be used for starting the holes, as it is far less liable to wander from the correct position than the relatively flexible twist drill.

To be continued.

Continued from August 1

by Edgar T. Westbury

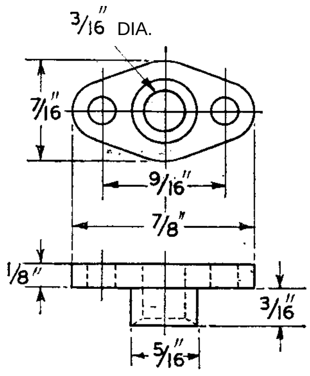
Machining the working parts

IT may be observed that the circular port of the cylinder contour is 1/16 in. less in diameter than the flanges of the end covers, which they might normally be expected to match. The reason for this is that the recessed parts of the cylinders are intended to be lagged with insulating material, and covered with either wood or metal cleading fitted flush with the edges of the covers.

The cylinder covers have register spigots which should fit closely in the ends of the cylinders, though this is important only in the ends which carry the piston rod glands. For the other end covers, the spigot, joint face and inner face may be machined at one setting by gripping over the edge of the flange in the chuck. The reverse side may be rough faced by holding in the same way, but to fiinish the face and also to turn the edge of the flange, it should be gripped over the narrow surface of the spigot, with the flange bedded against the chuck jaws. Somewhat different procedure is called for with the covers at the gland end to make certain that the register and the gland recess are exactly true with each other. If the inner side is machined first and the hole drilled for the piston rod, it may not be easy to ensure that the counterbored gland recess is truly concentric when the cover is reversed.

My favourite method is to first chuck the cover with the gland boss outwards, and to face, drill and counterbore the hole as truly as possible. A stub mandrel is then machined in the chuck, with a pilot extension to fit the small hole, and the cover mounted on it for machining the inner face and spigot. In this way the truth of the essential surfaces is positively assured, even if a slight error should occur in drilling and counterboring.

Incidentally, some constructors find difficulty in turning register spigots to a snug fit. The job will be simplified if the spigot is first made with extra length allowance, and when nearing finished size, trial cuts are taken only on the extreme end. If this part should accidentally be turned undersize, the rest of the spigot may still be made a little larger to fit properly; the excess length of spigot is then faced back to the finished length.



CYL. GLAND
2 OFF BRONZE

The top and bottom faces of the gland boss to the cover will need to be machined or filed exactly parallel with the axis, and at the same distance from it. This is another operation where the use of a milling attachment will help to ensure accuracy. The same applies to the drilling of holes in the flanges of both pairs of covers. Note that the holes above and below the gland bosses have to be countersunk; screws with projecting heads cannot be fitted in these positions, because the ends of the slide-bars have to be butted closely against the flange face.

Little need be said about the machining of the gland, as the essential turning and drilling operations can be carried out at one setting by gripping the flange in the four-jaw chuck. It should be an easy working fit on the piston, and also in the counterbore of the cover. The three-jaw chuck can be used to hold it in the reverse position for facing the top of the flange. After drilling the stud holes, the flange may be used as a jig to locate the tapping holes in the cover boss. In the same way, the covers may be used for jigging the holes in the cylinder. The angular position of the flats on the gland boss of the cover is important; it may be located by laying the cylinder bv its port face on a surface plate and, with the cover in position, checking the angle of the flats on both sides with a try-square.

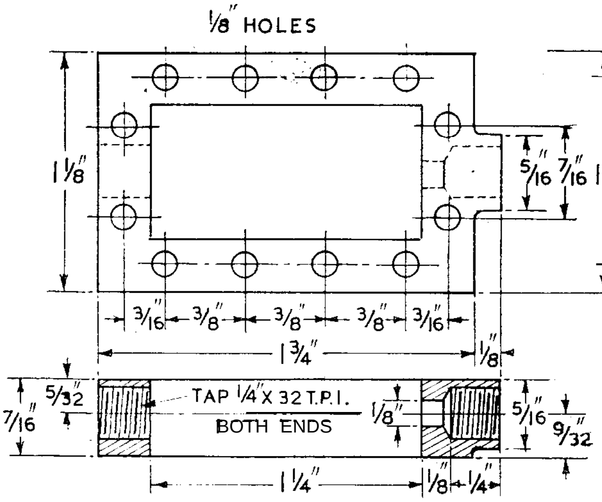
Note that front and back covers have the spigot chamfered or bevelled locally to avoid restricting the opening from the drilled steam passages into the cylinder. The position of the chamfer can be located from that on the mouth of the cylinder bore, and either milled or filed at approximately 30 deg. to the spigot face.

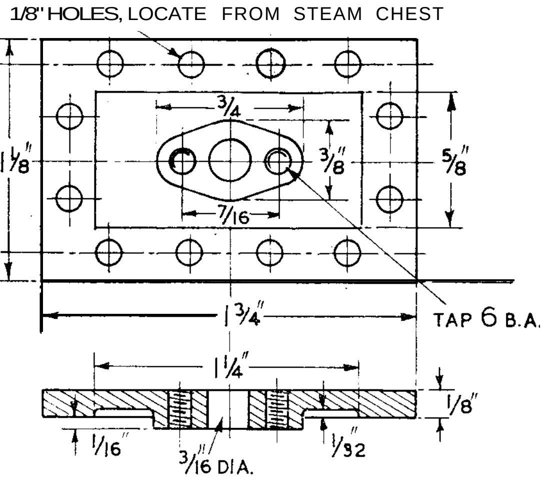
The steam chest is of a type familiar to steam engine builders, and is best made as a casting with a rectangular aperture, which will need to be filed to fit over the port face projection of the cylinder. For machining the two side faces, the casting may be held in the four-jaw chuck, and after the first facing operation, it should be reversed and bedded firmly against the chuck jaws, so that parallel accuracy of the two sides is assured.

To drill and counterbore the gland *recess,* the casting may be mounted on an angle plate by one or more bolts through the aperture, and set up on the faceplate with the boss running truly. It should be noted that the boss is not symmetrical with the two side faces, but is offset towards the outside face. After concentric drilling, counterboring and tapping of the boss, its external diameter and the end face may be skimmed at the same setting to produce a clean finish.

A piloted stub mandrel should then be turned in the chuck, and threaded to fit the gland recess, so that the casting can be mounted for drilling and tapping the reverse end exactly in line. After centre-drilling, but before drilling the hole, the tailstock centre may be used to support the work while facing the end surface. With due care in these operations, the valve rod, when fitted in the gland and tail guide, will slide freely and in true parallel alignment with the cylinder axis.

The steam chest cover casting is simply a flat plate with the centre relieved to form a recessed panel, with a raised flange face to match the steam pipe joint. If desired, it may be modified, by tapping the centre hole, to take a union or other pipe fitting. It





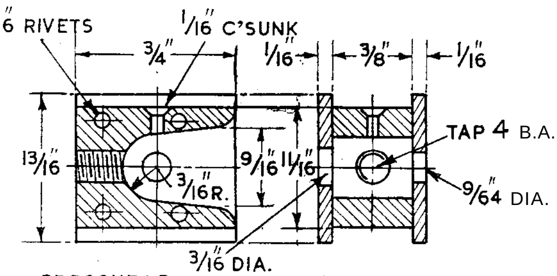
STEAM CHEST 2 OFF BRONZE STEAM CHEST COVER 2 OFF BRONZE

is also permissible to fit the steam supply pipe to the top face of the steam chest, if this position is more convenient, but care should be taken to avoid the fixing studs. Generally speaking, the flange joint on the cover will be found the neatest and most practical fitting. In any case, the cover must be faced truly flat on the inner side, and then reversed for facing the flange and the outer rectangle as truly parallel as possible. The inner cover face, and both sides of the steam chest, may be lapped to produce true flat joint surfaces.

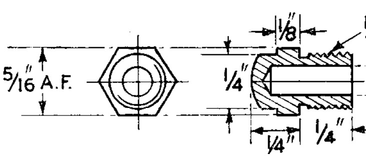
The fixing holes for these two parts should first be drilled in the steam chest, which is then used as a jig to spot the holes in the cover. Take care to identify the mating parts in relation to each other, by punch marks or figure stamps, so that they can be located the same way on final assembly. The cylinder should now be fitted to the aperture in the mainframe, the steam chest fitted in place, and clamps used to hold the parts in place while spotting the clearance holes in the frameplate and the tapping holes in the cylinder.

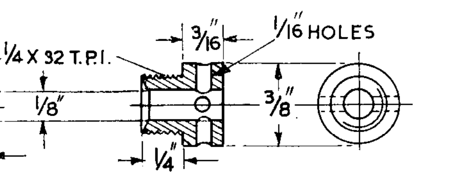
As it is necessary that the final location of the group of parts should be fixed for lining up other working parts, they should be assembled with the necessary jointing material between the surfaces on both sides of the frameplate. It should not be necessary to use thick packings, if machining has been carried out correctly. I find that tough brown paper, like that used for wrapping, is satisfactory for steam joints up to fairly high temperature; on final assembly, it should be coated on both sides with Wellseal or other jointing compound. The thickness of the paper, when under compression, will be about 4 to 5 thou, which must be allowed for when lining up both the crosshead slide-bars and valve-rod guide.

The piston should preferably be turned from a piece of cast iron, but if this is not available, hard bronze or stainless steel may be used. It is machined all over, and if the centre hole and the external glands are turned at one setting, their essential accuracy is assured. There are several ways of attaching the piston to its rod, all of which are satisfactory if properly carried out, but I have found that fitting the end of the rod closely to a parallel hole and securing it with a nut, is as good a method as any. Of course, it involves turning the rod down accurately, either in a good collet chuck or setting it up in the four-jaw chuck with the aid of a dial test indicator, but the

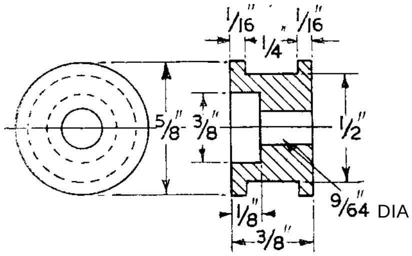


CROSSHEAD 2 OFF M.S

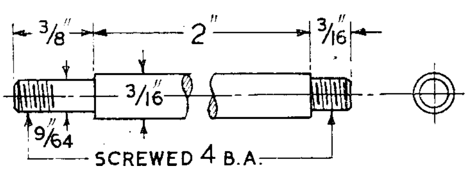




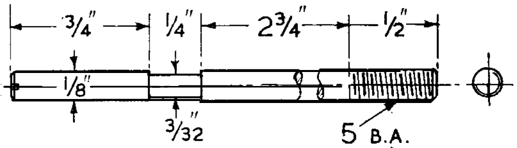
VALVE ROD GUIDE 2 OFF BRASS VALVE ROD GLAND 2 OFF BRASS



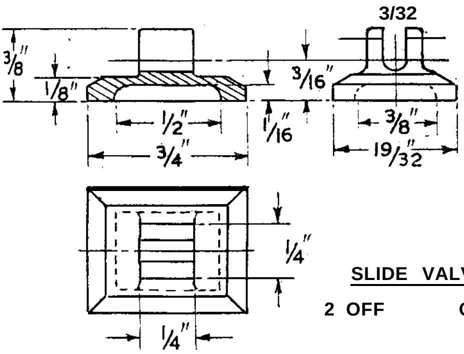
PISTON 2 OFF C.I



PISTON ROD 2 OFF STAINLESS S.



VALVE ROD 2 OFF STNLS S.



SLIDE VALVE 2 OFF C.I.

trouble involved is well worthwhile.

In some cases it may be considered best to leave the lands of the piston slightly oversize and finish them after fitting to the rod, but this is of no advantage unless the rod is set up to run truly while the operation is carried out. The piston should be fitted to slide smoothly in the cylinder bore. Its groove is packed with graphite impregnated asbestos yarn to produce a resilient but not excessively tight seal. Similar packing material is used for the piston and valve-rod glands, which should be well filled and compressed down, but not screwed up tighter than is necessary to prevent leakage when working.

The valve-rod tail guide and gland may be made from brass, and care should be taken to ensure that the threads are concentric with the bore in each case. Tommy-bar holes in the gland, as shown, will be found most convenient for running adjustment, but a hexagonal head, and a slightly domed blind end, is more appropriate for the tail guide. The length of the piston rod may be subject to slight modification on assembly.

It is possible to machine the crosshead from solid or from a casting, but the fabricated construction shown will be found simplest, as it avoids the need for milling or recessing operations which some constructions may find difficult. Mild steel, casehardened before final assembly, is recommended, but hard bronze may be used as an alternative. The centre piece should be made of a thickness to match the width of the slide-bars, and the vertical height should be the same as the distance between flats on the boss of the cylinder cover. This dimension may be left slightly oversize until the axial hole has been drilled and tapped, when it may be screwed on the piston rod, and with the piston and its rod assembled in the cylinder, the crosshead is lined up from the flats and its top and bottom faces machined or filed to the correct levels.

A crosshole is drilled through the centre of the piece, to take a bolt which will clamp the two side cheeks in place while drilling the four holes for the rivets through all three pieces. They are now separated, the crosshole through the centre part is opened out to 3/8 in. dia. and then sawn out to form the mouth, which must clear the swing of the connecting rod.

Though there is no objection to using rivets with projecting heads for joining the parts together, flush rivets will generally be preferred, and 1in. wire nails in fairly close-fitting holes can be used in the absence of more suitable soft iron rivets. A worthwhile tip in flush riveting, when it is desired to make the rivets invisible, is to taper the holes in the outer plates instead of countersinking them. A broach or D-bit with an angle of not more than 10 deg. inclusive, may be used for this purpose. This avoids the wire-edged flash formed when rivets are closed into an obtuse-angle countersink, and which often shows up when they are filed flush with the main surface. Finally, a countersunk hole is drilled through the top of the crosshead, so that some of the oil which is scraped off the slide-bars can be collected and fed to the little end bearing of the connecting rod.

The valve rod is made from 1/8 in. stainless steel, which must be set up to run truly for screwing the end with a tailstock die, and in the reversed position for reducing the diameter to 3/32 in. for a length of 1/4 in. This portion engages the slot in the back of the slide-valve and provides the means of moving it, without imposing any restraint on its ability to seat itself properly. A slot across the end of the rod will allow the valve to be finely adjusted for position, with a screwdriver, if the tail guide is removed. There are several alternative methods of coupling the rod to the valve, but this is one of the simplest which gives the required results.

Slide-valves for small engines are usually made of bronze or gunmetal, but I have always considered these unsuitable for working on a cylinder port face of the same or similar metal. Its chief merit appears to be that it is relatively easy to cast accurately to shape, though many slide-valve castings I have come across have been far from clean and accurate. I have made slide-valves of cast iron for several engines, and I find that they have much better wearing properties, especially when lubrication is meagre or infrequent, and they retain steam-tightness much longer than bronze.

It is possible to make slide-valves from solid without any great difficulty. My method is to take a piece of metal rod or solid cast stick, large enough to clean up to the diagonal size of the valve (in this case 15/16 in. dia.) and long enough to hold in the chuck with about 1/2 in. projecting. This is faced flat on the end and recessed 3/8 in. dia. for a depth of 1/16 in. with a flat ended drill or end mill. The back of the valve is then necked down to about 3/8 in. dia., leaving a disc 1/8 in. thick. Before parting the valve from the stock rod, most of the shaping, both on the outside edges and the rectangular recess, can be carried out. The use of a rotary-spindle milling attachment on a vertical slide, with the work still set up and the lathe mandrel locked in a fixed position, will simplify these operations. A very small end mill or dental cutter must be used to square out the four sides of the recess; even so, it will leave a slight radius in the corners, but this will not matter so long as it does not restrict the opening area of the ports to any great extent.

Greater skill and patience is necessary to shape the valve by hand methods; it is not difficult to file the outside edges, including the bevel (the object of which is simply to eliminate surplus metal), but the recess can only be squared with the aid of a small chisel if end milling facilities are not available. After parting off the valve, the projecting boss is milled or filed to shape, and a slot cut in it to take the reduced portion of the valve rod a close, but not tight fit, with no end play. The face of the valve should finally be lapped to exact flatness and smoothness on a slab of plate glass, using fine Carborundum or other suitable abrasive compound.

The cylinder group of components should now be assembled on the main frameplate, complete with joint packings as required, but the outer end cylinder cover should be left for the present to enable the piston to be moved easily, or removed entirely if required, in the course of fitting. The crosshead can now be screwed on to

Continued on page 655

More about sparks from steam

UNDER the heading "Sparks from Steam," the letter and the illustration in Postbag for October 1 last, from Mr H. H. Nicholls greatly interested me, having had experience of these phenomena without any special apparatus, which I described in MODEL ENGINEER for January 15 under " Blue Sparks on a Summer's Night " also because I had the original machine right under my nose in the Municipal Museum of Science and Engineering, Newcastle-upon-Tyne.

This, the prototype of the subject of Mr Nicholls' illustration, had only one cone to direct the steam on to the brass comb. In the illustration three cones are shown, thus indicating a much larger machine, and I have since learned that a very powerful apparatus was installed and used at the Polytechnical Institute in London, having no less than forty-six steam jets. It was capable of producing sparks almost two feet long.

I am sorry to have to disagree with Mr Nicholls about the steam being superheated. The pipe mentioned is apparently provided to carry off the steam arising from the water in the chamber, which actually is a condenser; the gauge glass that indicates the water level in this chamber can be plainly seen. The pipe could also act as a stay bracket for the chamber to steady it against the reaction of the steam jets. At any rate it could not be of much importance as it was not provided on the prototype, and must have been added as a refinement. The steam, of course, was admitted to the condensing chamber via the stopcock on the top of the dome.

In the prototype the collecting comb is mounted differently from that in the illustration. Instead of being mounted on the boiler the comb is carried on an insulated column, after the manner of an electric floor standard lamp, a coil of insulated wire being attached for conducting the experiments.

The well-made horizontal double-acting steam engine, now placed under the boiler to conserve space, was used to maintain the water levels in the boiler and the condensing chamber, the pump being driven by an eccentric on the crankshaft. The whole is built in a massive manner and is no doubt the original machine constructed by W. G. Armstrong 125 years ago. The three-cock water gauge on the boiler, if fitted with a guard, would seem in keeping with today's practice. No pressure gauge or thermometer is fitted; the pressure possibly being kept up to blowing-off point when using the apparatus. Several unused rivet holes were left, possibly to aid combustion, while the fire-lid appears to have endured some drastic increase in air admission below the grate area.

Jeynes' Corner

A commentary on current topics

The following is extracted from an ***Elementary Treatise on Natural Philosophy of 1875 AD*** by Deschanel:

"About the year 1840, W. G. Armstrong (later Lord Armstrong) invented an electric machine, in which electricity was generated by the friction of steam against the sides of orifices through which it was allowed to escape under high pressure.

"It consists of a boiler with a fire inside, supaorted on four glass legs; the steam, before escaping, passes through a number of tubes, which traverse a cooling box containing water, into which dip meshes of cotton, which are led over the tubes and passed around them.

"The cooling thus produced in the tubes causes partial condensation of the steam; this has found to be an indispensable condition, the function of perfectly dry steam being quite inoperative. Strictly speaking it is the friction of the drops of water against the sides of the orifices, which generates the electricity, the steam merely furnishes the means of applying the friction. The jet of steam becomes positively electrified, while the boiler becomes negatively charged.

" The positive electricity is collected on a metal comb communicating with an insulated conductor. The steam is checked in its course by a metal tongue, round which it has to pass before it can enter the wooden tube through which it escapes into the air.

"The machine to work well requires a pressure of several atmospheres; the water in the boiler should be distilled. If a saline solution be introduced into the tube through which the steam escapes, all traces of electricity disappear.

"The generated electricity varies both in sign and degree according to the liquid whose particles are carried out by the steam, thus when a small quantity of oil of turpentine is introduced into the jet of steam, the boiler becomes positively and the steam negatively charged.

"At the Polytechnical Institute in London, there was a machine with a boiler 78 in. long, and a diameter of 42 in., and having 46 jets. This machine was extremely powerful, and sparks were obtained at a distance of 22 in."

STERN-WHEELER

Continued from page 651

the piston rod, and by checking its distance from the frameplate at both ends of the stroke its alignment and the exact position of the slide-bracket can be established.

Reference has been made to the valve rod guide, which is fitted to the frameplate on the opposite side to the slide-bracket. To line up the guide, the valve rod is placed in position, through the gland and into the tail guide, and the distance between the projecting part of the rod and the frameplate is then measured with inside calipers on a slide-gauge. The guide casting, with a piece of 1/8 in. rod fitted through the bore, is laid on a flat surface and the distance from this to the rod similarly measured. The surface of the seating may be machined or filed down till the measurements coincide exactly. Errors in fitting can- be made good by fitting shims between the frame and the guide, but it is better to avoid the need for them. The vertical position of the fixing holes in the guide can be located by spotting from the frameplate, or vice versa. These observations apply generally also to the fitting of the slide-bracket.

The instructions for machining and fitting have so far been applied to the set of parts for one side only of the engines, but it will readily be understood that they are applicable equally to the other side, so long as their reversal from right to left hand is observed where necessary.

To ***be continued.***

Continued from September 1

by Edgar T. Westbury

THE MOTION WORK

THE slide-bars are made from rectangular mild steel bar 3/8 in. wide X 5/16 in. thick. After checking the straightness and flatness of each piece, the ends should be machined or filed to 1/8 in. thick for the specified lengths and the rest tapered down each way from the centre.

The object of making them this shape is to obtain maximum rigidity without excessive thickness; if they are parallel throughout, at the major section they would look unnecessarily massive and heavy.

A hole is drilled and tapped at the centre in each of the upper bars to take a lubricating cup. One end of each bar is attached by a single stud to the flat seating on the cylinder cover boss, and the other end to the inside seating of the slide bracket. As already mentioned, the components should be located and lined up so that the crosshead and piston rod assembly will slide freely over the full length of stroke without binding on the top, bottom or sides of the slide-bars.

The connecting rods are unusually long in comparison to those of most other steam engines, and to avoid excessive weight it is recommended that they should be made in the form of light alloy castings. Apart from trimming to remove flashes and rough spots, the only essential machining is the boring and fitting operations on the big and little ends. The design of big end (or crankhead bearing) specified, incorporates a gap piece secured by a gib and cotter. Some constructors may consider this difficult to machine and fit properly. As an alternative, it is permissible to use a solid big end, but it will then be necessary to modify the crankpin to allow the bearing to be assembled.

To fit the gap piece, the inside faces of the forkend should be machined true and parallel. This may be done by clamping the rod, flat side down, in the lathe toolpost and using a saw or slotting cutter running on an arbor between centres or in the chuck. If no other tool is available, a single-point fly cutter set crosswise in a boring bar will do the job. The gap piece is made to a close fit in the fork, and a cross-hole is drilled through the assembly and filed out to 1/8 in. square. When almost to finished size, a broach or drift made from 1/8 in. silver steel may be used to produce a true, smooth bore.

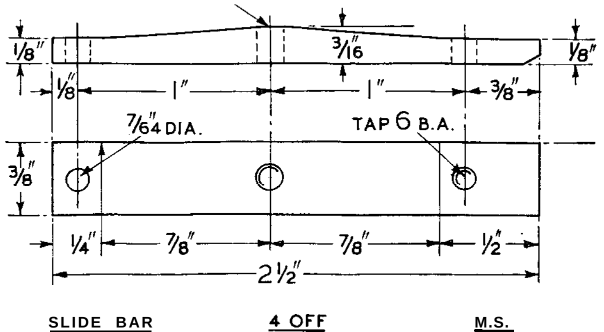
In the detail drawing of the cotter and gib, it will be seen that the two parts are complementary to each other, and are both tapered on their mating surfaces only to a very small angle. Both parts are made from 1/8 in. sheet or strip mild steel, and there is no advantage in making them out of any harder material. The cotter is just a plain wedge, but the gib has projections at both ends which should fit closely across the outside of the big end fork and prevent it from spreading. When the parts are fitted and the cotter driven in fairly tightly, the gap piece should be held in place securely and properly located. In the event that it may subsequently be necessary to take up wear in the bearing, the inner side of the cross-hole in the fork, and the outer side of that in the gap piece, may be eased with a file.

The bore of the bearing housing may be filed out to slightly under finished size, prior to boring and reaming. For these operations, the rod may be clamped to the side of an angle plate mounted on the lathe cross-slide, at right angles to the lathe axis. A mandrel held in the chuck may be used to find the centre location of the bore.

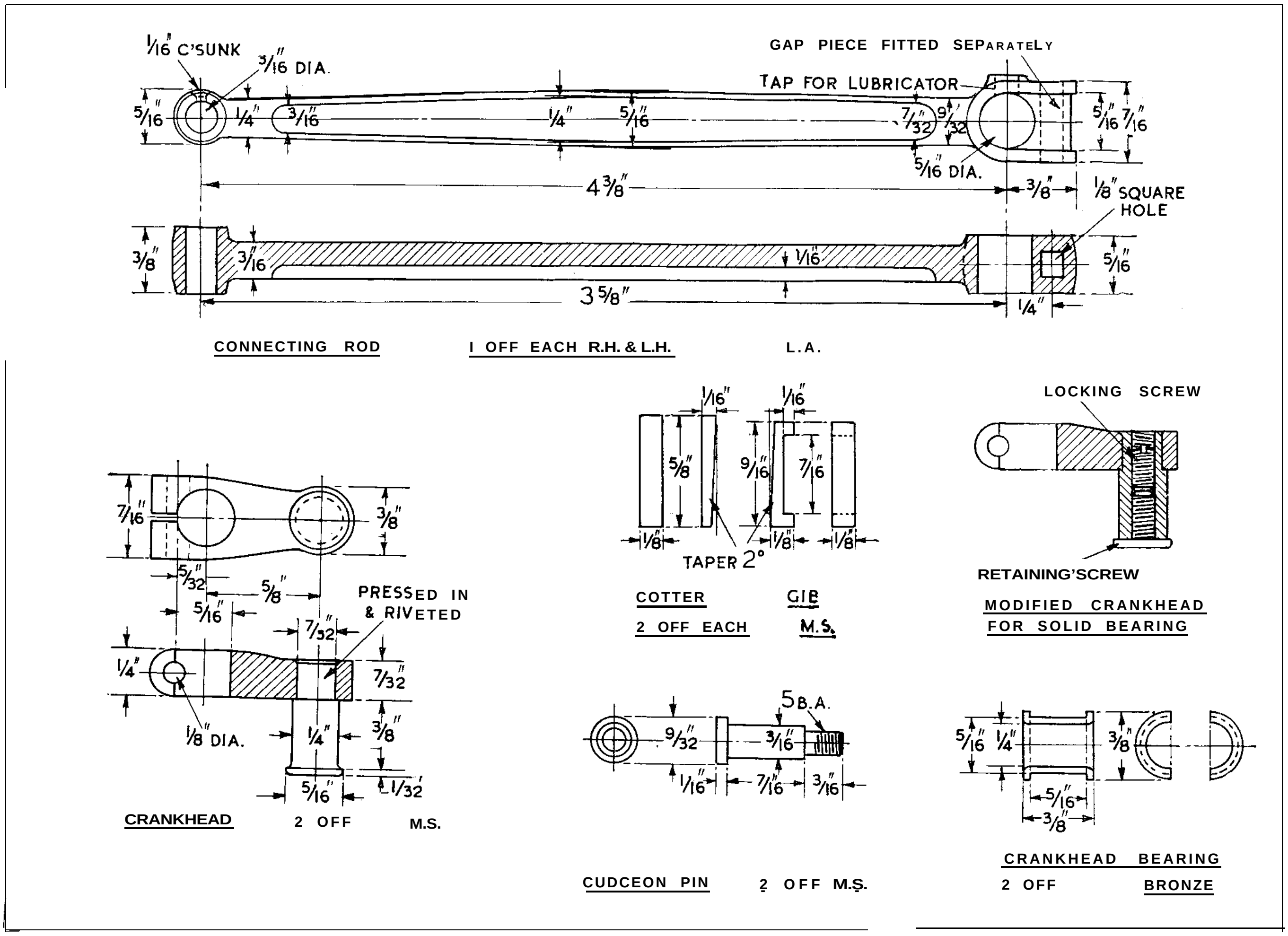
The most suitable tool for boring the bearing housing is an offset boring head, but if this is not available a small boring tool may be held in the four-jaw chuck and adjusted to the radius required. A reamer or D-bit may be used for finishing to size, and the two side faces of the bearing housing may be machined with a cutter set in a 3/8 in. boring bar. After the two crankhead bearings have been dealt with, the rods may be held in the reverse position on the side of the angle plate, for drilling, reaming and facing the little ends.

The simplest way to machine the split crankhead bearing is to take a piece of cast bronze or gunmetal stick, with ample outside machining allowance and long enough to provide a chucking piece. After drilling undersize, the piece is split right through lengthwise, the faces trued up, and temporarily sweated together. The piece is then re-chucked for boring and turning externally to finished size, then parted off. Mark the parts for identification before separating them by heating. When fitted to the crankhead housing, the halves may be located, and prevented from rotating by a spigot on the end of the lubricator.

Rectangular steel bar, 7/16 in. X 1/4 in., may be used for the web of the crankhead, with the crankpin made separately, pressed in and flush riveted at the back. Alternatively, the component may be made in one piece, machined from solid with integral crankpin.



SLIDE BAR 4 OFF M.S.



The built-up construction will generally be found easier and satisfactory if properly carried out, though brazing may be preferred to a press fit. In any case it is important that the crankpin axis should be in true parallel alignment with the bore which fits the main shaft.

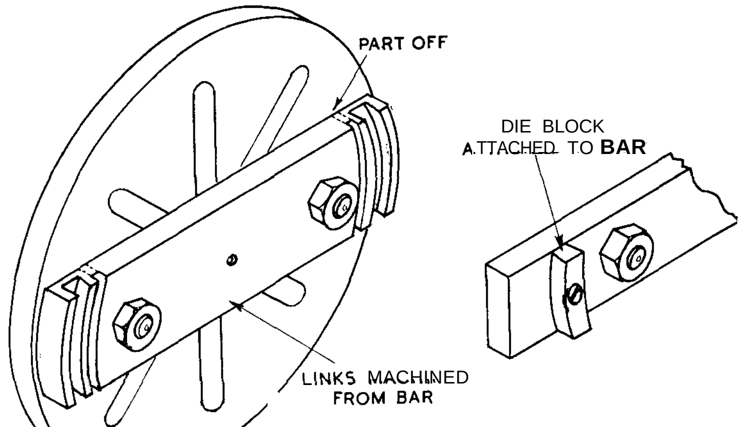
A simple way to ensure this is to take a piece of bar long enough to make both crankheads, and after marking out the hole positions, to clamp it across the lathe faceplate with each of the hole centres in turn set up for drilling and boring. An alternative method, which also ensures that the two cranks have exactly the same throw, is to cut separate lengths and sweat them together on the flat faces, then mount them edge-on to an angle plate by a strap or two clamps. The angle plate is shifted on the lathe faceplate to centre each hole in turn for drilling and boring the two pieces together.

By mounting the web on a 5/16 in. mandrel, the back face can be machined to 7/32 in. thickness at the outer end. The crankpin should be machined to finished size, with about 1/2 thou interference fit in the web, and about 1/32 in. extra length; the hole to receive it should have the burr removed at the front, and a slight countersink at the back for flush riveting. In the event of using a solid crankhead bearing, the pin cannot have a retaining collar formed on its outer end; this must be made as a separate piece, preferably like a large-headed screw but without a screwdriver slot, as this is entirely out of keeping with correct practice and looks unsightly. The crankpin, in this case, must be centrally drilled and tapped, and a grubscrew can be inserted from the inner side to lock the collar screw. Do not split the web or drill the cross-hole till the web is fitted to the main shaft.

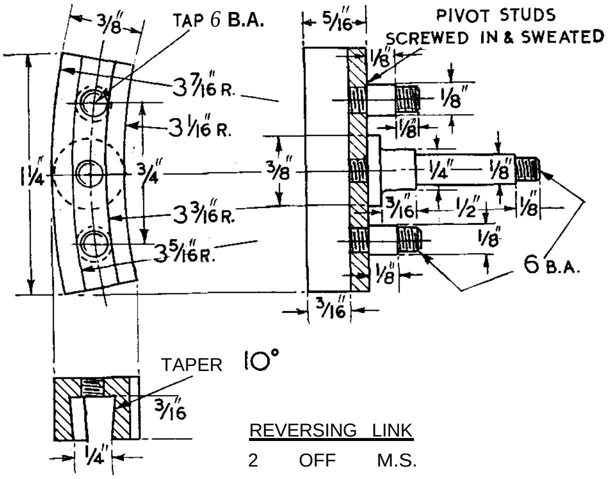
The gudgeon pin can be turned from mild steel bar, to 9/32 in. maximum diameter on the head, 3/16 in. on the shank, and reduced to 1/8 in. dia, for screwing 5 BA on the end. It is secured in the crosshead by a nut on the inside, and it may be prevented from rotating by a snug key at the back of the head, though this should not really be necessary.

The link reversing gear designed for this engine follows the principles of the Stephenson gear, but it is modified in detail in order to simplify it and reduce the number of parts, also to conform with the low centre line of the valve gear and the restricted movement of the link which it entails. It may be observed that marine engines cannot utilise the advantages of " linking up" to the same extent as locomotives, and therefore exact control of link position is of less importance.

This is because the load conditions of the two types of engines are entirely different. Locomotives encounter their maximum resistance to movement when starting a heavy load from rest, and run more lightly at high speed, except on gradients. Marine engines, on the other hand, start quite easily from rest, but the load increases steeply with the speed. Under normal conditions of service, expansive working of the steam is possible only to a



METHOD OF MACHINING
LINKS & DIE BLOCKS



REVERSING LINK
2 OFF M.S.

limited extent in marine engines of the "simple" type; that is, in a single stage as distinct from compound or triple-expansion engines.

Most marine engines run at or near full gear, and are controlled mainly by the throttle, or as it is generally termed, the " manoeuvring valve." Unlike locomotives, model boats do not have an engine driver on the spot to adjust the controls to best advantage, and though remote control of the link gear of the engine is possible, it has never been attempted, so far as I know.

The special feature of this valve gear is the use of an open-ended link, having minimum overall length in relation to its effective arc of movement, and capable of being machined accurately without special equipment. It allows either eccentric rod to be brought into exact horizontal alignment with the valve rod, so that the only link slip at full gear is that caused by the link suspension gear. As the articulated joints are not on the centre line of the link, the working thrusts are slightly offset, but this is not a serious matter in view of the length of the eccentric rods in relation to their travel. The ahead eccentric rod is arranged to line up as directly as possible with the link, but the astern rod is cranked to make up for the necessary endwise displacement of the eccentric sheave. As engines are normally run in the ahead direction, and only reversed for brief periods, this arrangement works quite satisfactorily.

To be continued.

GEARLESS CLOCK MOVEMENT
Continued from page 723

must be done carefully, as if you file too far the cutter will be too narrow, and if you do not file enough there will be a negative clearance at the sides of the cutter. Harden and temper to a straw colour in the usual manner.

When I first read about this way of making gear cutters, I was not very impressed. They looked so weak and the method of getting the side clearance appeared to me rather doubtful. However, I have made many like this now and have never had one break. In fact, recently I had to cut two large gears in dural, both of 20 d.p. One had 96 teeth and the other 84. The large one was 3/16 in. thick and the other 1/8 in. I made a silver steel cutter in just the way I have described and cut all the teeth in both gears with it, taking the full depth out in one cut or pass, and without breakage. I would not advise them for cutting mild steel, but for brass and dural they seem excellent.

Fig. 22 shows the general arrangement for cutting the minute wheel (36 teeth). The blank is turned to size on the little mandrel, which is gripped in a collet chuck. The home-made cutter is held in an adaptor and gripped in the chuck of the ME milling spindle, which is driven by a plastic belt and an electric motor mounted on the rear end of the lathe bed. A simple stop can be set to prevent you from running the cutter against the chuck and breaking the tip off.

Indexing for this particular wheel required the use of a compound gear train. All the other gears can be indexed by using a single wheel. Fig. 23 shows the change wheel quadrant with the detent engaged in the bottom wheel. In order to take up the backlash, a weight is hung on the end of a piece of string which is wrapped round the chuck. Figs. 22 and 24 show the idea.

Fig. 25 shows the smaller pinion after being cut and about to be reamed 3/32 in. with a home-made reamer in the tailstock chuck. After reaming, it is cut off and the other pinion cut on the next turned portion. Both pinions have a portion turned down. The minute pinion to be riveted in the minute wheel and the cannon pinion to fit the clamp collar. This one must be slit with a hacksaw as well.

To be continued.

ENGINES FOR A STERN-WHEELER

Continued from October ı

by Edgar T. Westbury

THE REVERSING GEAR

As the machining of the links and die blocks is an important operation, which some constructors may consider difficult, I propose to deal with this before describing other parts of the valve-gear.

The links are made of mild steel, and the pair may be machined at one operation from a piece of flat bar 1-1/4 in. wide X 5/16 in. (or more) in thickness, and slightly less than 7 in. long. Holes are drilled approximately 5 in. apart to allow the bar to be bolted across the middle of the lathe faceplate, where it is mounted and set up symmetrically both axially and lengthwise of the bar. Before bolting it in position, a slip of thin, soft sheet metal, such as copper or aluminium, should be interposed behind it, so that there is no danger of damaging the faceplate when the tool runs through it in turning the outside or parting off.

First, the outside edges of the bar should be turned to a diameter of 6-7/8 in., or in other words, 3-7/16 in. radius, as specified on the detail drawing. As the operations on these components all involve intermittent cutting, they demand a cautious approach with the lathe running at low speed, keen and properly set tools and well-adjusted slides. A parting tool may be used to produce a "witness" cut marking the inside radius of the link at 6-1/8 in. dia. (3-1/16 in. radius), but for obvious reasons it should only penetrate to a shallow depth at this stage. Note that a parting tool, when presented axially to the work to cut an annular groove, must have increased side clearance on the outer side.

Undercutting tool

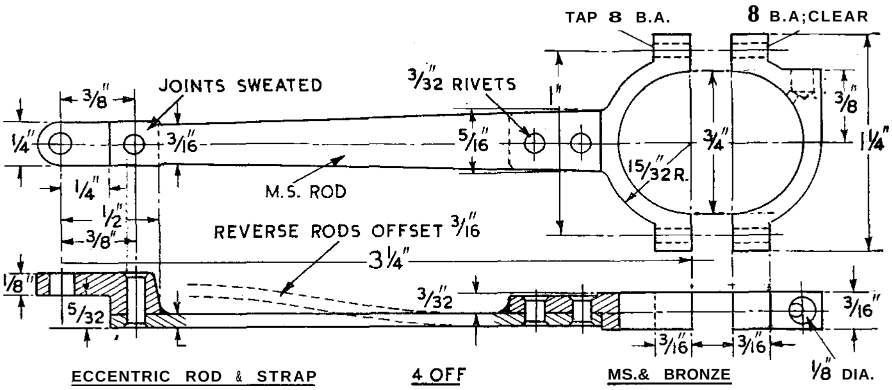
The parting tool can also be used to rough out the channel of the link to a depth and width slightly under 3/16 in. to allow of finishing and producing the included taper of 10 deg. on the sides. A special tool will be required for this-in fact, it will generally be found best to use separate tools, each fed in turn at an angle of 5 deg. on the topslide, for the two sides. With due care, a clean and accurate finish can be produced on the essential surfaces. It is difficult, or perahps impossible, to correct errors or clean up the surfaces by after-treatment. When the channel has been machined, the parting tool may again be used to penetrate the bar and separate the pair of links from it.

The principles employed in machining the die blocks are generally similar, but in this case short pieces of bronze or gunmetal may be used, roughly cut to shape, but well oversize and temporarily fixed to a flat bar of steel or other metal which is again mounted symmetrically across the lathe faceplate.

The segments may be sweated in position, but both location and security will be improved if in addition they are drilled and counterbored for the pivot screw, and the bar drilled and tapped to take it. Still better, the pieces may each be made long enough to produce two die blocks, and secured by two screws in each. This will produce twice as many die blocks as required, but spares are always useful. The segments can then be machined on both inner and outer sides to the same angles as the links, which can be "offered up" for checking up on the fit. They should preferably be fitted on the tight side, as the die blocks can be eased by rubbing down the front face on a superfine file or lapping plate.

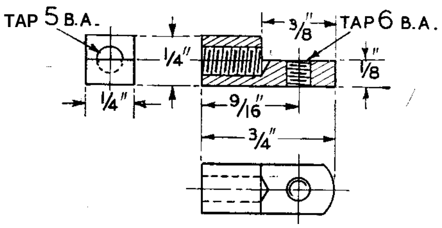
The links are drilled and tapped on the back face for the pivot pins, which must be securely and permanently fixed in position, and must not project on the inside of the channel. As their length is limited, they should be prevented from becoming loose by tinning the threads and sweating them in position. The flanged centre stud is used for the suspension of the link, and must project well beyond the other two pivots so as to clear the knuckle ends of the eccentric rods.

The eccentric straps may be made from bronze or gunmetal castings, or

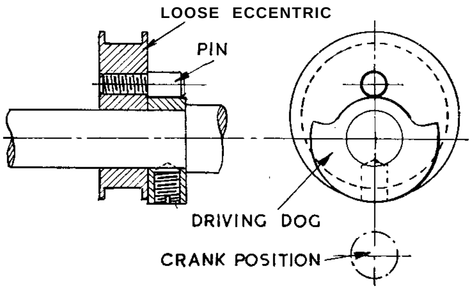


they may be machined from stock material. In either case, allowance should be made for the metal removed in splitting, and also for facing the two sides.

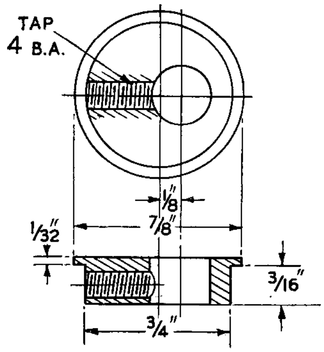
A good way of ensuring uniformity in the shape and size of the four straps is to use a piece of material thick enough to make them all, plus chucking and parting-off allowances, and of correct external shape. This may be set up in the four-jaw chuck, bored undersize, and the straps parted off. Before splitting them, the holes should be drilled and tapped, and temporary screws fitted to hold the halves together during subsequent operations. Do not forget to mark the pairs to identify them for correct assembly. The straps are then chucked and bored individu-

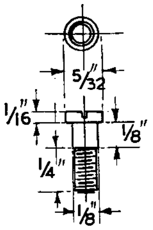


UCKLE 2 OFF M. 5.

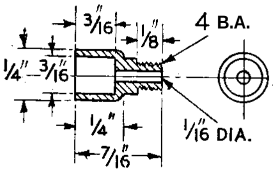


ARRANGEMENT OF SLIP ECCENTRIC VALVE GEAR

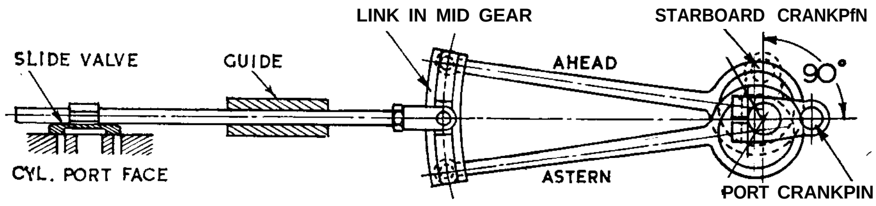




KNUCKLE PIVOT
2 OFF M.S.



LUBRICATOR
4 OFF BRASS



ECCENTRIC SHEAVE
4 OFF M.S.

ARRANGEMENT OF REVERSING VALVE GEAR (PORT ENGINE)

ally, and one side faced true with the bore; to face the reverse side, they may be clamped on a shouldered mandrel.

Sheet or strip steel, 1/16 in. thick, is used to make the rods, which are 5/16+ in. at the large end. They are attached to the straps by 3/32 in. rivets. The seatings on the lugs of the straps are stepped back to half their thickness, and they should be flat and true, with the ends of the rod butted against the shoulder. To promote rigidity of the joint, the surfaces of both parts may be tinned and sweated together after riveting; better still, they may be silver soldered. The same applies to the offset knuckle at the other end of the rod, which is only held on by a single rivet.

Note that if the straps are provided with lugs to take a lubricating cup as shown, they should be assembled to produce right and left-hand pairs. The distance between the strap centre and the knuckle pivot should be the same for all four rods, and as the reverse rods are cranked to line the knuckles up with the links, allowance should be made for the slight shortening which this involves. Care should be taken to see that the inner face of the knuckle is flat and parallel to the face of the strap, also that the pivot hole is square with it and a good fit on the link pivot. The thickness of the knuckle should be such that no end play is allowed when the retaining nut and washer are fitted to the pivot, but the rod should articulate quite freely.

The eccentric sheaves are machined from solid mild steel bar, and the simplest way to make them and to ensure accuracy and uniformity is to start with a piece of material long enough to make all four, with chucking and parting-off allowances. This is first faced truly on the end and marked off, with the throw centre at 1/8 in. from the main axis, to give a full travel of 1/4 in. The bar is then set up in an eccentric fixture, such as a Keats V-angle plate, and centre-drilled, drilled and reamed for the required depth for the four sheaves. It is then re-set to run true on the external surface, for turning each sheave to fit the strap, and parted off, leaving a rim 1/32 in. thick.

When assembled, the sheaves are disposed face to face, so that their rims are on the outer sides of the straps. No harm will be done if the straps rub against each other, but rubbing can be prevented by interposing a thin washer between each pair of sheaves. A sunk grubscrew, preferably of the socket-head type, is fitted to a hole drilled and tapped through the thickest part of the sheave, to secure it to the shaft when its position has been adjusted.

The valve rod knuckle is made from 1/4 in. square mild steed, which is first set up in the four-jaw chuck to run as truly as possible, for facing, drilling and tapping to fit the rod. It is then parted off at 3/4 in. long, cut away to half its thickness for a length of 3/8 in., and drilled and tapped crosswise for the pivot on which the die block articulates. The head of this pin must not project beyond the face of the die block, and when screwed into the knuckle and adjusted to take up end play, it is locked by a nut on the outer end.

In order to obtain the proper operation of the slide valve, and to eliminate lost motion as much as possible, it is important, with this form of valve gear, where slightly offset thrusts are inevitable, to avoid end play in pivoted joints. It has already been observed that the range of link movement is restricted by the low centre line of the motion work in relation to the deck of the boat. Even so, it will be necessary to provide a shallow well or recess to provide clearance for the lower end of the link and the astern eccentric rod in full ahead gear.

Though it is not possible to fit and adjust the valve gear until all parts of the complete pair of engines are made and assembled, the diagram showing the arrangement and disposition of its parts will help to explain how it operates. The means of suspending and shifting the link are not shown, but this will be subject to some variation to suit the design of the hull and the method of control adopted. By moving the link up or down, either of the two eccentric rods can be brought into line with the valve rod, thereby varying its timing to suit the direction of rotation required.

Quartered cranks

In intermediate positions, both timing and travel of the valve are modified to influence the lead and cut-off, so that in the mid-position, the eccentric motions combine to provide shortened valve travel and mean timing. The angular positions of the eccentrics, in relation to the crankpin are roughly indicated on the diagram, but the exact setting depends on various factors, including the amount of motion lost in the link, die block and pivots. Note that the cranks of the port and starboard engines are displaced at right angles to each other, or in locomotive parlance, " quartered." It does not matter, from the practical point of view, which crank is in the lead; there may possibly be some conventional rule about this, but I have not found any reference to it in marine engineering textbooks. As there are no coupling rods to take into account, slight inaccuracy in quartering the cranks does not affect working; the eccentric settings are related to the individual cranks, as for totally separate engines.

There are, no doubt, some constructors who do not wish to provide fully controlled reversing valve gear for these engines, and will be quite satisfied either with a non-reversing gear or a simplified reversing arrangement. It is quite in order to fit a single, fixed eccentric sheave to the shaft, with its rod connected directly to the valve rod knuckle. Alternatively, slip eccentric reversing gear may be fitted, in which the eccentric sheave is not fixed to the shaft but is driven by a dog which allows a certain angular motion in either direction before taking up the drive. This arrangement is shown in the drawing, where it will be seen that the dog has part of its circumference cut away to clear the pin fixed in the side of the sheave. The amount of free movement allowed for the designed valve setting is approximately 120 deg., but it may be varied to suit lap and lead-and not by shifting the dog (which should always be set in symmetrical relation to the crank) but by altering the angle of cutaway.

End location of the sheave is provided by the fixed dog on one side and the main bearing on the other; it should be fitted to turn freely on the shaft, but it should not be too slack. With this simple arrangement, the boat will run either ahead or astern if given a slight push off in the required direction, but no provision can be made for expansive working, or for remote control of reversing.

Oil cups

The small lubricating cup shown in the drawings is suitable for fitting to the slide bars and the crankhead bearings; for the latter, it may have a pilot spigot on the end of the thread to locate the joint of the split bearings but it should not bear hard against them. Open-topped cups similar to this appear to have been fitted to many of the early stern-wheelers; or perhaps they may have originally have had lids, which subsequently got lost. They may have been provided with internal tubes for wick syphon feed, but it is more likely that they were intended to contain tallow or other animal fat. Oil of really good lubricating quality, in those days, was scarce and relatively expensive.

The oil cups illustrated can be turned from 1/4 in, brass rod in one piece, and the simplest method is to face one end, drill 1/16 in. and counterbore, then part off and reverse in the chuck for shouldering down and screwing the small end. A 3/16 in. end mill, or a drill ground square across the end, may be used for counterboring the cup, though the angle formed by an ordinary drill point is permissible so long as it does not unduly weaken the base of the cup. Round off the angle of the outside with a hand tool, if no suitable form tool is available. Flats may be cut on the reduced diameter, to enable a thin spanner to be used for screwing the cup into position.

It may be possible to obtain ready-made lubricators of a size small enough to suit this purpose, but it is important that they should be inconspicuous, and not of a type obviously intended for some other kind of machine, such as a bicycle, as these small details are the ones which are always pounced upon by voracious critics.

The crankshaft, which is made from 3/8 in. dia. steel bar, forms a part of the paddle wheel assembly, and its length will depend upon the beam of the hull. When this is determined, and the two sets of mainframes are connected by the cross member, the extreme ends of the shaft should each project 1/4 in. outside the main bearings, to accommodate the crankheads. The shaft should be set up truly for centre drilling and turning down the ends to 5/16 in. dia. for a length of 1-1/8 in.

Make the shaft a tight wringing fit for the crankheads, which are then set in position at 90 deg. to each other. The cross holes are drilled and reamed to take closely fitted bolts. The bosses of the crankheads are then sawn through to form split clamps.

(To he continued)

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ERRATUM

In the drawings of the feed pump for ***Maid of Kent*** bv Mr K. N. Harris. page **678** September 15 issue, the bord was inadvertently given as 9/16 in. This should, of course, have been 1/2 in., as given in the detail drawings of the pump body and the ram.

Continued **from *October* 15**

by Edgar T. Westbury

Paddle wheel construction

THE paddle wheels of early stern-wheelers were usually fabricated in wrought iron, with rigid floats. Articulated or feathering paddles such as were used on many large seagoing steamers, were not used on any stern-wheelers so far as I can ascertain.

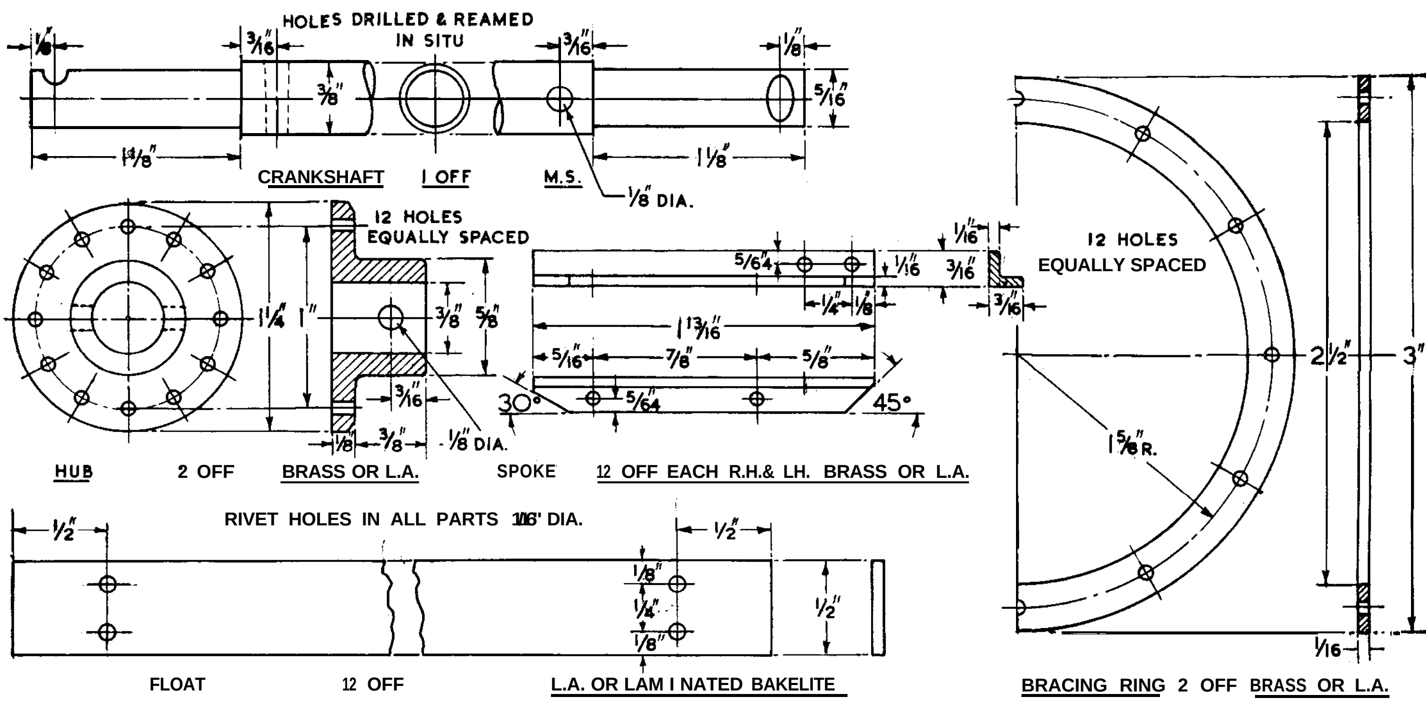
Their advantage did not amount to much when the immersion of the paddles was shallow and fairly constant but the main objection to their use was mechanical complication and liability to damage. Logs and other half-submerged debris often played havoc with paddle wheels, and a simple, easily repaired structure was obviously to be desired. For the same reason, the floats were commonly made of timber which could readily be obtained when replacement became necessary.

In a working model, strength and rigidity of the paddle wheel are essential, but heavy or cumbersome construction should be avoided. There is some latitude in the kind of material, and my original idea was to use duralumin or similar light alloy for the hubs and frame components. But it has not been found possible to obtain rolled or extruded angle section in this metal small enough for making the radial members or spokes. Brass is the next best material, and it will provide the necessary strength, though with a substantial increase in weight. It has the advantage that the complete structure can be sweated together to improve rigidity and eliminate risk of trouble due to imperfect riveting.

The two hubs may be turned and bored at one setting. They should be a tight fit on the shaft, and when finally located they should each be secured by a properly fitted taper pin. A taper reamer or broach should be used to ream the holes through hub and shaft in situ, and if standard taper pins are not obtainable, the pins should be machined to the same taper as the reamer, so that they fit the holes throughout their full length. It is permissible to use parallel pins as an alternative, but they must be equally well fitted, as any slackness will not only affect the strength of the structure, but also lead to hammering with eventual shearing or distortion of the pins. The cross holes should preferably be drilled at right angles to each other, as shown.

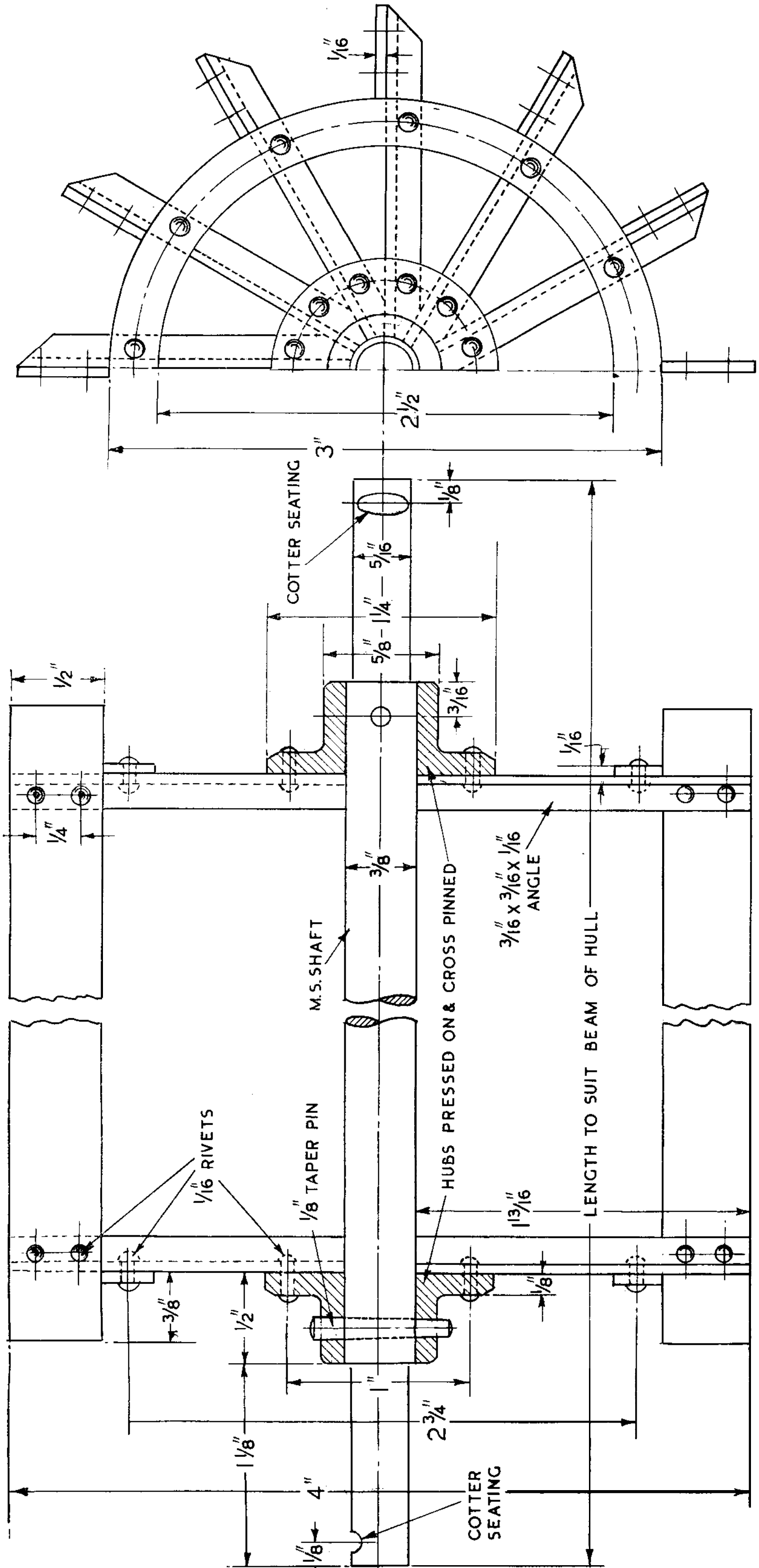
It is important that the rivet holes in the hubs should be equally spaced, at uniform radius, and the use of an indexing device for the lathe mandrel, together with a drilling spindle, is recommended at least for locating the holes. This operation can be carried out before parting-off each hub, or alternatively, the finished hub can be mounted on a stub mandrel for drilling. The inner face of the hub should be machined flat and square with the axis.

To make the frame bracing rings, pieces of 1/16 in. sheet material about 3-1/4 in. square may be mounted on a wooden backing plate by screws in the four corners, and set up on the face-plate or in the inverted jaws of the four-jaw chuck. A trepanning tool may then be used to cut the inside circle, or a small parting tool with ample



side clearance, presented endwise on to the work, will serve the same purpose. Before cutting the outer circle and thus detaching the ring from its mount, the rivet holes in the ring may be located and drilled in the same way as those in the hub. It is possible to machine both rings at once by mounting the two plates together and thus ensure that their essential dimensions are identical.

The spokes must all be of identical length, and with rivet holes correctly located, in order to produce a symmetrical and true running frame. Note that one flat face of each spoke is set on the radial line, and that the spokes on opposite side frames are right- and left-handed so that the other flat face will fit against the inner face of the respective hub. The inner ends of the spokes are tapered off at 30 deg., and if properly fitted they will lock each other in place, with their extreme ends in contact with the shaft.



PADDLE WHEEL 1 OFF FABRICATED CONSTRUCTION

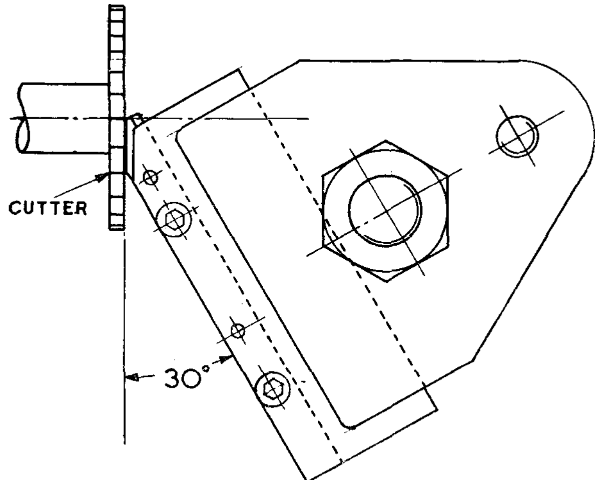
Using a jig

I strongly recommend the use of a simple jig to shape the ends of the spokes to the correct angle. It can be made from solid rectangular bar, with the groove milled in it, or it can be built up by riveting three pieces of lighter material together. The dimensions shown cn the drawing are only tentative; the essential thing is that the strips must be held in correct location sideways and endwise, and the jig held at the correct angle in the toolpost or on the cross-slide; this may be set with the aid of a protractor or even a set-square.

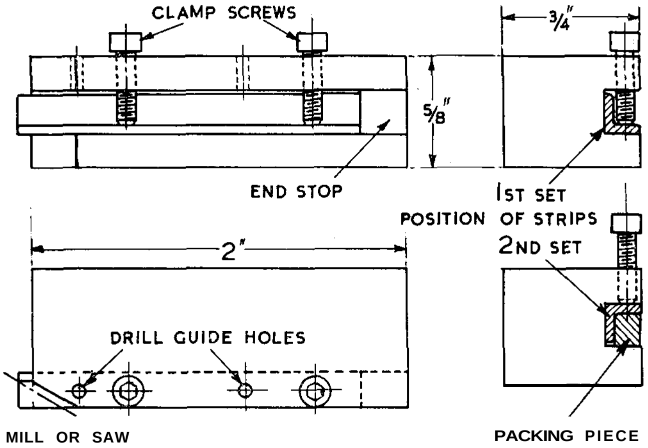
A side or end mill, or even a thick saw, mounted in the chuck may be used for milling the edge of the strip. One set of I2 spokes is clamped edge upwards, but the other set must have the flat side upwards, and will therefore require a square or rectangular packing strip slightly thicker than the inner dimension of the angle strip, and with the corner rounded or chamfered. When once the cut has been adjusted, the saddle should be locked so that all pieces are treated exactly alike.

The jig may be readjusted to chamfer the outer end of the spokes at 45 deg. (make certain that the right comer is cut away) and it may also be used for drilling the rivet holes by providing guide holes in the top and rear side.

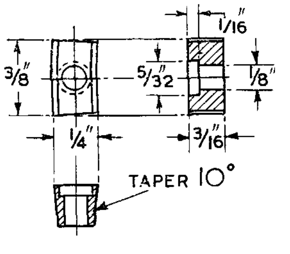
Before carrying out this operation, a check should be made to ensure that the holes will line up with those in the hub and the bracing ring. It may be found that, to make the spokes



JIG SET UP IN TOOL POST



JIG FOR MILLING & DRILLING ANGLE STRIPS



DIE BLOCK 2 OFF

BRONZE

fit closely together and also against the shaft, their ends may have to be trimmed; if so, all should have the same treatment, and hole locations taken from tnis end.

Owing to the restricted width of the spokes, there is very little room for the rivet heads, and if standard snap-head rivets are used it may be necessary to file flats on the heads so that they will clear the inside of the angle. A ball-pein hammer should be used for the initial closing down of the rivets, followed by the use of a concave rivet punch just deep enough to shape the end neatly without marking the surface of the material. A similar concave depression in the support or " dolly " will help to locate the head of the rivet.

Some care is necessary in all small riveting operations to avoid distortion or marring of the rivets. Rivets should fit the holes closely; and it will generally be found that the length allowed for closing them should be somewhat less than the " one diameter " prescribed in the textbooks. Too long an allowance increases risk of distortion and may cause the rivet to harden before it is neatly closed down. A large head does not necessarily mean a firmer hold.

If the frame is to be sweated together, the contact surfaces should be tinned before riveting, and when assembled the frame should be uniformly heated to fuse the joint. A little extra solder may be added, but not more than is absolutely necessary. Remember that thin sections of metal are liable to distortion when locally heated and so do not play a torch flame indiscriminately over the work. It is better to heat the assembly on a thick plate over a gas ring or bunsen burner.

Both side frames should be assembled and lined up on the shaft so that the floats, when attached, are truly parallel with the shaft axis. It is not advisable to sweat them permanently to the frames; in the interests of light weight, the floats may be made of hard light alloy or *laminated* resin plastic board such as Tufnol or Paxolin.

If all parts have been made to uniform dimensions, the assembled paddle wheels should be in correct balance, but it is a good policy to check up on this by rolling the shaft on parallel strips, such as steel rules clamped on edge at a suitable distance apart and levelled both individually and with each other. Any correction required may be made by filing the ends of the spokes, or by judicious trimming of the floats. It is not necessary to go to the extent of true dynamic balancing, in view of the low speed of the paddle wheel.

When the paddle shaft is fitted to the main bearings, and other working parts are connected up, the valve gear can be set to give correct timing at full ahead and astern positions. The eccentrics of both port and starboard engines should first be set approximately to their positions in relation to the respective crankpins, but their grubscrews should only be set up tight enough to prevent inadvertent movement at this stage.

The ahead eccentric on either side is first used to check valve travel, by turning the shaft to produce the full movement of the valve rod in either direction. This applies whether the double-eccentric link motion, slip, or fixed eccentric is used. The steam-chest cover is removed to allow inspection of the slide valve, and the tail-end guide is also removed so that the valve rod can be adjusted with a small screwdriver. In this way the slide valve can be set to give equal cylinder port openings at each end of the travel, and the valve rod is then locked to the knuckle by the lock nut.

The exact timing of the ahead eccentric is then adjusted by setting the crank at inner and outer dead centres in turn. Some readjustment of the eccentric may then be required to produce an equal amount of opening of the cylinder ports, in other words, " lead," at each crank dead centre, without altering the adjustment of the valve rod. Only a very small lead is required in engines of this kind, and for a given eccentric travel and cylinder port location it can only be changed by altering the lap, or the distance by which the slide valve overlaps beyond the cylinder ports at each end when in mid-travel. Such alteration necessarily entails changing the overall length of the slide valve, and it is only called for when making major experiments in valve setting.

The astern eccentrics are set in a

(Continued on page 811)

READERS' QUERIES

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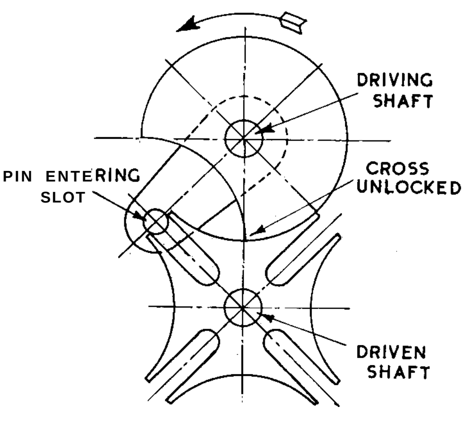
Geneva Mechanism

I would be grateful if you could give me sources of reference on the Geneva Mechanism, a3 I am experiencing difficulty in obtaining information for a sixth form applied science project, which is to be submitted for examination purposes--SK., Wirral.

The device known as the Geneva Stop Motion was originally used to prevent overwinding of clocks and watches by limiting the number of turns which could be applied to the spring arbor. It has been adapted to many other purposes where intermittent motion is required, such as counters, indexing gears, and for the film shift in cinematograph mechanism. This is perhaps the best-known modern application, and for practical reasons it is usually designed to give four 90 deg. shifts per revolution of the driven shaft; in this form, it is commonly known as the "Maltese Cross " mechanism.

The arrangement shown in the drawing gives smooth acceleration in either direction of shift, and positive locking



MALTESE CROSS MECHANISM

while stationary. It is important that the pin should enter the slot exactly on its radial line, and that the cutaway of the driving disc should unlock the cross at the same instant. Similar principles apply for mechanisms giving any number of shifts, but the proportions shown are correct only for a I-shift mechanism.

Magnetising

I would very much like to construct my own magnetiser in order to enliven some of my model locomotives with weak magnets (all 12 v. d.c.).

Could you kindly explain the principle used in this work and details of the size of a transformer required? Also, are the north and south pole connections critical ?

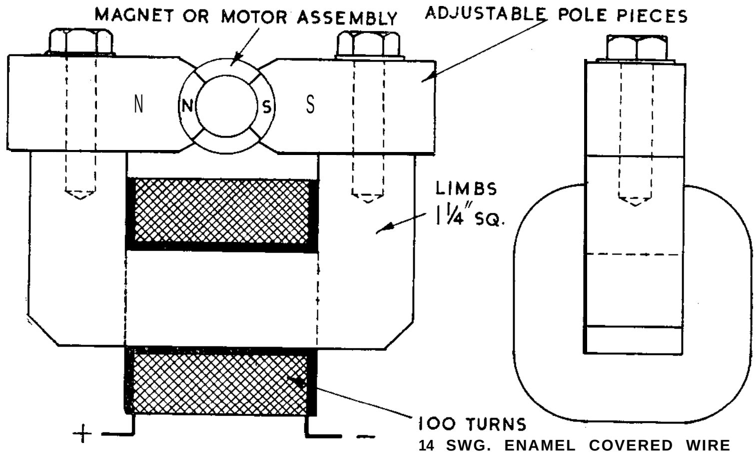
It is understood a large d.c. flash current is required.-G.M.H.B., Fareham.

A magnetiser consists essentially of an electro-magnet capable of producing a high-intensity field which can be applied to the poles of the magnet under treatment. Several methods are employed to produce the magnetic field, but the simplest for your particular purpose, assuming that the magnets to be dealt with are all of the simple two-pole type, would be to use a d.c. electro-magnet having a solid or built-up soft iron carcase, with a winding on one or more limbs, and pole pieces (adjustable to fit the magnets if necessary).

The intensity of field necessary for magnetising will depend on the nature of the steel in the magnet treated, and the cross section of its poles. For the small magnets of model locomotives, an excitation equivalent to 1,000 ampere-turns should be sufficient. This can be obtained at the most convenient voltage; that is, by using a suitable combination of turns in the field windings, and applied current (i.e. 1,000 turns at I ampere, or 100 turns at 10 amperes for instance). It is generally best to use a low-voltage source of supply, such as car batteries, for excitation, as a transformer and rectifier for high voltage would be large and expensive. Only a momentary application of current is necessary, and the circuit must be broken as sharply as possible by a heavy duty switch.

Where possible, the magnet should be magnetised in its circuit assembly rather than separately. The north pole of the magnet should be presented to the north pole of the magnetiser, and it is therefore essential that the polarity of the field windings should always be the same. ***For magnets having multiple poles, it is necessary to use a magnetiser with equivalent numbers of poles, or to make adaptor pole pieces to serve the same purpose.***

Some experiment in the voltage of supply may be necessary for the best results.



ELECTRO-MAGNET FOR MAGNETISING MOTOR MAGNETS

Engines for a Stern-wheeler ...

Continued from page **806**

similar way, and before replacing the steam chest covers, a check should be made at both ahead and astern positions for each cylinder. No discrepancies in timing should arise unless there are errors in eccentric throws or length of eccentric rods. Permanent fixing of the eccentrics to their shafts may be assured by tightening the grubscrews, and more positive keying should not be necessary. There is always a risk that in drilling a dimple in the shaft to locate the point of the screw, some deviation from the true setting may occur.

The steam connections to the port and starboard cylinders may be arranged to suit convenience in installation, but the steam flow to each individual cylinder should be free and unrestricted. A single stop valve, capable of fine adjustment, should be fitted to the common supply pipe or the branch junction.

To be concluded

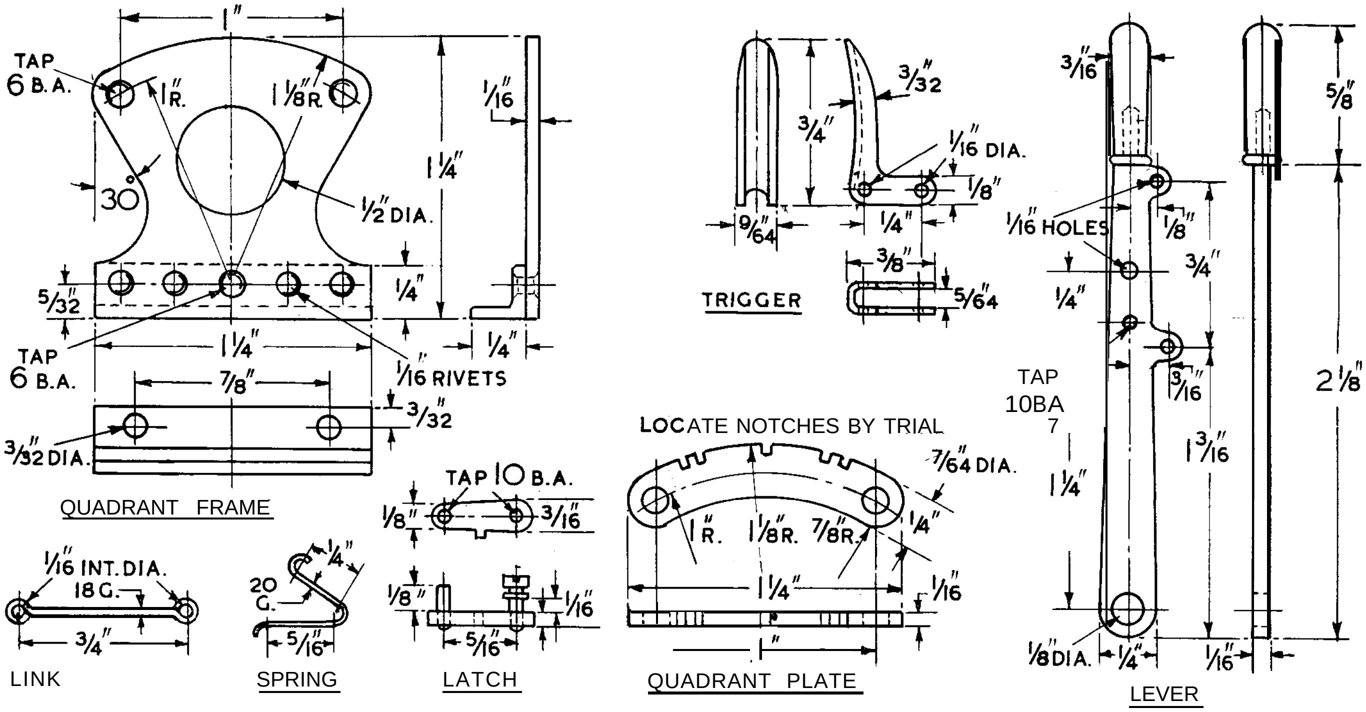
Concluded from November 1

by Edgar T. Westbury

Reversing control gear

ALTHOUGH the controls are not generally regarded as a part of the engines, they serve an essential purpose in the working of the complete installation, and anyone building a working model stern-wheeler will need to equip it with control gear of a practical and representative type. The means of shifting the reversing links were indicated in the general arrangement drawings, but the details of construction of the components must necessarily depend on the hull design and convenient positions for operating the controls. For nected to the central pivots of the reversing link. For endwise location of the weighshaft, the standards are fitted close up against the inner sides of the lifting arms, and these are then pinned to the shaft in exact angular alignment with each other.

As an alternative, the standards may be made without angle brackets, and attached to the inner sides of the main frames. They are more rigidly supported, but being more widely spaced the weighshaft is more liable to deflection,

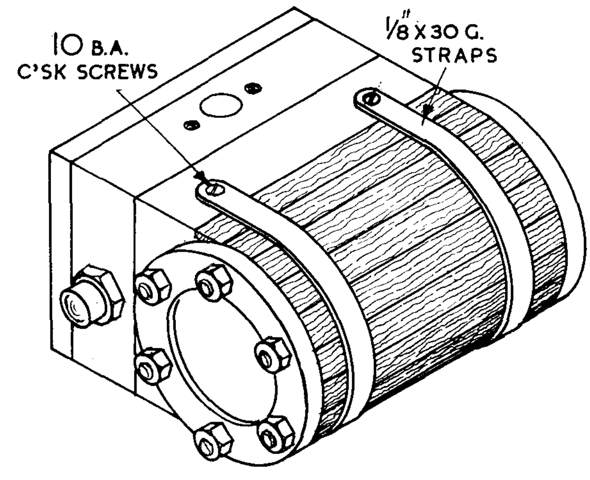


this reason, the drawings given here are subject to modification to suit individual requirements.

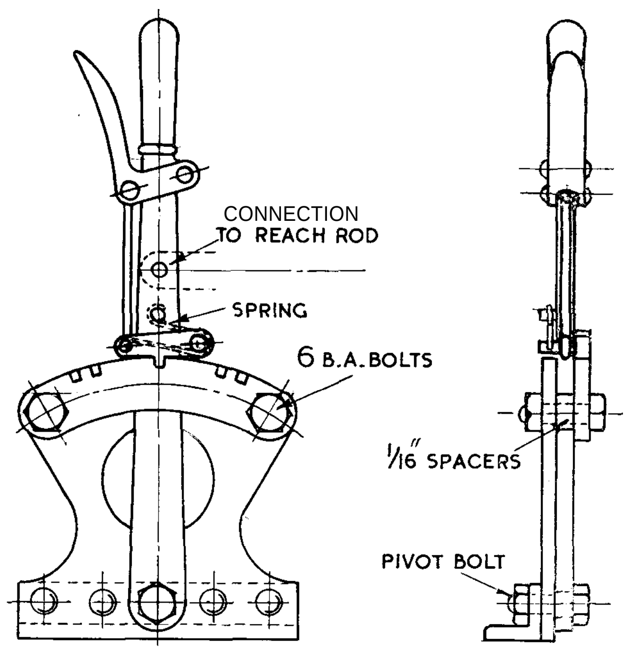
The weighshaft, to which is attached the lifting and reversing arms, is simply a length of 1/8 in. steel rod carried in bushes at either end, supported in standards which are mounted on the cross-member between the engines. They can be made from 1/16 in. sheet steel, in the form of A-frames, with angle brackets riveted to the base and bushes pressed or sweated in at the top. A tie bolt is fitted between the standards to stiffen the structure.

Fretting out of the apertures is optional, and their dimensions are not specified, but they lighten the structure and improve appearance. The location athwartships of' the standards is determined by that of the lifting arms, from which the lifting links should hang vertically when eon- unless made larger in diameter, and it will also need to be provided with end location collars. Stern-wheelers usually have a more or less vertical spray screen immediately forward of the paddle wheel, and this is sometimes used as a mounting for the weighshaft bearings and other parts of the control gear, but this is only possible if the supports of the screen are rigidly strutted to the deck.

The lifting and reversing arms are best made by machining from solid 1/4 in. square mild steel, though they can be built up by silver soldering if it is more convenient. If the former method is used, the hole in the boss should first be drilled with a No 31 drill and reamed to a wringing fit on the weighshaft. A 1/8 in. stub mandrel should then be made with the end screwed to take a nut to clamp the lever in position. The outside of the boss can be turned circular



Method of lapping cylinders



QUADRANT REVERSING GEAR ASSEMBLY

on each side, and the side faces machined as far as permitted.

It is also possible to cut the slot in the fork of the lifting arm with a narrow parting tool, while in this position, if a stop pin is fitted to the mandrel to prevent the work slipping on the pin. If desired, the reversing arm may be increased in length, or provided with more than one hole for attaching the reach rod, to suit the range of the control gear. This arm is pinned to the shaft at right angles to the lifting arms, in an endwise position to line up with the control lever, which may be amidships but are more often towards the port or starboard side of the deck.

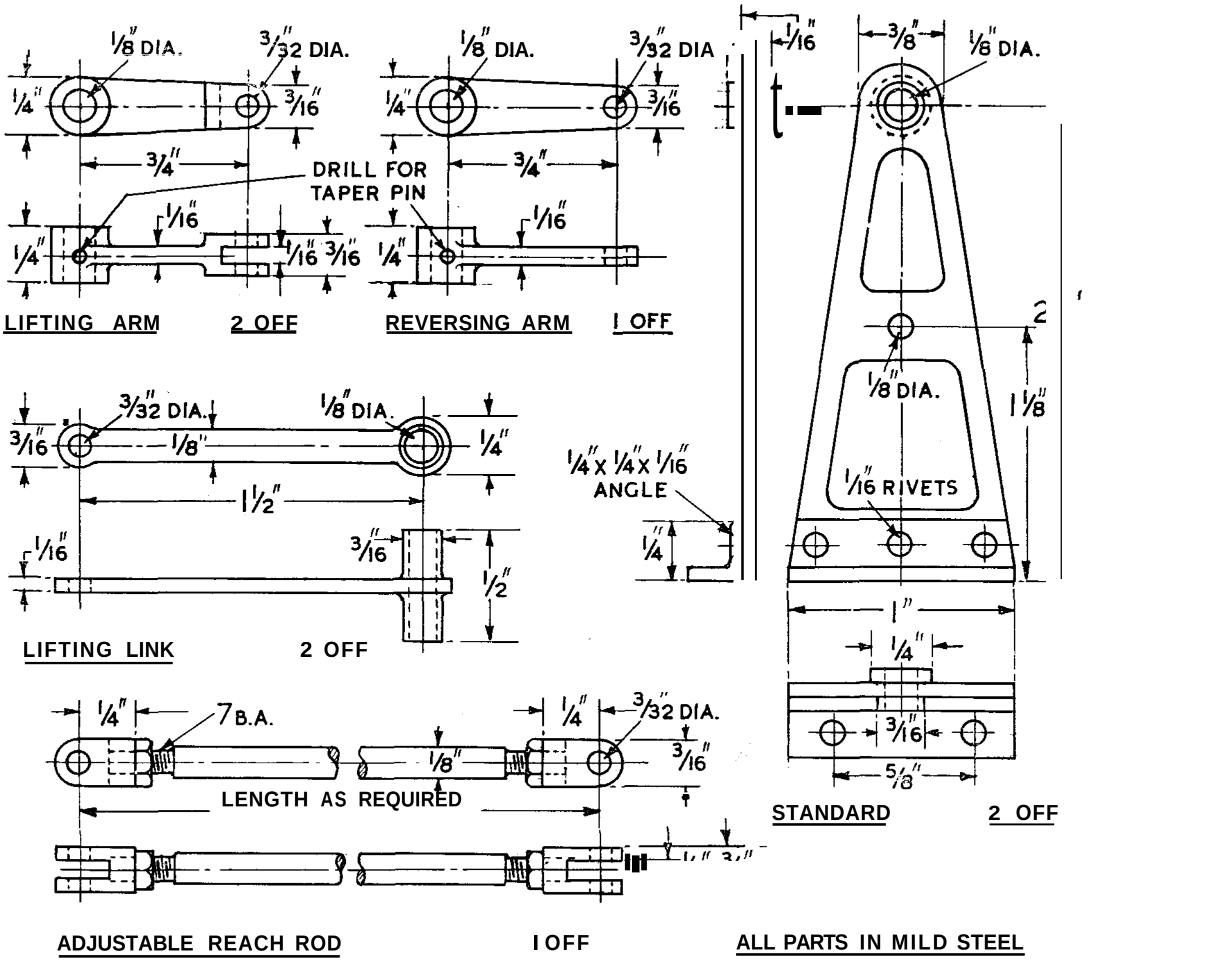
It will be seen that the lifting link is fitted with a long bush at the lower end where it fits the pivot of the reversing link. Its object is to ensure that the link swings in a true arc instead of tending to wobble sideways because of offset thrust. The bush may be made of bronze and sweated in (this term is intended to include either soft or silver soldering, the latter being much superior in strength of the joint in all cases); the shank of the link is made of 1/16 in. sheet or strip steel. Similar material may be used for the reach rod if it is not too long, but the adjustable rod of 1/8 in. round bar with screwed and lock-nutted knuckles will enable the gear to be more accurately adjusted. The pivots for the various joints may be in the form of 3/32 in. or 7 BA bolts, with plain shanks which fit closely in the holes.

The engines of even the smallest stern-wheelers were too large to be conveniently reversed by a direct-acting hand quadrant lever; the usual arrangement appears to be a screw gear with multi-start thread and a large diameter handwheel. But this is one item in which I consider that fidelity must be sacrificed to utility in a working model as the manipulation of a screw would be slow and awkward in the limited space. The quadrant gear, though suited mainly to locomotives and stationary engines of comparatively small size, is much easier to operate by hand. As shown here, it does not exactly follow any prototype but is designed to be built as simply as possible, while looking something like the orthodox type.

The quadrant frame is made from 1/16 in. sheet steel, with a riveted angle bracket at the base for mounting on the deck of the boat, in the most convenient operating position, and at such a height that the reach rod is approximately horizontal. To obtain the proper range of movement from full ahead to full astern, the lever and reversing arm should be vertical, and the lifting arm horizontal, when in the mid gear or "neutral" position of the reversing link. The lever is also made of 1/16 in. steel, with the top end narrowed down into a tenon, which can be screwed or sweated into a handle turned from 3/16 in. steel rod. It works on a pivot bolt, guided between the frame and quadrant plate, over a range of about twenty degrees either side of the central position. Spacer bushes 3/16 in. dia., of a length which just allows free movement of the lever, are fitted to the quadrant bolts, and the pivot bolt has an 1/8 in. journal of the same width, with the rest of the shank screwed 6 BA to fit a tapped hole in the frame, where it is secured by a lock-nut at the back.

To make the trigger, a piece of 1/32 in. or 20 g. sheet steel, a little over 3/4 in wide by 7/8 in. long, should be folded over a bending strip slightly over 1/16 in. thick, with rounded edges. This will produce the shape shown in the plan view, and when this is neatly formed the unwanted metal can be cut away to the required contour. To form the concave curve of the outside, the trigger should again be placed on the bending strip, and hammered along the inner edge of the hand grip. The latch is made from 1/16 in. steel, with the detent filed to the shape shown, and drilled and tapped 10 BA at the ends to take the pivot screw and the stop pin.

A groove is turned in the head of the pivot screw to locate the bend of the latch spring, which is made of 20 gauge piano wire bent to the shape shown. It is held in position at the back of the lever by a 10 BA screw so that it bears on the stop pin of the latch. A link bent from 18 g. steel wire, or cut from solid sheet steel connects the latch to the trigger. The pivots may be in the form of 10 BA or 1/16 in. bolts, with the heads as small and unobtrusive as possible, but where permanent assembly is permissible, 1/16 in. rivets are generally neater. Only two notches on each side of the neutral position are shown on the quadrant plate, giving full and three-quarter linkage ahead and astern, but ***more***



can be added to extend the range if desired. It is best to locate these notches by trial, after the assembly has been fixed to the deck and the reach rod has been adjusted for mid-gear.

While the quadrant gear is recommended for hand operation, remote control of any kind may be carried out more effectively by screw gear, powered by a servo-motor I have not attempted to show this mechanism, as it may be varied to suit individual choice, but I suggest that a screw 1/4in. dia., Whitworth (20t.p.i. could well be used, driven through worm gearing from a miniature reversible electric motor. Contacts or limit switches may be fitted to stop the motor at each end of the travel. It is also possible to control the reversing gear by a non-reversible motor with a worm-geared crank, connected directly to the arm on the weigh-shaft; but in this case all controls must be carried out in rotational sequence, which is not always convenient from the aspect of the transmitter.

One or two other details of the engine installation may be briefly dealt with. It has already been mentioned that the cylinders should be lagged, mainly with a view to appearance rather than thermal efficiency. Though conservation of heat is more desirable than ever in small engines, it is very difficult to insulate the cylinders effectively because, however well they are wrapped up, much heat is lost by conduction to the frame and other adjacent metal parts.

Generally, the only attempt at insulation of small cylinders is by lagging the barrel, while the greater areas of end covers and steam chest are left exposed. The actual insulating material may be felt, flannel or asbestos matting, packed in the recessed space around the cylinder. This, is covered and held in place by an outer casing or "cleading," attached in any convenient way to the cylinder.

The simplest from of cleading is sheet metal, wrapped around to fit neatly between the cylinder covers, and held top and bottom by small screws along the edges of the flat cylinder surfaces. Blued sheet steel is usually recommended for this purpose, but it is best suited to engines of relatively modern types. Earlier engines employed wooden battens held in place by brass straps; whether these are truly characteristic or not, they are certainly pleasing in appearance and not at all difficult to fit.

Hardwoods such as oak, teak or mahogany are preferred; the strips may be cut in the lathe with the aid of a small circular saw and an improvised table with adjustable fence, to a width of 3/16in. X 1/32in thick. To simplify fitting they may be glued to a backing of tough paper or tracing linen. Alternatively, a single sheet of veneer, scored by means of a stylus or blunt scribing knife with lines 3/16 in. apart, may be used. The cleading bands should be thin and unobtrusive, and the largest screws which can be used to hold them in position are 10 BA, with undersize heads.

In case the overhang of the cylinders forward of the main

Continued on page 839

some materials being supplied free by the many willing and skilful members.

The Round Pond was built by the members in 1957, and is to international standards. It is 100 ft in diameter, with concrete sides and an asphalt bottom. It is stocked with fish which keep the water free of algae.

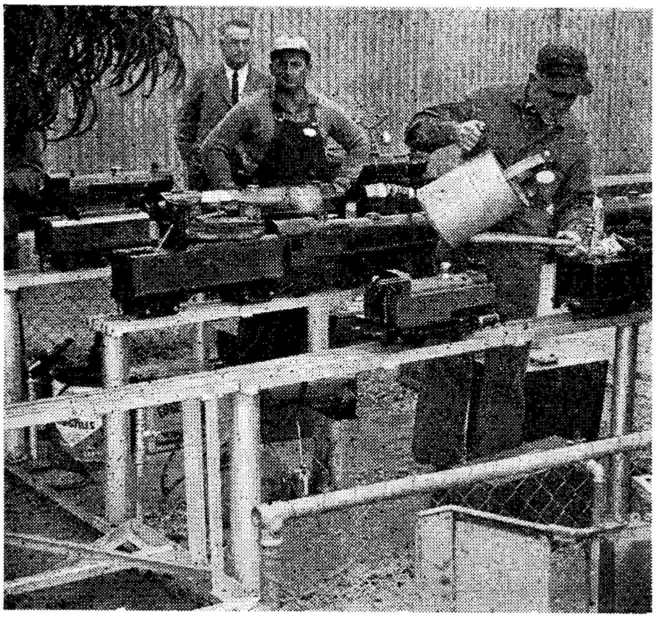
Level is kept constant by ball cock from the town mains. In a hot climate like this, with an evaporation of 5 ft per year and an annual rainfall of only 21 in., a water bill of about £25 a year does not seem excessive. The pond is the scene of much activity by the model boat enthusiasts and competition in speed events is keen in the 5 C.C. and I0 C.C. hydroplane class.

A variety of excellent working scale models of liners, tugs and other craft make an eye-catching display on the placid waters of the pond.

The working model stationary steam engines are supplied with steam from a vertical fire-tube boiler, 24 in. X 9 in., burning coal and evaporating about 30 lb. of steam per hour. Steam engines range in size from about 3/4 in. bore up to a couple nearing 3 in. bore X 6 in. stroke, several of them constructed in the last century. The beam engine, built in 1846, is reputed to have been the first actual steam engine imported into this colony. Referred to by the locomotive men as the Steam House, it is also the club workshop, with a workbench, a large power drill and grinder.

Steam is the ruling interest behind all members' activities -locomotives, boats and stationary engines-but two diesel engines have recently appeared and the speed events on the pond are, of course, in the i.c. field.

Steaming-up bay, a traverser serving twelve roads

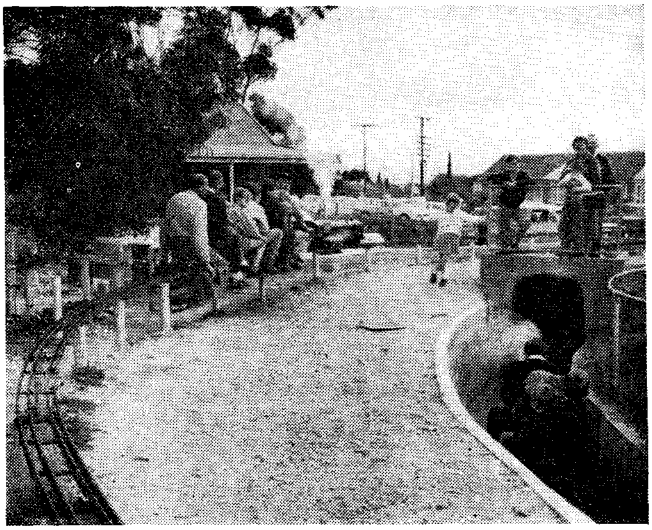


There is a midget racing car track; cars are also i.c. and attain fantastic speeds.

The SA Society, formed in 1927, has grown from a modest beginning to an active and virile group of enthusiasts. The decision in 1947 to acquire ground and establish permanent facilities has been fully vindicated and the present members look back with gratitude to the planners and workers who have made the Park possible.

While no major additions are at present planned, there is no doubt that with its steadily increasing membership and wider interests of members, the society will continue to grow on the firm base already established, and thus preserve, if only in miniature, the age of steam. ❑

View of the multi-gauge track curving towards the clubhouse



STERNWHEELER.. . *Continued from page* 825

frames should be considered to cause instability, it is possible to fit an additional cross-member on the deck, attached to the underside of the cylinder steam chests. The exhaust steam from the cylinders should, properly speaking, be taken to a condenser, but as this is hardly practicable in a model, the next best thing is to lead it into a separator vessel which collects oil and free condensate, then release the remaining steam to atmosphere through the funnel or smokestack. Unless highly superheated steam is used, engine lubrication can be kept to the minimum, and a simple displacement lubrication in the common steam line is capable of fulfilling requirements, but a more positive mechanical lubricator, as used on locomotives, may be fitted if desired.

I have not designed a boiler specially for these engines, but there are several types which can easily be adapted for the purpose, including locomotive boilers, which conform to the type generally used on small stern-wheel vessels of early date. Sometimes the boilers were housed more or less amidships, but in a few cases they were mounted, fully exposed, on the foredeck. Boiler firing of model marine boilers is most conveniently carried out by means of a liquid fuel or butane burner, as solid fuel is not easy to apply in this particular instance, unless a special type of boiler with hopper-fed furnace, is employed.

Questions may be asked about the method of steering used on stern-wheelers. Because of the shallow draught, the effective depth of the rudder was limited, and often two or even three rudders were used. They were fitted in the space immediately forward of the paddle wheel, coupled together and operated through chains and pulleys from an orthodox steering wheel. El