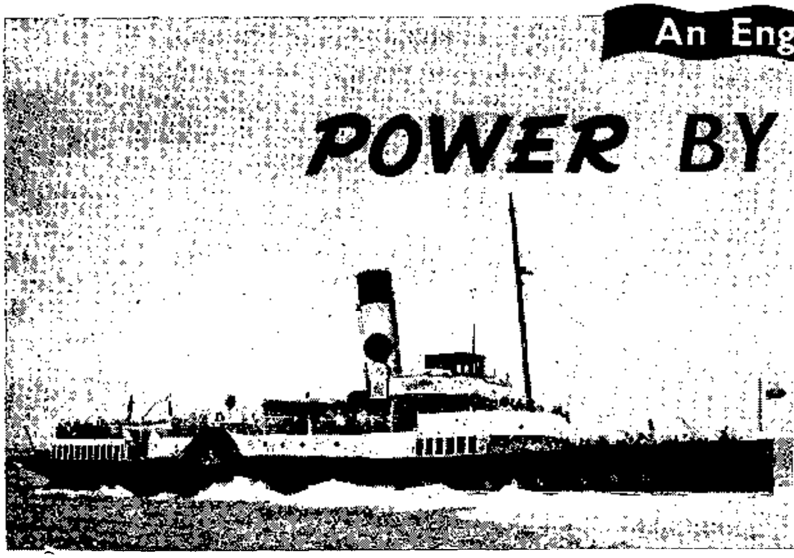


An Engine for DEVONIA

POWER BY PADDLES

EDGAR T. WESTBURY

describes a set of engines suitable for powering a 6 ft. paddle steamer

THE POWER UNIT described is a development of an earlier design published in response to the requests of many readers for information on engines of a suitable type for the propulsion of working model paddle steamers. *So* far as can be gathered, this was the first time a complete design of a specific type for such a purpose had been published and, previous to the issue of proper information, many builders of this popular and picturesque class of model steamshiv had installed engines of quite uncharacteristic design.

There are, however, some notable examples of paddle boats with engines of correct type, one of the best known being Mr. Eltridge's ***Royal*** Sovereign.

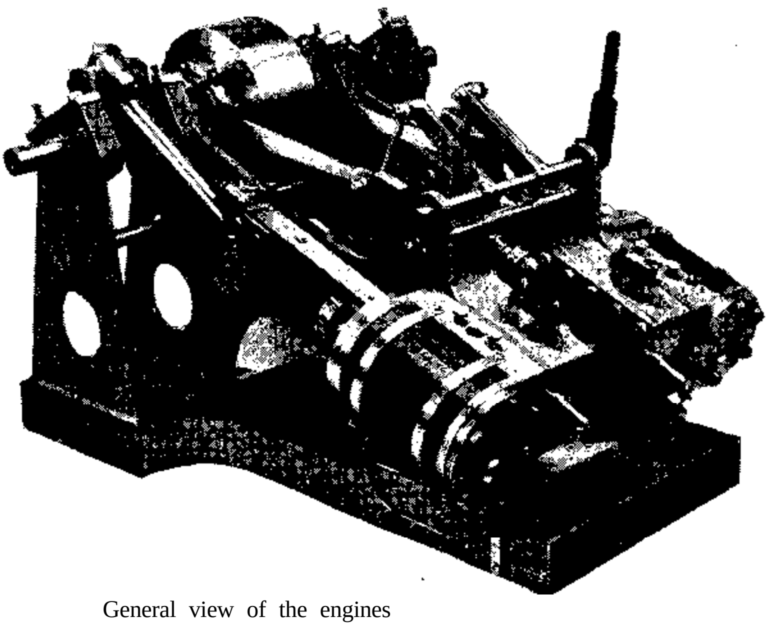
Diagonal engine advantages

The diagonal arrangement of steam engines was employed extensively in paddle steamers of all types from about the middle of last century onwards and may be regarded as a definite milestone in the development of marine engines, following up the very early types such as the sidelever and the oscillating cylinder engine. Its principal advantages over the latter were that it overcame its drastic limitations in length of stroke, afforded better accessibility and allowed the engine weight to be distributed over a greater area of the hull.

For engines intended to produce a high torque at low speed, a long stroke in relation to bore is mechanically desirable as it increases the leverage applied to the crank without imposing abnormal bearing loads. So reliable and efficient did this type of engine prove for its purpose that it was universally favoured in Great Britain for all types of paddle steamers, including small tugs, harbour tenders, passenger boats and ferries, up to at least the first 20 years of this century.

The later examples were usually of the compound type, with two or more cranks and, particularly in the case of tugs, engines in two self-contained halves were used, with a clutch in the centre of the shaft so that the port and starboard engines could be uncoupled and manoeuvred separately to facilitate steering.

The design featured here is not claimed to be a true scale model of any particular full-sized prototype, but is intended as a practical power unit for a working model steamer, of generally correct character, with avoidance of features which would be definitely out of place in a marine installation of this type. I make this clear in order to forestall any possible



General view of the engines

criticism from the purists who may find that I have omitted a few minor details or made the bolts and nuts out of scale!

There is a definite distinction between true scale models of engines and those intended to perform a full-time job of work. but that is no excuse for making the latter crude in appearance or completely out of character. The engine room of a model steamer, even though it may lack complete fidelity in every detail, can be made to produce the authentic atmosphere and in no case is this more marked than in a paddle steamer.

Made on the premises

The set of engines illustrated (incidentally, I would point out that in marine terminology engines are always referred to in the plural-not " an engine." but " a set of engines ") has been constructed in the M.E: workshops under my supervision by J. Message with a view to proving the practical merits of the design and the working out of all machining and fitting operations.

In the course of building the set of engines, a number of minor modifications have been found desirable and these have been incorporated in the drawings so that these differ in detail from the design published in ***Model Ships and Power Boats*** and also the blueprints subsequently issued. This does not render the latter obsolete, as many of the details are optional and, in common with most of my engine designs, are capable of adaptation to suit the varying requirements of constructors, or application to different types of hulls.

In the matter of dimensions, it may perhaps be considered by some readers that the engine is on the large side for popular demand, but my experience leads me to the conclusion that the most successful prototype model boats, from the navigational aspect, are those of fairly large size and a 6 ft. boat does not look very big when it is out in the middle of the pond.

Scaling-down suggestion

It is, of course, quite possible to build the engines to a smaller scale and I suggest that for those who wish to install them in a smaller hull, say 4 ft., all the dimensions could be reduced in scale proportion to two-thirds, giving a bore and stroke of 1/2 in. by 1 in.

If made much smaller than this, however, some of the operations would be rather finicky and it would be difficult to preserve scale proportions throughout while ensuring robustness of the working parts. Marine engines of all kinds lead a very strenuous life and must be sound in wind and limb.

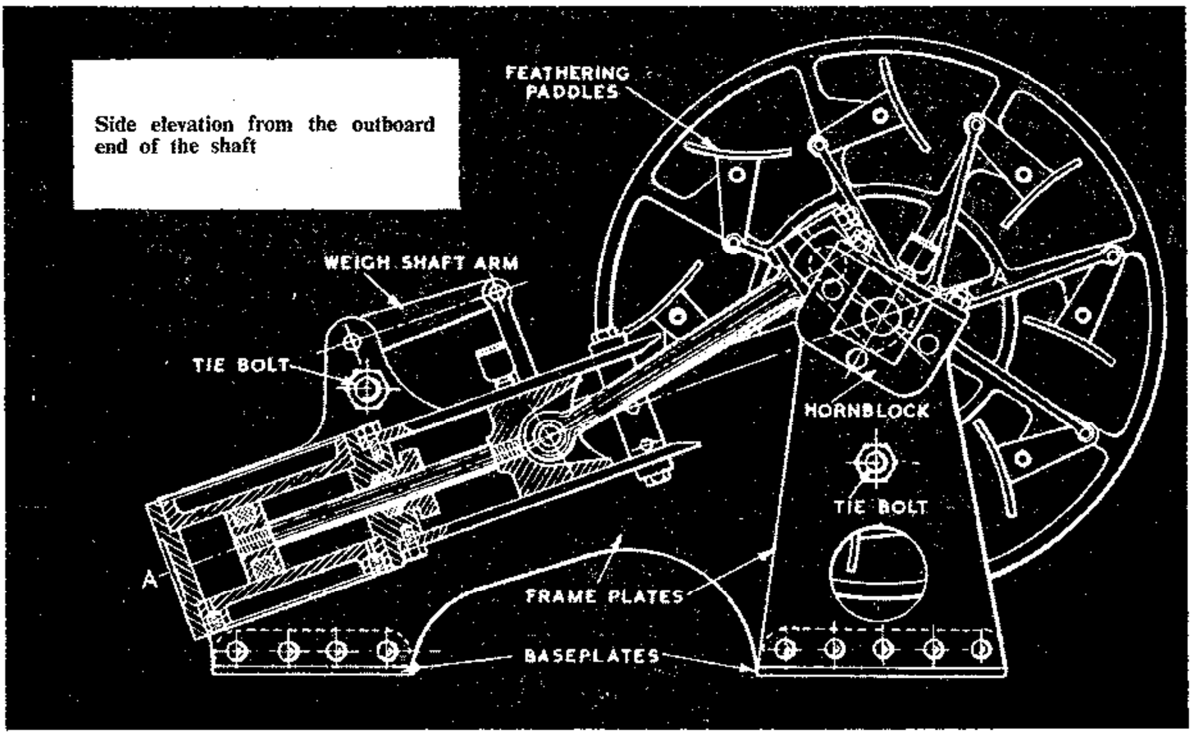
Unlike locomotives, in which by far the greater stresses and strains are encountered when starting from rest and the load is considerably decreased when running at full speed, ships engines, whether driving paddles or screws, meet very little resistance when starting, but heavy collar work when under way.

General design

In the general arrangement drawings, the side elevation shows the cylinder and the crosshead of one " engine " in section. The oblique plan, also in part section, viewed from square-on to the cylinder centre line, shows half the complete set, as the other half is identical, though mirror-reversed.

The two cylinders are inclined downward at an angle of 20 deg. to the horizontal driving on to separate but permanently coupled single-throw cranks, which may be made integral with the actual paddle shafts or connected by flange couplings. (Some engines, it may be noted, have been spur geared to the paddle shafts and it is possible to incorporate this feature if desired.)

The simple or single-expansion type of engine is used because it is not onlv less complicated but also generally found more satisfactory than the compound engine in small sizes-the advantages of the latter could hardly be realised at all without the addition of an efficient condenser.



Side elevation from the outboard end of the shaft

In the structure of the engine. steel plates are used, mainly in the interests of simplicity. Although most large paddle engines employed more or less complex structural castings, often incorporating a surface condenser and other working parts, the use of plate frames was by no means unknown in the smaller and less elaborately-equipped engines.

The main bearings are of the split type, rectangular in external shape and carried in hornblocks attached to the top of the frame plates. In this and several other features there is a similarity to locomotive practice so there will be little difficulty in building the components. Not many castings are necessary and those that are used are of simple and straightforward nature.

Temporary arrangements

In the photographs of the engine, which were taken when it was first set up for running in and testing, it will be seen that in place of the centre coupling, a flywheel has been fitted to the middle of the shaft. This is a temporary fitting, intended not only to provide some momentum in the absence of the paddle wheels, but also to serve as a brake drum to enable the engine to work under load.

Another temporary feature is the lever fitted to the weigh shaft for moving the links to reverse rotation.

Castings and parts for the construction of these engines are obtainable from Messrs. A. J. Reeves of

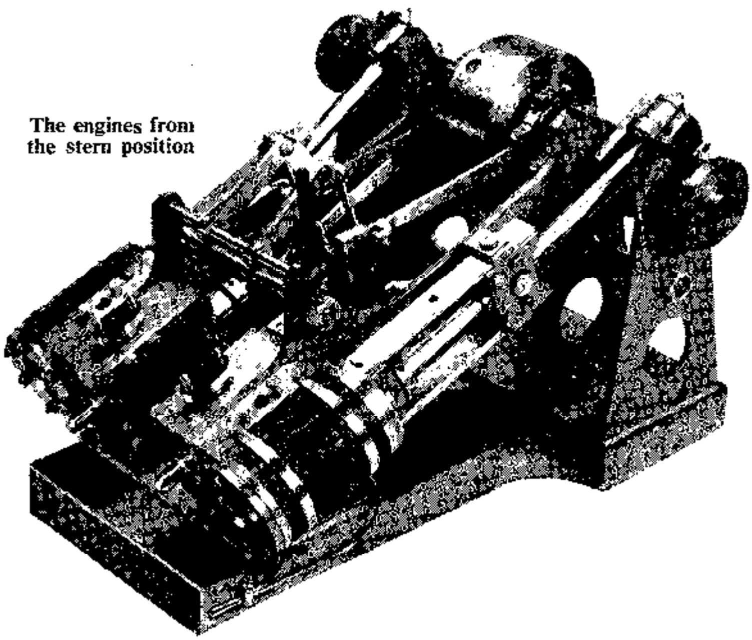
Reversing gear

While it is not absolutely necessary to provide means of reversing model marine engines, since nearly all active running of the boat on the pond can be confined to one direction-full ahead-it is a great convenience, besides adding to realism, if it can manoeuvre in either direction.

This is particularly important if the boat is radio-controlled, which is quite practicable in a model steamer of the size specified, though the only radio-controlled paddle boats I have seen have been electrically propelled. There are, however, an increasing number of constructors who seek to escape the limitations of electric power and are tackling the problem of remote control on steam and petrol-driven boats.

The great majority of marine steam engines, of all types, are fitted with Stephenson's link reversing gear, and it would be very difficult to improve upon it for this particular purpose. Alternative forms of valve gear, such as Joy, Hackworth and Marshall, etc., are by no means unknown on marine engines, however, and may have advantages in certain cases.

The "Eagle" class of Thames paddle steamers had Walschaerts gear, which, so far as my experience goes, is very unusual in marine practice and it is significant that in a well-known marine engineering text-book, known colloquially as "the greaser's Bible," all the above gears except the Walschaerts were described. While it is possible to ring the changes and adapt other forms of valve gear to this set of engines, therefore, there seems little to be gained by doing so.



The engines from the stern position

The launch link

The type of link used in these engines is appropriate to marine practice and is generally termed the " launch " link. It gives the maximum valve travel for a given eccentric throw, but is somewhat more liable to errors in timing, due to die slip, than the original link used by Stephenson.

These links do not show in the side elevation of' the engine and are only seen from the top edge in the half-plan, but will, of course, be fully detailed in a later issue.

They are controlled by a weigh shaft which runs right across the top of the engine and is connected to the reversing control, as mentioned, by suitable linkage, according to the position found most convenient for the latter.

Before commencing the construction of the engine (assuming that it is to be fitted to a hull) the space available for its accommodation, and the means of installation, should be carefully considered. In most cases it is possible to provide a flat surface on the floor of the hull so that the two flat soleplates shown on the drawings can be firmly screwed down to provide a true and rigid foundation.

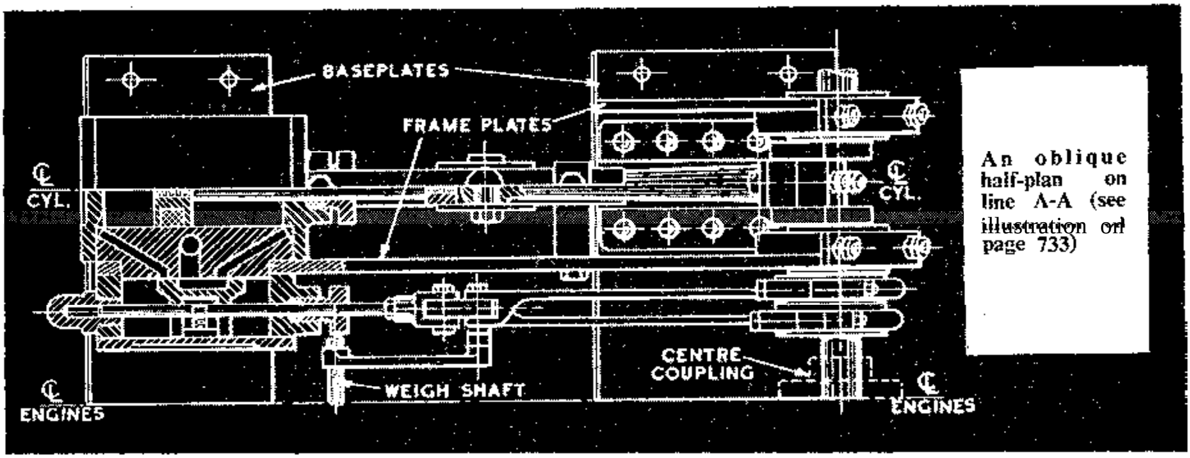
Alternative mounting

If, however, a flat surface is not available, some alternative method of mounting which will enable the frames to be equally well secured, with no stresses tending to twist them out of line, must be built into the hull structure. It is obviously desirable to keep the engine fixings as simple as possible so that it can be installed and dismounted without undue difficulty.

Location will, of course, be determined by the shaft position, as laid out in the hull design and the correct depth of immersion of the paddles has an important influence on their efficiency so that the displacement depth of the hull, fully loaded, must be taken into account.

The fore-and-aft position of the paddle shaft is also subject to variations in hull design; generally it is as near amidships as possible and the engines may be either forward or aft, as may be most convenient. To obtain a compact layout of the steam plant, the boiler will need to be placed as close to the engines as possible, at the shaft end and it is generally possible to adjust the trim of the hull by shifting auxiliary gear as required.

If the hull design allows, the crankshafts may be extended outwards so that the paddle wheels may be mounted



An oblique half-plan on line A-A (see illustration on page 733)

directly on them, but more often than not it will be found necessary to fit separate paddle shafts, with flange couplings to line up with the engine shafts.

The arrangement of the engine shown, with the cylinders on the outside and valve gear on the inside, will generally be found best for accessibility, but may be reversed if desired, and the width of the complete set is also adjustable to suit hulls of varying beam.

● *Further details of the engine will be given in the issue of December* 1.

AN ELECTRIC CLOCK

(Continued from page 731)

Before any further work can be carried out on the coil assembly, the frame itself must be accurately located on its pivots between the plates. The best way to do this is to secure the three columns to back plate and insert the bottom pivot of coil frame into its bearing hole. Place front plate into position, and secure it with three 6 B.A. screws. The long staff extension now projects through the 7/16 in. crutch boss hole. Now, place the cock-piece into position, with outer pivot in its appropriate hole. Slide cock-piece to the left; until the upper right hand corner is almost in line with the edge of plate. Lightly clamp it in this position, using a watchmaker's hand vice for the purpose.

Juggle the cock about until coil staff is exactly vertical and the frame swings freely on its pivots at which point mark off the cock anchorage screw position through the hole already drilled and remove the cock-piece. Drill and tap the hole 6 B.A. and replace the cock, slewing in slightly here and there to attain true alignment of the pivots, when the coil frame should swing quite freely. Lock the screw tightly.

Drill the two 3/64 in. steady pin holes and remove cock-piece. Slightly chamfer edges of holes on underside and remove the burred edge. File two pins slightly tapering forcing each into its repective hole, leaving about 1/16 in. protruding from the underside. Round both tips and file down surplus until flush with outside surface. Finish to light grain.

Slightly broach the pin holes in plate until the pin on cock-piece can just be forced in. Make sure that the pivot is in its bearing and lock clamping screw tightly. If insufficient end-play now exists, remove cock and counterdrill the pivot hole slightly. The coil must be quite free, with about 1/64 in. end-play when all screws are tightly locked. The plates can now be separated and the coil frame removed in readiness for winding and assembling to pendulum crutch.

Before winding is attempted the space between flanges of coil must be effectively insulated. This also applies to both protruding ends of the axis staff, that is, over the length covered by winding. This prepriration must not be rushed through, but every care taken to ensure all surfaces are absolutely flat so that a maximum number of turns can be wound on, without any probability of a short circuit between turns and frames.

Attach to the finishing end of coil, about 3 in. of thicker wire of about 36 S.W.G., double silk or cotton covered, and make one complete turn round that space between the lower flange and winding. It can now be bound tightly to the front staff extension, over insulating sheath, with fine thread. Varnish the binding and the loop. The loop can then be gently pressed in to clear the flange. Trim off all surplus sheathing from staff projection, leaving 5/16 in. clear for crutch attachment and 3/32 in. at lower pivot.

Pendulum crutch

Construct this to measurements as indicated in Fig. 10. Finish both faces after bending, also burnish the edge. Turn crutch attachment collet from 5/16 in. brass rod after-drilling through. Taper off the pipe on the left hand side from 1/8 in. to 1/16 in. ; this must now be slit with a very fine saw to form a friction grip on the staff. Polish all edges and finish the remaining surfaces to a light grain. The short hair-spring collet boss must fit fairly tightly into the collet of a standard spring and that taken from a " Crown " Ingersoll will be found just right for the job.

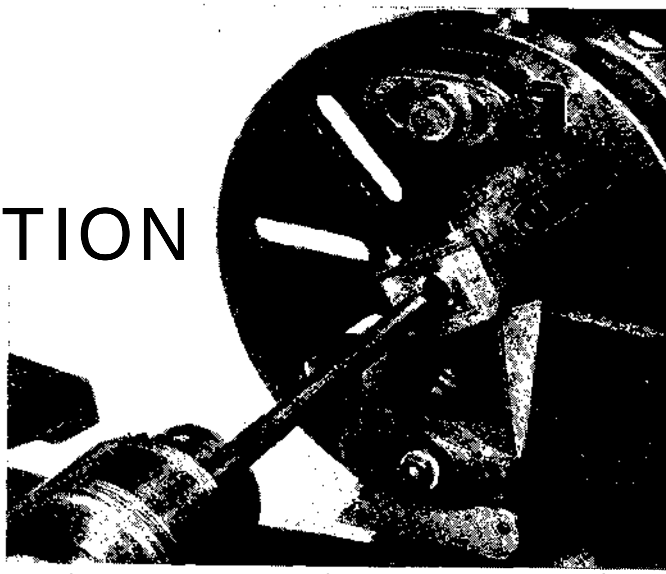
Attach the collet to crutch with the long extension facing inwards, by burring over the 3/16 in. dia. spigot, after inserting it through the appropriate hole.

● *Next week the author will conclude the article.*

POWER BY PADDLES

MAIN FRAME CONSTRUCTION

EDGAR T. WESTBURY gives instructions for making the engine frame plates and main bearings in this instalment of building diagonal paddle engines for a 6 ft. model ship

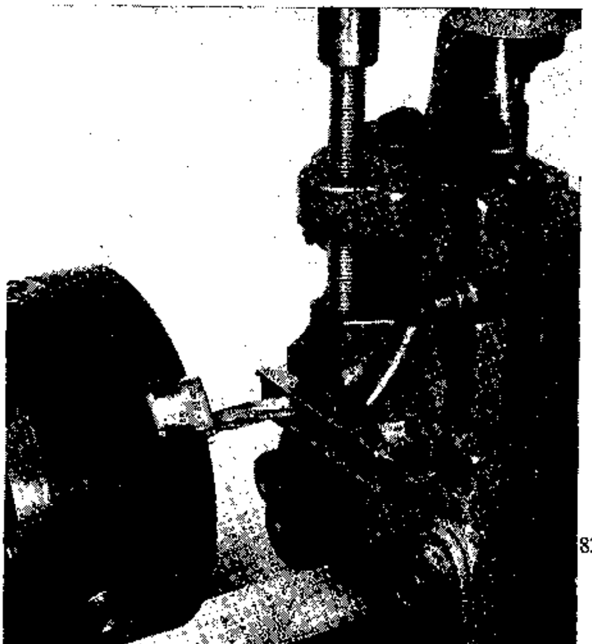


Outer frame plate mounted on faceplate to serve as a jig for boring bearings

THE ENGINE FRAME plates are cut from 1/8 in. mild steel plate, which "should be quite flat and true but not necessarily bright, as the surface will need to be painted eventually -if only in order to protect it from corrosion.

It is hardly practicable to keep every part of the engines clean and bright in the confined space of a model boat hull and the smaller the number of surfaces which have to be wiped down and oiled after every run, the better. Black steel is quite satisfactory and is generally less liable to buckle or distort than cold-rolled bright steel. Pitting or patches of mill scale must be avoided, at least in the part of the main

Milling grooves in bronze stick to make main bearings



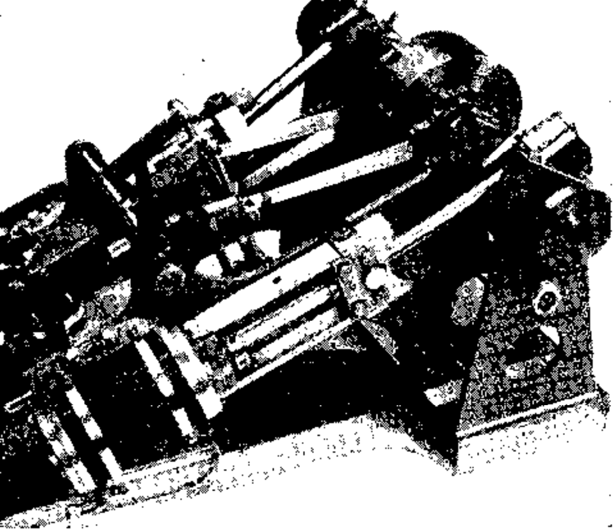
frames on which the cylinder and steam chest are mounted. It is necessary to make a steam joint on both sides of the plate here, so a true surface is most essential.

Methods of cutting the plates to shape will depend on the equipment available. no doubt most constructors will have to rely upon sawing, drilling and filing The use of a hammer and chisel should he avoided, or kept to the bare minimum necessary for breaking out closely-spaced holes, as it is liable to cause distortion.

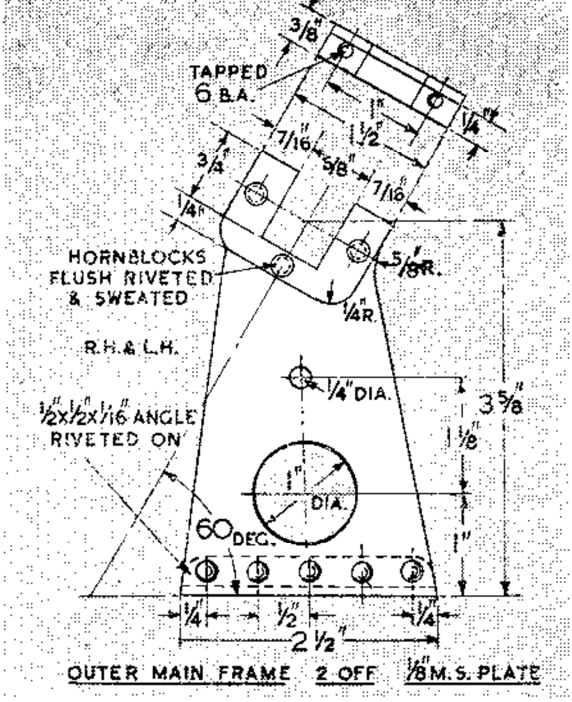
Exact outside contour is not highly important but obviously pairs of frames must be identical and holes common to the complete set of frames must be correctly aligned. One of the main frames, after marking out and drilling undersize holes, may be used as a jig for drilling the other plates, one at a time. They should not be clamped all together in a stack, as it is possible that in drilling through 1/2 in. thickness the drill point may wander an appreciable amount. The four plates should, however, be bolted together, in their relative positions (mark them 1, 2, 3, 4) for filing or milling the hornblock seatings to within about 1/64 in. of finished size. A trepanning tool or tank cutter is useful for formmg the lightening holes.

Hornblocks of 1/4 in. mild steel plate are next cut out and attached to the plates by riveting and sweating, the object of the latter process being to ensure that a perfectly rigid joint is obtained without using a large number of rivets or hammering them up so tightly as to distort the plates. Solder is not relied upon for mechanical strength but will definitely prevent the first tendency to that microscopic movement often detected in bolted or riveted joints.

Note that the hornblocks and also the angle brackets at the feet of the plates are fitted to alternate sides (outer side of inner frames and inner side of



View of engine illustrating frame assembly



Right: Details of outer main frame

outer frames) producing right-hand and left-hand frames, which face towards each other. This arrangement can be seen in the photograph of the frames set up temporarily for aligning the homblock seatings, with the aid of a test bar made from 5/8 in. silver steel bar.

Fixing the angle brackets

The angle brackets may also be riveted and sweated (unless it is found more convenient to make them detachable to suit the method of mounting the plant in the hull). in which case 6 B.A. or 1/8 Whit. bolts may be used. Snap-head rivets are recommended for fixing the angle brackets but projecting heads are undesirable in the homblocks, so that countersunk rivets, tiled flush, are advised. In all cases, the rivets are 3/32 in. dia.

It should not be taken for granted that commercial angle steel is necessarily true or square on the faces, when it is obtained. This should be checked and corrected by filing or machining if found necessary. The best way to locate the brackets correctly is to clamp them in place with toolmaker's clamps at each end, while resting on a flat surface, so that they are truly aligned with the edge of the frame plate, and jig drill them from the plates while thus secured.

Castings supplier

For constructors who do not wish to go to the trouble of building up the frames in this way, Messrs. A. J. Reeves can now supply castings in light alloy which incorporate both the hornblocks and the mounting feet. These differ slightly from the detail drawings in that they are reinforced by means of raised edges, but this makes no difference to essential dimensions and, if anything, the appearance is improved. Had they been available when the set illustrated was built, they would certainly have been used.

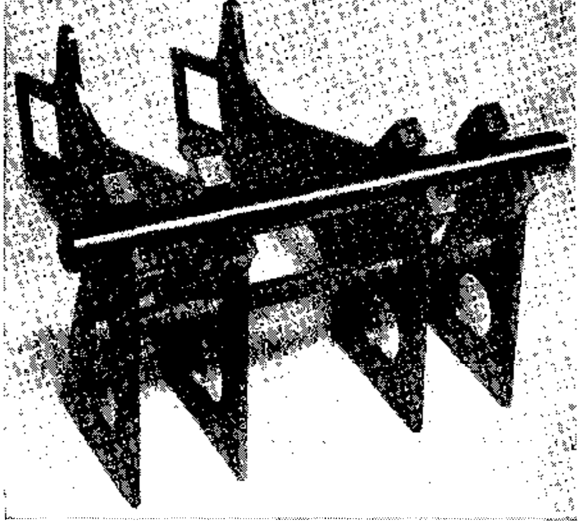
Main bearings

There are several ways of machining and fitting the main bearings and some readers may prefer to make them singly, fitting the external surfaces individually to the hornblocks. In this form of engine construction, the use of solid (non-split) bearings, like locomotive axleboxes, would be practicable, as the use of single-throw crankshafts enables them to be threaded over the ends, but the split bearings are more convenient for lining up and assembly.

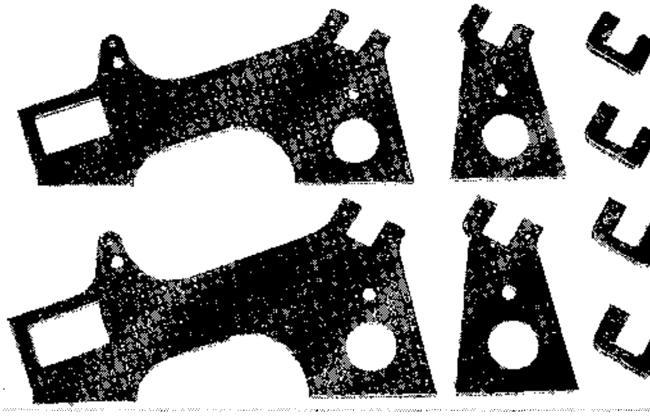
The method employed in this case was to machine a rectangular piece of bronze cast stick on the four sides bv facing in the lathe and. after checking its squareness, holding it in a Myford machine vice clamped on the vertical-slide for end-milling the grooves in the two sides with a home-made flat cutter. This set-up is clearly seen in the photograph. If a vertical slide is not available, the operation can be carried out by vackinn the work up exactly to centre height in the toolpost.

The dimensions were left on the full side and the width of the groove slightly tight for final fitting to the homblocks, after which the stick was held in the toolpost and sawn into lengths with a circular saw in the lathe, leaving them true and parallel on the end faces.

Before boring the split bearings, they should be carefully fitted to the homblock seatings, the alignment of which must be checked after. the frames are mounted on the soleplates, or other bearing surface and held in their proper location by temporary tie-bolts, which may be extemporised out of pieces of tubing and a length of fin. screwed rod, pending production of the permanent stays. A piece of 5/8 in. square steel rod is useful as an alignment gauge and



Frame plates set up in assembly position, showing the use of a test bar for aligning hornblocks



Inner and outer frame plates, and hornblocks, after catting out, and before attaching the latter

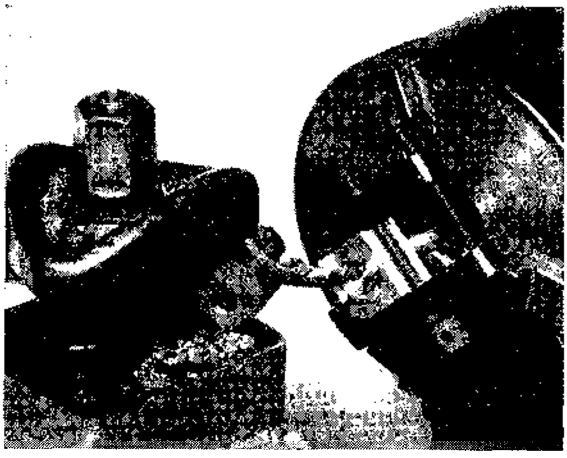
may be smeared with marking colour to indicate any high spots in the seatings.

When fitted, the bearings should bed firmly in the bottom of the seatings and the halves against each other, the top surface being very slightly proud of the hornblock faces. The keep plates are then made and holes drilled to take the securing studs, which fit tapped holes in the hornblocks. While clamped in position, the half-bearings are numbered to indicate their mating and location.

Boring the bearings

It is now necessary to bore the beatings accurately so that they line up when assembled. Setting them up individually would be extremely difficult and the method employed, therefore, entailed the use of a jig to ensure that uniformity in the bore position, relative to the hornblock surfaces, was obtained. Construction of a special jig, however, was not necessary, as the purpose was admirably served by using one of the outer frame plates.

Main bearing clamped on pin mandrel for facing the reverse side



This was mounted on the faceplate with a parallel packing piece behind it and with one pair of half-bearings in place, and was set up so that the exact centre point of the bearings was coincident with the lathe axis. After boring and facing one pair. it was removed, and the other three, in turn, placed in position and similarly dealt with, the position of the jig remaining unchanged. Take care that the bearings are all the same way round and, if the markings are removed by the facing operation, re-mark them before there is any chance of mixing them up.

A second operation on the outer face of the bearings could possibly be done in the same way but a simpler method is to clamp them together on a pin mandrel by means of a small toolmaker's clamp as shown in the photograph. Only a very light skim is required to true the bearing face and produce a relief on the outer part of the face. The ends of the bore should have a slight radius to prevent riding on the journal fillets.

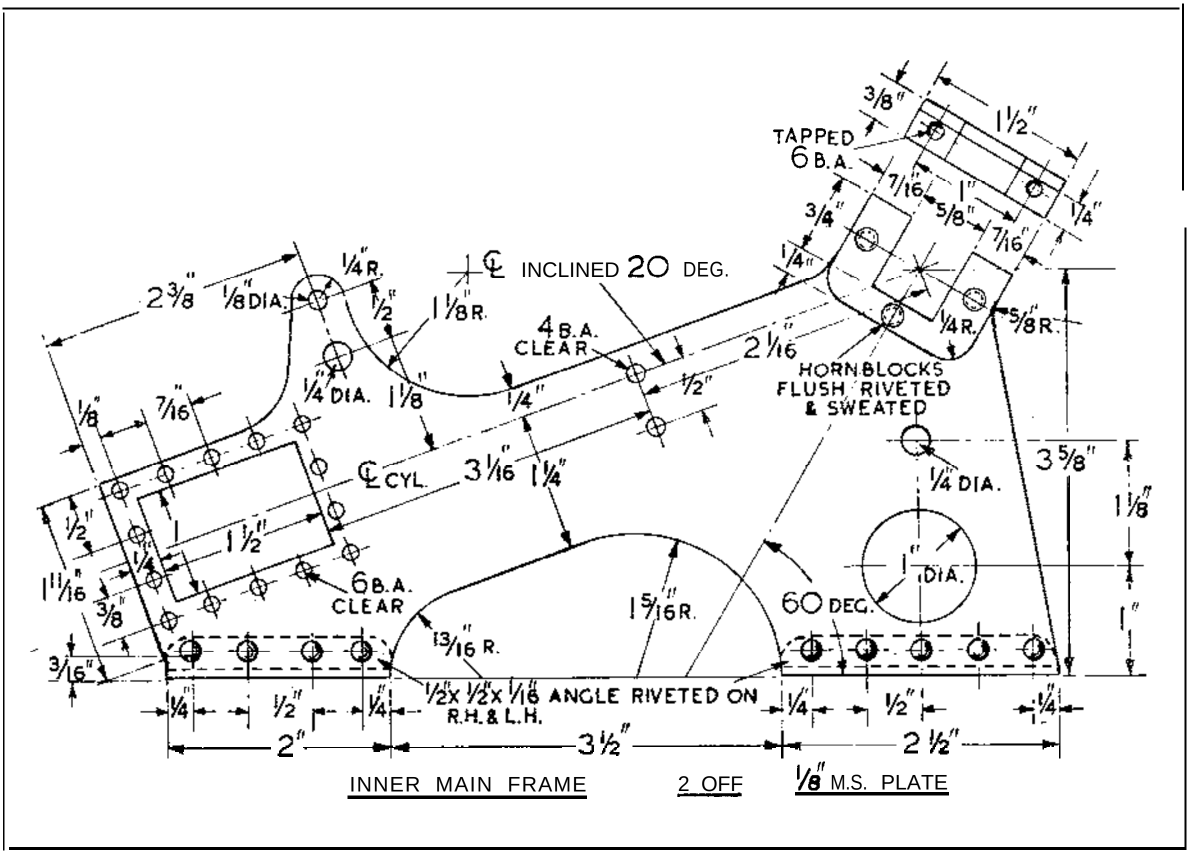
I regret that an error was detected in the drawing of the stay bolts too late for correction. Only two outer and one inner stay bolts are required as shown ; the other inner stay, fitted above the cylinders, should be made with male ends like the outer stay, but to a length of 2-3/4 in. between shoulders.

Bedding-in the bearings

Final bedding-in and lining up may be done with a scraper, with the bearings in position? using a 3/8 in. test bar, and marking to show up high spots, but very little treatment of this kind should be necessary.

The permanent stay bolts shown in this drawing are turned from mild-steel bar, all work being done between centres except drilling and tapping the holes in the centre bolts. The shanks of the studs should be a close fit in the holes in the frame plates to assist in maintaining true alignment.

Several readers have already expressed their appreciation of the design of this engine, as information on paddle boat engines has long been in demand. A few others, while welcoming any contribution to



Details of inner main frame

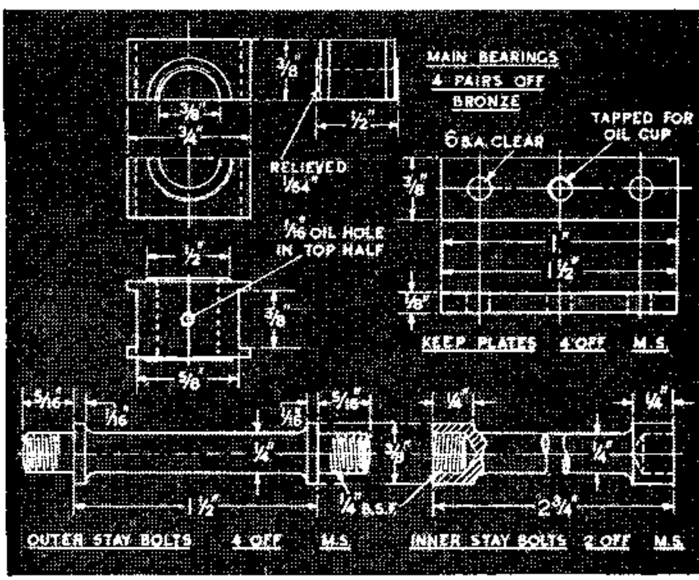
model marine engineering, suggest that it would have been more appropriate to have described a set of engines for screw-propelled boats, which are by far the more popular, and they are of the opinion that few constructors wish to build paddle steamers.

This is a question which always arises when anything a little way off the beaten track is described, but my experience has been that popularity does not always depend on sticking to well-known lines of design. When I introduced designs for a petrol driven road roller, for instance, some readers said this would never attract constructors-but how wrong they were !

What really matters, however, is not whether a large proportion of readers will rush to build a particular type of model, but how much the design contributes to general knowledge of design and methods of tackling constructional operations. If some of the components or processes introduce special problems which have to be tackled by the constructor, the information on these details will invariably be found valuable to readers who encounter comparable problems, even though they may occur in machinery of a vastly different type.

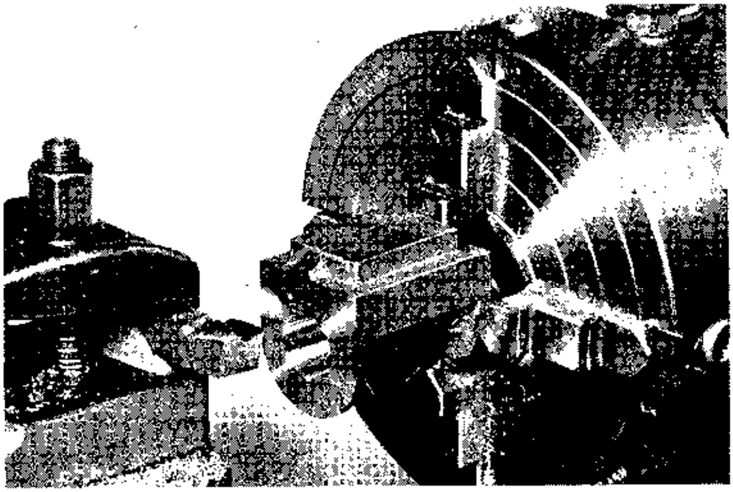
● ***Further details of this engine will be given in our December 15 issue.***

Main bearings, keep plates and stay bolts



MACHINING THE CYLINDERS

EDGAR T. WESTBURY continues his description of a set of engines for a model paddle boat



Right: First operation on the cylinder casting -boring and facing one end

Below: Second operation with the cylinder casting mounted for facing the reverse end

IN THE DESCRIPTION of the main frames, no reference was made to the rectangular apertures to which the cylinders are fitted. These should be roughed out by drilling and filing, but should be left undersize for final fitting after the cylinders are machined. The drilling of the holes around this frame, to take the fixing studs, should also be left till a later stage.

A great deal has been written about the machining of cylinders for steam engines in previous issues and as these particular cylinders are similar in most essential respects to those usually fitted to locomotives and other conventional types, I do not propose to lay down the law as to the methods to be employed, or the particular sequence of operations.

Readers who have already built engines and are satisfied with the results obtained may use the methods to which they are accustomed. I shall, however, describe how the job was tackled in the case of the engines actually constructed, with illustrations of the set-ups at each stage.

It will be seen that alternative materials for the cylinder castings are specified; no doubt most constructors willprefer bronze because of its resistance tocorrosion, but there is much to be said in favour of cast iron in respect of durability under hard working conditions. Contrary to common opinion I do not find the latter material more difficult to machine if the quality of the metal is good, but it generally calls for slower machining speeds unless special tools are employed, the expense of which is hardly justified by their usefulness in general model work.

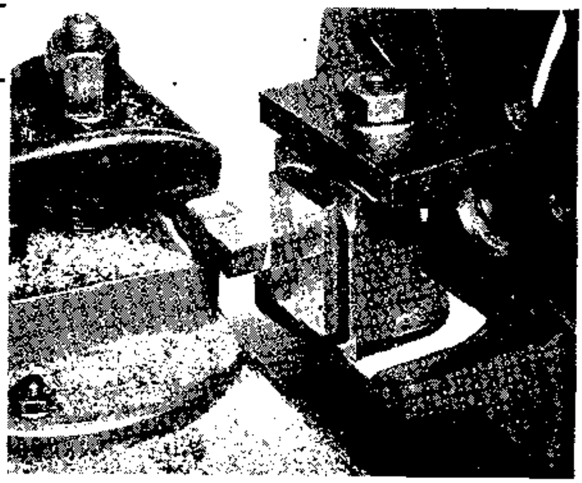
The first operation on the castings. was boring and end facing, for which purpose they were set up in the four-jaw chuck as shown. Here it may be mentioned that when a cylinder of any kind is held by radial pressure for machining the bore there is always a risk of distorting it, so that when subsequently released it springs out of true circular shape. This risk, of course, is greatest with thin-walled cylinders and in the present case, the stress is taken on a flange of heavy section, so that with reasonable discretion in applying chuck pressure no trouble in this respect need be anticipated.

An alternative method of mounting the cylinder is to an angle plate on the faceplate, after rough machining or filing the valve port face to ensure flatness. The usual practice of using a strap and two bolts to clamp it to the plate may impose worse stresses than the four-way pressure of the chuck jaws in many ways.

Setting up the cylinders

Having regard to the fact that the cylinder bore governs the location of other machined surfaces, care must be taken in setting up so that its relation to these surfaces can be properly maintained. It is not sufficient to set up to the cored hole in the bore, as cores may be, and often are, inaccurately located in the mould. In a large casting, careful marking-out will enable the position of all surfaces to be correctly located, but this is by no means so easy in small work, where the thickness of a line may be sufficient to introduce error.

I always set up castings by reference to the surfaces which cannot or do not have to be machined, subject to allowing sufficient metal for cleaning up the

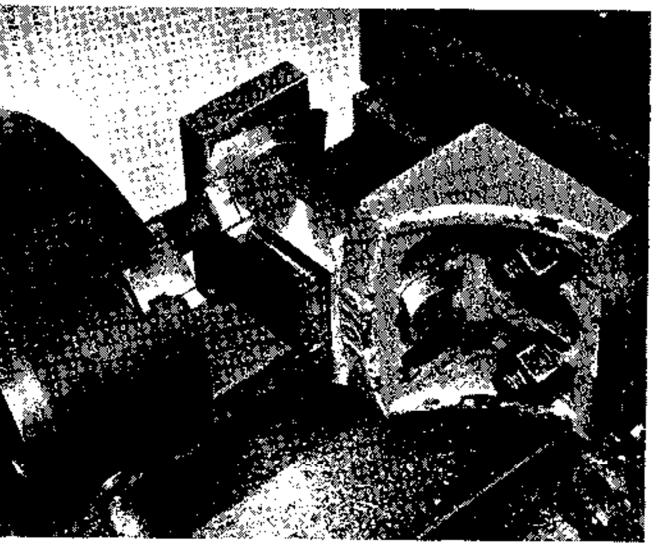


Third operation. The cylinder is mounted on the angle plate for machining the valve face

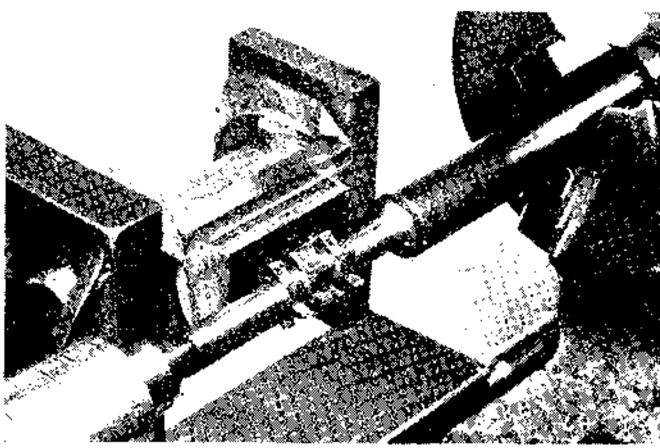
machined surfaces. In the present case, the cylinder barrel and the edges of the flanges should be set to run as truly as possible, both concentrically and on the face.

After cleaning up the end flange with a facing tool, the cylinder bore is machined with a single-point boring tool to within about 0.002 in. of finished size, the final cut being taken with the tool honed to a keen edge and several passes made without applying feed, to eliminate all spring and leave as smooth a surface as possible.

To face the other cylinder flange, it is advisable to mount the castings on a mandrel. As the bore is still undersize at this stage, a piece of 3/4 in. stock bar may be used, set up to run truly in the chuck and reduced by skimming or filing to a wringing fit for the cylinder bore. The end face of the bar should be centre-drilled for tailstock support.



Left: Fourth operation. The angle plate has been transferred to the vertical-slide
Below: Fifth operation. Cutting three parts at once in tht valve face



Next operation is the machining of the cylinder port face, the casting being mounted on an angle plate by a bolt through the bore and disc or plate across the open end, with paper interposed between surfaces at both ends to prevent bruising and improve the grip. After setting the port face parallel to the faceplate, the surface is machined to within a few thou. of finished dimensions, measured from the cylinder bore centre. While thus mounted, it is a good policy to machine top and bottom edges of port faces and flanges, but swinging the casting round 90 degrees each way in turn and squaring off from the port face. These operations are not absolutely necessary, but they clean up the casting and produce accurate reference planes parallel to the cylinder bore.

Mounting the cylinder casting

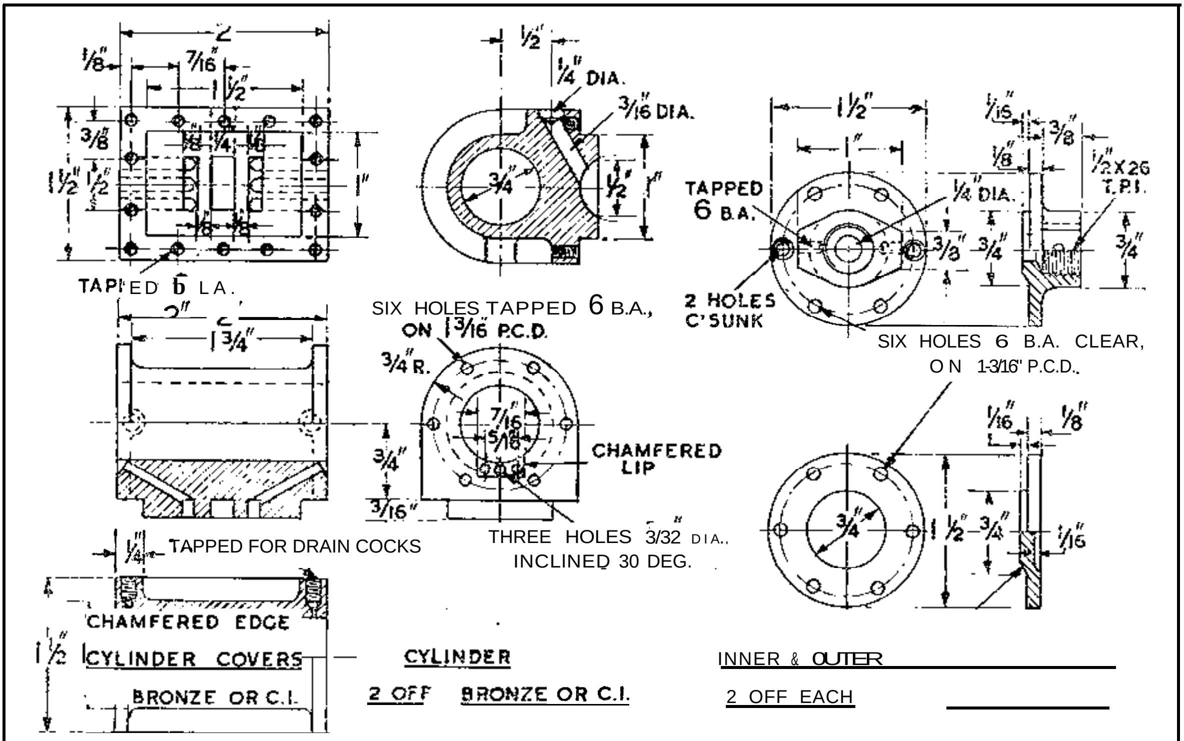
The surface by which the cylinder casting is mounted on the frame plate is set back 3/16 in. from the port face and must obviously be quite flat and true to produce a steam-tight joint. This can best be machined by a milling operation unless a shaper or planer is available, or if one has more than ordinary skill in filing-the latter method will certainly not be found easy by the novice! In the example illustrated, the angle plate was transferred to the vertical slide, and a home-made end mill, running in the chuck, employed to machine both the rebated face and the four edges of the port face, as shown, thus producing at once a true joint face and a true rectangular register to fit the aperture in the frame plate. The simple two-bladed cutter shown is easily made from silver steel and works, if anything, better than an expensive ready-made end mill.

Now comes a vital and critical operation on which the entire success and efficiency of a steam engine largely depend. There are many ways of forming these ports, all of which have been described in past issues and I am aware that there are differences of opinion as to the advantages of the methods I employ. Readers may, of course, use any alternative machining or hand-forming process they please.

It involves the production of a special cutter-not a very big job really-but it is worth while, as this can be adapted to many other jobs and it produces clean square-cut ports, automatically located. If the gang milling cutter is considered too complicated, a simpler cutter to deal with one port at a time can be used, but measurement of the distance between ports is easier to apply to the cutter than the cylinder.

The mounting of the cylinder for this operation is very simple, as the use of a vertical slide, though helpful, is not a necessity and an angle plate on the cross slide can be employed quite satisfactorily. Actual machining time is only a matter of seconds, the major work being the setting-up operations, but to those who grudge the time " wasted " in all the preliminary work of this nature, I can only say that it is the normal routine of nearly every workshop in which one-off or prototype work is undertaken.

The next instalment in this series will be published on December 29



Details of the cylinder with the inner and outer covers

CYLINDER COVERS AND STEAM CHEST

EDGAR T. WESTBURY continues his instructions for building engines for a paddle power boat

FINAL OPERATIONS ON the cylinder castings consist mainly of drilling and tapping holes for the fixing studs, but this can be deferred for the present, as it is best to spot them off from the covers and steam chest after these have been drilled, rather than mark off and drill the components individually, which is more likely to introduce errors.

Drilling passages from the ends of the cylinders into the ports is an equally important operation, in which, I am informed, several constructors come to grief. There is no reason why this should be so, however, and certain success can be assured by correct methods. There are some who can drill these passages by gripping the cylinder in the vice and getting to work with a hand brace, but the skill required to point the drill at the correct angle is, in my opinion, uncommon and I would not rely on it unless no other means were available.

A drilling machine with some form of angular adjustment fixture for the work is much better, but the photograph shows how it can be done in the lathe, with the aid of the vertical-slide and machine vice and with much greater certainty of success.

The work can be set to the correct angle for drilling by swivelling the slide, using a protractor or other means to measure the angle, and a further check is possible by lowering the slide so that the drill can be sighted over the top face. Before drilling, the chamfer at the lip of the cylinder bore can be end-milled, the job being adjusted exactly to centre height for this operation and, while in position, a small centre-drill may be used to start the first hole.

For the other two, the slide is raised or lowered the required amount and the centre-drill is used again. In this way no marking out or centre-punching is necessary and there is no question of the drill being sprung out of line. Use all the lathe speed you have and do not force the pace of the feed. This provided, the passages will come out in the ports-in the words of the famous few-" bang on."

An alternative method, to attain the same end, would be to use a drill spindle on the vertical-slide, with the work set over to the required angle on a suitable faceplate fixture.

The exhaust passage from the top surface of the cylinder to the central port is drilled at a suitable angle to break fairly into the port. The angle is not critical and demands no special setting arrangements, but it will be found easier to start the hole by sinking a 1/4 in. drill squarely into the face for about 1/16 in. This may be drilled deeper for 1/4 in. tapping hole to take a screwed pipe connection, but a flange joint is better.

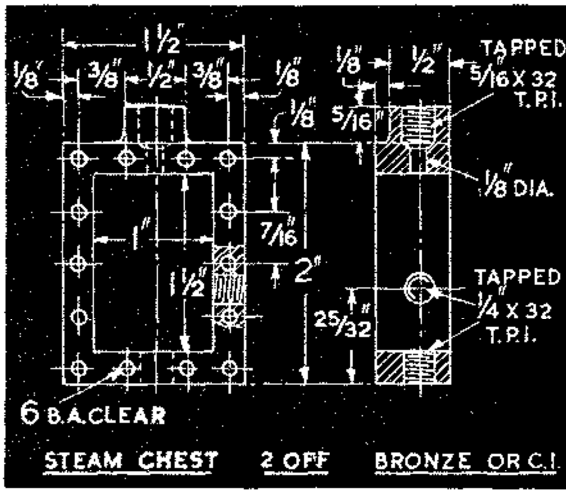
Drain cocks

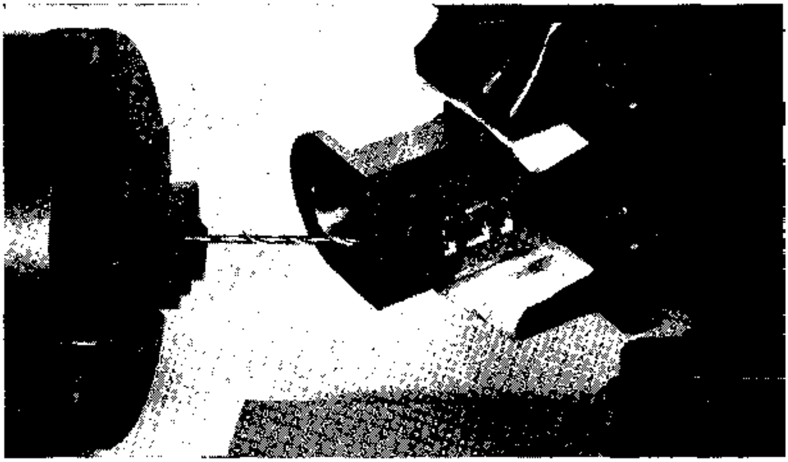
Drain cocks are not a necessity, but they assist in clearing condensate when starting, and the inverted detail drawing of the cylinder shows their position. The smallest available drain cocks, obtainable from Bond's, are screwed 5/32 in. x 40 t.p.i.

Finally, the cylinder bores should be lapped, using a solid or expanding lap, with a not-too-fierce abrasive

Right: Details of the steam chest

Below: Tapping the hole for the gland in the cylinder cover





Drilling the steam passages in the cylinder

such as aluminium oxide or brick dust, followed by tripoli or metal polish, to produce a high finish. Note that the bores should be finished before fitting the covers, the spigots of which should register closely, especially those at the packing gland end.

Cylinder covers

The cylinder covers are quite simple to machine, especially in the case of the outer covers where it is possible to provide a chucking piece Which will enable all essential operations to be carried out at one setting. The inner covers, which incorporate the tapped recess for the packing gland, call for somewhat different treatment and I prefer, after rough machining the rear surface, to mount them boss outwards for drilling, counterboring, and tapping, taking great care to maintain concentricity in all cases.

For machining the joint face and spigot, a piece of bar is held in the chuck, turned to size with a pilot to fit closely in the piston rod guide and screwed accurately to fit the tapped hole. This serves as a screw chuck to hold the cover truly and ensures. that the flange and spigot are true with the gland in both planes.

Stud-hole drilling

Drilling the stud holes in the cover flanges can be facilitated by the use of a drilling spindle, in conjunction with indexing of the lathe headstock, a centre-drill being used to start the holes in all cases-this ensures perfectly accurate location of the holes without the need for marking-out. Finally the flat faces on the opposite sides of the gland boss, for mounting the ends of the slide bars, must be machined or filed dead flat and parallel to the axis, also equidistant from the centre. This is another job which is much simplified by using a milling cutter in the spindle while the job is set up in the lathe chuck.

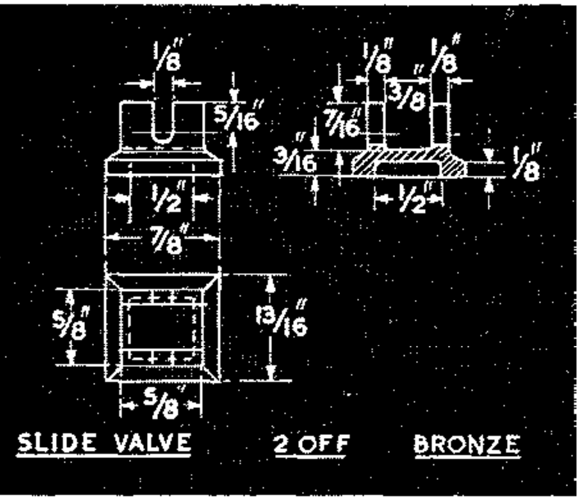
Steam chest

The usual " picture frame " type of steam chest is used as, although it is not in conformity with orthodox full-size practice (at least,in so far as marine engines are concerned), it simplifies machining and makes very little difference to external appearance when assembled.

Both sides of the steam chest casting are first machined flat by holding in the four-jaw chuck and applying a facing tool. Centering is not highly important, but the two sides must be exactly parallel to each other and the amount of metal removed each side must be so adjusted that the gland boss is properly located. As there is machining allowance on the latter, this dimension is not critical, but should not be disregarded.

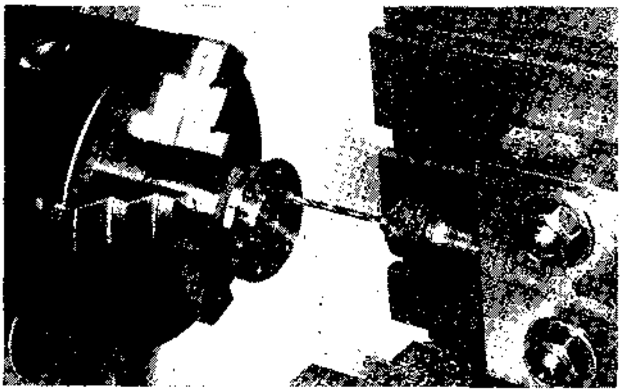
After facing one side, the steam chest casting may be gripped by the inside of the frame and the machined side pressed firmly against the step of the jaws, to ensure that it will finish parallel. Other methods of obtaining positive accuracy in this respect are to use a parallel packing block a little smaller both ways than the steam chest and thick enough to hold it clear of the jaws when placed behind it; or to mount it on a "solder chuck" -this will be referred to Iater.

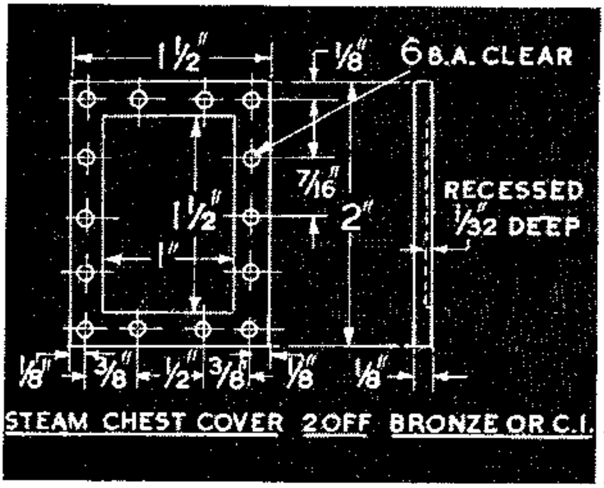
The thickness of the steam chest may be left a few thou. oversize for final lapping of the joint surfaces. It is not practicable to machine the inside surface of the steam chest, but this should be filed to fit neatly

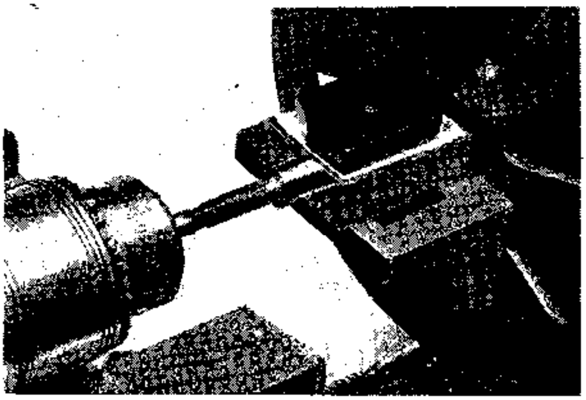


Left: Dimensions and details of the slide valve

Below: The cylinder cover held on a screwed mandrel for making the joint face and drilling bolt holes







Above: The steam chest mounted on an angle-plate for marking the gland boss

Left: Details and dimensions of the steam chest

POWER BY PADDLES . . . .

over the raised port face of the cylinder.

Setting up

After checking the distance of the gland boss centre from the inner joint face (nearest the cylinder) this should be centre-punched as a guide to setting up. It is possible to use the four-jaw chuck to hold the casting for boring the gland recess, but the use of an angle-plate on the faceplate is preferable, to ensure positive accuracy and avoid risk of bruising the finished surfaces.

A single bolt and a flat plate with protective paper packing will suffice to hold the casting (as shown in the photograph) and before attempting to centre the boss, the sides should be squared off from the faceplate as accurately as possible. The angle-plate is then shifted as required to bring the centre-punch mark on the boss exactly central for centre drilling, boring. tappine and external machining, after which the sides and back may be faced by swinging the job round to the required positions.

To complete the machining on the steam chest, the design specified a tail end guide for the valve rod,. and while this is not a necessity it is, in fact the exception rather than the rule in small engines-the avoidance of side movement which it provides takes a good deal of wear and tear off the gland, and it is generally preferable to an external front guide bearing in this respect, as the latter is often difficult to line up accurately.

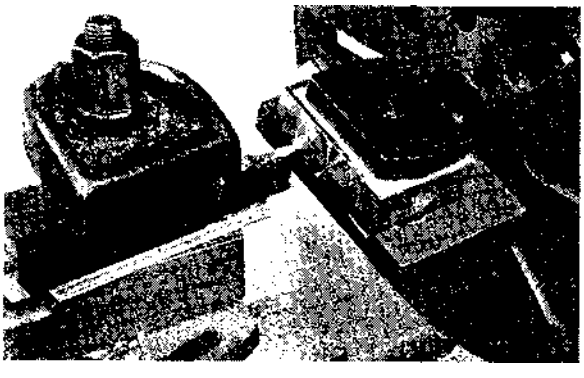
In the original design of this engine. a boss was provided on the back-end of the steam chest casting for this guide, but this must be drilled from the front end and it is difficult to ensure that the long drill, after passing right through the gland recess, will start truly on the inner surface of the frame to ensure accurate alignment of the rod. It is therefore, preferable to make the tall rod guide separate and screw it into the back face of the steam chest.

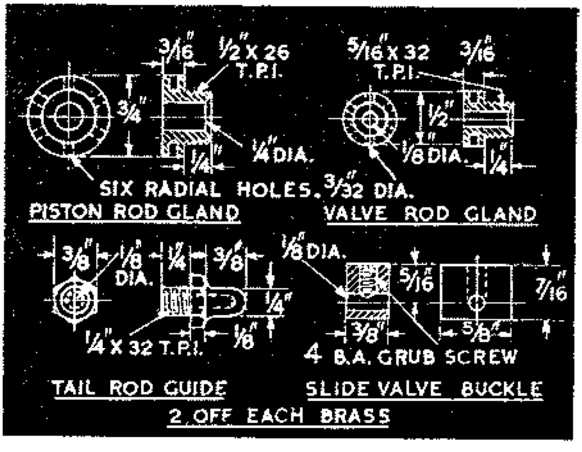
To ensure that it is properly located. the casting may be mounted on a screwed mandrel enabling the back face to be accurately centre-drilled then drilled and tapped for the tail rod guide, which is turned from hexagonal brass rod, as shown in the detail drawing.

● ***The next part of this serial will be published on January 12.***

Right: Details of the glands for the piston rod, tail rod, valve rod and slide valve

Below: Facing the sides of the steam chest

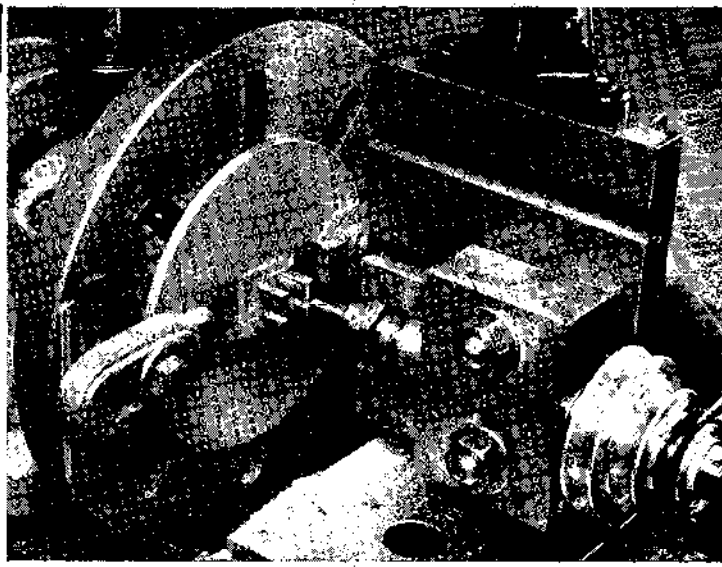




PISTONS AND GLANDS

Suggested techniques for further stages in the construction **of a** model paddle steamer

By EDGAR T. WESTBURY



The slide valve set up for milling the slots in the back, showing the use ***of a solder chuck for mounting on the faceplate***

THE NEXT COMPONENTS to be made for the paddle boat are the piston and valve rod glands; here the purists may find some grounds for criticism in the matter of fidelity, as these are not of the orthodox flanged and studded type. Screwed piston rod and valve rod glands would not be used on a full-size marine engine, but they are advisable here on the score of accessibility, and holes for a tommy bar as shown will be more convenient for adjustment than the use of a spanner on a hexagonal head.

Both glands should be machined with due care to ensure concentricity of the bore and the screwed external surface so that they do not bind or throw the rods out of alignment. The internal bevel of the glands, and also that of the recesses in cover and steam chest, may be formed with an ordinary drill, as the angle is not critical, but a special piloted cutter for these jobs will. produce a more accurate finish.

Improving accuracy and appearance

In the case of the steam chest cover, only the inner surface is really important, but the rim of the outer face should be skimmed up, not only to improve appearance, but also to provide an accurate seating for the fixing nuts. That the faces are parallel is not vitally important, but they may be made so by the same methods as mentioned above. It is advisable to mark out and drill the stud holes in the steam chest, and use this as a jig for drilling the clearing holes in the cover, the main frame plate and the tapping holes in the cylinder casting. Make sure that in each case the mating parts are the right way round and that proper identification marks are provided for future assembly.

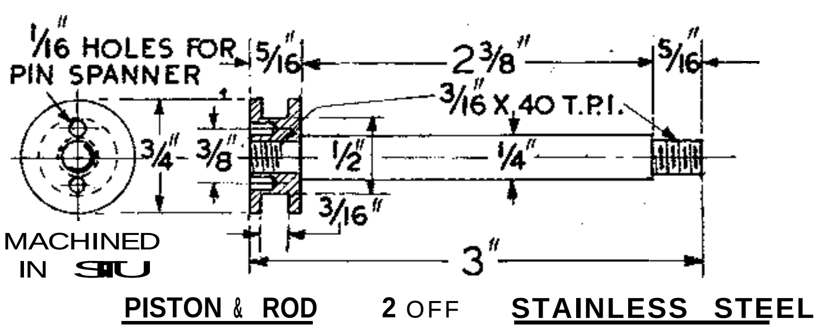
Locating holes

When spotting the holes in the frame plate, the cylinder casting should be put in position, so that the steam chest is registered on the port face, and a. clamp may be applied to hold the assembly together during this operation. Alignment of the cylinder bore with the main centreline may be facilitated by the use of a test bar long enough to extend to the shaft centre, and the aperture in the frame should be fitted to the cylinder port face so as to locate it positively in this position before drilling the stud holes.

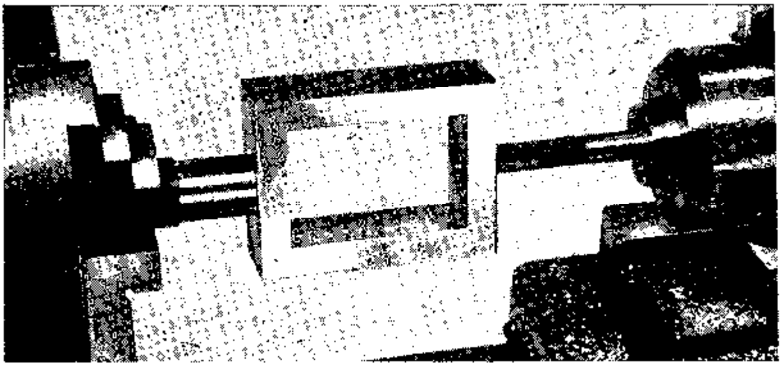
The slide valve is of conventional, design, though the method of operating it from the valve rod is slightly_ modified to enable the latter to be extended into the tail guide. A casting is provided for this item, but it could be made from the solid, or fabricated; apart from making sure that the working face is perfectly flat, it is equally important to ensure that the dimensions-of the exhaust cavity and the controlling edges at the two ends are correct.

In the casting, the cavity is cast in-it should not need to be touched but a check should be made to see that it exactly spans the inner edges of the cylinder ports at each end.. This is because when working, these ports are alternately open to exhausf, each for 180 degrees of crank movement. The outer edges of the valve, which

Details ***of*** *the piston and rod. These are made* ***of*** *stainless steel*



Left: Steam chest mounted on a screwed chucking, piece for drilling and lapping the rear face



control steam admission, are longer than the distance between the outer edges of the cylinder ports, to produce a certain amount of "lap," which means that the valve must travel some distance from its central position before either of the cylinder ports open to steam; the dimensions given (13/16 in.) give l/32 in. lap at each end.

In the original design, a greater amount of lap was allowed, but while this is good for steam economy it has been found that the engines run more smoothly, at the low speed for which they are designed, by reducing the amount of lap.

Holding the valve

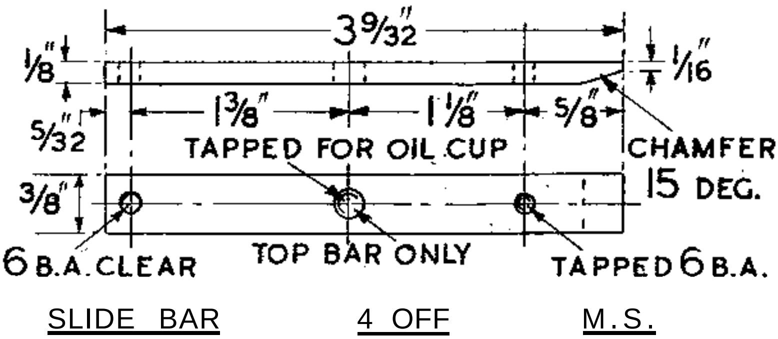
The valve may be held in the four-jaw chuck for facing the working surface, and while set up the control edges may be milled, though filing is satisfactory if due care is exercised; the important point is that these should be square and symmetrical, measured from the exhaust cavity.

For machining the slots across the back of the valve, it is necessary to mount it in the reverse position, but it is rather difficult to hold properly by orthodox methods. A somewhat unorthodox device was therefore employed, namely a " solder chuck," consisting of a flat brass plate about 1/8in. thick: a circular brass blank happened to be available (it could be of any shape so long as it is flat, of even thickness and capable of being clamped to the faceplate). The surface of this was tinned and the valve temporarily sweated to it under pressure (to ensure that it is not misplaced by an excessively thick solder film); it was then allowed to cool down.

The back of the valve can then be faced off to correct thickness and the slots milled. In this case the entire operation was carried out on the face-plate using a rotary milling spindle but if one is not available the job could be transferred to the vertical slide and the milling done by a cutter held in the chuck. The narrow slot merely serves as a clearance for the valve rod (be sure that this is located on the axis of valve motion), and the wider slot receives the " buckle " by which the valve is driven; the latter must be a free working fit but with no perceptible play. If no tail guide is used the more usual rectangular nut screwed on the end of the rod may be fitted instead of the buckle. Finally, the working face of the valve and the cylinder port face are carefully lapped to exact flatness.

Stainless steel is specified for the piston and piston rods; this avoids the risk of corrosion but, mind you, many small steam engines have been in use for years with mild-steel piston rods. Stainless steel, cast-iron or bronze may be used for the piston. The rod may be turned between centres and, if it can be chucked accurately for centre-drilling, it need not be touched on the parallel portion. Concentric truth of the threaded ends is most essential and the threads must be a good fit, that on the piston end must be definitely on the tight side and only screwed part of the way.

Dimensions of the slide bar which is made of mild-steel, four of these are required



After roughing out the piston, the centre is drilled and tapped, half the length of the hole is bored out to register closely on the diameter of the latter part, allowing it to screw right home against the shoulder; it is then screwed on tightly and permanently. If desired, the end of the rod may be burred over, or swelled by means of a blunt-ended centre-punch in the previously drilled centre hole, but if this is done great care must be taken to avoid distortion and putting the piston out of truth.

The assembly is now mounted either between centres or. in a perfectly true collet chuck for machining the outside of the piston, including the packing groove and the two lands., which should be a close but not tight fit in the cylinder bore.

Piston rings are optional

Piston rings may be fitted if desired, in which case two narrow and shallow grooves will be called for instead of one large groove; from the practical point of view, however, soft packing usually gives the best results in small steam engines working at moderate pressure and, unless made to extremely fine limits of accuracy, piston rings are worse than useless. The holes in the end face of the piston are useful to enable the assembly to be screwed into the crosshead, with the aid of a simple pin spanner.

The slide bars are simply lengths of flat mild-steel bar, 3/8 in. by 1/8in. section. If dead straight bars with true edges can be obtained, no more treatment than a rub on a strip of fine emery cloth will be needed. If it is necessary to correct inaccuracies, this may be done with a file and scraper. At the inner end, the bars are attached to the flat faces on the top and bottom of the cylinder cover boss by means of 6 B.A. set-screws (hex. head preferred) and at the outer end, to the jaws of a bracket mounted on the side of the main frame, with

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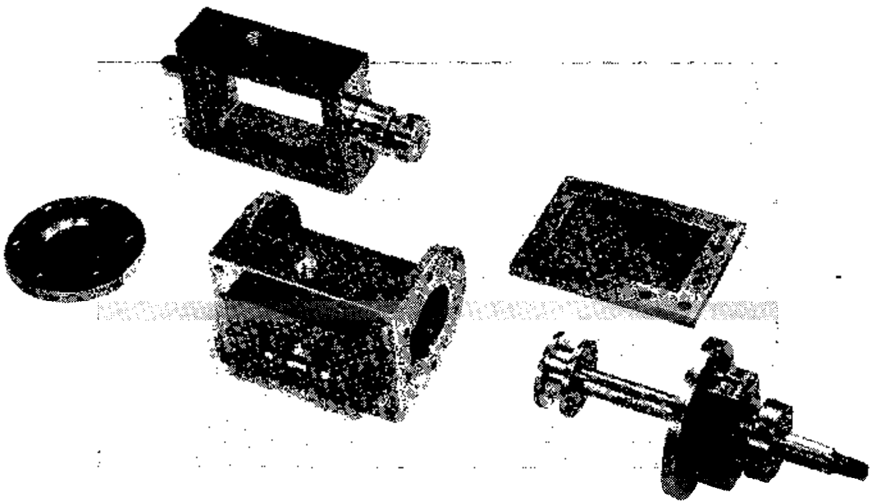


A set of components for the cylinder group assembly

similar set-screws. It is advisable to leave the drilling and tapping of these holes until the bracket is fitted, in case of any possible discrepancies in location.

The projecting ends of the bars are chamfered on the inside to give ample clearance for the connecting rod and, near the centre of the top bar only, provision is made for lubrication, preferably by fitting a small oil cup, though only a plain countersunk hole is provided in the engine illustrated.

The cylinder assembly

In the assembly of the cylinder and its attendant parts, it should be noted that alignment with other working parts is affected by the thickness of any packing material employed. It should not be necessary, however, to use thick packing anywhere to ensure steam-tightness of the joints, nrovided that the surfaces are accurately machined. For steam joints, where saturated steam or moderate superheat is employed, I have found that tracing linen makes excellent jointing material; it is tough and resilient, resists oil and water, and is only about 0.005 in. thick when compressed. With carefully lapped joint faces not even this thickness is necessary and it is possible to obtain a perfect seal with a smear of jointing . Alignment errors, if not excessive, can be corrected by shimming but it is better to avoid the need for this if possible.

The piston and valve rod glands, as well as the groove of the piston, are packed with graphite-impregnated asbestos yam, and for gland packing I have obtained the best results bv plaiting individual strands of this material and cutting it into lengths just sufficient to make one turn in the annular recess of the stuffing box. As many of these turns as will fill the space are used and the joints are staggered; a piece of tube can be used to press them into place.

For the piston packing, on the other hand, the texture of the yam should be fairly loose, so that it will pack smoothly when wound in a continuous length into the groove. Incidentally, I had a spot of bother with some graphited yam which did not bed down and produced excessive friction, despite careful running in. When the piston was removed after a period of running, the cylinder bore showed ominous-looking scratches, though they were not deep enough to be really serious.. I suspected grit in the packing but on examination it was found that there was a hard brass wire running through the strands, which had broken up and scratched the bore. A sample of packing from another source proved to be wire-free, and has been quite satisfactory.

Men, models and methods

In the course of recent correspondence, not to mention lectures and discussions at several club meetings I have attended, some pertinent comments have arisen regarding the methods of construction I have recommended for these engines and others I have described. There are, I find, many constructors-not necessarily all of the old do-it-bv-hand brigade-who " don't hold with gadgets," and question whether all this messing about with vertical-slides, milling spindles, jigs and such are really necessary. The answer is that of course they are not necessary-1 have never claimed. that they were; but they provide a means of obtaining accurate results with absolute certainty, and also, in my opinion, cut out a good deal of tedious and uninteresting work.

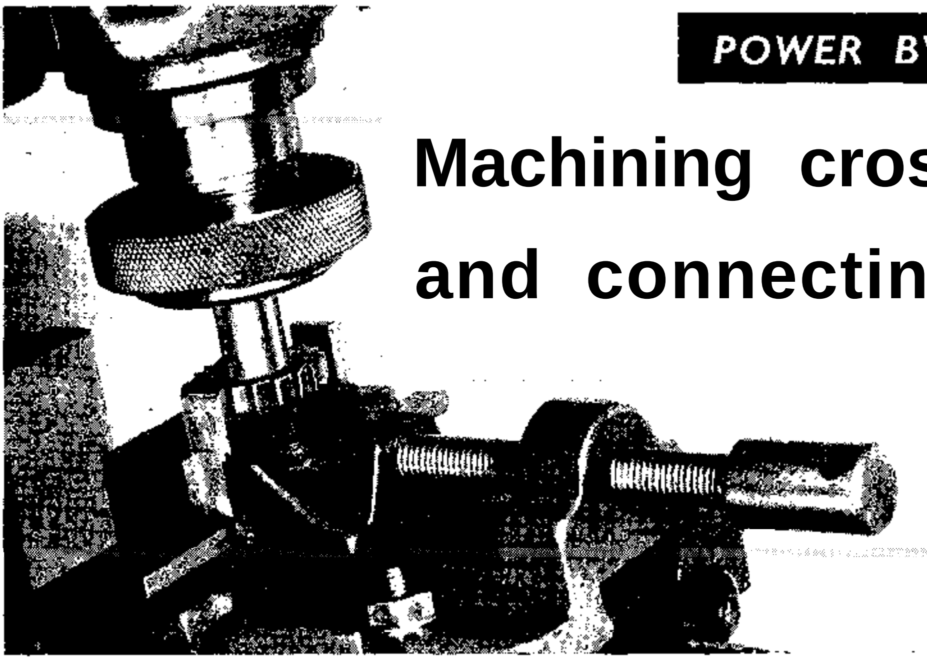
Every man to his method-there are always many ways of attaining the same end, and the methods I have illustrated show how operations have ***actually*** been carried out in particular cases, with complete success; but far be it from me to dictate to any model engineer how he should tackle his own machining or fitting problems. One of the unique attractions of model engineering is that one can make anything he pleases, in any way he pleases, and at his own convenience. So long as the methods I employ produce satisfactory results, I feel iustifled in passing them on to readers, but if anyone can show me how to improve upon them, I shall be more than grateful.

Time factor

The time taken to set up attachments or to make simple jigs may be grudged, but they usually save time in the end, as I have often vroved: and in anv case, the interest obtained from actually doing the job is a greater incentive to most model engineers than beating the clock in obtaining ultimate, results.

To produce by hand fitting, or by the minimum of machining results comparable to those which can be obtained by exploiting the inherent accuracy of slides, indices and spindles in machine tools demands a most unusual degree of manual skill; certainly more than I possess at any rate. When I wish to produce a flat or circular surface, a definite measured angle, or to devide a circle into an equal number of parts, I use machine methods where possible, and shall continue to do so unless and until someone convinces me of the error of my ways.

In his next instalment the author will deal with the crossheads and connecting rods.



POWER BY PADDLES

Machining crossheads and connecting rods

EDGAR T. WESTBURY continues his article on making a set of engines for a 6 ft. model paddle boat

THE CROSSHEADS are of the built-up " box " type, somewhat similar to those employed in certain types of locomotives. This is not, strictly speaking, correct marine epgine practice, though such crossheads have been used on paddle engines in one or two cases. The main reason for their adoption here, however, is to simplify construction by avoiding the need for forked connecting rods, which some constructors find difficult to machine.

For the main central portion of the crosshead, rectangular mild-steel bar is used and, if clean and accurate 1 in. by 3/8 in. bar can be obtained, it need not be machined on the sides and edges. In such cases, however, the utmost care must be taken in setting the bar up in the four-jaw chuck in order to ensure that the boss and the tapped hole for the piston rod are exactly central both ways.

The use of a dial test indicator will very much simplify setting up but in its absence, a check on accuracy may be made by taking a light cut over the edges at the end of the bar before turning down to form the boss. If the setting is correct, the same amount will be removed from each of the four corners, and if not, due correction can be made. The witness marks, if not taken too far along the bar, are removed when the boss is turned down. The usual care must be taken to drill and tap the hole dead truly.

Completing the fork

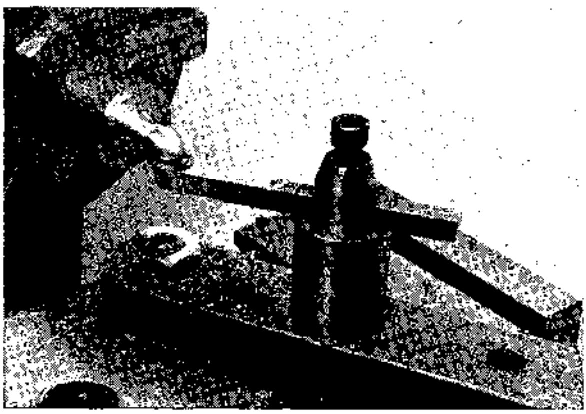
A hole 9/16 in. dia. is drilled through the centre of the crosshead-this is simply a clearance for the little end of the connecting rod and does not call for critical accuracy in size or location. It will. however. be found advisable to set the crosshead up crosswise in the four-jaw chuck, with a protecting pad over the face of the boss, and bore this hole after drilling it undersize. The fork is then sawn out and finished by filing or machining to join the hole tangentially.

The cheek plates are made from 1/16 in. or 16 s.w.g. sheet steel and are all identical in outline but differ in the drilling, as indicated on the drawing. In the example shown in the photograph, hexagon-headed set screws are used to secure the plates on either side of the crosshead, but alternatively countersunk screws could be fitted, or the assembly riveted up permanently using flush-sunk 3/32 in. rivets.

Sweating or silver-soldering is also quite practicable but excess of solder should be avoided, or the cleaning-up of the bearing faces and retaining strips will become a major operation.

Oil holes, at least as large as the screws or rivets which intersect them, are drilled through the top and bottom bearing faces and the oil grooves shown, though not absolutely essential,

Above: The slide bar bracket set up for milling the seatings



Right: Turning the spherical end of connecting rod are desirable to distribute oil all over the faces. Thev should not extend right to the corners. A scorper, or hand engraving tool, is the simplest means of cutting oil grooves for those who know how to manipulate it, but they can be produced by milling or shaping methods in the lathe.

The crosshead pin is a straightforward machining job which can be produced from steel bar at one setting and parted off, then faced on the head. Note that this pin must be a close fit in the outer cheek of the crosshead, the screwed end passing through the smaller hole in the inner cheek where it is firmly secured by a 2 B.A. nut. In normal practice, pivot pins of this type would have a " snug" key under the head to prevent them turning and I have shown, in previous articles, a simple method of fitting such keys. They may be dispensed with if the pins are made a tight push fit in the plates, and the nuts run freely on the threads.

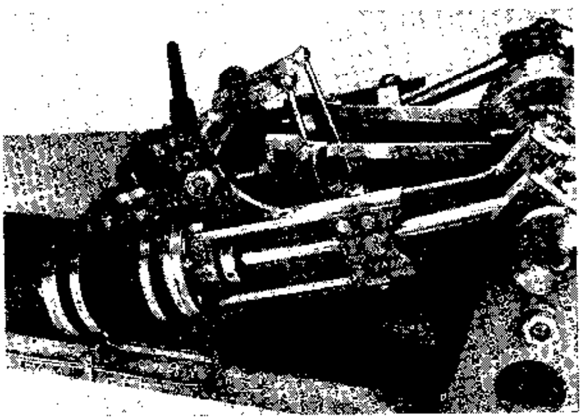
Do not slot the heads of the pins to enable them to be held while screwing up the nuts. All pivot pins may, with advantage, be case-hardened to give -maximum resistance to wear, but the risk of distortion in this process is very difficult to avoid and deters many constructors from attempting it.

Slide bar bracket

The slide bar bracket can also be made from 1 in. by 3/8 in. flat bar and the work entailed consists mainly of sawing and filing; there is not much advantage obtainable from milling or other machining processes, except possibly in forming the slide bar seatings. I understand that Messrs. A. J. Reeves have produced castings for the brackets which will undoubtedly simplify their production, but up to the time of writing, I have not seen a sample and therefore cannot say more about them.

It is most important that the location of the seatings for the slide bars should produce correct alignment with the cylinder centre line in both planes. The distance of the centre from the main frame plate should be very carefully checked, in case of any discrepancy in cylinder dimensions or to allow for the thickness of packing.

The width between the seating faces in the jaws of the bracket can be checked by measurement, or by using the actual crosshead plus both bars as a gauge. In the event of error, it is possible to fit shims to make up correct alignment, but if the need for them can be avoided, so much the better.



A close-up of the crosshead and slide bars

The photograph shows how the seatings were machined by means of a milling cutter in the lathe. After cutting the bracket to shape and size on its main contours, it was held horizontally in a Myford machine vice mounted on the vertical slide and the two seatings in turn milled by traversing the slide in a vertical direction. Note that the traverse should be upwards when working on the front seating and downwards on the further seating (assuming normal direction of cutter rotation) to avoid snatching and digging in.

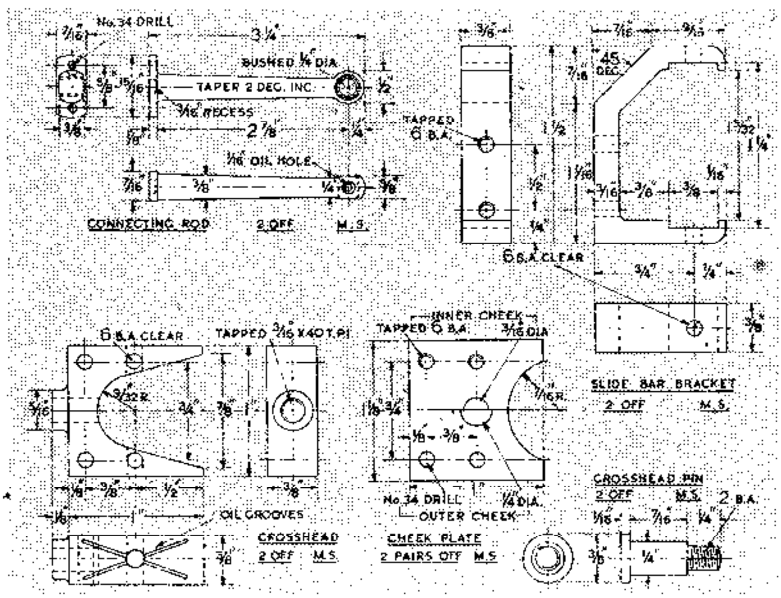
The cutter used was only half the width of the seating, so that more than one " bit " was necessary to produce the full width. but this is an advantage rather than otherwise as wide cutters do not work very well in the lathe, due to the heavy cutting stress they impose on the work.

Fixing the brackets

When fitting the brackets to the main frames. thev mav be clamped temporarily in position (so that alignments may be checked) by screwing the piston rods into the crossheads and sliding them over the full length of the stroke 'to make certain that they work smoothly and with no tendency to deflect the rod to either side. Having ascertained the proper location, the holes in the back face of the brackets can be spotted from the frame plate, then drilled and tapped.

The sequence of operations recommended for making the connecting rod may appear unusual, but they are based on experience. It has often been found that what appear to be orthodox or logical methods of machining certain components may lead one into

Dimensions of the connecting rod, crosshead and pin, slide bar bracket and cheek plates



POWER BY PADDLES . . . .

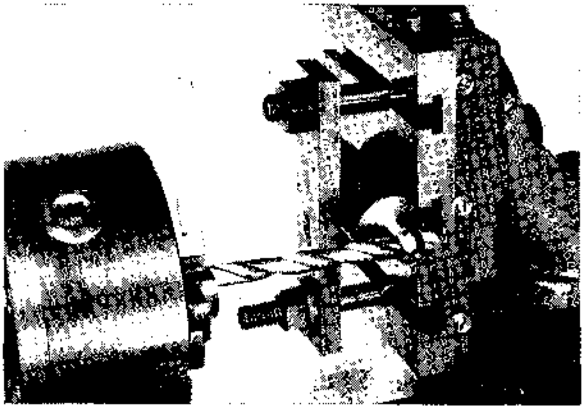
a blind alley where no positive means of locating the work for an important operation can be contrived. In such cases, the remedy is to get such operations done at an early stage in the machining before essential markings or reference surfaces are lost.

The rod is machined from solid mild-steel round bar (this will usually be found easier and quicker than fabricating it) and the first operation is to produce a parallel cylindrical bar with accurate centres at each end. It is unlikely that bar of 15/16in. dia. will be available, so a skim over a 1 in. bar after centring will be called for.

Do not drill the centre too large or deep at the end which will be reduced in size instead a 3/16 in. recess is drilled at the other end and slightly countersunk. The bar is now chucked accurately and the ball end of the rod turned to finished size.

Although spherical accuracy is not of critical importance, the use of a simple ball-turning tool, such as that shown in the photograph, will very much facilitate this operation. The neck immediately behind the ball should be reduced to finished size (or very near it) but only the minimum length of bar turned down at this stage. Check the length of the bar, measuring from the'ball centre, and correct if necessary.

The next operation consists of cross-drilling the ball exactly at right angles for the crosshead pin bearings-this is by no means so easy as it looks, if one relies on marking out and drilling in the usual way.. It can, however, be carried out with perfect accuracy by mounting the bar horizontally in the vertical slide, set at right angles to the lathe axis and adjusted to centre position by the cross and vertical feed screws'.



Details of cross-drilling the connecting rod

Accurate setting

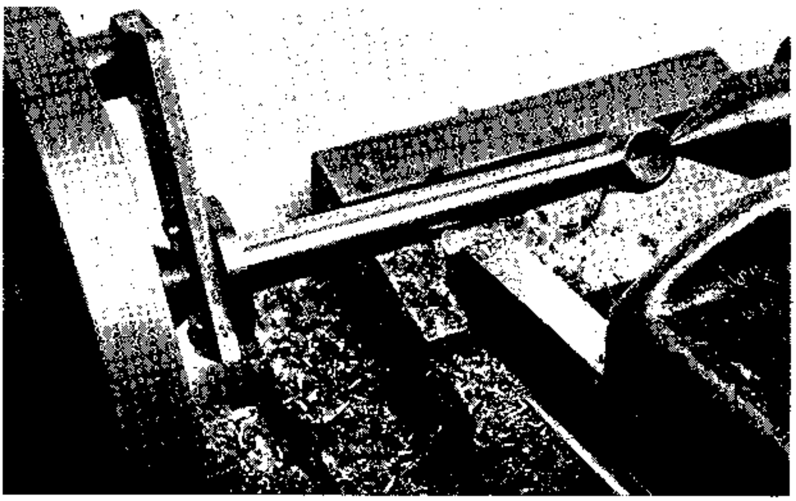
If a light facing cut with an end mill is taken over the side of the ball, it will very much facilitate accurate setting for starting the drilling operation with a centre-drill. Any inaccuracy in this respect, when the drill first contacts the work, will be seen and can be corrected before proceeding further. Drill the hole undersize, as shown in the photograph, and finish with a reamer or D-bit ; bushing is optional, but is certainly advisable unless the crosshead pin is case-hardened.

Before removing the bar from the vertical slide, a centre line should be marked out on the other end face, at right angles to the cross hole, using a square set up on the lathe bed or any other convenient method. This will enable the positions of the crankhead belts to be marked out and these may, with advantage be drilled, as they provide a means of driving the bar for the final operation of turning away the surplus metal and finishing the taper shank between centres, leaving the flange at the foot end.

An alternative method of driving the rod is to fit a bolt in the little end eye and work from the other end,; both methods have been tried, but it seems more natural to carry out turning operations from right to left where possible.

● *The next instalment of "Power by Paddles" will appear in the issue for February 2.*

The final taper turning of the connecting rod



SEVENTEENTH CENTURY RIGGING

By R. C. Anderson. Published by Percival Marshall & Co. Ltd., London. Price 25s.

Seventeenth century ships have always been popular with ship modellers. Probably one reason is that they look more like normal ships-ships that really would sail-then the galleons and caravels which preceded them. But perhaps the principal reason is the magnificence of the carved and gilded decoration which they carried. A well detailed model of such a ship is indeed something to be proud of. But the only book which gave authentic information about the rigging of ships of this period went out of print some years ago and second-hand copies reached a fantastic figure. The book under review is a revision by the author of the original book.