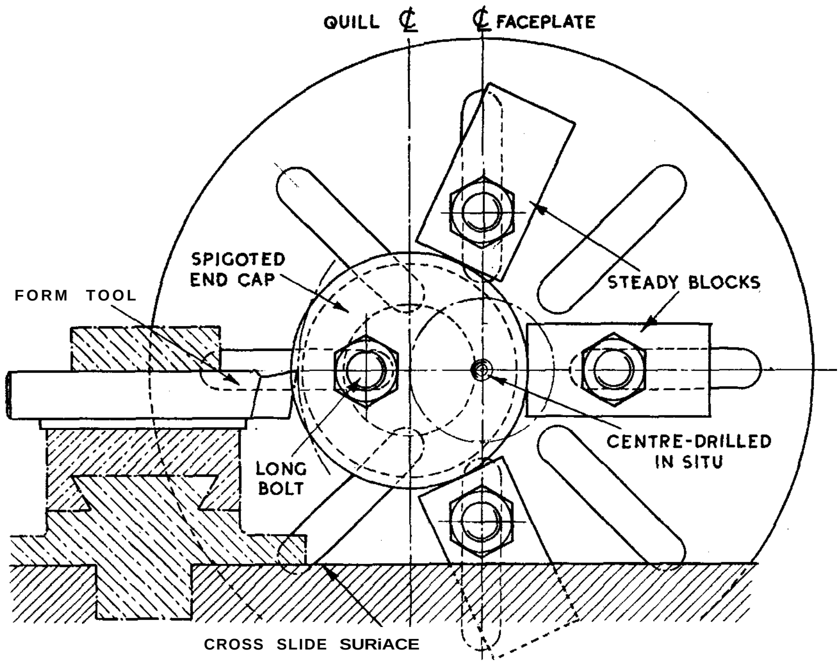
Light vertical MILLING MACHINE

Continued from May 15

By Edgar T. Westbury



METHOD OF MACHINING .RACK TEETH

How to make the components of the spindle group

DETAIL drawings of the spindle and quill were shown in the instalment for May I, on page 318, with minor group components, and the assembly of the spindle in its bearings, on page 319. A piece of 1 1/2 in. dia. mild steel bar 13 1/2in. long (to allow for end facing) will be required for the spindle. To avoid risk of distortion after the machining, you can normalise the steel by heating to redness and allowing it to cool naturally. You can centre drill the two ends, preferably in the lathe, by holding one end in the chuck, running the other in a fixed steady and then applying the drill from the tailstock. If this is not practicable, a centre-finder may be used, or the bar may be laid in V-blocks and marked out with the surface gauge, in the traditional manner, before the drilling by hand or machine.

The bar may be mounted between centres and rough-turned. to within about 1/32 in. of finished size all over. Owing to its length, there will probably be considerable spring near the centre, and this must be allowed for in sizing. By using a keen tool with a narrow cutting edge, you will be able to maintain concentric accuracy and avoid chatter. At this stage you had better check the straightness of the bar in case it has become distorted; a serious error is unlikely, but it is better to be safe than sorry. The use of a fixed (three-point) steady is considered essential to further operations on external machining.

Opinions differ whether the boring of the taper socket should be carried out before the outside of the spindle is finished or afterwards. I prefer the former method. For this operation, the small end of the spindle should be chucked truly, and the other end run in the steady. Reference has been made in ME to the tendency of work to move endwise when it is supported by a steady; this would be fatal to accurate taper boring, and must at all costs be avoided. It is nearly always caused by the incorrect adjustment of the steady pads, so that the work is forced out of true centre alignment. If the back centre is used to support the end of the bar while the radial position of the pads is adjusted and locked, no trouble should be encountered.

No 2 Morse taper is 0.599 in. per ft, equivalent to slightly under three degrees included angle (there is no point in working this out exactly, as the graduations of the swivelling slide, even on the best lathes, are rarely accurate enough to be relied upon alone, and some trial and error is nearly always necessary). The socket should first be drilled 9/16 in. dia. to a depth of 2 3/4 in., which will give sufficient end clearance for standard Morse arbors. If drills which have a driving tang on the end are to be used, the depth should be not less than 3 in. As we cannot slot the spindle to allow a taper drift to be used for extracting drills, some other means of doing so must be employed if this contingency is likely to arise. Generally it will be best to use parallel drills, cutters and arbors, held in a collet or another type of chuck which has a positive extractor.

A No 2 Morse reamer will help greatly in producing an accurate socket, but it should be used only for finishing, and not for taking out a great .deal of metal. In the lack of a reamer, the socket must be bored with a tool set exactly on centre level, and as large and rigid as possible. Well before reaching finished size, you should make tests with a standard lathe centre, or another taper-shanked tool, free from bruising or inaccuracy. Application of mechanic's blue or a similar marking colour to the gauge piece will show up errors or high spots in the socket. You must correct the errors by resetting the angle of the slide. The finished bore should be 0.700 in. dia. at the mouth.

After finishing the socket so that the gauge piece shows even contact over the full length of taper, you must carry out further machining of the spindle by locating from this bore. One way of doing so is by inserting an accurate Morse taper hollow centre, which permits the spindle to be mounted between the normal lathe centres; but for all finishing work, except screwcutting the nose, I prefer to use a plug mandrel turned in the chuck, as this gives steadier support than a point centre.

Assuming that the spindle still runs truly in the centre (if not, a fine skim may need to be taken to correct it), the steady can be set on the larger diameter to give support while the slender part is turned. It is not advisable to allow the steady pads to bear directly on finished work, except for brief operations, owing to the risk of scoring the surface; a strip of sheet brass, bent round and interposed between the pads and the work, will act as a bearing bush and prevent this. Good lubrication here is of course essential. After fmishing the smaller diameter to size, and truly parallel, you may transfer the steady to this surface for finishing the larger part, up to the thrust collar.

The fit of the ball races on the spindle is of the utmost importance. While the lower one may be made a light press fit, as its position is fixed, the upper one should be slightly easier, to allow of endwise adjustment, but must on no account have any play. It is permissible to finish the spindle with a very fine Swiss file, but lapping with a ring lap is more precise, though slower. The fine thread for the adjusting collars can be screwcut while the steady is in position; for turning and screwcutting the nose, the spindle must be reversed end for end, and supported by a truly centred plug, or a running centre. Leave a slight radius, or fillet, in all corners.

My method of cutting the four keyways at the top end of the shaft was to use a Woodruff cutter in a milling attachment on the vertical slide, with the spindle between centres, steadied in the middle as before. It was indexed in the four positions by a change wheel. The number of keyways may be increased, or the shaft splined or serrated, at the option of the constructor, but four have proved adequate to take the driving torque.

Possibly the quill could be made from a piece of the tubing used for the structural members. This is rather light and as I could not get a thicker-walled tubing I used a solid piece of mild steel bar. It was drilled through the centre, bored true, and recessed at one end while set up in the four-jaw chuck. To ensure truth of the recess at the other end, I mounted it on a stub mandrel held in the chuck. An improvised plug gauge, 0.0005 in. smaller than the outer ring of the ball race, was used for sizing the recesses.

Accurate fitting is again important at this point. Note that the face of each recess must be relieved so that the inner ring of the ball race cannot rub against it. The races used are made by Ransome and Marles, reference L JT/I ; if other makes are adopted, slight differences in detail specifications may call for modified dimensions. I have already explained that several different bearings, and methods of preloading them, are practicable.

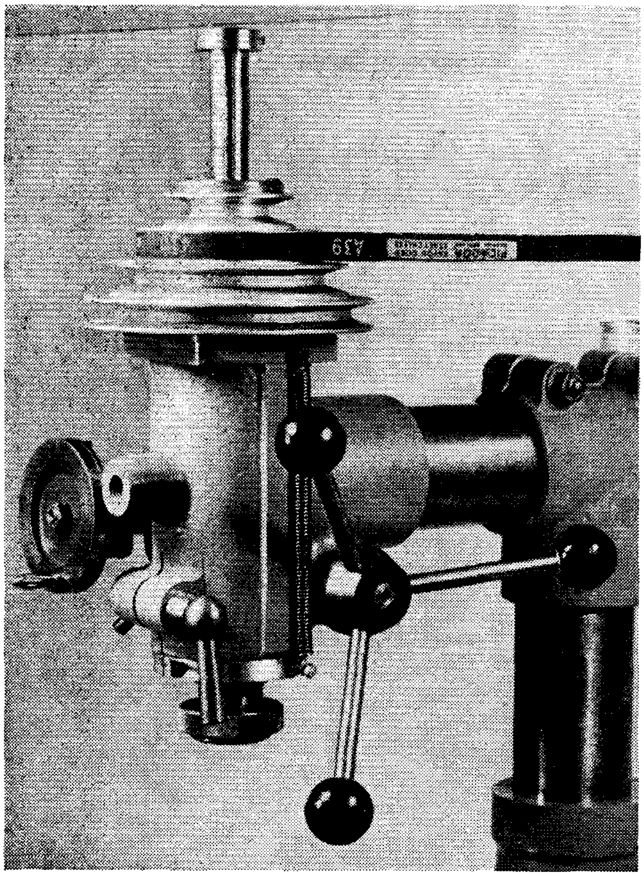
External machining of the quill, to the closest possible sliding fit in the spindle housing, is best carried out by locating from the bore on a mandrel between centres. Lapping is again recommended for final fit and finish. The rack for the vertical traverse of the quill might possibly have been easier to make as a separate part, but it would complicate the design of the housing, and would offset the thrust line further from the spindle centre, in relation to the length of the sliding surface, than might be desired. For this reason I decided to cut the rack teeth in the quill itself.

There are several ways of machining a rack. Special-purpose machines are usually employed in production practice, but a horizontal milling machine with an adequate cross traverse is quite efficient for cutting one tooth at a time with a form cutter. It is also possible to cut the teeth in the lathe, with a cutter spindle parallel to the lathe axis, traversed either across the top or at the front, on a vertical slide. But to arrange the drive for the cutter may present a difficult problem. The method which I adopted is unorthodox, and produces a convex tooth form which, theoretically at least, has relatively small bearing surface for engagement of the pinion; but it involves the minimum amount of special equipment, and the result is quite satisfactory.

You must make an end cap, preferably spigoted to fit the recess at the bottom end of the quill, and about 1/4 in. thick. A long bolt is also required to clamp the quill endwise against the faceplate, in an eccentric position. The Myford ML7 lathe, on which the actual operation was carried out, has about 2 1/16 in. clearance over the cross-slide, so that the maximum eccentric radius for the quill was only slightly over 3/4 in. For the long bolt to be anchored in the slot of the faceplate, it had to be located eccentrically in the quill, and the end cap was drilled to correspond with this, to take the other end of the bolt.

After mounting in this way, I checked along the length of the quill to make sure that it was parallel with the lathe axis.

Continued on page 421



Complete spindle head assembly

CLUB NEWS

Send news and notices to The CLUBMAN, 19-20 Noel Street, London WI

Docks trip

Reading SMEE are organising a trip to Southampton Docks, at a charge of EI per head, including lunch, on July 25. The trip will start from Reading by train, and the tour of Southampton Docks will be by coach. A welcome is extended to other clubs who would like to go along. Those interested should contact the secretary, Mr G. Shayler, at 14 Westwood Road, Tilehurst, Reading.

The club is now pressing ahead with the arrangements for the 1964 summer, and the live steam section has a full programme of events to attend. The 00 gauge is being extended and will be displayed.

A meeting is held every Thursday evening, and once a month a talk or a film show is given. Anyone interested in visiting the club or exchanging ideas should contact Mr V. P. Anger, rag Alpine Street, Reading.

Chairman's sudden death

Chairman of Perranporth and District MES, treasurer of Redruth Gladiator Club and a member of the West of England TES, Mr Richard Ewart Bawden of Camborne, Cornwall, died suddenly at the age of 63. These organisations were represented at his funeral held at the Wesley Chapel, Cambome.

MPBA National Regatta

The annual National MPBA regatta will be held at Witton Lakes, Birmingham on Sunday, June *7*, at 10 a.m. Both these excellent lakes will be used for the event, which is really three regattas held together.

There will be competitions for radio control, free-running craft and hydroplanes, and for the beat performance in each class the winner will hold a cup presented by the City of Birmingham for a year and he will retain a miniature.

Hydroplane enthusiasts will also have the opportunity to compete for the Ayrshire Cup, presented by a member of the pre-war hydroplane school, Mr Rankine of Glasgow, for standing-start hydroplane races.

The venue is most suitable for this event, but the support given last year was disappointing particularly by owners of free-running boats, and it is hoped that better support for the regatta will be forthcoming. Negotiations are proceeding to obtain the attendance of a tea bar and soft drink bars, but the area is well suited for a picnic and if the weather is dry cars can be parked overlooking the lakes.

Posthumous award

Birmingham SME Cup Competition Day was held recently. There was only one entry for the Picknell Cup, which is for finished work. This was awarded posthumously to Charlie Cockayne, who had put the finishing touches to his 5 in. gauge 0-6-0 PT *Speedy only* a few days before losing his life in a motor accident. Other members who had intended to compete withdrew as a gesture of respect, it being felt that this was the best way to pay tribute to Mr Cockayne and his painstaking work.

There was a good number of entries for the Lehmann Cup, for unfinished work. It was won by Bill Finch with his fine 5 in. gauge LNWR 2-4-o *Precede&.*

Diary dates appear on page x in the advertisement section.

MILLING MACHINE *Continued from page 403*

Error is unlikely unless the mounting face is untrue; it could be corrected by a slip of thin paper or metal foil under the face at front or back. To prevent any risk of movement, you may bolt steady pads to the faceplate in contact with the quill, as shown. They may be made from fairly heavy bar, as they help to act as balance weights, but neither they nor the bolts holding them must project far enough to interfere with the traverse of the cutting tool. Balance is not critical, as the lathe cannot be run very fast for this operation; bottom direct drive is the maximum, and some cautious readers may prefer to use back gearing.

To *be continued*

SHAKESPEARE'S SHIPS Continued from page *409*

from 2.3 to 3.0 for large ships and reached as much as 3.9 for the small. As we also have the length of the overhangs fore and aft, we can easily calculate the overall length of the ship from the keel-length. Taken together, the overhangs were two or three feet longer than the ship was wide. The depth in hold, throughout the Navy, was about half the breadth.

In the pursuit of these clues all the work has already been done for us. But there is still plenty of detection which the serious modeller can undertake on his own; indeed, he is often compelled to undertake it if his model is to be more than a general representation or a guess. And he will tell you that it really is fun fmding out. JOSEPH MARTIN.

HYDROFOIL *Continued from page 413*

from the water progressively as the boat gains speed. The other is that the foils should remain submerged at all times but should rise just near enough to the surface of the water to lift the hull clear.

The second system, excellent in theory, obviously needs some system of control over the angles of the foils for the boat to be " flown " through the water in the same way as an aeroplane is flown through the air. An auto-pilot which wuld sense the movement of the waves and continually adjust the angles of the foils would solve the problem, but its design would be entirely complicated.

It is also possible that some mechanical device could be developed to achieve the same object. As early as Igo6 one proposal was put forward by an American, William Meacham, for a system employing a long arm to reach forward from the boat and support a small 'I sensing " foil which would skim across the surface of the water. As the wave ahead of the boat rose, it would affect this foil, which would then react through a system of linkages to make compensating adjustments to the main foils beneath the boat.

Although the problems involved in achieving stability by mechanical means were the subject of much experiment, many felt that the secret of success lay in the design and placement of the ladder foils, which had already proved to be efficient. There were many variations in the type and placement of the foils. Some boats had a single tier of foils and others had multiple tiers.

To be continued