SALLY

Connecting rod and crosshead

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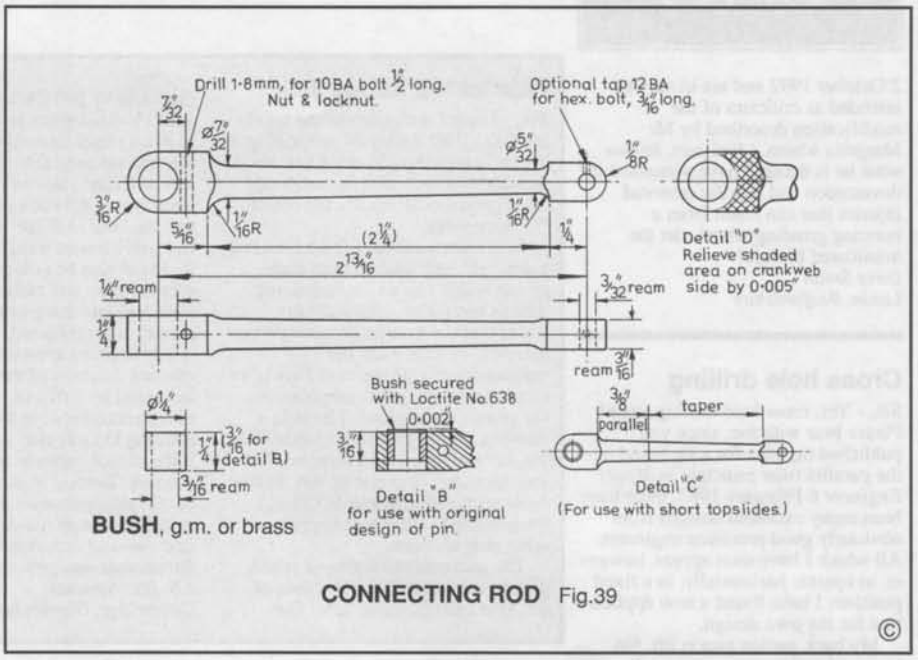
details the machining of the crankshaft, discusses the making and use of filing buttons and describes how to ensure that the crosshead functions properly.

● *Part VII continued from page 76 (15 January 1993)*

We regret the error which appeared in Fig.35. The crankshaft and crank-web should be screwed with the same thread, 3/16in.x32tpi for preference)



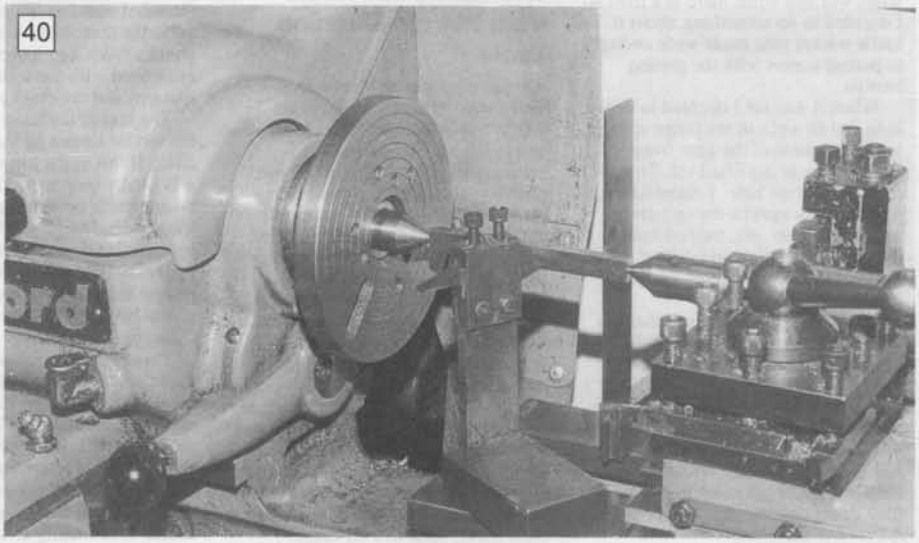
CONNECTING ROD Fig.39

Connecting Rod

Part 10, **Fig. 39**. This drawing differs in detail from those sent out with earlier kits, but the procedure is the same. You will see that I have shown a brass bush. I strongly recommend this whether you adopt the revised crankpin mentioned previously or are using the original slotted screw design. (Detail **B, Fig. 39** shows this arrangement). You will also see that I have added some embellishment. The bolt through the large end simulates a common type of bearing fixing, whilst the setscrew at the small end locks the crosshead pin in place. Don't worry if you have no screws of suitable size - you can leave them off.

Start by cleaning up the material provided, drawfiling it lengthways, then set in the 4-jaw chuck with about ¼in. projecting, and adjust to run truly. This can be done by advancing a tool until it just touches the work, noting the index reading, and repeating after turning the chuck through 180 degrees.If you do this carefully you should be able to get it running within a thou. Face the end, and then use a slocumbe drill to put in a small centre. Repeat for the other end, which should also be set to run very true.

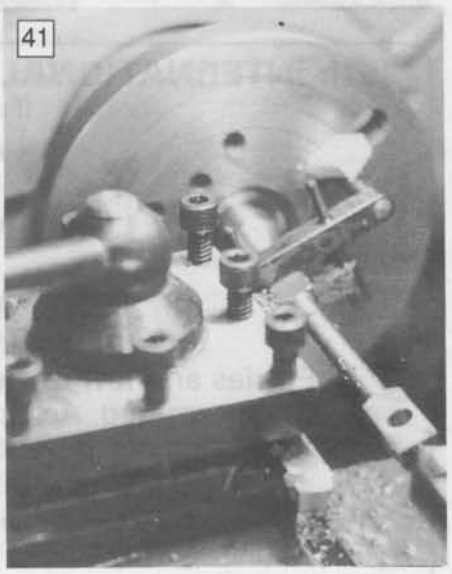
Now check that your topslide has sufficient travel to cover the length of the taper section. If so, well and good. If not you will shortly have to set your tailstock over. However, there is an alternative, shown at **C Fig. 39**. It was not uncommon for engine designers to use rods of this shape. But don't set over either topslide or tailstock just yet. Set the piece between centres (don't forget to clean the taper sockets thoroughly) and then, using a square to set the side upright, scribe a centre-line on both sides. Make sure that your scribing block is set dead at centre-height *as it actually is on your lathe*. "3½in." may in actual fact be from 3.496 to 3.505in.; there is always a tolerance on such dimensions. In **Fig. 40** I am using my combined tool-setting gauge and centre-height scriber.



40: ***Marking out the connecting rod blank, the try square at the back ensuring that the face is vertical. The Author is using his combined tool height setting gauge and scribing block.***

Remove from the machine and mark out for the longitudinal position of the holes. Scribe lines across too, to show the position of the end of the turned section - 3/16 and ¼in. from the hole centres. Then mark out for the two holes at 2 13/16in. centres.

Lightly centre-pop and then check with dividers that this pop is dead central between the sides of the rod. If not, adjust it until it is. The **line** may have been central, but there is always the possibility of the punch running off. Enlarge the pop with a small drill - I usually do this with a hand-drill. Now, take care. It is important that the two holes run squarely through the material, but even more important that they lie parallel to each other. If you have a vertical slide it is worth while setting this up, holding the stock in the vice and drilling from the headstock. You can then check squareness very easily. However, it can be done on the drilling machine if you have a reasonable drilling vice. Set a piece of parallel (check it) packing underneath. You will be drilling into this, so don't use a precious piece of ground parallel!. Drill 2.3mm dia. at

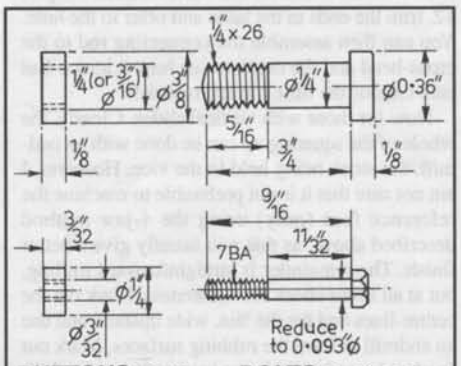


41: ***Roughing down the connecting rod shank. Note the wooden wedge to prevent the carrier rattling in the slot.***

both ends, and then enlarge the large end to 6.2mm dia. Remove the packing, put the machine on the slowest speed, and ream through ½in. and ¼in. dia. using plenty of cutting oil.

Set between centres on the lathe, with the carrier on the end with the smaller hole. Use a pointed tool with a small - about 1/64in. - radius on the end and at least 12 deg. of back rake to rough turn the shank down to a shade under ¼in. diameter; take the final cut at a relatively fine feed - use power traverse - and stop about 3/32 in. short of the marks at each end **Fig. 41**. Now prepare a straight round-nose tool with a nose radius of about 1/16in. and, with 12 - 15 deg. of back rake. Hone to a keen edge and set it exactly at centre-height. Use as stiff a section as you can to cope with the overhang - mine was 3/16in. square - as the topslide handle may otherwise foul the tailstock. Then set the saddle in a position which will allow the topslide to traverse the full length of the turned shank and lock it there. Set over the topslide to turn the taper, small diameter at the headstock end. Do this by trial to give about ½in. difference - 1/16in. on the diameter that is. Use a dial indicator if you have one; if not, employ the cross-slide index as you did before. (The taper is not critical). Lock the angular adjustment securely, and lock the saddle.

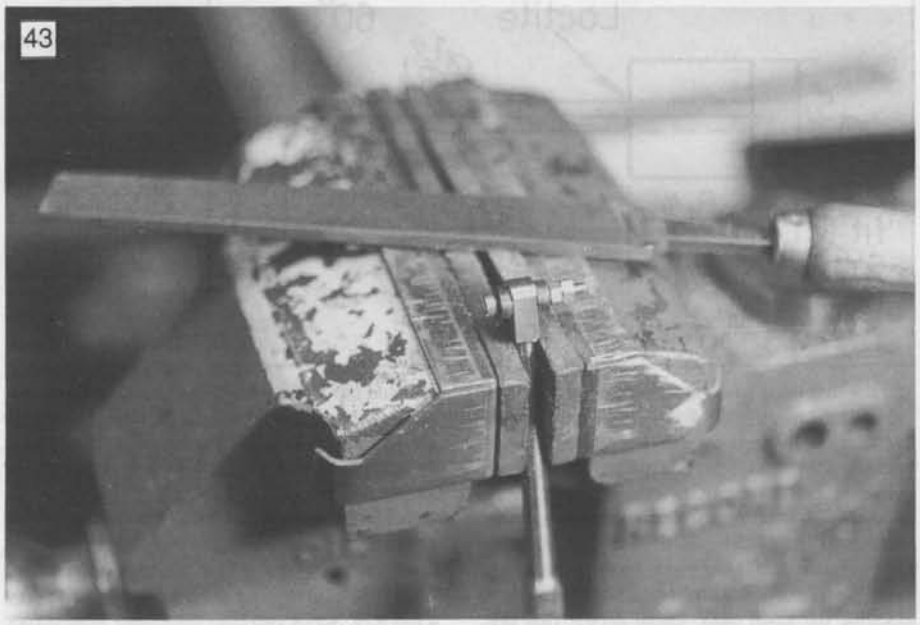
Start by forming radii at each end, back to the marks, but going in no deeper than the rough turned diameter, using light cuts. Then advance the tool to start turning the taper, commencing work at the headstock end and taking cuts of about 5 thou at a time. If you experience any signs of chatter *at all* first check that the tailstock centre is properly adjusted; then that the tool is securely held; and, if all else fails, reduce the speed. (I ran at 300 rpm). Use cutting oil, of course, and arrange this with a drip feed, since you need both hands to turn the handle. Carry on until the cut travels full length, then start checking the diameter. When you get to within ten thou of the drawing size take out the tool and re-hone it with a fine India oilstone. Reduce the depth of cut to two thou, with as fine



BUTTONS: 2 off each. Silver stl. **BOLTS:** 1 off each Mild steel

FILING BUTTONS Fig.42 ©

a feed as you can manage but a *steady* feed is more important than fineness. The exact diameter is not critical to the odd thou or so, and if you get a really good finish but are still a trifle oversize, leave it at that. Don't go "chasing skylines"! Now change to a knife-tool, reverse the work in the centres, and turn a small pip 0.187in. diameter at the small end. This is to act as a gauge when reducing the width there.



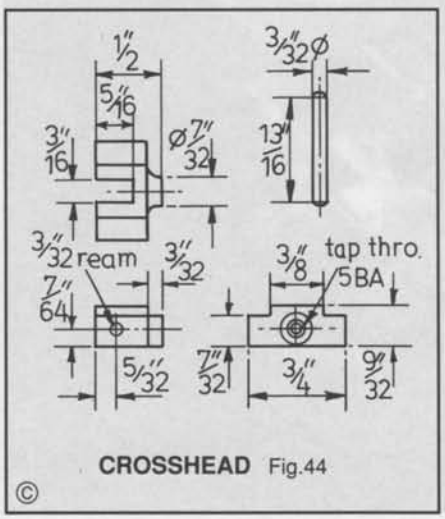
43: ***Filing buttons in use on the small end of the connecting rod.***

You will now need to make two pairs of filing buttons **(Fig. 42)** to enable you to form smooth radii at the two ends. These can be of mild steel, but I generally use silver steel and harden them. Not essential, but they may well come in handy on other jobs in the future. The buttons are drilled 0.1mm undersize and then opened out with the correct size drill - there is no need to ream them. The large pin can be a ¼in. dia. bolt, if you have one, which is a good fit to the hole in the connecting rod; the smaller is a 7BA bolt, set in the lathe and filed down to fit through a ½in. dia. hole. To harden the rollers, thread them on a wire, heat with a small blowtorch until they reach cherry red - about the red colour sometimes used for the title on the cover of *Model Engineer*. Hold at this temperature for a minute or so and then quench in oil. Cooking oil will do if you have no proper quenching oil. There is no real need to temper them but you can ease the brittleness enough for our purpose if, when you take the job out of the oil, you again hold it in a soft blowlamp flame until the oil takes fire before re-quenching.

First reduce the thickness of the small end until it matches the pip you turned. You can do this in a vice on the vertical slide if you like, but it is almost as quick to file it. Work on alternate faces, taking care not to let the file slip onto the turned shank. Finish by drawfiling. Then saw off most of the surplus metal at each end. My photo, **Fig. 43**, shows the filing buttons in use. Work with a coarse file at first, then change to a finer one as you get nearer the profile. Use a rocking motion on the file, which must be wide enough to lap over both rollers. As soon as you get down to size the file will run on the rollers and stop cutting. It does need a little contriving to get a nice sweep to the file, and if you have a smaller vice it will help to use that. Once done you may have to do a little final trimming by eye, especially if the hole is a fraction off the centre-line. (In making such components I always use oversize stock, but that supplied is exactly to dimension at the large end).

The bushes should present no problem. I find that ¼in. dia. drawn brass is a nice fit to a reamed hole and can be secured with Loctite 601, so there is no need to turn the O.D. (But lightly roughen it with fine emery). Drill 4.7mm and then part off a shade over length. Set in place with the glue, allow to set, and then put a 1/16in. reamer through. Finally, file the width until it is 0.002in. less than the length of the steel bush on the crankpin. Or, if using the original design, simply part off the bush to 1/16in. long, set it in place flush with the inside, then ream. Finally, drill the holes for the 10BA bolt and drill and tap for the 12BA setscrew at the other end. (You can use 10BA here too if you have no 12BA hexagon head screws).

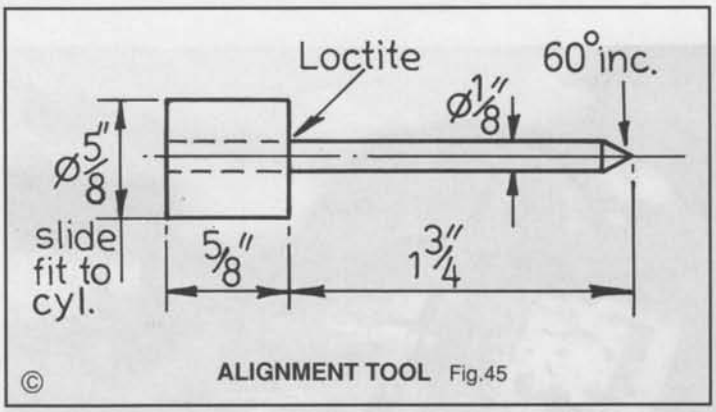
Finally, offer up to the crank and check that the rod rotates freely. You may have to ease the rod end on the inside as shown in my sketch, **Fig. 39d,** if it rubs too offensively on the crankdisc. If all is well, go round removing sharp edges and clean up any obtrusive file-marks. Don't use emery if you can help it - drawfiling with a fine file is much better.



CROSSHEAD Fig.44 ©

Crosshead

Part 11, **Fig. 44**. This is a case where a vertical slide proves its worth, but I will first deal with the situation facing those without one. The piece of stock provided has been sawn from brass extrusion



© **ALIGNMENT TOOL** Fig.45

and the first thing to do is to form a flat reference face. Set the piece in the 4-jaw chuck with the flattest face inwards and tapped back against parallel packing with about ⅛in. protruding. Machine off 1/16in. and then reverse in the chuck to clean up the opposite face to bring it to 9/32in. thick; not a critical dimension but a little thicker rather than thinner for preference. Using packing to protect the machined faces, set endways in the chuck to machine the sawn ends. Clean up the first one, then reduce the length to ¾in. or a shade over. Rechuck, again with packing to protect machined faces, and clean up the remaining faces, reducing the block to a shade over ½in. long.

You will now have to make a little device as shown in **Fig. 45**; this will enable you to mark the centre of the piston-rod hole and its boss accurately in line with the cylinder. I found that a piece of ⅝in. BDMS was a nice fit in my cylinder - it need not be close - but make sure there are no burrs. The length is not important so long as it is more than ½ inch. Chuck in the 3-jaw and drill ⅛in. x ½in. deep. The rod is best made from silver steel. Turn a sharp 60 deg. point on one end and then hone it with an oilstone. There is no need to harden it, as it will only be used the once, and that on brass. Attach the front (gland) cover and insert the device with the rod through the cover. Hold the cylinder firmly on its seating and offer the crosshead to the point, sliding on its guides. Mark the front (where the boss will be) and both sides. Check that this mark lies reasonably close to the 7/64in. dimension called for on the drawing, but even ten thou error will not matter too much. Determine and mark the centre crossways, in way of the boss.

Set the crosshead in the 4-jaw - again, I repeat, with smooth packing to protect machined surfaces - and centre the cross-lines as close as you can. Centre, and then drill and tap 5BA, at least 1/16in. deep. Take a skim off the surface and then form the boss. Don't forget, by the way, to guide the tap from the tailstock drill chuck. This thread is important. *Lightly* countersink the hole.

We are now faced with the job of making the two rubbing faces, shown as 1/32in. thick above the bottom reference face. This can be done by filing, but it is helpful to have something to work to. Try it this way. Scribe two lines diagonally from corner to corner, and put a tiny pop-mark where they cross. Scribe two lines to indicate the ⅜in. width of the upstand - these will be 1/16in. from each edge. Set in the 4-jaw (with protective packing!) with a parallel behind to allow the work to project so that 1/16in. lies within the jaws. Set true to the centre-pop, tapping the work back from time to time. Set a *right* side cutting knife tool with the edge parallel to the lathe centres. Adjust the cross-slide until the point of the tool will just clear the corners of the workpiece, and note the index reading. Check this several times.

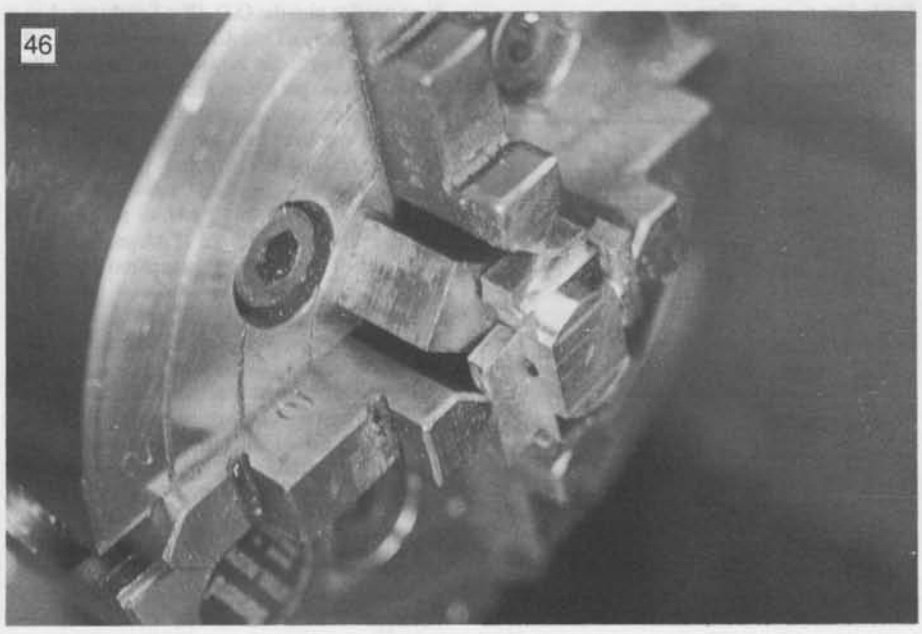
Lock the saddle and advance the topslide until the tool just touches the surface. Note the index reading. Machine down with light cuts and slow feed so that the cut leaves a part-circle just missing the corners of the ⅜in. wide upstand. The final cut should be at 0.062in. on the topslide index, and should be very light at a very slow feed, **Fig. 46.** You now have much less to file away and a witness surface to file down to, the metal to be removed being in the form of two partial half-moons. To reduce the risk of filing too much away, set the piece in the vice with two strips of steel on each side, the tops of these being at, or very slightly above, the level of the face you have machined. You can also ease matters by using a fine saw to delimit the scribed marks ⅜in. apart. Then it is no more than a case of care and patience, using a file with one safe edge. When you get to it, keep checking the ⅜in. width upstand, both for width and for squareness. So far as the surface is concerned, when you get down to the last thou or so, use a fine needle file to work on the half-moons only; it is better that these be below surface than that the machined surface be damaged. Finally, check and make a note of the nominal 7/32in. dimension. You will need this figure when you come to make the spacers, part 46.

Now for the slot. Mark out for it and then drill 4mm just inside the lines at the root of the slot. Carefully saw down to this hole, then use a warding file to bring the sides almost to the scribed lines. Square off the bottom of the slot, again leaving the line as a witness. Next, draw some more care and patience from the stores, and a fine-cut swiss file if you have one, to bring the slot to about 0.005in. wider than the small end of the connecting rod. This is not critical, but there *must* always be side clearance at the cross-head end of any connecting rod. To be frank, however, this is a case where the slot must look right, for it is a very obtrusive part of the engine.

For the cross-holes there will be the lines scribed from the cylinder which should take precedence over the 7/64in. dimension. The hole should be 1 1/32in. from the face of the boss, but this is a very small area to support the work whilst marking out. Check the nominal ½in. figure, adjust as need be, and scribe both sides. Use a magnifier to pop the centre on both sides. Then drill 1.5mm from each side into the slot. Follow (preferably) with a 1/16in. reamer if you have one, taken right through; otherwise use a 1/16in. drill. Follow again with a 2.3mm drill right through and, finally, with a 9/32in. reamer or drill. Cut off the 9/32in. material for part 12, trim the ends in the lathe and offer to the hole. You can then assemble the connecting rod to the cross-head and the crank to see how it looks. But take care of the little pin afterwards!

Now for those with vertical slides. Clearly, the whole of the squaring up can be done with an end-mill, the stock being held in the vice. However, I am not sure that it is not preferable to machine the reference face (only) using the 4-jaw method described above, as this will usually give a better finish. The remainder is straightforward milling, but at all times check for squareness. Mark out the centre-lines and for the ⅜in. wide upstand and use an endmill to form the rubbing surfaces. Mark out for the slot and cut this out using a 1/16in. slot drill. This may need widening with a fine file, but do that later. Clean off all burrs, and then use the marking device of **Fig. 45** to locate both the 5BA thread and its boss and the cross-pin holes. Set up in the 4-jaw (protective packing again!) to machine the boss and drill and tap the hole. Then drill the cross-hole using the vice on the vertical slide, drill in succession as previously described, checking very carefully that this hole will be square to a test-rod screwed into the boss.

● *To be continued*



46: ***Forming a machined witness face on the crosshead as an aid to filing.***