Light vertical MILLING MACHINE

FEEDSCREWS and HANDLES

Continued from May 1

By Edgar T. Westbury

HOWEVER accurate the main machining, you will almost certainly need to do some work on the slides so that they will be smooth and will bed in properly. While slideways grinders are used in industry, the amateur must rely on the art of hand-scraping. The essential of success in this process is patience, as the work always involves a good deal of trying and testing which cannot be hurried.

A fiat scraper of the normal kind can be used on the relatively broad surfaces, but for getting at the dovetail surfaces the best tool is a triangular scraper with one corner ground off to an acute bevel. Both can be made from old files. You may be able to grind them to shape without letting down the temper, but generally the best course is to anneal them. Bring them to red heat and cool them as slowly as possible (as in ashes or lime). Then, after grinding, filing or forging them to shape, re-harden and temper them, at the tip only, to a light straw colour. It is better to remove the teeth of files completely when re-hardening is involved, or they may form a focus for cracks. The edge of a scraper should preferably be thin, as a thick scraper will not reach into a corner, and it should be kept keen by the honing, on a fine grade oilstone, of the flat face and front edge.

A test slip for the dovetail slides may be made from a piece of flat steel, with its edge machined to the slideway angle. The truth of both faces can be tested on a surface plate. To check the parallelism of slideways, clamp two round bars, such as lengths of silver steel rod about 3/8 in. diameter in contact with the V angles, and take a measurement over the outside of them by a micrometer. The inside dovetails need to be hand-scraped only on one side opposite the gib strip, and the clearance surfaces do not need scraping at all, except for the sake of appearance. But the top and sides of the milling table should be scraped to a close limit of flatness,, as tested on a surface plate. Note that any parallel error between the table top and either its own slideway or that of the cross-slide will result in untrue machining of any work bolted to it unless it is packed up and individually checked for each operation.

Holes for the gib adjustment screws are drilled in one side of the cross-slide and the milling table. Before tapping them, assemble the respective slides with the gib strips in position, and pass the tapping drill through each hole in turn and into the strip, to the depth of the point only. The object is to locate the gib strip so that its position in relation to the moving slide is fixed. A hand drill can be used. YOU will generally find it best, after dealing with one hole in each slide, to tap the hole and fit the screw so that there is no risk of the gib's shifting between the drilling operations. The gib screws should be long enough to allow locking nuts to be fitted; apart from this, unnecessary projection should be avoided.

It remains only to drill and tap the holes for the feedscrews in the cross-slide and bolster. If square thread screws are fitted as recommended, a special tap will be required. There would be no real objection to the use of V threads for these screws, except that standard screw pitches are not very convenient for indexing. Yet another method is to make flanged nuts to take the feedscrews; some modification may then be needed in the location of the screw and its bearing position.

The castings for the feedscrew bearings may be chucked over the circular front boss, faced over the seating flange and inner boss face, and drilled and reamed, all at one operation. A stub mandrel may be used to mount the casting for machining the front of the boss and skimming it over the outside; the skimming is not absolutely necessary if the surface is clean enough to take a legible index mark at the top. The shape of the bearing is designed to give just that little extra length of traverse compared with the more usual flat bearing or keep plate.

Alignment of feedscrews

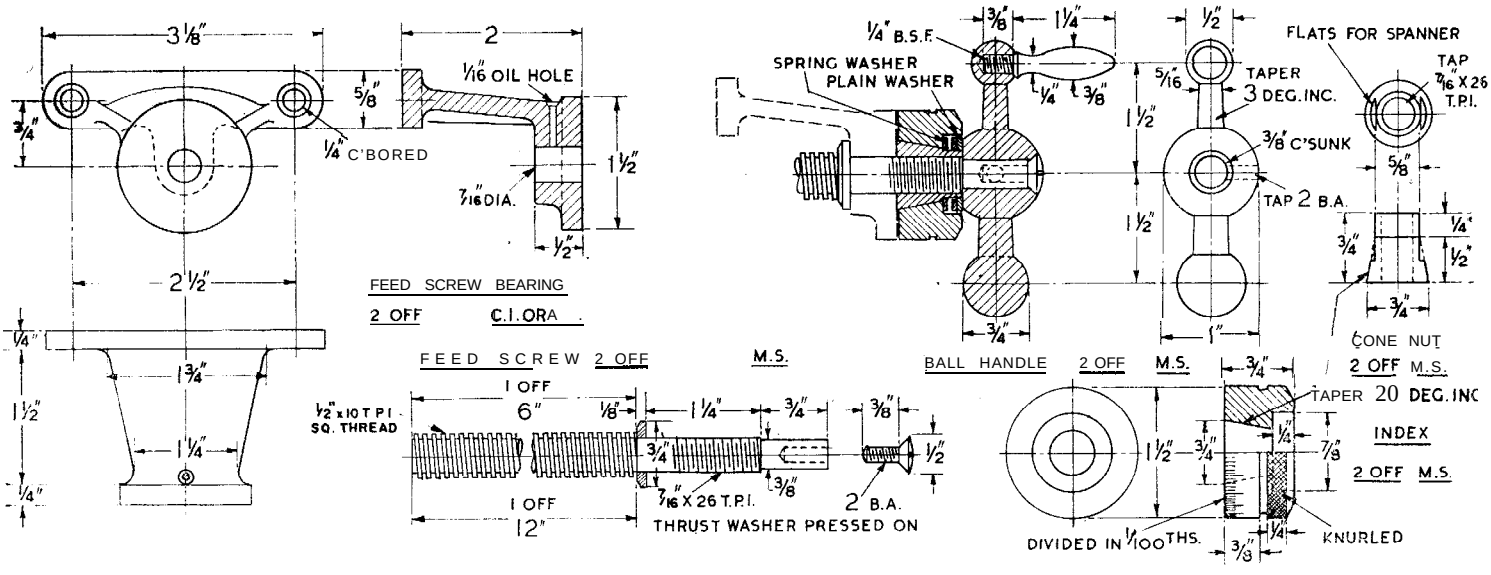
After drilling the fixing holes in the seating flange, locate it on the face of the slide by fitting the complete assembly, with gibs adjusted and feedscrews far enough in to allow the bearing to be brought into contact with the face. The screw holes can then be marked or spotted for location; if the tapped holes or nuts for the feedscrews have been accurately located the screws will be in correct alignment at any position of slide travel.

Machining the feedscrews is a normal exercise in screw-cutting. Owing to their length and especially the length of the table screw, the fitting of a travelling steady will be a necessity. You may use a piece of 1/2 in. bright mild steel bar, if it is quite straight and true and is centred truly at each end, with the thrust collar either pressed on tightly or brazed before the final machining, instead of turning down the main length of the screw from 3/8 in. diameter, a tedious and wasteful process.

The tool employed for cutting the square thread should be ground to a width of half the pitch, I/ZO in., or 0.050 in. with the barest amount of clearance for pitch angle on the leading side, and none at all on the trailing side. The front clearance can be the normal 5 to 71/2 degrees, and top rake up to 15. If you employ a properly adjusted travelling steady with hardened V contact surfaces, and lubricate with

soluble oil, the going should be easy, and the amount of feed at each pass may be constant, about 5 thou, up to the full depth of 50 thou. If you need to make a tap to cut **the** square threads in the slides, you should use the same screw-cutting tool, but the crest diameter of the thread should be two or three thou greater and the root smaller by the same amount. Make the tap about 3 in. long, with a gradual taper and three or four deep flutes, for easy cutting. Silver steel, hardened in oil, is suitable for the tap.

The indices and handles for the feedscrews can be modified according to convenience and preference. You may buy them ready-made, and perhaps you can get complete feed-screws in standard sizes and lengths. There is also much to



be said in favour of disc handwheels with index markings on the edge, giving a very plain and legible reading; but the ball-type handle with separate index is generally preferred. Sometimes the index is simply tapped and screwed on to the shaft of the feedscrew, with the handle also internally threaded, locked against it. This is usually satisfactory for light torque load, but as the index is fixed relatively to ***the*** handle, many users find it inconvenient.

With the arrangement shown in the drawings you have a ready means of thrust adjustment, and also of moving the index, without any serious constructional problems. A conical steel nut, with spanner flats on two sides, is screwed on the feedscrew shaft to take up end-play in the bearing, and is locked by the hub of the handle, pressed against it by a countersunk end screw. The index is bored to fit the conical nut, and is recessed at the back to take a double-turn spring washer, backed up by a plain washer. This allows the index to be frictionally adjusted, while it is secure enough for there to be no risk of inadvertent movement. The plain washer may be varied in thickness to provide just the required amount of friction.

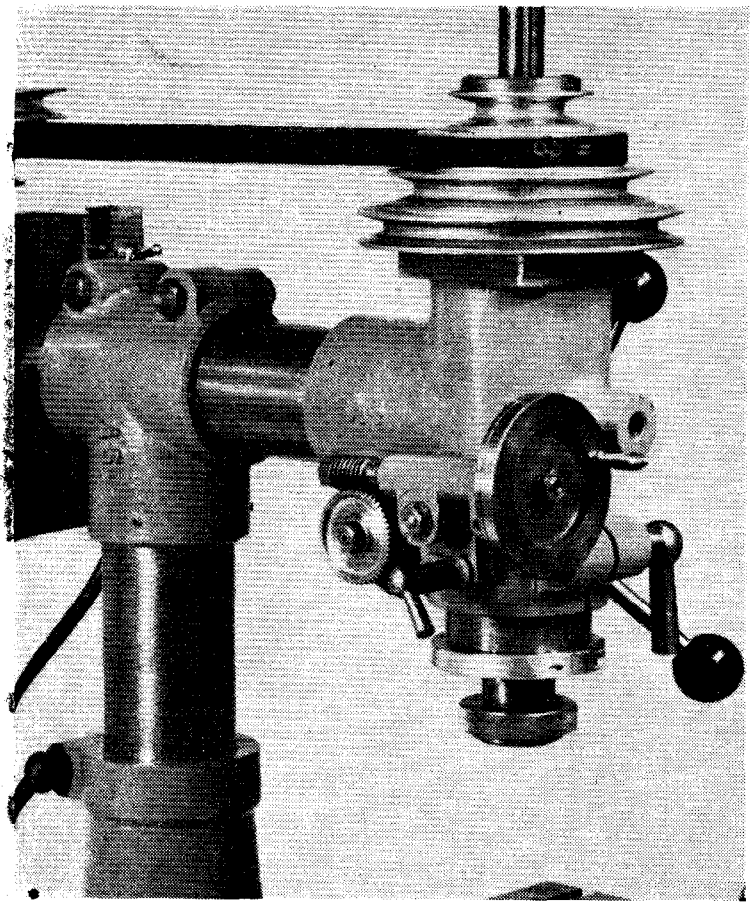
After turning, boring and knurling the index discs, mount them on an arbor or stub mandrel for engraving the divisions. Use a keen V-point tool, placed on its side in the toolpost at exact centre height. The lathe mandrel can be indexed with the aid of a gear wheel and spring plunger, described in ME and in the PM Handbooks ***Lathe Accessories*** and ***Milling in the Lathe.*** A roe-toothed wheel should be used, but it is not usually found in a standard set of lathe change wheels and a so-toothed wheel is the next best thing. Some users may be satisfied with 50 divisions, representing increments of two thou movement on the feedscrew, but you can split the divisions by going round the disc a second time, with careful re-adjustment of the change wheel. The marks should be cut to about 10 thou depth, and the length of cut adjusted by limiting the saddle movement. A convenient way is by fitting a stop on the lathe bed, set to suit the long marks to count tens and fives, and interposing a slip of metal between the saddle and stop for the remaining short marks. The numbers may be stamped, etched or engraved according to what facilities you have.

The machining of ball handles for machine tools has been described in these pages. It is an operation in which the skill and judgement of the operator is far more important than any written instruction. Form tools are of course impracticable for light lathes. A spherical turning device is helpful, but hand turning tools can be, and often are, used to form the ball contours accurately enough to satisfy the eye. I recommend that you employ a piece of 1in. steel bar long enough for chucking, and a bit extra for centring. Form the small ball at the outer end, after cuttirig back far enough to allow the centred end to be ultimately parted off. Turn the tapered parts by swivelling the topslide to 1½ in. degrees, and rough out the balls as closely as possible with slide-rest tools, checking with radius gauges. You should neck down the end balls as far as possible without weakening their support, before you finish them to shape, by hand or generating tools. After parting off, finish the ends by chucking them over the centre ball, the finished surface of which may be protected by being wrapped in thin sheet copper or aluminium.

Hold the handles crosswise in the four-jaw chuck, again protecting the finished surfaces, for cross drilling and facing the centre ball. Countersink the other side by mounting it on a stub mandrel. To ensure parallel alignment of the tapped hole for the crank handle in the small end ball, you may use the centre hole to secure the work by a setscrew to a flat plate, which can then be set up on the faceplate with the small end central. The contour of the crank handle is formed by hand tools and the handle threaded on the end to screw tightly into the ball. When the handle is fitted to the feed-

screw, and is secured endwise by the countersunk screw, a socket-head grubscrew, bearing on a dimple or flat on the shaft, locks it rotationally.

Both the column head and the spindle head castings involve two boring operations. It is extremely important that these parts should be exactly at right angles to each other, for accuracy in the vertical location of the spindle when the machine is assembled; and to correct errors after the parts have been machined is difficult or impossible. The method of machining will depend on your facilities. Generally it is best to bore and face the blind hole first, and then mount the casting on the saddle of the machine for boring the main through hole with a cutter bar between centres. A lathe or boring machine with a large capacity will be required; the Murad Bormilathe, which is provided with elevating movements for both the headstock and tailstock, is specially suited to dealing with work of this kind.



Spindle head and column head assemblies

For the first operation, either casting can be mounted on the lathe faceplate, with brackets made from heavy gauge angle iron at each end, and a long bolt through the main bore. If the faceplate is of limited size, the brackets may need to be turned inwards for the spindle head, which is 6 in. long plus a machining allowance at each end. To avoid any tendency of either casting to twist under the cutting load, you may clamp steady blocks to the faceplate, in contact with the lugs at the rear.

As the bores have to be machined to fit tightly on the vertical and horizontal tubes, interference fits are specified. In the lack of special facilities, such as a large hydraulic press, the best way, in my experience, is to shrink them on. The shrinkage allowance for cast iron, for a diameter of 2½ in., may be up to 5 thou, but quite a secure grip may be obtained on smooth accurate surfaces with 3 to 4 thou; this makes fitting easier, and removes the risk of jamming during the process. If you have no means of internal measurement to the required limits, you can turn an improvised plug gauge from any odd piece of material, 4 thou smaller than the tubes, for sizing the bores. You may use the machined front face of the blind hole as a bolting face when you are mounting the casting on the saddle for boring the long hole, but take care to see that the boring table is truly horizontal, parallel with the lathe axis, and that the casting is not tilted when bolted down. While a single heavy bar, or strap with bolts as close to each side of the casting as possible, will suffice for holding it, the fitting of additional steady pieces to prevent risk of movement, is a wise precaution. The bore of the spindle head demands special care if it is to produce a truly parallel and smooth surface, as it forms a sliding bearing for the quill or bearing sleeve.

Close machining limits essential

It is not practicable to allow more than a bare one thou for finishing by lapping or honing, as the bore is broken by the cross hole in the middle. On the other hand, the middle part of the bore cannot be relieved, because the quill must have close contact with it for its entire length. The column head needs to be a close sliding fit on the horizontal tube. You now have only to face two ends, drill and face the lugs to take clamping bolts, and slit right through at the top.

The spindle head casting may be held by a single long bolt through its centre, on the boring table, for boring the pinion housing and facing its flange; at the same setting, the facing for the seating of the wormshaft bracket may be milled flush with the flange. The hole for the spindle head clamp is drilled 1/4 in. lower than the pinion centre and spot faced at each end; then a sawcut is made through the middle of the lug, from the bottom, up to the centre boss of the casting.

As the purpose of the boss, with its central tapped hole, may be in question, I will explain that it was intended to provide a means of steadying the spindle head, should steadying be needed in specially heavy milling operations. Stays or struts, such as those used on horizontal milling machines, can be fitted from it to the corners of the base casting. So far, I have not needed this provision. The boss may be found useful for the attachment of an optical or other means of setting the spindle truly vertical, or at a specified angle.

To shrink the tubes into the head casting, heat them by a bunsen burner or blowlamp up to a black heat (just short of luminous) and hold them in a vice with the cross bore vertical. The tube should be as cold as possible-use refrigeration if you can-and may have a smear of moly or graphite grease. You will then be able to slide the tube into the casting by hand. Take care not to insert it far enough to foul the long bore; a collar clamped on the tube will positively prevent this.

You should lose no time in carrying out this operation, but there is no need for frantic haste or panic. As an extra security against movement, I have drilled and tapped three holes to take sunk 1/4 in. grubscrews in each of the castings, but I do not consider them absolutely necessary.

To be continued