ELEMENTS OF SPHERICAL TURNING

Part III ***Continued from May*** *19*

by Edgar T. Westbury

The rotational movement of the cutting tool, for generating a true spherical curve, may be in any plane, provided that it obays the first principle, that the centre line of the pivot must exactly intersect the axis of the work. Many appliances have been made having a horizontal pivot set at the level of the lathe centres, and a tool head equipped with convenient means of rotation and radial adjustment. This arrangement has advantages for certain applications, not the least being that its pivot location can be made positive, thus eliminating the risk of spherical error. It can also be designed in a form which is easily and quickly mounted, without the necessity for removing any of the normal slide rest fittings. The equivalent of height adjustment for the point of the cutting tool can be obtained by the cross-slide movement (which should be locked or clamped during the spherical turning operation) and the lathe mandrel may be run in either direction, according to the tool setting.

In the course of operations to which I briefly referred in the previous issue, 1 was led to experiment with various designs of appliances with a view to producing a quick-set type of fixture, interfering as little as possible with the use of standard tooling arrangements. The horizontal-pivot appliance seemed to offer a possibility of achieving this purpose, as it could be mounted on the back end of the cross-slide, well out of the way of any but the largest work, and instantly ready when required for use. I already had a rear tool with a detachable head, somewhat similar to that designed by Duplex several years ago, and this was used for the mounting of the spherical turning appliance.

In the original arrangement of this device, the rotating tool head was mounted in a spindle which worked in a horizontal bearing block, designed to be mounted on the pedestal of the toolpost fixture, interchangeable with the existing tool heads, and clamped down by the T-bolt in the slot of the cross-slide. A short radial tool slide was attached to the front end of the spindle, and a worm wheel again found in the scrap box fitted to the rear end, for operation by a worm with a vertical shaft and ball handle. The spindle bearing in the block was bored and reamed in situ from the lathe chuck while clamped on the toolpost at right-angles to its normal position. Its height, therefore, was positively set, with no possibililty of introducing spherical error, and it was unnecessary to provide a gauge pin in the pivot centre.

The radial tool slide was, as in the previous appliance, of dovetail form, with adjusting gib, but the feed screw could be centrally located, as it did not have to dodge a gauge pin Neither was it necessary to fit a rocker pad under the tool bit in the lantern toolpost, as the cross-slide provided the means of adjustment. A bracket was attached to the back of the pivot block to provide a bearing for the worm shaft, which was extended to a convenient height for operation by the ball handle. This device, though it started as a make-shift, and never really attained the status of a finished design, served its purpose, and enabled me to produce some accurate work with the minimum expenditure of time and trouble.

Ball handles

Some months ago, at a meeting of the Sutton Model Engineering Club, a question arose about the best method of producing ball handles for machine tools. This led to a discussion on spherical turning generally, and I demonstrated the appliances I had made, together with examples of work produced by their aid. Most of the club members considered that it was not worth while to make an “ elaborate gadget ” ‘to produce one or two ball handles, and this is obviously true in terms of workshop economics, as applied to all kinds of tool making. But there are many model engineers who will spare no pains to make their workshop equipment as complete and versatile as possible, irrespective of whether they have any urgent need to carry out highly specialised operations. Very rarely are efforts in this direction entirely wasted, provided that the gadgets they make are practical, and not so elaborate as to absorb considerable time, which might better be devoted to more worthy projects, or what is known as “ real model engineering.” This is a matter on which each individual must form his own judgment and make his own decision.

Mr Norman Cohen (who, incidentally, has now emigrated to Canada) was interested in these appliances, and after trying out the horizontal-pivot type, decide to construct his own version of it. This proved to be well suited to his requirements and he has made complete detail drawings of his design; which he has given me permission to reproduce. Not only is he a much better draughtsman than I am, but his appliance is much better made and finished than mine, so I have decided to illustrate it in preference to the original type, from which it differs in many minor details.

The general arrangement, next page, shows the complete appliance, and the location and assembly of the parts, to which the various members are allocated; to avoid confusion, therefore, the details are given only their part numbers and not further figure numbers. Part No. 1 is the pedestal, Which is essentially similar to that of the Duplex rear too1post, and if this already exists, can be utilised without the need for a specially made component. Cast iron is the most suitable material, but it could be made by brazing two pieces af mild steel bar together if preferred.

The underside of the base is first faced flat and true, and it is then reversed, either in the four-jaw Chuck or on the faceplate, with the square part set truly for turning the register spigot and drilling the vertical hole for the main T-bolt. This bolt, and the nut which holds the assembly down, is not shown in the drawings or photographs, but its purpose and location are obvious. Nothing more than the single bolt is really necessary for secure mounting, but a hole for a short bolt is provided in the base flange for further security, but more particularly to prevent the pedestal shifting if the main bolt is slackened for adjusting the head. Instead of two separate bolts, studs screwed at each end may be fitted to a T-strip to engage the slot of the cross-slide, as recommended for the previously described appliance. All finishing operations, such as scraping of the base or seating surfaces, which may affect the height af ‘the pedestal should be completed before proceeding with other components.

The bearing block

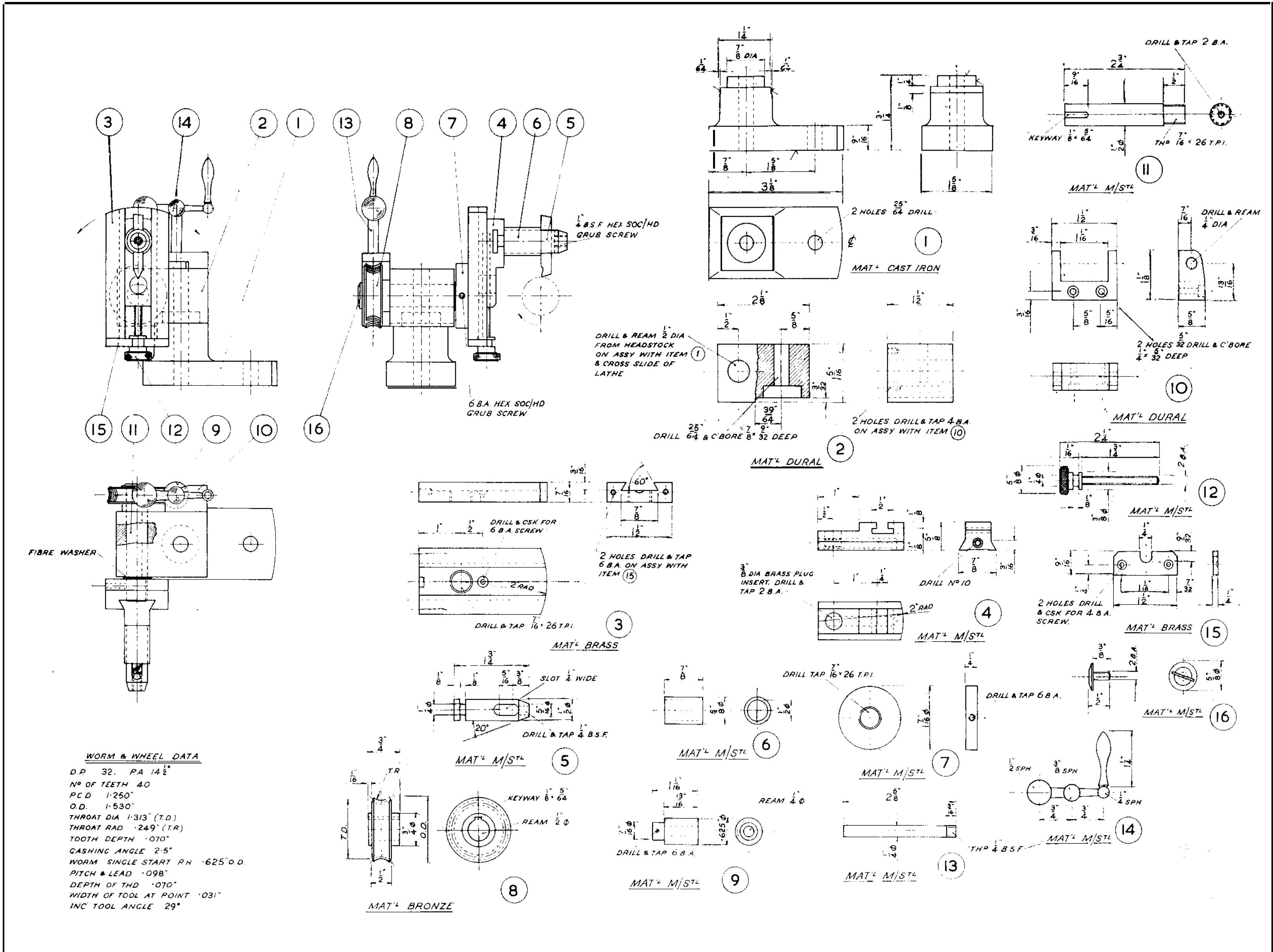
Duralumin is specified for the bearing block, part No. 2, but other materials such as cast iron or bronze are equally suitable. Steel can be used if a bronze bush is inserted to form the bearing. The base surface of the block is stepped to provide a square edge which fits against the machined side edge of the pedestal, to locate the block squarely ‘to the lathe axis when fitted. The seating surface on the underside must therefore be machined by milling or shaping. An alternative method, which may ‘be more convenient, is to face the underside of the block right across, at the same setting as the drilling and counterboring of the vertical hole, and attaching an aligning strip, or fitting a dowel in the top of the pedestal, to provide (positive square location. The drlling, facing and counterboring to a close fit on the base spigot can then be carried out at one setting, with the block set up in the four-jaw chuck.

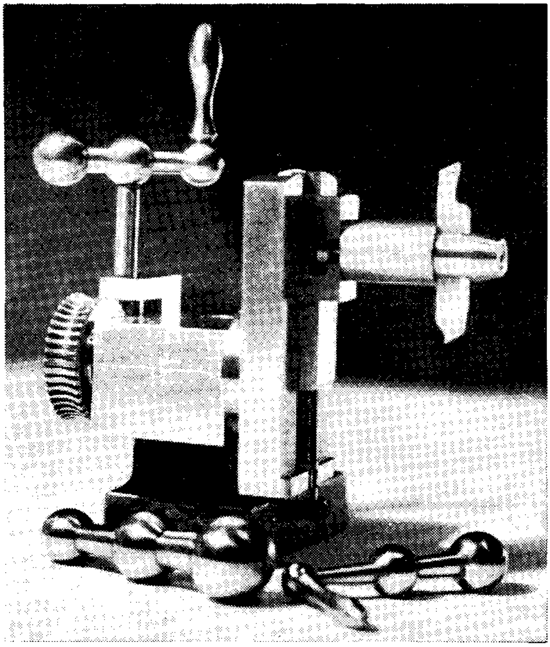
The block may now be mounted on the pedestal and secured by the T-bolt to the cross-slide, with its left-hand face set parallel with the lathe axis for centre-drilling, drilling and reaming the bore of the bearing. This is the critical operation which determines the spherical accuracy of the work produced by the appliance, therefore care should be taken to see that both the pedestal and the block are seated truly on the cross-slide, without any chance of grk or swarf being trapped between their surfaces; errors in height are difficult to correct afterwards. When drilling the block on the cross-slide, with tools held in the lathe chuck, there is a tendency for it to slew round under the applied end thrust, and this should be prevented by backing the work up by a drill pad held in the tailstock. Two or three stages of undersize drilling are recommended and if a reaming size drill is not available, a 31/64 in. drill may be used, followed by a D-bit, which can easily be made from silver steel rod. The end faces of the bearing should be maohined by mounting the block on a stub mandrel.

The rotating slide

Suitable materials bar the ratating slide member, part No. 3, are brass, bronze or cast iron. It is first machined flat and parallel on both sides by milling, shaping or facing methods; the edges and ends, though of no functional significance, may also be machined for the sake of neatness. The dovetail slot was produced by Mr Cohen with the aid of a vertical-spindle machine, but it could well be carried out by end milling in the lathe, with the work mounted on a vertical-slide. As shown, no provision was made for adjusting play in the slide, but this calls for meticulous fitting, and there is plenty of metal to allow of interposing a gib strip, with adjusting screws. The slideway should in this case be made 1/16 in. wider on one side (not symmetrically), and a strip of steel 1/16 in. by 1/4 in. fitted, as for the slide of the vertical-pivot appliance. For drilling and tapping the hole 7/16 in. fine thread, to attach the slide to its spindle, it may be mounted on the faceplate, so that positive squareness is ensured.

A piece of mild steel 5/8 in. X 7/8 in. X 2 in. long may be used for the radial tool slide, part No. 4, which is machined to dovetail section by the same cutter as that used for the slot of the former component. This is most conveniently done before stepping the top surface, but the 3/8 in. hole may be drilled to take a bolt for holding the part on the vertical-slide. It is set horizontally, with the under face outwards, and the top and bottom edges milled at one setting by adjusting the slide move-


MAT'L CAST IRON
2 HOLES 25/64 DRILL
MAT'L DURAL
DRILL & REAM 1/2 DIA FROM HEADSTOCK ON ASSY WITH ITEM (1) & CROSS SLIDE OF LATHE
DRILL 25/64 & C'BORE 7/8 × 9/32 DEEP
2 HOLES DRILL & TAP 4 B.A. ON ASSY WITH ITEM (10)
DRILL & TAP 2 B.A.
KEYWAY 1/8 × 5/64
THD 7/16 × 26 T.P.I.
MAT'L M/STL
DRILL & REAM 1/4 DIA
2 HOLES 5/32 DRILL & C'BORE 1/4 × 5/32 DEEP
MAT'L DURAL
1/4 B.S.F. HEX SOC/HD GRUB SCREW
6 B.A. HEX SOC/HD GRUB SCREW
FIBRE WASHER
DRILL & CSK FOR 6 B.A. SCREW
2 HOLES DRILL & TAP 6 B.A. ON ASSY WITH ITEM (15)
DRILL & TAP 7/16 × 26 T.P.I.
MAT'L BRASS
3/8 DIA BRASS PLUG INSERT. DRILL & TAP 2 B.A.
DRILL No 10
MAT'L M/STL
2 HOLES DRILL & CSK FOR 4 B.A. SCREW.
MAT'L BRASS
SLOT 1/4 WIDE
DRILL & TAP 1/4 B.S.F.
MAT'L M/STL
DRILL TAP 7/16 × 26 T.P.I.
MAT'L M/STL
DRILL & TAP 6 B.A.
MAT'L M/STL
KEYWAY 1/8 × 5/64
REAM 1/2 Ø
MAT'L BRONZE
REAM 1/4 Ø
DRILL & TAP 6 B.A.
MAT'L M/STL
THD 1/4 B.S.F.
MAT'L M/STL
MAT'L M/STL
WORM & WHEEL DATA
D.P. 32. P.A 14 1/2°
No OF TEETH 40
P.C.D 1·250"
O.D. 1·530"
THROAT DIA 1·313" (T.D)
THROAT RAD ·249" (T.R)
TOOTH DEPTH ·070"
GASHING ANGLE 2·5°
WORM SINGLE START R.H ·625" O.D.
PITCH & LEAD ·098"
DEPTH OF THD ·070"
WIDTH OF TOOL AT POINT ·031"
INC TOOL ANGLE 29°



The spherical turning appliance made by Norman Cohen, with examples of ball handles made with its aid.

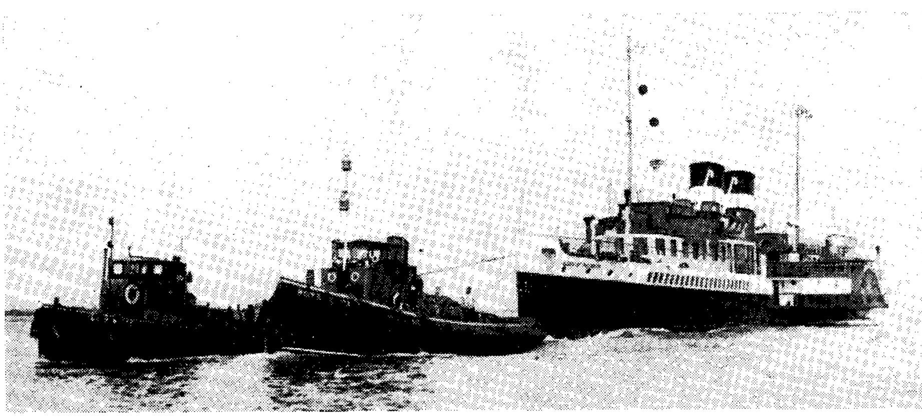
ment. This will ensure that the two edges are parallel with each other.

To mill the slot for anchoring the toolpost, a special T-slot cutter is normally required, but it is possible to file this out accurately enough for practical purposes if the centre channel is first cut to full depth by a 1/4 in. end mill. The work of removing metal by filing may be reduced if two 1/8in. holes 3/8 in. apart are first drilled horizontally through the block, to partially form the base of the slot. Filing is also good enough to shape the step of the slide, if most of the unwanted metal is cut away with a hacksaw; but maohining facilities, where they are readily available, should always be exploited to full advantage on work of this nature. A hole is drilled longitudinally through the slide to clear the feed screw, the nut of which is formed in a brass plug 3/8 in. dia., fitted to the hole already drilled, and cross-drilled and tapped to line up with the screw. This provides a measure of flexibility in alignment, as the nut can swivel or slide in the hole to adjust its position. The sliding surfaces of the two mating parts may call for final fitting by scraping, or the use of a fine file, so that they work smoothly together, and the slide gib, if fitted, is then adjusted to eliminate any perceptible play.

The toolpost, part No. 5, may be made from 1/2 in. dia. mild steel bar, 1-3/4 in. long, faced squarely on the end, and grooved to fit the T-slot in the slide. It is then chucked in the reverse position, tapered as the end, and drilled and tapped to take a 1/4 in. BSF screw. The hole may be drilled down as far as the lower end of the cross slot, to reduce the amount of metal which needs to be removed in forming it. End milling, with the work held in a small vice on the vertical-slide, is the quickest method of doing so, but as an alternative, three undersize holes can be drilled and filed out to merge with each other in an elongated slot.

Also in mild steel, the sleeve, part No. 6, is simply a piece of 5/8 in. dia. bright bar, drilled 1/2 in. dia. through the centre and faced at both ends. Its length is not critical, as the tool position can be adjusted by the cross-slide. A socketed screw, either with or without a head, can be used to clamp the tool bit, but there is much to be said for the good old-fashioned square-headed screw. made of carbon steel, and hardened and tempered on the point only.

Part No. 7 is simply a mild steel disc, drilled and tapped 7/16 in. X 26 t.p.i. (or to match other parts). It is used to back up the rotating slide, and provide the utmost rigidity when locked up as tightly to it as possible and further prevented from movement by a grub screw in the side.



The Queen of the South " returns for further service. *See page 527.*