# Build a universal cutting head

## RAY LEVY

**In previous issues, Ray described the making of his decorative turning lathe. Here he shows how to make a motor-driven universal cutting head to go with it.**

Raymond Levy received his formal woodwork training at aircraft mechanics' school. He was serving an apprenticeship as a toolmaker when World War II intervened and he found himself in the upper turret of a B-24 Liberator.

After leaving the USAF he worked for some years in the tool and die shops, eventually being recruited into the fledgeling aerospace industry.

Having operated apparatus-building shops for two different firms, he transferred to the drawing board and spent the next 20 years designing scientific apparatus.

Since retirement he has had a workshop, where he builds a variety of small, precise woodwork such as jewellery boxes, three-dimensional puzzles and wooden demonstration mechanisms. Ray is the author of *Making Mechanical Marvels in Wood* (Sterling Pub. Co. Inc.).

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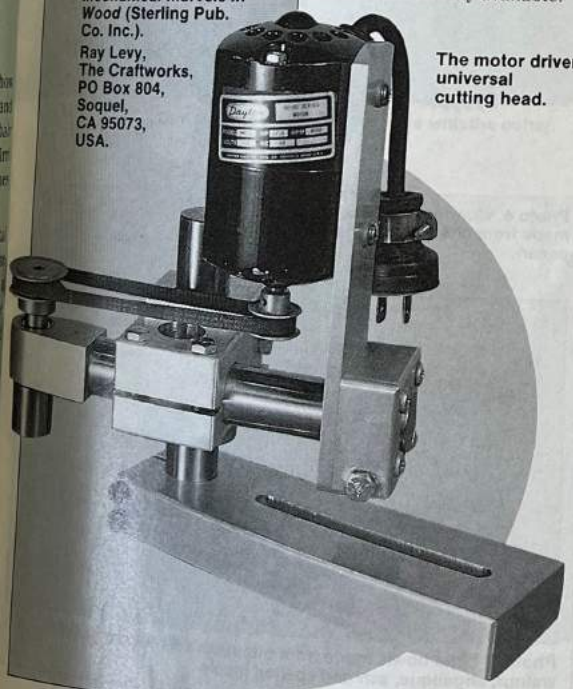
As a young machinist I often used lathe accessories driven from overhead works by round leather belts. These belts were generally awkward to work around, and were prone to slipping under load. So when I set about designing a cutting head for my lathe, I took advantage of the compact, high speed electric motors now readily available.

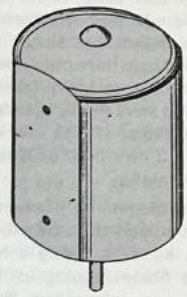
The resulting tool is a self-contained unit whose cutting plane is adjustable from horizontal through vertical. Motor and cutter spindle are mounted on a polished steel shaft which can be axially positioned to accommodate the work to be done. Adequate vertical adjustment allows a cutter to operate in any location from the top to the side of the work.

The motor and spindle mounting shaft can be removed and may be replaced by other tooling when desired.

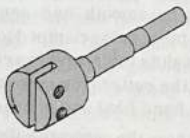
The assembly drawings of the fabricated parts show the construction (FIGS 1 and 2), much ▶



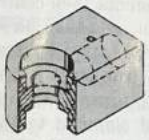
**The motor driven universal cutting head.**



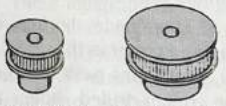
Universal motor, 75 watt, 8000 RPM



Spindle (tool steel)



Spindle head showing bearing seats



Motor pulley (28 teeth)

Spindle pulley (48 teeth)

**FIG 1** Cutting head components.

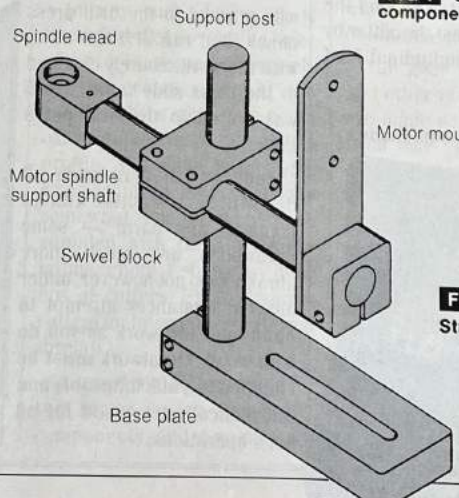



**FIG 2** Structure assembly

of it designed to make use of material at hand. All parts were machined on my wooden lathe and a drill press (pillar drill), using procedures to be described.

The base plate, swivel block, and spindle head were machined from aluminium blocks purchased from the surplus metals dealer. The cutter spindle and the two steel shafts were made from 25mm 1" DIA tool steel rod, left over from making the lathe spindle.

The aluminium blocks were laid out, and cut nearly to size on a bandsaw, using a hard-tooth blade running at 1000 feet per minute. A single toothed 'fly cutter' in the lathe spindle was used to mill all surfaces smooth and square, each piece being clamped to the cross slide table, and traversed past the cutter. The large radii were hand filed and polished.

To bore the accurate holes for the shafts in the several components, their centres were laid out, and the holes rough-drilled to within 1.5mm $\frac{1}{16}$" of size in the drill press. Each piece in turn was then blocked up and clamped to the cross slide table, aligning the desired hole centreline coaxial with the spindle centreline.

A shop-made boring bar, having a cutter in the middle of its length, was passed through the rough-drilled hole, and mounted between centres. The cutter bit was advanced radially until it just touched the drilled hole, the lathe started, and the workpiece fed past the cutter by cranking the longitudinal feed handle.

**Photo 1 Box of home-made cutters.**

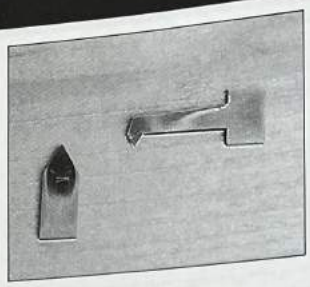


**Photo 2 Internal and external thread cutters.**

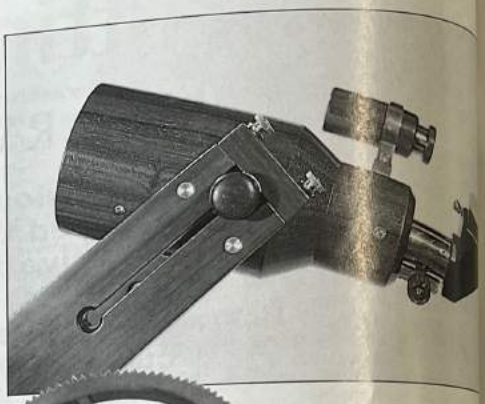


**Photo 3 Small astronomical telescope made on the lathe.**

Repetitive cuts were taken, with the cutter advanced in small increments each time until a sliding fit on the shaft was obtained. Using a micrometer across the tip of the cutter and the back of the boring bar afforded very close control over the depth of each cut.

A dividend of this line boring technique is that it's almost impossible to bore other than a perfectly cylindrical hole.

When all large holes were bored, the clamping screw holes were drilled and threaded, before cutting the clamping slots across them. These slots were milled using a lathe-driven cutter, but could be sawn and filed.

## Router bit

I rounded all corners on my aluminium parts, using an ordinary high-speed steel, corner-rounding router bit. This was gripped in the drill press chuck, and run at 1400 RPM, with the work securely clamped to the cross slide table, which was bolted to the drill press table.

You can cut aluminium all day with such a cutter without doing it any harm — some hardwoods are much more abrasive. Do not however, under any circumstances attempt to hand-hold the work as you do with wood. Metalwork **must** be clamped to a machine table and mechanically traversed for all such operations.

**Photo 4 Wooden gear wheels made from cherry, bubinga and pecan.**

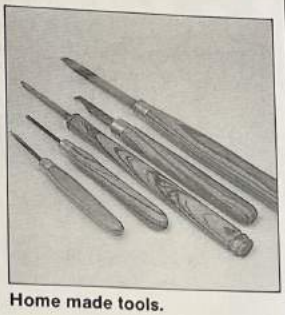
**Photo 5 Little bowls made from offcuts of zebrawood, padauk, walnut, angelique, ash and spalted maple.**

The spindle head was held in a four jaw chuck, and a small boring bar used to machine a light press fit for a ball bearing. The central hole was also bored smooth and concentric with the bearing seat, although it is a clearance hole with no diametral precision required.

A piece of scrap steel rod was gripped in the chuck, and two diameters turned and polished, so that the two bored holes could be wrung onto them. This allowed the second bearing seat to be bored, with some assurance that it would be aligned with the first one.

A hole was bored in the end face of the spindle head, to a press fit for a reduced diameter turned on the support shaft. A hole for a dowel pin was drilled through both parts after assembly, and a pin driven in.

My spindle is made to accept cutters that I file from annealed, flat-ground tool steel 3mm x 12mm ⅛" x ½", and hardened to suit the material to be cut. I heat-treated the spindle to a spring temper, giving it wear resistance, and rendering it virtually indestructible.



Home made tools.

Cutting gear wheels on the lathe with the cutter.

Cutting head with gear cutter.

In any such device, it is important that the cutting faces of the tools are placed precisely on the centre plane of the spindle, if the work is to be an exact duplicate of the cutter profile. As I make cutters only when required, my collection is somewhat smaller than those supplied with the Holtzapffel lathes. Photo 1 shows my little box of cutters. Photo 2 shows cutters for internal and external threads.

A speed control was made for the motor, using purchased components, and it works well. Today I would simply acquire one of the small electronic control modules advertised by woodworking supply dealers. Be aware that these work only with universal, brush type motors.

A standard 25mm 1" shaft collar with a padded set screw is placed on the vertical post underneath the swivel block. This allows the head to swivel, without affecting the vertical adjustment.

My primary use of this tool has been to cut gear teeth, splines and decorative fluting in both wood and metal. I hope to do more complex decorative work soon.

I am collecting material to build an adapter which will mount my new hand grinder in place of the motor-spindle assembly, thus providing the capability for grinding special router bits, and other work in hard materials.

## Versatility

I intend also to build a drilling spindle to use Holtzapffel-style cutters. The versatility of this mounting allows the substitution of a variety of alternate tooling.

The photographs show some work done on my lathe. On the small astronomical telescope built with surplus lenses, all wood and metal parts were made on the lathe (Photo 3). These include the friction-drive focuser, and the mirror diagonal which was carved out of a block of aluminium.

The gear wheels for clocks and other machinery (Photo 4) are made with cutters laid out from the 1907 printing of *Grant's Odontograph*, and filed to shape. The little bowls (Photo 5) are included just to show what you can do with offcuts of rare woods too small for other uses.

Should you decide to build a similar cutting head for your lathe, it will amply repay you for the time and effort you put into it. ■