Continued from **15** *December 1963*

Fixtures for angular machining

IT IS often a problem to the small workshop to machine surfaces which have to be turned, bored **or** faced at any angle other than a right angle to a primary base or reference surface. You may have to make or improvise special fixtures to hold the work. A great deal depends on the size of the work and the stiffness of the mounting required to resist the machining load. The fixture used on large machines, broadly a form of machining jig, may be quite inapplicable to the faceplate of a small lathe, with limited swing and width of gap. A light and compact fixture, so long as it provides enough rigidity for the job in hand, is to be preferred.

The degree of angular accuracy needed in the machining operation is another point to be considered. Usually we do not need to work to very high precision, and sometimes the angle specified is only nominal and arbitrary; in other words, a slight error in the plane of the surface may have no effect on the quality of the work. But it may be very important to produce a truly flat surface, and to bore or tap a hole at right angles to the surface at the same setting. If the angle does not need to be varied or adjusted, and the work is not too heavy, you may be able to use a block with two faces at the appropriate angle, one of them mounted in contact with the faceplate and the other used to hold it.

An operation well suited to be dealt with by this simple fixture is the drilling and tapping of the sparking plug hole in the cylinder head of a small petrol engine. It is often necessary to set the plug at an angle. While there are several ways of drilling, tapping and facing the hole, you can best assure the relative accuracy of these operations by setting up the work in the lathe. As the machining load is quite light, the material used for the block need not be specially strong or hard; a piece of well-seasoned hardwood, with the work secured to it with wood screws, is nearly always suitable. The drilling and facing of angular joint flanges or seatings, crankcase breather housings, and so forth, in which locations are not **highly critical,** can be dealt with just as efficiently by this simple method as with more elaborate and cumbersome fittings.

Improved fixtures

When adjustment of angle, together with greater precision, is necessary, you will be well repaid for the trouble of producing fixtures which can be adapted to a variety of applications. For some angular operations such as boring an inclined pump barrel, you may improvise a fixture by mounting a small angle plate on the face of a larger one, and swinging it round at the required angle. But unless you make special angle plates, to give a wide swivelling angle without taking up an abnormal amount of room on the faceplate, this method has rather severe limitations. I adapted the idea in making a special fixture for machining the cylinder head of an engine with inclined inlet and exhaust valves. The inside of the head had to be machined to a spherical curve, the axis of which fell on the line of intersection of the valve centres. **To carry** out the spherical turning operations, and the boring of valve ports and seatings, in true relation to each other, I designed the fixture to swivel on the spherical centre, without altering the major setting location on the faceplate.

I made the larger of the two angle plates deep and narrow, with a close fitting pivot bolt to position and clamp the smaller angle plate, which was inverted-machined on the inner face. To this face, the cylinder head casting was secured by screws through the holes for its holding-down studs, with the combustion head facing outwards. The swivelling plate was first set centrally, and then the whole assembly was adjusted on the faceplate so that the casting could be centred for the inside of the head to be turned with a spherical tool. Then the pivot bolt was loosened, and the plate swivelled to the required angle for the boring operation on one valve port-30 degrees from the centre. The plate was then set to the same angle on the other side of the centre for the other valve port. This method, with a suitably adapted fixture, can be used for many components which call for exact symmetry of angle about a common centre.

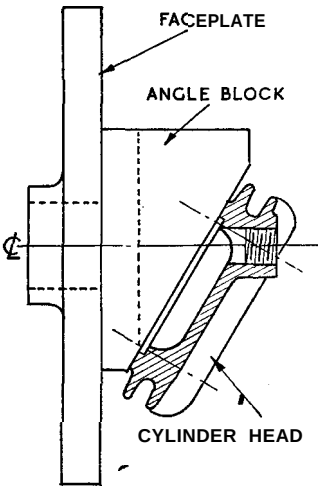
Swivelling **angle plates**

The kind of fixture employed to deal with a wide range of angular machining operations consists of two more or less similar plates with lugs at the back to take a pivot bolt which is used to hold them together. Both plates are provided with slots to take mounting bolts. Fixtures of this kind are obtainable in large sires, but, so far as I know, none of them ***is*** made 'in a size suitable for a 33 in. lathe. Some years ago, a swivelling angle plate with a mounting face about 3 in. square was produced by an accessory firm. Both components were of similar shape and sire, and had an offset lug at the back, drilled to take the pivot bolt. This form of angle fixture involves the minimum complication in both design and construction, but the form of joint does not provide very good resistance to angular movement, as it is liable to move when tightened. A broader mounting surface on the rear plate is an advantage for stability and latitude of adjustment.

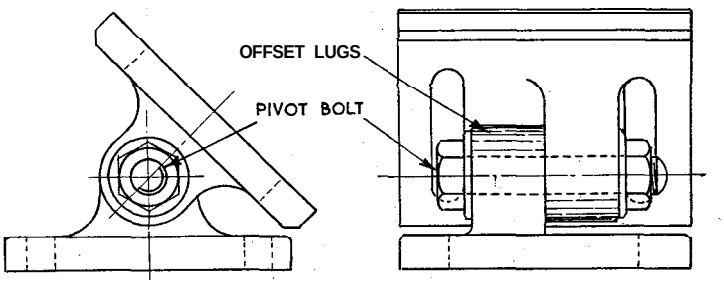
A more practical design of fixture is one with a single central lug on the swivelling plate, and straddle lugs 'on the rear plate. The clamping surfaces, on the outside and inside of the lugs, should be fairly broad and accurately machined, so that one fits closely between the other, and a firm grip is provided with normal tightening of the pivot bolt. Any end play between the lugs would of course make it impossible for you to clamp the joint without distorting the outer straddle lugs, unless you employ a different method of clamping. Sometimes one or both of the outer lug faces may be graduated to indicate the setting angle, but in a

small size you would find it difficult to ensure accuraq by relying on this method alone.

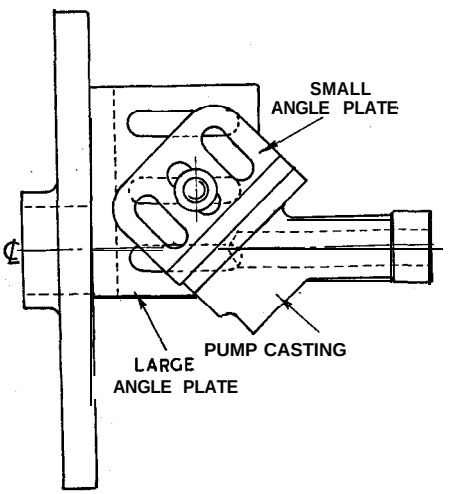
For most of the angular work in the model workshop, it is best to set the angle face by a protractor, or a master gauge or template. You can use the protractor, or inclinometer, supplied with a 12 in. combination rule set. For " absolute " precision measurement of angle, the principle of the sine bar, in one or other of its forms, is generally employed. This instrument is considered essential because components machined on angular fixtures often have to be interchangeable, or to fit parts machined elsewhere. Fixtures which incorporate a sine table, sometimes in duplicate, for dealing with compound angles, are frequently used, but they are expensive and hardly come within the scope of the small



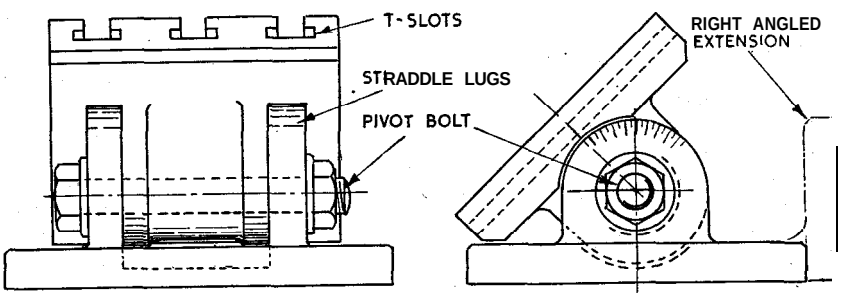
Angle block on faceplate for holding a cylinder head in correct location for drilling, tapping and facing sparking plug hole



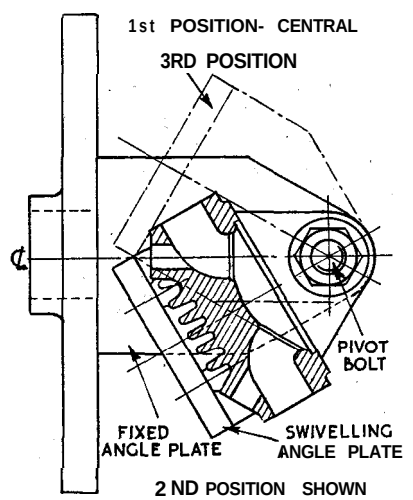
A simple *form of adjustable angle plate*



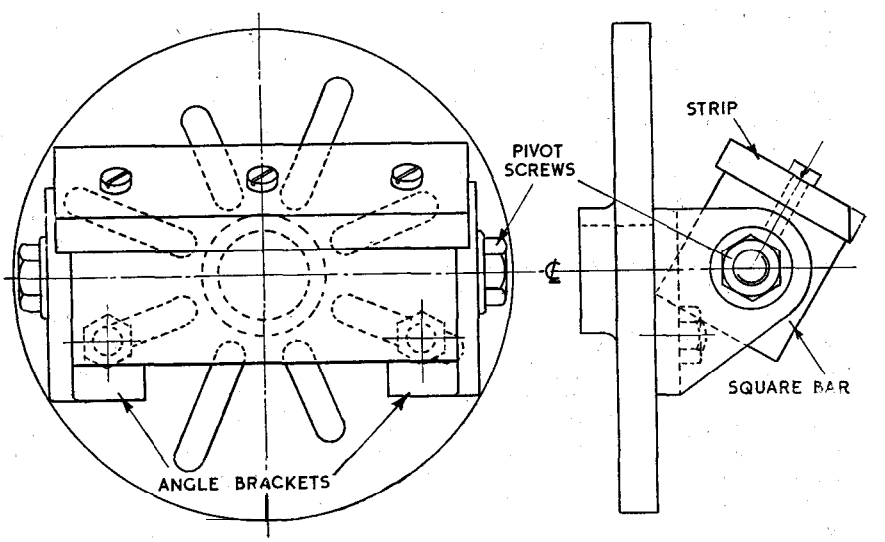
Superimposed angle plates for holding wmponents at various angles



Improved adjustable angle plate, providing *greater security*



A fixture for holding inclined-valve cylinder1 heads *in three (or more) angular positions!*



Method of holding slideway strips for facing angular edge

workshop. In many years of modelling, I have rarely had to perform an operation in which the use of a sine bar was really necessary. Where all operations in machining, fitting and assembly are carried out by an individual operator, it is usually sufficient to work to the closest approximate angle that can be obtained by ordinary measuring instruments.

The angular range of most adjustable angle plates is usually limited to about 45 degrees on either side of the centre. When angles less acute to the plane of the faceplate are required you can avoid the need of a special fixture by mounting the adjustable angle plate on a go-degree standard angle plate. If much work of this kind is likely to be done, a more compact and convenient arrangement would be to provide a supplementary go-degree machined face on the angular fixture itself, and for this to be mounted on the faceplate.

Facing angle strips

In fabricating small dovetail slides from flat metal strip material, you need some means of machining the angular edge. This can of course be done by milling or shaping. If you have only a lathe, an angular fixture on the faceplate will enable you to machine the work by surfacing cuts. A well-known. method is to bolt a piece of large diameter hexagonal steel bar across the faceplate by one of its facets,' and mount the strips to one of the 6o-degree angular facets in any convenient way. It is nearly always possible to use the holes which will eventually help to secure the strip to the other parts of the assembly and to drill and tap corresponding holes in the hexagonal bar for temporary holding screws. This method has been described by Martin Cleeve in writing of built-up slide-rests. It is very satisfactory, provided that the hexagonal bar is dead flat and true in angle-though neither condition should be taken for granted without a careful check.

When a slide-rest is built from scratch, the angle of 60 **degrees is** satisfactory for the dovetail ways, but if strips are fitted to existing parts a different angle may be required. I have' seen slides in which the angle is 55 degrees. To accommodate this angle, or others, I have used a square bar drilled and tapped exactly centrally at each end to take pivot screws. With these screws I mount the bar in inverted angle brackets bolted to the faceplate, so that it can be adjusted to the required angle for holding the strip material for facing the edge. The square bar provides a wider clamping face than the hexagonal bar, and if the brackets are shaped as shown they do not restrict either the angular adjustment or the length of strip which can be held; a 6 in. strip can be machined in a 3 1/2 in. lathe with a fairly deep and wide gap. The back corner of the bar at the two ends may be taken off to prevent it from fouling the bolting faces of the brackets.

With other fixtures which I have described, adjustable angle plates are just as useful on shapers, surface grinders, milling and drilling machines, as on the lathe. For drilling operations, they are much to be preferred to an adjustable angle drill table, as they allow us to move the work freely to fix the drilling position, instead of our having to clamp it to the table, in exact alignment, foi each individual hole. In ***my*** experience, swivelling drill tables are more nuisance than they are worth, because after the angle has been shifted it is difficult to be quite sure that they are put back exactly to the horizontal position, unless a test is made with a dial itidicator, mounted on a radial arm from a mandrel in the chuck. Often this precaution is neglected, and in deep drilling serious errors occur which are not detected until it is too late. Angular adjustment to fairly close limits, is often involved in such operations as drilling steam ports in cylinders, and long oil passages in crankshafts or crankcase castings, and a fixture which can be pre-set to the specified angle is a great aid to accuracy.

NED.

To be continued

TALYLLYN DRAWING

The Midland Area of the Talyllyn Railway Preservation **Society have prepared a fully detailed and sectional drawing of the locomotive *Talyllyn,*** 2 **ft 3 in. gauge, to a scale** 14 **in. to the foot. It shows the locomotive as it was reconditioned by Messrs Gibbons Brothers of Dudley in 1958. Copies of the drawings,** 52 in. by 26 in., may be had at one guinea each. They are printed in black dyeline on stout white paper. **The price is inclusive of postage and cardboard tube. Half size copies, 26 in. by 13 in., are also available, They cost** 10s. 6d. **inclusive of postage and cardboard tube. Orders should be sent to: Mr L. Bedder, T.R.P.S. (Midland Area),** 105 **Butt Lane, Allesley, Coventry. A copy of the drawing is reproduced below.**