CERTAIN operations necessitate the use of a counterbore or pin cutter, and for frequent use and long runs, especially where ferrous metals are involved, one cannot do better than to employ a good commercial "high speed" steel counterbore. These are obtainable either as single solid cutters or in sets comprising interchangeable cutter heads and pilots; however, for the model workshop, the amount of work involved in such operations does not usually justify the costly purchase of such, and it is therefore common practice to make one's own, in which case the hardening facilities available usually limit the tool material to "plain" carbon steels.

Apart from their specialised uses for such operations as recessing and spot facing, the pin cutter has other advantages which make its use preferable in many instances to a conventional drill; especially is this so when boring holes from say 5/16 in. upwards in small gauge materials. For such operations the pin cutter can be relied on to cut the size expected of it; the hole will be round and clean, and "catching up" is almost non-existent, which in general instills a greater measure of confidence in the user.

The suitability of a cutter for spot facing and recessing may be largely dependent on the permissible size of the pilot hole, but for the singular purpose of cutting holes the pilot size is influenced only by the considerations of reasonable cutting conditions. It was for this latter application that the writer was most interested, and in seeking a partial solution to the problematic inconvenience of making innumerable cutters that the design herewith described and referred to as a pin cutter, was evolved. Whilst it is not intended to compete (as regards heavy duty work) with solid and more technically correct designs, it is thought that the simplicity of making the interchangeable blades may prove rather attractive. Under general working conditions they have given every satisfaction.

Basically, it is a development of a method common to bar-and-cutter boring tools, the main considerations being as follows:

1. Self centring of cutter blades.
2. General rigidity.
3. Simplicity of blade design.
4. Size of pilot.

The requirements of self-centring are met by slotting the cutter blade and machining two keyways through the pilot and well up into the body; these keyways are cut to a depth calculated to give a fair amount of support to the blade, and providing the fitting is kept within close limits a sound interlock is created, being finally clamped by means of a locking screw passing down the shank.

The blades are made from ground flat stock (high carbon steel) often referred to as "gauge plate," and are heat treated as per normal practice; a satisfying feature of the design being the ease of stoning or re-grinding the cutter edges.

To effect a keyway of suitable proportions, and at the same time preserving a reasonable margin of strength, naturally imposes a limitation on the minimum diameter permissible for the pilot. The size resulting from these considerations and chosen as being most suitable for the range of cutters involved (say 3/8 in. to 3/4 in) is 0.250 in. diameter; strictly speaking, however, the actual size can be no more than a compromise where a large range of cutters is used with a common pilot, because within certain limits the pilot should increase relative to the cutter size. Such a condition reduces the amount of material removed by the cutter and so relieves the loading on the tool. This relation between cutter and pilot begins to assert itself if diameters larger than 3/4 in. are attempted. (This latter statement is based on cutting mild-steel and may be exceeded where softer materials are concerned.) Such a relation may be complied with for larger sizes if a sleeve is fitted to the existing pilot, but caution must limit this practice to within the reasonable possibilities of the tool as a whole. If larger sized holes are the rule rather than the exception, then a
holder of more ample proportions should be considered.

The Holder

Detail I. The holder is a single turned piece and comprises the shank, body and pilot; a detailed sequence of machining operations will not be given as these will depend largely on available facilities; the important point to bear in mind is the relative concentricity of shank and pilot.

A few notes on the blade interlocking section may prove an advantage, because that which may appear somewhat complicated from the drawings actually resolves itself into a few simple operations. A study of the photograph will show an incomplete version of this section, which with the aid of the following notes will make the procedure quite clear.

At a suitable stage when the pilot at least has been turned to size, mark out slot and keyway, then drill a series of holes to suit; these should be preferably of a diameter less than the finished slot size (a No. 32 drill is suitable and this will allow for correction of any drilling errors when cleaning out the webs), after which set up carefully and proceed to mill keyways.

Although the original was machined with a 4 in. cutter as per drawing, it will be apparent that the required results may be effected by quite a small cutter set up in the lathe. When this has been accomplished, the amount of drill as per drawings (this will be standard for all blades). The dimension X may be of rough finish, but in excess of final requirements. Machine or file slot to size and then locate securely in the holder (Detail I) clamping by means of the locking pin (Detail 2), the shank of Detail I is then mounted in a lathe and used as a spigot for turning dimension X of the blade to finished requirements.

Before removing blade for the next operation, make a reference mark on the blade to coincide with a similar mark on the holder; this will ensure that the blade is subsequently returned to its original position of mounting as per the turning operation.

Form the cutting angles as drawing (Detail 3); the "backing off" angle is shown to be radiused on the face, resulting, of course, from the method used, i.e. milling. This was found to be most convenient, although it may be filed, but whichever method is used, it is most important to avoid interference with that portion of the blade face which constitutes a locating surface with
the body and pilot (see assembly drawing).

The slot radii shown in drawing should have been adhered to, as sharp corners are often the cause of fracture during the hardening process; in any case such corners are invariably a source of weakness and should be avoided where possible throughout.

Prepare now for hardening by securing the blade with a piece of iron wire and bring to red heat (800 deg. C. approx.). Quench in water which has been topped with oil and agitate freely until cool; clean the surfaces and make ready for tempering, which must be carried out carefully, as much may depend upon this operation.

The cutting end of the blade alone needs this high quality or hardness (yellow), while the base end, extending at least to the slot radius, needs toughness (blue). On this reasoning, then, it is not good enough to temper the blade to a common hardness. It is, of course, well known that such a condition is produced automatically if the complete colour range of tempering is incorporated in a hardened workpiece, and such must be the objective; special mention of it is made, however, because it becomes increasingly difficult to incorporate such selectivity in small articles, and one may be tempted to produce a common temper which in this particular case is most undesirable. Fortunately, the length of blade is such that with reasonable care the range of blue to yellow is just accommodated. The method used was quite simple and entails holding the base end of the blade in an old toolmaker’s clamp and by playing the flame on the limbs rather than on the blade itself a good measure of control is gained: observe the colours run up and quench in water when a medium yellow approaches the cutting edge. This should just coincide with a changing blue at the base:

It will be appreciated that blades less than the body diameter, e.g. 1/2 in., will have a limit to their depth of penetration. For the smallest practical size, which is in the region of 5/16 diameter, this amounts to 1/4 in. It is recommended that either pinning or soft solder; the latter has been used with satisfaction and may be preferable for possible interchange of pilot sizes. If the cap is left oversize when fitted, it may be turned to size in situ thus ensuring concentricity. (Note the dimensions are such that the edge of cutter blade does not bottom on the pilot cap. This is important.)

To sum up, the tool may be used for most of the everyday materials, being particularly suited to brasses; mild-steel too may be cut, provided the speeds are reasonably slow and a copious supply of cutting oil or compound is used.

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