

FORGING DIE

5 The present invention relates to a drilling and thread forming fastener capable of manufacture by a forging process and in particular to a forging die for forming such a drilling and thread forming fastener.

10 In the art of fastener manufacturing, a type of threaded fastener having the capabilities of drilling a pilot hole and forming threads for entry of the fastener, all combined in the same operation is well known. It is also known to manufacture these fasteners by employing a pair of dies which are effective to forge the drilling point into a configuration which is best suited for the drilling operation in a particular material, or for a particular size
15 fastener. One such a fastener is shown in U.S. Patent 3,395,603.

While many of these drilling and thread forming fasteners have gained commercial acceptance, including that described in said U.S. Patent Specification, areas have been
20 uncovered which are considered to be subject to improvement, to provide both increased utility of the particular fastener, and ease of manufacturing with a decrease in cost per fastener.

For instance it has been found that many of the
25 prior art drilling and thread forming fasteners are not adaptable to performing their function in heavier gauge materials, that is material of a thickness greater than five-sixteenths (5/16) of an inch (0.8 cm).. While some of the fasteners disclosed in the prior art have the capability
30 to perform this drilling function, the high heat generated by the drilling operation in addition to the increased drilling time, in many applications, render the use of the self-drilling and thread forming fasteners undesirable.

In the area of manufacture, many of the prior art
35 drilling and thread forming fasteners are constructed having

an outer pilot end surface which in cross section contains a number of sharp corners or sharp recesses which are designed into the drilling tip. Such sharp corners are detrimental when the fastener is manufactured by a forging process employing a female die to produce the fastener pilot end in that they create stress areas in the female die. Over a period of time, the stress areas are subject to cracking and will eventually result in die breakage of a premature nature. Thus, dies employed to manufacture that type of fastener having a plurality of sharp external surfaces which are subject to replacement after a somewhat limited number of cycles of use.

It is therefore an object of the present invention to provide a forging die for forming a drilling and thread forming fastener from heavier gauge materials, for instance those materials having a thickness greater than 0.8 cm.

A further object of the invention is to provide a forging die for forming a drilling and thread forming fastener of the type discussed, which reduces or eliminates sharp corners in the fastener pilot end which are produced by sharp recesses in the forging die and thus, to allow manufacture of the fastener by a forging process employing the die having few, if any, sharp recesses on the forming surface.

In our copending UK application 8600729 (2169826) is described and claimed a drilling and thread forming fastener comprising a threaded shank and a pilot end, said pilot end having a major axis extending through the centre of rotation of said fastener, and a minor axis intersecting said major axis at right angles at the fastener centre of rotation and of less length than said major axis, a pair of flutes formed in said pilot end in opposed quadrants and extending longitudinally and parallel with the centre of rotation of said fastener, a pair of lands disposed in opposed quadrants adjacent said flutes, said flutes being of substantially

arcuate cross sections and said lands of substantially arcuate cross sections throughout the greater portion of said pilot end, said arcuate cross section of a said flute and said arcuate cross section of a said land terminating at an intersection at said major axis to form a pilot cutting edge.

According to the present invention we provide a forging die for forming a drilling and thread forming fastener comprising a cavity wherein said cavity is formed having a first arcuate surface projecting outwardly into said cavity and terminating at the edge of said cavity, a second arcuate surface projecting inwardly and terminating at the opposite edge of said cavity, each surface extending over substantially the length of said cavity, and wherein said first and second arcuate surfaces are connected by a third arcuate surface of a smaller radius than said first and second arcuate surfaces whereby said cavity is substantially free of sharp indentations on the surfaces.

In order that the invention may be better understood, a preferred embodiment will now be described by way of example in greater detail with reference to the accompanying drawings in which:-

Figure 1 is an elevational view showing a drilling and thread forming fastener according to UK application 8600729 (2169826);

Figure 2 is a fragmentary elevational view similar to Figure 1 showing an alternative construction of a portion of the fastener;

Figure 3 is a fragmentary elevational view showing a portion of the structure of Figure 1 viewed at 90° from the showing in Figure 1;

Figure 4 is a fragmentary elevational view showing a portion of the structure of Figure 1 taken on an enlarged scale for clarity;

Figure 5 is an end view showing the structure of Figure 4; Figure 6 is a cross-sectional view taken along the lines VI-VI of Figure 5 showing details of the structure;

Figure 7 is a cross-sectional view taken along the lines VII-VII of Figure 5 showing further details of the structure;

Figure 8 is a cross-sectional view taken along the lines VIII-VIII of Figure 5 showing the fastener details at that section; and

Figure 9 is an elevational perspective view of one of a pair of dies in accordance with the present invention, used in the manufacture of a drilling and thread forming fastener such as are described with reference to Figures 1 to 8.

Referring now to the drawings, and in particular to Figures 1 and 2, there is shown a drilling and thread forming fastener 10 having a hexagonal head 11, a threaded shank 12 and a pilot end 14. The fastener of Figure 1 also comprises an unthreaded shank portion 15 which extends from the threaded portion 12 to the pilot end 14.

The fastener 10A depicted in Figure 2 is identical to that of Figure 1 but for the deletion of the unthreaded shank portion 15 which is shown in Figure 1. Depending on the particular application, the unthreaded shank portion 15 may be of any suitable length, or may be eliminated, in which instance the pilot end 14 extends into the threaded portion, as in Figure 2.

The threaded shank 12 may contain lobes (not shown), or other form of thread forming elements well known in the art (not shown) which serve to provide threads in an opening formed by the pilot end 14 of either the fastener shown in Figure 1 or that in Figure 2.

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Referring now to Figures 4 and 5, the pilot end 14 is shown in detail as comprising a pair of arcuately shaped flutes 16 and 18 formed over substantially the length of the pilot end, and a pair of arcuate lands 20 and 22 adjacent the flutes.

Referring to Figure 5, it will be noted that in transverse cross-section a major axis X and a minor axis Y of the fastener, which are at right angles to one another, pass through the centre of rotation of the fastener and define the minimum transverse dimension (on the Y axis) and the maximum transverse dimension (along the X axis) of the pilot end 14 of the fastener. It will also be noted from Figure 5 that the intersection of the arcuate land 20 or 22 with an associated arcuate flute 16 or 18 occurs on the major axis X-X and defines a pilot cutting edge 24 or 26 which lies in a plane with the centre of rotation of the fastener. This pilot cutting edge 24 or 26 extends over the greater portion of the pilot end 14 and is depicted in Figures 7 and 8 which are sections taken along the pilot end of the fastener. It will be understood that the configuration of the pilot end 14 is such that opposed quadrants of the fastener contain the lands 20, 22 and the flutes 16, 18 which are dimensionally the same at any right angle section of the fastener 10 or 10A and any description of the invention which will be made with reference to flute 16 and land 20 will be equally applicable to flute 18 and land 22.

In Figures 7 and 8, land 20 and flute 16 are shown having a respective radius RL and RF defining surfaces which meet at a surface 28 having a radius RS, which radius is smaller than that radius of land 20, or flute 16. Thus, the entire surface of the pilot end 14 over substantially the entire length of the pilot end contains no sharp corners other than the cutting edges 24 and 26. A drilling tip 30 is formed at the distal end of the pilot end 14 and at the



maximum dimension along the X-X plane of the cutting edges 24, 26. The cutting edges 24 and 26 extend from the cutting tip 30 towards the head 11 of the fastener inwardly towards the centre of rotation of the fastener at an angle P (see Figure 2) which is generally in the area of one degree, depending upon the application.

Referring to Figure 3, it will be seen that the dimension of the pilot end 14 along the minor axis also is provided with a taper angle Q which is in the area of four degrees (4°) and in the opposite direction from that of the pilot end cutting edges, tapering toward the centre of rotation of the fastener, from the threaded shank towards the drilling tip 30.

Reference should now be made to Figures 3, 4 and 5 wherein the drilling tip 30 is shown in detail. The drilling tip 30 comprises a pair of substantially flat planar surfaces 32, 34 which extend from the widest part of the pilot end 14 to a point adjacent the intersection of the X and Y axes of the fastener and are disposed at an angle R to the X axis as best shown in Figure 5. Each of the planar surfaces 32 and 34 terminates at a radial cutting edge 36 or 38 (Figure 4); they are connected by a linear tip cutting edge 40 intersecting the axis of rotation of the fastener.

In operation, the drilling tip 30 performs the function of starting the drilling operation when the tip cutting edge 40 is rotated into the material and the radial cutting edges 36, 38 serve their drilling function in the metal, much in the manner of a power drill. However, the transition from this operation takes place between the flat planar surfaces 32, 34 which are provided with a transition into the flutes 16 and 18, wherein metal chips are directed upwardly and out of the opening being formed by the drill tip 30. The heavy gauge material then is encountered by the pilot end cutting edges 24 and 26 which serve to continually ream the material from the drilled portion, and to direct

chips of material upwardly and away from the drilled hole. Thus, the combination of surfaces serves to produce a fastener having a pilot end 14 which is efficient and effective in drilling materials of heavier gauge, yet may be employed over a wide range of material thicknesses.

Additionally, it has been found that the disclosed configuration, in addition to its applicability where heavy gauge metal materials are used, is extremely effective in cement or cinder block applications.

In the context of manufacturing, it will be noted from the sections shown in Figures 6, 7 and 8 that in manufacturing the subject fastener by a forging process, if the dies are manufactured to separate at the cutting edges 24, 26, that is, the separation plane of the dies lies generally along the axis X-X of the fastener 10, the entire die cavity may be constructed without any sharp indentations on the surfaces thereby eliminating areas subject to undue stress within the forging dies. This is an extremely important factor in the manufacture of drilling and thread forming fasteners by the forging process, in that the life of the die is an important economic factor in the mass production of such fasteners.

A die 48 which comprises one-half of a die set employed in the manufacture of the fastener 10 or 10A is shown in Figure 9 wherein a cavity 50 is formed in the die to forge an article of round stock into the desired configuration, when pressed between mating dies.

The cavity 50 comprises an outwardly projecting arcuate surface 116 for forming the flute 16, an inwardly projecting arcuate surface 120 for forming the land 20 and a smaller radius arcuate surface 128. With a pair of mating dies constructed in the form of die 48, the cutting edges 24, 26, 36, 38 and 40 are all formed at the separation line 124 of the dies. Therefore, there are no sharp angles or indentations formed in the cavity 50, and stress points are

substantially reduced in the die 48, and its corresponding mating die (not shown).

It has therefore been shown that by forming a drilling and thread forming fastener using a forging die within the teachings of the present invention, the various objects set forth are achieved. The desirability of the forging die is further increased in that the manufacture of the fastener is more economical than in the prior art, due to increased die life.

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Claims

1. A forging die for forming a drilling and thread forming fastener comprising a cavity wherein said
5 cavity is formed having a first arcuate surface projecting outwardly into said cavity and terminating at the edge of said cavity, a second arcuate surface projecting inwardly and terminating at the opposite edge of said cavity, each surface extending over substantially the length of said
10 cavity, and wherein said first and second arcuate surfaces are connected by a third arcuate surface of a smaller radius than said first and second arcuate surfaces whereby said cavity is substantially free of sharp indentations on the surfaces.

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2. A forging die for forming a drilling and thread-forming fastener substantially as hereinbefore described with reference to Figure 9 of the accompanying
20 drawings.

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