

COLD-HEADED STANDOFF1 FIELD OF THE INVENTION

2 The present invention relates to the formation of a self-clinching type metal
3 fastener by a progressive forging process.

4 BACKGROUND AND DESCRIPTION OF THE PRIOR ART

5 Internally-threaded, self-clinching type fasteners are well-known in the art.
6 When installed, they provide materials such as sheet metal panels with a threaded
7 structure to receive a screw so that elements can be secured to the panel. A typical
8 self-clinching fastener of the standoff type which includes an elongate barrel is shown
9 in Figures 3 and 4. The basic structures of this type of fasteners include a head, a self-
10 clinch groove, a barrel, and an internal bore with threads. The fastener is installed by a
11 press and anvil so that the groove receives the cold flow of metal from the sheet while
12 the polygonal head is embedded into the sheet. These structures secure the fastener to
13 the sheet rigidly, both axially and rotationally.

14 One effective means for producing a self-clinching fastener of the above-
15 described type is by a progressive die forging process. This process utilizes sequential
16 punch and die forging to create the head, the clinch groove, the barrel, and the internal
17 bore of the fastener from a metal blank or slug. Such a formation process is described
18 for example in U.S. Patent Application Serial No. 2002/0054806 entitled "Grooved
19 Nut and Manufacturing Method Thereof" filed on January 3, 2001 by Sakamura et al.
20 and published on May 9, 2002. This document discloses the progressive punch and

1 die tooling used in this process as exemplified by Figure 3. As shown in this figure, a
2 horizontally reciprocating ram holds a series of punches, each opposite a respective die
3 providing a series of forging stations. The punches and dies progressively form the
4 basic shape of the fastener from a blank of metal which is moved between stations
5 after each stroke of the ram. The shearing action between the punch and die of the
6 final station trims metal from around the edge of a temporarily formed circular head of
7 the fastener as the blank is pushed through the die by the punch to create the final
8 polygonal shape.

9 A problem exists with this manufacturing process, however, because the
10 shearing process in the last station of the progressive forging leaves an undesirable
11 upward-facing burr on the top side of the head of the fastener. Furthermore, there is
12 another problem with this final head trimming station in that the scrap ring which
13 results from cutting the material away from the periphery of the circular head to
14 achieve the final polygonal shape often sticks to the face of the trim die, obstructing
15 the continuous operation of the progressive forging process. There is therefore a need
16 in the art to utilize a cold forging process to create a self-clinching fastener which does
17 not have these deficiencies.

18 SUMMARY OF THE INVENTION

19 The present invention has been devised to cure the above-described problems
20 of the undesirable manufacturing burr on the head of the fastener and to effect the
21 efficient removal of the trimmed scrap ring at the final station of the head trimming
22 station of the forging process. According to one aspect of the invention, the forging

1 apparatus of the prior art is modified in that the punch and die tooling in the head
2 trimming station are reversed in position. That is, the punch is positioned on the die
3 block while the die is located on the reciprocating punch block. This reverses the
4 direction of relative movement between the fastener and the die so that the burr is
5 formed on the underside of the fastener head rather than the top side. This is more
6 desirable since the underside of the head is embedded into the sheet material once the
7 fastener is applied to a sheet. The burr is then not visible and cannot affect the final
8 appearance of the clinched assembly. Because in the new system the barrel of the
9 fastener is necessarily held within a cavity of the trim punch at the last station, an
10 added reciprocating knock-out pin is employed to eject the part from the punch and
11 through the opposite side of the die.

12 Reversing the relative direction of movement between the die and the fastener
13 during head-trimming also leaves the scrap ring around the outside of the punch at the
14 final station rather than against the face of the die as in the prior art. This is
15 advantageous since the scrap ring then may be quickly and reliably removed from
16 around the trim punch by a stripper sleeve which pushes the scrap ring off the end of
17 the trim punch after the trim process is completed. This avoids the unreliable scrap
18 removal of the prior art. Additionally, this is also advantageous in separating the
19 finished product from the scrap material, whereby also eliminating the need for costly
20 sorting or manual inspection operations to remove the scrap from the finished product.

21 Steps of the forging process of the invention at the final head-trimming station
22 may be further described as follows. The fastener blank having a tubular barrel and a

1 temporarily formed circular head is placed into a bore of a punch with the barrel of the
2 fastener residing in the bore and an underside of the circular head abutting an end face
3 of the punch. The forging apparatus then moves the die toward the top side of the
4 fastener until a polygonal cutting edge of the die shears metal from around the edges
5 of the circular head of the fastener blank. Movement of the die stops when the cutting
6 edge lies beyond the punch end face and the underside of the head of the fastener. At
7 this point, a knock-out pin which is reciprocal within the bore of the punch forceably
8 ejects the fastener through a passage in the die and beyond an opposite side of the die
9 into a container for completed parts. The forging apparatus then moves the die away
10 from the punch. Once the die is clear of the punch, a stripper sleeve which is
11 reciprocal about the outside surface of the punch moves from a retracted position over
12 the end of the punch and in doing so removes a scrap ring left around the outside of
13 the punch. Since the orientation of the tooling is horizontal, the scrap ring then falls
14 away from the punch by gravity, and may also be assisted by pressurized oil or air to
15 ensure the downward motion of the scrap ring is achieved. The cycle is then
16 completed and the trim station is now ready to receive the next partially formed
17 fastener blank.

18 The apparatus for performing the inventive head-trimming process comprises a
19 stationary punch having a bore for holding a barrel portion of a fastener blank, an end
20 face for supporting an underside of a head portion of the fastener blank when held in
21 the bore, and a polygonal shank. The invention further includes a reciprocal die having
22 an internal passage and a trim plate including an aperture, the trim plate aperture

1 having a circumferential polygonal edge closely corresponding to dimensions of the
2 shank of the punch for receiving the punch. The die is movable from a retracted
3 position toward a top side of the fastener blank to an extended trim position where the
4 cutting edge lies beyond the punch end face. There is a knock-out pin reciprocal
5 within the punch bore for ejecting the fastener blank from the bore and through the die
6 passage to an opposite side of the die. A stripper sleeve slidably mounted to the
7 outside surface of the punch is reciprocal between retracted and extended positions by
8 a spring-activated mechanism, the extended position placing a distal end of the sleeve
9 even with the punch end face for removing a scrap ring from the punch. Since the die
10 is movable in a substantially horizontal plane, the scrap ring falls away from the end
11 face of the punch by the force of gravity and can be assisted by pressurized oil and or
12 air as needed. Other objects and advantages of the present invention will be readily
13 apparent to those of skill in the art from the following drawings and description of the
14 preferred embodiments.

15 BRIEF DESCRIPTION OF THE DRAWINGS

16 Figure 1 is a top diagrammatic view of a prior art multi-station cold forging
17 apparatus.

18 Figure 2 is a top plan view diagrammatically showing the cold forging
19 apparatus of the present invention.

20 Figure 3 is a side partial cross section view of a fastener formed by the prior art
21 method.

22 Figure 4 is a partial cross section view with an enlarged area of a fastener

1 produced by the present invention.

2 Figure 5 is an exploded isometric assembly view of the various elements of the
3 present invention corresponding to forging station number six shown in Figure 2.

4 Figures 6A through 6D are side elevation partial cut-away views of the cold
5 forging apparatus of the present invention showing its sequential operation.

6 DESCRIPTION OF THE PREFERRED EMBODIMENT

7 Figure 1 diagrammatically depicts the cold forging apparatus of the prior art
8 which includes reciprocating punch block 11 that holds a series of punches 8 that
9 strokes toward and away from die block 13 that holds a series of dies 9 to perform a
10 sequential forging of a metal slug 15 into the general shape of a standard type self-
11 clinching fastener as shown in Figure 3. This prior art apparatus and the apparatus of
12 the present invention both utilize six forging stations, S1 through S6, beginning with a
13 first station in which metal slug 15 has been severed from a rod-like substrate material
14 17 and ending with the final sixth station where the cylindrical head is trimmed to a
15 hexagonal shape on a fully formed part. The slug is sequentially moved between
16 stations from one die cavity to the next after each stroke of the punch block by a
17 transfer mechanism well known in the art (not shown). The invention lies within the
18 apparatus and operation of the sixth and final forming station where the circular head
19 of the fastener blank is trimmed to a hexagonal shape.

20 Referring now to Figure 2, the fifth and sixth stations of the present invention
21 are depicted, stations 1-5 being essentially the same as shown in the prior art device of
22 Figure 1. One of the aspects of the invention is the reversal of punch 8 and die 9

1 elements of the previous stations so that the die assembly **12** of the invention at the
2 sixth station is held by the reciprocating punch block **11** while the punch assembly **14**
3 is fixed in the stationary die block **13**. By reversing the position of these elements, the
4 direction of the head trimming shear is reversed. Also, as will be further described, the
5 finished part is ejected through the punch block rather than falling through the
6 stationary die block **13** as in the prior art.

7 Changing the direction of trim operation has the beneficial effect on the surface
8 characteristics of the fastener head as depicted by Figures 3 and 4. As shown in Figure
9 3, the prior art method of cold forging shown in Figure 1 results in an upward-facing
10 trim burr which protrudes from the head of the fastener. This burr is a rough and
11 sharp edge which is aesthetically undesirable. Using the apparatus of the present
12 invention however the burr, which inevitably results from the die shearing method of
13 trimming the head to its final hexagonal shape, now resides along the underside surface
14 of the head of the fastener. Since after installation the head of the fastener is
15 embedded in a substrate material, the trim burr is not visible and the top surface of the
16 head of the fastener is flush with the outside surface of the substrate exhibiting an
17 aesthetically acceptable final appearance after assembly.

18 Referring now to Figure 5, the various elements of the invention at the sixth
19 station shown in Figure 2 are depicted further including the resulting finished part **16**
20 and the trim scrap ring **18**. Trim die **12** includes trim plate **27** that has a hexagonal
21 opening with a cutting edge along its inside surface. Punch assembly **14** includes a
22 holder **19** that rigidly secures hexagonal punch **23**. The punch assembly further

1 includes a stripper sleeve 25 and a knock-out pin 21 that are slidable within the
2 assembly relative to the fixed punch 23 and holder 19. Means to effect the motion of
3 the stripper sleeve and the knock-out pin are not shown and are well within the
4 knowledge of one of skill in the art.

5 Referring now to Figures 6A through 6D, the four stages of the trim process
6 using the apparatus depicted in Figure 5 are shown in sequence. Referring first to
7 Figure 6A, the fastener blank 16 is delivered by a transfer mechanism (not shown) so
8 that a barrel of the fastener resides within the cylindrical bore of a hexagonal punch 23
9 which is rigidly secured within holder 19. The first step in the trim process begins with
10 the motion of the die 12 toward the fastener. In this position, the underside of the
11 circular head 15 of the fastener blank abuts an end face of the punch.

12 Referring now to Figure 6B, the die has moved to the end of its stroke to the
13 completed trim position. A cutting edge on the trim plate 27 on the face of the die has
14 severed a scrap ring 18 from the fastener blank which is sheared by the punch 23 from
15 the circular head of the fastener to provide a resulting hexagonal shape. The
16 hexagonal head now resides within a passage of the die beyond a backside of the trim
17 plate.

18 The next step of the operation of the invention is shown in Figure 6C. The
19 knock-out pin 21 which is preferably spring-loaded (spring mechanism not shown) is
20 released and forceably ejects the finished fastener 16 through the die passage 20 and
21 away from an opposite side of the die falling away by the force of gravity as depicted
22 by the arrows shown in this figure. It should be noted at this stage that the scrap ring

1 **18** remains around the outside of the punch **23**.

2 The final stage of the operation of this station is shown in Figure 6D in which
3 several events occur simultaneously. While the die **12** is being withdrawn to its home
4 position, the knock-out pin **21** is retracted and stripper sleeve **25** is extended to a point
5 flush with the end face of the punch, forcing the scrap ring **18** off of the end of the
6 punch and away from the apparatus by gravity as shown by the arrows. Thereafter,
7 the stripper sleeve **25** is retracted to its home position flush with the endface of holder
8 **19**. Now the elements of the punch assembly are in the same position shown in Figure
9 6A ready to accept the next fastener from the transfer mechanism and the cycle is thus
10 complete.

11 It should be understood that there may be other modifications and changes to
12 the present invention that will be obvious to those of skill in the art from the foregoing
13 description, however, the present invention should be limited only by the following
14 claims and their legal equivalents.

CLAIMS

- 1
2 1. A fastener blank head-trimming device utilized in a cold-forging
3 apparatus, comprising:
4 a stationary punch holder;
5 a punch having a bore for holding a barrel portion of a fastener blank
6 including an end face for supporting an underside of a head portion of said fastener
7 blank held in said bore and having a polygonal shank; and
8 a die having an internal passage and a trim plate including an aperture,
9 said trim plate aperture having a circumferential polygonal cutting edge closely
10 corresponding to dimensions of the shank of said punch for receiving said punch, said
11 die being movable coaxially relative to said punch from a retracted position toward a
12 top side of said fastener blank to an extended trim position where said cutting edge lies
13 beyond the punch end face.
- 14 2. The apparatus of claim 1 further including a knock-out pin reciprocal
15 within said punch bore for ejecting said fastener blank from said bore and through said
16 die passage to an opposite side of said die.
- 17 3. The apparatus of claim 2 further including a stripper sleeve slidably
18 mounted to the outside surface of said punch, said sleeve being movable between
19 retracted and extended positions, said extended position placing a distal end of said
20 sleeve beyond said punch end face for removing a scrap ring from said punch.
- 21 4. The apparatus of claim 3 wherein said die is movable in a substantially
22 horizontal plane and said scrap ring falls away from the end face of said punch by the

1 force of gravity upon removal from said punch.

2 5. The method of head trimming a fastener blank in a cold-forging
3 process, comprising:

4 placing a fastener blank into a bore of a punch having an end face;

5 supporting an underside of a head portion of said fastener blank with
6 said punch end face;

7 moving a die having an internal passage and a trim plate with a cutting
8 edge toward said fastener blank;

9 shearing the head of said fastener blank with the cutting edge of the
10 trim plate;

11 stopping movement of said die at an extended trim position where said
12 cutting edge lies beyond an underside of the head portion of said fastener blank;

13 ejecting said fastener blank from said punch bore and through said die
14 passage to an opposite side of the die;

15 retracting said die; and

16 removing a scrap ring from around the punch by moving a stripper
17 sleeve slidably mounted to the outside surface of said punch until said scrap ring is
18 pushed off the end face of the punch by said sleeve.