July 8, 1969 R. M. VAUGHN 3,453,972

APPARATUS FOR FORMING UNDERCUT SCREW HEAD SLOTS

Original Filed Jan. 14, 1966

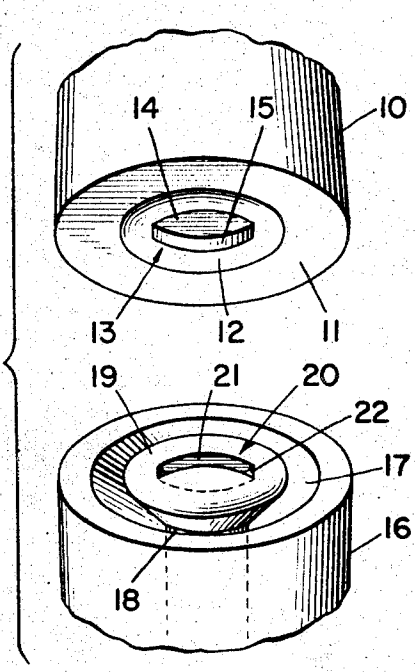



FIG. 1.

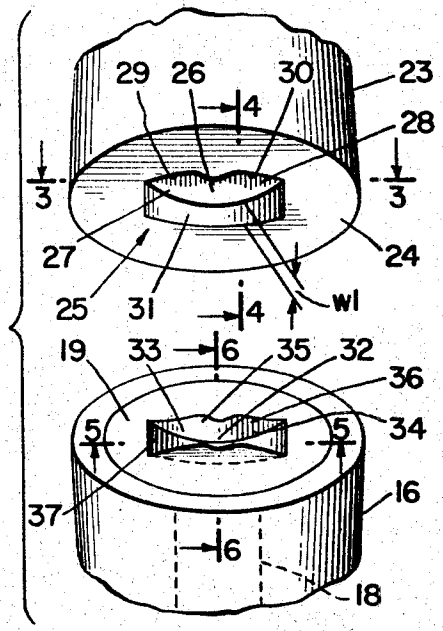



FIG. 2.

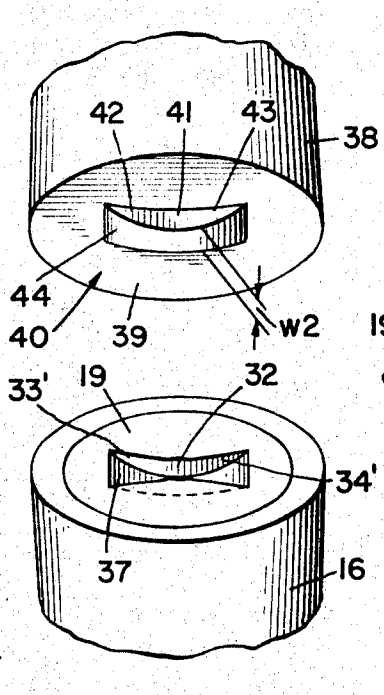



FIG. 7.

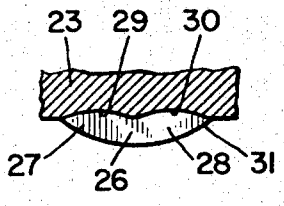



FIG. 3.

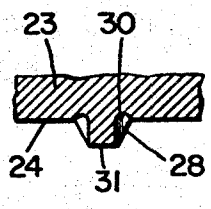



FIG. 4.

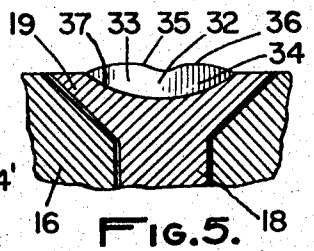



FIG. 5.

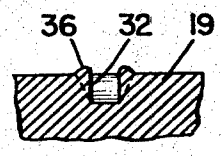



FIG. 6.

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# APPARATUS FOR FORMING UNDERCUT SCREW HEAD SLOTS

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Original application Jan. 14, 1966, Ser. No. 520,727, now Patent No. 3,388,411, dated June 18, 1968. Divided and this application Dec. 8, 1967, Ser. No. 720,005

Int. Cl. B23g 9/00; B21k 23/00

U.S. Cl. 10—7

3 Claims

## ABSTRACT OF THE DISCLOSURE

An apparatus is provided for forming an undercut slot in the head of a screw. This is accomplished by forming the screw head with raised portions bordering on a modified diverging slot structure formed in the head and then flattening the top surface of the head to cause the raised portions to expand laterally and thereby define the desired undercut slot with diverging side wall. The provision of the raised portions and the flattening of the top surface of the screw head are accomplished by successive headers which impact the screw head.

This application is a division of my copending application Ser. No. 520,727 filed Jan. 14, 1966, now U.S. Patent 3,388,411 issued June 18, 1968.

This invention relates generally to apparatus for forming screw head slots and more particularly to an improved apparatus for forming an undercut slot in a screw head for cooperation with a high torque driver member.

To enable a high torque to be applied to a slotted screw head or bolt, the slot has generally been designed with undercut sidewalls to prevent camming of the driver edges of the screw driver out of the slot. The driver itself may be provided with diverging driving sidewalls to correspond substantially to the undercut portions of the slot walls. A slotted screw head of the foregoing type is fully described in my United States Patent No. 2,667,985 and a desired type of driver for such screw head slot is shown and described in my United States Patent No. 2,808,087.

In the above-noted patents, the slotted screw heads and drivers are designed such as to enable full surface contact between the driving surfaces of the driver itself and the slot walls. By this arrangement, the forces exerted on the sidewalls of the slot are distributed over a relatively large area.

In an improved version of a screw driver for use in slotted screw heads of the type described in my United States Patent No. 2,677,985, the driver walls diverge as before but constitute modified non-planar surfaces to effect an initial engagement on slot side-walls at the central portion of the screw head. As increased torque is applied, the sidewalls of the screw slot will yield until eventually full surface contact is achieved. By employing such an improved type of driver, a higher torque is possible. Such improved screw driver is described in my United States Patent No. 2,994,354 for "Improved Screw Driver."

As a consequence of the capability of the screw head slot sidewalls to yield under high torque, it is not always essential for many applications that the undercut sidewalls of the screw head slot define perfect non-planar undercut surfaces, such as shown in my above referred to United States Patent No. 2,677,985. Any deviations from the type of surface which yields full surface contact will not be serious, provided that the slots are still undercut and include diverging sidewalls, such deviations yielding to the high torque applied by a driver so that eventually full surface contact is realized.

Thus, for many applications, it is not required that the non-planar slot sidewalls be manufactured with the precision required for certain special applications. In these latter special instances, the provision of the undercut non-planar slot sidewalls generally requires a series of milling operations which is time consuming and expensive. It would be desirable if the advantages of a high torque screw slot could be achieved and yet the forming of the slot itself simplified to the end that high torque screws could be manufactured more rapidly and thus more economically than heretofore possible.



One means for more rapidly and economically manufacturing a screw head is by a cold heading process wherein a single header member is caused to strike the head of the screw and thereby form the slot. With such a member, it is possible to form a slot with diverging sidewalls, although the sidewalls themselves are not undercut. However, by using a high torque driver, the inner, lower marginal ends of the slot adjacent the bottom will yield to be formed into an undercut configuration when a high torque is applied to the driver. Such type of slot formed with a single header member is described in United States patent application Ser. No. 16,531, filed Mar. 21, 1960, and entitled, "Screw Head Slot," now abandoned.

While heading operations in forming screw head slots are known in the art, there is not any obvious means of forming an undercut slot by a heading operation. If such could be achieved, the desirable feature of being able to form high torque screw head slots in a rapid and economical manner could be realized.

More particularly, it is an object to provide a screw head slot having undercut sidewalls wherein simple cold heading operations are carried out on the screw head as opposed to expensive and time consuming milling operations, all to the end that a more rapid and economical manufacturing of the screw head slot structures can be realized.

Another important object is to provide an apparatus for forming a high torque screw head slot having diverging undercut sidewalls for use with high torque screw drivers such as shown and described in my above referred to United States Patent No. 2,808,087 and with my improved modified driver structure shown and described in my other above referred to United States Patent No. 2,994,354.

Briefly, these and many other objects and advantages of this invention are attained by employing a series of cold heading operations on the head of a screw. In accordance with the invention, the head of the screw is first shaped into an upraised convex surface having a transverse slot with an arcuate bottom and straight parallel sidewalls. The head of the screw is then modified to flatten the head and form the slot with diverging sidewalls having upraised marginal portions adjacent the upper marginal edges of the diverging sidewalls. Finally, the head is flattened to cause the upraised portions adjacent the upper marginal edges of the slot to expand laterally and thereby define an undercut slot.

The preferred apparatus in accordance with the present invention comprises first, second, and third header members having suitable impact surfaces designed to shape the head of the screw and slot in the manner described.

A better understanding of the invention will be had by now referring to the preferred embodiment thereof as illustrated in the accompanying drawings, in which:

FIGURE 1 is a fragmentary perspective view illustrating a first header member and a die for holding a screw for carrying out a first step of the method in forming an undercut screw head slot;

FIGURE 2 is a view similar to FIGURE 1 showing a second header member for modifying the screw head and slot structure of FIGURE 1;

FIGURE 3 is a fragmentary cross section taken in the direction of the arrows 3—3 of FIGURE 2;

FIGURE 4 is another fragmentary cross section taken in the direction of the arrows 4—4 of FIGURE 2;

FIGURE 5 is a third fragmentary cross section taken in the direction of the arrows 5—5 of FIGURE 2;

FIGURE 6 is a fourth fragmentary cross section taken in the direction of the arrows 6—6 of FIGURE 2; and,

FIGURE 7 illustrates in perspective view a third header member for completing the formation of the undercut screw head slot.

Referring first to FIGURE 1, there is illustrated in fragmentary form in the upper portion of the drawing a first header member **10** having an impact surface **11** including a concave surface portion **12**. A first protruding transversely extending slot forming member, designated generally by the numeral **13**, is positioned in the central portion of the concave surface **12** and includes straight parallel sidewalls, one of which is visible at **14**, and an end surface of convex arcuate shape as indicated at **15**.

Cooperating with the header member **10** is a die **16** having a conical recessed portion **17** receiving the head of a screw **18**. The head of the screw **18** is designated **19** and is shown after the header member **10** has impacted the screw head, which initially is in the form of a simple blank. It will be noted that the screw head **19** is formed by the concave surface **12** of the header member **10** into an upraised convex surface including a transverse slot, designated generally by the numeral **20**, having parallel sidewalls, one of which is indicated at **21** and an arcuate bottom **22** conforming to the first slot forming member **13** of the header member.

It should be understood in FIGURE 1 that the shaping of the head of the screw **18** into the upraised convex surface **19** with the slot **20** is such that the convex top surface **19** of the screw head extends above the plane of the die **16**.

Referring now to FIGURE 2, there is shown a second header member **23** having a flat impact surface **24** and a second protruding, transversely extending, slot forming member designated generally by the numeral **25**. As shown, the slot forming member **25** includes a flat sidewall in its central area **26**, the sidewall then diverging as at **27** and **28**. Further, the flat impact surface **24** includes recessed areas **29** and **30** at the intersection of the diverging wall portions **27** and **28** of the slot forming member **25** defining therewith marginal cavities, the purpose for which will become clearer as the description proceeds. The member includes an arcuate end surface **31**. In the perspective view of FIGURE 2, it is to be understood that the other side of the protruding slot forming member **25** has similarly shaped sidewalls merging into marginal cavities formed in the impact surface **24**.

After the second header member **25** has impacted the screw head surface **19** of FIGURE 1, the screw head will have a configuration as shown in the die **16** below the second header member **25** in FIGURE 2. Thus, the modified screw head slot has flat central sidewall portions such as **32** and diverging sidewalls such as indicated at **33** and **34**. Further, because of the cavities **29** and **30** described in the second header **23**, there result raised portions **35** and **36** along the upper marginal edges of the diverging sidewalls **33** and **34**. The bottom of the modified slot is arcuate as indicated at **37** to correspond with the convex arcuate end surface **31** of the second slot forming member **25**.

It will be evident from the foregoing description of the second header member **23** and its associated second slot forming member **25** that the resulting slot structure will assume a bow-tie configuration when viewed normal to the top surface **19** of the screw. The slot forming member itself, when viewed normal to the impact surface **24**, will also have a bow-tie configuration.

The foregoing step in the method of modifying the slot of FIGURE 1 into a slot having diverging sidewalls with upraised marginal portions constitutes an extremely important step of this invention. The exact configuration resulting from the impacting of the second header member **23** with the top surface **19** of the screw head will be better understood by referring to the various cross sections in FIGURES 3, 4, 5, and 6 wherein the numerals employed correspond to the same numerals used in FIGURE 2.



Thus, in FIGURE 3, the flat central portion of the sidewall of the second slot forming member in the second header **23** is shown at **26** and the diverging sidewall portions at **27** and **28** with their associated marginal cavities **29** and **30**. In the cross section taken at 90° of FIGURE 4, the recessed areas defining marginal cavities such as the cavity **30** will be clear.

In the cross sections of FIGURES 5 and 6 relating to the actual slot formed in the screw head, the configuration of the upraised portions **35** and **36** will be clear.

Referring now to FIGURE 7, the final step in the formation of the undercut screw head slot will be understood. In FIGURE 7, there is shown a third header member **38** having a flat impact surface **39** and a protruding transversely extending third slot forming member **40**. The slot forming member **40** has a sidewall including a flat central portion **41** and diverging wall portions **42** and **43**. Again, this third slot forming member, when viewed normal to the impact surface **39**, has a bow-tie configuration. However, the width between the diverging sidewalls indicated at W2 in FIGURE 7 is less than the width of the diverging sidewalls indicated at W1 in FIGURE 3.

As a consequence, after the header member **38** has impacted the screw head configuration described in FIGURES 2–6, the upraised portions are caused to expand laterally and thus provide the desired undercut sidewalls as indicated at **33'** and **34'** in FIGURE 7. In other words, the raised portions along the upper marginal edges of the slot expand inwardly towards each other as a consequence of the lesser width of the third slot forming member **40**. This arrangement permits the third slot forming member **40** to be withdrawn from the screw head slot and yet there still results the desired undercut sidewalls.

While the undercut sidewalls of the completed screw head illustrated in FIGURE 7 are not necessarily nonplanar surfaces of the type described in my referred to U.S. Patent No. 2,677,985, the slot configuration is sufficiently close that a high torque driver may readily be employed, any deviations from the exact desired surface as described in the above patent yielding under the high torque of the driver itself. The essential features of diverging and undercut side walls are preserved in the finished screw formed in accordance with the present invention so that insertion of a high torque driver and torquing of the screw can be carried out.

In the actual mass production of screws, the first, second, and third header members **10**, **23**, and **38** may be provided on a turret assembly and automatically actuated to impact the screw head successively, the same die **16** being employed in all instances. Alternatively, the die **16** may be caused to move in a linear manner beneath three serially spaced header members. In either event, the manufacture of the screw head slot can be carried out far more rapidly with a consequent savings in costs than by milling operations as have heretofore been required to form the screw head slots.

From the foregoing description, it will thus be evident that the present invention has provided a greatly improved apparatus for forming undercut screw slots in which the various objectives set forth are fully realized.

What is claimed is:

**1.** An apparatus for forming a slot in the head of a screw including: a header member having an impact surface including a protruding, transversely extending slot forming member with diverging side walls to define a bow-tie configuration when viewed normal to said impact surface such that upon impact with the head of said screw, the top surface of said head is provided with a transverse slot having diverging side walls, said impact surface in-

cluding recessed areas adjacent to the intersection of said walls therewith to define marginal cavities such that said slot in said head of said screw includes marginal raised portions along the upper marginal edges of the diverging side walls of said slot; and an additional header member having a flat impact surface with an additional protruding slot forming member with diverging side walls to define a bow-tie configuration when viewed normal to said impact surface, the width of said additional slot forming member measured between said diverging side walls being less than the width of said first mentioned slot forming member as measured between its diverging side walls such that impact of said additional header member on said head of said screw causes said raised portions to expand laterally and thereby modify the side walls of said slot into undercut side walls to provide an undercut slot.

2. An apparatus for forming an undercut slot in the head of a screw including: a header member having an impact surface including a protruding transversely extending slot forming member, areas of said impact surface adjacent said protruding slot forming member being recessed to define marginal cavities such that upon impact with the head of said screw, the top surface of said head is provided with a transverse slot having raised portions along portions of its upper marginal edges; and an additional header member having a flat impact surface with an additional protruding slot forming member of width less than the width of at least some portions of said first mentioned slot forming member such that upon impact of said additional header member with the top surface of said head of said screw, said raised portions are caused to expand laterally, thereby providing said undercut slot.

3. An apparatus for forming an undercut slot in the head of a screw including: first, second, and third header members for cold heading said head of said screw into said undercut slot upon successive impacts of said header members, said first header member having a concave impact surface with a protruding transversely extending first slot forming member in the central area of said concave



surface, said first slot forming member having a convex arcuate end surface and straight parallel sidewalls such that upon impact with the head of said screw, the top surface of said head is shaped into a convex top surface with a transverse slot having an arcuate bottom and straight flat sidewalls, said second header member having a flat impact surface with a protruding transversely extending second slot forming member having a convex arcuate end surface and sidewalls diverging from the central area of said flat impact surface to define a bow-tie configuration when viewed normal to said flat impact surface, areas of said flat impact surface adjacent the intersection of said diverging walls therewith being recessed to define marginal cavities such that upon impact with the head of said screw, said slot is further shaped to have diverging sidewalls and the top surface of said head is flattened except for raised portions along the upper marginal edges of said diverging sidewalls of said slot, and said third header member having a flat impact surface with a protruding transversely extending third slot forming member having a convex arcuate end surface and sidewalls diverging from the central area of said flat impact surface to define a bow-tie configuration when viewed normal to said flat impact surface, the width of said third slot forming member measured between the diverging wall portions thereof being less than the width of said second slot forming member measured between diverging wall portions thereof such that upon impact with the head of said screw, said raised portions along the upper marginal edges of said slot are caused to expand laterally to define said undercut slot with diverging sidewalls.

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RONALD D. GREFE, *Primary Examiner.*

U.S. Cl. X.R.

10—26