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Wedler

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[54] **METHOD AND APPARATUS FOR MAKING A FASTENER**

[75] Inventor: **John F. Wedler,** Pepper Pike, Ohio

[73] Assignee: **The Lamson & Sessions Co.,** Cleveland, Ohio

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[52] **U.S. Cl.** ..... **72/70,** 72/102, 10/86 F

[51] **Int. Cl.** **B21h 7/00**

[58] **Field of Search** ..... 72/70, 72, 80, 102, 429, 72/703; 10/85, 86 R, 86 F

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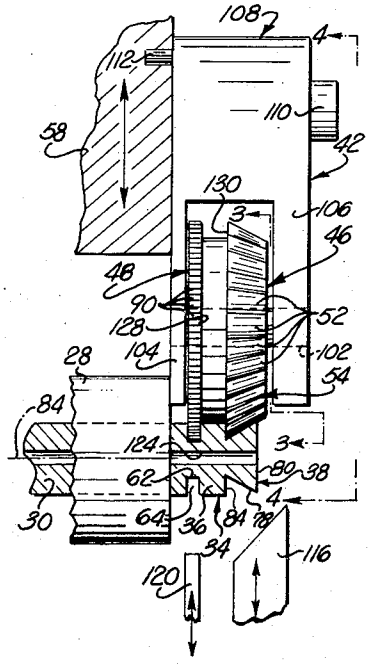
Primary Examiner—Lowell A. Larson

[57] **ABSTRACT**

An improved method and tool are utilized to form flat side surfaces on the outwardly flaring shank of an insert as it is rotated by the chuck of a screw machine. The insert is made by forming a blank having a cylindrical head and a frustro-conical shank which extends from one end of the head. The flat side surfaces are formed on the frustro-conical shank by the improved tool which has a form roller which is rotated by a drive roller. The drive roller has teeth or serrations which are pressed against the rotating insert to provide a positive driving action from the insert to the drive and form rollers. The form roller has a plurality of arcuate segments arranged in an annular array about its surface. These arcuate segments are shaped so as to form the flat surfaces on the rotating shank as the form roller is rotated by the drive roller and pressed against the shank.

27 Claims, 9 Drawing Figures



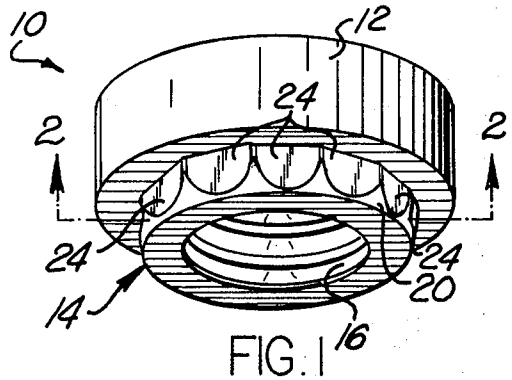


FIG. 1

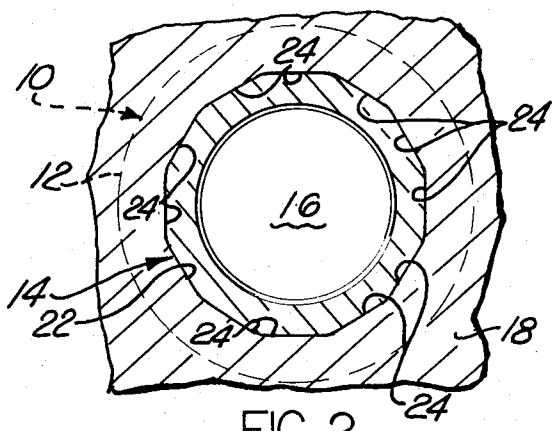


FIG. 2

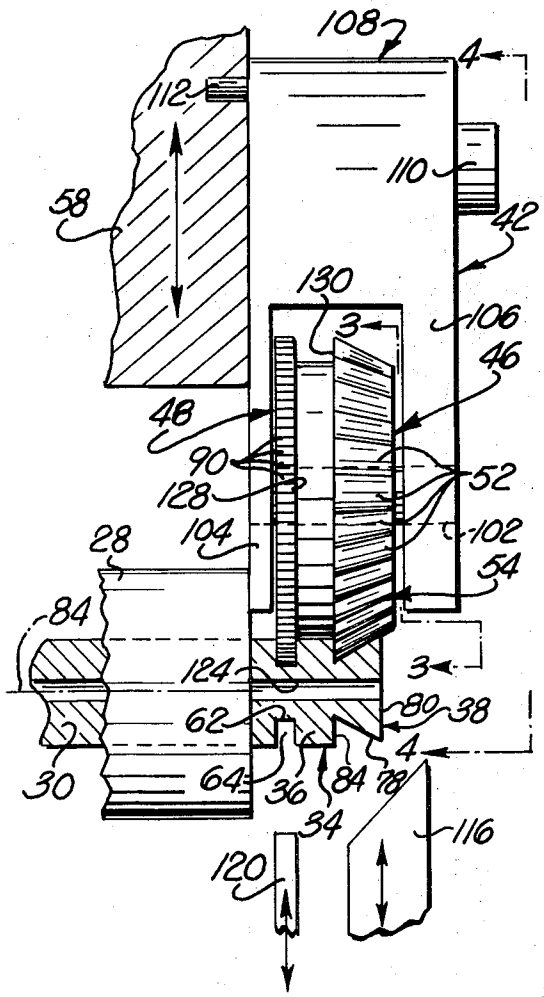


FIG. 3

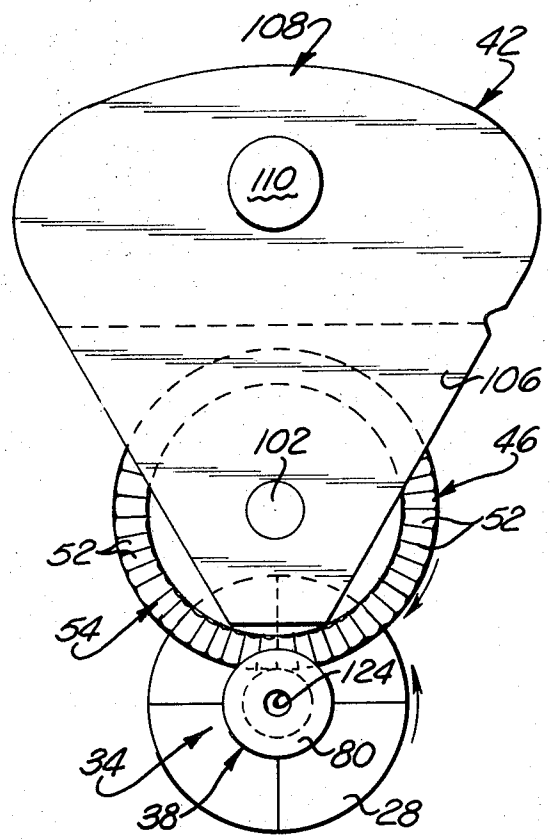


FIG. 4

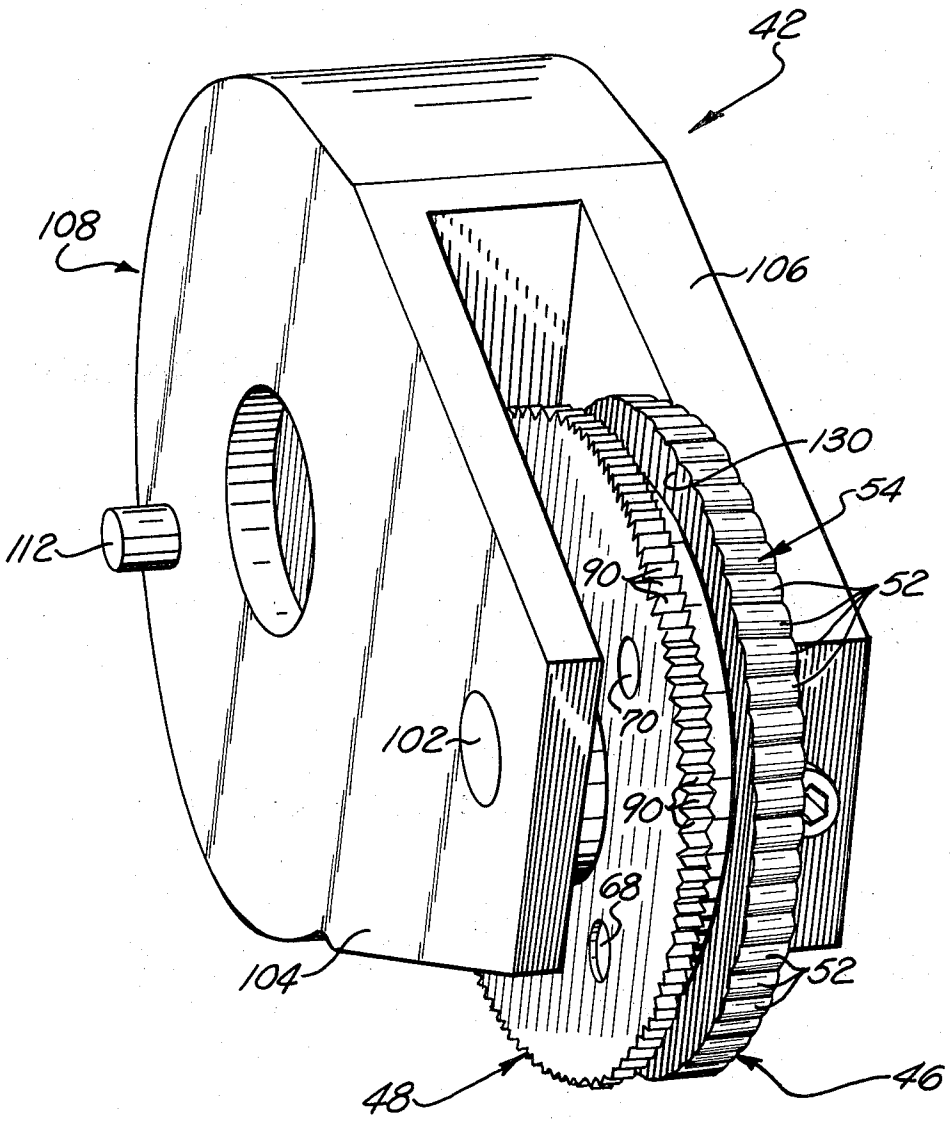


FIG. 5

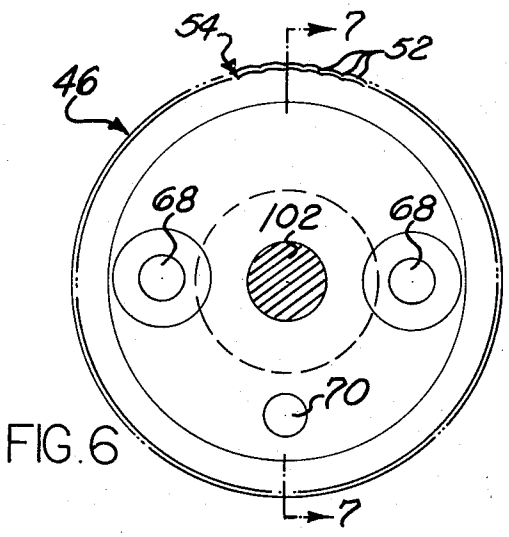


FIG. 6

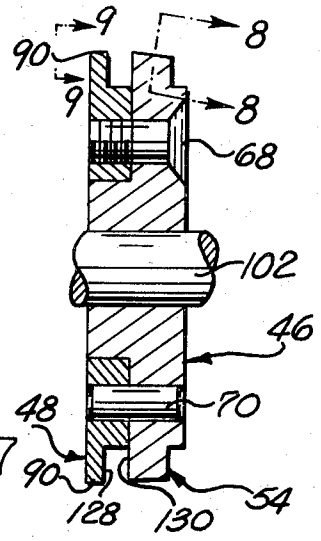


FIG. 7

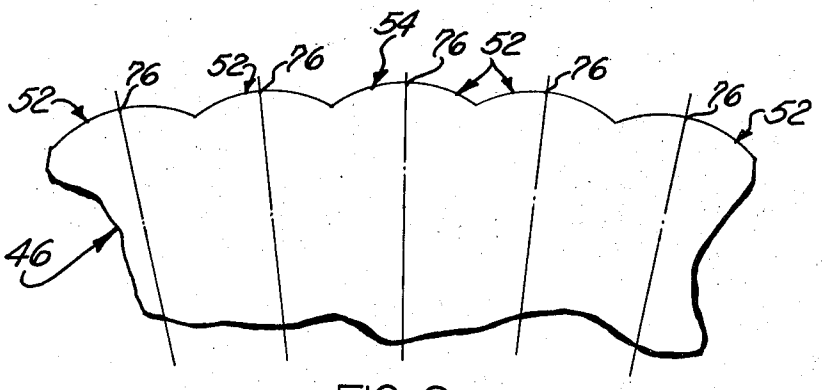


FIG. 8

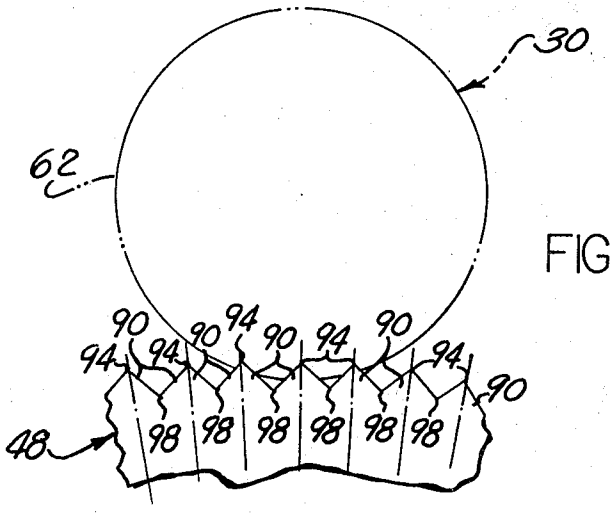


FIG. 9

METHOD AND APPARATUS FOR MAKING A FASTENER

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates generally to a method and apparatus for forming a plurality of surfaces about the circumference of a rotating workpiece and more specifically to a method and apparatus for forming flat surfaces on an outwardly flaring shank of an insert.

A self-staking insert having a polygonal shank with flat side surfaces which flare outwardly to a bluge at the outer end portion of the shank has been formed by upsetting or cold forging one end of the shank in the manner disclosed in U.S. Pat. No. 3,399,409. Although this method is generally satisfactory for forming self-staking inserts, problems have been encountered in forming inserts of a relatively small size. These problems arise due to the fact that small self-staking inserts are relatively difficult to handle and have very small shanks which are difficult to accurately and economically form to the desired configuration.

In an effort to solve the problem of economically making a relatively small self-staking insert of the type disclosed in U.S. Pat. No. 3,399,409, it was attempted to form the flat outwardly flaring side surfaces on the shank of a rotating insert with a fly cutter. However, due to the high speed of relative movement between the cutter and the shank, the cutter became dull or burned out after a relatively short time. The undercut or flaring configuration of the shank of the insert makes it difficult to form flat side surfaces on the shank by moving a toll axially along the shank with a reciprocating cutting action.

The present invention provides a new and improved method and apparatus which are advantageously utilized to form a plurality of flat outwardly flaring side surfaces on the shank of a small self-staking insert. The flat axially outwardly flaring surfaces are formed on the shank of the insert by cold working the shank as it is rotated by the chuck of a screw machine. This cold working is performed by arcuate segments arranged in an annular array on the periphery of a form roller. The form roller is rotated by a drive roller which is itself rotated by engagement with the rotating workpiece. Although in the present instance it is desired to form the shank of a self-staking insert with flat outwardly flaring surfaces, it is contemplated that either concave or convex surfaces could be formed on the shank of the insert if desired by changing the radius of curvature of the arcaute segments. While the method and apparatus of the present invention are particularly well suited to the formation of outwardly flaring surfaces on the shank of an insert, it is contemplated that the method and apparatus could be utilized to form many different types of items.

Accordingly, it is an object of this invention to provide a new and improved method and apparatus for forming a plurality of surfaces about the circumference of a workpiece as the workpiece is being rotated and which are advantageously utilized to form flat surfaces on the shank of an insert.

Another object of this invention is to provide a new and improved method of making an insert and which includes the steps of forming an outwardly flaring shank having a generally circular cross sectional configuration and forming the shank to a non-circular cross sectional configuration as it is being rotated.

Another object of this invention is to provide a new and improved method for forming a workpiece and which includes the steps of pressing a circular array of arcuate segments on a form roller against the workpiece as it is being rotated to form a plurality of surfaces on the workpiece.

Another object of this invention is to provide a new and improved method and apparatus for forming a plurality of axially extending flat surfaces about the circumference of a rotating workpiece by engaging the surface of the rotating workpiece with a rotating form roller.

Another object of this invention is to provide a new and improved tool for forming a plurality of surfaces on a rotating workpiece and wherein the tool includes a rotatable form roller and a drive roller which is connected with the form roller and transmits drive forces from the rotating workpiece to the form roller to rotate the form roller about its central axis, the form roller being provided with a circular array of arcuate segments which form the plurality of surfaces on the rotating workpiece during rotation of the form roller.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and features of the present invention will become more apparent upon a consideration of the following description taken in connection with the accompanying drawings wherein:

FIG. **1** is a pictorial illustration of a self-staking insert having a shank portion with flat side surfaces formed by a method and apparatus which are in accordance with the present invention;

FIG. **2** is a sectional view, taken generally along the line **2—2** of FIG. **1**, illustrating the engagement of the flat surfaces on the shank of the insert with a receiving plate or sheet member;

FIG. **3** is a schematic illustration depicting the formation of flat outwardly flaring surfaces on the rotating shank of an insert by a forming tool constructed in accordance with the present invention;

FIG. **4** is an elevational view, taken generally along the line **4—4** of FIG. **3**, further illustrating the relationship of the forming tool to the shank of the insert;

FIG. **5** is an enlarged pictorial illustration of the forming tool, depicting the relationship between drive and form rollers;

FIG. **6** is a plan view, taken generally along the line **6—6** of FIG. **3**, illustrating the configuration of the form roller;

FIG. **7** is a sectional view, taken generally along the line **7—7** of FIG. **6**, illustrating interconnections between the form and drive rollers;

FIG. **8** is an enlarged plan view, taken generally along the line **8—8** of FIG. **7**, illustrating the configuration of arcuate segments disposed in an annular array about the surface of the form roller; and

FIG. **9** is an enlarged plan view, taken generally along the line **9—9** of FIG. **7**, illustrating the configuration of a plurality of teeth arranged in an annular array about the perpheral surface of the drive roller.

DESCRIPTION OF ONE EMBODIMENT OF THE PRESENT INVENTION

A self-staking insert or nut **10** (FIG. **1**) formed by the method and apparatus of the present invention includes

a cylinderical head 12 and an outwardly projecting shank 14 which has a polygonal cross sectional configuration (FIG. 2). A tapped central opening 16 extends through the insert 10 and has internal threads for engagement with external threads on a bolt or other member. If the insert 10 is to be utilized as a bearing or support element, it is contemplated that the thread 16 would be omitted.

When the insert 10 is installed in a plate or a sheet metal member 18, the insert acts as its own punch to form a hole in the plate. Thus, the insert 10 is pressed against the plate 18 by a ram or other tool with sufficient force to cause a tapered leading end portion 20 of the shank 14 to punch a circular hole 22 in the plate. As this occurs, the shank 14 enters the hole 22 and the head 12 presses the metal of the plate 18 into tight engagement with flat outwardly flaring side surfaces 24 on the shank 14.

The flat surfaces 24 of the polygonal shank 14 engages the metal plate 18 and holds the insert 10 against rotation in the hole 22. The flat surfaces 24 extend axially between the inner and outer end portions of the shank 14. The flat surfaces are disposed in transversely extending planes which intersect in a radially extending plane through the shank 14 of the insert 10 (FIG. 2). The general configuration of the insert 10 and the manner in which it cooperates with the plate 18 is disclosed in U.S. Pat. No. 3,399,705 therefore will not be further described herein in order to avoid prolixity of description.

In accordance with the present invention, the insert 10 is made in a known screw machine having a chuck 28 which rotates a piece of bar stock 30 (FIG. 3). A blank 34 having a cylinderical head 36 and frustro-conical shank 38, corresponding to the head 12 and shank 14 of the insert 10, is formed on the outer or leading end of the bar stock 30 with known tools. The flat side surfaces 24 are then formed on the shank 38 with a forming tool 42.

The forming tool 42 includes a circular form roller 46 which is rotated by circular drive roller 48. The drive roller 48 is rotated by engagement with the rotating bar stock 30. As the form roller 46 is rotated by the drive roller 48, arcuate segments 52 arranged in a circular array on a scalloped forming surface 54 (see FIGS. 3, 4 and 5) cold work the shank 38 to form the flat surfaces 24.

When the flat surfaces 24 are to be rolled on the circular shank 38 of the blank 34, the forming tool 42 is moved radially inwardly toward the blank by a suitable cross slide or other device 58 on the screw machine. As the forming tool 42 is moved toward the blank 34, the drive roller 48 is moved into engagement with an annular bottom or inner surface 62 of a groove 64 at the inner end of the head of the blank (FIG. 3). Since the blank 34 is being rotated by the chuck 28, the drive roller 48 is rotated by engagement with the blank. Rotation of the drive roller 48 is transmitted to the form roller 46 by connecting screws 68 and pins 70 (FIGS. 6 and 7) which fixedly interconnect the drive roller and form roller.

Continued inward movement of the form roller 46 moves a crest portion 76 (FIG. 8) of one of the arcuate segments 52 into pressure engagement with a frustro-conical outer surface 78 of the shank 38 (see FIG. 3). At this time the form roller 46 is being rotated by the drive roller 48 in a direction opposite to the direction of rotation of the bar stock 34. For example in FIG. 4 the form roller 46 is shown rotating in a clockwise direction under the influence of the drive roller 48 while the bar stock 30 is being rotated in a counterclockwise direction by the chuck 28. Therefore, a crest 76 of an arcuate segment 52 is moving in the same direction as the surface 78 of the shank 38 while they are in engagement. The speeds of the engaging portions of the surface 78 and crest 76 will be substantially the same since the form roller 46 has approximately the same diameter as the drive roller 48 (see FIGS. 5 and 7).

Due to the relative rotation between the shank 38 and the form roller 46, the crest 76 of each of the arcuate segments 52 is moved in turn into engagement with the surface 78 of the shank. This results in the formation of a plurality of flat spots about the circumference of the shank 38. Initially the crests 76 of the arcuate segments 52 will barely engage the outer surface 78 of the shank 38. Therefore, each of the flat spots formed by the arcuate segments 52 will initially have a very small circumferential extent and will be separated from an adjacent flat spot by a circular arc formed by a portion of the shank surface 78. Although the flat spots are initially formed with a very small circumferential extent, the arcuate segments 52 slope or taper inwardly at the same angle as the surface 78 of the shank 38 (see FIG. 3) so that each of the flat spots extends from the head 36 of the blank 34 to a radially extending outer end face 80 of the blank.

The circumferential extent of each of the flats formed in the frustro-conical of the surface 78 of the shank 38 is increased by continuing the movement of the form roller 46 radially inwardly toward the central axis 84 about which the bar stock 30 is being rotated by the chuck 28 (FIG. 3). As the arcuate forming segments 52 are moved inwardly toward the center of rotation of the blank 34, the extent of engagement of the arcuate segments with the frustro-conical surface 78 of the shank 38 increases with a resulting increase in the circumferential extent of each of the flats and a decrease in the extent of the circular segments of the surface 78 between the flats. As the form roller 46 continues to move inwardly, the circumferential extent of the flats increases until flat side surfaces 24 (FIG. 1) are fully formed on the shank 38 of the blank 34. If desired, the inward movement of the form roller 46 could be stopped with a larger arcuate separation between the longitudinally extending side portions of the flat surfaces 24.

The fully formed flat surfaces 24 extend from a bottom surface 84 of the head 36 to the face end surface 80 of shank 38. To enable the flat surfaces 24 to be formed throughout the longitudinal extent of the shank surface 78, the arcuate segments 52 are formed about axes which slope inwardly toward the center of rotation of the form roller 46 at the same angle as the surface 78 of the shank 38 slopes inwardly toward the axis of rotation 84 of the blank 34. Therefore, each of the arcuate forming or working surfaces on the segments 52 extend outwardly from the head 36 of the blank 34 at the same angle as does the surface 78 of the shank 38 to provide for abutting engagement between the arcuate segments and the surface 78 of the shank 38 throughout the longitudinal or axial extent of the shank (see FIG. 3). This results in the formation of flat surfaces 24 having a generally trapezoidal configuration with one of the parallel sides adjacent to the annular

bottom surface 84 of the head 34 the other parallel side at the end face 80. However it should be understood that the flat surfaces will not be exactly trapezoidal since the middle of the shank 38 will tend to flow slightly outwardly toward the face surface 80 as the flat surfaces are formed in the shank.

The arcuate segments 52 (FIG. 8) are shaped so that the side surfaces 24 (FIG. 1) on the shank 14 of the insert 10 are flat and form cords of a major diameter circle circumscribing the shank and tangents to a minor diameter circle inscribed within the surfaces 24. However, the shape of the arcuate segments 52 could be changed to change the configuration of the surfaces 24 from the flat configuration shown in FIGS. 1 and 2. For example, arcuate segments 52 could be bowed outwardly from the configuration shown in FIG. 8 to form an indented or concave surface 24 in the shank 14 of the insert 10. By reducing the extent to which the arcuate segments 52 curve outwardly (as viewed in FIG. 8), the surfaces 24 can be formed with a convex configuration.

It should be noted that the frustro-conical surface 78 of the shank 38 (see FIG. 3) flares outwardly from the head 36 to the end face 80 of the shank. The flat surfaces formed in the shank 38 by the form roller 46 also flare outwardly from the head 36 to the face surface 80. This undercut or outwardly flaring configuration of the shank 38 makes it extremely difficult, if not impossible, to form the flats by moving a tool axially along the frustro-conical surface 78 of the shank. If a rotating fly cutter is utilized to form the flat surfaces 24 on the frustroconical shank 38, the speed of movement of the cutting edge of the fly cutter will be so great that the fly cutter will become dull or burn out after relatively few inserts 10 have been formed with the cutter. Since the outer surfaces of the arcuate segments 52 on the form roller 46 taper inwardly at the same angle as which the shank 38 flares outwardly, the form roller can be moved radially inwardly, that is in a direction perpendicular to the axis of rotation 84 of the blank 34, to form the outwardly flaring flat surfaces on the shank. Therefore, the form roller 46 is merely subjected to radially directed pressure forces as the flat surfaces 24 are cold forged or worked in the surface 78 of the shank 38 and the form roller will have a relatively long service life.

The drive roller 48 is driven by the rotating bar stock 30. To provide for a positive driving engagement between the bar stock 30 and the drive roller 48, a circular array of teeth 90 (FIGS. 5 and 9) is formed about the periphery of the drive roller 48. The teeth 90 indent the annular bottom surface 62 (FIG. 3) of the groove 64 as the cross slide 58 moves the drive roller 48 and form roller 46 radially inwardly toward the axis of rotation 84 of the bar stock 30. This indenting action provides a positive or gear type of driving relationship between the bar stock 30 and roller 48.

As the tool 42 moves inwardly toward the axis of rotation 84 the bar stock 30 to enable the form roller 46 to increase the circumferential extent of the flat surfaces formed on the shank 38, the depth to which the teeth 90 indent the surface 62 of the bar stock 30 increases. Thus as the tool 42 is initially moved toward the rotating bar stock 30, crests or peaks 94 (FIG. 9) on the teeth 90 are moved into engagement with the annular bottom surfaces of the groove 64 (FIG. 3) prior to engagement of the crests 76 of the arcuate segments 52 with the surface 78 of the shank 38. As the drive roller 48 continues to move inwardly, the peaks 94 on the teeth 90 begin to penetrate or indent the surface 62 (see FIG. 9) to provide for positive engagement of the drive roller with the rotating bar stock 30. At this time, the forming roller 46 will have just moved into engagement with the surface 78 of the shank 38. Still further inward movement of the forming tool 42 increases the extent to which the teeth 90 are indented into the bar stock 30 and the extent of pressure engagement between the form roller 46 and shank 38.

The teeth 90 are sized so that the root or bottom portion 98 of the teeth will not have moved into engagement with the bar stock 30 prior to complete formation of the flat surfaces 24 by the forming roller 46. If the space between adjacent teeth 90 became filled with metal prior to complete formation of the flats 24 on the shank 38, the metal between the teeth 90 would block further inward movment of the drive roller 48. This would prevent form roller 46 from moving further inwardly to completely form the flat surfaces 24. The teeth 90 have flank surfaces disposed at right angles to facilitate disengagement of the teeth from the bar stock 30.

The drive roller 48 and form roller 46 are mounted for rotation about a common support shaft or axle 102. The axle 102 extends between a pair of arms 104 and 106 (see FIGS. 3 and 5) of a support mounting bracket 108. The support bracket 108 is connected with the cross slide 58 by a shaft 110 (see FIGS. 3 and 4) and is held against rotation relative to the cross slide 58 by a position or locating pin 112. Although the support bracket 108 has been illustrated as having particular configuration, it is contemplated that the support bracket could have many different configurations and could be mounted in many different ways on a suitable support, such as the cross slide 58, for movement relative to the bar stock 30.

When the flat surfaces 24 have been fully formed in a shank 38, the cross slide 58 is moved away from the bar stock 30 to move the drive roller 48 and form roller 46 out of engagement with the blank 34. The tapered leading end portion 20 (see FIG. 1) of the insert 10 is then formed on the axially outer end portion of the shank 38 with a suitable forming or cutting tool 116 (see FIG. 3). The blank 34 is then severed from the bar stock 30 with a cutting or parting tool 120.

The cutting or parting tool 120 is utilized to form the groove 64 during initial formation of the blank 34. The drive roller 48 has a thickness which is very slightly less than the thickness of the cutting tool 120 and the teeth 90 on the drive roller can move into engagement with the bottom 62 of the groove 64. Since the drive roller 48 and the cutting tool 120 are of substantially the same thickness, the groove 64 is not unnecessarily extended along the bar stock 30 to thereby prevent wastage of material.

After the blank 34 has been cut from the end of the bar stock 20, a cylinderical central passage 124 is reamed and tapped to form the central opening 16 and complete the formation of the insert 10. The central passage 124 was drilled in the bar stock 30 prior to the forming of the blank 34 since the drilling of the single hole in a long piece of bar stock is easier than locating and drilling a hole through each one of the many small inserts 10 formed from the bar stock. However, it is necessary to ream the opening 124 prior to tapping since there will be a slight collasping of the opening due

to the forces applied against the shank **38** as the flats **24** are formed by the roller **46.** Depending upon the use to which the insert is to be put, it is contemplated that the central opening **16** would be left untapped.

The drive roller **48** and form roller **46** are axially separated by a distance equal to the axial thickness of the head **36** of the blank **34.** Thus, the distance between a radially extending inner side surface **128** of the drive roller **48** and a radially extending inner surface **130** of the form roller **46** is equal to the axial extent of the head **36** (FIG. **3**). Of course, the distance between the annular surfaces **128** and **130** varies with variations in the size of the head **12** and the insert **10.** In addition, the axial slope of the arcuate segments **52** of the form roller **46** and the axial extent of the arcaute segments may vary with variations in the size of the insert **10.** It should be understood that the slope of the surface **78** of the shank **38** and the arcuate segments **52** has been exaggerated in FIGS. **3** and **4** for purposes of clarity of illustration and that they will have a relatively small slope in accordance with FIGS. **6** and **7.**

In view of the foregoing description, it can be seen that the present invention provides an improved method and apparatus for forming a plurality of surfaces about the circumference of a workpiece as the workpiece is being rotated. Although the method and apparatus of the present invention can be used to form many different types of objects, they are advantageously used to form the insert **10** on a screw machine. During the formation of the insert **10,** the form roller **46** engages the outwardly flaring shank **38** of the blank **34** and forms a plurality of outwardly flaring flat surfaces **24** about the circumference of the shank. Although the arcuate segments **52** on the form roller **46** are shaped so as to form flat surfaces **24** about a circumference of the shank **38,** it is contemplated that the arcuate segments **52** could be shaped so as to form surfaces having a configuration other than the flat configuration illustrated in the drawings.

When flat surfaces **24** are to be formed on the outwardly flaring shank **38,** the form roller **46** is rotated by the drive roller **48.** The drive roller is itself rotated by engagement with the rotating bar stock **30.** As the form roller **46** is being rotated by the drive roller **48,** the arcuate segments **52** on the form roller are pressed against the rotating shank **38** to cold forge the surfaces **24** on the shank.

Having described a specific preferred embodiment of the invention, the following is claimed:

1. A method of making an insert adapted to be disposed in a hole in a plate or sheet member and having a head portion and an outwardly flaring shank which is adapted to be received in the hole and is of a noncircular cross sectional configuration throughout at least a portion of its length to enable the shank to resist rotation in the hole, said method comprising the steps of providing a longitudinally extending piece of material, forming the head portion of the insert from the piece of material, rotating the piece of material about its longitudinal axis, and forming the outwardly flaring shank of the insert from the piece of material, said step of forming the shank including the steps forming the shank with an axially outer end portion which is spaced from the head portion of the insert and has a first circular cross sectional area which is coaxial with the longitudinal axis of the piece of material in a first radial plane extending perpendicular to the longitudinal axis of the piece of material, forming the shank with an axially inner end portion which is adjacent to the head portion of the insert and has a second circular cross sectional area which is smaller than the first circular cross sectional area and is coaxial with the longitudinal axis of the piece of material in a second radial plane extending perpendicular to the longitudinal axis of the piece of material, and thereafter continuing the forming of the shank during rotation of the piece of material about its longitudinal axis by forming about the circumference of the shank a plurality of outwardly flaring surfaces extending transversely to each other and extending at least part way between the inner and outer end portions of the shank, said step of forming a plurality of outwardly flaring surfaces about the shank including the steps of forming the first circular cross sectional area at the outer end portion of the shank to a first noncircular cross sectional area as the piece of material is being rotated and forming the second circular cross sectional area at the inner end portion of the shank to a second noncircular cross sectional area which is smaller than the first noncircular cross sectional area as the piece of material is being rotated.

2. A method as set forth in claim **1** wherein said steps of forming first and second noncircular cross sectional areas during rotation of the piece of material include forming a plurality of flat surfaces flaring axially outwardly from the inner end portion of the shank to the outer end portion of the shank.

3. A method as set forth in claim **1** wherein said steps of forming the shank with axially outer and inner end portions having first and second circular cross sectional areas includes the step of forming at least a portion of the shank to the configuration of a truncated cone which extends between the inner and outer end portions of the shank and has its base at the outer end portion of the shank.

4. A method as set forth in claim **1** wherein said steps of forming first and second noncircular cross sectional areas during rotation of the piece of material include forming the first and second noncircular areas to a polygonal configuration.

5. A method as set forth in claim **1** further including the step of providing a tool having a circular drive roller and a circular form roller, said steps of forming the first and second noncircular cross sectional areas during rotation of the piece of material including the steps of pressing the circular drive roller against the rotating piece of material at a location axially displaced from the shank of the insert to rotate the drive roller under the influence of forces transmitted to the drive roller from the rotating piece of material, rotating the form roller under the influence of forces transmitted from the drive roller to the form roller, and pressing the form roller against the shank of the insert.

6. A method as set forth in claim **5** wherein said step of forming the head portion of the insert includes the step of forming a circular groove in the piece of material adjacent to an end of the head portion which is opposite from the shank of the insert, said step of pressing the circular drive roller against the rotating piece of material including the step of pressing a circular peripheral surface of the drive roller against an inner surface of the circular groove.

7. A method as set forth in claim **1** wherein said steps of forming the first and second noncircular cross sectional areas during rotation of the piece of material in-

cludes the step of simultaneously cold working the inner and outer end portions of the shank.

8. A method as set forth in claim **1** further including the step of providing a form roller having generally circular working surface on which a plurality of arcuate segments are formed, said step of forming the first and second noncircular cross sectional areas during rotation of the workpiece including the step of pressing the working surface of the form roller against the shank of the insert and forming the plurality of outwardly flaring surfaces by pressure engagement of the arcuate segments with the shank of the insert.

9. A method comprising the steps of rotating a workpiece about its central axis, forming an outwardly flaring section on the rotating workpiece, said step of forming an outwardly flaring section on the rotating workpiece including the steps of forming the outwardly flaring section with one end portion which has a first circular cross sectional area which is coaxial with the central axis of the workpiece and which is disposed in a first radial plane extending perpendicular to the central axis of the rotating workpiece and forming the outwardly flaring section with a second end portion which has a second circular cross sectional area which is smaller than the first circular cross sectional area and is coaxial with the central axis of the rotating workpiece and which is disposed in a second radial plane extending perpendicular to the central axis of the rotating workpiece, providing a tool having a generally circular drive roller and a form roller having a generally circular working surface which is at least partially formed by a circular array of arcuate segments having centers disposed radially outwardly of the center of the form roller, pressing the drive roller against the rotating workpiece to rotate the drive roller under the influence of forces transmitted to the drive roller from the rotating workpiece, rotating the form roller under the influence of forces transmitted from the drive roller to the form roller, and forming on the outwardly flaring section of the rotating workpiece a plurality of outwardly flaring surfaces extending axially along the workpiece and disposed in planes which intersect each other in a radial plane extending perpendicular to the axis of rotation of the workpiece by pressing each of the arcuate segments on the rotating form roller in turn against the outwardly flaring section of the rotating workpiece, said step of forming a plurality of outwardly flaring surfaces on the rotating workpiece including the step of forming the first circular cross sectional area at the first end portion of the outwardly flaring section to a first noncircular cross sectional area by sequentially pressing the arcuate segments of the form roller against the workpiece as it is being rotated about is central axis and forming the second circular cross sectional area at the second end portion of the outwardly flaring section to a second noncircular cross sectional area which is smaller than the first noncircular cross sectional area by sequentially pressing the arcuate segments of the form roller against the workpiece as it is being rotated.

10. A method as set forth in claim **9** wherein the drive roller has a plurality of teeth disposed in a circular array, said step of pressing the drive roller against the rotating workpiece including the step of indenting the rotating workpiece with the teeth on the drive roller to provide a positive drive between the rotating workpiece and drive roller.

11. A method as set forth in claim **10** further including the step of moving both the form roller and the drive roller toward the central axis of the workpiece to increase the circumferential extent on the rotating workpiece of the outwardly flaring surfaces formed by the arcuate segments of the form roller and to increase the extent to which the teeth on the drive roller indent the workpiece.

12. A method as set forth in claim **9** wherein said step of forming a plurality of outwardly flaring surfaces on the workpiece includes the step of forming a plurality of flat surfaces which flare outwardly from said first end portion to said second end portion.

13. A method as set forth in claim **12** wherein said step of pressing each of the arcuate segments on the rotating form roller in turn against the rotating workpiece includes the step of moving the circular array of arcuate segments radially toward the central axis of the rotating workpiece.

14. A tool for forming a plurality of outwardly flaring surfaces on a rotating workpiece, said tool comprising a base, a forming roller, means for rotatably connecting said forming roller with said base and for enabling said forming roller to rotate about its central axis, and drive means for rotating said forming roller about its central axis, said forming roller including a plurality arcuate segments disposed in a circular array, each of said arcuate segments having an arcuate forming surface disposed on a radially outer portion of said forming roller, each said forming surfaces sloping toward the central axis of the forming roller and extending from a first end portion of the forming roller at which crests of the arcuate segments extend tangentially to a circle having a first diameter to a second end portion of the forming roller at which crests of the arcuate segments extend tangentially to a circle having a second diameter which is smaller than said first diameter.

15. An apparatus for forming a plurality of axially extending and inwardly tapered surfaces on a workpiece, said apparatus comprising chuck means for rotating the workpiece about its central axis, and forming tool means for forming a plurality of surfaces around the circumference of and extending axially along the workpiece as it is rotated by said chuck means with each of the surfaces being disposed in planes which intersect each other in a plane extending perpendicular to the central axis of the workpiece, said forming tool means including drive roller means for engaging the workpiece as it is rotated by said chuck means to effect rotation of said drive roller means about its central axis at a speed which is a function of the speed at which said chuck means rotates the workpiece, form roller means disposed in a coaxial relationship with said drive roller means for forming the plurality of tapered surfaces on the workpiece as it is rotated by said chuck means, and means for interconnecting said form and drive roller means to effect rotation of said form roller means at the same speed as said drive roller means under the influence of forces transmitted to said tool means from the rotating workpiece by said drive roller means, said form roller means including a generally circular body, means for supporting said body for rotation about its central axis, and a circular array of arcuate segments disposed on the periphery of said body, each of said arcuate segments defining an arcuate forming surface which extends transversely to the central axis of said body and is moved in turn into engagement with the

workpiece during rotation of the workpiece by said drive roller means to form the plurality of tapered surfaces on the workpiece by cold working the workpiece, each of said arcuate forming surfaces including an outer portion having a first crest diameter for forming a first portion of the workpiece to a first non-circular cross sectional area in a first plane extending perpendicular to the central axis of the workpiece and an inner portion having a second crest diameter which is larger than said first crest diameter for forming a second portion of the workpiece to a second noncircular cross sectional area which is smaller than said first noncircular cross sectional area in a second plane extending perpendicular to the central axis of the workpiece.

16. An apparatus as set forth in claim **15** wherein said arcuate forming surface means are shaped so as to form each of the plurality of surfaces on the workpiece to a flat configuration during rotation of the workpiece by said chuck means and rotation of said form roller means by said drive roller means.

17. An apparatus as set forth in claim **15** wherein said drive roller means includes an annular array of tooth means for indenting the rotating workpiece to provide positive driving engagement between the workpiece and drive roller means.

18. A method of making an insert adapted to be disposed in a hole in a member and having a head portion and a shank which is adapted to be received in the hole and is of a noncircular cross sectional configuration throughout at least a portion of its length to enable the shank to resist rotation in the hole, said method comprising the steps of providing a longitudinally extending piece of material having a generally circular cross sectional configuration throughout at least a portion of its length, forming the head portion of the insert from the piece of material, rotating the piece of material about its longitudinal axis, providing a tool having a generally circular drive roller with a plurality of radially extending teeth and a form roller disposed in a coaxial relationship with and connected to the drive roller and having a generally circular working surface which is at least partially formed by a circular array of arcuate segments having spaced apart crest portions, rotating the form and drive rollers by pressing the teeth of the drive roller against the rotating piece of material at a location disposed on a first side of the head portion, forming the shank of the insert with a noncircular cross sectional configuration by sequentially pressing the crest portions of the arcuate segments on the rotating form roller against the rotating piece of material at a location disposed on a second side of the head portion opposite from the first side to initiate the formation of a plurality of longitudinally extending surfaces at circumferentially spaced apart locations about the piece of material, and continuing the formation of the shank by pressing the drive and form rollers against rotating piece of material and moving the teeth of the drive roller and the crest portions of the arcuate segments of the form roller toward the axis of rotation of the rotating piece of material to increase the circumferential extent of the longitudinally extending surfaces.

19. A method as set forth in claim **18** further including the method steps of disengaging the form and drive rollers from the rotating piece of material and severing the piece of material at the location where the teeth of the drive roller engaged the piece of material to separate the insert from the remaining portion of the piece of material.

20. A method as set forth in claim **19** wherein said step of providing a longitudinally extending piece of material includes the step of providing a piece of material having a cylinderical central passage, said method further comprising the steps of reaming and tapping a portion of the cylinderical passage disposed within an insert after forming the shank of the insert.

21. A method of making a threaded insert adapted to be disposed in a hole in a member and having a head portion and a shank which is adapted to be received in the hole and is of a noncircular cross sectional configuration throughout at least a portion of its length to enable the shank to resist rotation in the hole, said method comprising the steps of providing a longitudinally extending piece of material, forming the head portion of the insert from the piece of material, forming the shank of the insert from the piece of material, forming a generally cylinderical axially extending bore in the insert, and tapping at least a portion of the said bore, said step of forming the shank including the steps of forming about the circumference of the shank a plurality of longitudinally extending surfaces which extend transversely to each other and extend at least part way between inner and outer end portions of the shank, said step of forming a plurality of longitudinally extending surfaces about the shank including the steps of providing a form roller having a generally circular working surface which is at least partially formed by a circular array of arcuate segments having centers disposed outwardly of the center of the form roller, simultaneously rotating the form roller and shank, and sequentially pressing each of the arcuate segments on the rotating form roller against the rotating shank.

22. A method as set forth in claim **21** wherein said step of providing a longitudinally extending piece of material includes the steps of providing a piece of material having a longitudinally extending passage formed therein, and said step of forming a generally cylinderical bore includes the step of reaming at least a portion of said passage after performing said step of forming the shank.

23. A method of making a threaded insert as set forth in claim **21** wherein said step of forming the shank further includes the steps of providing a drive roller connected with the form roller and having a plurality of radially projecting teeth disposed in a circular array, said step of rotating the form roller including the step of pressing the circular array of teeth on the drive roller against the piece of material while rotating the shank and the piece of material.

24. A method as set forth in claim **21** wherein said step of forming a plurality of longitudinally extending surfaces about the shank includes the step of forming a plurality of surfaces having longitudinal axes which extend transversely to the longitudinal axis of the piece of material and the axis about which the shank is rotated.

25. A tool as set forth in claim **14** wherein said arcuate segments are portions of intersecting circles and are effective to form on the rotating workpiece a plurality of flat surfaces extending axially along the workpiece and disposed in planes which intersect each other in a radial plane extending perpendicular to the axis of rotation of the workpiece.

26. A tool as set forth in claim 14 wherein said forming surfaces are effective to form flaring surfaces on the workpiece which extend transversely to an axis of the workpiece at an angle which is a function of the angle at which said forming surfaces extend relative to the axis of rotation of said forming roller.

27. A tool as set forth in claim 14 wherein said drive means includes a drive roller mounted in a coaxial relationship with said forming roller, said drive roller having an outer surface means for engaging the rotating workpiece to effect rotation of said drive and forming rollers under the influence of forces transmitted to said drive roller from the rotating workpiece.

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