

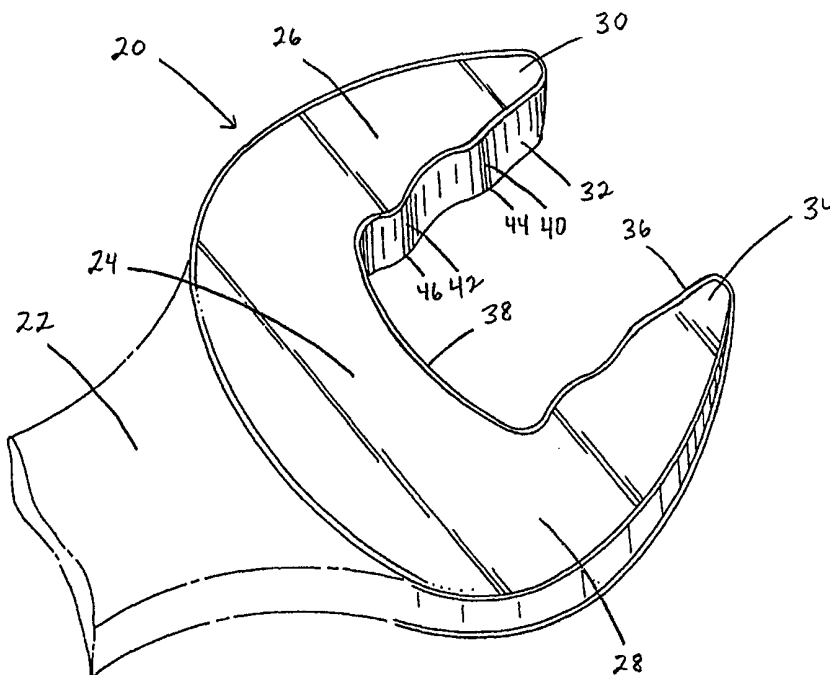


INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : B25B	A2	(11) International Publication Number: WO 00/10773 (43) International Publication Date: 2 March 2000 (02.03.00)
(21) International Application Number: PCT/US99/19246 (22) International Filing Date: 20 August 1999 (20.08.99) (30) Priority Data: 09/138,060 21 August 1998 (21.08.98) US (71) Applicant: THE STANLEY WORKS [US/US]; 1000 Stanley Drive, New Britain, CT 06053 (US). (72) Inventor: GARG, Ajay; 7005 Ridgemoor Lane, Plano, TX 75025 (US). (74) Agent: STANDLEY, Jeffrey, S.; Standley & Gilcrest LLP, Suite 210, 495 Metro Place South, Dublin, OH 43017 (US).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>Without international search report and to be republished upon receipt of that report.</i>

(54) Title: SPLINE DRIVE OPEN END WRENCH**(57) Abstract**

An open end wrench that is adapted to rotate a predetermined hexagonal nut having equal, flat sides without deforming any of the corners of the nut. The wrench includes a lever arm and a head. The head is joined to the lever arm. The head has a first jaw that may be integrally joined to a second jaw. Each of the jaws has an open end and a drive face. The drive face of the first jaw opposes the drive face of the second jaw. In addition, the drive face of the first jaw is joined to the drive face of said second jaw by a rear face. Each of the drive faces has a plurality of contact surfaces. Each contact surface is a convex curve that protrudes toward the opposing drive face. Each contact surface has a peak. The distance between opposing peaks may be about equal for each set of opposing peaks and only slightly greater than the distance between opposing sides of the nut. The jaws of the wrench may be slid over the nut such that a corner of the nut is placed in contact with the rear face. When a corner of the nut is placed in contact with the rear face, the peaks of at least two of the contact surfaces of each drive face are adapted to be substantially adjacent to intermediate portions of respective sides of the nut. In this drive position, the wrench is adapted to rotate the nut without placing a corner of the nut in contact with either of the drive faces. As a result, the wrench may rotate a nut without deforming the corners of the nut.



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SPLINE DRIVE OPEN END WRENCHBACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to wrenches and, more particularly, to open end wrenches having improved driving faces. In a conventional open end wrench, the wrench head has two jaws which define a U-shaped opening. Each jaw has a drive face which is a straight, flat surface. The drive faces are parallel, and they are spaced a sufficient distance apart such that a nut may be inserted in the U-shaped opening. A nut may be loosened or tightened by sliding the jaws of the conventional open end wrench over the sides of the nut and then rotating the wrench head in a desired direction.

10 In order to enable the jaws to slide over the sides of the nut, the distance between the drive faces of the jaws must be larger than the distance between parallel sides of the nut to be driven. In other words, at least a slight clearance must be provided between each drive face of the jaws and the respective side of the nut to be driven. As a result, the wrench head will rotate a few degrees relative to the nut when
15 a user applies torque to the wrench head.

Rotation of the wrench head relative to the nut places the drive faces in contact with corners of the nut. The torque applied by a conventional open end wrench will, therefore, not be distributed along the sides of the nut. Instead, the torque will be concentrated on the corners of the nut. Consequently, there is a tendency to round, and eventually strip, the corners of the nut which receive the bulk of the torque. The deformation caused by a conventional open end wrench may eventually make it
20 difficult to loosen or tighten the nut.

In light of the shortcomings of conventional open end wrenches, a need exists for an open end wrench that has driving faces which distribute torque along the sides of a nut. A need also exists for an open end wrench that limits the torque applied to the corners of a nut. Still yet another need exists for an open end wrench that has multiple driving positions that do not deform a nut.

The present invention accomplishes some or all of these needs. Preferred embodiments of the open end wrenches of the present invention have drive faces that do not make contact with the corners of a predetermined nut when torque is applied by the wrench head in the drive position. As a result, preferred embodiments of the open end wrenches of the present invention do not deform the corners of predetermined nuts during tightening or loosening.

A preferred embodiment of an open end wrench of the present invention is adapted to rotate a hexagonal nut having equal, flat sides without deforming any of the corners of the nut. A preferred embodiment of an open end wrench includes a lever arm and a head. The head is joined to the lever arm. The head has a first jaw that may be integrally joined to a second jaw. Each of the jaws has an open end and a drive face. The drive face of the first jaw opposes the drive face of the second jaw. In addition, the drive face of the first jaw is joined to the drive face of said second jaw by a rear face.

Each of the drive faces has a plurality of contact surfaces. Each contact surface is a convex curve that protrudes toward the opposing drive face. Each contact surface has a peak. The distance between opposing peaks may be about equal for each set of opposing peaks and only slightly greater than the distance between opposing sides of the nut.

The jaws of the wrench may be slid over the nut such that a corner of the nut is placed in contact with the rear face. When a corner of the nut is placed in contact with the rear face, the peaks of at least two of the contact surfaces of each drive face are adapted to be substantially adjacent to intermediate portions of respective sides of the nut. In this drive position, the wrench is adapted to rotate the nut without placing a corner of the nut in contact with either of the drive faces. As a result, a preferred embodiment of a wrench of the present invention may rotate a nut without deforming the corners of the nut.

In addition to the novel features and advantages mentioned above, other objects and advantages of the present invention will be readily apparent from the following descriptions of the drawings and preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a partial perspective view of a first preferred embodiment of a wrench of the present invention;

Figure 2 is a partial plan view of the wrench shown in Figure 1;

Figure 3 is a partial end elevation view of the wrench shown in Figure 1;

Figure 4 is a partial side elevation view of the wrench shown in Figure 1;

Figure 5 is a partial perspective view of a second preferred embodiment of a wrench of the present invention;

Figure 6 is a partial plan view of the wrench shown in Figure 5;

Figure 7 is a partial end elevation view of the wrench shown in Figure 5;

Figure 8 is a partial side elevation view of the wrench shown in Figure 5;

Figure 9 is a partial perspective view of a third preferred embodiment of a wrench of the present invention;

Figure 10 is a partial plan view of the wrench shown in Figure 9;

Figure 11 is a partial end elevation view of the wrench shown in Figure 9;

Figure 12 is a partial side elevation view of the wrench shown in Figure 9;

Figure 13 is a partial plan view with preferred dimensions of a fourth preferred
5 embodiment of a wrench of the present invention;

Figure 14 is a partial plan view with preferred dimensions of a fifth preferred
embodiment of a wrench of the present invention; and

Figure 15 is a partial plan view with preferred dimensions of a sixth preferred
embodiment of a wrench of the present invention.

10 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT(S)

The present invention is directed to open end wrenches having improved driving faces. A preferred embodiment of the wrenches of the present invention will be described with reference to Figures 1 through 4. Figures 1 through 4 illustrate an open end wrench 20. The wrench 20 has a lever arm 22 and a head 24. The head 24
15 includes a first jaw 26 and a second jaw 28. The first jaw 26 is preferably integrally joined to the second jaw 28.

The first jaw 26 has an open end 30 and a drive face 32. Similarly, the second jaw 28 has an open end 34 and a drive face 36. The drive face 32 is joined to the drive face 36 by a rear face 38. It is preferred that the drive face 32 is substantially
20 symmetrical to the drive face 36. However, those skilled in the art should recognize that the present invention may still be achieved even though there may be variations between the drive face 32 and the drive face 36.

The first jaw 26 and the second jaw 28 are adapted to slide over the flat sides of a nut. Each of the drive faces 32, 36 has a plurality of contact surfaces. Since the

drive face 32 is substantially symmetrical to the drive face 36 in this embodiment, only the drive face 32 will be described with reference to Figures 1 through 4. The drive face 32 has contact surfaces 40 and 42. As shown in Figure 2, the contact surfaces 40, 42 are convex curves that protrude toward the opposing drive face 36.

5 The contact surface 40 has a peak 44, and the contact surface 42 has a peak 46. In order to distribute torque as evenly as possible along the sides of a nut which is to be rotated, the distance between opposing peaks is preferably about equal for each set of opposing peaks and only slightly greater than the distance between opposing sides of the nut. However, those skilled in the art should recognize that the distance
10 between opposing peaks may vary slightly for each set of opposing peaks and still accomplish the present invention.

 The wrench 20 is adapted to rotate a hexagonal nut having substantially equal, flat sides. When the first jaw 26 and the second jaw 28 are slid over the sides of that type of nut until a corner of the nut is in contact with the rear face 38, the peaks of
15 each drive face 32, 36 are adapted to be substantially adjacent to intermediate portions of respective sides of the nut. As a result, the wrench 20 may rotate the nut substantially without placing a corner of the nut in contact with either of the drive faces 32, 36. This preferably enables a user to rotate the nut without deforming the corners of the nut.

20 Figures 9 through 12 illustrate an embodiment of a wrench 50. The wrench 50 is similar to the wrench 20. The wrench 50 differs from the wrench 20 in that the drive faces on the open ends of its jaws have deeper concave curves than the drive faces 32, 36 on the open ends 30, 34 of the wrench 20. Nevertheless, the wrench 50 may perform substantially the same function in substantially the same way as the wrench 20.

Accordingly, the wrench 50 will not be described with reference to Figures 9 through 12.

Figures 5 through 8 illustrate an embodiment of a wrench 60. The wrench 60 has a lever arm 62 and a head 64. The head 64 includes a first jaw 66 and a second jaw 68. The first jaw 66 is preferably integrally joined to the second jaw 68.

The first jaw 66 has an open end 70 and a drive face 72. Similarly, the second jaw 68 has an open end 74 and a drive face 76. The drive face 72 is joined to the drive face 76 by a rear face 78. It is preferred that the drive face 72 is substantially symmetrical to the drive face 76. However, those skilled in the art should recognize that the present invention may still be achieved even though there may be variations between the drive face 72 and the drive face 76.

The first jaw 66 and the second jaw 68 are adapted to slide over the flat sides of a nut. Each of the drive faces 72, 76 has a plurality of contact surfaces. Since the drive face 72 is substantially symmetrical to the drive face 76 in this embodiment, only the drive face 72 will be described with reference to Figures 5 through 8. The drive face 72 has contact surfaces 80, 82, 84, 86, 88, 90. As shown in Figure 6, the contact surfaces 80, 82, 84, 86, 88, 90 are convex curves that protrude toward the opposing drive face 76.

Each contact surface 80, 82, 84, 86, 88, 90 has a respective peak 92, 94, 96, 98, 100, 102. In order to distribute torque as evenly as possible along the sides of a nut which is to be rotated, the distance between opposing peaks is preferably about equal for each set of opposing peaks and only slightly greater than the distance between opposing sides of the nut. However, those skilled in the art should recognize

that the distance between opposing peaks may vary slightly for each set of opposing peaks and still accomplish the present invention.

The wrench 60 is adapted to rotate a hexagonal nut having substantially equal, flat sides. When the first jaw 66 and the second jaw 68 are slid over the sides of that type of nut until a corner of the nut is in contact with the rear face 78, at least two of the peaks of each drive face 72, 76 are adapted to be substantially adjacent to intermediate portions of respective sides of the nut. The number of peaks of each drive face 72, 76 that are adapted to be substantially adjacent to intermediate portions of respective sides of the nut depends on the length of the sides of the nut and the number, positioning, and spacing of the peaks. The wrench 60 may rotate the nut substantially without placing a corner of the nut in contact with either of the drive faces 72, 76. This preferably enables a user to rotate the nut without deforming the corners of the nut.

Figure 13 shows a wrench 110 which is adapted to rotate a nut 120 without deforming the corners of the nut 120. The wrench 110 is similar to the wrench 20. On the other hand, Figure 15 illustrates a wrench 130 that is similar to the wrench 50. As shown in Figure 15, the wrench 130 is adapted to rotate a nut 140 without deforming the corners of the nut 140.

Figure 13 shows how to determine the preferred dimensions for a wrench 110, and Figure 15 shows how to determine the preferred dimensions for a wrench 130. In each of these figures, the distance between opposing peaks is indicated by an arrow F. Accordingly, the distance between adjacent peaks on each drive face is preferably about 0.4042 times the distance indicated by the arrow F. However, the distance between adjacent peaks for these embodiments may be any distance that enables each

of the peaks on each drive face to be substantially adjacent to intermediate portions of respective sides of the nut to be driven.

Figure 14 shows a wrench 150 which is adapted to rotate a nut 160 without deforming the corners of the nut 160. The wrench 150 is similar to the wrench 60.

5 The distance between opposing peaks of the wrench 150 is indicated by the arrow F. In this embodiment, the distance between adjacent peaks on each drive face of the wrench 150 is preferably about 0.13474 times the distance indicated by the arrow F. However, for embodiments that have more than two peaks on each drive face, the distance between any set of adjacent peaks may be any distance so long as (1) at least
10 two of the peaks on each drive face are adapted to be substantially adjacent to intermediate portions of respective sides of an equilateral, hexagonal nut when a corner of the nut is in contact with the rear face and (2) the wrench may rotate the nut without placing a corner of the nut in contact with either of the drive faces when a corner of the nut is placed in contact with the rear face.

15 The wrenches of the present invention are adapted to rotate hexagonal nuts having equal, flat sides. However, those skilled in the art should recognize that the wrenches of the present invention may be utilized to rotate some other shapes of nuts without deforming the corners of the nuts. For example, some embodiments of the wrenches of the present invention may be utilized to rotate different shapes of nuts
20 including, but not limited to, square nuts and/or rectangular nuts. Moreover, those skilled in the art should recognize that preferred embodiments of the wrenches of the present invention may rotate a nut that is in an intermediate drive position in which a corner of the nut is not in contact with the rear face of the wrench.

The preferred embodiments herein disclosed are not intended to be exhaustive or to unnecessarily limit the scope of the invention. The preferred embodiments were chosen and described in order to explain the principles of the present invention so that others skilled in the art may practice the invention. Having shown and described
5 preferred embodiments of the present invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention. Many of those variations and modifications will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

WHAT IS CLAIMED IS:

1. A wrench for rotating a predetermined hexagonal nut having equal, flat sides, said wrench comprising:

a lever arm; and

5 a head joined to said lever arm, said head having a first jaw integrally joined to a second jaw, each of said jaws having an open end and a drive face, said drive face of said first jaw opposing said drive face of said second jaw, said drive face of said first jaw joined to said drive face of said second jaw by a rear face;

each of said drive faces having a plurality of contact surfaces, each contact
10 surface being a convex curve protruding toward an opposing one of said drive faces, each contact surface having a peak, the distance between opposing peaks being about equal for each set of opposing peaks and only slightly greater than the distance between opposing sides of said nut;

wherein said peaks of at least two of said contact surfaces of each drive face
15 are adapted to be substantially adjacent to intermediate portions of respective sides of said nut when a corner of said nut is placed in contact with said rear face; and

wherein said wrench is adapted to rotate said nut without placing a corner of said nut in contact with either of said drive faces when a corner of said nut is placed in contact with said rear face.

20 2. The wrench of claim 1 wherein said drive face of said first jaw is substantially symmetrical to said drive face of said second jaw.

3. The wrench of claim 2 wherein said first jaw is substantially symmetrical to said second jaw.

4. The wrench of claim 1 wherein the distance between adjacent peaks of said drive faces is about equal for each set of adjacent peaks of said drive faces.
5. The wrench of claim 4 wherein the distance between adjacent peaks is about 0.4042 times the distance between opposing peaks.
- 5 6. The wrench of claim 4 wherein the distance between adjacent peaks is about 0.13474 times the distance between opposing peaks.

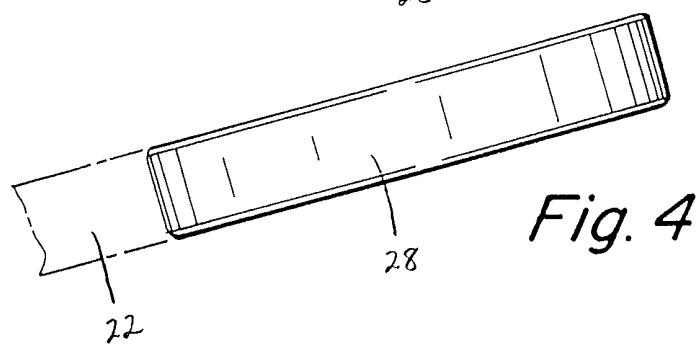
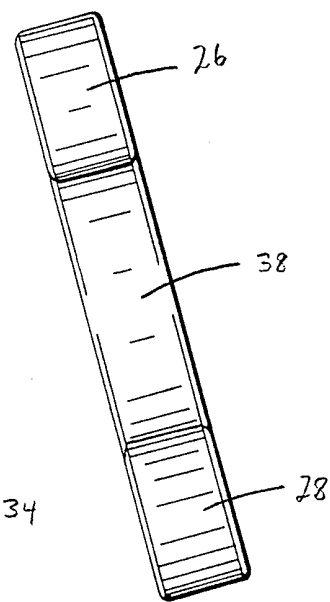
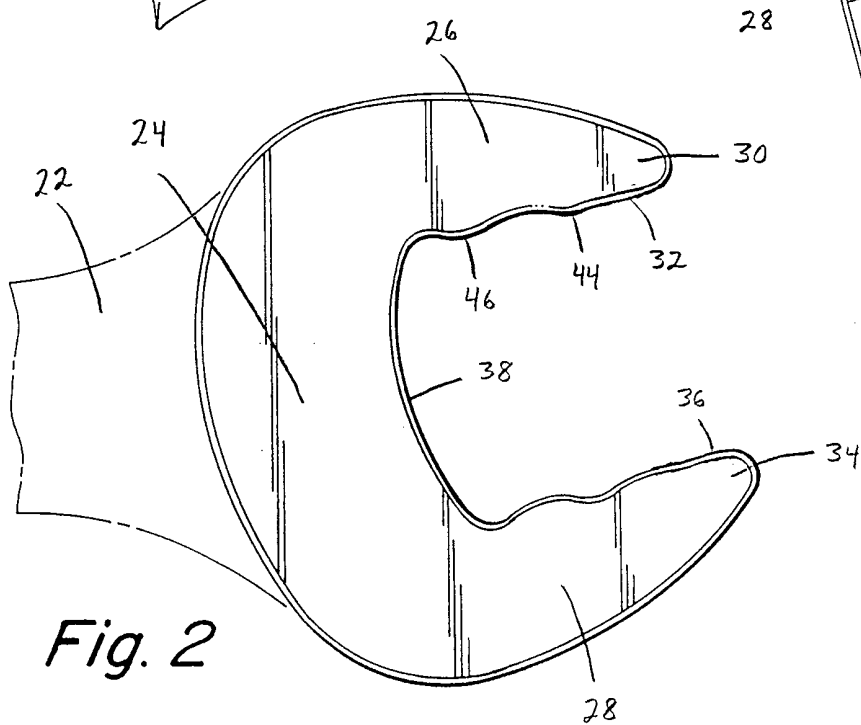
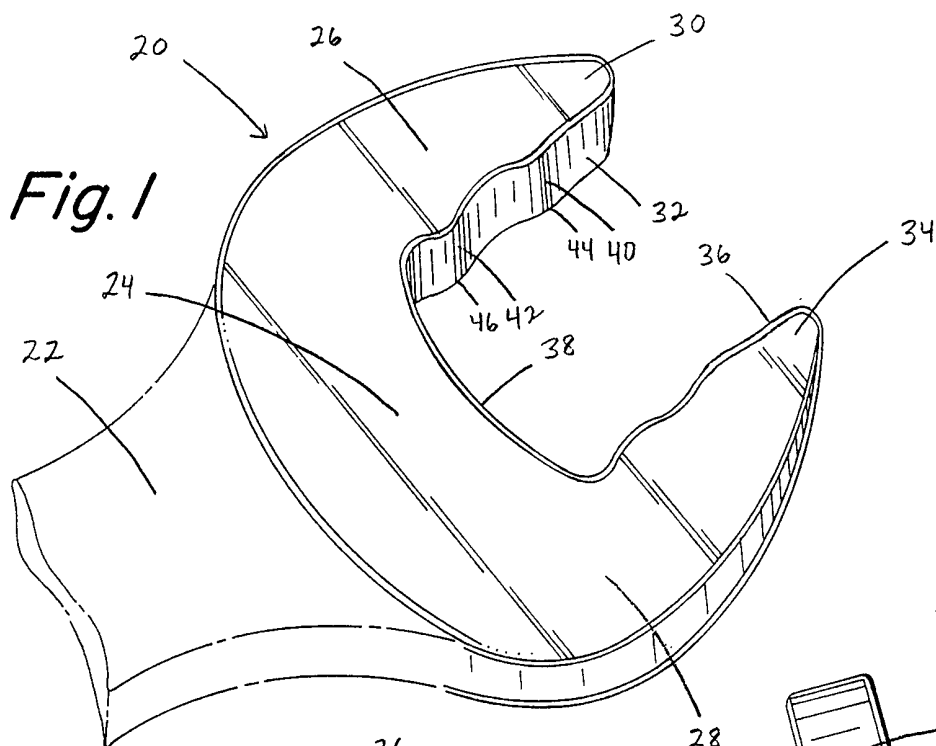


Fig. 5

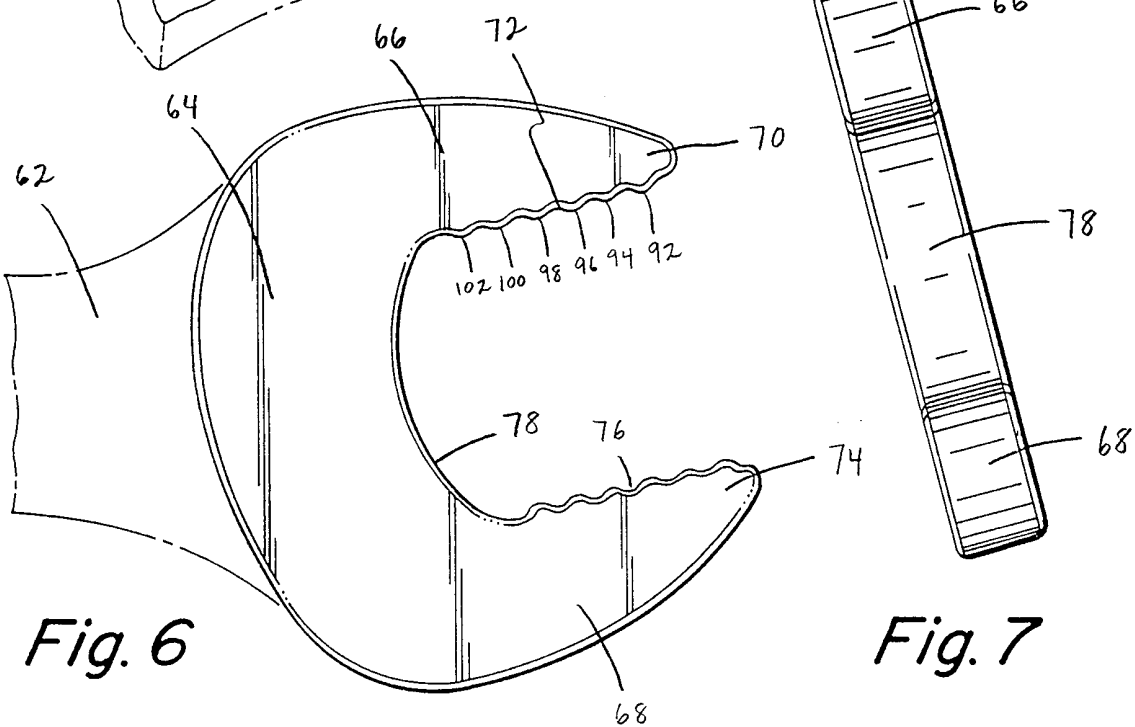
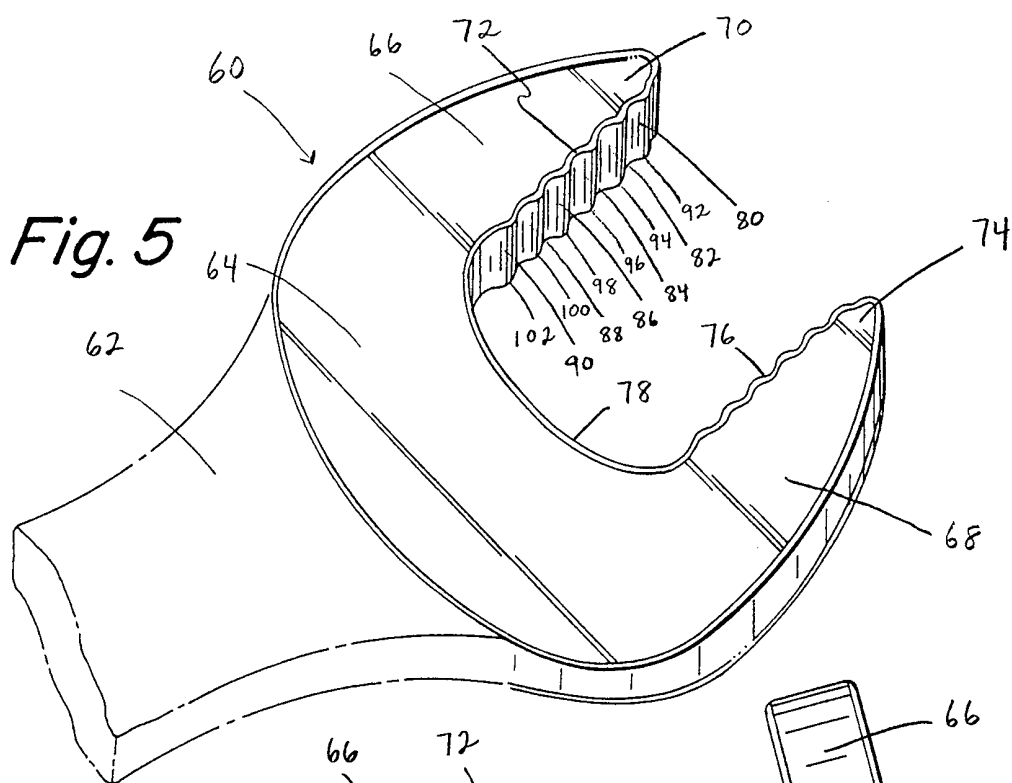


Fig. 6

Fig. 7

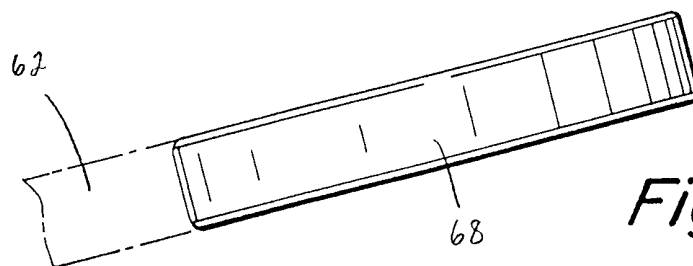
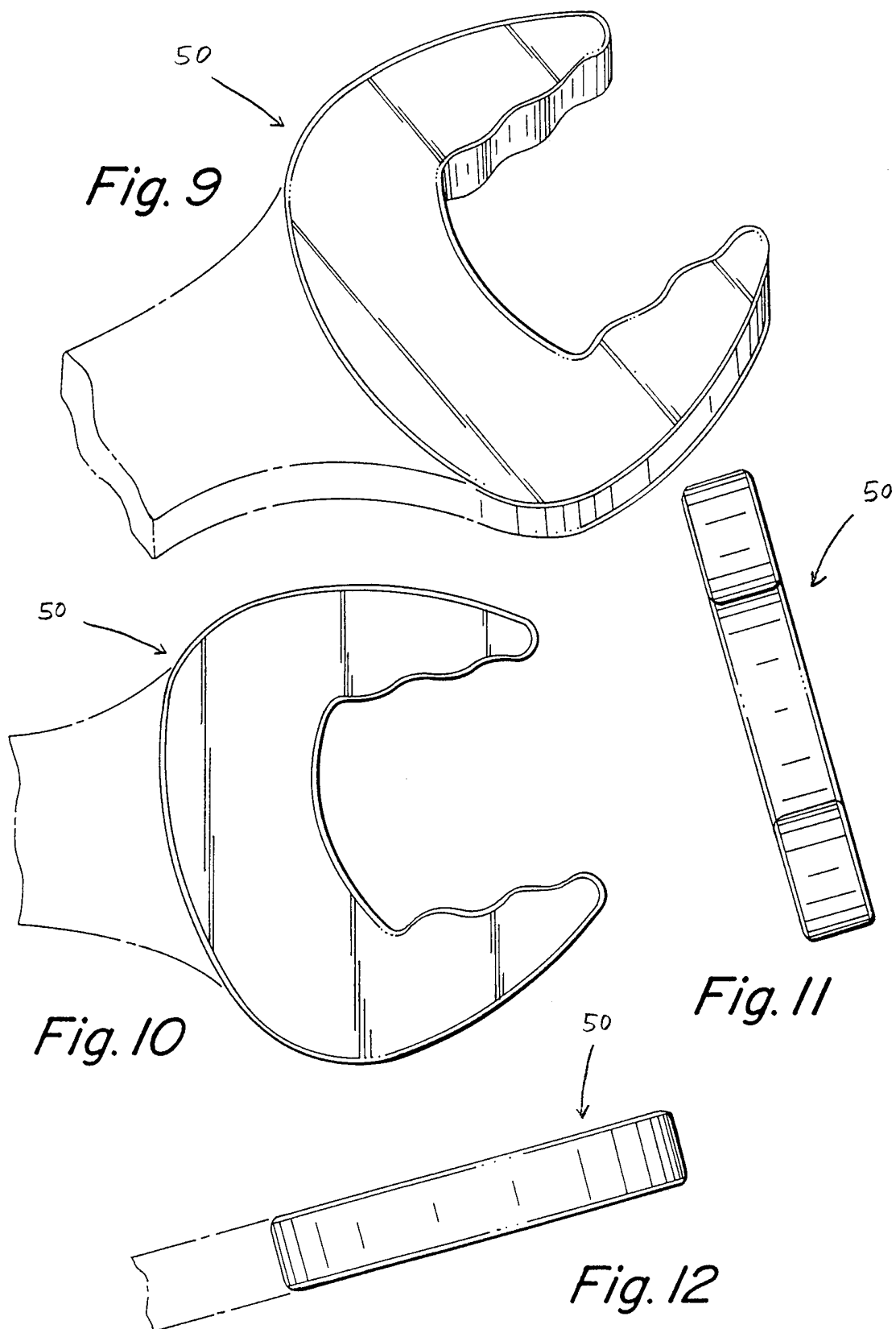


Fig. 8



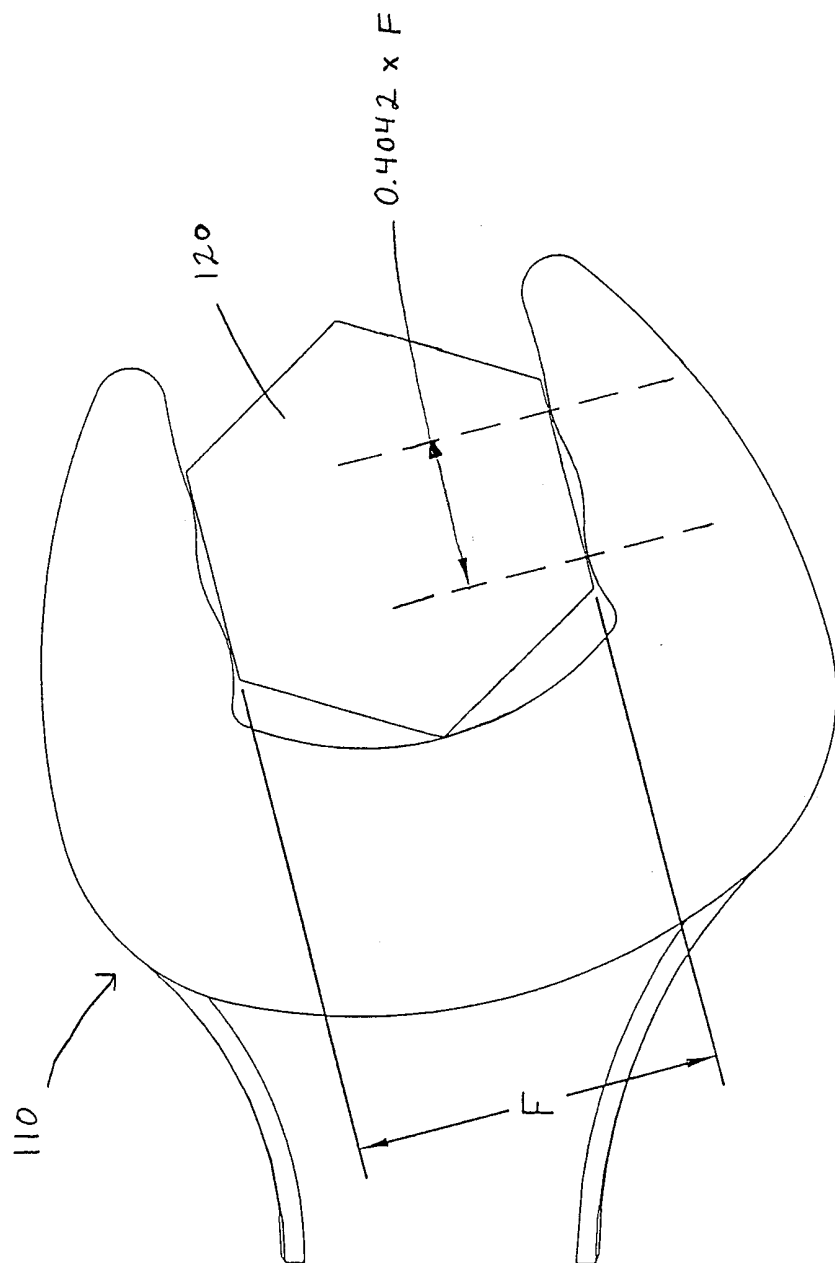


Figure 13

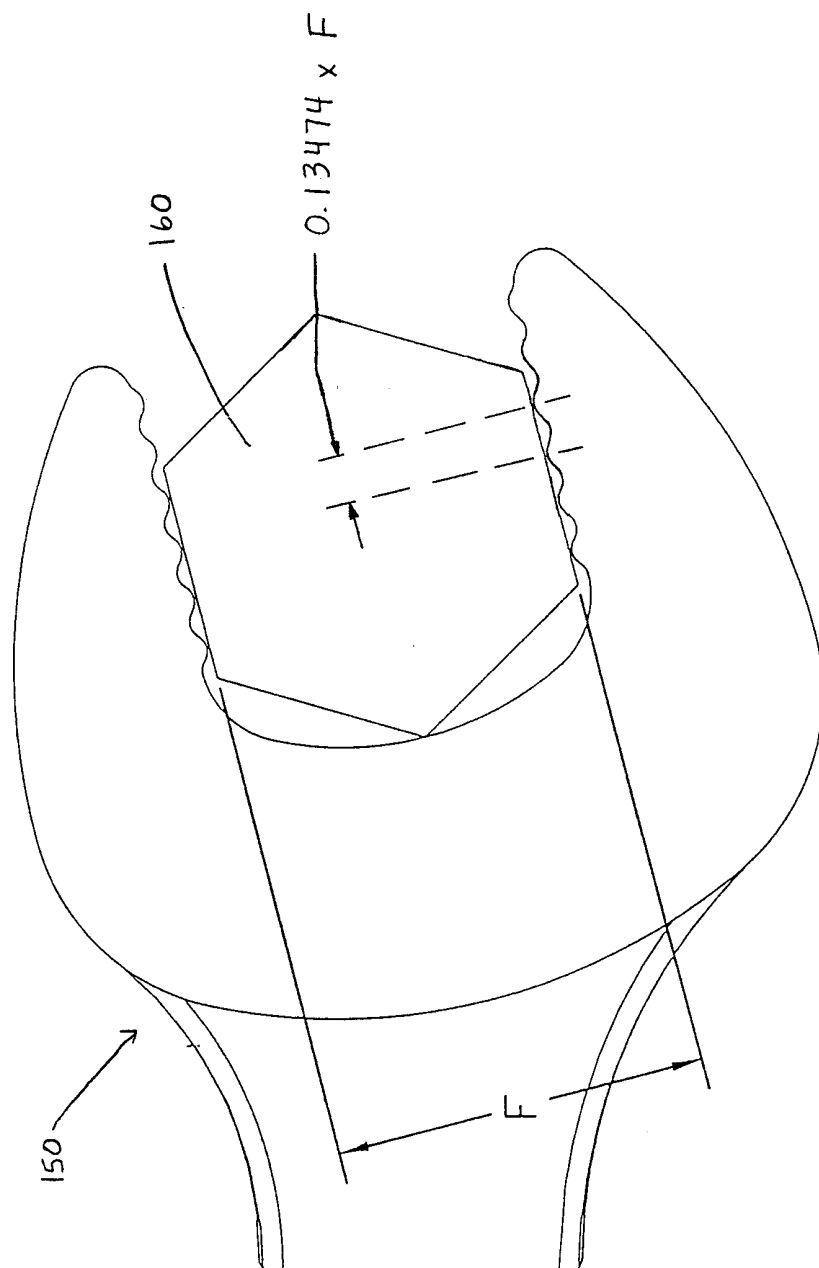


Figure 14

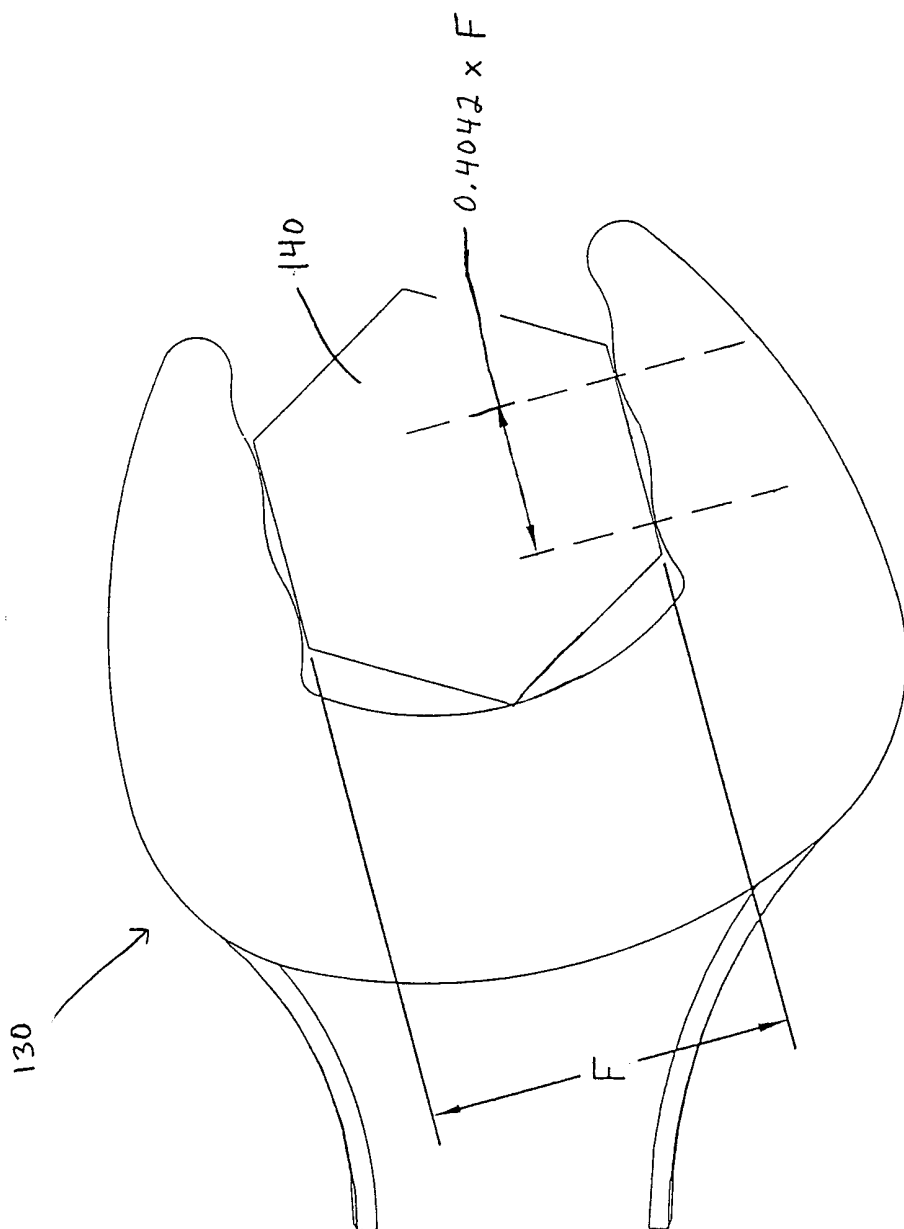


Figure 15