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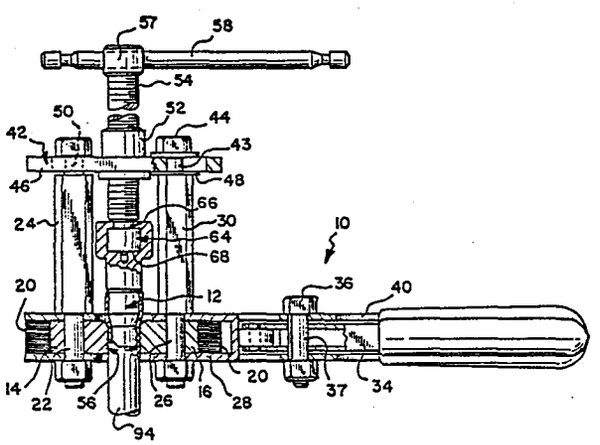
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(54) Manually operated tool for flaring tubes.

(57) A flaring or swaging tool system having a main body (10) in which a threaded shaft (54) includes a die-supporting end (64) terminating in a head portion (65) and having a circumferential groove (66) adjacent the head portion (65), the head portion having a lower bearing surface (68), and a plurality of dies (12, 12A, 12B, 12C, 12D, 12E, 12F, 12G) each die having a recess (80, 80F) sized to receive the head portion therein and having a mating bearing surface (90, 90G, 90F) which abuts the bearing surface (68) of the head portion (65) to transmit therethrough the compressive forces generated during a forming operation. In a preferred embodiment, the recess (80) includes a pair of opposing shoulders (82, 84) located opposite a swaging surface (72, 72A, 72B, 72D, 72E) of the die and forming a slot (88) therebetween for slidably receiving the groove (66) such that the die may be retained on the die supporting end (64) of the shaft (54) by engagement of the head portion (65) with the shoulders (82, 84). The main body (10) is of the type having a pair of clamping members (14, 16) for grasping a workpiece (94, 94A, 94B, 94D, 94E) therebetween and a strap member (42) spaced from the clamping members; the shaft (54) is threaded into the strap member (42) for movement outward and away from the clamping members (14, 16). In an alternate embodiment, each die (12G) includes a cam spring (118) and pin (122) which can be actuated to lock the die (12G) on the shaft (54). The tool system also includes dies (12A, 12B) for performing a double-flaring operation and gauges (97, 98C) for determining the proper positioning of a tubular workpiece (94E) to the main body (10).



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TOOL SYSTEM

Background of the Invention

The present invention relates to tool systems for flaring metal tubing, and more particularly to hand-held flaring tool systems in which a die is advanced toward a workpiece by rotating a threaded shaft.

Hand-held flaring tools typically are used for expanding, flaring, and sizing tubing made of a relatively soft material such as copper and having a diameter of between 3/16 in. and 5/8 in. (4.76 - 15.87 mm). One example of such a tool is disclosed in Franck U.S. Patent No. 2,493,127, and comprises a pair of elongated clamping blocks which define a plurality of holes of varying diameters corresponding to the diameters of the tube to be worked or flared, a generally U-shaped yoke which attaches to the clamping bars and a threaded shaft mounted to the yoke, which supports a die. A threaded collar is rotatably mounted on the threaded shaft and is concentric with a cylindrical thrust element having a frusto-conical bottom. The die has a bore with a sloping bottom sized to receive the thrust element and a threaded upper portion which screws into the collar.

The clamping bars are locked together by wing nuts to grip a tubular workpiece therebetween and the shaft is rotated to displace the die toward the workpiece. The die typically includes a short pilot portion sized to fit within the open end of the workpiece, and an annular bead to swage or otherwise enlarge the end of the workpiece. Continued rotation of the shaft forces the die

into the end of the workpiece where the bead enlarges the inside diameter of the end of the workpiece.

After the swaging operation has taken place, the shaft is rotated in a reverse direction to withdraw the end of the die from the workpiece. Since the die expands the inside diameter of the workpiece, the inherent resiliency of the wall material often causes the wall to grip the die, thereby resisting its removal from the end of the workpiece. However, because the die is threaded onto the shaft, it can resist the tensile forces which arise when the die is removed from the workpiece and remains secured to the shaft.

A device of this type possesses several disadvantages. For example, it is somewhat difficult and time consuming to remove a die from the end of the shaft and replace it with a different die, since the dies must be successively unscrewed from and screwed into the collar. The relative rotation between the die and the collar may be made more difficult due to the tensile and compressive forces which may be exerted on the threaded connection during swaging and withdrawing operations. If the connection between the die and shaft does not permit relative rotation, the difficulty of rotating the threaded shaft by hand during a swaging operation is greatly increased since the die must rotate against the fixed workpiece.

Another disadvantage is that the threaded connection may limit the useful life of the swaging tool. Should the threads of either the die or the shaft become stripped or otherwise deformed after prolonged use, the

shaft or die may be rendered useless. Furthermore, foreign matter, i.e., dirt, metal flakes, corrosion, etc., may hinder the successful screwing or unscrewing of the die and collar.

Another type of hand-operated flaring tool is disclosed in Wolcott U.S. Patent No. 2,595,036. That flaring tool is of the type having a pair of clamping members which are urged together by an overcenter lever arrangement and are adjustably mounted within a channelshaped body. A strap is positioned above the clamping members by a pair of posts and supports a threaded shaft having a die attached to a lower end. The strap is pivotally mounted to one of the posts and can be swung into position so that the shaft and die are in registry with a tubular workpiece held by the clamping members.

In one embodiment, an annular recess is spaced from the lower end of the threaded shaft and retains a flexible annular washer thereon having an outside diameter greater than that of the shaft. The die includes a bore on an upper face thereof sized to receive the washer and shaft and an annular rib which partially closes the bore. The die is mounted on the lower end of the shaft by an interference fit in which the washer is retained within the bore by the annular rib.

While this interference fit provides a connection between the shaft and die which enables a relatively rapid substitution of dies, the connection has a relatively low resistance of tensile forces. Should the die become stuck to the tubular workpiece during a swaging operation,

reverse rotation of the shaft to back the die out of the workpiece would result only in the shaft separating from the die, leaving the die embedded in the end of the workpiece to be removed by other means.

The aforementioned Wolcott patent also discloses apparatus for double-flaring metallic tubes. That apparatus consists of a plate having a plurality of annular, concave working faces of varying diameters, each concentric with a cylindrical guide portion. The plate is positioned so that the guide portion is inserted into the end of a tubular workpiece held in the clamping members, and a ram is positioned on the opposite side of the plate and held in registry by a flange which engages the posts of the tool body.

The ram is struck with a hammer to drive the end of the tube against the annular concave working face, which causes the end of the tube to collapse in a longitudinal dimension to form an annular rib. The annular rib is collapsed further by a conical die mounted on a threaded shaft in the aforementioned manner to form the double-flared end.

A disadvantage of this type of apparatus for forming a double-flared end is that two separate tools are required: the flaring tool and the plate having a plurality of working faces for performing the initial steps of the double-flaring process. A second disadvantage is that often a guide portion will become stuck in the end of a tubular workpiece, necessitating its removal by hand; a procedure requiring the expenditure of time and labor by the user.

Accordingly, there is a need for a hand-held swaging or flaring tool system in which the die is mounted to the threaded shaft by a connection which permits relative rotation between the die and the shaft to reduce the effort required to rotate the shaft and drive the die into the workpiece. There is also a need for a hand-held tool system for flaring, expanding or sizing in which the connection between the die and shaft facilitates the rapid substitution of dies and yet resists tensile forces sufficiently to permit the shaft to be rotated to withdraw the die from the end of the workpiece. Furthermore, such a tool system should be capable of swaging other than soft copper and should perform a double-flaring operation with a minimum of time and effort.

Summary of the Invention

The present invention provides a hand-held tool system in which a selected die is mounted to a threaded shaft by a connection which facilitates the rapid substitution of dies. Furthermore, the die and threaded shaft can be relatively loosely toleranced and still function properly, thus reducing the cost of manufacture of the tool. The present invention provides a connection between the die and shaft which permits relative rotation between the die and shaft to reduce the effort required to rotate the shaft, yet resists the application of tensile forces sufficiently to enable the shaft to be reversed in rotation to withdraw the die from a workpiece.

The present invention is a tool system of the type having a pair of clamping members for grasping a

workpiece therebetween, a strap member spaced from the clamping members, a shaft threaded into the strap member for displacement toward and away from the clamping members, and a die mounted to the threaded shaft and having a working surface for forming a workpiece grasped by the clamping members upon displacement of the shaft toward the clamping members. The threaded shaft includes a die supporting end which terminates in a head portion and includes a circumferential groove adjacent the head portion. The head portion of the shaft is generally cylindrical in shape and includes a substantially flat bearing surface facing the clamping members. The die includes a recess having a substantially flat, mating bearing surface oriented to face the head portion such that, when the die is mounted on the shaft, the bearing surfaces engage to transmit a compressive force exerted by the shaft through the die to a workpiece held by the clamping members. Rotation of the threaded shaft causes the bearing surface of the head portion to rotate against and relative to the bearing surface of the die recess, thus permitting relative rotation between the die and shaft.

In a preferred embodiment, the die includes a sidewardly-opening recess sized to receive the head portion therein and includes a pair of shoulders located opposite the working surface and forming a slot therebetween for slidably receiving the circumferential groove of the threaded shaft. The die is retained on the die-supporting end of the shaft by engagement of the head portion with the shoulders of the sidewardly-opening recess.

An advantage of the sidewardly-opening recess is that a die may be mounted on the end of the shaft without having to back the shaft away from the clamping members sufficiently to enable the end of the shaft to be inserted into the end of the die opposite its working surface, a distance greater than the length of the die. Rather, the shaft need be backed away from the clamping members only enough to enable the shaft end to enter the sidewardly-opening recess, a distance less than the length of the die. This is particularly important when using long tube-expanding dies.

The preferred embodiment also includes a detent which comprises a spring-loaded detent ball retained within the bearing surface of the head portion of the shaft and a detent hole formed in the bearing surface of the die recess. The detent ball and hole are positioned relative to their respective bearing surfaces to be in registry when the die is properly mounted on the head portion of the shaft. Since substantially all of the forces exerted upon the connection between the die and shaft extend along a central axis of these members, there is no need for additional securing means to prevent the die from moving in a radial direction relative to the shaft. Therefore, the recess may remain open at all times during operation. When the tool is not in use, the force exerted between the detent ball and hole is sufficient to retain the die on the shaft.

In another embodiment of the invention, the head portion of the shaft is retained within the die recess by a slotted cap which is rotatably mounted to the top of the

die. The cap may be rotated such that its slot is in registry with the slot of the die so that the head portion may be positioned within the recess. Rotation of the slot out of registry with the slot of the die recess causes the head portion to be captured within the recess. The previously described detent is not needed with this embodiment.

In another embodiment of the invention, the die is modified so that the die recess is a straight bore through the top of the die body, without side openings. A cam spring is rotatably mounted on the cylindrical side wall of the die and includes a convexity extending away from the surface of the die body. The spring passes through a pin which is slidably received within the die body and oriented to engage the groove on the shaft. Rotation of the cam spring causes the pin to engage the groove, and thereby retain the die on the shaft, or retract the pin from enagement with the groove so that the die may be removed from the shaft.

The tool system of the present invention also includes a gauge to facilitate a double-flaring operation. The gauge preferably is a bar having a plurality of notches formed along its longitudinal edges and sized to indicate the correct length of tubing which should protrude from the jaws of the clamping members upwardly to the die for a proper double-flaring operation; each notch corresponding to a different diameter tube. The gauge can also take the form of an annular notch formed on the outer surface of a die.

To ensure proper swaging with predictable and repeatable results, the dies of the tool system of the present invention which perform a diameter expanding operation on a tube include a stop, spaced a predetermined distance from the swaging or expanding surface of the die, so that the length of expanded tube is optimal for forming a leak-free soldered joint.

An advantage of the invention over prior art devices in which the die is threaded onto a shaft is that the mounting means can accommodate greater clearance between mating parts than would be permitted between engaging threads. This feature renders the invention more tolerant of dirt and wear, and less expensive to manufacture.

Another advantage of the invention over prior art devices of the threaded shaft type is that the swaging die working surface configuration is not limited to swaging only copper tubing in a soft condition. Harder copper tubing, such as types L and M, can also be successfully swaged.

The tool system of the present invention also includes a die which facilitates the rapid formation of a double-flared end on a metallic tubular workpiece. This die has as its working surface a generally cylindrical pilot portion which extends outwardly from the surface, and a generally concave annular portion concentric with the pilot portion. To perform the double-flaring operation, the aforementioned die is mounted on the shaft and advanced into the end of a tubular workpiece. The end of the workpiece is collapsed by the die and is bent by

the annular portion in a longitudinal direction to form an annular rib. The double-flaring die is thus mounted to the shaft by a connection which facilitates its mounting and easy withdrawal from the end of the workpiece.

The die is removed, and a die having a conical working surface is mounted on the shaft to complete the operation by bending the end of the tubular member inwardly to form the double-flared end.

Accordingly, it is an object of the present invention to provide a hand-held swaging tool system in which the swaging die is mounted to the shaft by a connection which facilitates relative rotation between the die and shaft; a tool system in which the connection between the die and shaft is sufficiently strong to bear tensile forces exerted during the withdrawal of the die from a workpiece; a tool system in which the connection between the die and shaft permits the rapid mounting and removal of the die; and a tool system which performs single and double-flaring, swaging, and sizing operations in a rapid, accurate and repeatable manner on materials including harder copper tubing.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

Brief Description of the Drawings

Fig. 1 is a side elevation of the main body of the tool system of the present invention, partially broken away to show the structure of the clamping members and in which the swaging die is partially in section;

Fig. 2 is a top view of the main body of Fig. 1 in which the clamping members are shown in phantom;

Fig. 3 is a detail in perspective of an end of the shaft of the main body of Fig. 1;

Fig. 4 is a side elevation of a die of the tool system utilized for enlarging the ends of tubular workpieces by a swaging operation;

Fig. 5 is a top view of the die of Fig. 4;

Fig. 6 is a detail side elevation of the tool system of the present invention utilizing a double-flaring die to collapse the end of a tubular workpiece, in which the die and clamping members are in section;

Fig. 7 is a detail side elevation of the tool system of the present invention utilizing a flaring die to complete the double-flaring process upon a workpiece having been collapsed by the die shown in Fig. 6;

Fig. 8 is an exploded perspective view of a die of another embodiment of the tool system of the present invention, also showing a fragment of the shaft of the main body;

Fig. 9 is a side elevation of the die of Fig. 8, partially in section;

Fig. 10 is a perspective detail of the die of Fig. 8;

Fig. 11 is a detail side elevation of a die of another embodiment of the tool system of the present invention in which the die is in section and also showing a fragment of the shaft;

Fig. 12 is a top plan view in section of the die of Fig. 11 taken at line 12-12 of Fig. 11;

Fig. 13 is a top plan view in section of the die of Fig. 11, similar to Fig. 12, but in which the cam spring has been rotated;

Fig. 14 is a detail top plan view of the strap of the main body of Fig. 1, showing in phanton the strap in a pivoted position;

Fig. 15 is a detail side elevation in section of the toolsystem of Figs. 1-7, showing a die flaring a tubular workpiece;

Fig. 16 is a detail side elevation in section of the tool system of Figs. 1-7, showing a die forming a 180 °flare;

Fig. 17 is a detail side elevation of the shaft and handle of the main body of Fig. 1, showing the shaft in section;

Fig. 18 is a detail side elevation of a die of another embodyment of the invention;

Fig. 19 is a perspective view of the gauge of the tool system of the present invention; and

Figs. 20 to 25 show details of the modified embodyment of the invention.

Description of the Preferred Embodiments

As shown in Figs. 1 and 2, the tool system of the present invention comprises a main body, generally designated 10, and a die, generally designated 12, shown as a swaging die.

The main body 10 is generally channel-shaped and encloses a pair of complementary clamping members 14,16. Clamping members 14,16 each include a plurality of clamping faces 18 having threaded, semi-cylindrical cutouts 20 of varying diameters which correspond to standard outside diameters of metal tubing.

Clamping member 14 is rotatably mounted to the main body 10 by a rod 22 which is threaded through the body and is an integral extension of post 24 which extends outwardly from the body. Clamping member 16 is rotatably mounted to a rod 26 which passes through a yoke 28 slidably mounted within the main body 10 and is an integral extension of post 30 extending from the body parallel to post 24. Both integral rods 22,24 provide increased strength and rigidity over similar prior art devices having posts which are an assembly of separate parts.

The yoke is limited in its sliding movement by engagement with a guide slot 32 formed in the main body 10 so that it can be displaced toward or away from clamping member 14. A lever 34 is pivotally attached to the main body 10 by an adjusting screw 36 having an eccentric shank 37 and includes a roller 38 on an inner end which acts as a cam to engage the end of the yoke 28 and thereby drive the yoke and clamping member 16 toward clamping member 14 as the lever is moved toward a handle portion 40 of the body.

A strap 42 is pivotally mounted on an upper extension 43 of post 30 and retained thereon by a nut 44, and includes a hook 46 on an opposite end thereof which engages an upper necked portion 50 of post 24. A spring washer 48 is mounted on the extension 43 beneath the strap 42 and urges the strap upwardly against the nut 44. This spring action keeps the strap 42 from pivoting freely about extension 43. However, the strap 42 can be pivoted about extension 43, as shown in Fig. 14, to position 42',

to facilitate the substitution of dies when clamping member 16 is retracted from clamping member 14.

The strap 42 includes a central boss 52 which receives a threaded shaft 54 therethrough. The strap is positioned such that the shaft is in registry with, and is coaxial with, a bore 56 formed by the complementary cutouts 20 of the clamping members 14,16 when the strap is secured to the posts 24,30. The upper portion of the shaft 54 includes a housing 57 which slidably receives a handle 58 to facilitate the rotation of the shaft by the user.

As best shown in Fig. 17, the housing 57 includes a spring-loaded detent 59 positioned in a recess 60 extending inwardly from the hole 61 receiving the handle 58, and the ends of the handle each include a necked, frusto-conical portion 62, and an inwardly-facing stop 63. The handle 58 is inserted through the hole 61 so that the detent 59 engages the outer surface of the handle 58. An attempt to remove the handle 58 from the hole 61 causes the detent 59 to abut the stop 63, thereby preventing disassembly of the handle and shaft 54. The frusto-conical portion 62 is gradually sloped to allow the detent 59 to be displaced downwardly away from the handle 58 during normal in-and-out handle movement. Furthermore, the detent 59 pressing against the outer diameter of handle 58 maintains it in any released position.

As best shown in Figs. 1 and 3, the lower portion of the shaft 54 terminates in a die-supporting end 64 which includes a generally cylindrical head portion 65 and a circumferential groove 66 located adjacent the head

portion. The head portion 65 terminates in a bearing face 68 which is substantially flat and oriented normal to a longitudinal axis of the shaft. The bearing face 68 includes a spring-loaded detent ball 70 which is positioned concentrically with respect to the central axis of the shaft 54.

As shown in Figs. 4 and 5, the swaging die 12 includes a sizing surface 72 which, in this embodiment, comprises a generally cylindrical pilot portion 74 and a swaging frusto-conical portion 76, concentric with the pilot portion. It should be noted that the tool system of the invention preferably includes a number of such dies 12, each sized to engage a tubular workpiece of a different diameter.

Positioned perpendicular to surface 72 is an annular stop wall 77, which provides an automatic stop of a swaging operation when abutted by the expanded end of a tubular workpiece which has passed over the sizing surface 72. The stop wall 77 is spaced from the frusto-conical portion 76 a predetermined distance to form an enlarged end of the workpiece having the optimum length for forming a leak-free soldered joint. This distance will vary with the diameter of the tube to be swaged.

The long pilot portion 74 of the die 12 serves a dual function. Not only does the pilot portion 74 facilitate positioning the die over the tubular workpiece, but, during swaging, it functions as a guide for the frusto-conical portion 76 of the moving die 12, resulting in improved concentricity of an enlarged end.

The body 78 of the die 12 includes a sidewardly-opening recess 80 sized to receive the head portion 65 of the shaft (see Fig. 1) therein. The recess includes a pair of shoulders 82,84 on a surface 86 opposite the surface 72, which form a slot 88 therebetween to receive the annular groove 66 of the shaft. The recess 80 includes a substantially flat bearing surface 90 which faces the shoulders 82,84 and has a concentrically located detent hole 92 sized to receive the detent ball 70 of the shaft 54 (Fig. 3).

Generally, the swaging operation of the tool of the present invention begins with mounting the swaging die 12 on the shaft 54 of the body 10. The die 12 is positioned so that the recess 80 is adjacent and faces the head portion 65 of the shaft 54, and the die is displaced sidewardly until the head portion is within the recess. The engagement of the detent ball 70 with the detent hole 92 prevents the die 12 from inadvertently slipping out of position off of the shaft 54.

The lever 34 is pivoted away from the handle portion 40 of the body 10, thereby enabling the clamping member 16 to be displaced away from clamping member 14. The end of a tubular workpiece 94 (Fig. 1) is positioned between the opposing complementary cutouts 20 of the clamping members 14,16, and moved longitudinally toward the swaging die 12 until the end of the workpiece 94 engages the frusto-conical portion 76. The lever 34 is pivoted toward the handle portion to bring the clamping members 14,16 into locking engagement with the tubular workpiece.

While holding the lever 34 and handle 40 together in one hand, the user grasps the handle 58 with his other hand and rotates the shaft 54 to move the die 12 toward the workpiece 94. As the frusto-conical portion 76 enters the end of the workpiece, the end of the tubular workpiece 94 is expanded. Further displacement of frusto-conical portion 76 enlarges the workpiece 94 until the end of the workpiece abuts stop wall 77. During this displacement, sizing surface 72 properly sizes the inside diameter of the tubular workpiece 94. It is this combination of the frusto-conical portion 76 with the sizing portion 72 that enables the die 12 to swage harder copper tubing.

Once the expansion process has been completed, the user reverses the rotation of the shaft to withdraw the die 12 from the end of the workpiece 94. The lever 34 is then rotated away from the handle portion 40, and the user separates the clamping members 14,16 to remove the finished workpiece 94 therefrom.

As shown in Figs. 6 and 7, a double-flaring operation can be performed with the tool of the present invention, utilizing double and single flaring dies 12A, 12B having differently formed working surfaces 72A,72B. The surface 72A of die 12A includes a substantially cylindrical pilot portion 74A extending therefrom, and an annular concave portion 96, concentric with the pilot portion. The single flaring die 12B has a conical working surface 72B and is equally useful for single flaring and completing double flares.

As shown in Fig. 6, to begin the double-flaring process, the tubular workpiece 94A is grasped between the

clamping members 14,16 in the manner previously described. A gauge, such as that disclosed in Wolcott U.S. Patent No. 2,595,036, the disclosure of which is incorporated herein by reference, is used to determine the length of workpiece 94A to protrude above the clamping members 14,16. However, the tool system preferably includes a bar gauge 97, shown in Fig. 19, having a plurality of notches 98. Each notch 98 has a depth which corresponds to the appropriate length a workpiece of a given diameter should protrude above the clamping members 14,16. In an alternate embodiment shown in Fig. 18, each die 12C in the tool system which is used to perform a double-flaring operation may be formed with an annular notch 98C having a depth corresponding to the appropriate amount of protrusion for the size tubing to be flared by that die.

The die 12A or 12C is mounted on the shaft 54 and advanced toward the workpiece 94A until the end of the workpiece engages the annular portion 96. Continued displacement of the die 12A downwardly causes the end of the workpiece 94A to collapse outwardly in a longitudinal dimension, forming an annular rib 99.

The next step of the double-flaring process is shown in Fig. 7. The die 12A is removed from the shaft 54, and the die 12B mounted in its place. The shaft 54 is moved downwardly until the conical swaging surface 72B encounters the collapsed end of the workpiece 94A. Continued movement of the die 12B downwardly causes the already collapsed end to fold over upon itself, forming the double-flared end 100.

The tool system of the present invention preferably includes a die 12D, shown in Fig. 16, for forming 180° single flares. With die 12D, the swaging surface 72D is a flat, annular surface oriented substantially normal to the longitudinal axis of the die, and includes a pilot portion 74D. To form such a 180° flared end, a tubular workpiece 94E is first mounted between clamping members 14,16 (Fig. 15) so that an end portion 102 protrudes above the members. The end portion is first flared by a die 12E having a frusto-conical swaging surface 72E with a 90° included angle. Die 12D (Fig. 16) is then mounted to the shaft 54 and the flat swaging surface 72D forces the end 102 outwardly until the 180° flare is formed. Die 12E may be formed to have angles less than 90°, such as a 74° included angle, and would also be effective in performing the first step of this flaring operation and in single flaring.

An alternate embodiment of the tool system of the present invention is shown in Figs. 8-10. In this embodiment, the detent ball 70 and detent hole 92 (Figs. 3 and 4) are eliminated, and the head portion 65 is retained within the recess 80F by a cap 104. Cap 104 includes a top surface 106 and an annular side wall 108 which include a radially extending slot 110. The lower edge of the side wall 108 includes an inwardly extending rim 112 which is sized and positioned to engage an annular groove 114 formed on the body 78F of the die 12F. The cap 104 preferably is made of a strong plastic material which is sufficiently flexible that the cap can be snapped over the top of the body 78F to be retained thereon by the

engagement of the rim 112 with the groove 114. The fit should be loose enough, however, so that the cap 104 can be rotated relative to the die 12F.

To mount the die 12F on the shaft 54, the cap 104 is first rotated so that the slot 110 is in registry with the slot 88F of the die 12F, as shown in Fig. 8. The head portion 65 of the shaft 54 can then be inserted sidewardly into the recess 80F. To secure the shaft 54 within the recess 80F, the cap 104 is then rotated so that the slot 110 is in a position out of registry with the slot 88F of the die 12F, as shown in Fig. 10.

The rounded ends of the slots 110, and 88F are sized such that, when the cap 104 is rotated, their intersection forms a circular opening which corresponds in diameter to the diameter of the groove 66 which separates the head portion 65 from the remainder of the shaft 54. Thus, the shaft 54 can rotate freely relative to the die 12F, and the downward thrust of the shaft 54 can be transmitted directly from the bearing face 68 of the head portion 65 to the bearing surface 90F of the die 12F. To release the die 12F from the shaft 54, the process is reversed: the cap 104 is rotated so that the slot 110 once again is aligned with the slot 88F, and the die is then removed from the head portion 65 of the shaft.

Another embodiment of the invention is shown in Figs. 11-13. In this embodiment, the die 12G is modified so that the recess 80G is in the form of a straight bore so that the body 78G has no sideward opening. The body 78G includes an annular groove 116 which receives a cam spring 118 that is substantially circular in shape and

includes an outwardly protruding convexity 120. The cam spring 118 is positioned within the groove 116 such that it may be rotated relative to the body 78G. A locking pin 122 is slidably mounted within a radially oriented hole 124 located within the body 78G of the die 12G at an elevation corresponding to the groove 66 formed in the end of the shaft 54 when the shaft is inserted in the recess 80G. An outer end of the pin 122 includes a hole 126 which slidably receives the cam spring 118 therethrough.

To attach the die 12G to the shaft 54, the cam spring 118 is rotated such that the convexity 120 passes through the hole 126 in the pin 122, as shown in Fig. 12. The pin 122 is displaced outwardly relative to the hole 124. The pin 122 is sized such that it is completely displaced from the recess 80G when the cam spring 118 is rotated to this position. The head portion 65 of the shaft 54 can then be inserted into the recess 80G. To secure the head portion 65 within the recess 80G, the cam spring 118 is rotated to a position such as that shown in Fig. 13. In this position, the cam spring 118 urges the pin 122 into the hole 124, where its radially inner end enters the groove 66 which separates the head portion 65 from the remainder of the shaft 54. In this configuration, the head portion 65 cannot be removed from the recess 80G.

With all of the dies 12,12A-12G, the compressive forces transmitted from the shaft 54 through the die to the workpiece 94 pass from bearing surface 68 of the head portion 65 to bearing surface 90G within the recess 80. Rotation of the shaft causes a rotation of the bearing

surface 68 relative to the bearing surface 90 such that the rotational movement is not transmitted to the die 12 itself, thus reducing the effort required to rotate the shaft. Removal of the die 12 from the end of the workpiece 94 is facilitated by the engagement of the head portion 65 with the shoulders 82,84 or pin 122, each of which is sufficiently strong to bear the tensile forces which tend to separate the die from the shaft 54 during withdrawal.

It is to be understood that while the invention is described as used with metallic tubing such as copper, it is equally useful with tubing made of other materials such as aluminum and mild steel. Accordingly, references to metallic tubing are to be understood as illustrative and not as limiting the scope of the invention. Similarly, while the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and changes may be made therein without departing from the scope of the invention.

The positions of the head portion 65 and the recess 80, 80F, 80G sized to receive said head portion 65 may be reversed, i.e. the head portion 65 may be formed at the end of the dies opposite the working surface, and the recess mating the head portion may be formed at the end of the threaded shaft 54. This only requires that the housing 57 either has a smaller diameter than the threads or is manufactured separately and attached to the shaft after the shaft is screwed into the strap member 42. The connection then may have the same geometry and dimensions but is just positioned upside-down.

The details of such an embodyment of the invention are shown in Figures 20 to 25, the main body 10 of the tool system shown in Figures 1 and 2 being essentially the same.

According to Figures 20 and 21 the die supporting end 64 has been machined from a steel rod with hexagonal cross section. A T-shaped recess 80 has been formed at one of the ends of the rod, which is limited on both sides by shoulders 82 and 84. The end of the recess forms the bearing surface 68, and in the center of this bearing surface is positioned a spring-loaded detent means, being a ball or a pin. In the end opposite the T-shaped recess 80 a bore with threads is provided, into which the lower end of the shaft 54 is inserted.

As shown in Figure 21 the die 12, which stands for each of the different dies, is terminating in a head-portion 65, which is separated from the rest of the die 12 by a circumferential groove 66. The head-portion is a body of revolution, so that the complete die may be automatically produced from a steel rod. On top of the head portion 65 there is a mating bearing surface 90, having in its center a detent recess 92 which is complementary to the detent means 70. Due to the mating geometry of the recess 80 on one hand and of the head portion 65 on the other hand, the latter may be shifted into the recess 80 from either side, until the detent means 70 is snapping

into the detent recess 92. Upon exerting a compressive force upon the connection portion 64 the bearing surface 68 is pressed against the mating bearing surface 90 thereby pressing the die 12 against the workpiece.

Figures 22 to 25 show head portions 65 and grooves 66 of identical dimensions for different kinds of dies. Figure 22 shows a die 12, the working surface 72 of which is identical with that of Figure 4. Figure 23 shows a die 12A, the working surface 72A of which is identical to that of Figure 6. Figure 24 shows a die 12D, which essentially corresponds to that shown in Figure 16, and Figure 25 shows a die 12E, the working surface 72E is identical to that of Figure 15.

It can be taken from Figures 20 to 25, that the main body and the operation of the tool system is substantially unchanged, and that only the head portion 65 and the recess 80, forming a connection system or "clutch" has just been reversed, i.e. turned upside-down.

Claims:

1. A tool system of the type having a main body (10) with a pair of clamping members (14, 16) for grasping a workpiece (94, 94A, 94B, 94E) therebetween, a strap member (42) spaced from said clamping members (14, 16), a shaft (54) threaded into said strap member (42) for movement toward and away from said clamping members (14, 16) and having a die-supporting end (64) adjacent said clamping members (14, 16), and a plurality of dies (12, 12A, 12B, 12C, 12D, 12E, 12F, 12G), each of said dies having a working surface (72, 72A, 72B, 72D, 72E) for forming a workpiece grasped by said clamping members upon movement of said shaft (54) toward said clamping members, the improvements comprising:

   - said die-supporting end (64) terminating in a connection portion with a bearing surface (68) facing said clamping members (14, 16);
   - each of said dies (12, 12A, 12B, 12C, 12D, 12E, 12F, 12G) having a member mating said connection portion therein;
   - a circumferential groove (66) in either the connection portion or the member mating the connection portion;
   - and including means (82, 84; 122) for engaging said groove (66) and thereby retaining said die at said die-supporting end (64); and

- said die having a mating bearing surface (90, 90G, 90F) positioned to abut said bearing surface (68) of said connection portion (65) under a compressive force.

2. A tool system of claim 1, wherein

said die-supporting end (64) terminating in a head portion (65) and having a circumferential groove (66) adjacent said head portion (65) and a bearing surface (68) at an end thereof facing said clamping members (14, 16);

each of said dies (12, 12A, 12B, 12C, 12D, 12E, 12F, 12G) having a recess (80, 80F, 80G) sized to receive said head portion (65) therein and including means (82, 84; 122) for engaging said groove (66) and thereby retaining said head portion (65) within said recess (80, 80F, 80G); and

said die recess (80, 80F, 80G) having a mating bearing surface (90, 90G, 90F) at an inner portion thereof positioned to abut said bearing surface (68) of said head portion (65) when said head portion is located within said recess (80, 80F, 80G) such that compressive forces are transmitted from said bearing surface (68) to said mating bearing surface (90, 90G, 90F) as said working surface forms a workpiece grasped by said clamping members (14, 16).

3. A tool system of claim 1, wherein each of said dies (12, 12A, 12B, 12C, 12D, 12E, 12F, 12G) terminating in a head portion (65) and having a circumferential groove (66) adjacent said head portion (65) and a mating bearing surface (90) at an end thereof facing said connection portion (64),

said die-supporting end (64) having a recess (80) sized to receive said head portion (65) therein and including means (82, 84) for engaging said groove (66) and thereby retaining said head portion (65) within said recess (80); and

said recess (80) having a bearing surface (68) at an inner portion thereof positioned to abut said mating bearing surface (90) of said head portion (65) when said head portion is located within said recess (80) such that compressive forces are transmitted from said bearing surface (68) to said mating bearing surface (90) as said working surface forms a workpiece grasped by said clamping members (14, 16).

4. The tool system of claim 1, wherein said groove engaging means (82, 84; 122) includes:

an annular cam spring (118) rotatbly mounted on said die (12G) about said recess (80G) and including a convexity (120) thereon;

a locking pin (122) slidably attached to said die (12G) and extending radially inwardly into said recess (80G) such that an inner end of said

pin (122) may engage said circumferential groove (66) when displaced radially inwardly, and

said pin (122) having a radially outward end slidably engaging said cam spring (118).

5. The tool system of claim 1 wherein said groove engaging means (82, 84; 122) includes:

said recess (80, 80F) having sideward opening sized to receive said head portion (65) therethrough and shoulder means (82, 84) forming a slot (88, 88F) therebetween for slidably receiving said circumferential groove (66) such that said die is retaining on said die-supporting end (64) by engagement of said head portion (65) with said shoulder means (82, 84); and

means (70, 92, 104) for releasably retaining said head portion (65) within said recess (80, 80F).

6. The tool system of claim 5 wherein said retaining means (70, 92) comprises a spring-loaded detent means (70) positioned in said bearing surface (68) on said head portion (65); and a detent recess (92) formed in said mating bearing surface (90) of said die.

7. The tool system of claim 5 wherein said retaining means comprises a cap (104) rotatably mounted to said die (12F) and having slot means (110) positioned thereon such that said cap (104) can be rotated

either to place said slot means (110) in registry with said slot (88F) on said die (12F) to allow said head portion (65) to enter said recess (80F) or to place said slot means (110) out of registry with said slot (88F) on said die (12F) such that said head portion (65) is captured within said recess (80F).

8. The tool system of claim 1 wherein at least one of said dies (12G) includes gauge means (98C) formed thereon for setting an optimum distance a tubular workpiece (94E) should protrude from said clamping members (14, 16).

9. The tool system of claim 8 wherein said gauge means (98C) includes an annular notch formed on said die, said notch having a depth corresponding to said optimum distance, and a width not less than the outside diameter of a tubular workpiece (94E) to be swaged.

10. The tool system of claim 1 wherein said shaft (54) of said main body (10) comprises:

a housing (57) at an end opposite said die-supporting end (64) and having a hole (61) extending transversely therethrough;

a handle (58) slidably positioned in said hole (61) and having a frusto-conical necked portion (62) adjacent an end thereof and a stop (63) positioned between said necked portion (62) and said adjacent end; and

spring-loaded detent means (59) located in said housing (57) and contacting said handle (58) such that said handle end can be inserted through said hole (61), whereby said detent means (59) engages said frusto-conical necked portion (62) but contact between said detent and said stop (63) prevents withdrawal of said handle (58) from said hole (61).

11. The tool system of claim 1 wherein at least one of said dies (12A, 12D) includes a working surface (72A, 72D) having a flat, annular shape and oriented in a plane normal to a longitudinal axis of said die.

12. The tool system of claim 1 wherein said working surface (72A) comprises a generally cylindrical pilot portion (74A) and a generally concave annular portion (96) concentric with said pilot portion (74A).

13. The tool system of claim 1 wherein said working surface (72) comprises a generally frusto-conical portion (76), and a pilot portion (74) concentric with and extending outwardly from said frusto-conical portion (76).

14. The tool system of claim 1, wherein said working surface (72B, 72E) is substantially conical in shape.

15. The tool system of claim 1 wherein said working surface (72) of said die (12) includes a

pilot portion (74), a frusto-conical portion (76) located inwardly of said pilot portion (74), and a cylindrical sizing portion located inwardly of said frusto-conical portion.

FIG-1

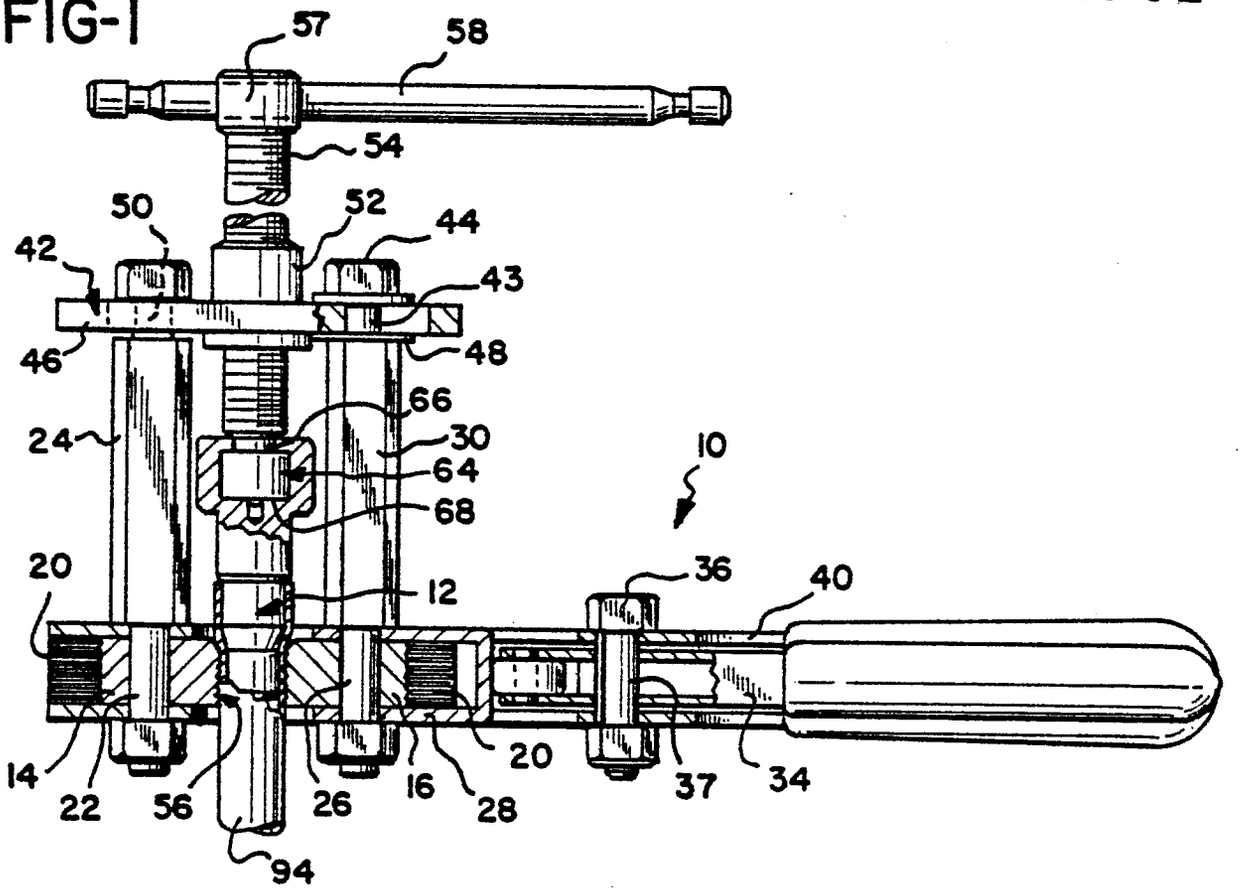


FIG-2

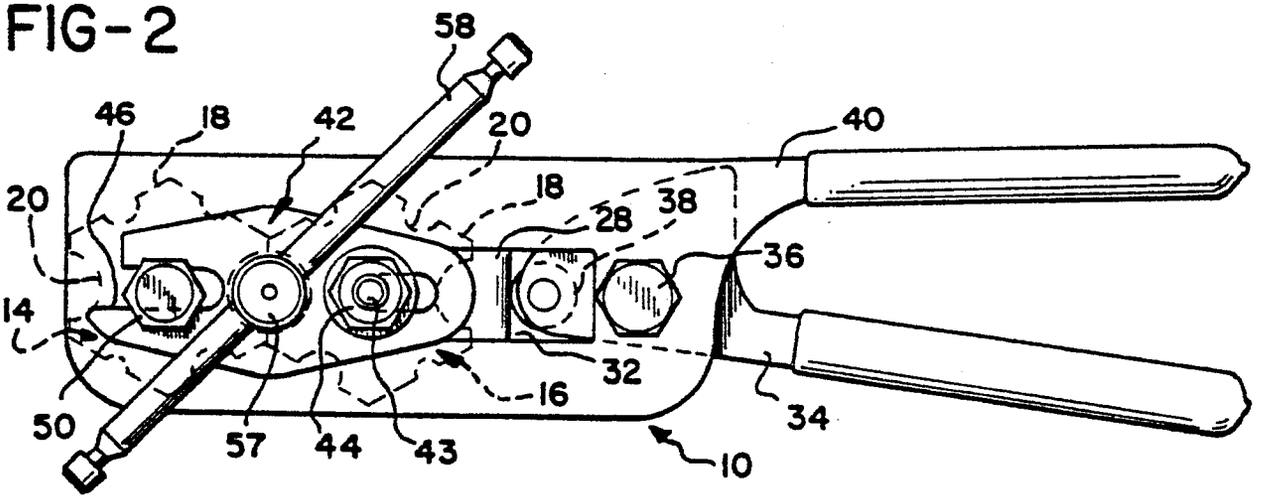


FIG-3

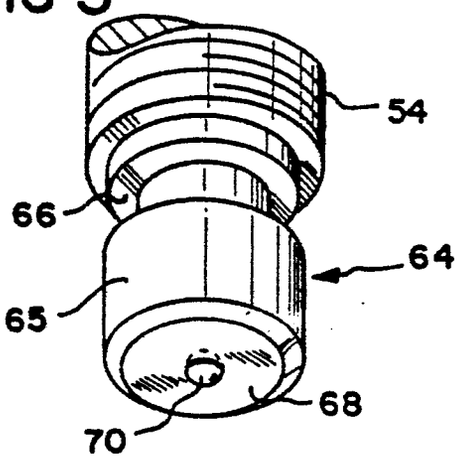


FIG-4

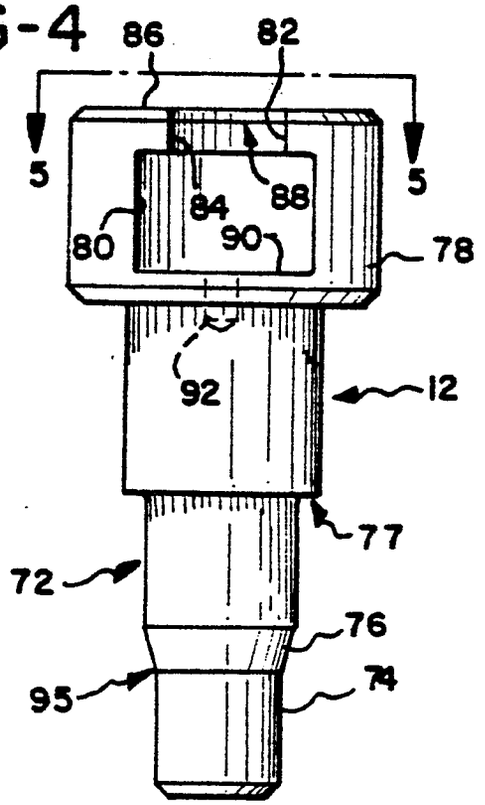


FIG-5

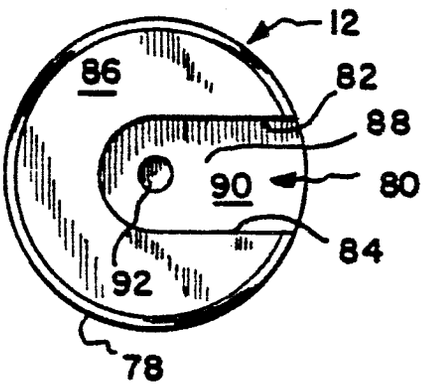


FIG-6

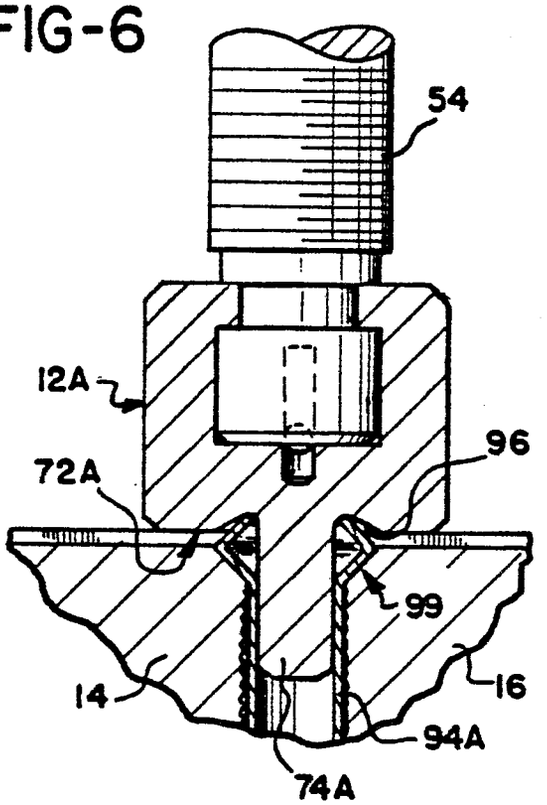


FIG-7

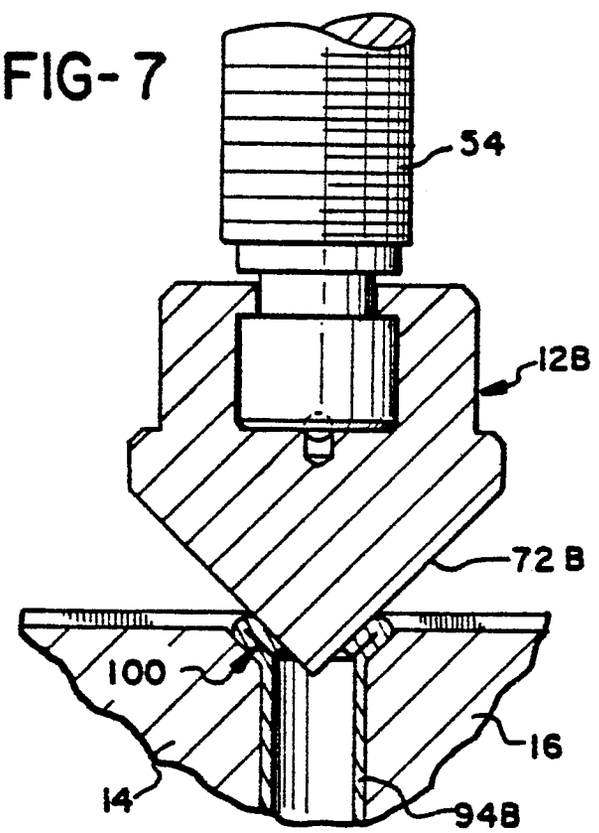


FIG-8

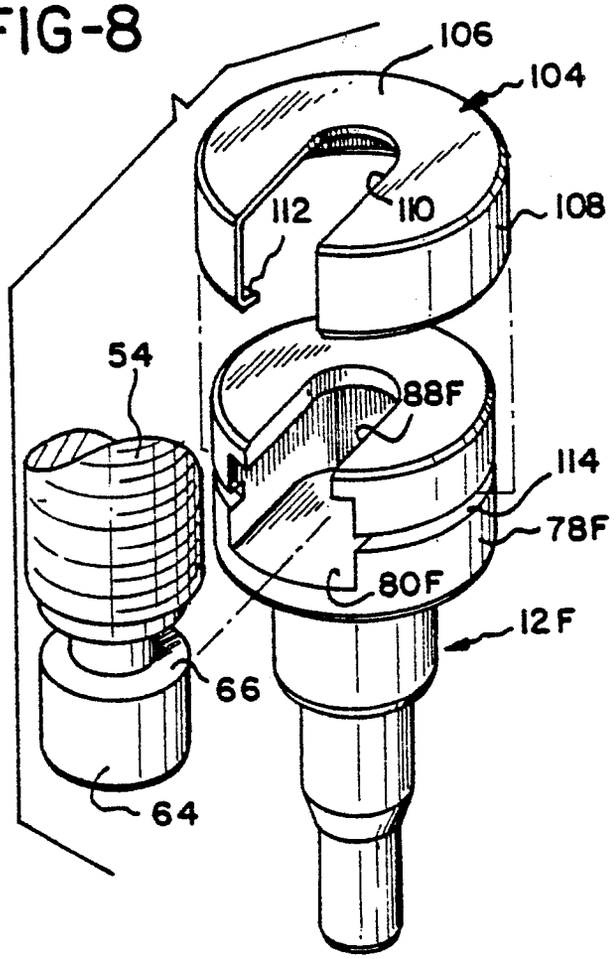


FIG-9

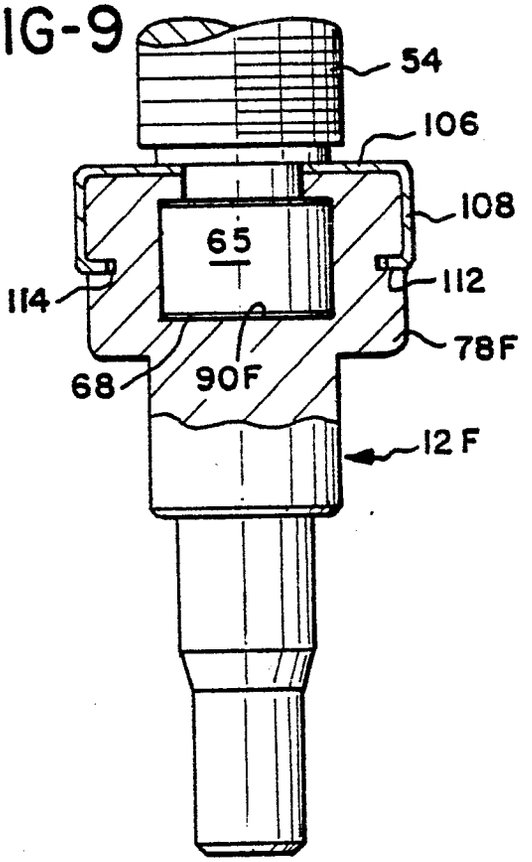


FIG-10

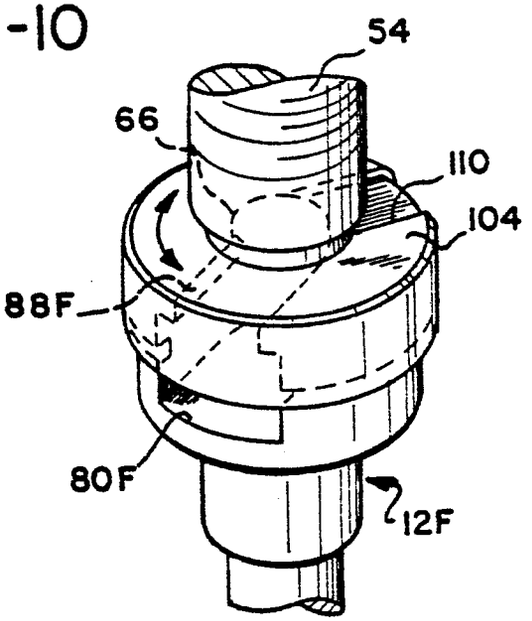


FIG-11

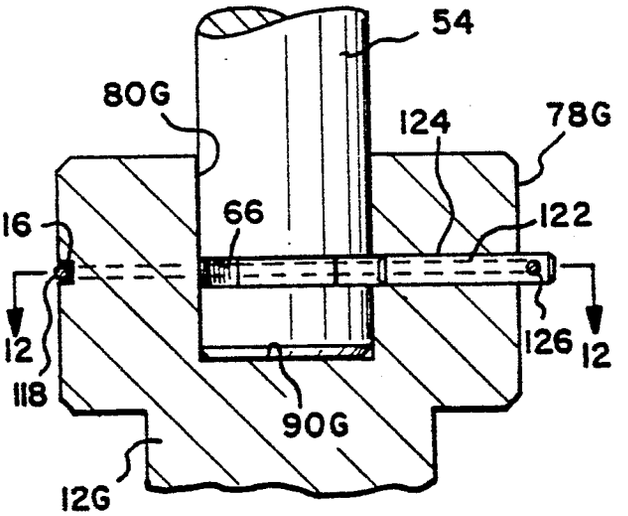


FIG-12

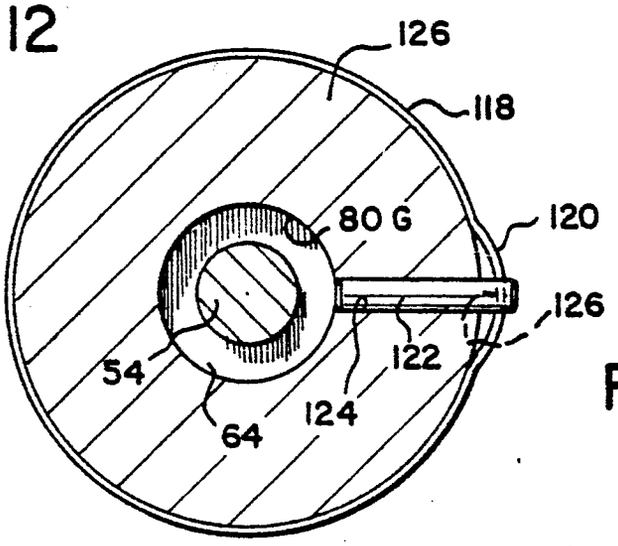


FIG-13

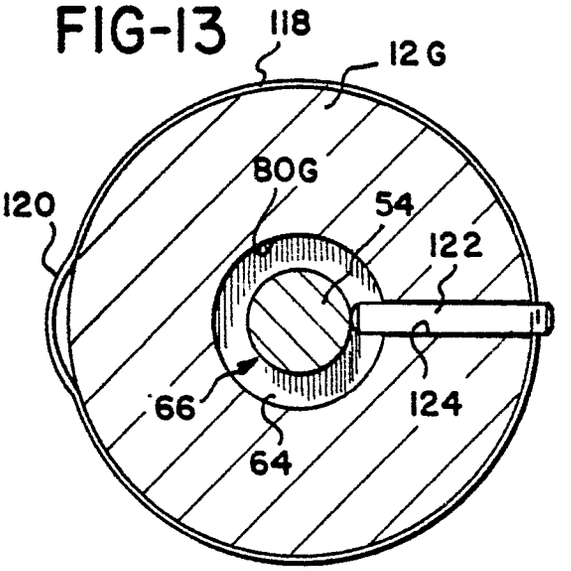


FIG-14

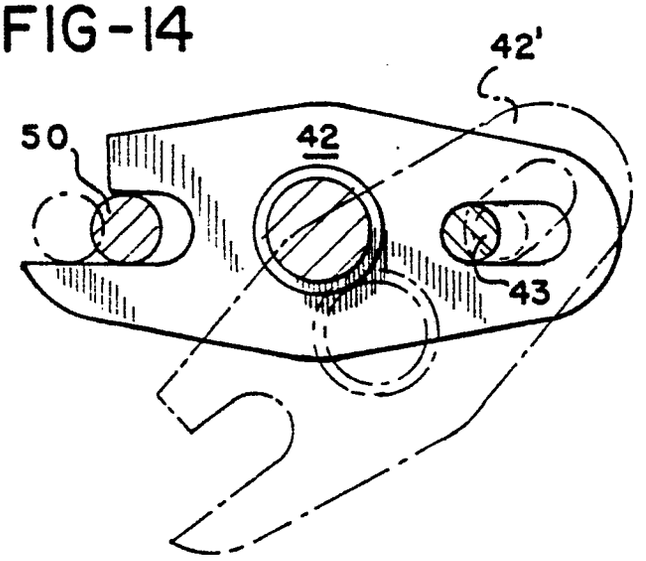


FIG-15

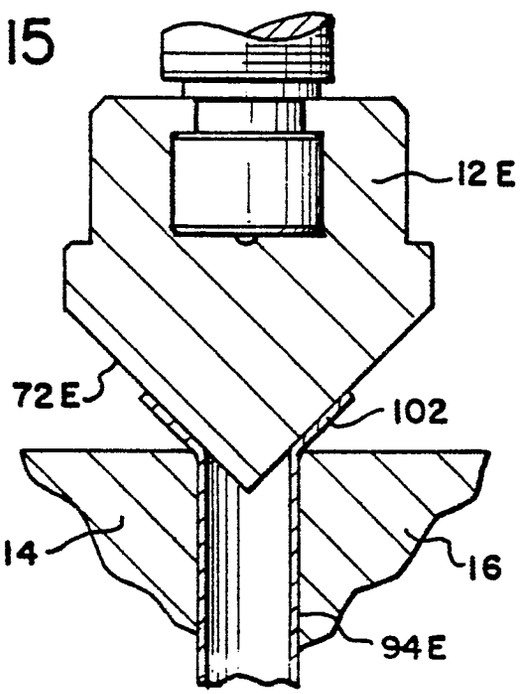


FIG-16

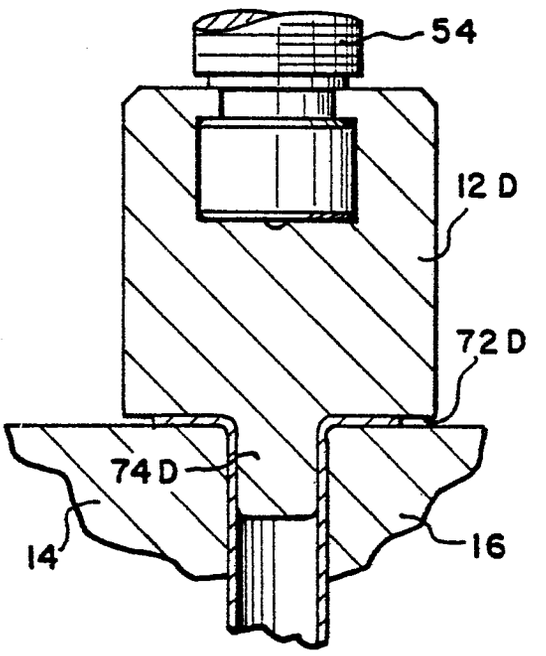


FIG-17

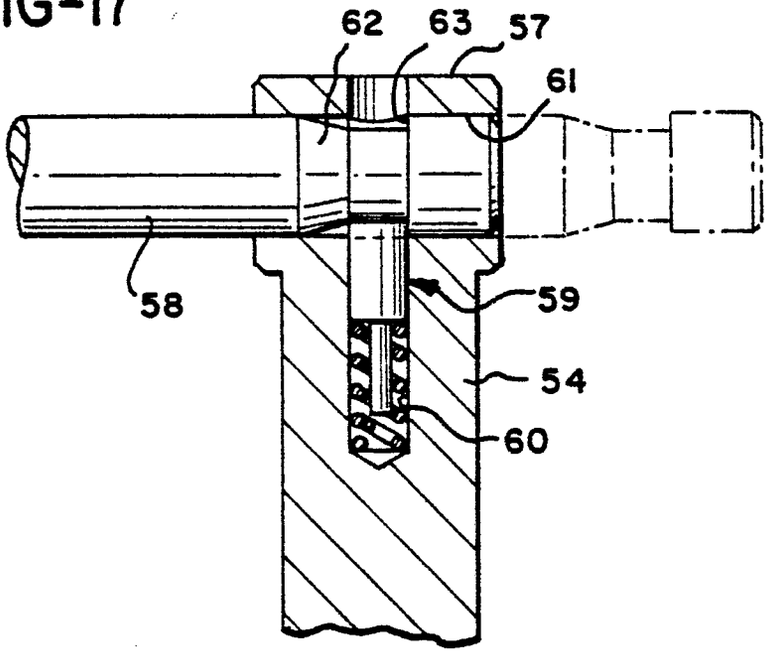


FIG-18

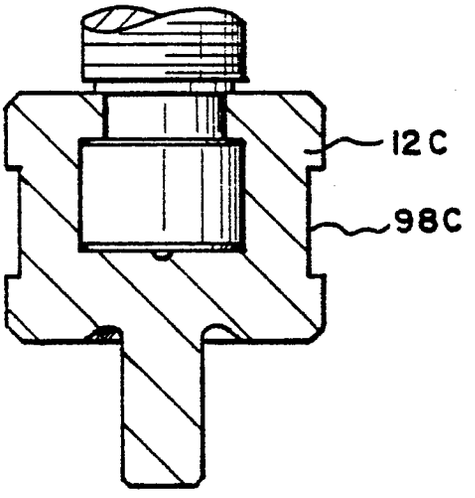


FIG-19

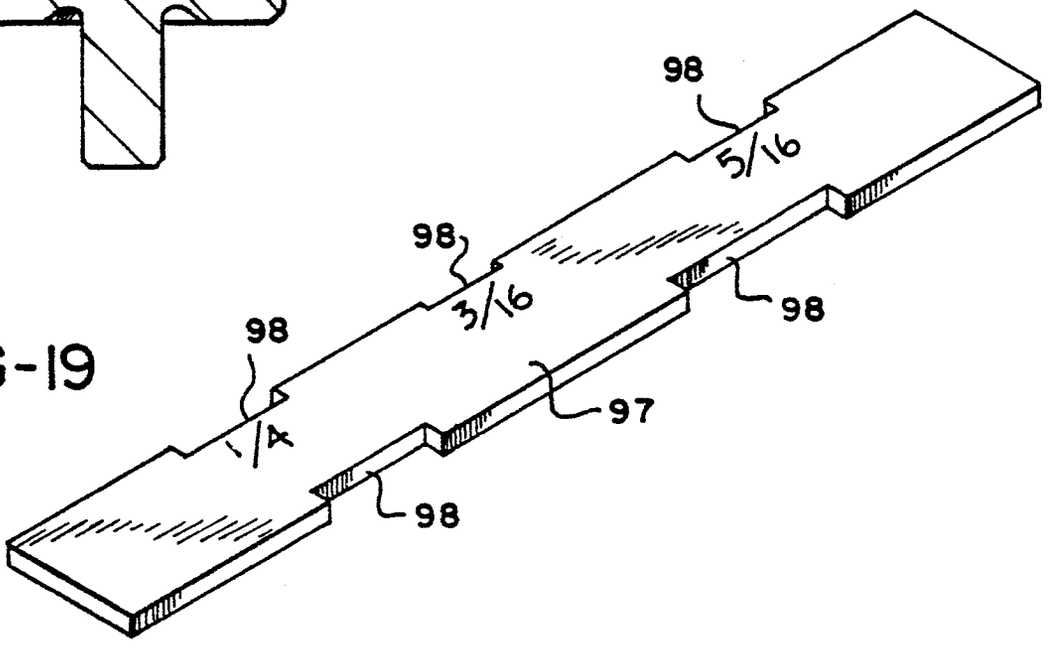
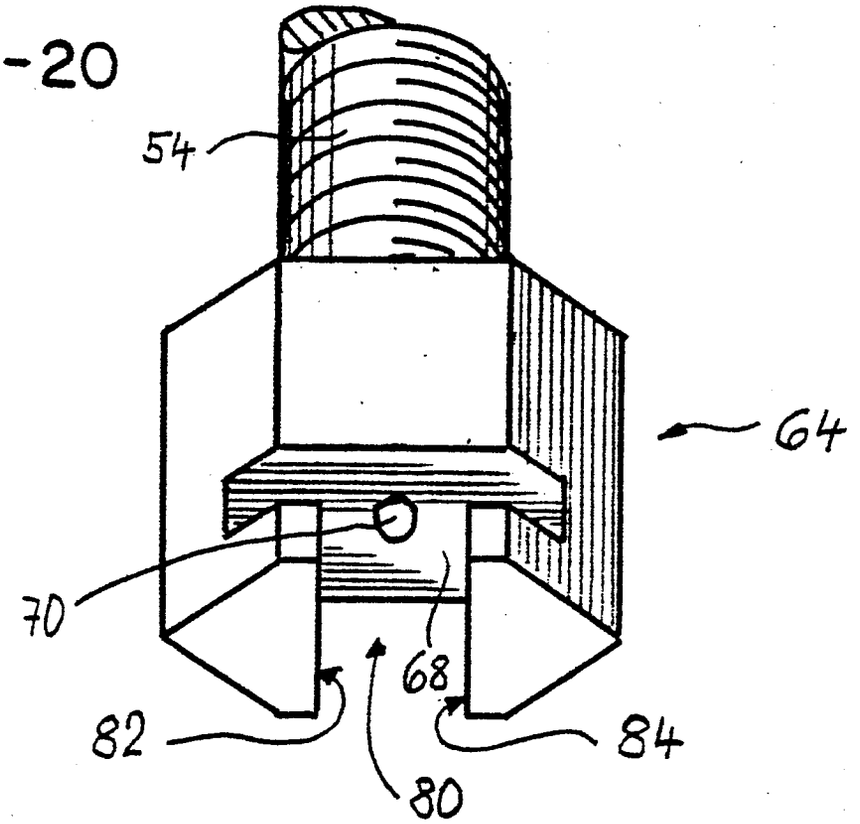


FIG-20



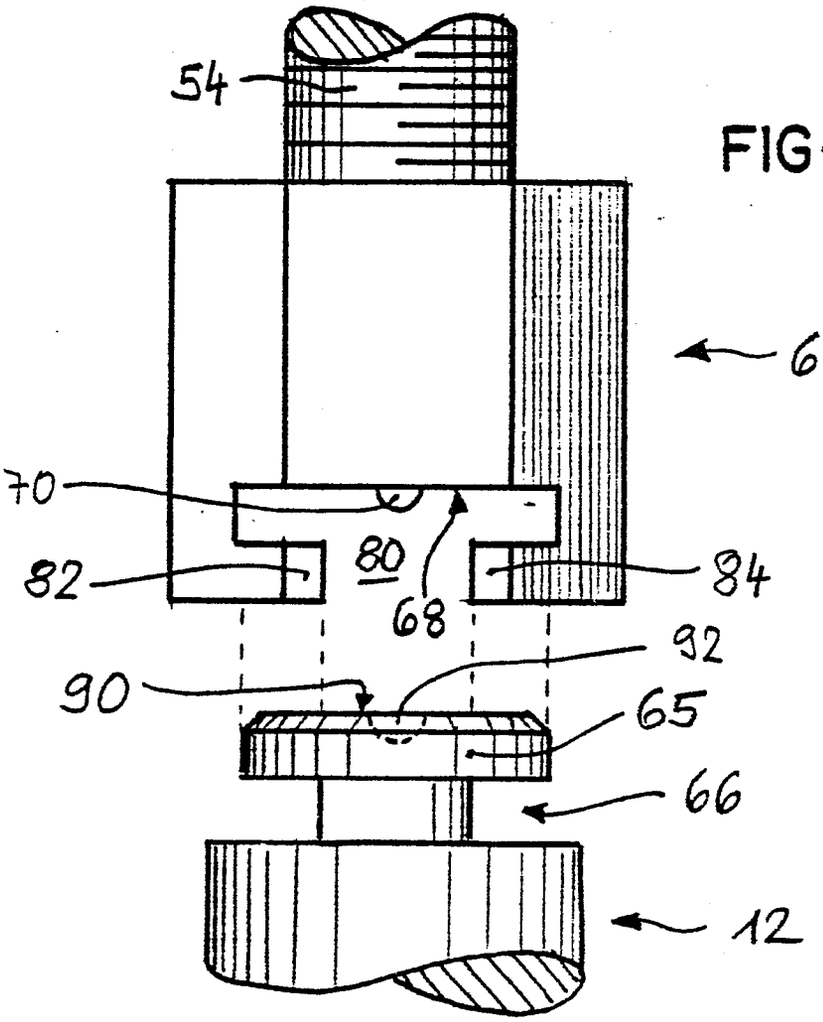


FIG-21

FIG-22

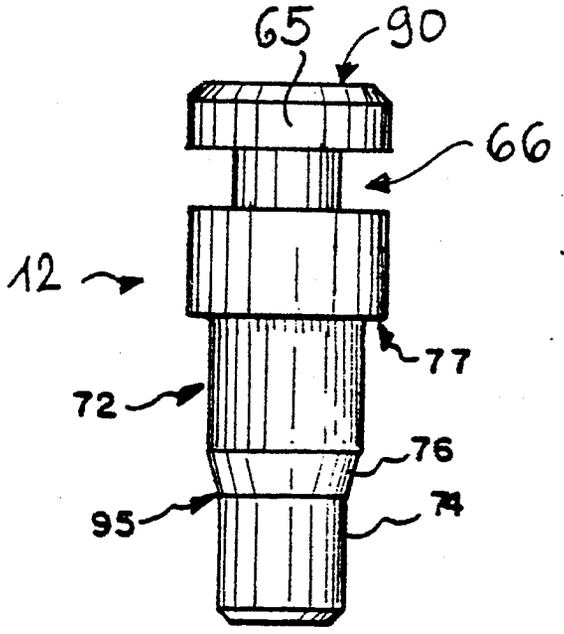
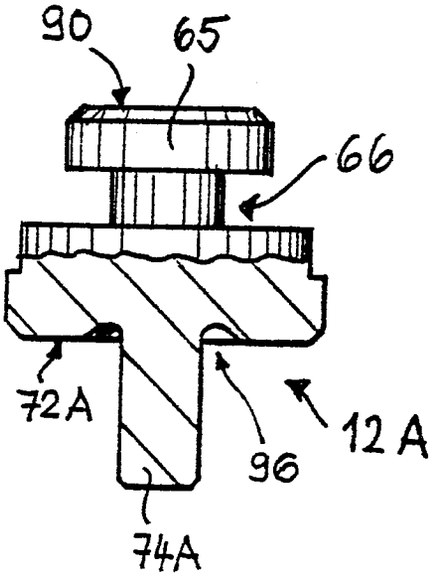


FIG-23



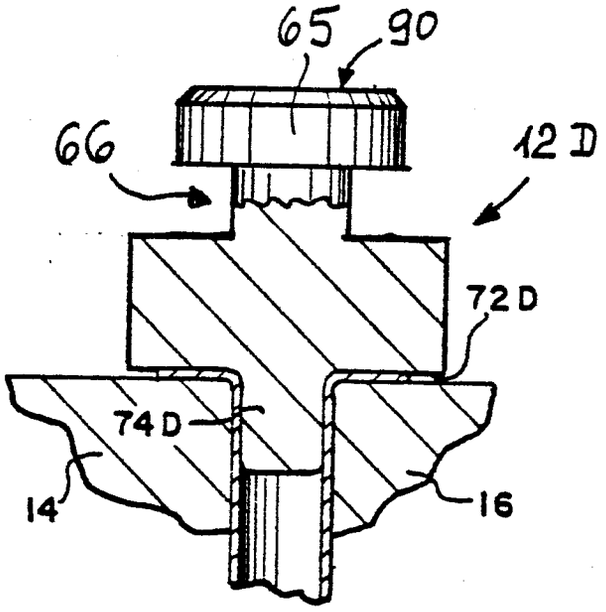


FIG-24

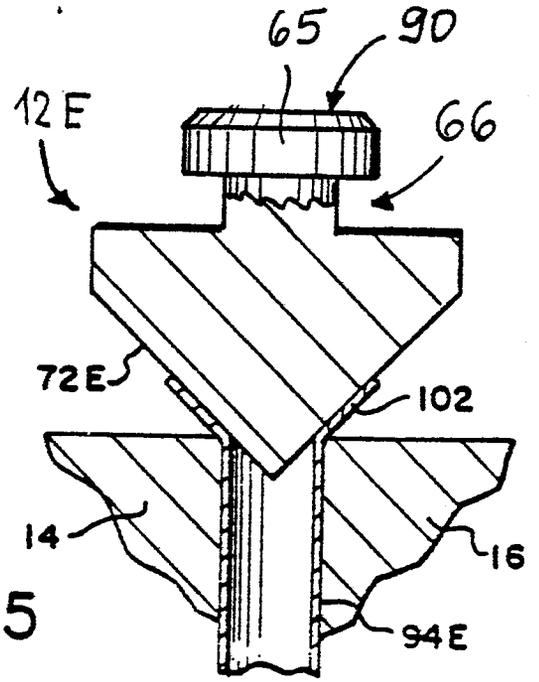


FIG-25

European Patent Office

EUROPEAN SEARCH REPORT

Application number 0133952

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 84108783.6

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.)4
A	US - A - 4 050 286 (JAMES MILLS) * Totality; especially fig. 1-4 * --	1,2	B 21 D 41/02
A	GB - A - 1 442 123 (IMPERIAL-EASTMAN) * Totality * --	1-3	
A,D	US - A - 2 595 036 (GLENN W. WOLCOTT) * Totality * ----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.)4

B 21 D 41/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	24-09-1984	DRNOWITZ

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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