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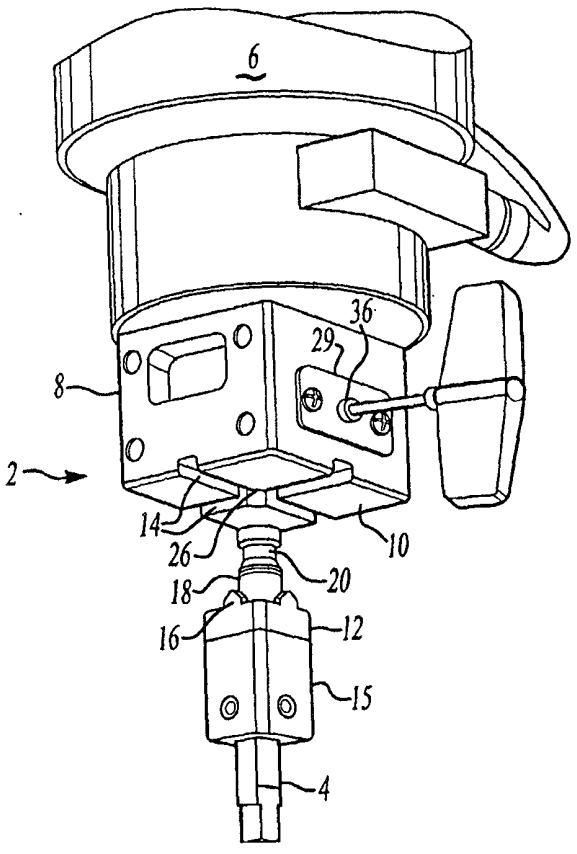
(57) Abstract

A machine tool holding device (2) having a tool holder (12) with raised locating teeth (16), that engage with channels (14) formed in a tool chuck (8), wherein the tool chuck (8) has an internal cavity (22) formed therein for receiving a clamping mechanism (24). The clamping mechanism (24) includes an adjustable plunger (32) that has a contoured end (37) that engages with a draw bar (18). The draw bar (18) pulls the tool holder (12) into engagement with the tool chuck (8) to maintain the relationship of the two parts, as well as ensures the proper location of the assembly.



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TOOL HOLDER

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a machine tool holding device. More particularly, the present invention relates to a machine tool holding device having a tool chuck with clamping mechanism, tool holder. With even more particularity, the present invention relates to a machine tool holding device having a tool holder with raised locating teeth, that engage with channels formed in the tool chuck, wherein the tool chuck has an internal cavity formed therein for receiving the clamping mechanism.

DESCRIPTION OF THE BACKGROUND ART

There exists the need for a tool holding device that is easy to clean, has a low wear resistance, allows for variation in sizing of holders and is easy to load and operate and has accurate repeatability of the holder's location. There also exists the need for a tool holding device that is solid and stable for heavy milling operations.

Various tool holding devices are known in the art, for example, U.S. Patent No. 4,855,558 discloses a clamping device having a plurality of posts extending from the chuck which has two rails projecting from its underside. The clamping device further includes a tool holder having two slots formed therein, that have elastic lips for abutting with the two rails.

The referenced invention does not provide central channels for receiving various size tool holders with raised location teeth, nor does the invention disclose a clamping mechanism with a contoured clamp and rollers to prevent bending of the draw bar as the clamp is engaged. The above referenced invention is also deficient, as it does not provide a solid contact area, which may have a damping effect to control the vibrations of the tool holder during use. The flexible lips by their nature do not provide the desired contact area and stability to provide a damping effect.

It is an object of the present invention to cure those deficiencies outlined above, by providing a tool holder with locating teeth that allow for different sizes of holders to be used with a common chuck. It is also an object of the present invention to provide a tool chuck having a roller mechanism included with the clamping mechanism to prevent bending of the draw bar as the clamp is engaged. It is a further object of the invention to provide a tool holder with a solid contact area to provide a damping effect for vibrations produced during milling or grinding operations.

SUMMARY OF THE INVENTION

There is provided an apparatus for detatchably connecting a tool to a manipulating device. The apparatus includes a tool chuck that has an internal cavity formed therein and an exposed frontal surface and a center bore. The frontal surface of the tool chuck has a plurality of channels formed therein. The channels have angled side walls and extend radially outward from the center of the frontal surface.

The apparatus also includes a tool holder having a plurality of raised locating teeth that have angled sides and extend radially from a center. The locating teeth align with the channels when the tool chuck and tool holder are mated to locate the tool holder.

The apparatus further includes a draw bar extending from the center the of the tool holder. The draw bar has a contour to mate with a clamping mechanism.

The apparatus also includes a clamping mechanism disposed within the internal cavity of the tool chuck. The clamping mechanism has an opening that aligns with the center bore of the tool chuck to receive a distal end of the draw bar when the draw bar is engaged. The clamping mechanism also includes a plunger that is threadably engaged within the clamping mechanism. The plunger has a contoured end for engagement with the contour of the draw bar to firmly pull the tool holder into engagement with the tool chuck and maintain the relationship of the tool holder and tool chuck.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Figure 1 is a perspective view of a machine, tool chuck, and tool holder.

Figure 2 is an exploded view of the tool chuck and clamping mechanism.

Figure 3 is a cross sectional view of the tool chuck and the tool holder in functional engagement.

Figure 4 is a side view of the tool holder and tool chuck.

Figure 5 is a partial sectional view of the tool holder and tool chuck.

Figure 6 is a bottom view of the tool chuck showing the roller mechanism.

Figure 7 is a top view of the recess and roller mechanism.

Figure 8 is a top view of the recess and roller mechanism of an alternative embodiment.

Figure 9 is a top view of the clamping mechanism.

Figure 10 is a side view of the draw bar.

Figure 11 is a bottom view of a large tool holder.

Figure 12 is a top view of a large tool holder.

Figure 13 is a top view, side view and end view of the plunger and screw.

Figure 14 is a photographic view of the tool chuck, clamping mechanism and two different size tool holders with draw bars.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, Figure 1 generally shows an apparatus 2 for detachably connecting a tool 4, such as an electrode, to a machine, such as for example an EDM machine 6. The apparatus 2 includes a tool chuck 8 which mounts to the end platen or table of a machine, such as an EDM machine, mill grinder, lathe, or spin grinding fixture. The tool chuck 8 has a square or round configuration, with one side having a finished surface for mating with the machine 6, and an opposite side which is finished for receiving a tool holder 12. The tool holder 12 mounts adjacent the frontal

surface 10 of the tool chuck 8. The frontal surface 10 includes a plurality of channels 14. The channels 14 have a defined width and depth, and are beveled on each side. In the preferred embodiment, the tool chuck 8 will have four channels 14 extending outward from a center of the frontal surface 10. It will be understood by those skilled in the art that the number of channels 14 can be any number of at least two. Preferably, the channels 14 are spaced symmetrical around the frontal surface 10, and all join at the center. Even more preferably, the channels 14 are perpendicular to each other.

A machine tool or electrode 4 is mounted to the tool holder 12. Typically, the electrode 4 or work piece is mounted to the tool holder 12 with screws. As shown in Figure 1, alternatively the tool 4 can be mounted into an adapter 15 which is in turn mounted to the tool holder 12 with screws. Preferably, the tool 4 is a graphite or copper electrode for an EDM machining process or a work piece to be machined. It will be understood by those skilled in the art that various different machining tools or work pieces could be mounted to the tool holder 12, such as for example, metal or plastic parts to be milled or turned. The opposite side of the tool holder 12 is configured for mounting to the tool chuck 8. The tool holder 12 is equipped with raised locating teeth 16 that align with the channels 14 in the frontal surface 10 of the tool chuck 8. These teeth 16 have a defined height and width and are beveled on each side at an angle which is preferably equivalent to the beveled angle on the channel 14 walls. Referring to Figures 4 and 5, in the preferred embodiment, the channel 14 has a first section 14a near the top of the channel 14 where the wall is beveled inward at an

angle ranging from 0 to 60 degrees as measured from a line perpendicular to the frontal surface 10. The channel also has a second section 14b where the wall continues to a flat bottom 14c of the channel 14 to meet the bottom 14c of the channel perpendicularly. The bottom 14c of the channel 14 is flat and parallel to the frontal surface 10.

Referring to Figures 4 and 5 the locating teeth 16 have beveled sides to correspond to the beveled walls of the channels 14. In the preferred embodiment, the locating teeth 16 have a first section 16a nearer to the base of the tool holder 12 where the angle of the side is in the range of 0 to 60 degrees, preferably, 20 degrees as measured from a line perpendicular to the top surface of the tool holder 12. This first section 16a corresponds to the first section 14a of the channel 14. The locating teeth 16 also include a second section 16b nearer to a tip 16c of the locating teeth 16 where the angle of the side wall is in the range of 10 to 80 degrees, preferably, 45 degrees from a line perpendicular to the surface of the tool holder 12. The second section 16b of the locating teeth 16 acts as a lead-in to make the insertion of the locating teeth 16 into the channels 14 easier. The tip 16c of the locating teeth 16 is generally flat and parallel to the flat bottom 14c of the channel 14. When the tool holder 12 is engaged to the tool chuck 8, the beveled sides 16a of the locating teeth 16 are in contact with the beveled sides 14a of the channel 14. The locating teeth 16 on the tool holder 12 and the channels 14 on the tool chuck 8 align with each other to allow the tool holder 12 to be mounted to the tool chuck 8 quickly while insuring that the tool holder 12 is

located at the exact center of the tool chuck 8, as well as maintaining the proper radial alignment of the tool holder 12.

The tool holder 12 is also equipped with a draw bar 18 extending from a center of the tool holder 12 on the same side as the locating teeth 16. The draw bar 18 is contoured with an annular groove 20 at a distal end 21 thereof. The groove 20 has a generally hourglass configuration with upper and lower inward sloping surfaces and a minimum diameter at a center which is less than the overall diameter of the draw bar 18. Figure 2 is a partial view of the tool chuck 8 from the side which connects towards the machine 6. Referring to Figures 2 and 6, the tool chuck 8 includes an internal cavity 22 which houses a clamping mechanism 24, and a circular bore 26, see Figure 1, in the center of the frontal surface 10 that extends into the inner cavity 22.

The clamping mechanism 24 slides into the cavity 22 of the tool chuck 8 through an opening 28 in a side of the tool chuck 8.

Further included within the cavity 22 are two recesses 80, 82 which house roller mechanisms 84, 86 to facilitate engagement of the clamping mechanism 24 with the draw bar 18 and to minimize application of a side load to the draw bar 18, which can result in inaccurate positioning of the tool holder 12. The recesses 80, 82 may be of various shapes to accommodate various roller mechanisms 84,86. The roller mechanisms 84, 86 prevent the clamping mechanism 24 from binding frictionally with the tool chuck 8 when engaging the clamping mechanism. The roller mechanisms 84, 86 minimize the frictional resistance outlined above and minimize the side load applied to the draw bar 18. With reference to Figures 6 and 7, the roller mechanisms

84, 86 have a cylindrical roller 88 and a biasing spring 90. The spring 90 may be in the shape of a bone as shown in Figure 7, or alternatively the spring 90 may be in the shape of an arc as shown in Figure 8. Various other configurations of springs may also be used by the present invention, such as a coiled spring and other known spring configurations. The spring can be made of plastic or other appropriate material having the necessary flexibility and spring memory return, such as steel. The cylindrical roller 88 and biasing spring 90 are positioned within the recesses 80, 82 such that the cylindrical roller 88 is positioned slightly above the top surface of the cavity 22 of the tool chuck 8. This relationship allows for smooth operation of the clamping mechanism 24. The biasing spring 90 maintains the cylindrical roller 88 within the recesses 80, 82, as well as, positions the cylindrical roller 88 in its initial or starting position after release of a load to keep the cylindrical roller 88 in an appropriate position to enable smooth movement of the clamping mechanism 24 the next time it is engaged.

Alternatively, the roller mechanisms 84, 86 of the present invention may be housed in a configuration other than the recesses 80, 82 mentioned above. The roller mechanisms 84, 86 may be held by a plate or cage, so long as the roller mechanisms 84, 86 are maintained in an appropriate position to engage the clamping mechanism 24.

The roller mechanisms 84, 86 provide a superior means of facilitating engagement of the clamping mechanism 24, as compared to other means known in the art. For example, it is known that a piece of Teflon plastic may be positioned within

an opening to provide a reduced frictional resistance. The friction of the Teflon however has been shown to lock the movement of the clamping mechanism 24 resulting in the deflection of the draw bar 18 by two thousandths of an inch or more, resulting in a less accurate positioning of the tool holder 12. The roller mechanism of the present invention has shown deflection of the draw bar 18 of only .0002 of an inch or less to provide a superior location for the tool holder 12.

Preferably, the clamping mechanism 24 slides into an opening 28 in a side that is adjacent to the frontal surface 10. A cover plate 29 is used to cover the opening 28 and retain the clamping mechanism 24. The clamping mechanism 24 has a circular opening

30 at a distal end which is large enough to easily accommodate the draw bar 18 portion of the tool holder 12.

With reference to Figures 3 and 9, the clamping mechanism 24 is equipped with a plunger 32 which extends into the opening 30 at the distal end of the clamping mechanism 24.

The hole in the clamping mechanism 24 allows the plunger 32 to slide into and out of the opening 30 at the distal end of the clamping mechanism 24, but does not allow the plunger 32 to fall completely out of the clamping mechanism 24. The clamping mechanism 24 also includes two fixed clamping members 34 which are located along the inner surface of the opening 30 in the clamping mechanism 24 opposite the plunger 32. The plunger 32 is controlled by a drive screw 36 which when tightened forces the plunger 32 to extend outward into the opening 30 in the clamping

mechanism 24. When the drive screw 36 is loosened, the plunger 32 is pulled back by the screw 36 into the clamping mechanism 24 as the draw bar 18 is removed or reinstalled. Alternatively, a biasing means could be included to cause the plunger 32 to retract automatically when the drive screw 36 is loosened. Preferably, a distal end 37 of the plunger 32 is angled to correspond to the angle of the sloped surface of the groove 20 at the distal end 21 of the draw bar 18.

Referring to Figure 3, when the plunger 32 is positioned in the tool chuck 8, the circular opening 30 at the distal end of the clamping mechanism 24 is concentric with the circular bore 26 in the tool chuck 8. As the tool holder 12 is mounted to the tool chuck 8, the draw bar 18 is inserted into the bore 26 in the tool chuck 8 and the distal end of the draw bar 18 extends into the inner cavity 22. In this position the draw bar 18 will extend into the opening 30 at the distal end of the clamping mechanism 24. When the draw bar 18 of the tool holder 12 is within the opening 30 in the clamping mechanism 24, the plunger 32 extends out to engage the draw bar 18 such that the angled end 37 of the plunger 32 contacts the upper sloped surface 21 of the groove 20. Preferably, the plunger 32 and the draw bar 18 are perpendicular to each other when they are engaged.

When the angled end 37 of the plunger 32 exerts a lateral force against the upper sloped surface of the groove 20 in the draw bar 18, the draw bar 18 is forced against the two fixed clamping members 34. The resultant force exerted on the draw bar 18 as the plunger 32 extends into the opening 30 forces the sloped surface of the groove 20 to slide along the angled surface of the plunger 32 and fixed members 34. The

draw bar 18 is prevented from movement in the lateral direction by the two fixed clamping members 34. The plunger 32 is prevented from movement in the vertical direction by the body of the clamping mechanism 24. Therefore, the plunger 32 can only continue to extend laterally, and the relative movement between the sloped surface of the groove 20 and the angled surface of the plunger 32 is translated into vertical movement of the draw bar 18. Therefore, the force of the plunger 32 extending against the draw bar 18 acts to pull the draw bar 18 upward into the tool chuck 8, until the flat tips 16c and side walls of the locating teeth 16 are locked in contact with the flat bottom 14c and side walls of the channels 14. The locating teeth 16 and channels 14 align the tool holder 12 centrally and radially.

Referring to Figures 4 and 5, prior to engagement with the clamping mechanism 24 a clearance exists between the flat tip 16c of the locating teeth 16 and the flat bottom 14c of the channel 14. Preferably, this clearance is on the scale of 0.0 to 0.0005 inches. When the clamping mechanism 24 and the plunger 32 act to pull the draw bar 18 upward into the tool chuck 8, the flat tip 16c and side walls of the locating teeth 16 come into contact with the flat bottom 14c and side walls of the channel 14 at a point A. At this point the tool holder 12 is in the "locked" position. As illustrated in Figures 4 and 5, when locked, the first section 16a also engages the first section 14a.

Referring to Figures 3 and 10, there is shown a rubber seal 56 which seals against the distal end of the draw bar 18. The draw bar 18 also includes a bore 58 through the center which transfers flush fluid through the draw bar 18 to the tool 4. When the tool holder 12, the draw bar 18, the clamping mechanism 24 are all

functionally engaged, the flush fluid flows through the flush mechanism 40, into the lock member 40, through the draw bar 18, and finally to the tool 4.

When the tool holder 12 is mounted to the tool chuck 8, the locating teeth 16 and channels 14 provide two dimensional location, as well as maintain the proper radial position, while the draw bar 18 holds the tool holder 12 tightly against the tool chuck 8 so that the flat tips 16c of the locating teeth 16 are locked in contact with the flat bottom 14c of the channels 14 for location positioning in a third dimension. This arrangement provides an accurate way to maintain positioning, as well as, an easy way to change tools 4.

In an alternative embodiment, the flat tips 16c of the locating teeth are not locked in contact with the flat bottom 14c of the channels 14, but rather there is a clearance maintained along the bottom. The contact is along the side walls of the locating teeth 16 and channels 14.

With reference to Figures 11 and 12, the tool holder 12 also includes a plurality of mounting holes 75 for receipt of machine bolts or dowels to bolt onto the electrode 4 other attachments or workpieces. These additional mounting holes 75 provide additional versatility to the tool holder of the present invention.

The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within

the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

CLAIMS

What is claimed is:

1. An apparatus for detachably connecting a tool to a manipulating device, said apparatus comprising,

a tool chuck having an internal cavity, an exposed frontal surface, and a center bore,

a plurality of channels formed in said frontal surface having angled side walls and extending radially outward from a center of said frontal surface,

a tool holder having a plurality of raised locating teeth having angled sides and extending radially outward from a center of said tool holder such that said locating teeth align with said channels in said frontal surface of said tool chuck for centering said tool holder when said tool holder is in locking engagement with said tool chuck,

a draw bar extending from said center of said tool holder, said draw bar having contoured features,

a clamping mechanism disposed within said internal cavity of said tool chuck, said clamping mechanism having an opening which aligns with said center bore in said tool chuck for receiving a distal end of said draw bar when said draw bar is engaged with said center bore, and

a plunger threadably engaged with said clamping mechanism and having a contoured end for selective engagement with said draw bar such that when said plunger is moved into said clamping mechanism said

contoured end engages said contoured features of said draw bar to firmly pull said tool holder into engagement with said tool chuck and hold said tool holder in place.

2. The apparatus of Claim 1, wherein the internal cavity further includes at least one recess formed therein to house a roller mechanism, said recess having a lower surface and a boundary surface intersecting the lower surface to define the periphery of the at least one recess.

3. The apparatus of Claim 2, wherein the roller mechanism is seated within the at least one recess slightly above an upper boundary defined by the top of the boundary surface.

4. The apparatus of Claim 2, wherein the roller mechanism comprises a cylindrical roller and a biasing spring.

5. The apparatus of Claim 3, wherein the biasing spring is bone shaped.

6. The apparatus of Claim 3, wherein the biasing spring is arc shaped.

7. The apparatus of Claim 1, further including a cover plate attached to the tool chuck for covering the internal cavity and retaining the clamping mechanism when disposed within the internal cavity.

8. The apparatus of Claim 1, wherein the tool holder is a large tool holder.

9. The apparatus of Claim 1, wherein the tool holder is a small tool holder.

10. The apparatus of Claim 1, wherein the plurality of channels having angled side walls have angles from zero to sixty degrees, as measured from the frontal surface.

11. The apparatus of Claim 1, wherein the tool holder further includes a plurality of mounting holes for attachment of additional components.

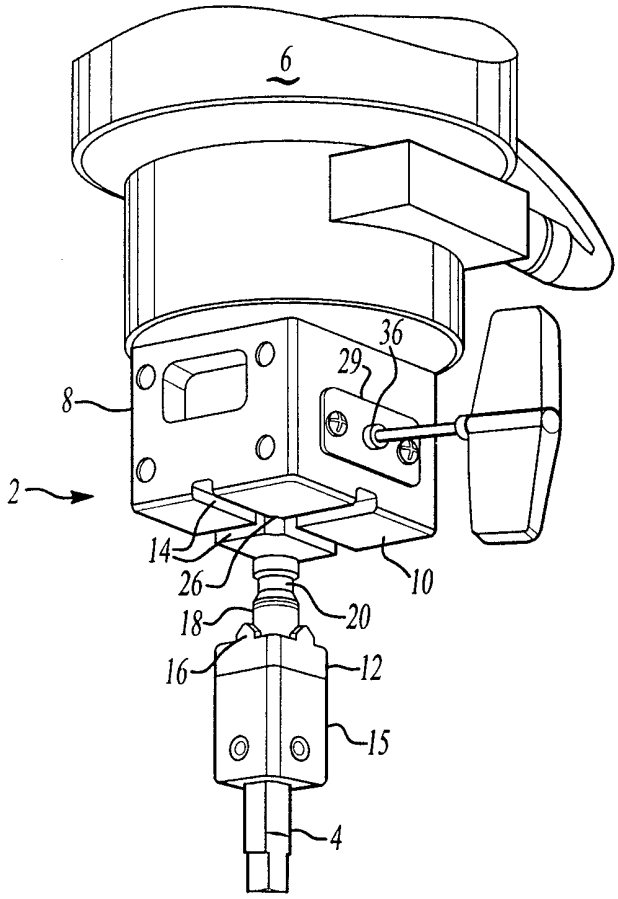

Fig-1

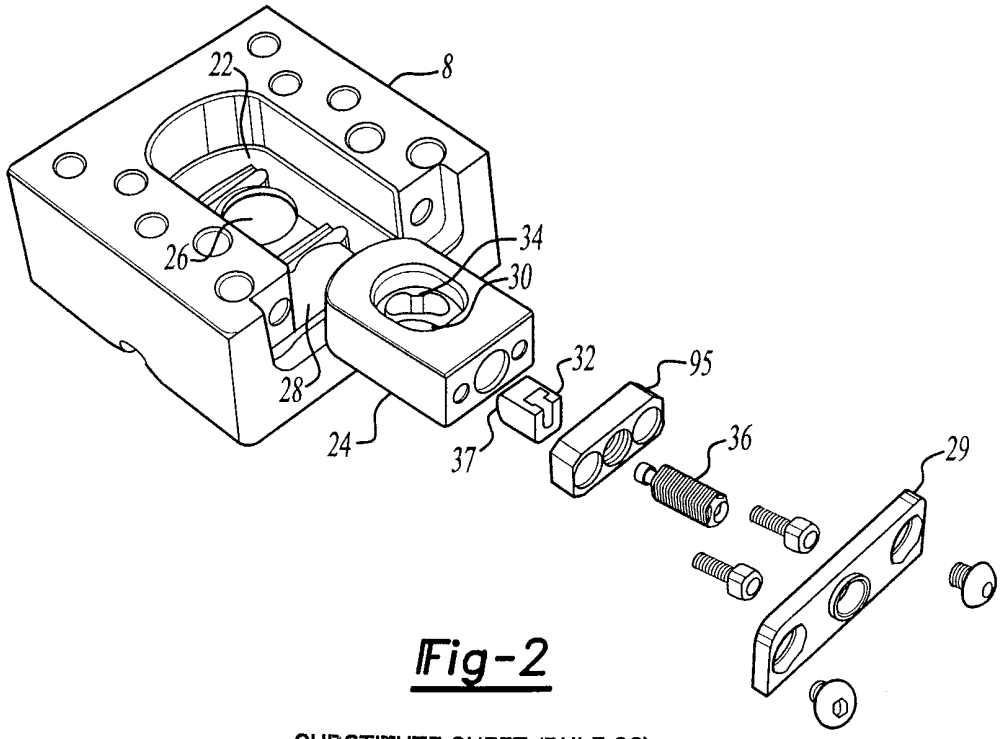

Fig-2

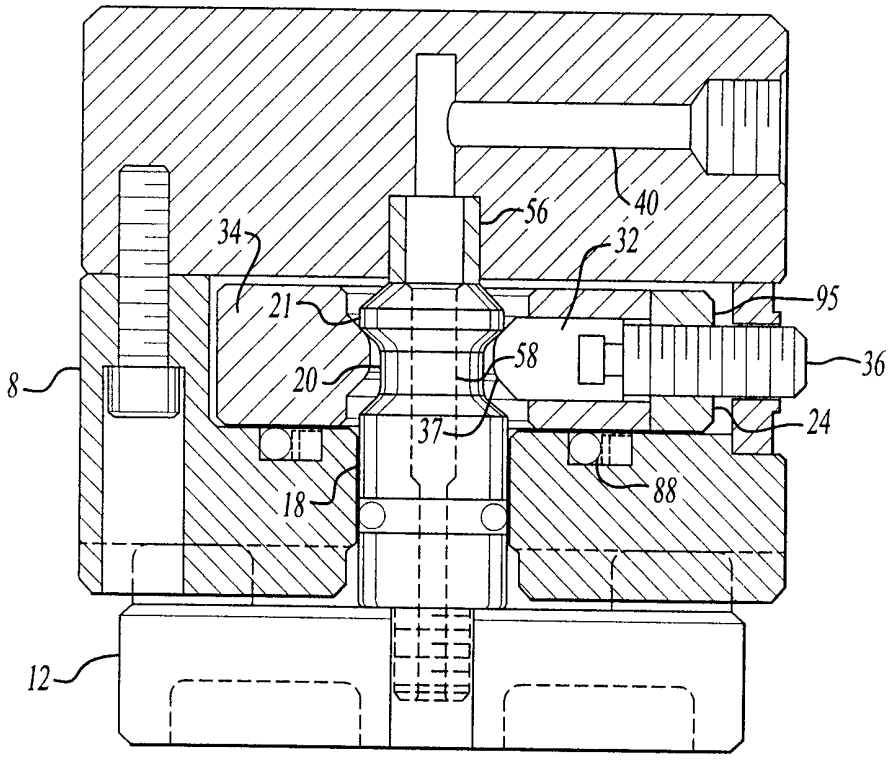

Fig-3

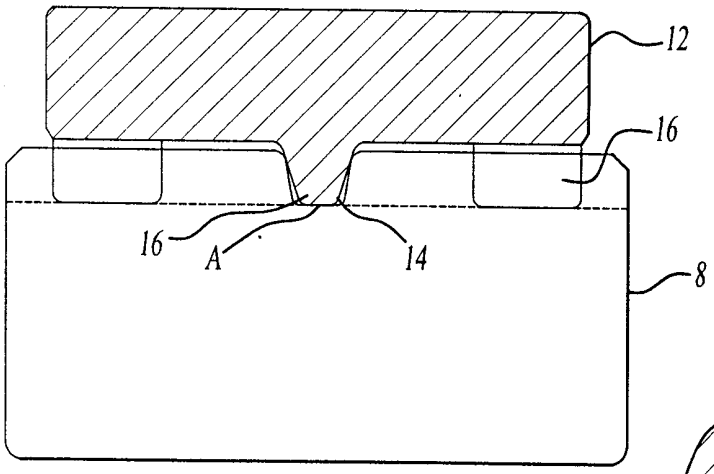

Fig-4

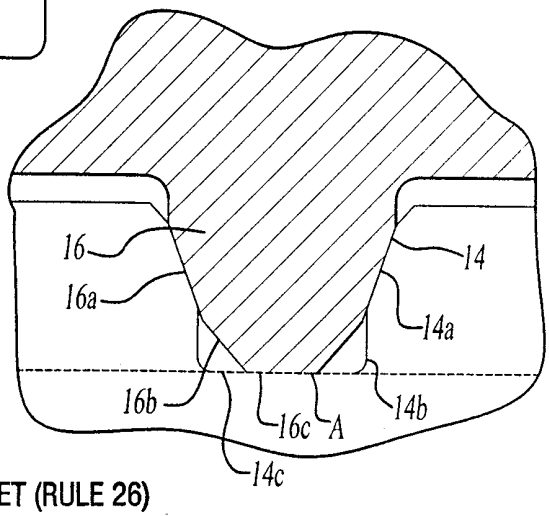

Fig-5

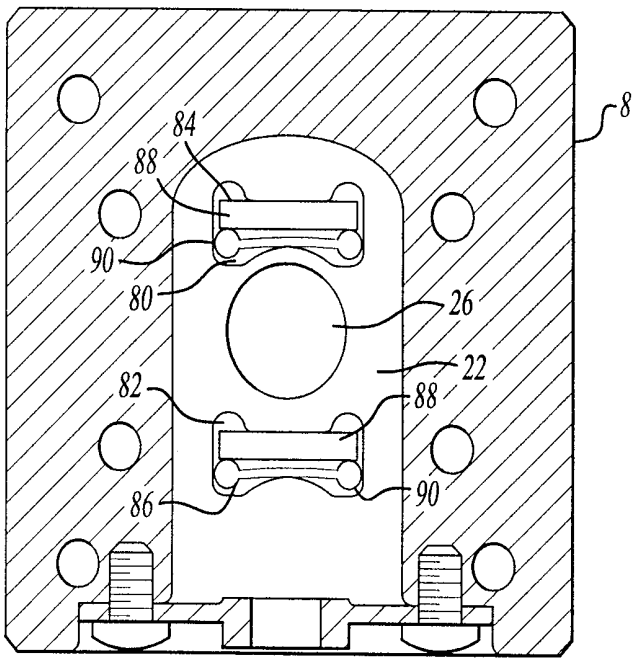

Fig-6

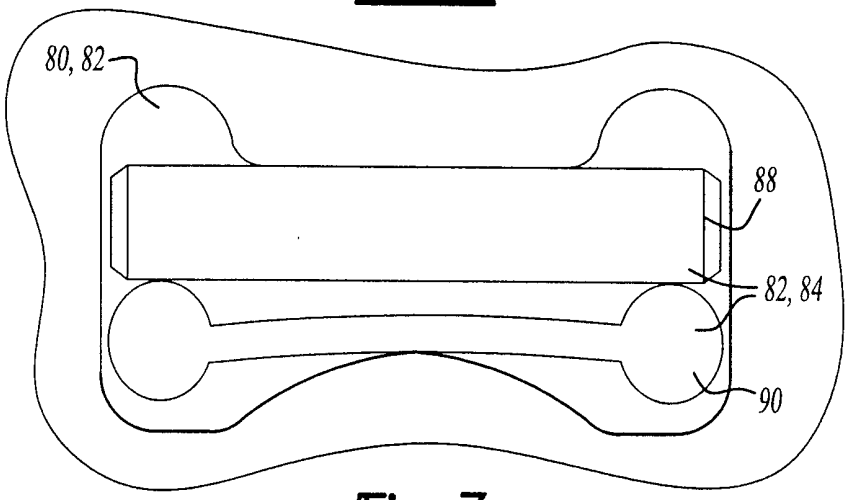

Fig-7

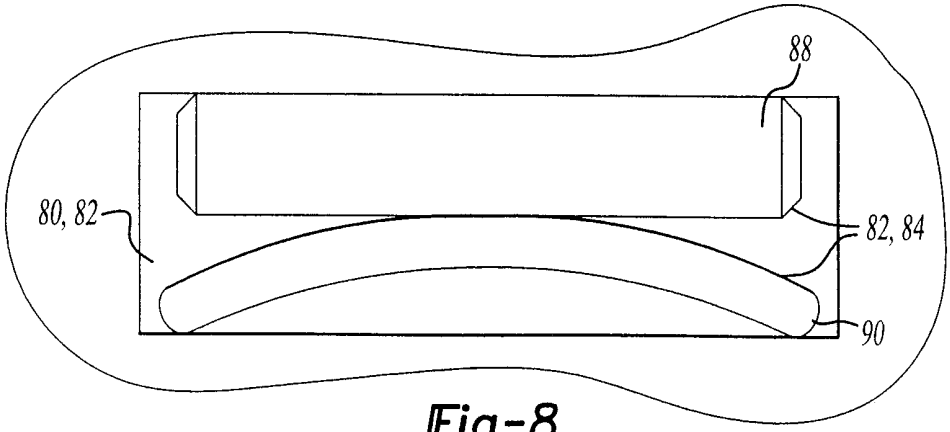

Fig-8

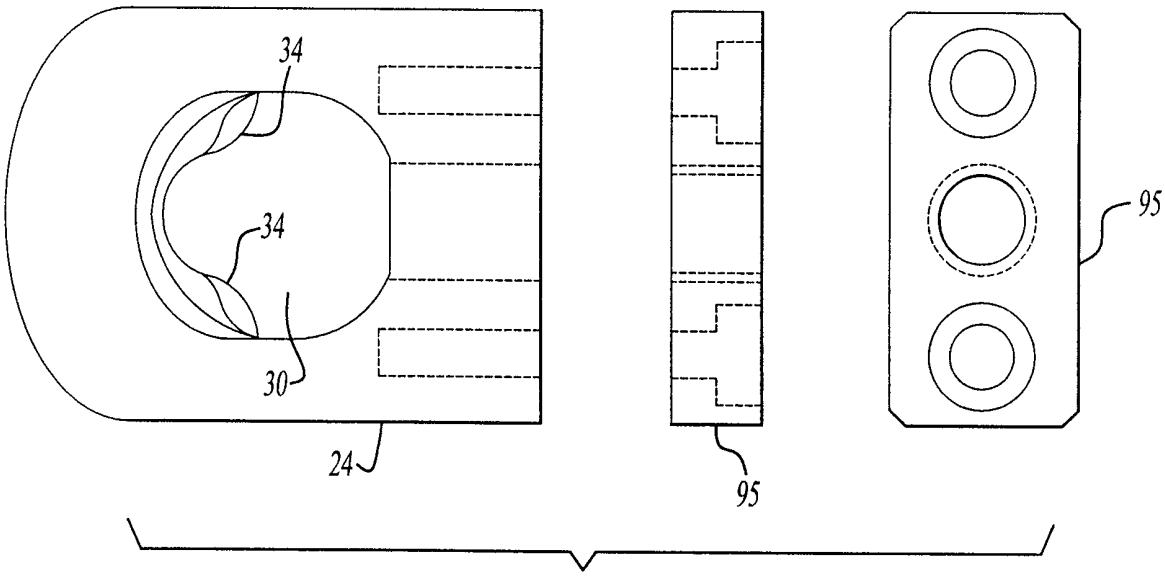

Fig-9

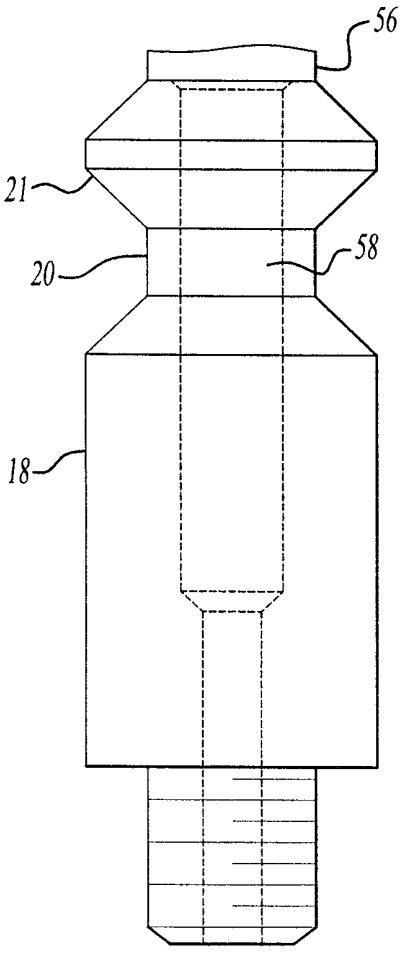

Fig-10

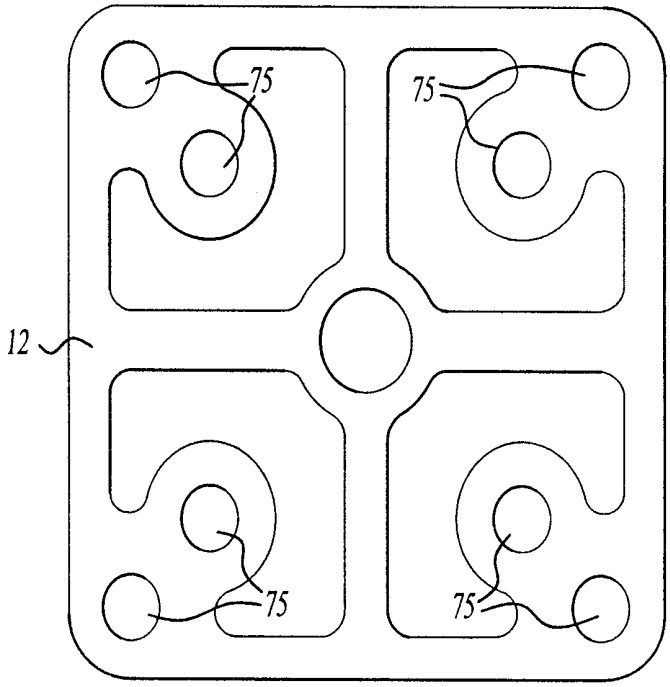

Fig-11

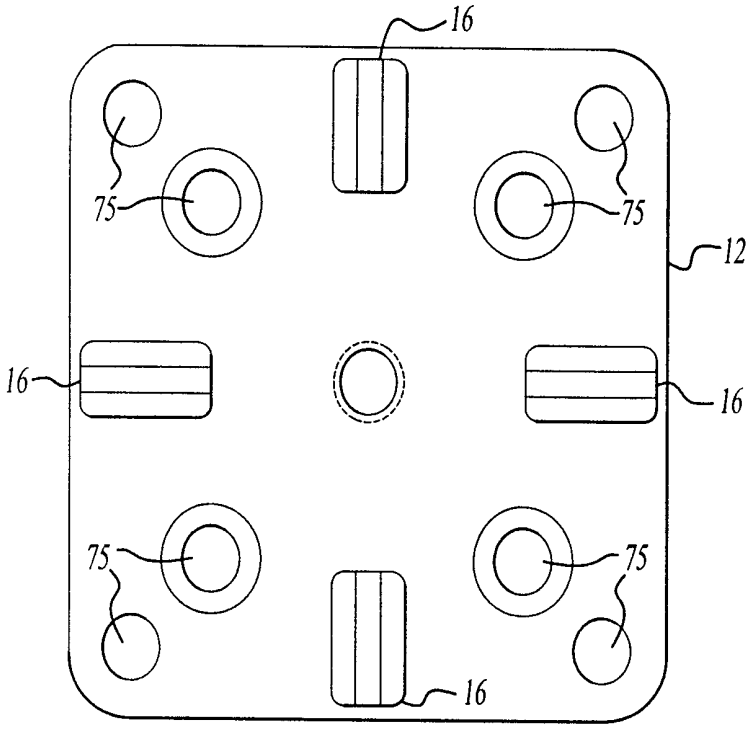

Fig-12

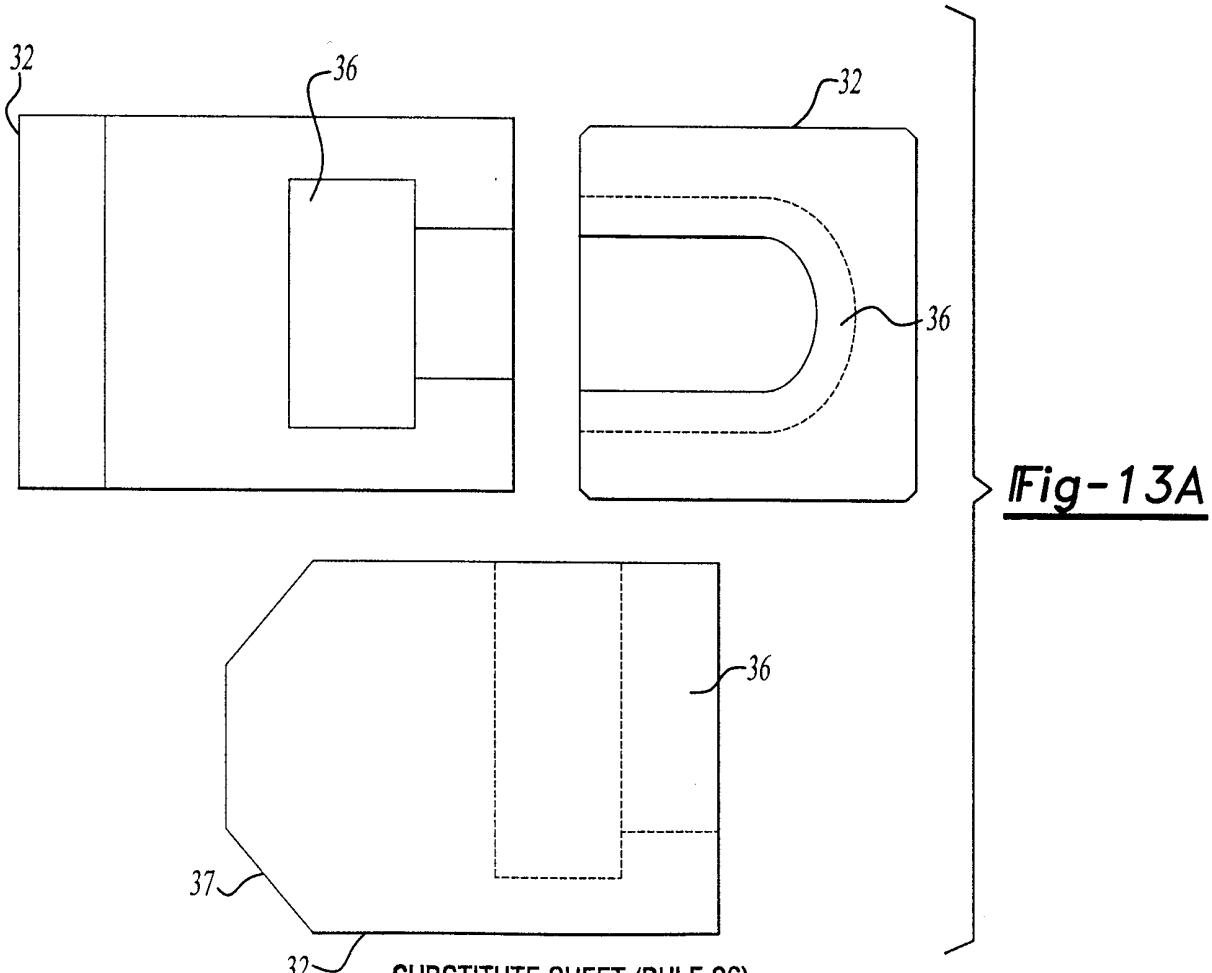

Fig-13A

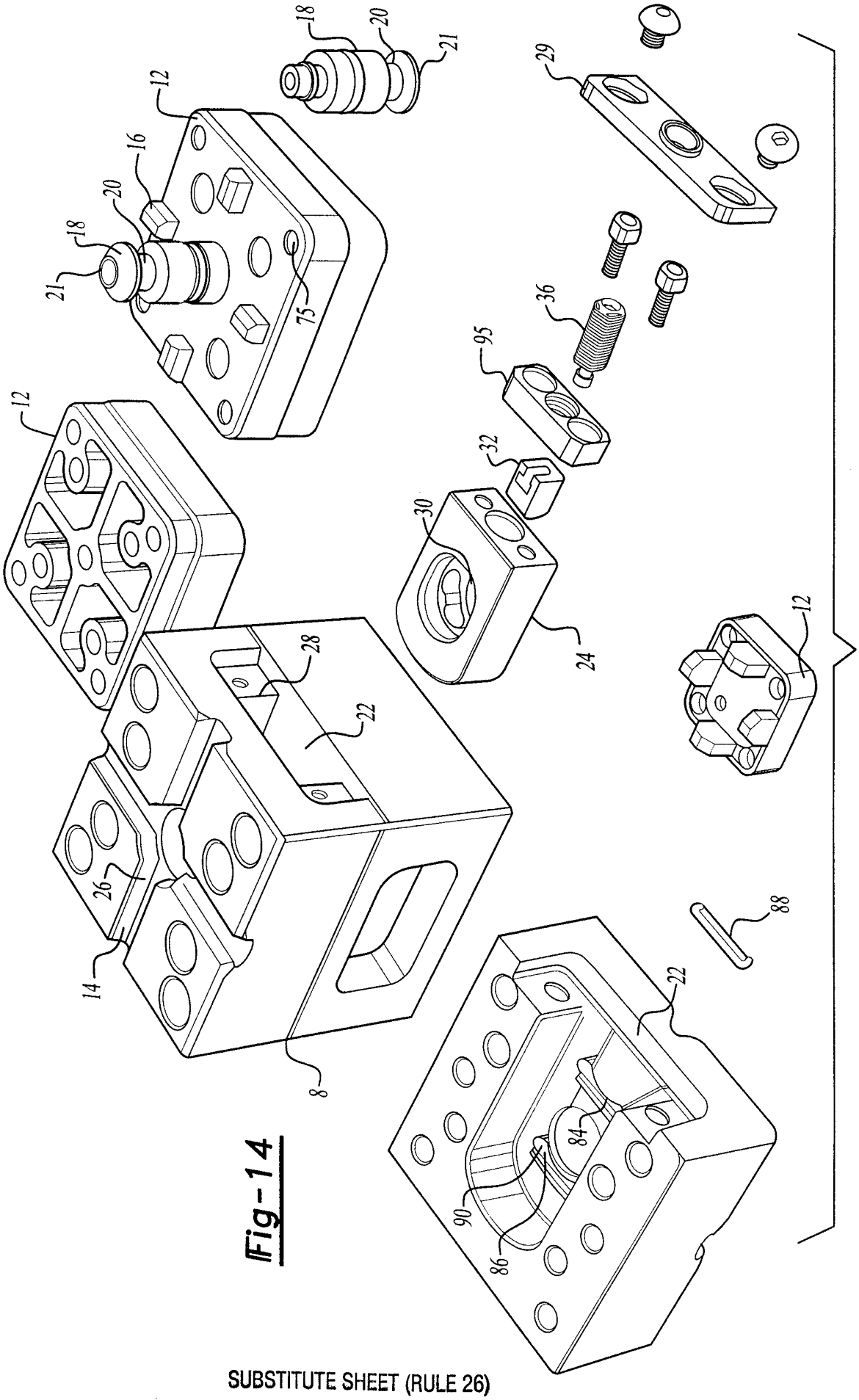
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Fig-14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/06513

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B23B 31/107; B23H 7/26
US CL :279/44, 76, 89, 133; 219/69.15; 82/160; 409/234
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 279/44, 76, 83, 89, 97, 133; 219/69.15; 82/160; 409/232, 234; 403/322.1, 360

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,271,848 A (MONTANDON) 13 SEPTEMBER 1966, SEE FIGS. 2-8, COL. 2, LINE 56 - COL. 3, LINE 57.	1, 7-11
Y	US 4,655,655 A (SCHURFELD) 07 APRIL 1987, SEE FIG. 8, COL. 8, LINE 50 - COL. 9, LINE 10.	1, 8-10
Y	US 4,799,837 A (VOLLMER) 24 JANUARY 1989, SEE FIGS. 1-6, COL. 4, LINE 37 - COL. 5, LINE 54.	1, 8-10
Y	US 4,855,558 A (RAMSBRO) 08 AUGUST 1989, SEE FIG. 6, COL. 4, LINES 45-55.	11
Y	US 5,683,212 A (CIRINO ET AL.) 04 NOVEMBER 1997, SEE FIGS 10-13, COL. 5, LINE 38 - COL. 6, LINE 9.	1, 7-10

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
11 MAY 2000	25 MAY 2000

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/06513

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,449,027 A (FUJIKAWA) 15 MAY 1984, SEE THE ENTIRE DOCUMENT.	1-11
A, P	US 6,015,961 A (LOZON ET AL) 18 JANUARY 2000, SEE THE ENTIRE DOCUMENT.	1-11