(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 353 008 A2**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **89307512.7**

(51) Int. Cl.5: **B 21 D 28/00**

(22) Date of filing: **24.07.89**

(30) Priority: **25.07.88 US 223908**

(43) Date of publication of application:
31.01.90 Bulletin 90/05

(84) Designated Contracting States: **DE ES FR GB IT**

(71) Applicant: **CONNELL LIMITED PARTNERSHIP**
One International Place Fort Hill Square
Boston Massachusetts 02110 (US)

(72) Inventor: **Gerhart, Roland T.**
4000 Grondinwood Lane
Milford Michigan 48042 (US)

(74) Representative: **Valentine, Francis Anthony Brinsley et al**
REDDIE & GROSE 16 Theobalds Road
London WC1X 8PL (GB)

(54) **Fluid-pressure operated punch.**

(57) A fluid-pressure operated punching apparatus (10) includes an elongated substantially cylindrical punch support assembly (31) slidably disposed for reciprocatory, lengthwise sliding movement in a cylindrical opening (13) in a body (11). The punch support assembly (31) has a piston head (36) at the rearward end thereof and a piston rod (35) extending lengthwise forwardly from the piston head (34). A punch retainer (33) is mounted on the forward end of the piston rod (35) and carries a punch (78). Annular sealing means (50) are provided on the piston head for sealingly engaging the internal surface defining the cylindrical opening (13) of the elongated body. A fluid pressure supply port (94) is formed in the body (11) for supplying pressure fluid to move the punch support (31) assembly toward the forward end of the body (11).

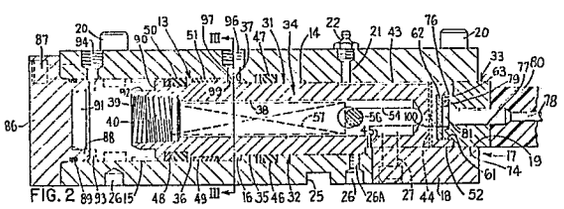

FIG. 2

EP 0 353 008 A2

Description

FLUID-PRESSURE OPERATED PUNCH

This invention relates to a fluid-pressure operated apparatus for supporting and operating a punch to pierce a workpiece.

U.S. Patent No. 4 471 680 discloses a cam-operated unit for supporting a punch and effecting movement of the punch in one direction, in response to movement of a press in another direction, in order to pierce a workpiece. For example, the cam-operated unit of Patent No. 4 471 680 can support a side-piercing punch so that when the press is closed, the punch is moved sidewardly toward the workpiece to form a hole in the side of the workpiece. This cam-operated unit is highly satisfactory in operation when it is mounted on a press, but it is not suited for operation under conditions in which a press is not available.

This invention provides a fluid-pressure operated, particularly a hydraulically operated, piercing unit which can be installed and operated separately from a press and which will be effective to perform piercing operations on a wide variety of different workpieces. Piercing operations may require precise control of the speed of movement and/or the position of the piercing punch. Hydraulic operation provides precise control over the rate of movement and magnitude of thrust of the punch and the cycle sequence of motions thereof.

The fluid-pressure operated piercing unit, according to the invention, can be used to perform secondary operations, incident to a forming or trimming operation, without using a large mechanical press. The fluid-pressure unit can be easily set up in an off-line processing step. It is highly suitable for producing relatively low quantities of workpieces at relatively low production rates. Yet, it can operate at a high pressure so as to obtain a very high piercing force from a unit which requires only a minimum amount of space.

The invention provides a fluid pressure operated punching apparatus comprising an elongated body having a cylindrical internal opening extending lengthwise thereof. The cylindrical opening is closed at the rearward end and is open at the forward end thereof. An elongated punch support assembly is disposed inside the body for reciprocable, lengthwise, sliding movement therein. The punch support assembly has a piston head at the rearward end thereof, and a piston rod extending forwardly lengthwise from the piston head. A punch retainer is mounted on the forward end of the piston rod and remote from the piston head. The punch retainer is adapted for supporting a punch for reciprocable movement between a retracted or rearward position and an advanced or forward position, whereby to pierce a hole in a workpiece. The piston head of the punch support assembly has annular sealing means on the periphery thereof which sealingly engage the surface defining the internal opening in the elongated body of the punching apparatus. Fluid pressure supply port means are provided in the elongated body and are adapted for supplying pressure fluid in order to move the punch support assembly toward the forward end of the body and thereby move the punch to its advanced position.

Fig. 1 is a plan view of a punch apparatus according to the present invention.

Fig. 2 is a sectional view taken along the line II-II of Fig. 1 and showing, in broken lines, the position of the piston head in its retracted position.

Fig. 3 is a sectional view taken along the line III-III of Fig. 2.

Fig. 4 is a view, similar to Fig. 2, and showing a modification of the invention.

Fig. 5 is an enlarged view of a portion of Fig. 4.

Fig. 6 is a sectional view taken along the line VI-VI in Fig. 4.

Certain terminology will be used in the following description for convenience in reference only and will not be limiting. The words "right" and "left" will designate the directions in the drawings to which the reference is made. The terms "front" or "forward" and "rear" or "rearward" will designate directions toward the right and left, respectively, in Figs. 2 and 4.

Referring to Figs. 1 and 2, according to the invention, there is provided a punch operating unit 10 having a housing 11 which includes a substantially rectangular body block 12. A horizontal, stepped, cylindrical opening 13 extends lengthwise through the body block 12. The horizontal opening comprises a front section 14, a rear section 15 of larger diameter than the front section, and an annular, radially extending shoulder 16 at the juncture of said sections 14 and 15.

The body block 12 is releasably securable to any suitable supporting surface by means of bolts 20 located close to the corners of the body block. A recess 25 of rectangular cross-section is provided in the underside of the body block 12 and extends in a direction perpendicular to the axis of the cylindrical opening 13. A key (not shown) of square cross-section is receivable in the recess 25 and a matching recess in the supporting surface. The key is effective for absorbing thrust forces applied on the unit. Two vertical dowel holes 26 are provided in the underside of the body block 12. The dowel holes 26 are precision reamed on the centerline of the unit 10 at selected distances from each other and from the front edge of the unit 10. Location dowels (not shown) are receivable in the dowel holes 26. The dowel holes 26 and locating dowels (not shown) provide means for exactly locating the punch operating unit in relation to the workpiece on which it is operating. The threaded portion 26A of the forward hole 26 is provided for manufacturing purposes and it has no functional effect on the operation of the unit.

A rectangular recess 17 (Fig. 2) is provided in the underside of the body block 12 at the front end thereof and said recess intersects the lower portion

of the cross-section of the front section 14 of the horizontal opening 13. A guide plate 18 having a size identical to that of the recess 17 is located in the recess 17 and is fixedly secured to the body block 12 in any conventional manner, for example, by screws 20. The guide plate 18 projects upwardly a short distance into the lower side of the front section 14 of the cylindrical opening 13 at the front end thereof. The guide plate 18 is secured to the body block 12 by screws, such as screw 27. The guide plate 18 has a flat upper surface 19 for a purpose to be described hereinbelow.

A vertical opening 21 (Fig. 2) is provided in the top of the body block 12 and it communicates with the front section 14 of the horizontal opening 13. A conventional lubrication fitting 22 is threadedly received in the upper end of the opening 21. A lubricant can be supplied to the interior of the front section 14 of the horizontal opening 13 through the fitting 22 and the opening 21 for effecting periodic maintenance of the punch operating unit. The lubricant will facilitate smooth reciprocation of the punch support assembly, as will be described hereinbelow.

A substantially cylindrical punch support assembly 31 (Fig. 2) is horizontally slidably disposed in the horizontal opening 13. The punch support assembly 31 comprises a punch retainer 33 and a slide assembly 32.

The slide assembly 32 comprises a substantially cylindrical, stepped slide 34 having a front section 35 which acts in the nature of a piston rod in the present invention, an enlarged rear section 36 which functions in the nature of a piston head in the present invention, and an annular, radially extending shoulder 37 at the juncture of said sections. The external configuration of the slide assembly 32 substantially corresponds to the configuration of the horizontal opening 13 so that the slide assembly 32 is linearly reciprocable in the horizontal opening 13.

The slide assembly has a coaxial cylindrical bore 38 extending therethrough. The cylindrical bore 38 has internal threads 39 at the rearward end thereof. An SAE high pressure pipe plug 40 threadedly engages the internal threads 39 and seals the rearward end of the bore 37 and prevents penetration by hydraulic fluid. The other end of the cylindrical bore 38 has an opening therethrough.

The slide member 34 has a lengthwise extending oil groove 43 extending frontwardly from the opening 21 to the front end of the slide member. The lengthwise oil groove 43 communicates with a circumferential oil groove 44 which is located close to, but spaced from, the front end of the slide member 34. Lubricant can be supplied through the fitting 22 to lubricate the periphery of the front section 35 of the slide member 34. The small hole 45 in the slide 34 is an air venting hole.

The wall of the front section 14 of the horizontal opening 13 has an annular groove 46 therein located close to the shoulder 16 and spaced forwardly therefrom. An annular seal 47 is disposed in the groove 46. The seal 47 sealingly engages the periphery of the front section 35 of the slide member 34 in order to prevent leakage of the operating fluid frontwardly along the front section 35 of the slide member 34.

The external wall of the enlarged rear section 36 of the slide 34 has an annular groove 48 located close to the rearward end thereof and a relatively shallow annular channel 49 located frontwardly of the groove 48. An annular seal 50 is disposed in the groove 48 and it sealingly engages the internal surface of the rear section 15 of the horizontal opening 13. An annular wear ring 51 is disposed in the channel 49. The enlarged rear section 36 of the slide member 34 in effect functions as a piston head and the annular seal 50 and the wear ring 51 serve to prevent flow of pressurized fluid axially along the outer surface of the rear section 36 of the slide member 34. Thus, when pressure fluid is applied onto the rear surface of the rear section 36, such pressure fluid is effective to move the slide member 34 frontwardly.

The seal 47 can, for example, be a standard POLYPAK seal and the seal 50 can, for example, be a PIP seal, both available from Parker Hannifin Corp., Cleveland, Ohio. They comprise a lip-type seal combined with an O-ring type synthetic rubber O-spring to provide high sealability at low and high pressures.

The wear ring 51 can, for example, be a nylon band effective to prevent metal-to-metal contact of the moving parts and to maintain centering thereof.

As shown in Fig. 2, a substantially planar surface 52 is provided on the underside of the slide member 34 at the frontward (rightward) end thereof and is slidably disposed against the planar top surface 19 of the guide plate 18. Rotation of the slide member 34 about its central axis is thereby prevented.

A slot-like opening 54 is oriented parallel to the lengthwise axis of and extends transversely through the slide member 34. A stationary dowel or rod 56 extends through the opening 54 in the slide member 34 and has its ends fixably supported, such as by pressfitting, in the body block 12 on opposite sides of the horizontal cylindrical opening 13. The rod 56 and slot 54 are preferably positioned so that the centerline of the rod 56 intersects the common axis of the slide member 34 and cylindrical opening 13. A helical compression spring 57 is provided in the cavity defined by the cylindrical bore 38 and plug 40, and has one end disposed against the end of the rod 56 and its other end disposed against the inner end of the screw stud 39. The spring 57 thereby continuously urges the punch support assembly 31 rearwardly (leftwardly in Figs. 1 and 2) with respect to the housing 11.

A coaxial cylindrical recess 61 having a diameter slightly greater than that of the bore 38 in the slide member 34 is provided in the frontward end of the slide member 34. A punch backing plate 62 is disposed in and has a diameter substantially equal to that of the recess 61 in the slide member 34. The punch backing plate 62 has a substantially planar punch backing surface 63 thereon which faces and contacts the punch retainer 33. Referring to Fig. 2, the punch retainer 33 has a planar lower surface 74 thereon which slidably engages the planar top surface 19 of the guide plate 18, thereby preventing rotation of the punch retainer 33 about its axis. A

coaxial cylindrical projection 76 is provided on the punch retainer 33 and is slidably received in and has a diameter substantially equal to that of the recess 61. The coaxial cylindrical projection 76 has a coaxial counterbore 79. A coaxial cylindrical opening 77 is provided through the punch retainer 33 and has a diameter substantially equal to that of the shank of a selected conventional head-type punch 78 which is operationally supported by the unit 10. The punch extends through the opening 77. The head 81 of the punch 78 is disposed within the counterbore 79 and is adjacent to the punch backing surface 63 on the punch backing plate 62. The depth of the counterbore 79 is substantially the same as the height of the punch head 81 so that the punch head is clamped between the backing plate 62 and surface 100. The diameter of the counterbore 79 is very slightly larger than the diameter of the punch head 81 and the counterbore 79 is coaxial with the cylindrical opening 77.

A tubular stripper sleeve 80 of elastomeric material, such as urethane rubber, can be provided on the punch 78 for stripping the workpiece off the punch after the punching operation has been completed.

The punch retainer 33 is releasably fixedly secured to slide member 34, for example, by screws in the same manner as described in Patent No. 4 471 680.

The punch 78 is held against rotation relative to the punch retainer 33 in any suitable way, such as any of the various structures shown in Figs. 7 through 10 of Patent No. 4 471 680, the entire contents of which are incorporated herein by reference. Therefore, those structures need not be described herein.

The rearward end of the body block 12 is closed by an end cap 86 which is secured to said body block by suitable means, such as screws 87. The end cap 86 has a boss 88 which extends into and closes the rearward end of the opening 13 in the body block 12. An O-ring seal 89 is disposed in an annular groove in the external surface of the boss 88. The O-ring seal 89 serves to prevent leakage of pressure fluid rearwardly between the boss 89 and the wall of the opening 13.

The boss 88 has an internal recess 91 adapted for receiving the adjacent end portion 92 of the rear section 36 of the slide member 34 when the slide member is in its rearward (leftwardmost) position, as appearing in Fig. 2. The end portion 92 of the slide member 34 is of slightly smaller diameter than the recess 91 so that when said end portion enters said recess, during retraction of the slide 34, in effect, there is provided a hydraulic cushion which reduces mechanical shock to the punch operating unit. When the adjacent end portion 92 is received in the recess 91, an annular gap 93 is provided between the boss 88 and the rear wall 90 of the slide member 34. A port 94 for supplying pressure fluid, such as hydraulic fluid, is provided in the body block 12 and it communicates with the gap 93 so that when pressure fluid is supplied to the port 94, it acts on the rearward surface of the slide member 34 and shifts the entire slide assembly forwardly, that is, rightwardly as appearing in Fig. 2.

A second port 96 is provided in the body block 12 and it communicates with the recess between the flange 99 and the shoulder 37. Pressure fluid can be supplied to the port 96 to assist the spring 57 in returning the slide assembly 32 to its retracted position.

Figs. 4 through 6 show a modification in which shifting of the slide assembly 32 frontwardly and rearwardly is effected entirely by fluid pressure. Parts in Figs. 4-6 corresponding to those in Figs. 1-3 are identified by the same reference numbers with the suffix "a" added thereto.

The slide member 34a is free of the cavity, spring and associated parts provided in the slide member 34 in the embodiment of Figs. 2 through 4. In the embodiment of Figs. 4 through 6, there is provided an axially lengthened space 101 between the flange 99a and the shoulder 37a. An annular ring 102 is disposed in the space 101 and it acts as a hardened fixed stop for limiting forward movement of the slide 34a. The ring 102 has an axially extending flange 103 projecting rearwardly (leftwardly) therefrom so as to define an annular cavity 104 between ring 102 and flange 99a. When pressure fluid is supplied to the port 96a, the pressure fluid acts on the flange 99a to move the slide member 34 rearwardly (leftwardly in Fig. 5). In all other respects, the embodiment of Figs. 5 through 7 is the same as the embodiment of Figs. 1 through 3 and further detailed description thereof is believed to be unnecessary.

Although persons skilled in the art will understand the operation of the punch operating unit 10 from the foregoing description, a brief summary of such operation is now given for convenience. First, the punch operating unit 10 is mounted on a suitable support, such as a table, and is appropriately located with respect to the workpiece that is to be pierced. The table or other support will be provided with four threaded holes having a relative spacing identical to that of the screws 20 of the punch supporting unit 10. The punch supporting unit will be securely mounted on the support by screws which extend downwardly through the respective openings in the body block 12 and threadedly engage the respective threaded openings in the support. In addition, an elongated key of square cross-section is provided on the support and is received within the recess 25 of the punch supporting unit in order to minimize movement of the punch supporting unit 10 relative to the workpiece and to take up shear stresses induced by piercing or forming. Dowel pins are press-fitted into the holes 26 and into the support to fix the punch supporting unit 10 exactly in position.

The punch retainer 33 is removed from the slide member 34. As previously described, the projection 76 is counterbored by the toolmaker to the appropriate diameter and depth to enable it to receive the punch head 81 of the punch, thus establishing surface 100. A punch is inserted through the opening 77 with its head disposed against the surface 100 of the punch retainer 33. The punch is then secured against rotation with respect to the punch retainer 33 in any suitable way, for example, by one of the means shown in Figs. 7 through 10 of Patent No. 4 471 680. The punch retainer 33 is then

placed in the punch supporting unit, and the head 81 of the punch 78 is securely clamped between the surface 100 of the punch retainer 33 and the punch backing surface 63 on the punch backing plate 62.

The punch support assembly 31 will normally be positioned in its retracted position (leftward position in Fig. 2) by means of the spring 57.

The object in which a hole is to be punched is then fixedly supported in an appropriate manner at a location just beyond the tip of the punch 78. Then fluid pressure is supplied to the port 94 and thereby the punch support assembly 31 is moved rightwardly to the position shown in solid lines in Fig. 2, thereby effecting rightward movement of the punch 78 into operative engagement with the object to be punched. When supply of pressure fluid to the port 94 is stopped, the spring 57 will urge the punch support assembly 31 leftwardly to its original position as described above. Retraction of the punch support assembly 31 can be assisted by supplying pressure fluid to port 96. The elastomeric stripper sleeve 80 also assists in initiating retraction of the punch.

The operation of the embodiment of Figs. 5 through 7 is the same as that described above, except that the retraction of the punch support assembly to its starting position is effected by supplying pressure fluid to the port 96.

Although particular preferred embodiments of the invention have been disclosed in detail for illustrative purposes, it will be recognized that variations or modifications of the disclosed device, including re arrangement of the parts, lie within the scope of the present invention.

Claims

1. A fluid-pressure operated punching apparatus, comprising:
an elongated body having a cylindrical internal opening extending lengthwise thereof, said cylindrical opening being closed at the rearward end thereof and being open at the forward end thereof,
an elongated substantially cylindrical punch support assembly, slidably disposed in said body for reciprocable, lengthwise sliding movement therein, said punch support assembly having a piston head at the rearward end thereof, a piston rod extending lengthwise forwardly from said piston head, and a punch retainer mounted on the forward end of said piston rod, said punch support assembly being adapted to support a punch for reciprocable movement between a retracted position and an advanced position, said piston head having annular sealing means on the periphery thereof and sealingly engaging the internal surface defining said cylindrical opening of said elongated body; and fluid pressure supply port means in said elongated body for supplying pressure fluid to move said punch support assembly toward the forward end of said body.

2. A fluid-pressure operated punching apparatus as claimed in Claim 1 in which said punch support assembly has an internal, lengthwise extending cavity therein and has an elongated opening which extends in a second direction substantially normal to said first direction, is elongated in said first direction and communicates with said cavity;
a rod supported on said body and extending in said second direction through said elongated opening and into said cavity; and a compression coil spring disposed in said cavity and cooperable with said punch support assembly and said rod for yieldably urging said punch support assembly toward the retracted position.

3. A fluid-pressure operated punching apparatus as claimed in Claim 1 in which said punch retainer has an opening therethrough substantially parallel with the axis of said cylindrical opening, first means removably supporting said punch retainer on said piston rod, and a punch backing surface provided on said piston rod, facing substantially toward the forward end of said body and aligned with said opening through said punch retainer.

4. The fluid-pressure operated punching apparatus of Claim 3, wherein:
the forward end of said piston rod has a substantially cylindrical recess therein;
said punch retainer has a substantially cylindrical projection thereon which has an outside diameter substantially equal to the inside diameter of and is slidably disposed in said recess in said piston rod, said opening in said punch retainer extending through said projection; and
a disk-shaped punch baking plate disposed in said recess and having an outside diameter substantially equal to said inside diameter of said recess, said punch backing surface being provided on said punch backing plate.

5. A fluid-pressure operated punching apparatus as claimed in Claim 1 in which said piston head has a pair of axially spaced-apart, annular recesses in the external surface thereof, an annular sealing ring disposed in one of said recesses and sealingly engaging the wall of said cylindrical internal opening in said body, an annular wear ring disposed in the other of said recesses; and fluid-pressure supply ports communicating with said cylindrical internal opening of said body on opposite axial sides of said piston head.

6. A fluid-pressure operated punching apparatus as claimed in Claim 5 in which said cylindrical internal opening has a rearward portion in which said piston head is slidable and a frontward portion in which said piston rod is slidable, said frontward portion being of smaller diameter than said rearward portion and an annular radially outwardly extending shoulder between said rearward and forward portions, said piston rod substantially slidably contacting said frontward portion of said cylindrical internal opening, said frontward portion having an annular cavity therein, and an annular seal

disposed in said cavity and sealingly engaging the surface of said piston rod.

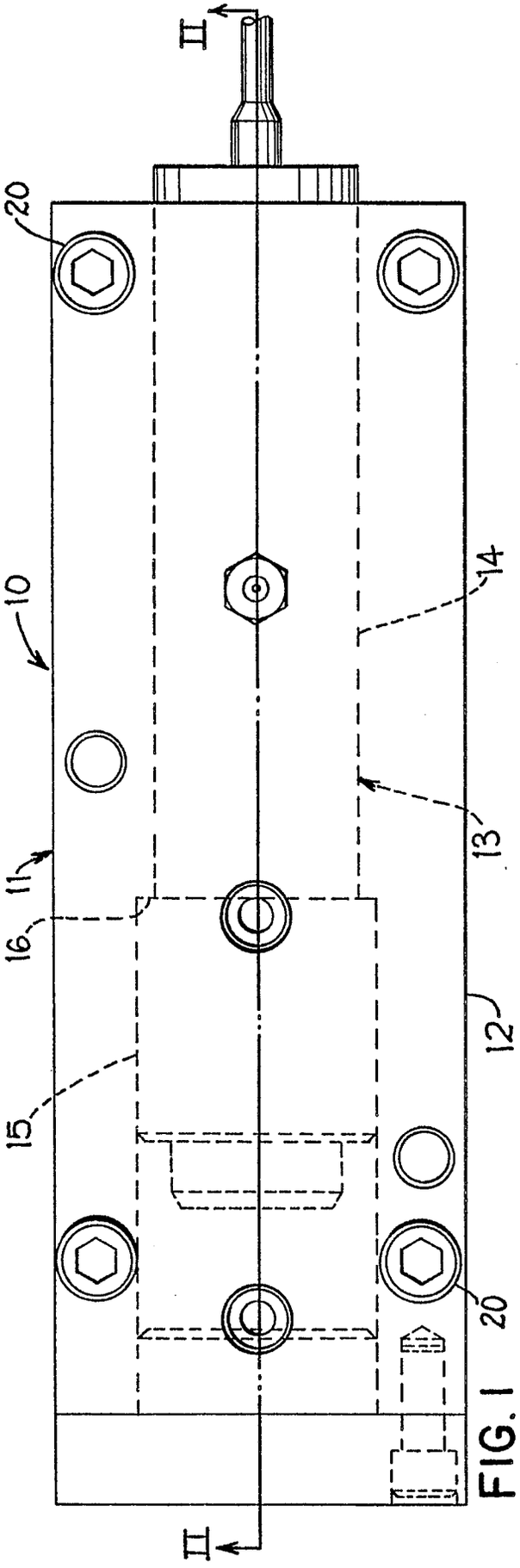
II
20
10
14
13
11
16
12
15
20
II

FIG. 1

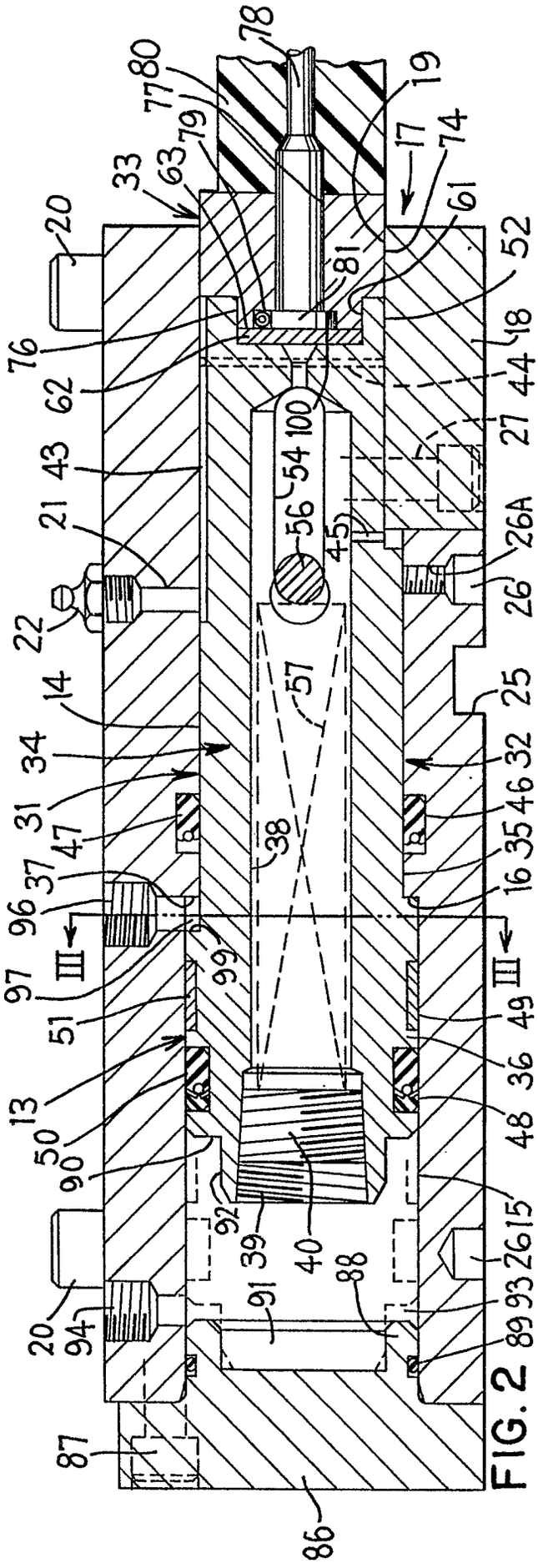
78
80
77
79
19
17
74
33
63
61
20
52
81
76
18
62
44
27
100
54
43
56
21
45
26A
26
22
57
14
25
34
32
31
46
47
38
37
35
16
96
99
III
III
97
51
49
13
36
50
48
90
92
15
39
40
88
26
20
91
93
94
89
87
86

FIG. 2

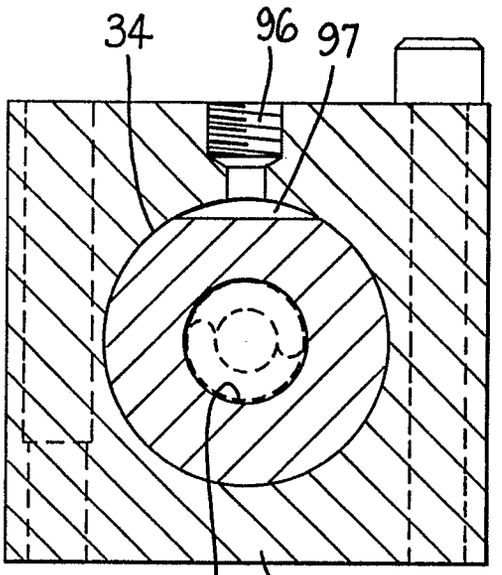

FIG. 3

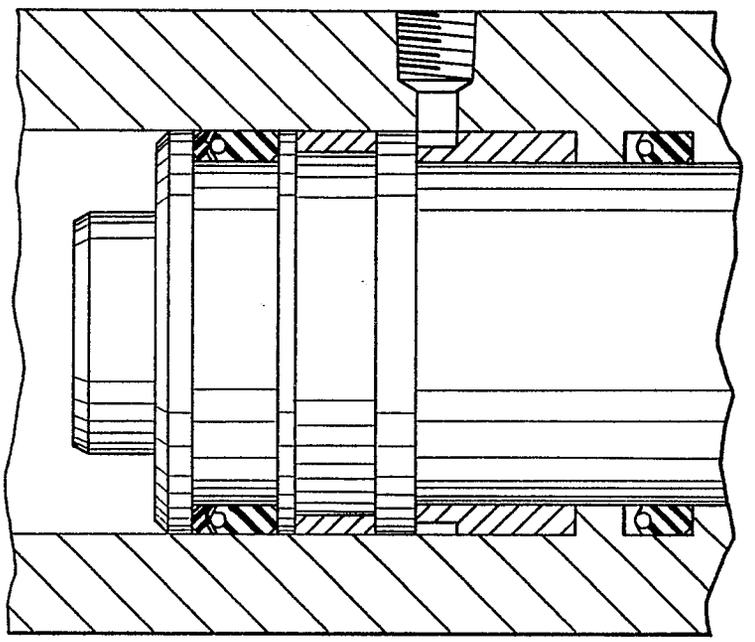

FIG. 5

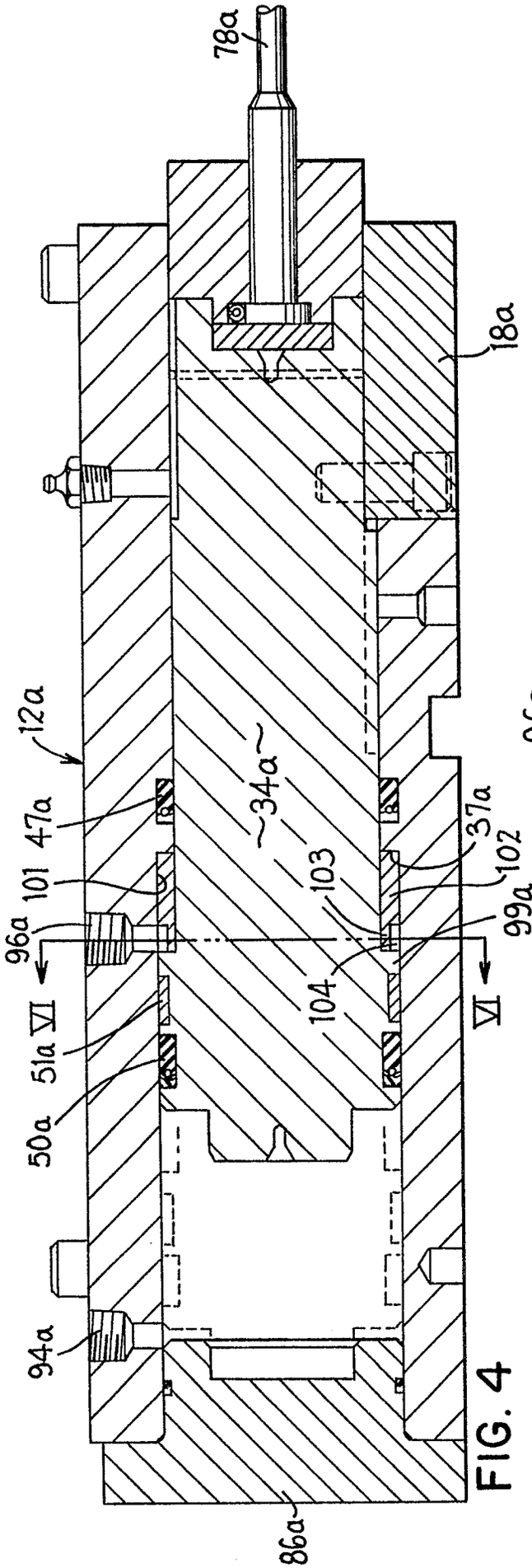
78a
18a
12a
34a
47a
37a
101
103
102
96a
99a
104
VI
VI
51a
50a
94a
86a

FIG. 4

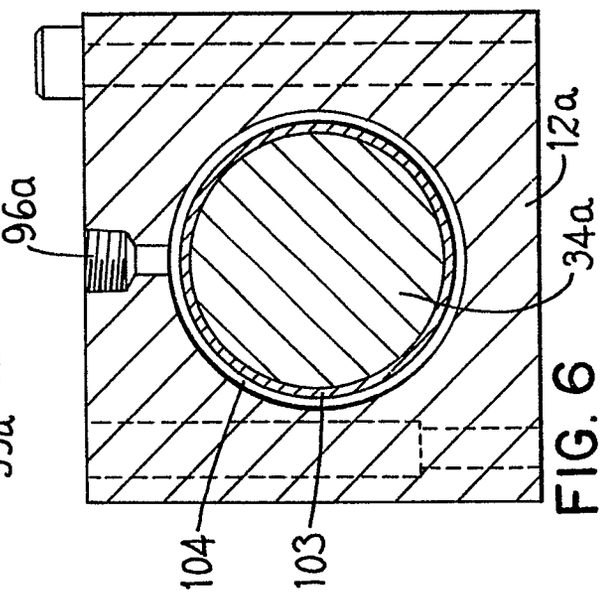
96a
12a
34a
104
103

FIG. 6