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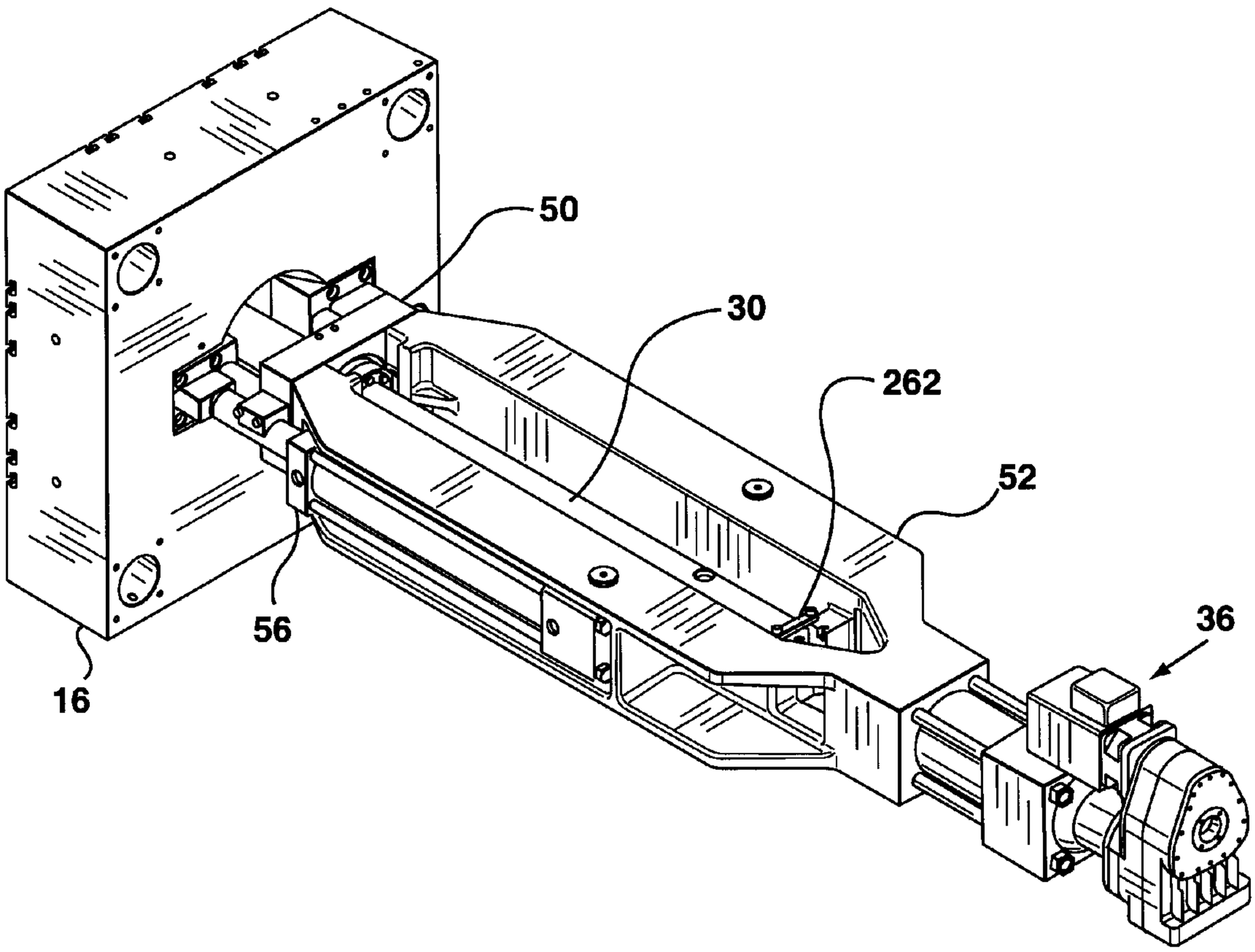

(57) Abrégé/Abstract:
An injection assembly including a barrel assembly and carriage assembly having first complementary couplers and second complementary couplers. The first couplers interlock to secure the barrel assembly between the ends of the barrel assembly to a carriage assembly. The second couplers retain an end of the barrel assembly in the carriage assembly preventing rotation of the barrel assembly during operation.

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ABSTRACT OF THE DISCLOSURE

An injection assembly including a barrel assembly and carriage assembly having first complementary couplers and second complementary couplers. The first couplers interlock to secure the barrel assembly between the ends of the barrel assembly to a carriage assembly. The second couplers retain an end of the barrel assembly in the carriage assembly preventing rotation of the barrel assembly during operation.

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INJECTION UNIT

TECHNICAL FIELD

The present invention broadly relates to injection molding machines and, in particular to the injection unit of an injection molding machine. Injection molding machines include machines for injecting plastic material, or metal material, or metal material in a thixotropic state.

BACKGROUND OF THE INVENTION

Operation of an injection molding machine introduces a number of forces, pressures, and stresses on the injection unit. For example, axial carriage force is a force applied to engage the nozzle end of a barrel assembly against a sprue bushing of a mold. This provides a force sealing connection between the nozzle and sprue bushing preventing leakage of melted material during injection. Carriage force is applied and maintained prior to injecting the melt of material.

Injection force is a force directed along the length of a reciprocating screw located in a bore of a barrel assembly. Injection force results in injecting a melt of material into a mold. There is an axial reactive injection force acting along the length of the barrel assembly as a result of moving a screw forward during the injection stage of a molding process.

Injection pressure is a pressure required to overcome the resistance to the flow of the melt of material in the nozzle, runner system, and mold cavity. Injection pressure is exerted on the melt in front of the screw tip during the injection stage of a molding process. The accumulator end of a barrel assembly must withstand injection pressure.

Injection units for molding machines are very well known. For example, the book entitled "Injection Molding machines A User's Guide 3rd Edition" by Johannaber was published in 1994 by Carl Hanser Verlag (ISBN 1-56990-169-4) and contains a detailed description of conventional injection units for plastic

injection molding machines in Chapter 3 on pages 38, 39 42, 43, 44, 75, and 76. The reciprocating screw (RS) injection unit includes a barrel assembly which includes a nozzle, barrel head, barrel, axial bore, feed port, heater bands, and thermocouples. A reciprocating screw, which includes a non-return valve, is disposed in the axial bore of the barrel. The axial bore of the barrel includes a metering section and a feeding section. An electric or hydraulic drive operates the screw to feed and meter a melt of material and inject the metered material into a mold. The barrel assembly is fixed and supported, cantilevered, at one end of the barrel by a carriage. Hydraulic or electric actuators connect between the carriage and a frame member or fixed platen of the injection molding system. Operation of the actuators move the barrel assembly towards and away from the stationary platen and provides an axial carriage force through the entire length of the barrel during injection minimizing leakage between the nozzle tip and the sprue bushing. The axial reactive injection force is directed through the entire length of the barrel during injection.

The book entitled "Injection Molding Operations" produced by Husky Injection Molding Systems Ltd., and printed in Canada, copyright 1980 also contains a description of conventional injection units for plastic injection molding machines on pages 41 through 44. Again, for the reciprocating screw injection unit, a barrel is supported at a distant end by a carriage, which houses the injection cylinder and a rotational drive. A hydraulic cylinder is connected between the carriage and a stationary platen. In operation of the hydraulic cylinder, the carriage force is applied along the entire length of the barrel. For a two stage injection unit, a barrel is supported at one end by a carriage. The carriage houses the drive. The nozzle of the barrel feeds into a shooting pot which includes an injection piston. The carriage supports another end of the shooting pot. A hydraulic cylinder is connected between the carriage and a stationary platen. In operation of the hydraulic cylinder, the carriage force is applied along the entire length of the shooting pot. The axial reactive injection force is directed through the entire length of the shooting pot during injection.

United States patent 5,040,589 issued on August 20, 1991 to Bradley et al (assigned to The Dow Chemical Company). The patent describes an injection apparatus for injection molding a thixotropic semi-solid metal alloy. The patent contains a description of an apparatus for processing a metal feedstock into a thixotropic state as the metal is fed into a hopper, located at one end of the barrel, and transported into an accumulation zone located at another end of the barrel. The barrel is constructed of a single piece of material with thick walls. A number of heating zones are defined along the length of the barrel, including sections of the barrel having differing thickness. The feed throat area and zone 4 are relatively thick sections. Zone 3 is a slightly thinner section, and zone 2 is the thinnest section. The barrel is conventionally mounted in the injection unit. A feed throat end of the barrel is mounted in an upright support secured to the frame of an injection unit. A bottom surface of the barrel, intermediate the distant ends of the barrel, rests on a second support also secured to the frame. The carriage force is applied along the entire length of the barrel in operation of the apparatus. All sections of the disclosed barrel must be thick enough to withstand the combination of axial carriage force and axial reactive injection force directed through the entire length of the barrel during injection.

United States patent 5,983,978 issued on November 16, 1999 to Vining et al (assigned to Thixomat Inc.). The patent describes a thixotropic metal injection molding apparatus. The barrel is formed in two sections to define a high pressure section and a low pressure section. The low pressure section is thinner than the high pressure section. A feed throat end of the barrel is mounted in an upright support of an injection unit. A bottom surface of the barrel, intermediate the distant ends of the barrel, rests on a second support also secured to the frame. The carriage force is applied along the entire length of the barrel in operation of the apparatus. All sections of the disclosed barrel must be thick enough to withstand the combination of axial carriage force and reactive injection force through the entire length of the barrel during injection.

United States patent 4,863,362 issued on September 5 1989 to Hehl is directed to an improved plasticizing assembly. In accordance with the invention, the plasticizing cylinder is arranged in a reinforcing skeleton, including a track constituted by a track surface of a track bar, which is spaced from the plasticizing cylinder by radial spacers, one of the spacers fixedly connected to the track bar and to a rear portion of the plasticizing cylinder and at least one centering spacer is connected to the track bar and surrounds the plasticizing cylinder as a sliding fit and defines a clearance with the plasticizing cylinder. Installed in the injection unit, the plasticizing assembly is supported about a middle portion between the legs of a U-shaped bracket that is fixed with respect to the injection unit frame; the arrangement results in a simple guidance of the plasticizing assembly with the engagement of stationary rollers rotatably mounted in the U-shaped bracket with the track of the skeleton. Further, the portion of the plasticizing cylinder that protrudes from a guard surrounding the skeleton is received from the rear as an axial sliding fit in the bore of a receiving body of the injecting unit; in operation the plasticizing cylinder is axially force coupled to the injection unit only through its engagement with the receiving body of the injection unit, and hence an axial carriage force acts through the length of the plasticizing cylinder.

Great Britain patent 1297783 issued on November 29 1972 to Haynes et al is directed to an injection unit that eliminates the screw non-return valve and the associated problems of manufacture and assembly. The invention provides an injection unit including: an injection head with an injection nozzle installed in a headstock; a plastics feed structure which is moveable relatively to the injection head and defines therewith a telescopic injection chamber, the feed structure comprising a barrel, a feed screw rotatable in a supply conduit in the barrel which may be connected to a plastics supply source; and means for moving the feed structure as a unit in a forward direction relatively to the injection head in performance of an injection stroke, characterized by the fact that the feed screw has a

leading end portion which cooperates with a part of the barrel adjacent the injection chamber to form a valve by which the supply conduit may be opened and closed, and means are provided to move the screw axially relatively to the barrel to open this valve for filling the chamber with plastics material, and to close it during the performance of an injection stroke. The configuration of the injection unit is such that it does not accommodate the controlled application of a carriage force linking the injection assembly with the stationary platen.

Japanese publication 59187824 published on October 25 1984 to Hiroshi is directed to a service tool to improve the ease of maintenance and inspection of the barrel of an injection unit. In accordance with the invention, the service tool can be engaged to detachably hold a barrel. The service tool consists of a holder including a shaft supporter to rotatably support a trunnion that is projectionally oriented and fixed to the barrel. During maintenance, the barrel is rotatably supported by the service tool and can thus be held in the horizontal attitude and the injection screw can be drawn out of the heating cylinder. The carriage force is applied through an attachment plate and the length of the barrel to engage the injection nozzle into the mold sprue.

There are a number of problems and deficiencies with the known prior art devices. Barrels are costly due to the amount of material required to provide a suitable thickness for withstanding the axial force along the entire length of the barrel. The axial force may be the carriage force, or the reactive injection force, or a combination of these two forces.

Special materials are required for barrels in use with thixotropic materials and these special materials are very expensive and are difficult to manufacture.

Thick barrels have a high thermal resistance which affects the efficiency and controllability of heating a material in the axial bore of a barrel.

Barrels, conventionally mounted in the injection unit, are

typically difficult to install and remove. The process of installation and removal within a carriage is time consuming. Installation of the barrel in a carriage is further prone to alignment problems.

SUMMARY OF THE INVENTION

In accordance with an aspect of the invention, an injection assembly is provided that includes a barrel assembly, and a carriage assembly. The barrel assembly includes first and second barrel portions having an axial bore therethrough, and a first barrel coupler, the location of the first barrel coupler defines a boundary between the first barrel portion and the second barrel portion. The carriage assembly includes a first carriage coupler to engage the first barrel coupler, and a carriage actuator for linking with a stationary platen of a clamp unit. The injection assembly mounted in an injection unit includes a drive assembly for operating a screw disposed in the axial bore of the barrel assembly. In use, the first barrel coupler interlocks with the first carriage coupler to secure the barrel assembly in the carriage assembly, thereby isolating the second barrel portion from axial carriage force.

As an alternative, the injection assembly may comprise a second barrel coupler, and a second carriage coupler. The second barrel coupler disposed on said second portion of the barrel. The second carriage coupler aligned with the lengthwise axial opening and the first carriage coupler, wherein the second barrel coupler and the second carriage coupler retain the barrel to the carriage intermediate an end of the barrel and the first barrel coupler.

As an alternative, the injection assembly may comprise an axial force linkage member. The axial force linkage member is disposed intermediate the first barrel coupler and the first carriage coupler wherein the axial force linkage member distributes axial force.

As an alternative, the injection assembly may comprise a thermal isolator. The thermal isolator is disposed intermediate the first barrel coupler and the first carriage coupler wherein the

thermal isolator reduces conductive heat transfer between the barrel assembly and the carriage.

As an alternative, the injection assembly may comprise a linkage insulator. The linkage insulator is disposed intermediate the first barrel coupler and the first carriage coupler wherein the linkage insulator distributes axial force and reduces conductive heat transfer between the barrel and the carriage.

As an alternative, the injection assembly may comprise a barrel alignment member. The barrel alignment member aligned with the lengthwise axial opening wherein the barrel alignment member aligns the barrel with the carriage.

The injection assembly for use in an injection molding machine comprises a clamp unit, and an injection unit. The clamp unit for receives a mold, and is operable between an open position, a closed position, and a clamped position. The injection unit creates a shot of material for injection into the mold. The barrel has a first portion, a discharge end, an opening, and a lengthwise axial bore extending from the discharge end. The screw is disposed in the lengthwise axial bore of the barrel. The screw is rotatable and reciprocatable in the lengthwise axial bore of the barrel. The first barrel coupler is disposed on the first portion of the barrel. The cradle member has a lengthwise axial opening for receiving the barrel. The mounting surface mounts the carriage to the injection unit. The first carriage coupler is aligned with the lengthwise axial opening wherein the first carriage coupler and the first barrel coupler secure the barrel to the carriage.

In an embodiment of the invention, the second barrel coupler is a recess formed in an outer surface of the second portion of the barrel. In another embodiment of the invention, the recess is a substantially flat pad. In another embodiment of the invention, the recess forms a spline. In another embodiment of the invention, the recess is an axially aligned slot.

As an alternative, the first carriage coupler comprises a yoke coupler and a carriage coupler. The yoke coupler is disposed on

the yoke and the carriage coupler is disposed on the cradle member. The yoke coupler and the carriage coupler engage the barrel for securing the barrel to the carriage.

As an alternative, the yoke coupler is an engaging surface formed on a side of the yoke opposite the carriage coupler. In an embodiment of the invention, the engaging surface is a barrel seat formed in a central opening of the yoke.

As an alternative, the carriage coupler comprises a first upright support and a second upright support. The first upright support and the second upright support are separated by an opening for receiving the barrel. The first upright support and the second upright support secure the barrel to the carriage.

As an alternative, the first upright support includes a first coupling surface and the second upright support includes a second coupling surface wherein the first coupling surface and the second coupling surface engage a coupling surface of the barrel.

As an alternative, the second carriage coupler includes an engagement member for retaining the barrel.

As an alternative, the engagement member includes a first coupling member and a second coupling member. The first coupling member and the second coupling member are separated by an opening for receiving the barrel. The first coupling member and the second coupling member retain the barrel to the carriage.

As an alternative, the first coupling member includes a first coupling surface and the second coupling member includes a second coupling surface.

In an embodiment of the invention, the first coupling surface and the second coupling surface are a flat recess for engaging a complementary surface of the barrel.

As an alternative, the second carriage coupler includes a

retaining plate releasably secured to the cradle member for retaining the barrel in the carriage.

As an alternative, the barrel alignment member aligns the barrel axially and aligns the barrel vertically in the cradle.

As an alternative, the barrel alignment member includes a first barrel support member and a second barrel support member. The first barrel support member and the second barrel support member support the barrel at a predetermined height in the carriage.

As an alternative, the first barrel support member includes at least one standoff and the second barrel support member includes at least one standoff.

Further advantages of the present invention will appear hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described, by way of example only, with reference to the attached figures, wherein:

Figure 1 is a diagrammatic side view representation of an injection molding machine illustrating a clamp unit interconnected to an injection unit;

Figure 2 is a perspective view of an injection assembly;

Figure 3 is an exploded perspective view of the injection assembly illustrating a barrel assembly and a carriage assembly;

Figure 4 is a cross sectional view taken along line AA from figure 2 illustrating a multi-piece barrel assembly located in the carriage assembly;

Figure 5 is a cross sectional view taken along line AA from figure 2 illustrating a nozzle section with a spigot tip;

Figure 6 is a cross sectional view taken along line AA from figure 2 illustrating an alternative nozzle section with a semispherical tip;

Figure 7 is a perspective view illustrating an accumulator section of the barrel assembly and a first barrel coupler;

Figure 8 is a cross sectional view taken along line AA from figure 2 illustrating an accumulator section of the barrel assembly and a first barrel coupler;

Figure 9 is a cross sectional view taken along line AA from figure 2 illustrating a second portion of the barrel assembly;

Figure 10 is a partial perspective view of a second portion of the barrel assembly illustrating a second barrel coupler;

Figure 11 is a top view of cradle member;

Figure 12 is a cross sectional side view of the cradle member taken along line C-C of figure 11 illustrating the first carriage coupler, the second carriage coupler, the first barrel support member, and the second barrel support member;

Figure 13 is a front view of the cradle member illustrating the first carriage coupler and the first barrel support member;

Figure 14 is an end view of the cradle member illustrating the drive mount;

Figure 15 is a front view of the yoke;

Figure 16 is a back view of the yoke;

Figure 17 is a cross sectional side view of the yoke taken along line D-D of figure 16;

Figure 18 is a partial perspective view of the barrel assembly and carriage assembly illustrating installation of the barrel

assembly within the carriage assembly;

Figure 19 is a partial perspective view of the barrel assembly and carriage assembly illustrating the barrel assembly installed in the carriage assembly;

Figure 20 is a top view of the carriage illustrating the relationship between the second barrel coupler and the second carriage coupler;

Figure 21 is a partial top cross sectional view taken along line BB of figure 2 illustrating the relationship between the first barrel coupler and the first carriage coupler with a spigot tip nozzle for axial carriage force;

Figure 22 is a top cross sectional view taken along line BB of figure 2 illustrating the relationship between the barrel assembly with a spigot tip nozzle and the carriage assembly for axial reactive injection force;

Figure 23 is a partial top cross sectional view taken along line BB of figure 2 illustrating the relationship between the first barrel coupler and the first carriage coupler with a semispherical tip nozzle for axial carriage force;

Figure 24 is a top cross sectional view taken along line BB of figure 2 illustrating the relationship between the barrel assembly with a semispherical tip nozzle and the carriage assembly for axial reactive injection force;

Figure 25 is a cross sectional view taken along line AA of figure 2 illustrating a screw located in the barrel assembly in a first operative position; and

Figure 26 is a cross sectional view taken along line AA of figure 2 illustrating a screw located in the barrel assembly in a second operative position.

Nomenclature List

10	Injection molding machine.
12	Clamp unit.

14	Injection unit.
16	Stationary platen.
18	Clamp frame member.
20	Moving platen.
22	Actuator.
24	Moving half of a mold.
26	Stationary half of a mold.
27	Injection assembly.
28	Injection unit frame.
30	Barrel assembly.
32	Tie bars.
34	Carriage assembly.
36	Drive assembly.
38	Screw translation drive.
40	Screw rotation drive
42	Carriage actuator.
44	First barrel portion.
46	First barrel coupler.
48	Second barrel portion.
50	Yoke.
51	Opening
52	Cradle member.
53	Opening
54	Drive mount.
55	Opening.
56	First carriage actuator.
57	Opening.
58	Second carriage actuator.
60	Second barrel coupler.
62	Nozzle.
64	Accumulator.
66	Sealing joint.
68	Sealing joint.
70	Elongate section.
72	Mounting flange.
74	Bores.
76	Accumulator end.
78	Spigot.
80	First diameter axial bore.
82	First concentrator.
84	Second diameter axial bore of a nozzle.
86	Mold end.
88	Spigot tip.
90	Semispherical tip.
92	Opening.
94	Opening.
96	Axial force linkage member.
98	Thermal isolator.
99	Linkage insulator.
100	Bore.
102	Threaded bores.
104	Elongate section.
108	Threaded bores.
110	Second Concentrator.
112	First accumulator diameter bore.
114	Bore.
116	Second diameter bore.
118	End wall.
120	First end wall.
122	Bore.
124	Second end wall.
126	Side.
128	Cylindrical connector.
130	Flange.
132	Bores.
134	Second opening.
136	Second end wall.
138	Liner.

140	Feed throat.
142	Outer barrel.
146	First opening.
147	Axial bore.
148	Second carriage coupler.
150	Second axial force linkage member.
152	First carriage coupler.
153	Engagement member.
155	Support surface.
156	First carriage stop.
158	Second carriage stop.
160	Screw tip.
162	Check valve.
164	Reciprocating screw body.
170	First carriage actuator housing.
172	Second carriage actuator housing.
174	First end.
176	Lengthwise axial opening.
178	First carriage coupler.
180	Support Web.
182	Upper carriage member.
184	Lower carriage member.
186	Support web.
188	Upper carriage member.
190	Lower carriage member.
192	Upright wall member.
194	Upright wall member.
196	First support.
198	First coupler member.
200	Second coupler member.
202	First coupling surface.
204	Second coupling surface.
206	Second support
208	First coupling member.
210	Second coupling member.
212	First coupling surface.
214	Second coupling surface.
216	Support Gussets.
218	First barrel support member.
222	First upright standoff.
224	Second upright standoff.
226	First upright standoff.
228	Second upright standoff.
230	Yoke mounting surface.
232	Barrel first coupler opening.
234	Mounting surface.
236	Threaded bores
238	Opening
240	Front face.
242	Back side.
244	Left side.
246	Right side.
248	Opening.
250	Central axial bore.
252	Barrel seat.
254	First yoke support.
256	Supporting surface.
258	Second yoke support.
260	Supporting surface.
262	Retaining plate.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

An embodiment of the invention is initially described referring to Figure 1, which illustrates an injection molding machine,

generally indicated at 10. The injection molding machine includes a clamp unit, indicated at 12, interconnected and secured to an injection unit, indicated at 14.

A stationary platen 16 is fixed to a clamp frame member 18 of the clamp unit 12. A moving platen 20 is operable between an open position and a closed position through an actuator 22. Those skilled in the art appreciate that the actuator 22 may be either hydraulic, electric, or a combination of hydraulic and electric actuators. A plurality of tie bars 32 extend between the stationary platen 16 and the actuator 22. A moving half of a mold 24 is mounted on a face of the moving platen 20 and a stationary half of a mold 26 is mounted on a face of the stationary platen 16.

The clamp unit 12 of figure 1 is a two platen clamp. Alternatively, the clamp unit 12 may be a multi-station clamp unit, for example a stack mold carrier, having more than one moving platen and more than one mold. Alternatively, the clamp unit 12 may be an index clamp unit having a rotating multi-face turret block in place of a moving platen. Alternatively, the clamp unit 12 may be a tandem clamp unit having two molds operated in sequence.

An injection assembly 27 is mounted on a injection unit frame 28 of the injection unit 14. The frame 28 typically houses the control system, electronics, and power pack. The injection assembly 27 further includes a barrel assembly 30, a carriage assembly 34 for supporting and securing the barrel assembly 30, and a drive assembly 36. The drive rotates a screw to create a melt of material and feed the material forward in the barrel into an accumulation zone. The drive also reciprocates the screw to inject the melt of material into the mold.

Referring now to Figure 1 and Figure 2, the drive assembly 36 is further described. In an embodiment of the invention, the drive assembly includes both hydraulic and electric components. A screw translation drive 38 provides axial movement of the screw (not shown) in the barrel assembly 30. A screw rotation drive 40 rotates the screw (not shown) within the barrel assembly 30.

The screw translation drive 38 is hydraulic and the screw rotation drive 40 is electric. Alternatively, the drive could be completely hydraulic or completely electric. Activation of the translation drive 38 axially reciprocates the screw without rotation of the screw by the screw rotation drive 40.

The barrel assembly 30 is mounted and securely retained within the carriage assembly 34. The carriage actuator 42 extends between the carriage assembly 34 and the stationary platen (see Figure 1). Operation of the carriage actuator 42 moves the injection assembly 27 towards and away from the stationary platen for locating the end of a nozzle into contact with a sprue bushing.

Referring now to Figure 3, the injection assembly 27 is further described. The carriage assembly 34 includes a cradle member 52, a yoke 50, and a drive mount 54 for mounting the drive assembly 36 (see Figure 1 and 2).

The barrel assembly 30 includes a first barrel portion 44, a first barrel coupler 46, a second barrel portion 48, and a second barrel coupler 60. The first barrel coupler 46 is disposed on the barrel assembly 30 and interlocks with first carriage coupler to secure the barrel assembly 30 in the carriage assembly 34. The first carriage coupler is formed intermediate the yoke 50 and an end of the cradle member 52 to be described later.

The location of the first barrel coupler 46 defines a first barrel portion 44 and a second barrel portion 48 of the barrel assembly 30. The first barrel portion 44 is a section of the barrel that is capable of withstanding injection pressure. The second barrel portion 48 is a section of the barrel that is isolated from axial forces, both the axial carriage force and the axial reactive injection force.

The second coupler 60 is disposed on the second barrel portion 48 and communicates with a second carriage coupler located at another end of the cradle member 52, near the drive mount 54, retaining the second portion 48 of the barrel assembly 30 in the

cradle assembly 34. Alternatively the second coupler 60 may be disposed between the first barrel coupler 46 and an end of the second barrel portion 48.

The carriage actuator 42 includes a pair of hydraulic actuators indicated as 56 and 58. One end of the first carriage actuator 56 connects to one side of the carriage assembly 34 through a conventional fastener such as a pin (not shown) through the openings 51 and 53. The other end of the first carriage actuator 56 connects to the stationary platen (see Figure 1). One end of the second carriage actuator 56 connects to a second side of the carriage assembly 34 through another conventional fastener such as a pin (not shown) through the openings 55 and 57. The other end of the second carriage actuator 58 connects to the stationary platen (not shown).

Referring now to Figure 4, a cross sectional view of the barrel assembly 30 is now further described. The barrel assembly 30 is shown mounted within the carriage assembly 34. The barrel assembly 34 includes the first barrel portion 44 and the second barrel portion 48. The first barrel coupler 46 is disposed on the barrel assembly 30 and defines the boundary between the first barrel portion and the second barrel portion. The second barrel coupler 60 is disposed at an end on the second barrel portion 48. In this embodiment, the first barrel coupler 46 is integrally formed on the first barrel portion 44 and the second barrel coupler 60 is formed onto the outer surface of the second barrel portion 48.

The first barrel portion 44 includes a nozzle 62 and an accumulator 64. The nozzle 62 is mechanically secured by a plurality of fasteners to an end of the accumulator 64. The nozzle 62 seals at the joint 66 with the end of the accumulator 64 preventing leakage of melted material. An axial bore of the nozzle 62 aligns with an axial bore of the accumulator 64 permitting a flow of melt during injection. Alternatively, the nozzle 62 is of unitary construction with the barrel assembly 30.

The second barrel portion 48 is a feed section and is

mechanically secured by a plurality of fasteners to another end of the accumulator 64. The second barrel portion 48 seals at the joint 68 at the other end of the accumulator 64. An axial bore of the second barrel portion 48 aligns with the axial bore of the accumulator permitting a flow of melt from the second barrel portion 48 to the accumulator 64. In an alternative embodiment of the invention, the first barrel portion 44 and the second barrel portion 48 are of unitary construction without the joints 66 and 68.

Referring now to Figure 5 and 6, two embodiments of a nozzle 62 are described. The nozzle 62 has an elongate cylindrical section 70 extending from a mounting flange 72 to a mold end 86 of the nozzle 62. The mounting flange 72 is cylindrical and formed integral to the elongate cylindrical section 70. The mounting flange 72 has a diameter greater than the elongate section 70. The mounting flange 72 includes a plurality of spaced apart bores 74 for receiving mounting bolts (not shown). The accumulator end 76 of the nozzle 62 includes a spigot seal 78. The spigot seal 78 is cylindrical and extends outwardly from a side of the flange 72. The nozzle 62 includes a melt channel made up of a first diameter axial bore 80, a first concentrator 82, and a second diameter axial bore 84. In operation during injection, the melt channel receives the melt from the accumulator through the opening 92. The melt travels along the melt channel in the nozzle 62 and exits the nozzle at another opening 94 en route to a mold.

In a first embodiment of the nozzle 62, the mold end 86 includes a spigot tip 88. The spigot tip 88 is cylindrical and extends into a complementary cylindrical bore in a sprue bushing (not shown) for tight sealing engagement between the mold end 86 of the nozzle 62 and the sprue bushing during injection of a melt of material. In operation, the spigot tip 88 is in sliding sealing engagement with the complementary cylindrical bore in the sprue bushing. The spigot tip 88 is permitted to move with respect to the sprue bushing.

In a second embodiment of the nozzle 62, the mold end 86 includes a convex semispherical tip 90. The semispherical tip

90 engages a complementary concave semispherical opening in a sprue bushing (not shown) for tight sealing engagement between the mold end 86 of the nozzle 62 and the sprue bush during injection of a melt of material. In operation, the semispherical tip 90 is in force sealing engagement with the complementary concave semispherical opening in the sprue bushing.

Referring now to Figure 7 and 8, an accumulator section, generally indicated as 64 is described. The accumulator includes an elongate section 104, and a first barrel coupler 46. In an embodiment of the invention, the coupler 46 includes an axial force linkage member, indicated as 96, and a thermal isolator, indicated as 98. Alternatively, the coupler 46 may include a linkage insulator 99 which is an axial force linkage member 96 integrated with a thermal isolator 98. An axial melt channel extends through the accumulator 64. The axial melt channel includes a first accumulator diameter bore 112, a second concentrator 110, and a second diameter bore 116. The first accumulator diameter bore 112 aligns and connects with the first diameter bore 80 of the nozzle 62. The second diameter bore 116 aligns and connects with an axial bore 147 of the second barrel portion 48 (not shown). The volume defined by the second diameter bore 116 (which defines an accumulation zone) determines the maximum available shot size for injection into a mold.

The accumulator 64 is substantially cylindrical with a suitable wall thickness (between the outer surface of the elongate section 104 and the melt channel) to withstand high pressure due to injection and reactive injection force. In an embodiment of the invention, the wall thickness of the accumulator 64 must also withstand axial carriage force.

The nozzle 62 connects to an end wall 118 of the accumulator 64 through the flange 72 of the nozzle 62. The end wall 118 of the accumulator 64 includes a plurality of threaded bores 108. The flange 72 of the nozzle 62 includes a corresponding plurality of bores 74. Bolts interconnect the nozzle 62 to the accumulator 64 by the bores 74 and threaded bores 108. The bore 114 in the

accumulator 64 is of complementary diameter to tightly receive the spigot 78 of the nozzle for sealing engagement between the nozzle 62 and the accumulator 64. Alternatively, a seal may be installed to prevent leakage between the nozzle 62 and the accumulator 64. Heater bands are conventionally secured to an outer surface of the accumulator 64 and the side 126 of the coupler 46.

In an embodiment of the invention, the coupler 46 is integrally formed on an end of the accumulator 64. Alternatively, the coupler 46 may be a separate component retained or secured to the accumulator 64. For example, the coupler 46 may be welded to the outer surface of the accumulator 64, or threaded to the accumulator 64. Those skilled in the art will appreciate that any retained or secured connection must be designed to withstand axial forces.

In an embodiment of the invention, the coupler 46 includes an axial force linkage member 96. For the embodiment illustrated, the axial force linkage member 96 is a pair of outwardly extending members integrally formed on the first end wall 120 of the coupler 46. Alternatively, the axial force linkage member 96 may be a plurality of outwardly extending members, or a plurality of standoff posts, or a cylindrical ring member that may be integral or separate from the coupler 46. In another embodiment of the invention, the coupler 46 includes a pair of axial force linkage members (150, 96, see figure 21 and figure 23) disposed on the first end wall 120 and the second wall 124 of the coupler 46.

Those skilled in the art will appreciate that the cross sectional area of the force linkage member 96 of the coupler 46 is such to withstand the required axial forces. In addition, placement of the axial force linkage member 96 is such to provide an even symmetrical load distribution.

Alternatively, the coupler 46 may include a second axial force linkage member (or linkage insulator) located on a second end wall 124 of the coupler 46.

In an embodiment of the invention, the axial force linkage member 96 includes a thermal isolator, generally indicated as 98. For the embodiment illustrated, the thermal isolator 98 is integrally formed on an end of the axial force linkage member 96 to minimize the cross sectional area of the linkage member 96 contact with a first carriage coupler (not shown) in the cradle member 52. In operation, the thermal isolator reduces the conductive heat transfer from the hot accumulator 64 and the coupler 46 to the cradle member 52 and the yoke 50. Alternatively, the thermal isolator may be separate from the axial force linkage member 96, or may be a coating, or may be a different material for reducing the conductive heat transfer. The thermal isolator is disposed intermediate all contacting surfaces between the first barrel coupler 46 and the first carriage coupler. Those skilled in the art will appreciate that the thermal isolator is designed to withstand the required axial forces.

The nozzle 62 and the accumulator 64 together form the first barrel portion 44 of the barrel assembly. The first barrel portion 44 optionally includes a liner or protective coating to protect the melt channel from abrasive and corrosive materials.

Referring now to Figure 9 and 10, a second barrel portion 48 is described. The second barrel portion 48 shown is a feed section of the barrel assembly 30 and includes an axial bore 147, a first opening 146, a second opening 134, and a feed throat 140. Material enters the second portion 48 through the feed throat 140. A screw (not shown) disposed in the axial bore 147 conveys the material forward in the axial bore 147 towards accumulator 64.

The second barrel portion 48 is substantially cylindrical with a suitable wall thickness (between the outer surface of the elongate barrel and the axial bore 147 acting as a melt channel) to withstand pressure developed due to compacting and sheering the feed material. Axial forces are not directed through the second barrel portion 48.

The second barrel portion 48 optionally includes a liner 138

installed within an outer barrel 142 to protect the barrel from abrasive and corrosive materials.

The opening 146 permits the installation and removal of a screw (not shown) within the axial bore 147.

The second end wall 136 of the second portion 48 connects to the coupler side of the accumulator 64 through the flange 130. The end wall 120 of the coupler 46 includes a plurality of threaded bores 102. The flange 130 of the second portion 48 includes a corresponding plurality of bores 132. Bolts interconnect the second portion 48 to the coupler 46 by the bores 132 and thread bores 102. The bore 100 in the coupler 46 is of complementary diameter to tightly receive the cylindrical connector 128 of the second portion 48 for sealing engagement between the coupler 46 and the second portion 48. The bore 122 in the coupler 46 is of complementary diameter to receive the flange 130. Alternatively, a seal may be installed to prevent leakage between the first portion and the second portion 48. The second diameter bore 116 of the accumulator 64 axially aligns with the axial bore 147 of the second portion 48.

A second barrel coupler 60 is formed on an end of the second portion 48. The second barrel coupler 60 includes at least one engagement member, indicated as 153 for complementary engagement with a cradle engagement member for preventing rotational movement of the barrel assembly 30 during operational rotation of the screw (not shown). Heater bands are conventionally secured to an outer surface of the second barrel portion 48.

In the embodiment illustrated, the engagement member 153 is a flat recess machined on the outer surface of the barrel. Alternatively, the engagement member 153 may be an outwardly projecting member, or a groove, or a slot, or splined. Optionally, another recess 155 engages a removal plate (not shown) for preventing the barrel assembly from tipping forward when released from the cradle assembly and aligning the second barrel portion vertically with the drive assembly.

In an application of the machine where the melt of material is a

metal in a thixotropic state, for example, magnesium, the nozzle 62 may be made from DIN 2888 or DIN 2999. The accumulator 64 and first barrel coupler 46 (including the axial force isolator) may be made from Inconel 718 with a Stellite 12 liner. The second portion 48 may be also made from Inconel 718 with a Stellite 12 liner. Inconel is a registered trade mark of INCO, Inc. for nickel alloys and alloys of nickel, chromium and iron. Stellite is a registered trade mark of Deloro Stellite Co. Ltd. For cobalt based alloys.

In an application of the machine where the melt of material is plastic, the nozzle 62 may be made from SAE 4140 steel with an H13 tip. The accumulator 64 and first barrel coupler 46 (including the axial force isolator) may be made from 4140 with a cast liner. The second portion 48 may be made from 4140 with a cast liner.

The nozzle 62, accumulator 64, first barrel coupler 46, and second portion 48 may be machined from a billet of material, or alternatively, they may be formed by a hot isostatic pressing (HIP) process and then machined.

Referring now to Figures 3 and 11, the cradle member 52 of the carriage assembly 34 is further described. The cradle member 52 is substantially rectangular as shown in the top view of Figure 11. A first carriage coupler 178 is formed on one end of the cradle member 52. A drive mount 54 is formed on a second end of the cradle member 52. The drive mount 54 includes an axial bore to connect the drive assembly to an end of a screw located in an axial bore of a barrel (not shown). The first carriage coupler 178 and the drive mount 54 are aligned about a longitudinal axis of the cradle member 52.

The first carriage coupler 178 and the drive mount 54 are interconnected by a first carriage actuator housing 170 and a second carriage actuator housing 172.

The first carriage housing 170 forms a lengthwise U-shaped rectangular channel for housing a first carriage actuator 56. The first carriage housing 170 includes a support web 180

located near an end of the first carriage housing 170 and extends between an upper carriage member 182 and a lower carriage member 184. An upright wall member 192 connects the upper carriage member 182 and the lower carriage member 184.

The second carriage housing 172 forms a second lengthwise U-shaped rectangular channel for housing a second carriage actuator 58. The second carriage housing 172 includes a support web 186 located near an end of the second carriage housing 172 and extends between an upper carriage member 188 and a lower carriage member 190. A second upright wall member 194 connects the upper carriage member 188 and the lower carriage member 190.

The cradle member 52 has a lengthwise axial opening 176 extending from the first end 174 of the cradle member 52 to the drive mount 54. This opening provides clear unobstructed access for inserting and removing a barrel assembly (see Figure 3) within the cradle member 52.

Referring now to Figure 11 and Figure 12, the first carriage coupler 178 and the second carriage coupler 148 are further described.

The cradle member 52 includes a second support 206 that extends between the upright wall members (192, 194) at the first end 174 of the cradle member 52. In an embodiment of the invention, a first carriage coupler 178 includes a first coupling member 208 and a second coupling member 210. The first and second coupling members (208, 210) extend outwardly from the upright wall members (192, 194). The first coupling member 208 includes a first coupling surface 212 and the second coupling member 210 includes a second coupling surface 214. The first carriage coupler 178 forms an opening about the longitudinal axis to receive the first barrel coupler 46. In an embodiment of the invention, the first coupling surface 212 and the second coupling surface 214 engage the axial force linkage member 96 the barrel coupler 46. Alternatively, the first coupling surface 212 and the second coupling surface 214 engage the thermal isolator 98. A pair of support gussets 216 extend between a back surface of the first and second coupling members

(208, 210) and the upright wall members (192, 194).

The cradle member 52 also includes a first support 196 that extends between the upright wall members (192, 194) and the drive mount 54. The first support 196 is T shaped. In an embodiment of the invention, the second carriage coupler 148 includes a first coupler member 198 and a second coupler member 200. The first and second coupler members (198, 200) extend upwardly from a surface of first support 196 and inwardly from the upright wall members (192, 194). The second carriage coupler 148 forms an opening about the longitudinal axis to receive the second barrel coupler 60. A first coupling surface 202 and a second coupling surface 204 engage complementary surfaces (153) of the second barrel coupler 60.

A first barrel support member 218 is formed on an upper surface of the second support 206. The first barrel support member 218 includes a first upright standoff 222 and a second upright standoff 224. The standoffs (222, 224) are of a height above the upper surface of the second support 206 to engage an outer surface of the barrel assembly 30 for locating the first barrel coupler 46 with respect to the first carriage coupler 178.

A second barrel support member is formed on an upper surface of the first support 196. The second barrel support member includes a first upright standoff 226 and a second upright standoff 228. The standoffs (226, 228) are of a height about the upper surface of the second first support 196 to engage an outer surface of the barrel assembly 30 for locating the second barrel coupler 60 with respect to the second carriage coupler 148.

The first barrel support member 218 and the second barrel support member form a barrel alignment member and axially align the barrel assembly 30 when housed in the cradle member 52. The cradle member 52 may include additional barrel support members.

Referring now to Figure 13, the first end 174 and first carriage coupler 178 of the cradle member 52 are described. A yoke mounting surface 230 extends between the first carriage housing

170 and the second carriage housing 172. The yoke mounting surface 230 includes a number of threaded bores for receiving bolts to secure the yoke 50 to the cradle member 52. The first upright standoff 222 and the second upright standoff 224 are spaced apart a distance to securely support an outer surface of the barrel assembly 30. The cross sectional area of the first coupling surface 212 and the second coupling surface 214 is selected to withstand and distribute axial carriage force to the first barrel coupler 46. The first barrel coupler 46 fits into the barrel coupler opening, generally indicated as 232.

Referring now to Figure 14, the drive mount 54 of the cradle member 52 is further described. The drive mount 54 includes a mounting surface 234 for mounting a drive assembly 36. A number of thread bores 236 are provided to receive bolts for mounting the drive assembly 36 to the drive mount 54. An opening 238 is provided to connect the drive assembly 36 to an end of a screw mounted in a barrel (not shown).

Referring now to Figure 15, 16, and 17, the yoke 50 is further described. The yoke 50 is rectangular having a front face 240, a back face 242, a left side 244, a right side 246, top and bottom. The yoke 50 is of suitable thickness to withstand axial carriage force. The yoke 50 includes a number of openings 248 for receiving bolts to secure the yoke 50 to the yoke mounting surface 230 of the cradle member 52. The central axial bore 250 has a first diameter for receiving the barrel assembly 30 and a second diameter for receiving the barrel coupler 46. In one embodiment, the coupling surface of the yoke 50 engages the second axial force linkage member 150 (see Fig. 21). In an embodiment of the invention, the coupling surface is a barrel seat 252 formed between the first diameter and the second diameter. The barrel seat 252 has a cross sectional area to withstand and distribute axial carriage force.

In an embodiment of the invention, the first carriage coupler 152 is formed by the yoke 50 and the first carriage coupler 178 of the cradle member 52.

The yoke 50 includes a pair of yoke supports (254,258). A first

yoke support 254 is mounted on a side of the yoke 50. A second yoke support 258 is mounted on another side of the yoke 50, opposite the first yoke support 254. The yoke supports are axially aligned. The first yoke support 254 includes a supporting surface 256 and the second yoke support 258 includes a supporting surface 260. The supporting surfaces (256, 260) engage complementary surfaces of the first carriage actuator 56 and the second carriage actuator 58 for supporting the yoke 50 during assembly of the carriage assembly 34.

In an embodiment of the invention, the yoke is plate steel A36 and the cradle assembly is cast from A536. Alternatively, the cradle assembly may be a pair of couplers interconnected by tie bars.

In an alternative embodiment of the invention, the first carriage coupler is interconnected to the second carriage coupler by a plurality of tie bars. In another alternative embodiment of the invention, the first carriage coupler is interconnected to the second carriage coupler by a frame member.

Installation of the barrel assembly 30 in the cradle member 52 is described with reference to Figure 18 and 19. The cradle member 52 is mounted on the frame 28 of the injection unit 14 for axial movement of the injection assembly with respect to the injection unit frame 28 (not shown). The carriage actuator 42 is mounted in the cradle member 52 and connected to a stationary member, for example the stationary platen 16 of the injection molding machine 10. The carriage actuator 42 is operated to move the cradle member 52 away from the stationary platen 16 (see figure 18). The yoke 50 is placed on the carriage actuator 42 away from the first end 174 of the cradle member 52. The supporting surface 256 engages one actuator and the supporting surface 260 engages the other actuator.

The barrel assembly 30 is lowered into the opening of the cradle member 52. The first barrel coupler 46 is aligned with the first carriage coupler 178. The second barrel coupler 60 is aligned with the second carriage coupler 148. The barrel assembly 30 is lowered until the barrel assembly 30 engages the

first barrel support member 218 and the second barrel support members 198 and 200. The barrel support members (218, 198 and 200) align the barrel assembly 30 in the cradle member 52.

A rectangular retaining plate 262 (see figure 19) engages the support surface 155 (see Fig. 10) of the second barrel coupler 60 for retaining the barrel assembly 30 vertically in the cradle member 52. The plate 262 is secured by conventional bolts to the second barrel support members (200, 198). A lower surface of the plate 262 engages the support surface 155 permitting axial movement of the barrel assembly 30 in the carriage assembly 34.

The yoke 50 is moved towards the first end 174 of the cradle member 52 and secured to the first end 174 of the cradle member 52 by a number of bolts. A number of alignment pins and openings are provided between the yoke 50 and the yoke mounting surface 230 for aligning the yoke 50 to the carriage assembly 34. The first barrel coupler 46 is effectively secured and clamped to the carriage assembly. The reciprocating screw (located within the axial bore of the barrel assembly) is then connected to the drive assembly 36

Those skilled in the art will appreciate that removal of the barrel assembly 30 from the carriage assembly 34 is the reverse operation of mounting.

Referring now to Figure 20, the barrel assembly 30 and second barrel coupler 60 are shown mounted in the carriage assembly 34 as a top view without the yoke 50.

The second barrel coupler 60 engages the second carriage coupler 148, retaining the second barrel portion 48 of the barrel assembly 30 to the cradle member 52. The second barrel coupler 60 and the second carriage coupler 148 prevent the barrel assembly 30 from rotating about the longitudinal axis during rotational operation of the screw (not shown). The second barrel coupler 60 and the second carriage coupler 148 permit axial longitudinal movement of the second barrel portion 48 effectively isolating the second barrel portion 48 from axial

forces.

Referring now to Figure 21, a partial view of the barrel assembly 30 is shown mounted in the carriage assembly 34 as a partial cross sectional view taken along line BB of figure 2.

The barrel assembly 30 is housed and secured in the carriage assembly 34. In an embodiment of the invention, the thermal isolator and the first axial force linkage member 96 engages a surface of the first carriage coupler 152. A ring shaped second axial force linkage member 150 is located on an other side of the coupler 46. A thermal isolator surface of the second axial force linkage member 150 engages an inner surface (barrel seat) of the yoke 50. The yoke 50 is located at the front of the carriage assembly 34. The yoke 50 is bolted to a forward section of the carriage assembly 34 to securely clamp the first barrel coupler 46.

The clamping force to secure the barrel assembly 30 with the carriage assembly 34 is provided between the yoke 50 and the carriage assembly 34. The clamping force is directed through the second axial force linkage member 150 (including a thermal isolator), the first barrel coupler 46, and the first axial force linkage member 96 (including a thermal isolator).

In operation, there are two different applications where axial carriage force is directed through the barrel coupler 46. When the nozzle 62 includes a spigot tip 88 (see figure 5), the yoke 50 includes a first carriage stop 156 and a second carriage stop 158 (alternatively, a single carriage stop). The first and second stop are mounted by bolts to a front face of the yoke 50. The first and second stop extend outwardly from the front face 240 of the yoke 50 to engage a surface of the stationary platen. The length of the first and second stop is such to permit a length of the spigot tip 88 to enter into the sprue bushing. Operation of the carriage actuator 42 moves the carriage assembly 34 and barrel assembly 30 towards the stationary platen 16 (see figure 1) until the first and second stop engage the stationary platen 16 preventing further forward movement. The carriage actuator 42 is further operated to create the axial

carriage force. The axial carriage force is directed through the first carriage actuator 56 and the second carriage actuator 58 to the carriage assembly 34. The carriage assembly 34 further directs the axial carriage force through the first carriage coupler 152 to the first axial force linkage member 96, the first barrel coupler 46, the second axial force linkage member 150, the yoke 50, and the first and second stops. This isolates both barrel portions 44 and 48 from axial carriage force.

Referring now to Figure 22, axial injection force is described. During the injection phase, the screw translation drive 38 is operated to move the screw forward in the barrel assembly 30. An injection force is directed from the translation drive 38 to the reciprocating screw body 164, and to the melt of material located in front of the reciprocating screw. A reactive injection force is directed back through the accumulator 64, to the first barrel coupler 46, (including linkage members) to the first carriage coupler 152, to the first and second carriage actuator housings (170, 172), to the drive mount 54, and to the screw translation drive assembly 36. The second barrel portion 48 is isolated from the axial reactive injection force.

Referring now to Figure 23, when the nozzle 62 includes a semispherical tip 90 (see figure 6), the first stop 156 and the second stop 158 are not required. Operation of the carriage actuator 42 moves the carriage assembly 34 and barrel assembly 30 towards the stationary platen 16 until the semispherical tip 90 engages the sprue bushing. The carriage actuator 42 is further operated to create the axial carriage force. The axial carriage force is directed through the first carriage actuator 56 and the second carriage actuator 58 to the carriage assembly 34. The carriage assembly 34 further directs the axial carriage force through the first carriage coupler 152 to the first axial force linkage member 96, the first barrel coupler 46, the accumulator 64, and the nozzle 62. The first barrel portion distributes axial carriage force and the second barrel portion is isolated from axial carriage force.

Referring now to Figure 24, axial injection force is described.

During the injection phase, the screw translation drive 38 is operated to move the screw forward in the barrel assembly 30. An injection force is directed from the translation drive 38 to the reciprocating screw body 164, and to the melt of material located in front of the reciprocating screw. A first reactive injection force is directed back through the accumulator 64, to the first barrel coupler 46, (including linkage members) to the first carriage coupler 152, to the first and second carriage actuator housings (170, 172), to the drive mount 54, and to the screw translation drive assembly 36. A second reactive injection force is directed back through the nozzle 62 to the accumulator 64, to the first barrel coupler 46, (including linkage members) to the first carriage coupler 152, to the first and second carriage actuator housings (170, 172), to the drive mount 54, and to the screw translation drive assembly 36. The second barrel portion 48 is isolated from the axial reactive injection force.

Referring now to Figure 25 and 26, operation of a screw in the barrel assembly is described. The barrel assembly, including the nozzle 62, accumulator 64, first barrel coupler 46, second barrel portion 48, and second barrel coupler 60 is secured and retained respectively in the carriage assembly 34 as previously described. A screw is located within the axial bore of the accumulator and the second barrel portion. The screw includes a screw tip 160, a check valve 162, and a reciprocating screw body 164. The screw is reciprocatable between an injected position (see figure 13) and a maximum shot position (see figure 14).

In operation, the screw starts at the injected position. Feed material enters the axial bore of the barrel assembly through the feed port. The material is melted and conveyed forward along the screw body 164 towards the screw tip 160. As a shot of material develops in front of the screw tip 160 in the accumulation zone of the accumulator 64, the screw moves aft until an appropriate shot volume is received in the accumulator zone. Then, the screw is advanced forward injecting the shot of melt into a mold. The check valve 162 permits the melt to move forward, but not backward of the check valve. In operation, the check valve reciprocates only within the axial bore of the

accumulator 64.

In an embodiment of the invention, the barrel assembly is formed by a single unitary construction. In another embodiment, the barrel assembly is a first section connected to a second section. In another embodiment, the first section is a nozzle connected to an accumulator. In another embodiment, the first section is nozzle connected to a barrel head which is connected to an accumulator.

It is to be understood by persons skilled in the art that the invention is not limited to the illustrations described herein, which are deemed to illustrate the best modes of carrying out the invention, and which are susceptible to modification of form, size, arrangement of parts and details of operation. The invention is intended to encompass all such modifications, which are within its spirit and scope as defined by the claims.

WHAT IS CLAIMED IS:

1) An injection assembly comprising:
a barrel assembly 30, and a carriage assembly 34;
the barrel assembly including first and second barrel portions having an axial bore therethrough, and a first barrel coupler 46, the location of the first barrel coupler 46 defining a boundary between the first barrel portion 44 and the second barrel portion 48;
the carriage assembly 34 including a first carriage coupler 178 to engage the first barrel coupler, and a carriage actuator 42 for linking with a stationary platen of a clamp unit 12;
wherein the first barrel coupler 46, in use, interlocks with the first carriage coupler to secure the barrel assembly 30 in the carriage assembly 34, thereby isolating the second barrel portion 48 from axial carriage force.

2) The injection assembly of claim 1, wherein the first barrel coupler 46 has an end wall 120 and further includes an axial force linkage member 96 comprising at least one outwardly extending member disposed on the first end wall 120.

3) The injection assembly of claim 2, wherein the first barrel coupler 46 includes a thermal isolator 98 disposed on the axial force linkage member 96.

4) The injection assembly of claim 3, wherein the first barrel coupler 46 includes at least one linkage insulator 99.

5) The injection assembly of claim 4, wherein the first barrel coupler 46 has a second wall 124 and includes at least one second axial force linkage member 150 disposed on the second wall.

6) The injection assembly of claim 2, wherein the axial

force linkage member 96 is a plurality of outwardly extending members.

7) The injection assembly of claim 2, wherein the axial force linkage member 96 is a cylindrical ring member.

8) The injection assembly of claim 1, wherein the second barrel portion 48 is secured to the end of the first barrel portion.

9) The injection assembly of claim 8, wherein the first barrel portion 44 includes a nozzle 62 secured on an end of an accumulator 64.

10) The injection assembly of claim 9, wherein the nozzle 62 has an elongate cylindrical section 70 extending from a mounting flange 72 to a mold end 86.

11) The injection assembly of claim 10, wherein said nozzle 62 includes a spigot section 78 that extends outwardly from a side of the mounting flange 72 and is situated at said end of said accumulator.

12) The injection assembly of claim 11, wherein the mold end 86 of the nozzle 62 includes a spigot tip 88.

13) The injection assembly of claim 11, wherein the mold end 86 of the nozzle 62 includes a convex semispherical tip 90.

14) The injection assembly of claim 12, wherein the nozzle 62 is made from DIN 2888 or DIN 2999.

15) The injection assembly of claim 13, wherein the nozzle 62 is made from SAE 4140 steel with an H13 tip.

16) The injection assembly of claim 9, wherein the accumulator includes an elongate cylindrical section 104, the first barrel coupler 46 disposed at a first

end thereon.

17) The injection assembly of claim 16, wherein the accumulator further includes bores 100, 122 of a complementary diameter to tightly receive the second barrel portion 48.

18) The injection assembly of claim 16, wherein the accumulator includes a bore 114 to tightly receive a spigot 78 of the nozzle.

19) The injection assembly of claim 16, wherein the axial bore through the first barrel portion 44 includes either a liner or a protective coating.

20) The injection assembly of claim 19, wherein the accumulator 44 and first barrel coupler 68 are made from INCONEL 718 alloy with a STELLITE 12 cobalt steel alloy liner.

21) The injection assembly of claim 16, wherein the accumulator 44 and first barrel coupler 68 are made from 4140 steel with a cast liner.

22) The injection assembly of claim 8, wherein the barrel assembly 30 further includes a second barrel coupler 60 disposed on the second barrel portion 48 and communicates with a second carriage coupler located on the carriage assembly 34 to retain the second portion 48 of the barrel assembly 30.

23) The injection assembly of claim 22, wherein the second barrel coupler 60 is disposed between the first barrel coupler 46 and an end of the second barrel portion 48.

24) The injection assembly of claim 22, wherein the second barrel coupler 60 is disposed at an end on the second barrel portion 48.

25) The injection assembly of claim 24, wherein the second

barrel portion 48 has a second end wall 136, a feed throat 140 in communication with the axial bore, and a flange 130 disposed adjacent the second end wall 136.

26) The injection assembly of claim 25, wherein the second barrel coupler 60 includes at least one engagement member 153.

27) The injection assembly of claim 26, wherein the engagement member 153 is a flat recess machined on the outer surface of the second barrel portion 48.

28) The injection assembly of claim 25, wherein the axial bore through the second barrel portion 48 includes a liner 138 or a protective coating.

29) The injection assembly of claim 28, wherein the second portion 48 is made from INCONEL 718 alloy with a STELLITE 12 cobalt steel alloy liner.

30) The injection assembly of claim 28, wherein the second portion 48 is made from 4140 steel with a cast liner.

31) The injection assembly of claim 22, wherein the carriage assembly 34 further includes a cradle member 52, a yoke 50, and a drive mount 54 for mounting the drive assembly 36.

32) The injection assembly of claim 31, wherein the first carriage coupler is formed between a first cradle coupler 178 disposed at an end of the cradle member 52, and a yoke coupler disposed on the yoke 50.

33) The injection assembly of claim 31, wherein the second carriage coupler is located on cradle member 52 retaining the second barrel portion 48 of the barrel assembly 30 in the carriage assembly 34.

34) The injection assembly of claim 31, wherein the drive mount 54 is formed on a second end of the cradle member

52.

35) The injection assembly of claim 31, wherein the cradle member 52 includes first and second carriage actuator housings 170, 172 interconnecting the first cradle coupler 178 and the drive mount 54.

36) The injection assembly of claim 35, wherein the carriage actuator 42 includes a pair of hydraulic actuators 56 housed in the first and second carriage housings 170, 172.

37) The injection assembly of claim 32, wherein the first cradle coupler 178 includes first and a second coupling members 208, 210 with first and second coupling surfaces 212, 214 respectively to engage the first barrel coupler 46.

38) The injection assembly of claim 31, wherein the second carriage coupler includes a first coupler member 198 and a second coupler member 200 with first and second coupling surfaces 202, 204 respectively to engage the second barrel coupler 60.

39) The injection assembly of claim 37, wherein the cradle member 52 includes a first barrel support member 218 to engage an outer surface of the barrel assembly 30 for locating the first barrel coupler 46 with respect to the first cradle coupler 178.

40) The injection assembly of claim 39, wherein the first barrel support member 218 includes a first upright standoff 222 and a second upright standoff 224.

41) The injection assembly of claim 38, wherein the cradle member 52 includes a second barrel support member 220 to engage an outer surface of the barrel assembly 30 for locating the second barrel coupler 60 with respect to the second carriage coupler 148.

42) The injection assembly of claim 41, wherein the second barrel support member 220 includes a first upright standoff 226 and a second upright standoff 228.

43) The injection assembly of claim 35, wherein the cradle member 52 has a first end 174 that includes a yoke mounting surface 230 extends between the first carriage housing 170 and the second carriage housing 172.

44) The injection assembly of claim 43, wherein the yoke 50 includes a central axial bore 250 having a first diameter for receiving the barrel assembly 30, a second diameter for receiving the first barrel coupler 46, and a coupling surface.

45) The injection assembly of claim 44, wherein the yoke 50 mounting surface 230 is a barrel seat 252 formed between the first diameter and the second diameter.

46) The injection assembly of claim 45, wherein the yoke 50 includes a pair of yoke supports 254, 258 to engage respectively a first carriage actuator 56 and a second carriage actuator 58 for supporting the yoke 50 during assembly of the carriage assembly 34.

47) The injection assembly of claim 46, wherein the yoke is made from plate steel A36.

48) The injection assembly of claim 31, wherein the cradle assembly is cast from A536.

49) The injection assembly of claim 22, wherein the carriage assembly 34 is a first carriage coupler interconnected to the second carriage coupler by a plurality of tie bars.

50) The injection assembly of claim 22, wherein the carriage assembly 34 is a first carriage coupler interconnected to the second carriage coupler by a frame member.

51) The injection assembly of claim 31, wherein the yoke 50 has a front face, with at least a first carriage stop 156 thereon, the first stop, in use, engaging a surface of a stationary platen, thereby isolating the first and second barrel portions 44, 48 from axial carriage force.

52) The injection assembly of claim 51, wherein the yoke 50 includes a second carriage stop 158.

53) The injection assembly of claim 1, wherein the barrel assembly and the carriage assembly are mounted on an injection unit frame, and the injection assembly further comprises a drive assembly which, in use, operates a screw disposed in the axial bore of the barrel assembly.

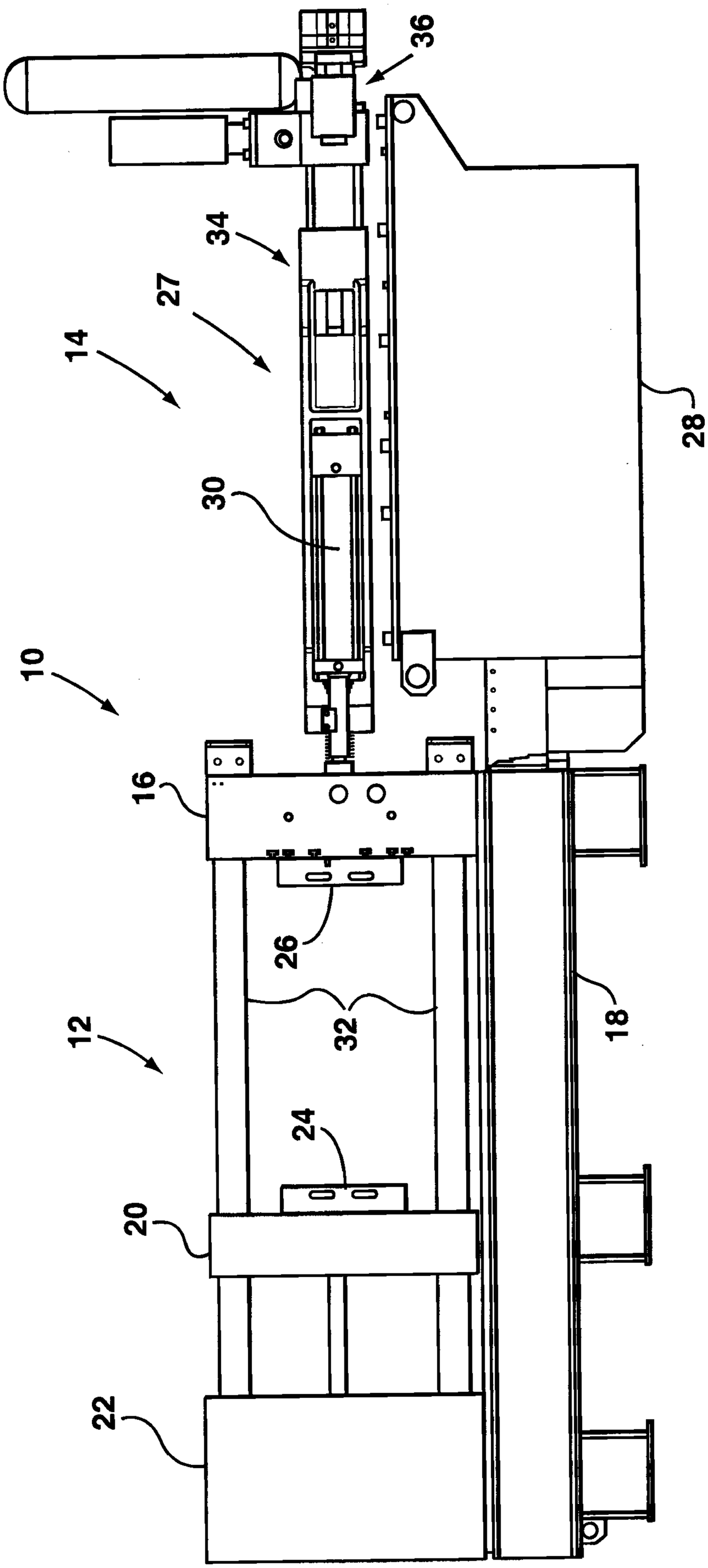

FIG. 1

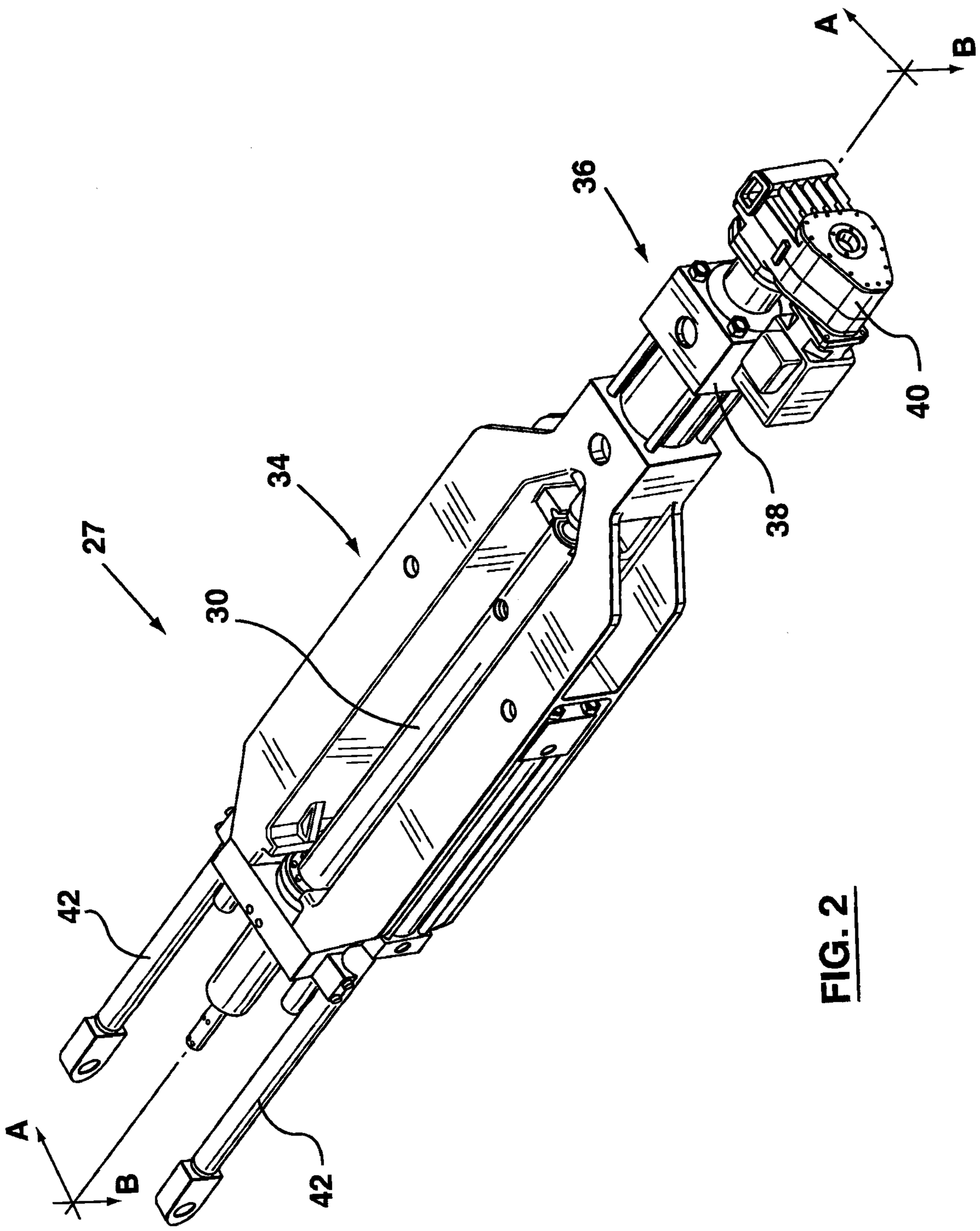

FIG. 2

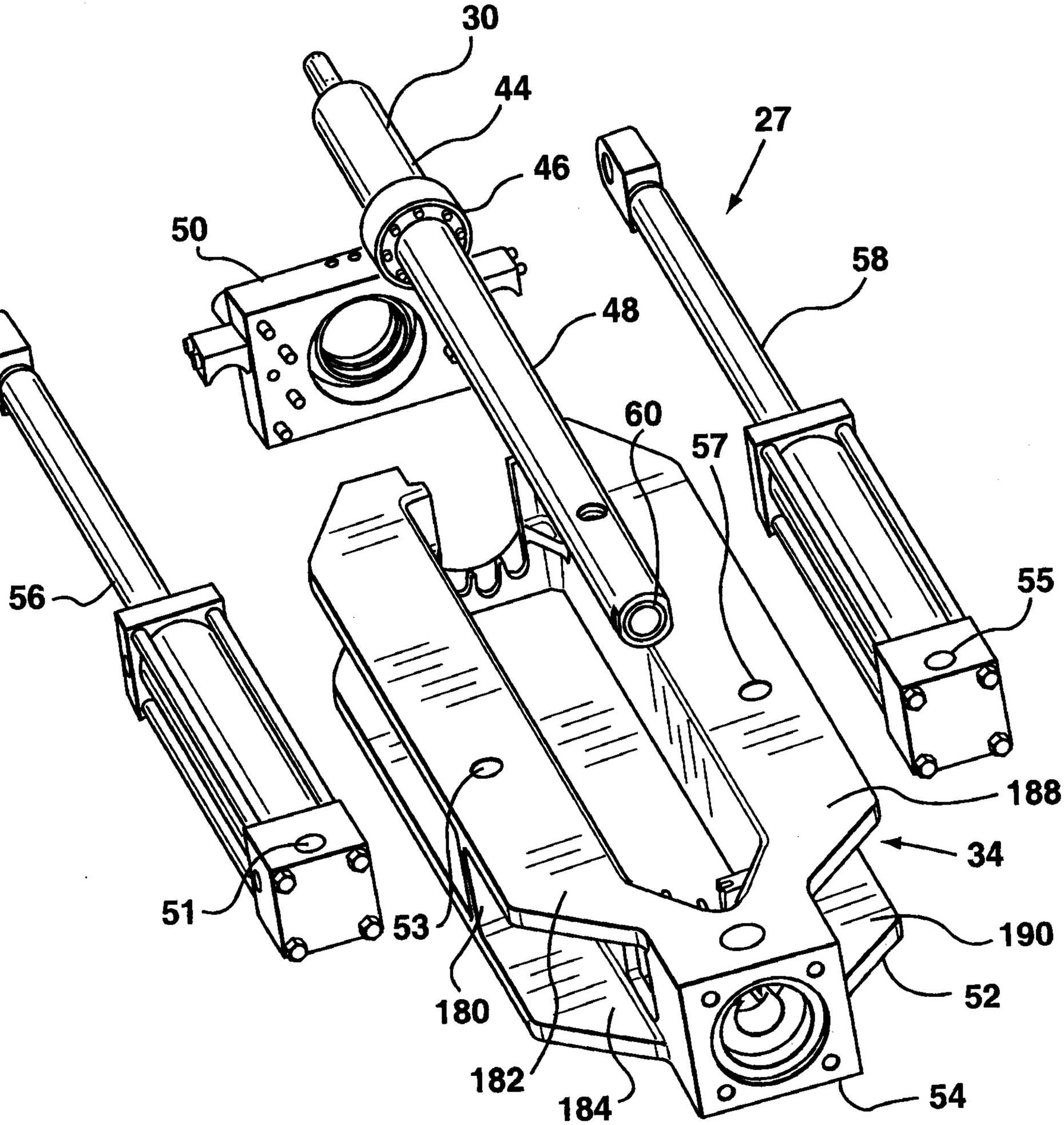

FIG. 3

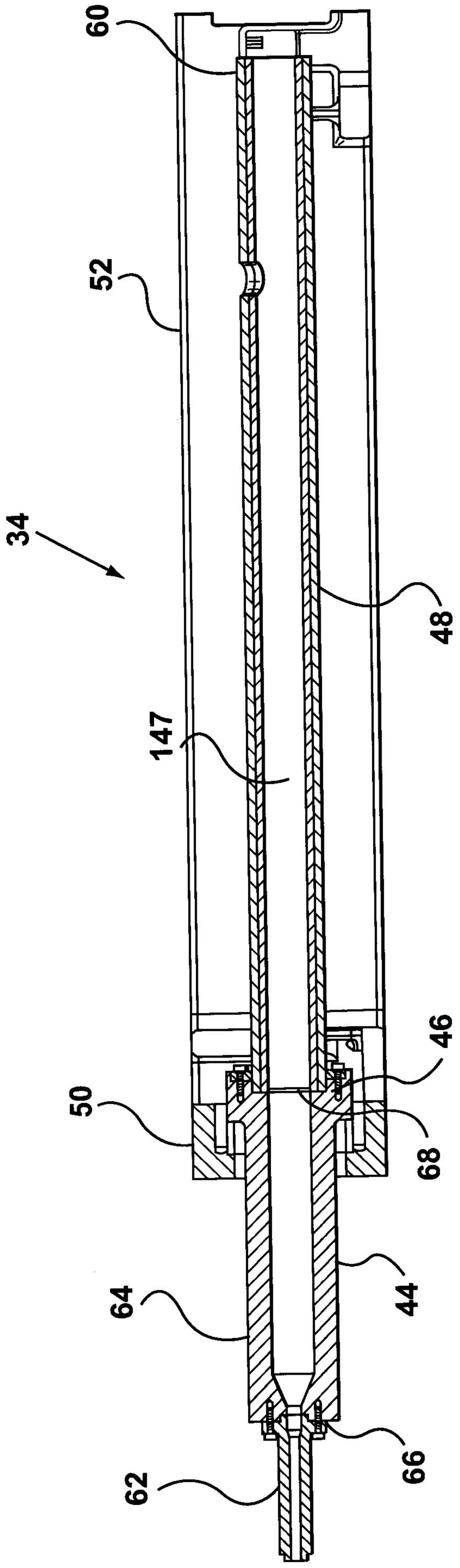

FIG. 4

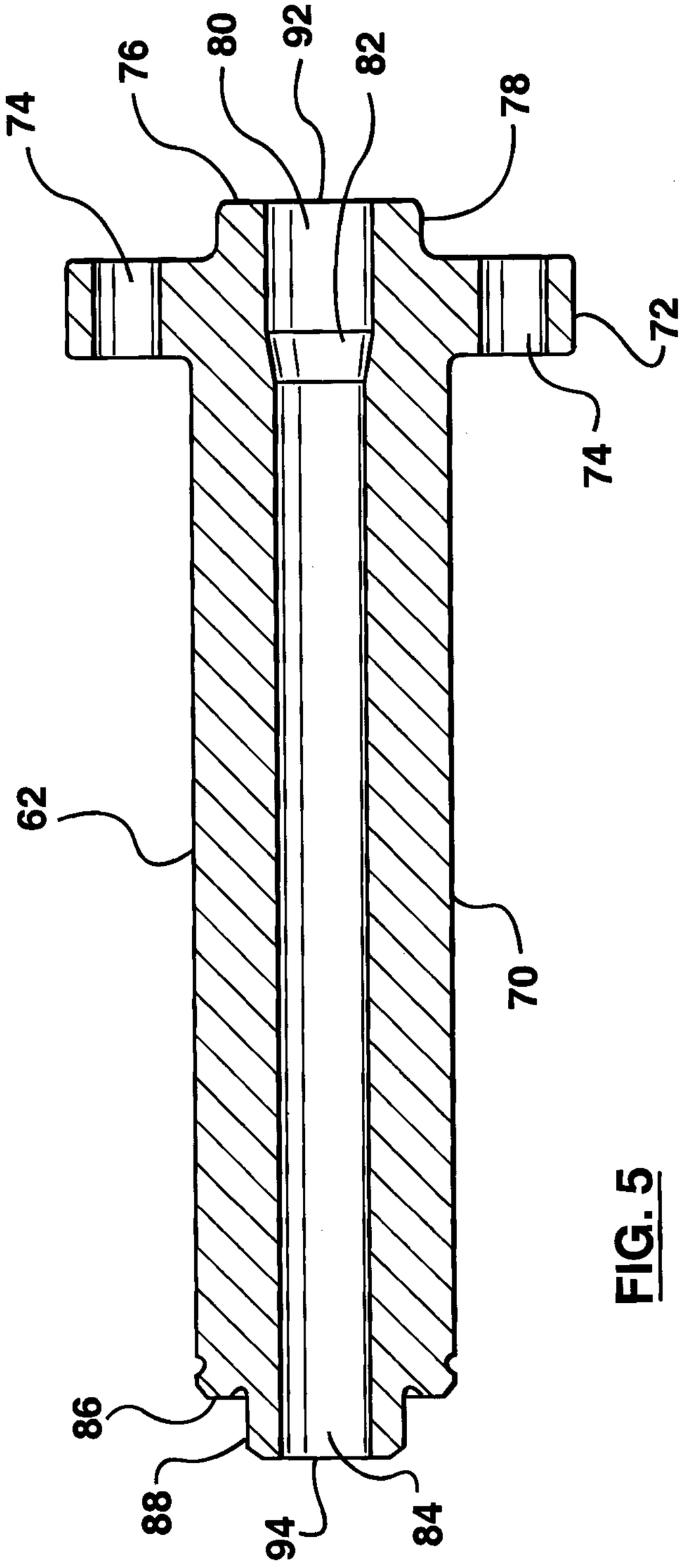

FIG. 5

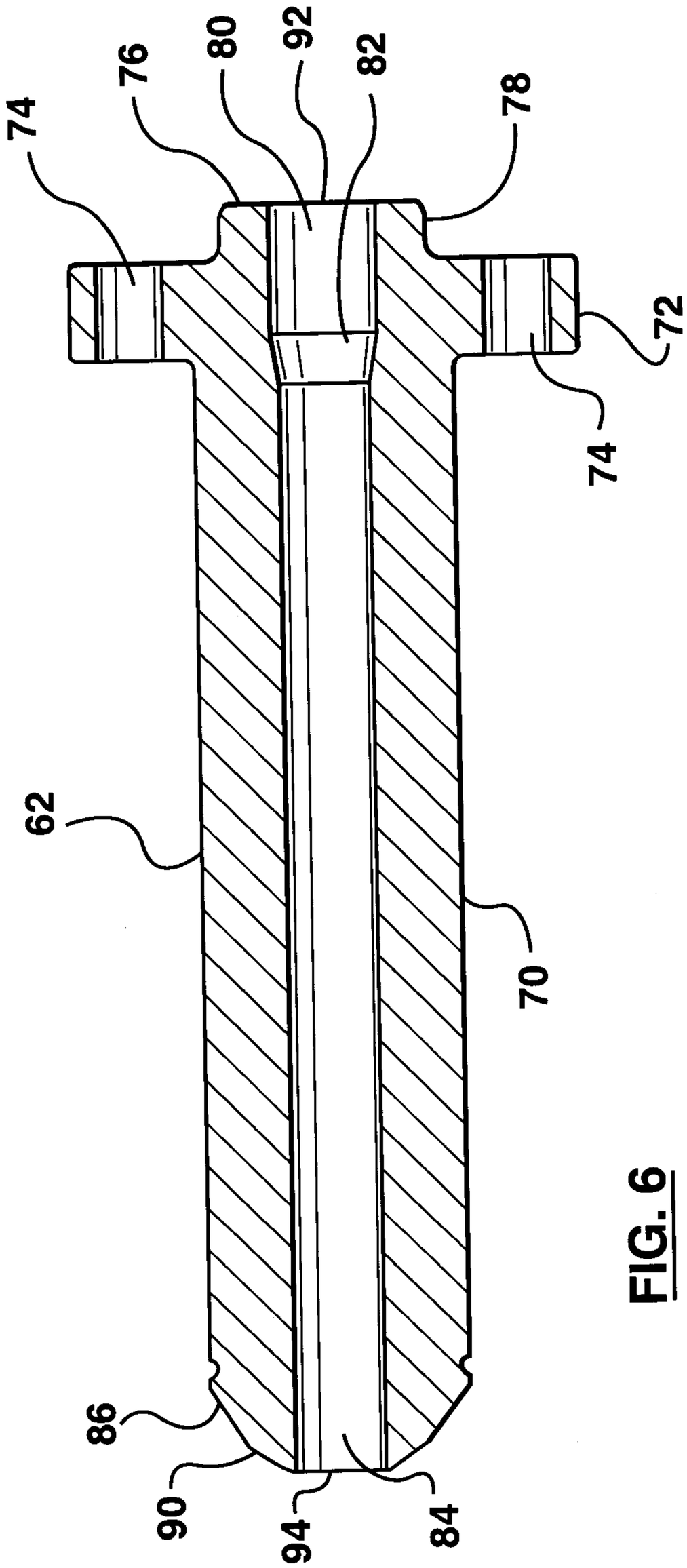

FIG. 6

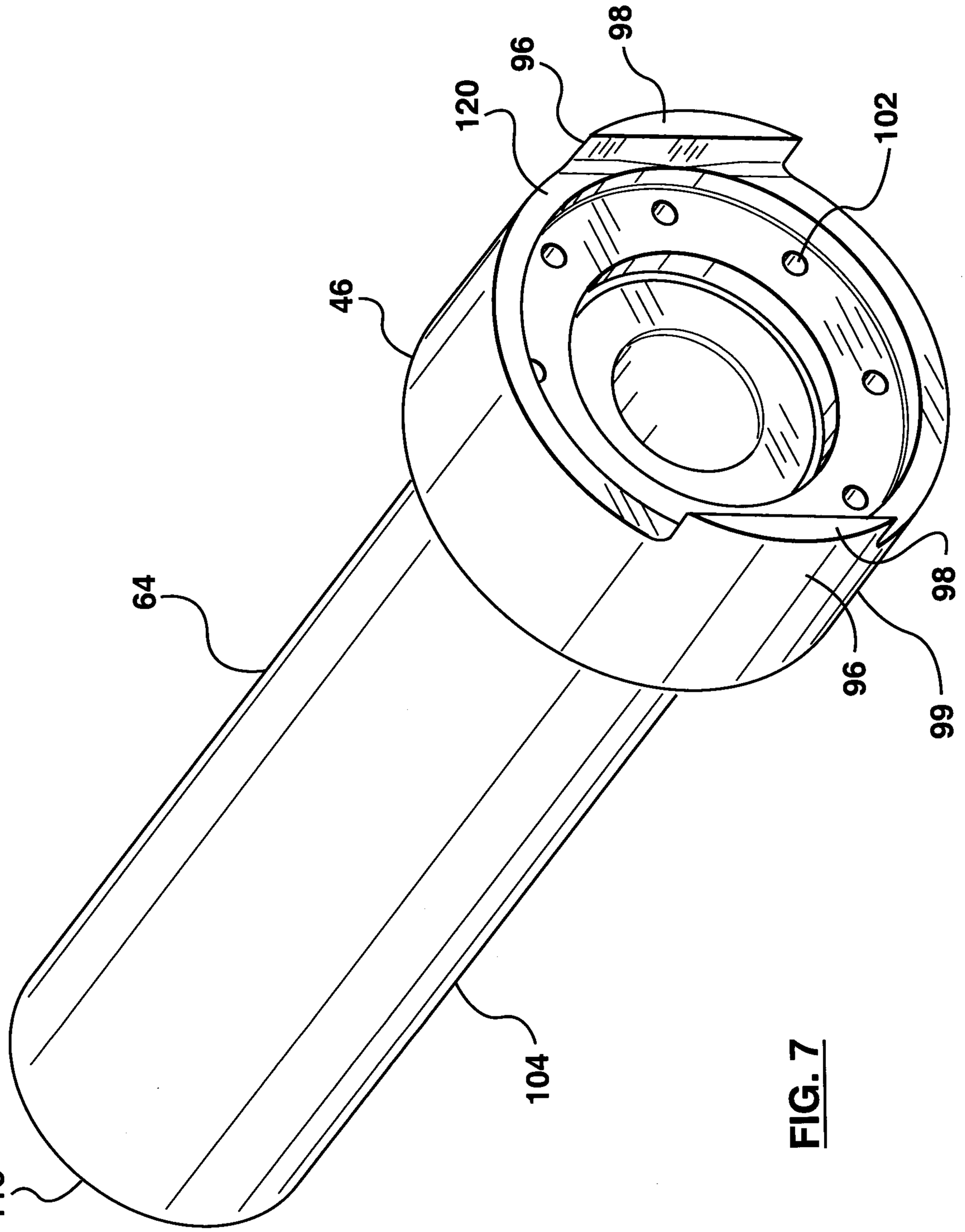

FIG. 7

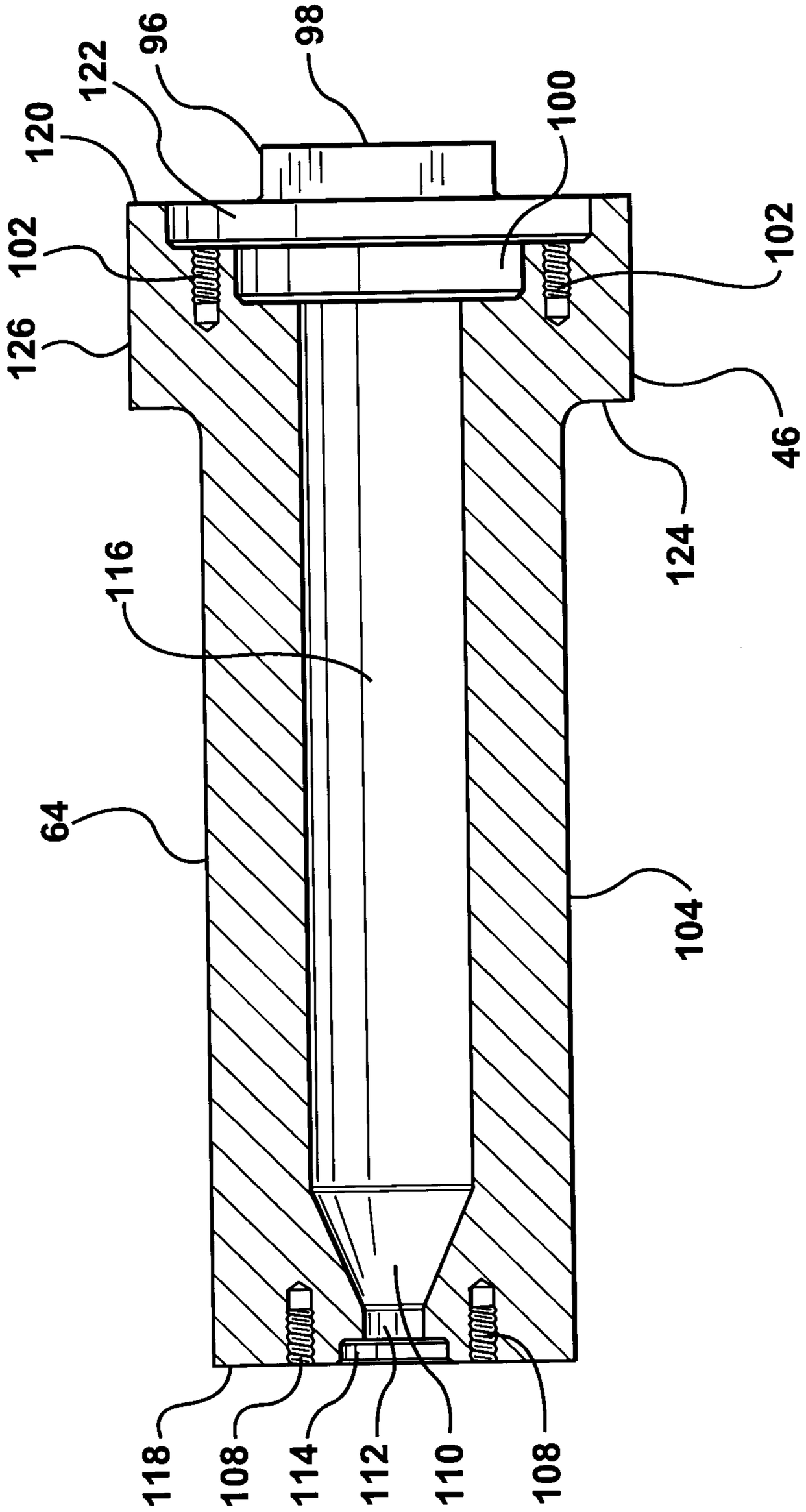
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FIG. 8

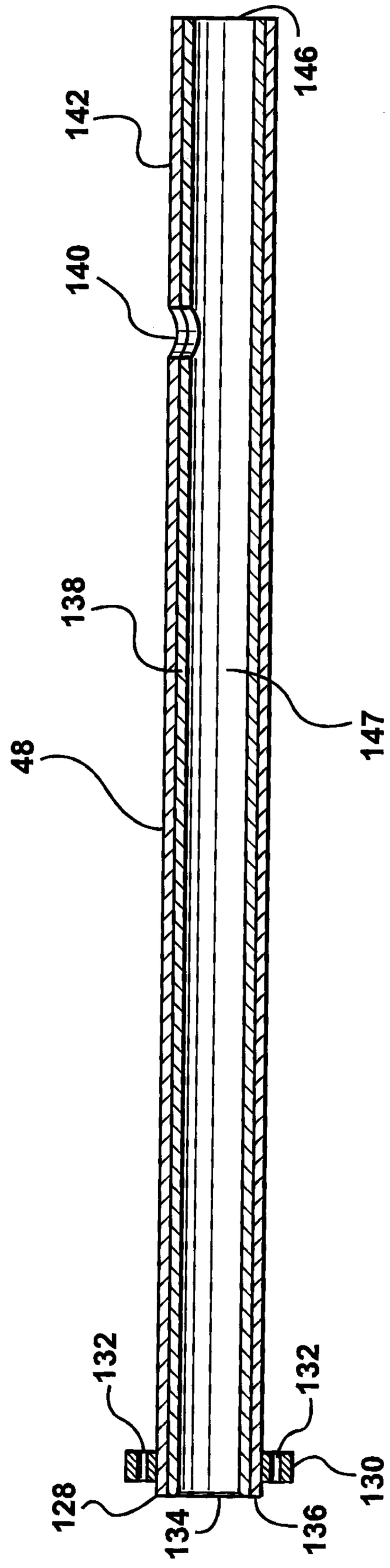

FIG. 9

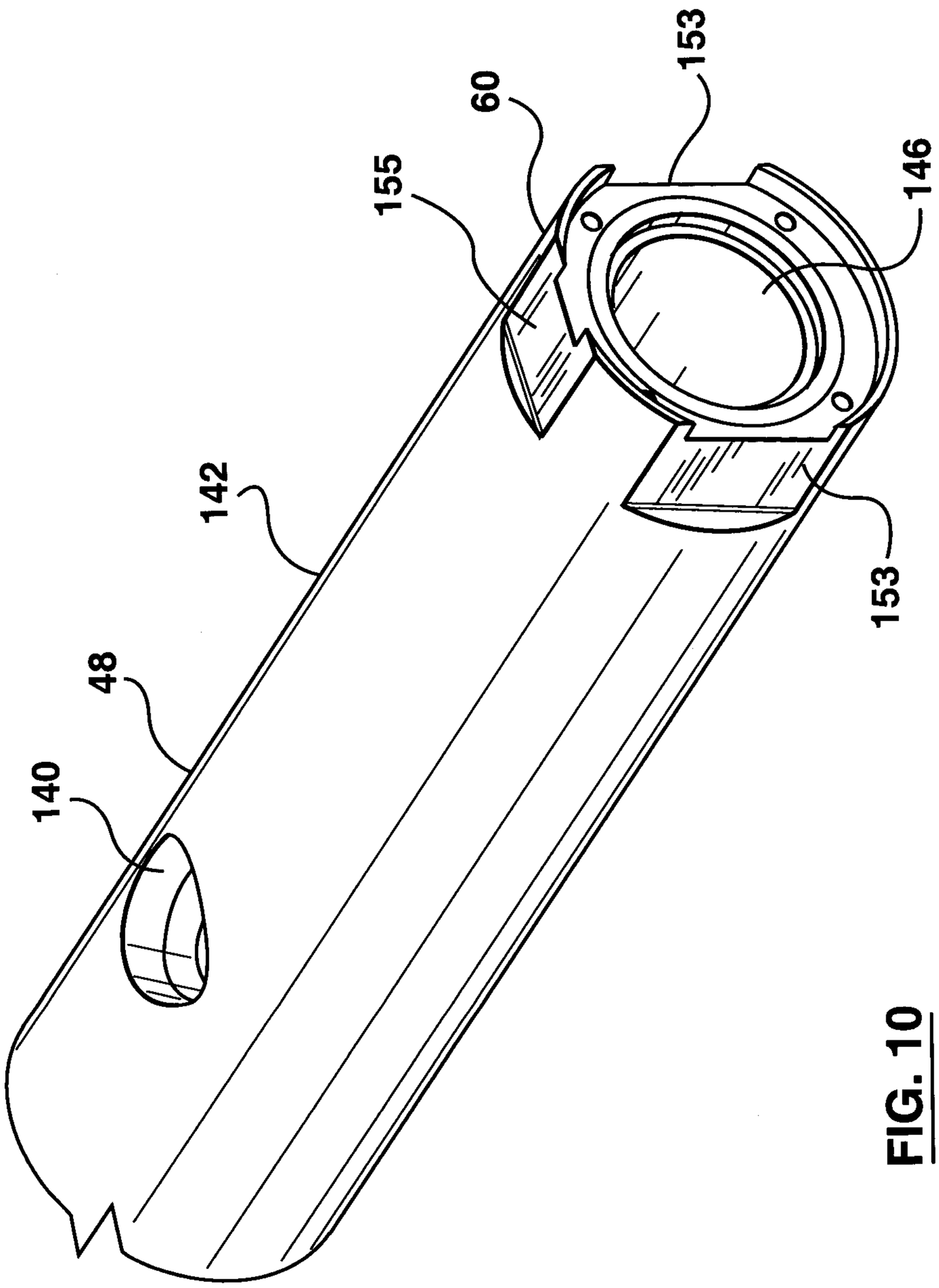

FIG. 10

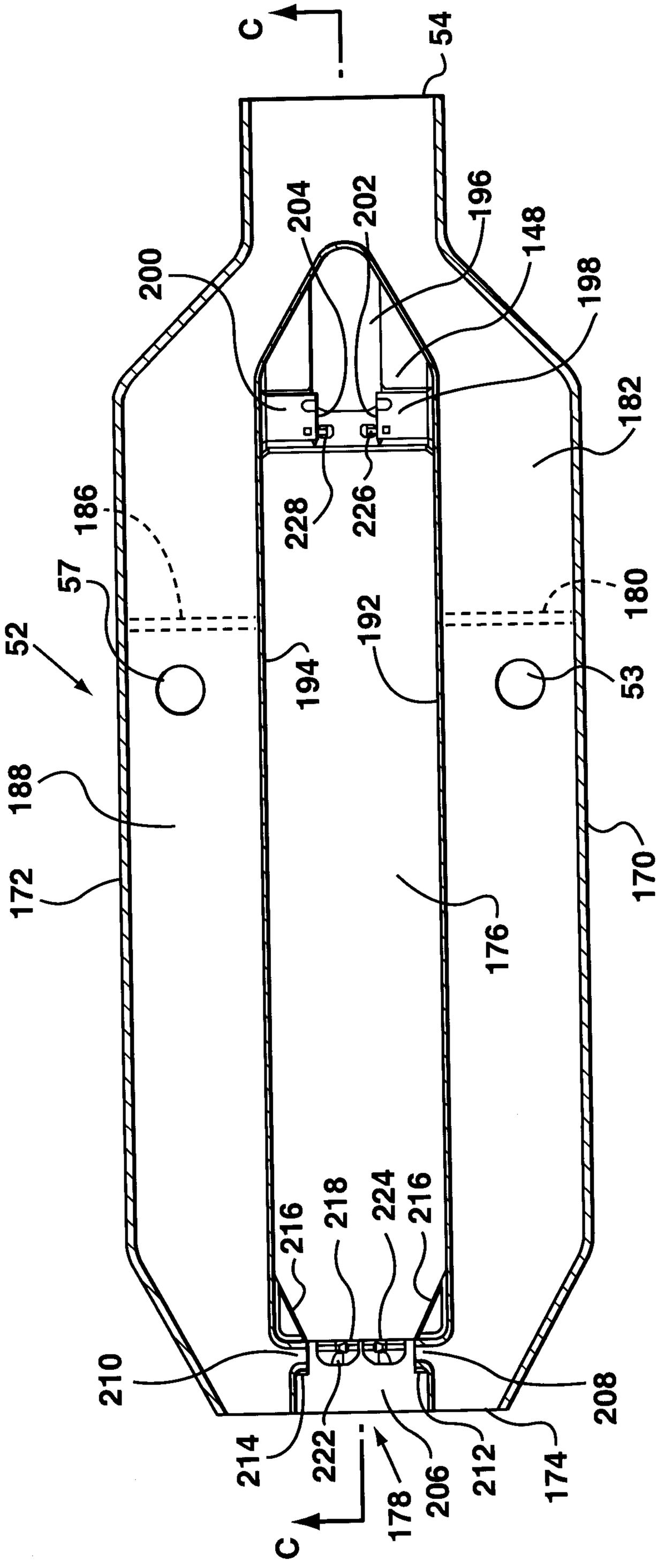
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FIG. 11

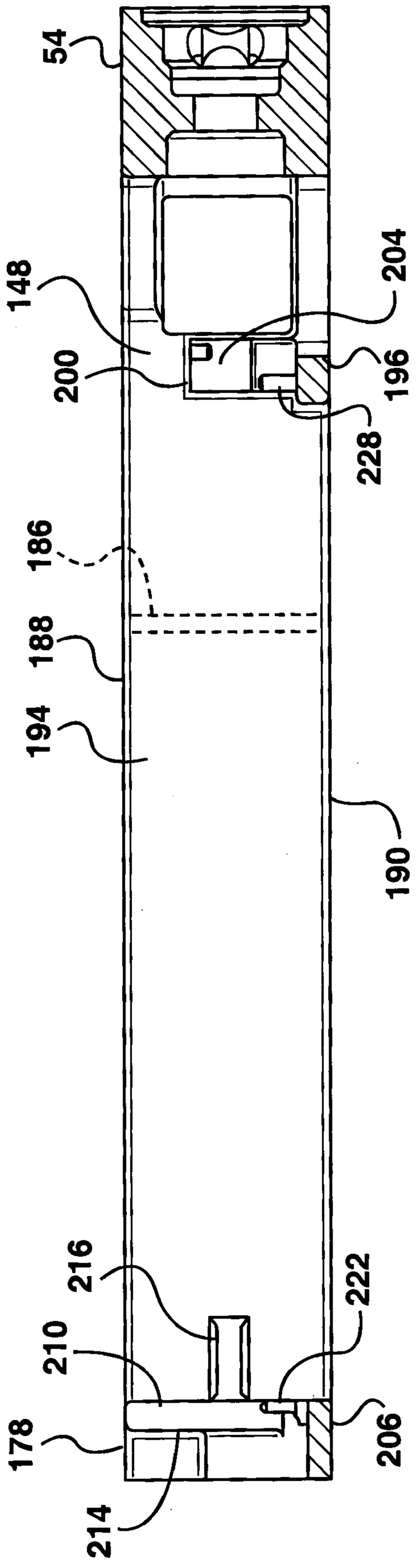


FIG. 12

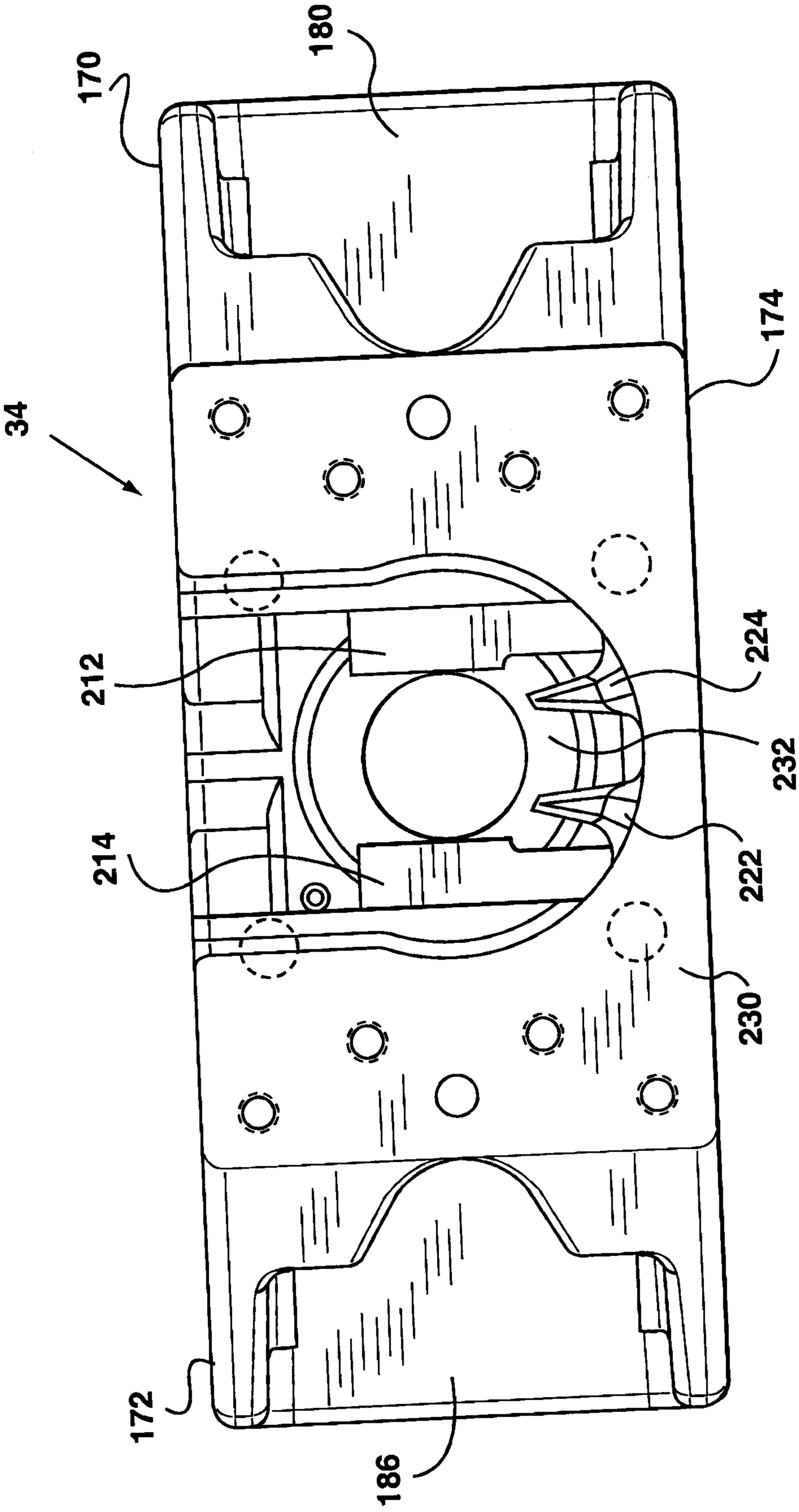


FIG. 13

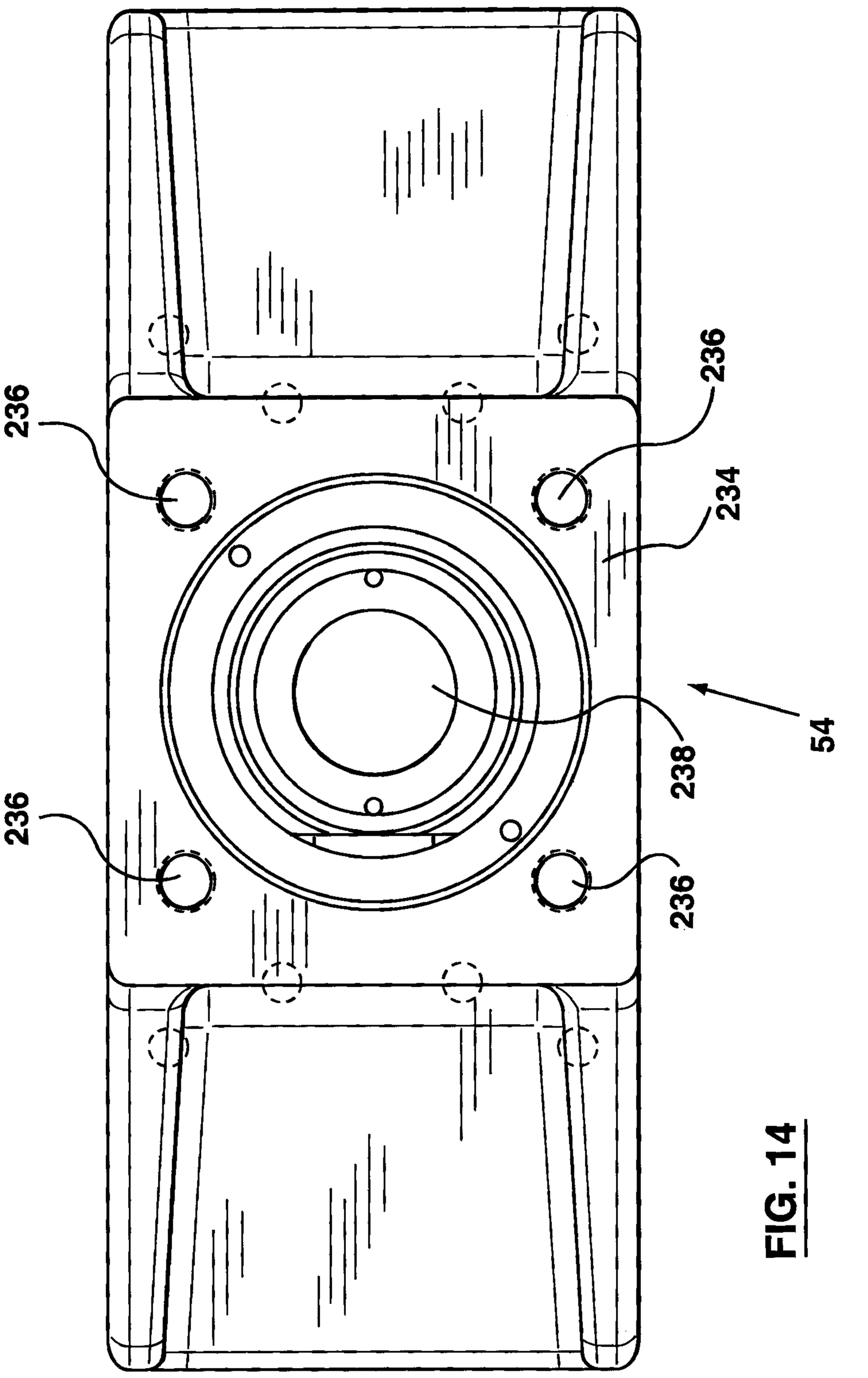


FIG. 14

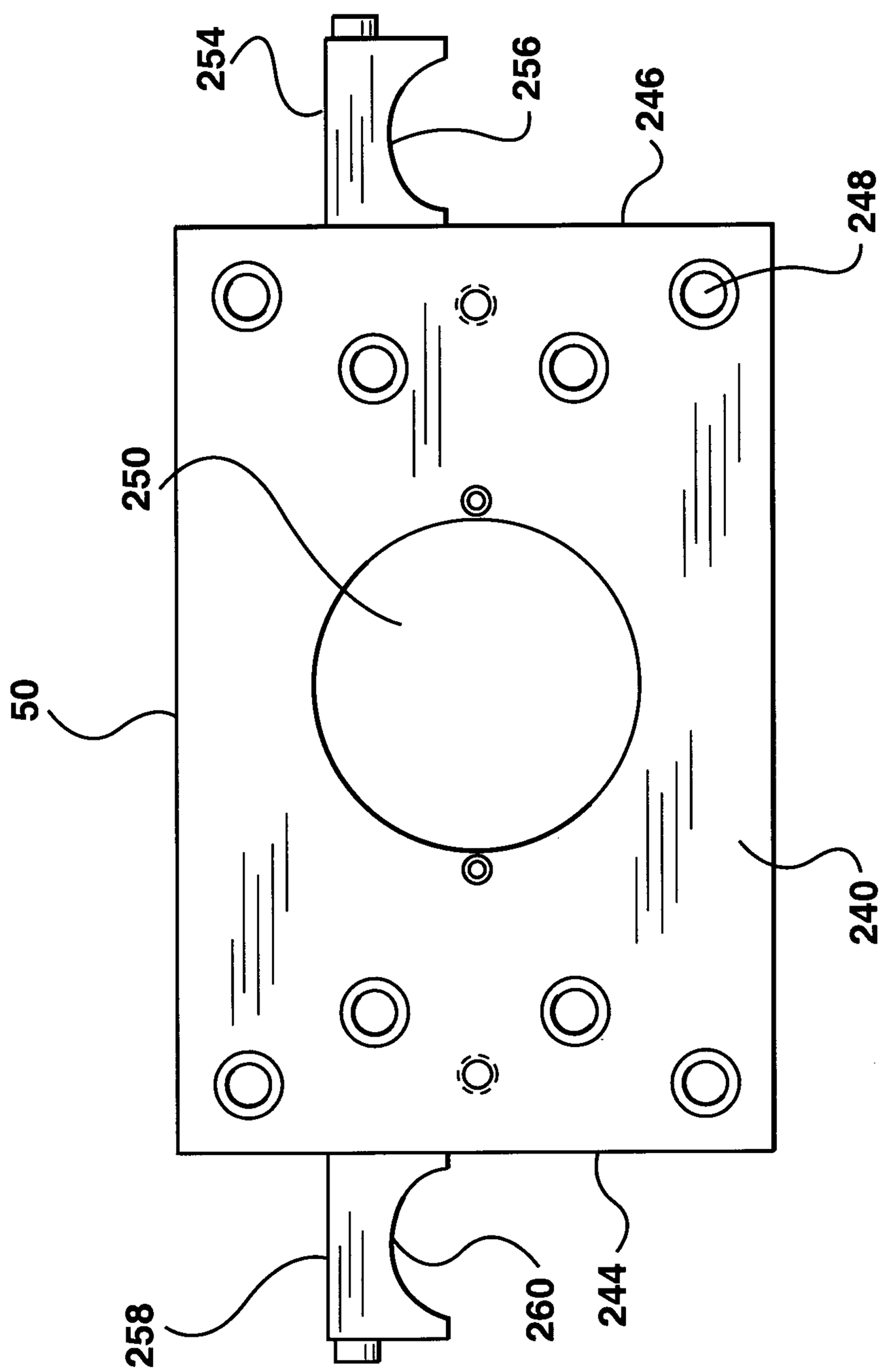


FIG. 15

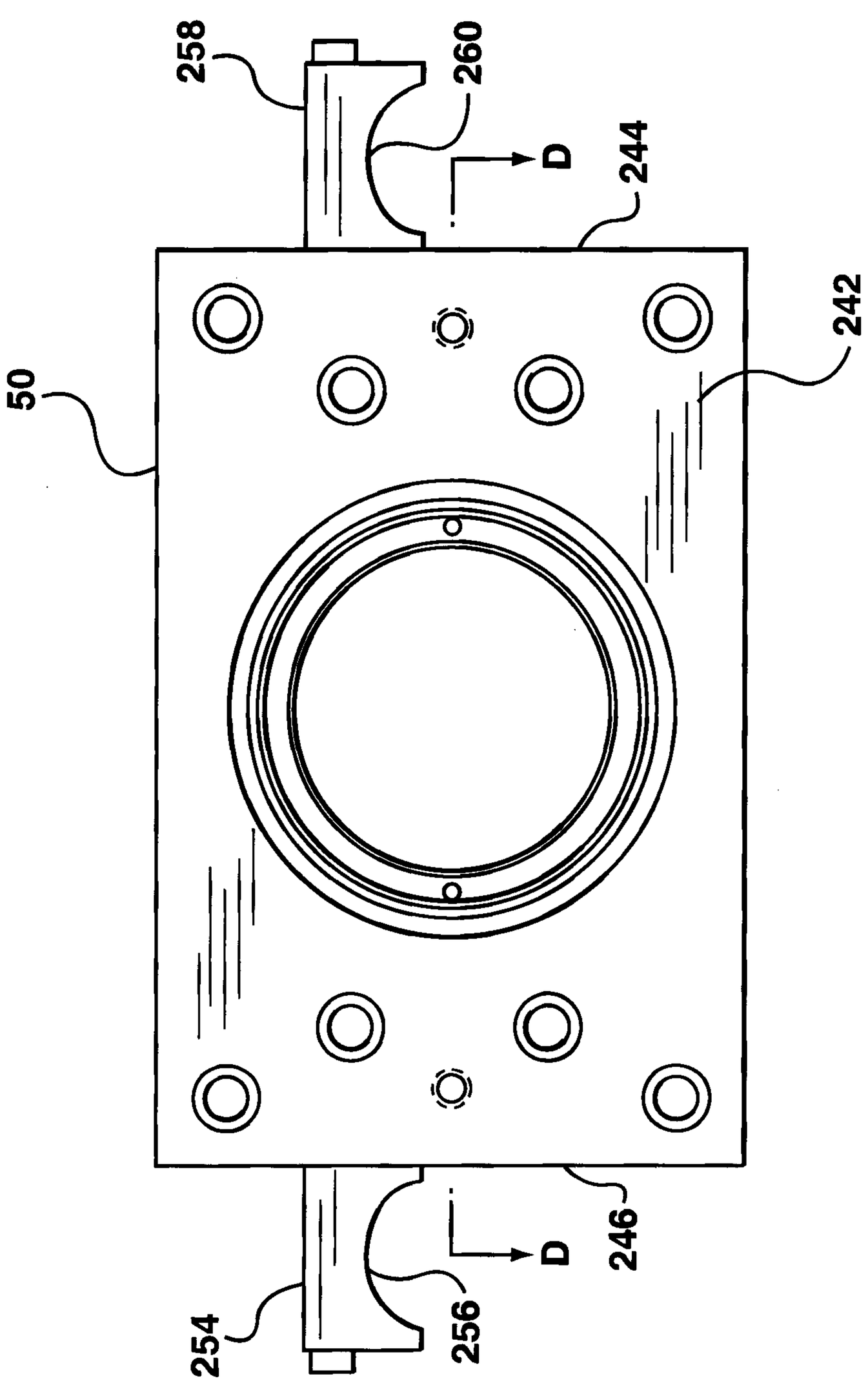


FIG. 16

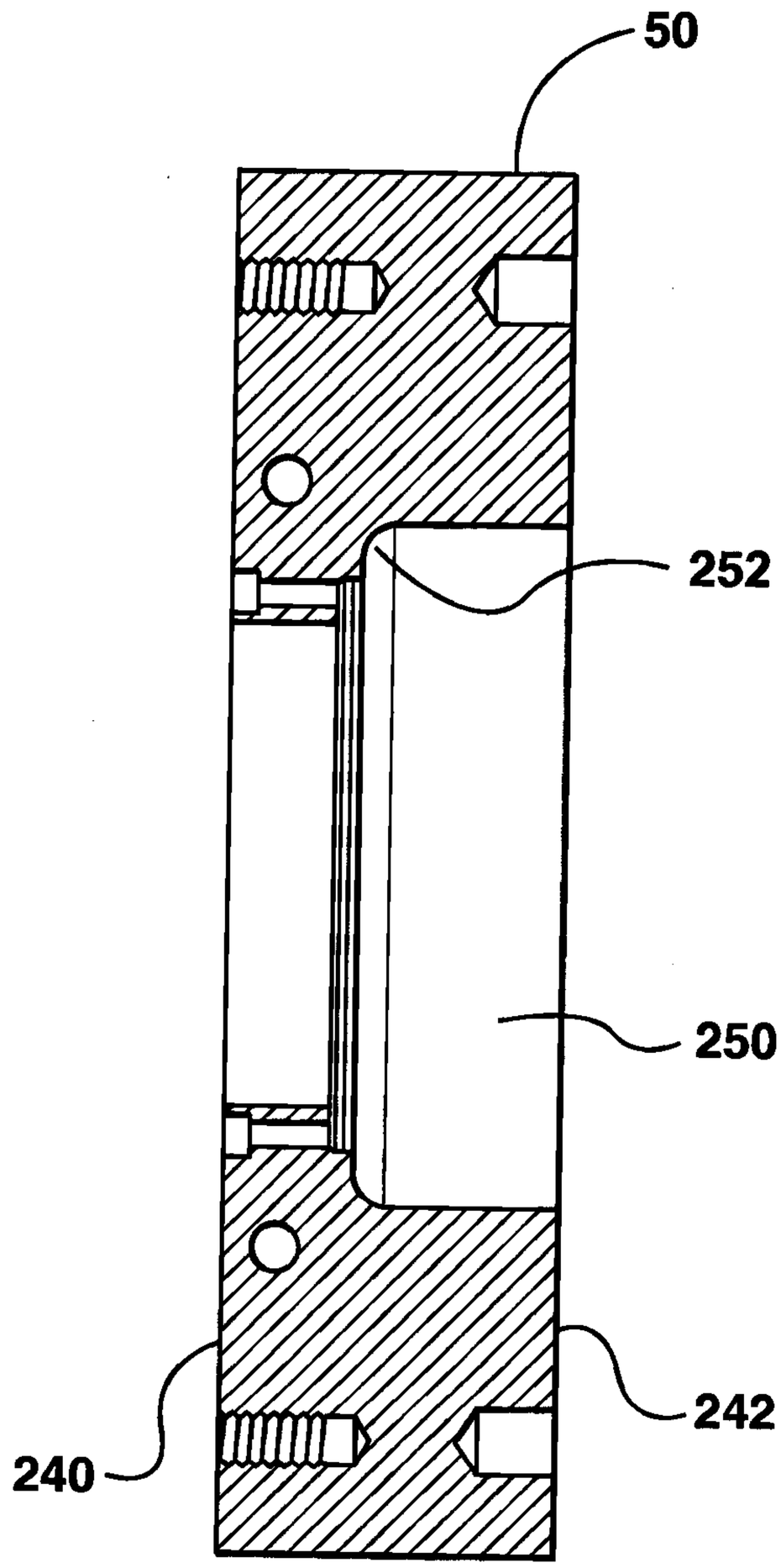


FIG. 17

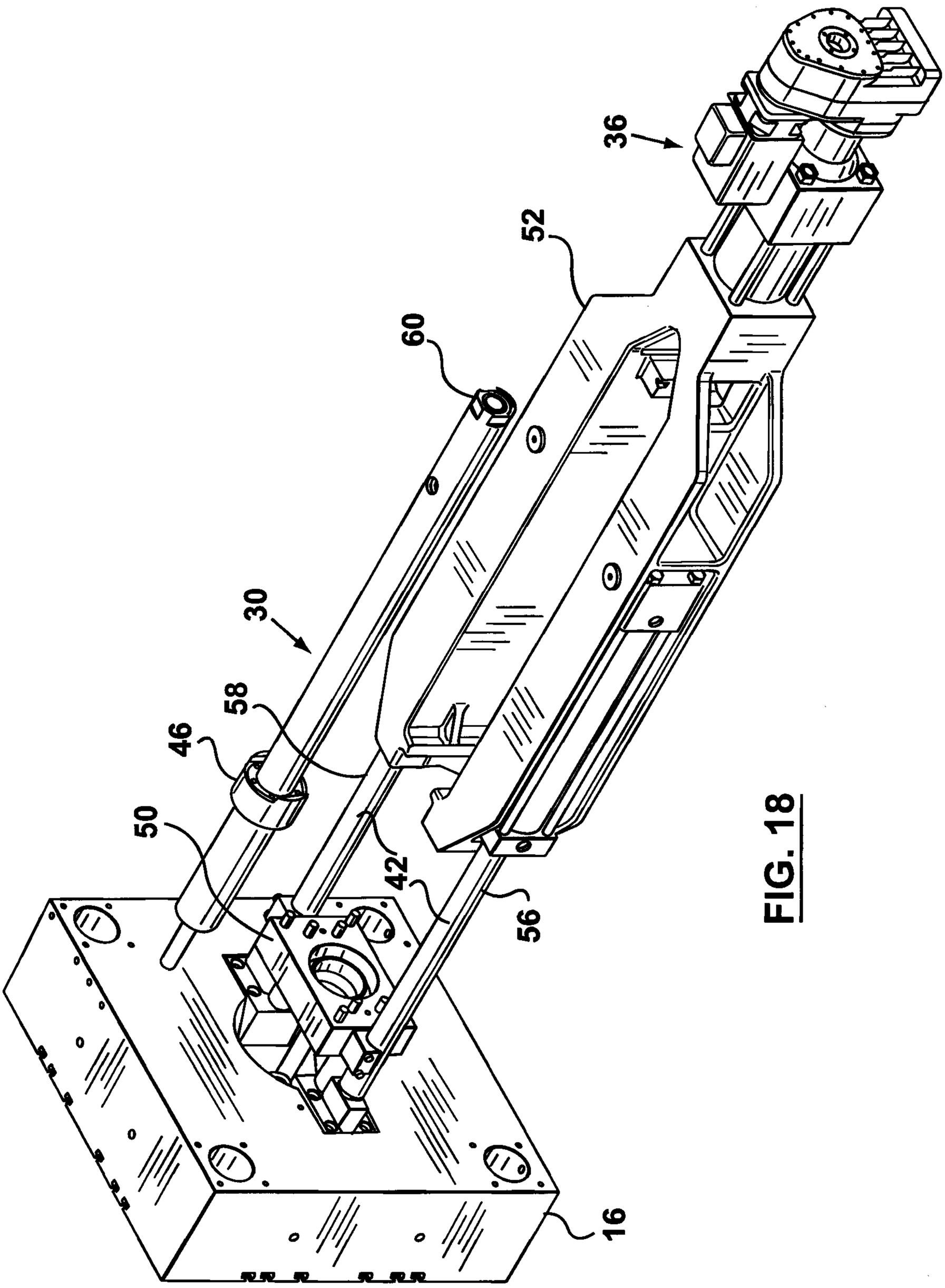


FIG. 18

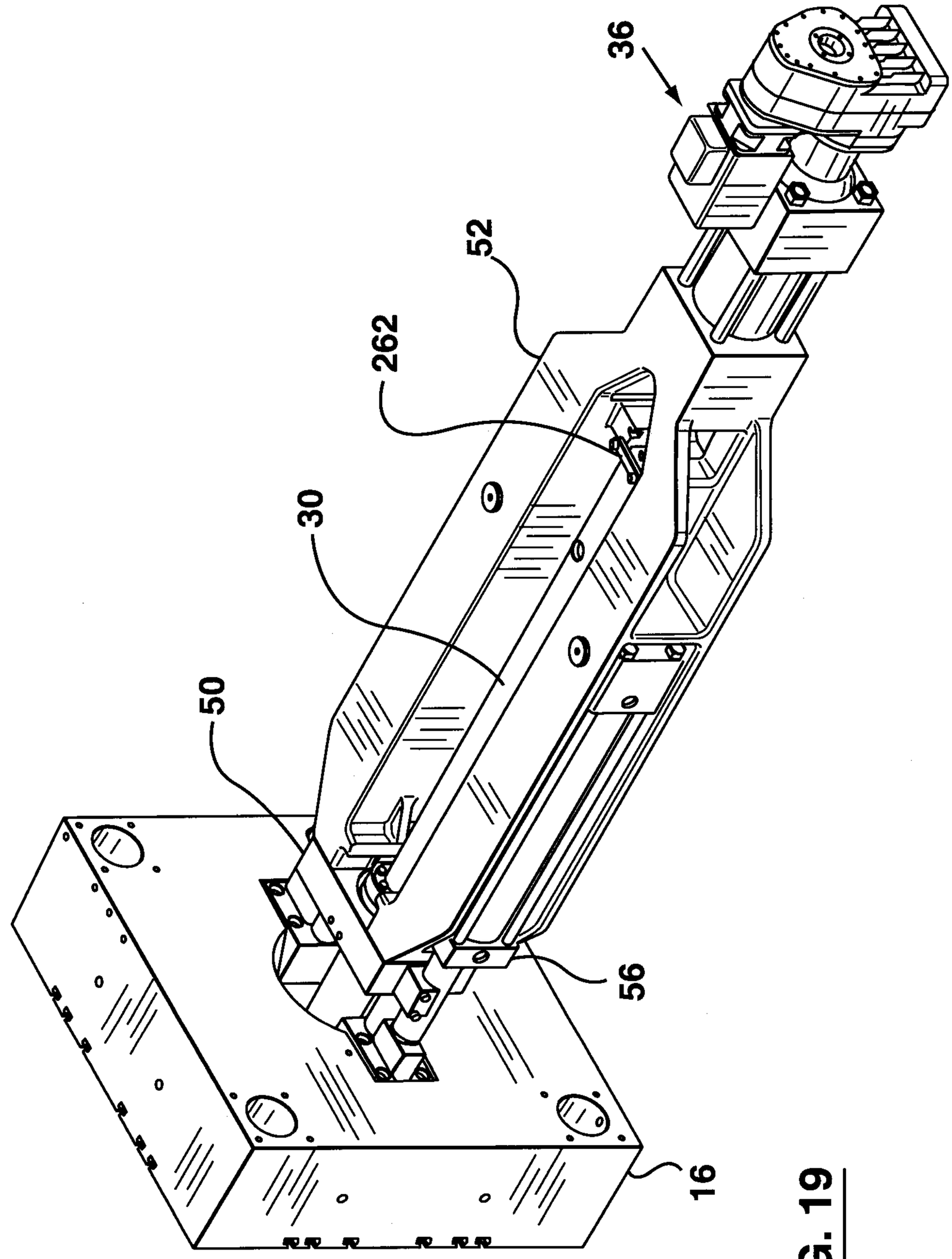


FIG. 19

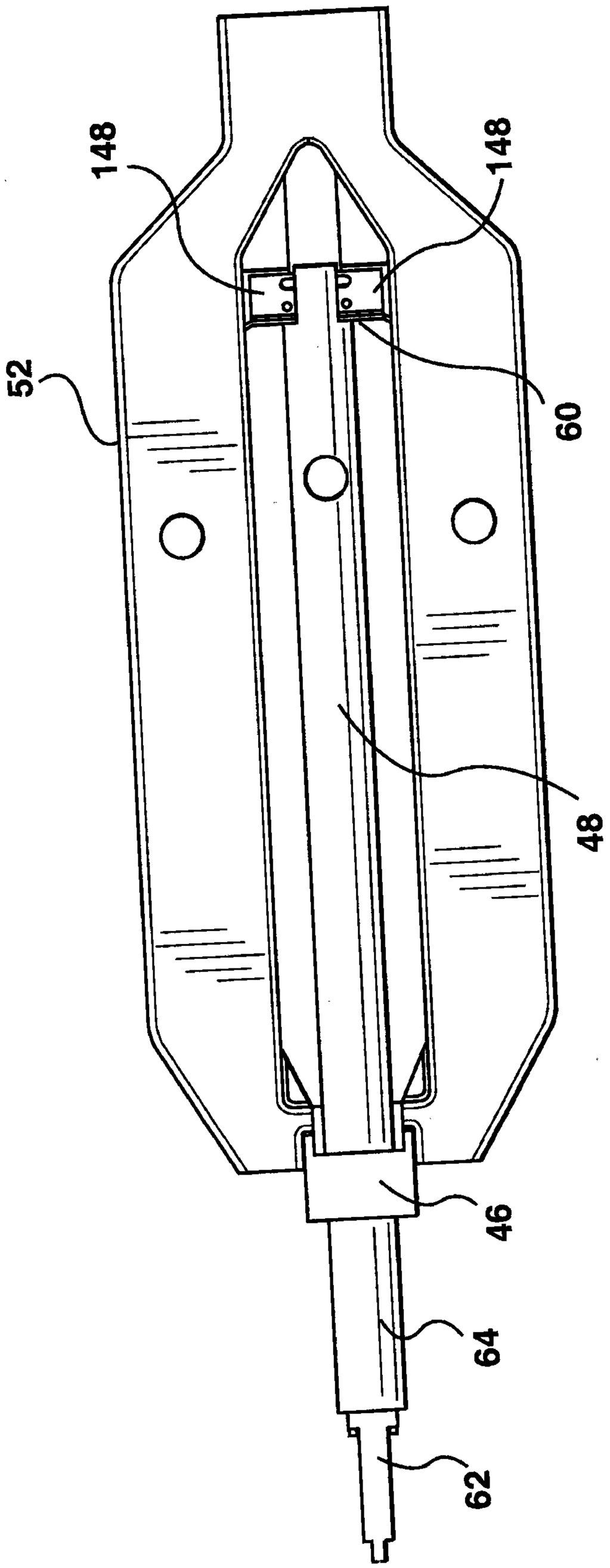


FIG. 20

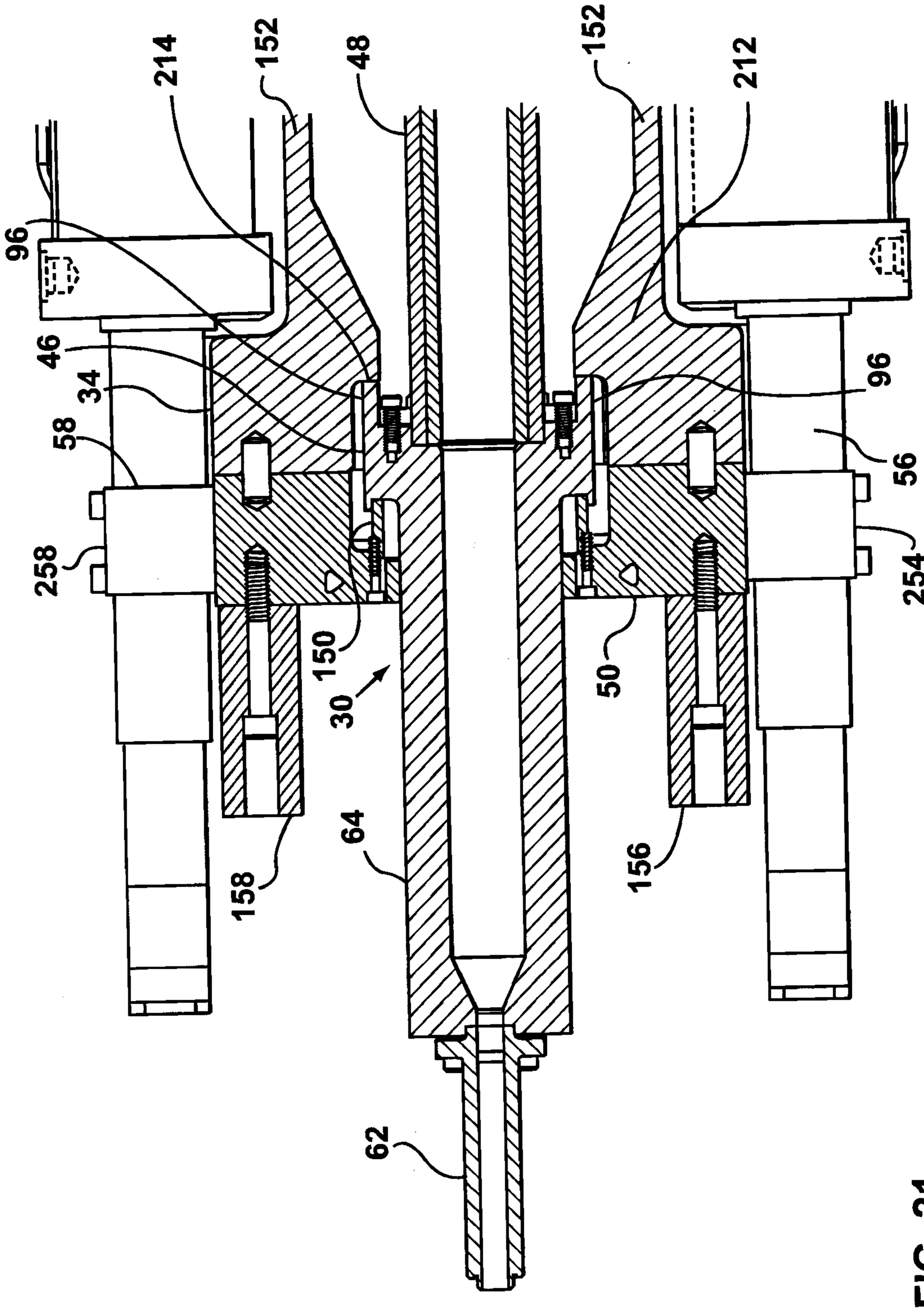


FIG. 21

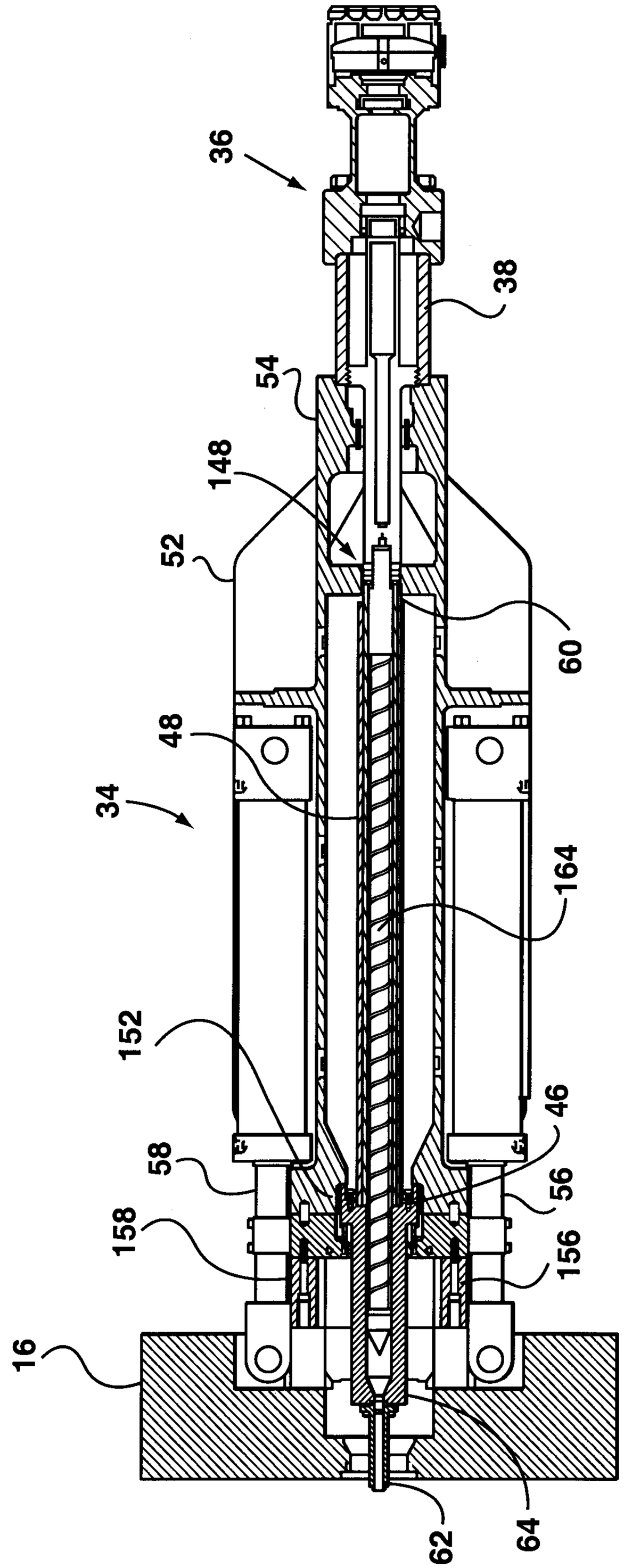


FIG. 22

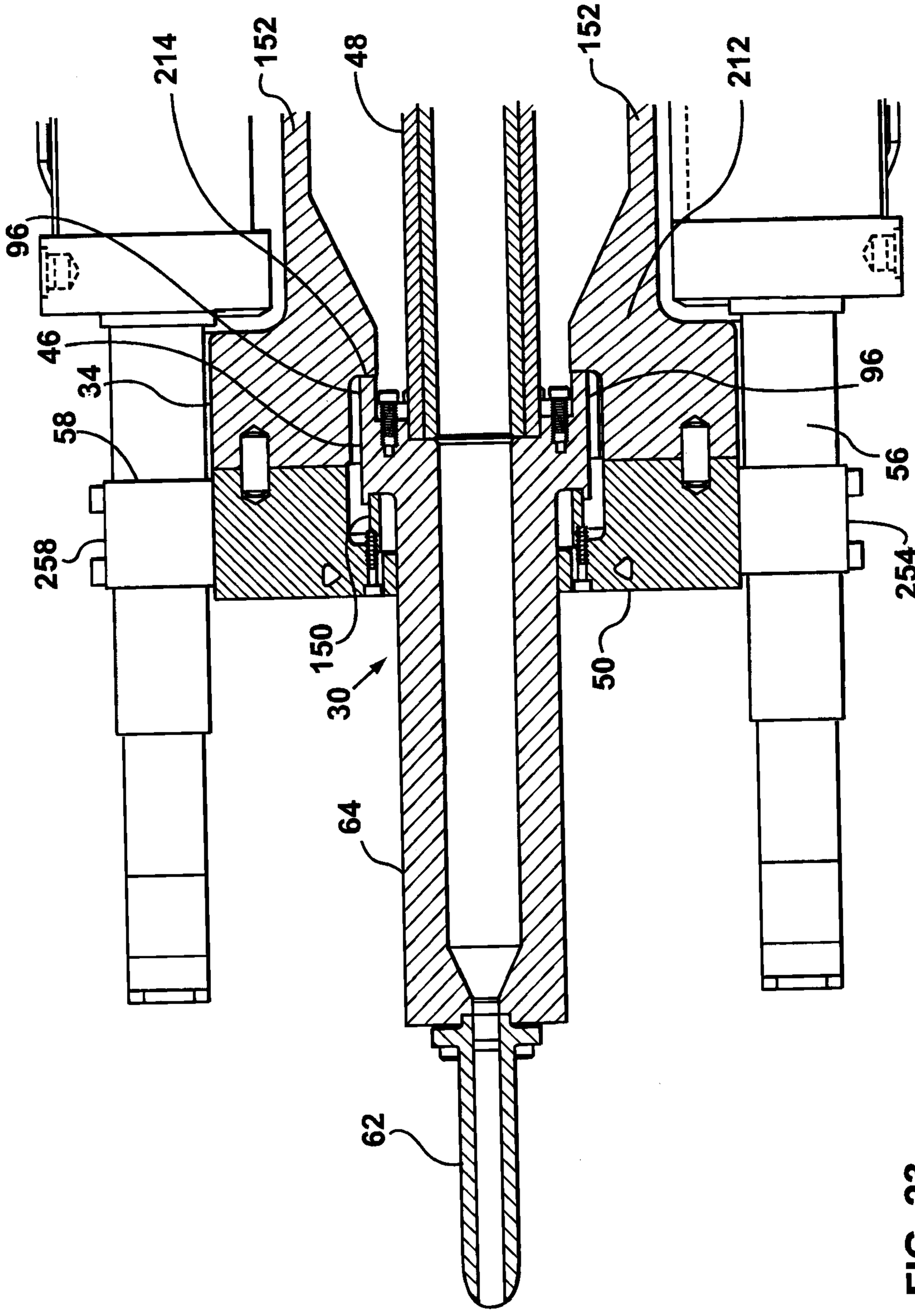


FIG. 23

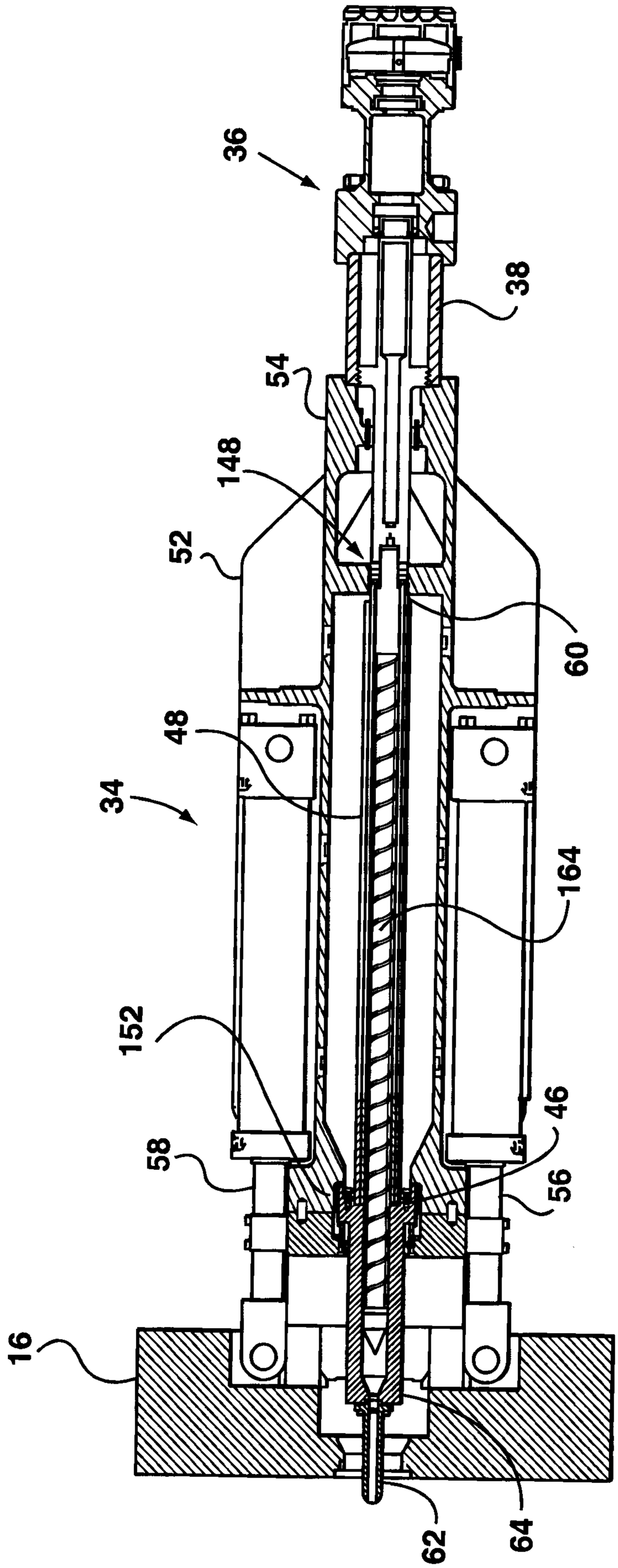


FIG. 24

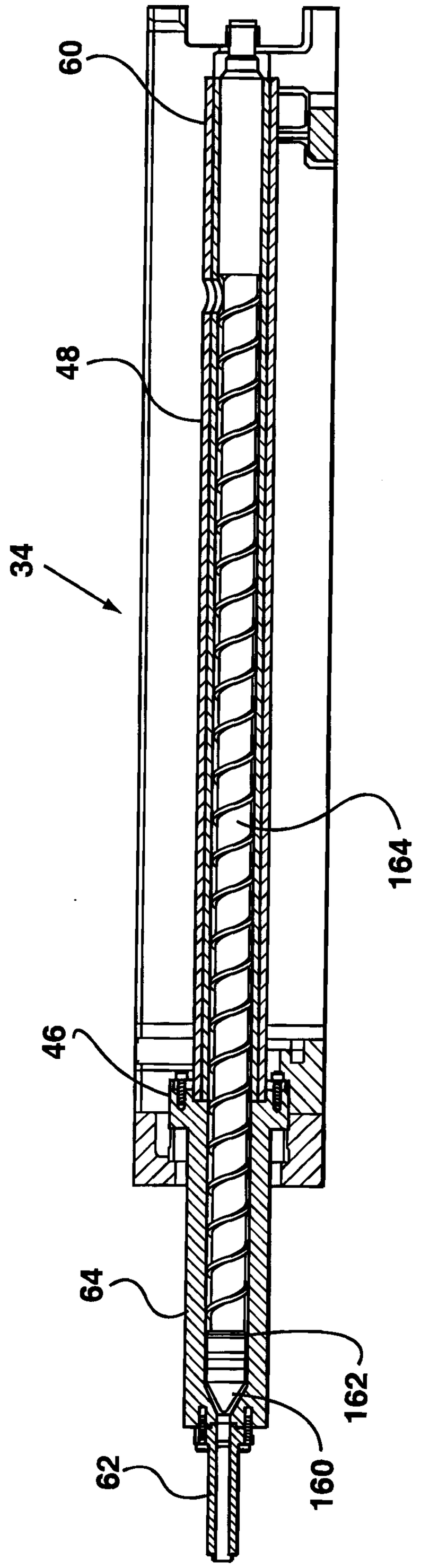


FIG. 25

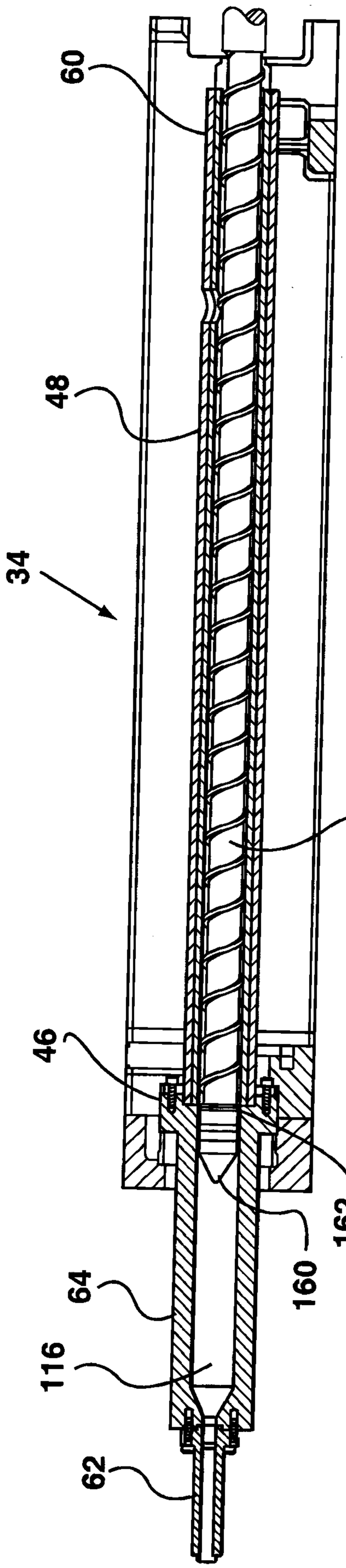
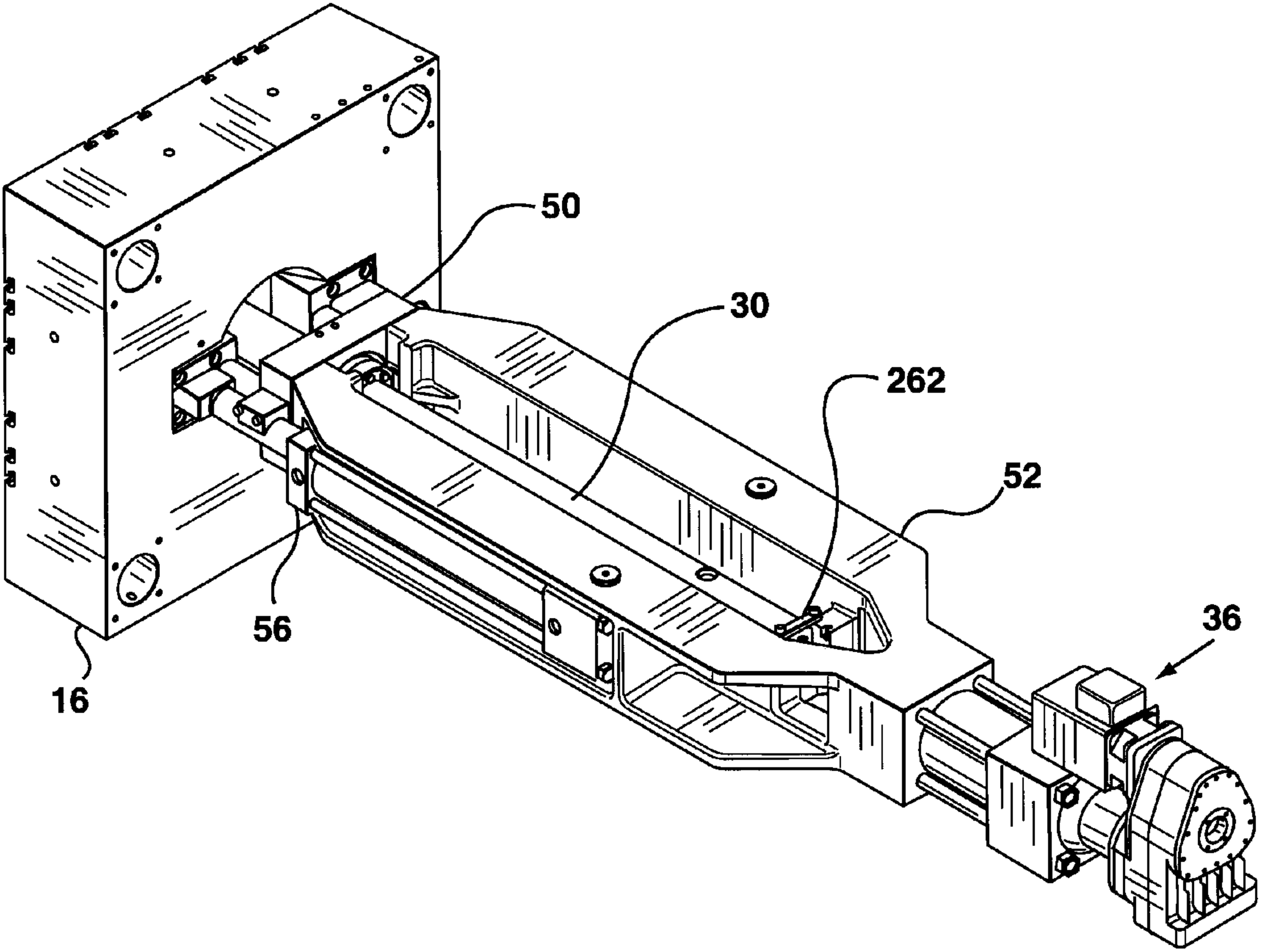


FIG. 26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