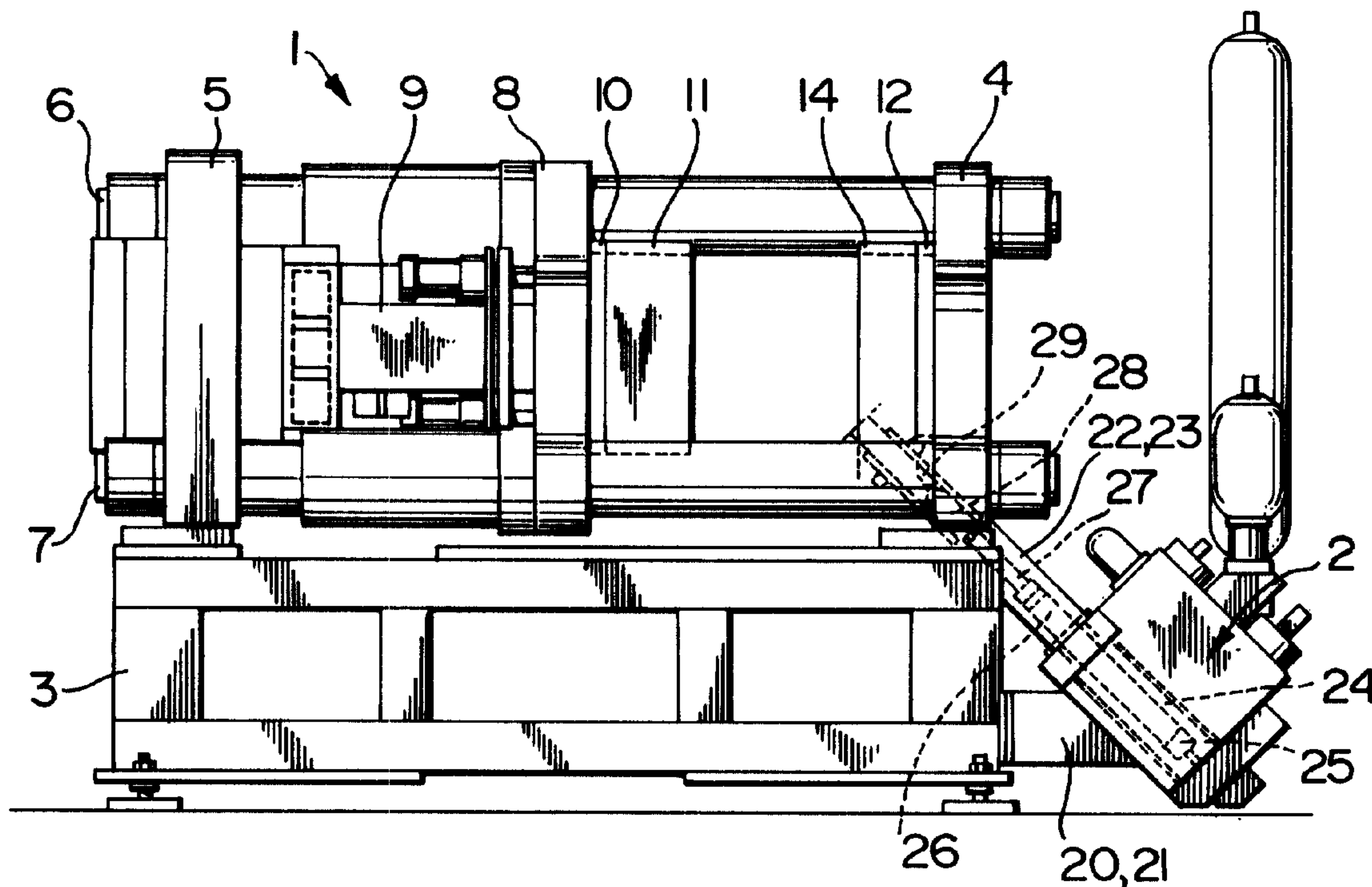




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(72) Inventeurs/Inventors:  
PERRELLA, GUIDO, CA;  
BIGLER, NICOLAS, CA  
(73) Propriétaire/Owner:  
UNICAST TECHNOLOGIES INC., CA  
(74) Agent: OGILVY RENAULT

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(54) Title: COLD CHAMBER DIE CASTING MACHINE INJECTION SYSTEM



(57) Abrégé/Abstract:

An injection unit for a cold chamber die casting machine having dies which close on a part line, the injection unit being comprised of an open upwardly inclined injection sleeve, an injection plunger, means to advance and retract the injection plunger and means to control the extent of advance or retraction of the injection plunger, the top of the injection sleeve being disposed at or proximate the part line during die casting.

ABSTRACT OF THE DISCLOSURE

An injection unit for a cold chamber die casting machine having dies which close on a part line, the injection unit  
5 being comprised of an open upwardly inclined injection sleeve,  
an injection plunger, means to advance and retract the  
injection plunger and means to control the extent of advance  
or retraction of the injection plunger, the top of the  
injection sleeve being disposed at or proximate the part line  
10 during die casting.

COLD CHAMBER DIE CASTING MACHINE INJECTION SYSTEM

5 This invention relates to an injection system for injecting metal into a die in a cold chamber die casting process.

10 The injection system includes an upwardly disposed injection sleeve having an open top which is adapted to be top filled with molten metal. The volume of the injection sleeve is varied by adjusting the lower position of the plunger in the injection sleeve. The injection system is used with a die casting machine having a fixed die attached to a fixed platen. The top of the injection sleeve is proximate or on the part line at which the dies close. The plunger in the  
15 injection sleeve is adapted to force the hot metal into the die cavity after the dies are locked.

20 An injection sleeve receiver adapted to receive the injection sleeve is connected to the fixed platen immediately below the fixed die which is also connected to the fixed platen. The injection sleeve may be withdrawn from the injection sleeve receiver for servicing and returned to the injection sleeve receiver where it remains during casting operations.

25 In another embodiment of the invention an aperture in the fixed die is substituted for an injection sleeve receiver.

In preparation for top filling the injection sleeve with molten metal, the dies are opened, the top of the injection sleeve extends into an injection sleeve receiver which is fastened to the fixed platen below the fixed die so as to

present an open cylinder adapted to receive hot metal by ladle  
or other means. The volume of the injection sleeve is  
controlled by controlling the position of the injection  
plunger in the injection sleeve. The position of the  
5 injection plunger is controlled so that the size of the metal  
shot required for a particular casting will substantially top  
up the injection sleeve when the injection sleeve is filled  
with molten metal.

The extent of retraction of the injection plunger is  
10 adjusted relative to the volume of molten metal required to  
complete the metal casting. For a large metal casting  
requiring considerable metal the injection plunger is  
retracted deeply into the injection sleeve whereas for a  
smaller casting requiring less metal the plunger is retracted  
15 less deeply into the injection sleeve. It is desirable that  
the injection sleeve be top filled by ladling or other means  
approximately to the top of the injection sleeve to minimize  
air inclusion during the casting operation.

After the injection sleeve is filled with metal the  
20 moving platen and moving die are closed on the part line,  
clamping pressure is applied to the moving platen and die, the  
injection plunger is advanced driving the molten metal through  
a runner in the face of the moving die into the cavity. When  
the casting is sufficiently solid, the injection plunger is  
25 retracted, the clamping pressure is released and the moving  
platen and die are opened. The casting and biscuit are  
simultaneously removed with the left hand die. When the dies  
are open molten metal may be ladled or otherwise transferred

into the injection sleeve prior to the next cycle.

The injection system of this invention avoids any ninety degree turns between the injection sleeve and the dies in which the casting is effected. The forcing of molten metal into the dies through a combination of turns may result in pressure drops causing the metal to cool or in the alternative introducing the molten metal at a higher temperature to allow for temperature loss. The instant injection system without any ninety degree turns between the injection sleeve and the runner or dies is consistent with maintaining a suitable time cycle per shot.

One problem in some existing die casting machines is caused by air entrapment associated with ninety degree turns between the injection sleeve and the dies in which casting is effected. Air entrapment is caused by wave fronts created as the metal approaches and travels around a ninety degree turn into the runners and cavity. Transferring molten metal around ninety degree turns also causes unwanted load losses and turbulence.

Some metals such as liquid aluminum used in cold chamber die casting are very corrosive. In prior die casting machines for casting aluminum the aluminum travelled a substantial distance before reaching the cavities in the mold. Being highly corrosive the longer the distance the liquid aluminum has to travel the greater the wear on the delivery system. In this invention the injection sleeve when in operative position is immediately adjacent the part line. The aluminum or other corrosive metal has a very short distance to travel during

injection.

In the processes of filling the injection sleeve the liquid metal is ladled, poured or otherwise transferred directly into the top of the injection sleeve which is open when the dies of the die casting machine are opened. The opening at the top of the injection sleeve is closed by the closing of the moving platen and moving die. The injection unit is disposed either below the dies or at an angle up to 15° below the horizontal centerline through the dies. The instant invention has the advantage of easy top ladling or transfer by robot of molten metal into the top opening of the injection sleeve. Metal filling of the injection sleeve close to the top of the injection sleeve results in less entrapped air in the injection sleeve when the top of the injection sleeve is closed by the moving die.

The avoidance of any ninety degree angles between the sleeve of the injection unit and the cavity of the dies results in less entrapped air.

The injection unit of the instant invention includes an injection plunger which displaces the molten metal from the injection sleeve through a short runner directly into the die cavity. The die filling is less affected by gravity than most existing machines. The injection system for a die casting machine disclosed herein has a metal to air ratio of 80/90% compared with 30% for some conventional machines.

The injection unit of the instant invention includes a temperature control system associated with the injection plunger such that the temperature of the injection plunger may

be controlled to improve the speed of each cycle and thus the speed of the machine. In the machine of this invention removal of the casting and filling of the injection sleeve can be carried out simultaneously once the dies have opened.

5           The applicant's earlier Canadian Patent Application Number 2,045,879-8 entitled Die Casting Machine disclosed an improved die casting machine which has a frame comprising two opposed fixed end platens separated by two connecting rods, a moving platen being mounted on said connecting rods. The  
10 moving platen and the opposed fixed platen have dies mounted thereon for closing and clamping prior to casting. The patent application also discloses a novel and an improved injection system in which said injection system is disposed in close  
15 proximity to the fixed die so that the injection nozzle may be inserted in the bottom portion of the fixed die below the cavity.

          The injection unit of this invention differs in important respects from the invention disclosed in the earlier application referred to above. In the invention which is the  
20 subject matter of this invention the liquid metal is ladled or otherwise transferred directly into the opening at the top of the injection unit receiver of the injection sleeve. The volume of the liquid metal which must be injected varies from casting to casting. To minimize air entrapment the bottom  
25 position of the injection plunger is adjusted so that the volume of the interior of the injection sleeve is substantially topped up with molten metal whether the casting calls for a small volume or larger volume of metal. Other

differences include temperature control of the injection plunger and temperature control of the injection sleeve. A still further difference is the projecting shape of the injection plunger head which is so shaped as to reduce the size of the biscuit left cooling in the top of the injection sleeve when the casting is cooled. The injection plunger is retracted as soon as the metal has solidified. The biscuit cooling on the top of the injection sleeve remains attached to the runner and casting and is removed from the part line with the withdrawal of the moving platen and moving die. The biscuit and runner are subsequently trimmed from the casting during the trimming operation. The fact that the biscuit is limited in size and is removed with the moving die leaves the top of the injection sleeve free of debris and ready for filling for the next shot.

One embodiment of the invention is an injection unit for a cold chamber die casting machine having a part line on which the dies meet, the injection unit being comprised of an open upwardly inclined injection sleeve, an injection plunger, means to advance and retract the injection plunger and means to control the extent of retraction of the injection plunger, the top of the injection sleeve being disposed at or proximate the part line.

Another embodiment of the invention is an injection unit for a cold chamber die casting machine having a part line on which the dies meet, the injection unit being comprised of an open upwardly inclined injection sleeve, an injection plunger, means to advance and retract the injection plunger and means

to control the extent of retraction of the injection plunger, the top of the open upwardly inclined injection sleeve being disposed at the part line, the bottom of the stroke of the injection plunger is within the injection sleeve and is  
5 adjusted to enable the injection sleeve to be substantially filled to the top with molten metal when the dies are open.

A further embodiment of the invention is an injection unit for a cold process die casting machine having a part line on which the dies meet, an injection unit receiver mounted  
10 below one of the dies on the part line, the injection unit being comprised of an open upwardly inclined injection sleeve, an injection plunger, means to advance and retract the injection plunger and means to control the extent of retraction of the injection plunger, the injection sleeve is  
15 open and upwardly disposed, an injection unit receiver mounted below the fixed die on the part line adapted to receive the upwardly inclined injection sleeve of the injection unit.

Another embodiment of the invention is an injection unit for a cold chamber die casting machine having a fixed die with  
20 an upwardly inclined aperture therein and a moving die, the upwardly inclined aperture in the fixed die is adapted to receive the upwardly inclined injection sleeve of the injection unit in the aperture therein

In still a further embodiment of the invention there is  
25 provided an injection chamber for a cold process die casting machine having a part line on which the dies meet, the injection unit comprised of an open upwardly inclined injection sleeve, an injection plunger and means to advance

and retract the injection plunger, an injection unit receiver mounted below the fixed die on the part line adapted to receive the upwardly inclined injection sleeve of the injection unit, in which the moving die closes on the fixed die and the injection unit receiver prior to the advance of the injection plunger of the injection unit.

The invention also relates to a method of injecting molten metal in a cold chamber die casting machine having a moving die and a fixed die, the fixed die fastened to a fixed platen, the fixed die and moving die meeting on the part line, an injection sleeve having a retractable plunger therein disposed at a vertical or inclined angle at or proximate the part line, the retractable plunger being adapted to receive or dispel molten metal therefrom, the method comprising the steps of

(a) opening the moving die sufficiently to fill the injection sleeve at the part line substantially to the top with molten metal,

(b) closing the moving die on the fixed die and top of the injection sleeve,

(c) operating the injection plunger to inject the molten metal into the dies.

In the drawings:

Figure 1 is a side elevation view of a cold chamber die casting machine with an injection unit connected to the end of the machine to which the fixed platen and fixed die are  
5 connected.

Figure 2 is a perspective view of the injection unit connected to the machine base at one end of the cold chamber die casting machine.

Figure 3 is a cross-sectional view along the longitudinal centerline of the injection unit showing the injection plunger in open position adapted to receive hot liquid metal.  
10

Figure 4 is a cross-sectional view along the longitudinal centerline of the top of injection unit showing the relationship of the injection unit to the closed left and right hand side dies during the injection step.  
15

Figure 5 is a cross-sectional view along the longitudinal centerline of the injection unit showing a protruding cooled nose extending from the face of the left hand side die in close proximity to an injection plunger with a flat face.  
20

Figure 6 is a perspective view of a 4-tie bar cold chamber die casting machine with toggles.

Figure 7 is a cross-sectional view through a cold chamber die casting machine in which the injection unit is disposed in a bevel sleeve in an aperture in the base of the fixed die.  
25

Referring to Figure 1, there is shown a cold chamber die casting machine 1 with an injection unit 2 mounted on the right hand end of the cold chamber die casting machine 1. The cold chamber die casting machine 1 is comprised of a die

casting machine base 3. A fixed right hand platen 4 is mounted towards the right hand end of die casting machine base 3 and a fixed left hand side platen 5 is mounted above the left hand end of die casting machine base 3. The fixed right and left hand platens 4, 5 have rods 6,7 mounted therethrough. A moving platen 8 is mounted on rods 6, 7 for movement towards the fixed right hand platen 4 or withdrawal from fixed right hand platen 4. The moving platen 8 is moved towards fixed left hand side platen 5 or withdrawn from fixed left hand side platen 5 by hydraulics, toggles or other mechanical means known in the art represented by number 9. Cooling base 10 and moving die 11 are mounted on moving platen 8. Fixed platen cooling base 12 and fixed die 14 are mounted on fixed right hand side platen 4.

As seen in Figures 1 and 2 injection unit 2 is mounted by front and rear brackets 20, 21 and injection unit support arms 22, 23 to the right hand end of die casting machine base 3 and fixed right hand side platen 4 respectively.

The injection unit 2 is comprised of an injection cylinder 24 having a piston 25 mounted near the base of the injection cylinder 24 for movement of the injection plunger 28 towards and away from the fixed right hand side platen 4, cooling base 12 and fixed die 14. A piston rod 26 is connected at one end to the piston 25 and at the other end to the piston rod - injection plunger connecting link 27. the piston rod - injection plunger connecting link 27 is connected at its upper end to injection plunger 28.

As seen in Figure 1, the moving die 11 is mounted on

cooling base 10 which in turn is mounted on moving platen 8. As seen in Figure 4, the face of moving die 11 closes on the part line immediately prior to injection, during injection and until the injected metal solidifies sufficiently to withdraw the moving platen 8, cooling base 10 and moving die 11 away from the fixed die 14 mounted on fixed platen cooling base 12. The face of moving die 11 attached to cooling base 10 attached to the moving platen 8 includes a runner 30 through which the molten metal 31 travels to the cavity 32 remaining between moving die 11 and fixed die 14.

Figure 5 discloses an injection plunger 28 having a flat face as opposed to the nose of the injection plunger 28 shown in Figure 4. The left hand die 11 has a protruding cooled nose 37 which extends across the part line between the left hand die 11 and right hand die 14 when the dies are closed. When the dies are opened after the casting has solidified, the casting, runner and biscuit 35 are withdrawn with the left hand die 11 which is connected to the left side moving platen 8.

Referring to Figure 4, the fixed die 14 terminates at a downwardly inclining angle adapted to receive injection unit receiver 33 which may be fastened to and removed from the downwardly inclined base of fixed die 14. Injection unit receiver 33 has a cylindrical opening 34 adapted to receive injection sleeve 29 forming the outside portion of the injection unit 2.

Referring to Figure 7, a fixed die is disclosed which has a cylindrical opening 34 adapted to receive injection sleeve

29 forming the top part of the injection unit 2. The injection sleeve 29 shown in Figure 7 extends close to the face of fixed die 14. The fixed die of Figure 7 differs from the fixed die of Figure 4 in that the fixed die of Figure 7 does not have a lower downwardly inclined base adapted to receive an injection unit receiver 33 as shown in Figure 4.

Referring to Figure 4 the injection sleeve 29 may be withdrawn from the opening 34 in the injection unit receiver 33 if the piston injection sleeve 29, piston 25, piston rod 26 or piston rod-injection plunger connecting link 27 require adjustment or repair. Likewise the injection sleeve 29 may be removed from the cylindrical opening 34 in fixed die 14. The range of movement of piston 25 in injection cylinder 24 is adjusted with each die so as to reduce air at the top of the injection sleeve 29 to a minimum during filling of the injection sleeve 29 with molten metal and secondly to limit the size of the biscuit 35 remaining above the injection plunger 28 when the casting 36 cools.

While the injection unit 2 is shown in Figures 1 to 3 mounted on the right hand end of the cold chamber die casting machine 1 in such a manner that the injection unit 2 extends upwardly at forty-five degrees relative to the right hand end of the cold chamber die casting machine 1, it will be appreciated by those skilled in the art that the angle of the injection unit 2 relative to the dies may extend from vertical, where the injection power unit 2 would be located under the part line on which the moving die 11 and the fixed die 14 meet anywhere up to approximately  $20^{\circ}$  relative to

horizontal where the benefits of gravity and control of air entrapment are greater.

As seen in Figures 1 and 3 the moving platen 8 is withdrawn from the fixed right hand side platen 4. The top of the injection sleeve 29 is open at the part line and adapted to receive molten metal. The injection plunger 28 has been withdrawn within the injection sleeve to a position such that when the injection sleeve 29 is filled with molten metal the injection sleeve 29 will be substantially topped up with metal decreasing air entrapment during the injection cycle. When the injection sleeve 29 is filled, the moving left hand side platen is moved towards the part line until the moving die 11 closes on the fixed die 14 as shown in Figure 4. Following the closing of the moving die 11 and fixed die 14 the dies are clamped shut prior to injection of the molten liquid. After clamping the injection plunger 28 is advanced towards the part line driving the molten liquid in the injection sleeve 29 into the runner 30 and cavity 32 between the moving die 11 and the fixed die 14. When the molten liquid has solidified into a casting, the left side moving platen 8 is withdrawn from the part line. The casting, runner and biscuit 35 are withdrawn with the moving die 11 which is connected to the left side moving platen 8. The casting, runner and biscuit 35 are subsequently removed from the moving die 11 and runner 30 by ejection pins prior to commencement of the next cycle. The injection plunger 28 is withdrawn within injection sleeve 29 prior to the addition of molten metal to the injection sleeve 29 as part of the next cycle.

While the injection power unit has been described herein with respect to a cold chamber die casting machine 1 having a fixed platen and a moving platen, it will be recognized by those skilled in the art that the power injection unit of this invention may be adapted for use with any cold chamber die casting machines which have been suitably adapted without departing from the scope of the invention.

5

10

## CLAIMS

1. A method of injecting molten metal into a cold chamber die casting machine using an injection unit,

the top filling injection unit consisting of an open upwardly inclined injection sleeve, an injection plunger, an injection plunger-piston rod connecting link, a piston rod, a piston and a hydraulic cylinder,

the injection plunger being connected by the injection plunger-piston rod connecting link to the piston rod, the piston rod is connected to the piston located in the hydraulic cylinder,

the injection plunger located within the upwardly inclined injection sleeve having an upper injecting position and a retracted filling position within the open upwardly inclined injection sleeve,

the upwardly inclined injection position being proximate the top of the upwardly inclined injection sleeve,

the lower retracted filling position of the injection plunger located within the upwardly inclined injection sleeve being adjustable to any desired retracted filling position within the upwardly inclined injection sleeve,

characterized by selecting a lower retracted filling position of the injection plunger in the upwardly inclined injection sleeve,

filling the space in the inclined injection sleeve above the injection plunger with molten metal substantially completely, and

moving the injection plunger upwardly in the injection sleeve to the injection position proximate the top of the injection sleeve forcing the molten metal into the cold chamber die casting machine.

2. A top filling injection unit for a cold chamber die casting machine, the top filling injection unit consisting of an open upwardly inclined injection sleeve, an injection plunger, an injection plunger-piston rod connecting link, a piston rod, a piston and a hydraulic cylinder,

the injection plunger being connected by the injection plunger-piston rod connecting link to the piston rod, the piston rod is connected to the piston located in the hydraulic cylinder,

characterized by the injection plunger located within the upwardly inclined injection sleeve having an upper injecting position and a lower retracted filling position within the open upwardly inclined injection sleeve,

the upwardly inclined injection position being proximate the top of the upwardly inclined injection sleeve,

the lower retracted filling position of the injection plunger located within the upwardly inclined injection sleeve being adjustable to any desired retracted filling position within the upwardly inclined injection sleeve.

3. The top filling injection unit for a cold chamber die casting machine of claim 2, in which the top of the injection plunger has an upwardly and outwardly extending surface.

4. A cold chamber die casting machine having a top filling injection unit, a fixed platen, a moving platen, a fixed die half, a moving die half, and a part line on which the moving die half and the fixed die half meet,
- the fixed die half is mounted on the fixed platen and the moving die half is mounted on the moving platen,
- the top filling injection unit consisting of an open upwardly inclined injection sleeve, an injection plunger, an injection plunger-piston rod connecting link, a piston rod, a piston and a hydraulic cylinder,
- the injection plunger located in the injection sleeve being connected by injection plunger-piston rod connecting link to the piston rod, the piston rod is connected to the piston located in the hydraulic cylinder,
- an aperture defining an upward opening in the fixed die half,
- the injection sleeve located in the aperture defining the upward opening in the fixed platen,
- the injection plunger located within the upwardly inclined injection sleeve having an upper injecting position and a lower retracted filling position within the open upwardly inclined injection sleeve,
- the upwardly inclined injection position being proximate the top of the upwardly inclined injection sleeve,
- the lower retracted filling position of the injection plunger located within the upwardly inclined injection sleeve being adjustable to any desired retracted filling position within the upwardly inclined injection sleeve.

5. The cold chamber die casting machine of claim 4 having a fixed die half and an injection unit receiver, the injection unit receiver fastened to the base of the fixed die half, an aperture defining an upwardly inclined passage in the injection unit receiver, the injection sleeve disposed in the aperture defining the upwardly inclined passage in the injection unit receiver.
6. The cold chamber die casting machine of claim 4 in which the injection sleeve is disposed between a vertical position and a position 45° from vertical.
7. The cold chamber die casting machine of claim 4 in which the nose of the injection plunger inclines forwardly and upwardly.
8. The cold chamber die casting machine of claim 6 in which the moving die half has a protruding nose which extends over the part line when the die halves are clamped.

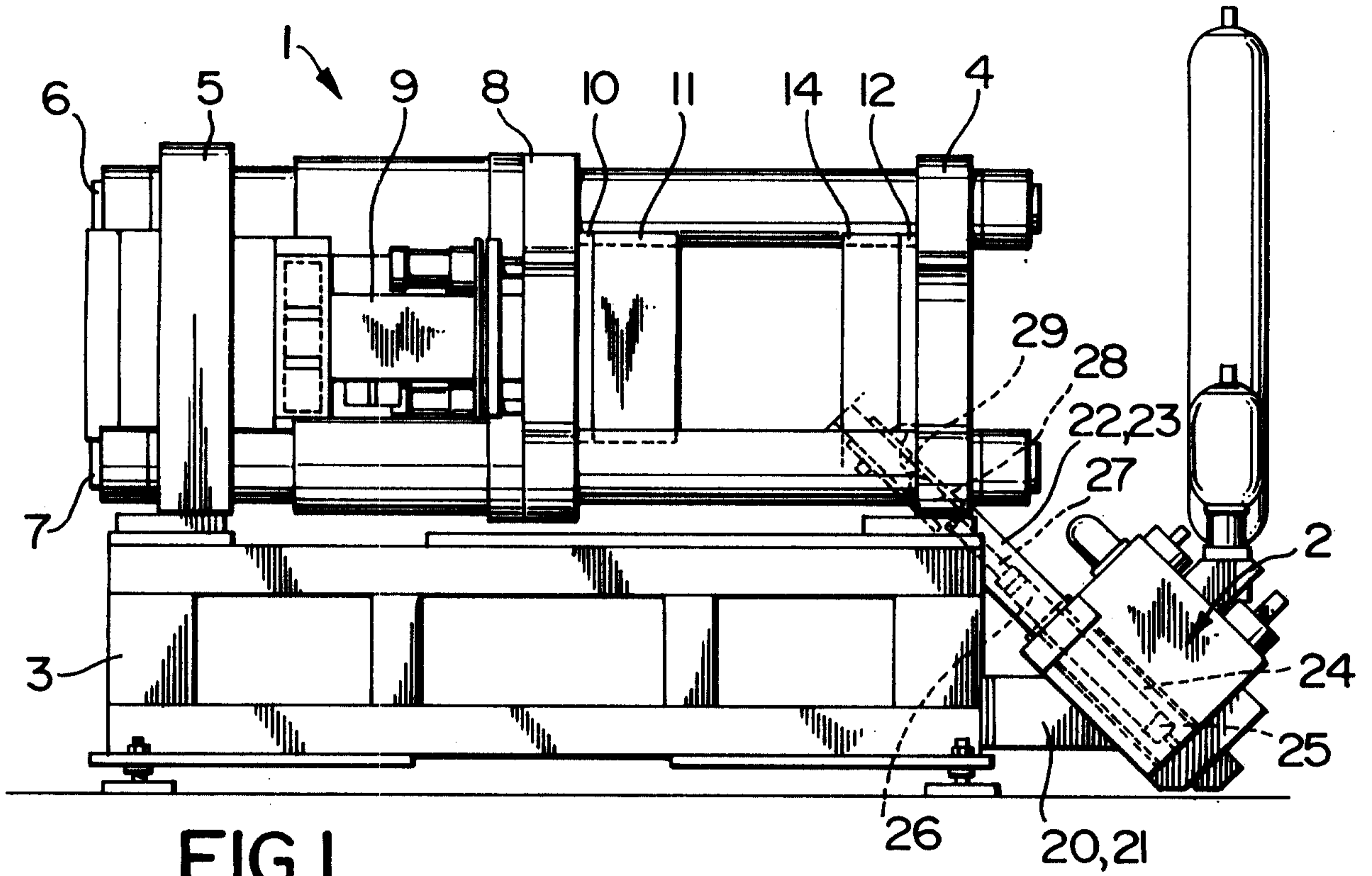


FIG. 1

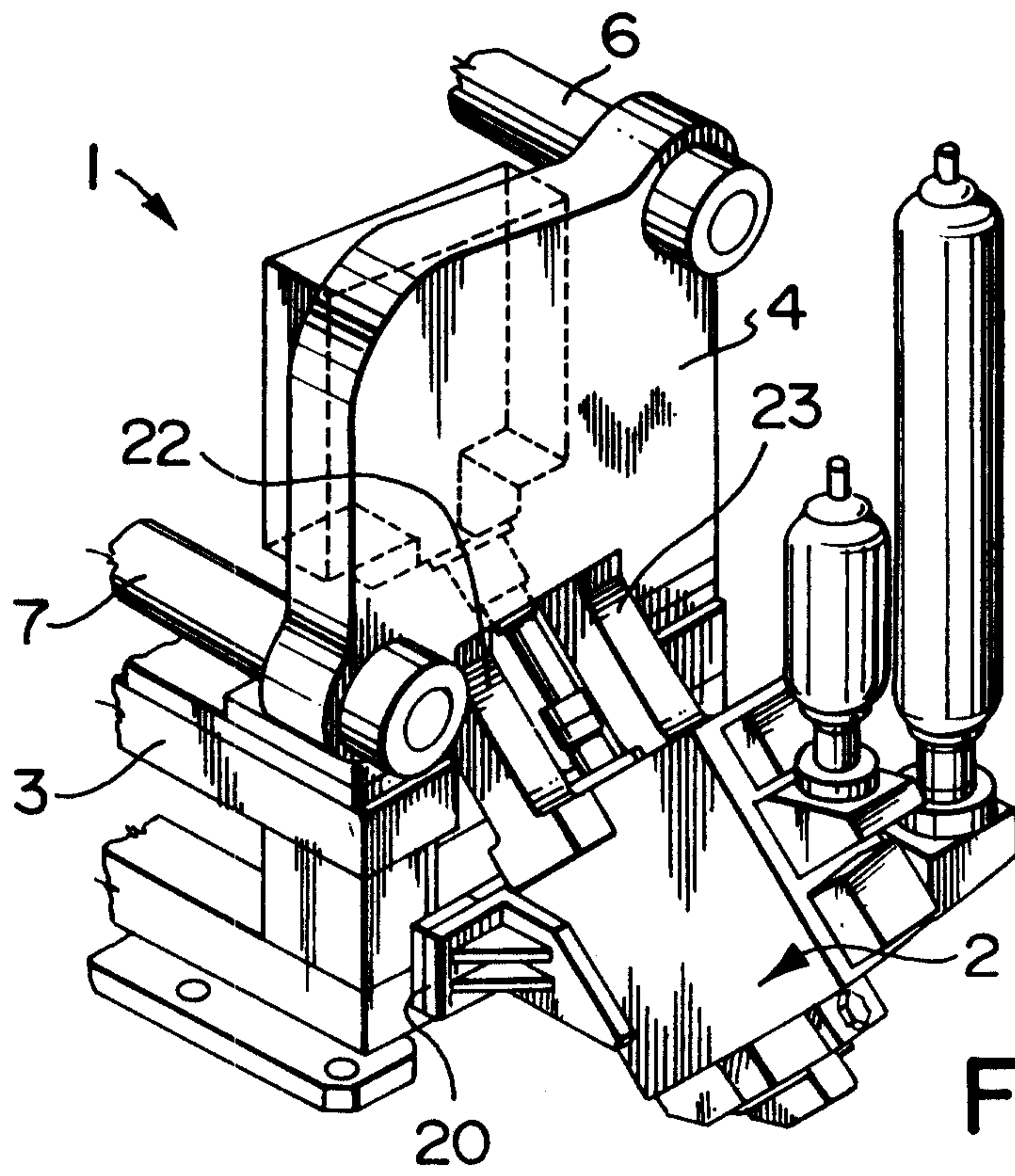


FIG. 2

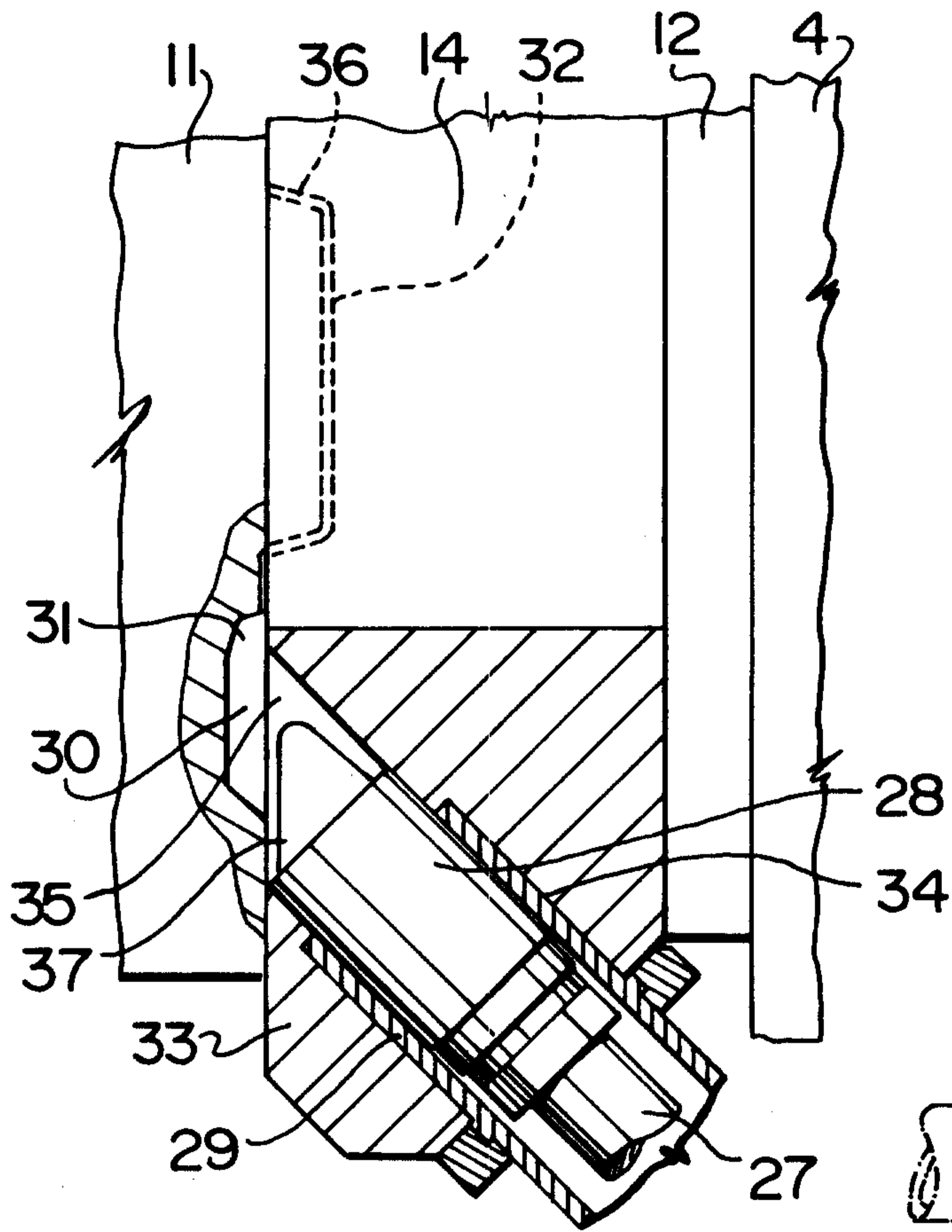


FIG. 4

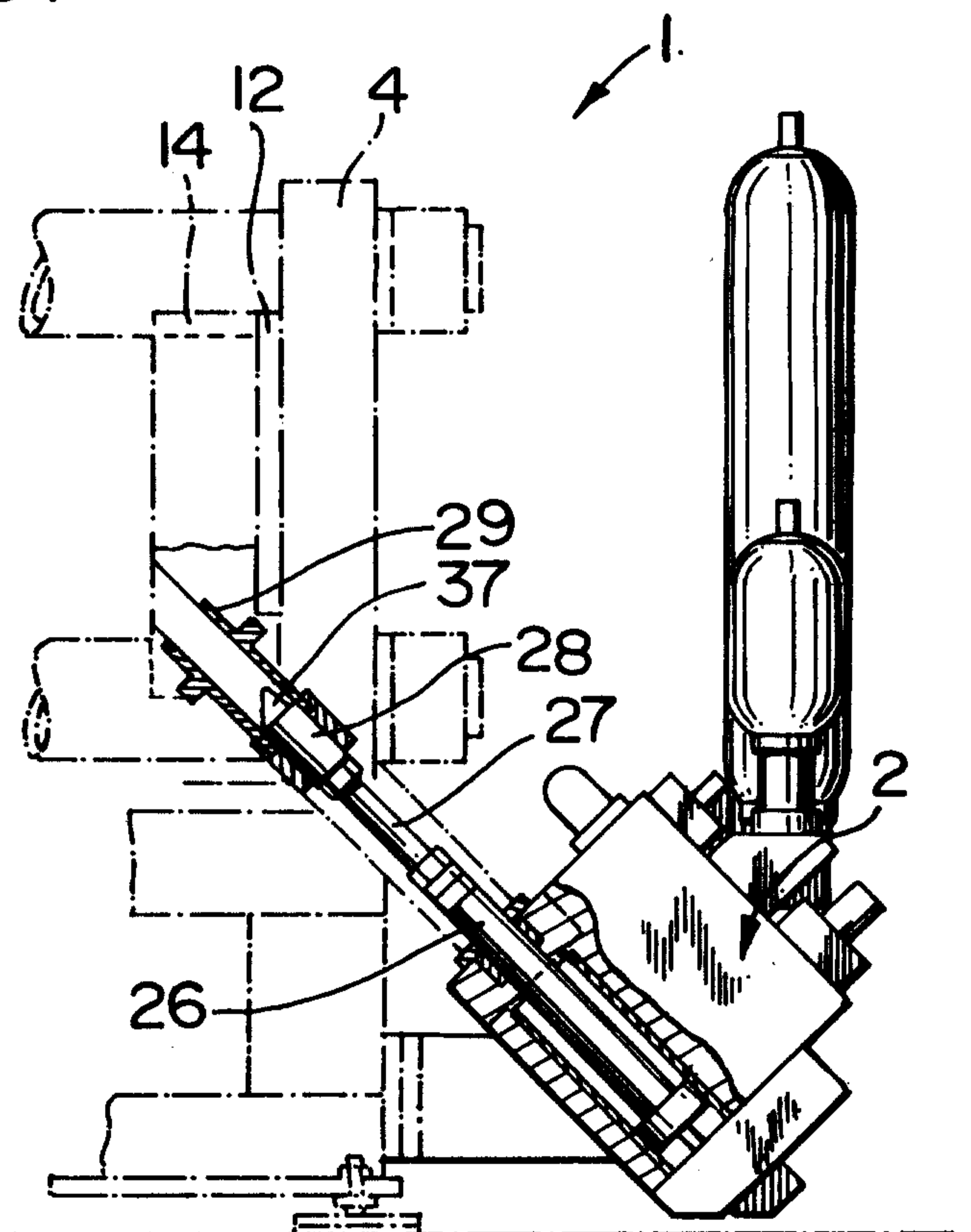


FIG. 3

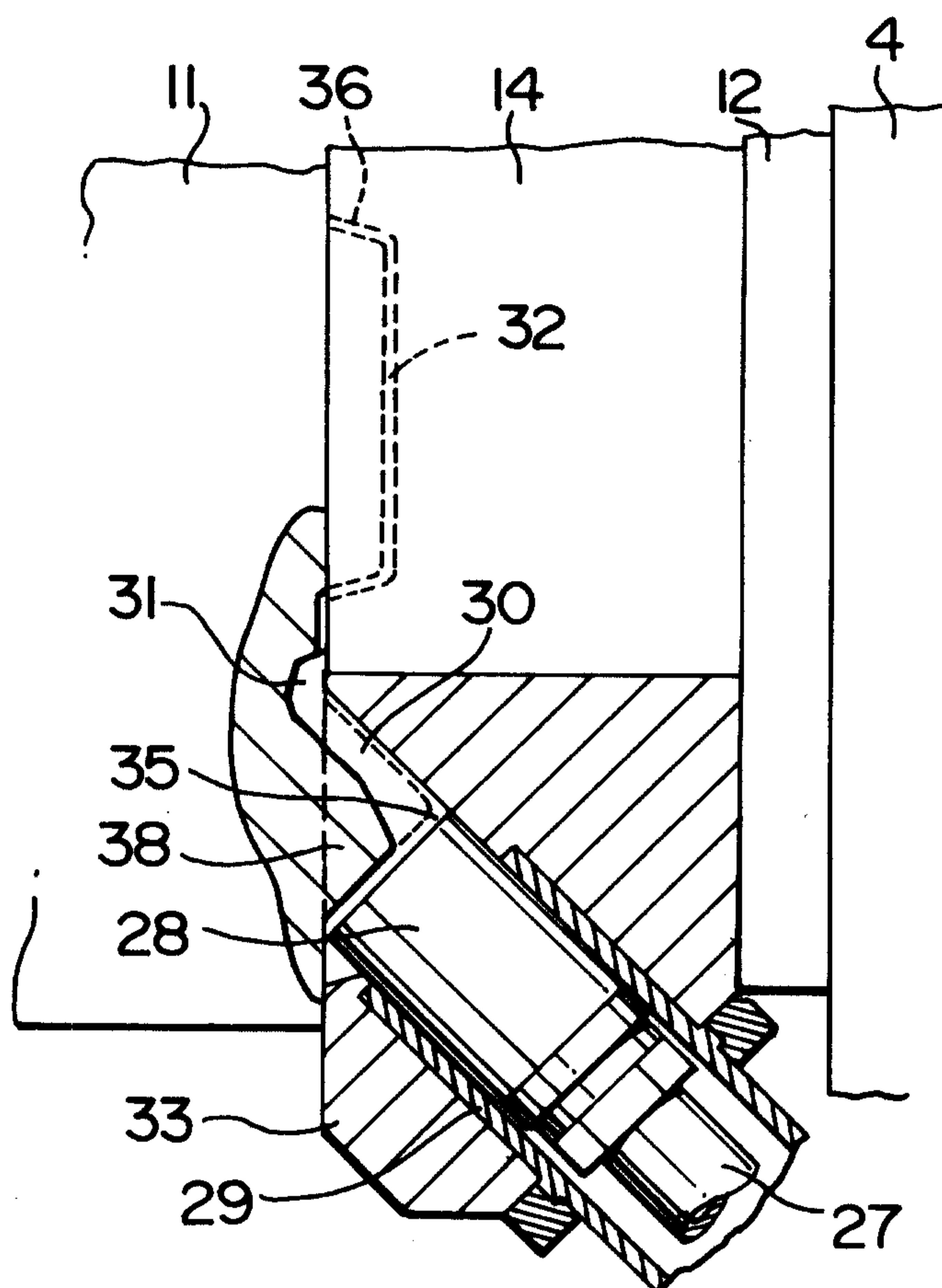


FIG. 5

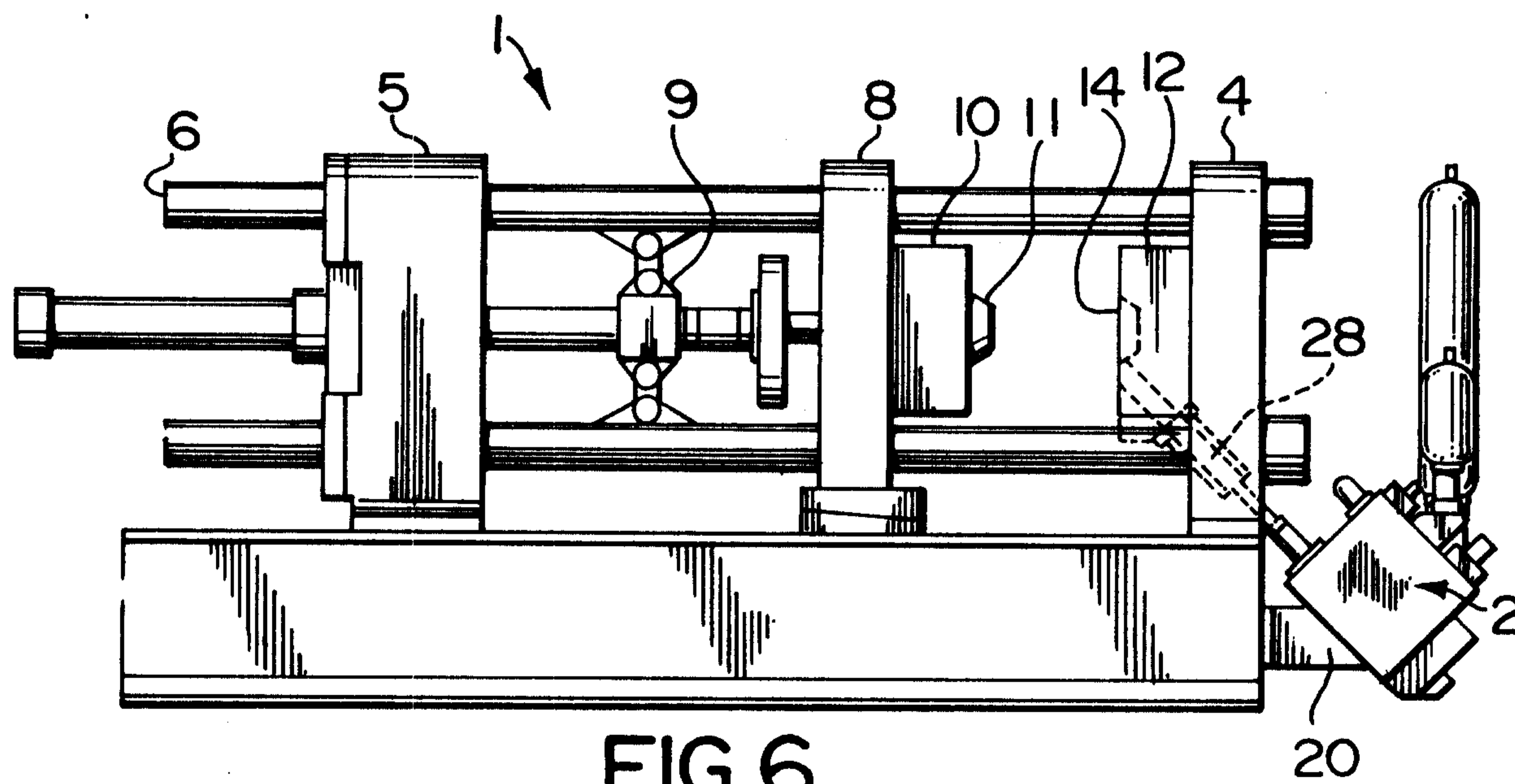


FIG. 6

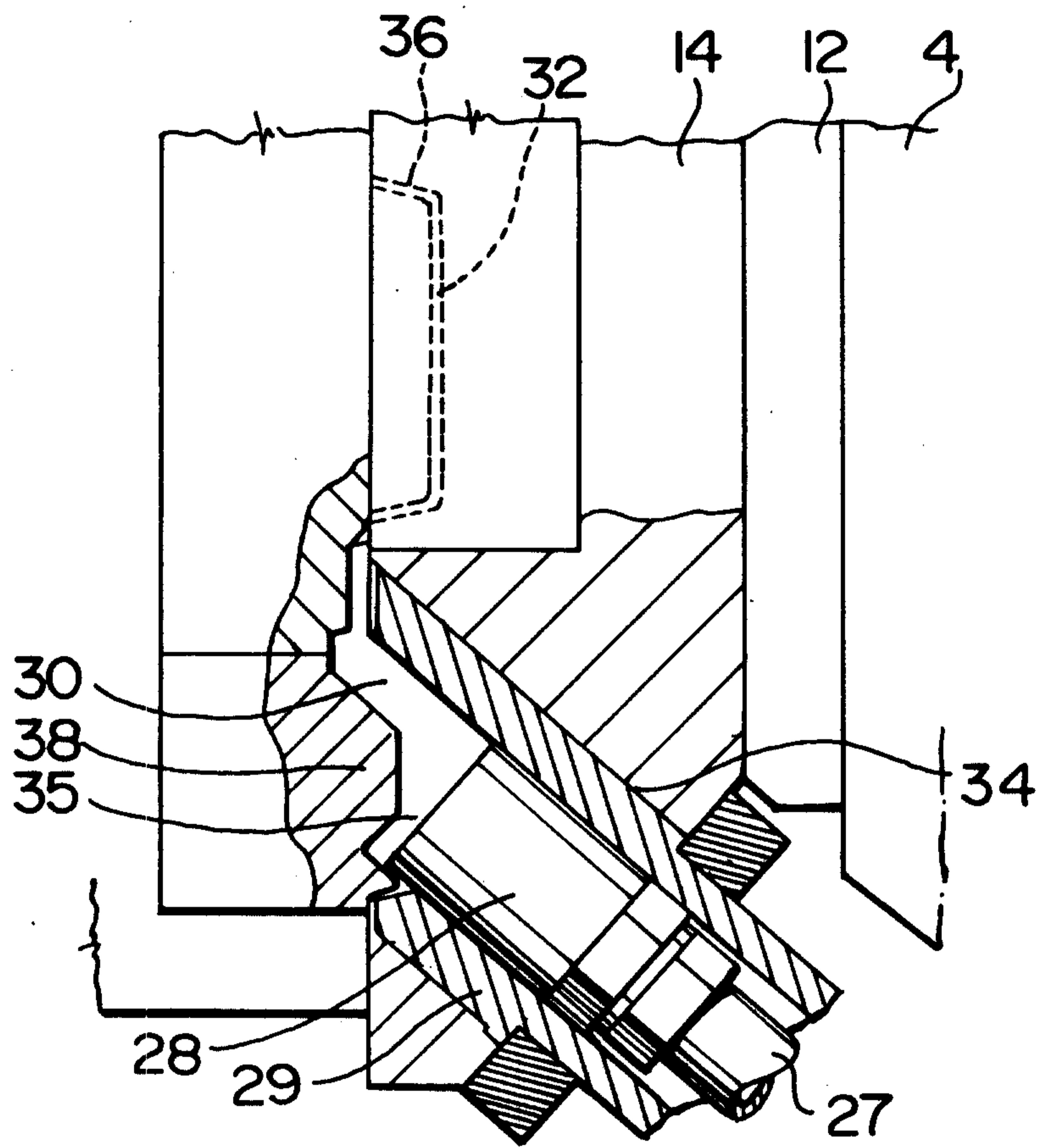


FIG. 7

