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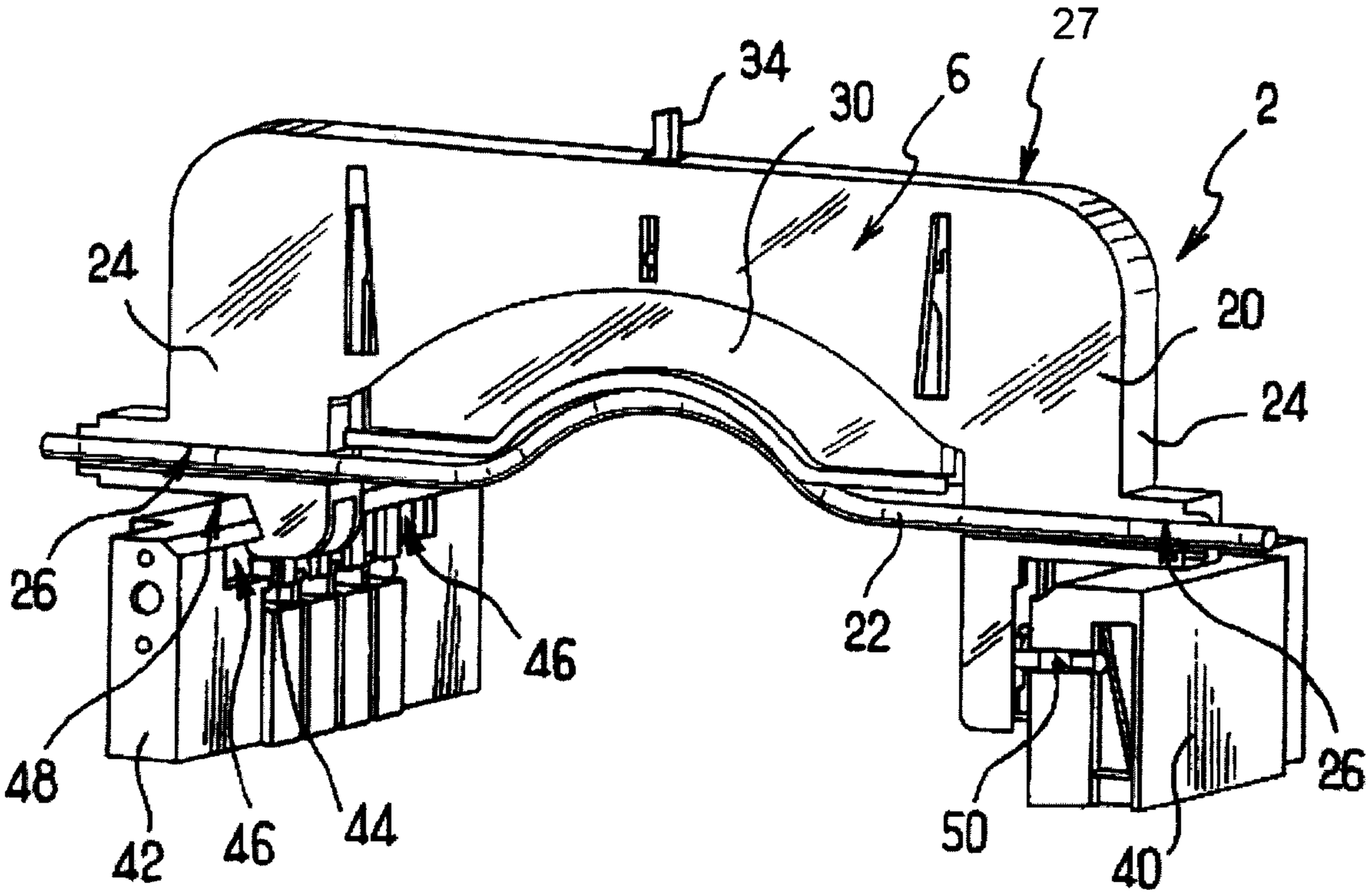
(54) Titre : POMPE PERISTALTIQUE COMPRENANT UNE CASSETTE AMOVIBLE VERROUILLABLE
(54) Title: PERISTALTIC PUMP COMPRISING A LOCKABLE REMOVABLE CASSETTE



(57) Abrégé/Abstract:
The peristaltic pump (2) comprises: at least one cassette (6), and one support. It is fitted such that the cassette of the support can be unlocked by pressure (90) on a main body (20) of the cassette.

ABSTRACT OF THE DISCLOSURE

A peristaltic pump is provided which includes a removable cassette that can be mounted to the peristaltic pump using a single hand of a user. The peristaltic pump includes, a pump frame, a plurality of rollers configured to mount to the pump frame, an actuator operably coupled to move the plurality of rollers, and the removable cassette. The cassette includes a cassette frame and a cam positioned to compress a tube against the plurality of rollers. The cassette is mountable to the pump frame by applying pressure in a first direction to the cassette frame and is dismountable from the pump frame by applying pressure in the first direction to the cassette frame. In an exemplary embodiment, a pin mounts to the pump frame and the cassette frame includes a ramp configured to receive the pin so that the pin is held in a seat of the ramp.

PERISTALTIC PUMP COMPRISING A LOCKABLE REMOVABLE CASSETTE

This application is a continuation application of International Application No. PCT/FR2005/001524 filed on June 17, 2005, the entire disclosure of which is incorporated herein by reference, which claims the benefit of French Patent Application No. 04/06764 that was filed June 22, 2004, the entire disclosure of which is incorporated herein by reference.

FIELD

The field of the disclosure relates generally to peristaltic pumps. More specifically, the disclosure relates to cassettes that are readily attached and detached from the pump.

BACKGROUND

Peristaltic pumps have been known for many years, and are commonly used for medical and research purposes. Peristaltic pumps move a liquid through a tube without any part of the pump ever touching the liquid. As a result, it is possible to pump liquids, such as blood, which are sensitive to external contamination. Typically, a pump comprises rotating rollers that compress a part of the flexible tube as they move, which propels the liquid through the tube.

For example, such a pump is described in document EP 339 857, the entire disclosure of which is incorporated herein by reference. The flexible tube must withstand the compressive force while remaining leak proof. The pump in the aforesaid document includes removable cassettes that each include a tube and a means for securing the cassettes to the pump frame so that the tube is held against the rollers to ensure good contact between tube and rollers. The means described for securing the cassettes include a notch and cam arrangement which requires two hands to operate a release lever to unlock the cassette from the pump. Additionally, a second hand simultaneously holds the cassette to prevent it from jumping off of the frame. What is needed is a peristaltic pump cassette which may be easily mounted to and dismounted from a peristaltic pump using a single-hand.

SUMMARY

A mechanism for mounting and dismounting a removable cassette from a peristaltic pump is provided. The removable cassette is easily mounted to a pump frame of the peristaltic pump using a single-hand of a user. Additionally, a similar motion both mounts the cassette to the pump frame and dismounts the cassette from the pump frame.

In an exemplary embodiment, a peristaltic pump includes, but is not limited to, a pump frame, a plurality of rollers configured to mount to the pump frame, an actuator operably coupled to move the plurality of rollers, and a cassette. The cassette includes a cassette frame and a cam positioned to compress a tube against the plurality of rollers. The cassette is mountable to the pump frame by applying pressure in a first direction to the cassette frame and is dismountable from the pump frame by applying pressure in the first direction to the cassette frame.

In another exemplary embodiment, a method of using a cassette in a peristaltic pump is provided. A cassette frame of a cassette is positioned for mounting to a pump frame of a peristaltic pump. A hook is engaged in a notch to mount a first end of the cassette frame to the pump frame. A pin slides in a first direction to accept a second end of the cassette frame. The pin slides along a ramp and is held in a seat of the ramp to mount the cassette to the peristaltic pump.

Other principal features and advantages of the invention will become apparent to those skilled in the art upon review of the following drawings, the detailed description, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will hereafter be described with reference to the accompanying drawings, wherein like numerals denote like elements.

Fig. 1 is a perspective view of a peristaltic pump head with a cassette in a position to be mounted onto the pump in accordance with an exemplary embodiment.

Fig. 2 is a perspective view of the peristaltic pump head of Fig. 1 with the cassette mounted on the pump in accordance with an exemplary embodiment.

Fig. 3 is a front cross sectional view of the pump head of Fig. 2, and designated by the line along III - III with the cassette in accordance with an exemplary embodiment.

FIG. 4 is a front perspective view of the cassette FIG. 2 in a mounted position.

FIG. 5 is a side perspective view of the cassette as in FIG. 2.

FIG. 6 is a larger scale view of a ramp of the cassette of FIG. 5 in accordance with an exemplary embodiment.

FIGS. 7-11 are partial perspective views showing the steps in mounting the cassette to a pump frame and dismounting the cassette from the pump frame using a pin and a ramp in accordance with an exemplary embodiment.

FIGS. 12 and 13 are lateral views of the pin indicating the longitudinal motion in accordance with an exemplary embodiment.

DETAILED DESCRIPTION

While a single style of cassette has been illustrated in the figures, a plurality of cassettes similar in construction to that described are contemplated. For the purposes of this disclosure and unless otherwise specified, "a" or "an" means "one or more."

With reference to FIGS. 1-3, a peristaltic pump head 2 of a peristaltic pump is shown in accordance with an exemplary embodiment. The peristaltic pump may include peristaltic pump head 2 and an actuator. Peristaltic pump head 2 may include a crankcase 4, a frame 5, a plurality of rollers 16, and a removable cassette 6. Frame 5 may include a center support 14, a front wall 10, a back wall 8, a first brace 40, and a second brace 42. Crankcase 4 mounts to front wall 10 and includes an axis of symmetry 18. As used in this disclosure, the term "mount" includes join, unite, connect, associate, insert, hang, hold, affix, attach, fasten, bind, paste, secure, bolt, screw, rivet, solder, weld, and other like terms.

In the exemplary embodiment of FIG. 1, the plurality of rollers 16 includes eight rollers symmetrically arranged around the axis of symmetry 18. The rollers are mounted in a rotating fashion on central support 14. In the exemplary embodiment of FIG. 1, each

roller of the plurality of rollers 16 has a spherical shape and rotates about an axis parallel to the axis of symmetry 18. Central support 14 rotates around the axis of symmetry 18.

The actuator is operably coupled to rotate the plurality of rollers 16. For example, the actuator may include a rotor connected to the plurality of rollers through a shaft 11 as known to those skilled in the art. The actuator may be any device as known to those skilled in the art for causing rotation of the plurality of rollers. Exemplary actuators include an electric motor, a servo, stepper, or piezo motor, a pneumatic actuator, a gas motor, etc.

Front wall 10 and back wall 8 define between them a cassette housing 12 sized to accommodate one or more removable cassettes 6. Front wall 10 and back wall 8 are linked together by a first brace 40 and a second brace 42 which extend parallel to the axis of symmetry 7, and act as a support and locking mechanism for the removable cassette(s) 6. With reference to FIG. 1, the removable cassette 6 is shown released from the two braces 40, 42. With reference to FIG. 2, the removable cassette 6 is shown mounted to the two braces 40, 42 for use with the peristaltic pump. A plurality of cassettes 6 may be held in the cassette housing 12, side by side, parallel to one another, and/or in contact with each other. When mounted to frame 5, removable cassette 6 extends parallel to front wall 10 and back wall 8 in a plane, which is perpendicular to the axis of symmetry 7.

With reference to FIGS. 2-5, a front perspective view of removable cassette 6 is shown in accordance with an exemplary embodiment. Each removable cassette is basically flat. The removable cassette 6 includes a cassette body 20. In the exemplary embodiment of FIGS. 2-5 the cassette body 20 has essentially an inverted U shape formed by a front wall 21 and a back wall 25 with a frame edge 27 extending between the front wall 21 and the back wall 25. A cavity 29 (shown with reference to Fig. 5) is formed between the front wall 21 and the back wall 25. The inverted U shape of cassette body 20 is formed by the front wall 21 and the back wall 25 includes legs 24.

The removable cassette 6 includes a cam 30 accommodated in cavity 29. Cam 30 has an essentially flat rectangular shape with a saddle-shaped hollow formed by a lower edge designed to face the plurality of rollers 16. The front wall 21 and the back wall 25 partially cover each side of cam 30.

With reference to FIG. 3, a front cross sectional view of the removable cassette 6 mounted to frame 5 is shown in accordance with an exemplary embodiment. A flexible tube 22 is mounted to cassette frame 20 in a removable manner. In particular, flexible

tube 22 is held in slots 26. The tube 22 rests against the lower edge of cam 30. The part of tube 22 resting against the lower edge extends between the parts of tube 22 housed in slots 26. The removable cassette 6 includes a biasing member 32. In an exemplary embodiment, biasing member 32 is a blade spring. Tension on the cam 30 may be modulated by a control knob 34 extending from an upper edge of the cassette body 20.

The removable cassette 6 mounts to the peristaltic pump head 2 at the ends of legs 24 adjacent to slots 26. For example, as shown in FIGS. 4 and 5, a hook 44 extends from one of the legs 24 and is capable of engaging in a notch 46 in the second brace 42 of frame 5. One of the legs 24 has a ramp 52 (shown with reference to FIG. 5) capable of engaging a pin 50 in first brace 40 of frame 5. When the removable cassette 6 is mounted to frame 5, a shoulder 48 of the removable cassette 6 rests on an upper edge of second brace 42. For each cassette position, second brace 42 has a notch 46 and first brace 40 has a pin 50.

FIGS. 7-13 illustrate a pin 50 according to an exemplary embodiment. Exemplary pins 50 have an elongated cylindrical body 55 with a head 56 at a first end of the cylindrical body 55 and a distal end 54 opposite head 56 of the cylindrical body 55. The pin 50 is rigidly or slidably encased in a rectangular parallelepiped housing 51. The distal end 54 of the pin 50 extends beyond an inside face 53 of first brace 40. The pin 50 and the parallelepiped housing 51 is slidable within an aperture 60, the aperture 60 extending from an inner face 53 of first brace 40 to a cavity 67 located within first brace 40, or near an outer face 57 of first brace 40. The head 56 of the pin 50 resides in cavity 67 inside first brace 40.

The aperture 60 allows the pin 50 to slide back and forth, along a longitudinal axis of the pin 50, while being retained within first brace 40 by a retaining clip 63. The retaining clip 63 has a shape that is complementary to that of cavity 67. The retaining clip 63 includes a fork 68 through which the distal end 54 of the pin 50 is inserted such that the fork 68 maintains the head 56 of pin 50 within the aperture 60. The retaining clip 63 also has a leaf spring 66 which exerts a force on head 56.

When a force is applied to the distal end 54 of the pin 50 in a direction parallel to the longitudinal axis of the pin 50, the pin 50 is pushed against leaf spring 66 and into first brace 40 (FIG. 12). When the force is removed, the leaf spring 66 exerts a force on the head 56 of the pin 50 to return it to the original position (FIG. 13).

The aperture 60 allows the pin 50 to pivot freely within the aperture 60 around an axis 64, indicated in FIGS. 11 and 13, which extends perpendicular to the longitudinal axis

of the pin 50. The parallelepiped housing 51 of the pin 50 guides it as it moves within aperture 60.

FIGS. 5 and 6, illustrate a ramp 52 according to an exemplary embodiment. The ramp 52 is integrally formed in an outer side of one of the legs 24. In describing the ramp 52, it will be apparent to those of skill that the ramp is multileveled. The ramp 52 is integrally formed to have different levels of relief from the full depth of the ramp 52 into the leg 24 of the removable cassette 6. The same areas of the ramp 52 may also be of varying levels. For example, area 70 of the ramp 52 is angled such that it is adjacent to exit area 90 along facet 71, and area 70 is also flush with launching area 78 along facet 75, despite launching area 78 being less deeply cut into leg 24 (i.e. having a greater relief) than exit area 90. Area 70 is more deeply cut at edge 72 than at facet 75. Launching area 78 may also be sloped such that a point proximal to facet 71 is of higher relief than an area proximal to facet 72 (see FIG. 8). As such, the ramp 52 is stepped from a "high" point of the ramp at launching area 78 to a lower point of exit area 90, to the lowest point along edge 72 in area 70. Each of the successive facets 72, 73, 75, 76 along the direction of ramp 52 is a step down from the areas previous to the facet along the direction of travel along the ramp 52.

As used herein, facet is used to refer to an area that may be flush, but of a different plane than that of an adjacent area (e.g. FIG. 6), or to an area having a higher or lower relief whereby a wall separates the adjacent areas (e.g. FIG. 8).

The form and function of the various elements of the peristaltic pump 2 and a removable cassette 6 will be more apparent using a description of a method for mounting and dismounting the removable cassette 6.

The hook 44 of one of the legs 24 of removable cassette 6 is engaged in the notch 46 of the second brace 42. The ramp 52 of the removable cassette 6 is brought into close proximity with the distal end 54 of pin 50. As pressure is applied to the cassette body 20, tube 22 is compressed, and the distal end 54 of pin 50 enters the ramp 52 at area 70. As pressure is continuously applied, the distal end 54 of pin 50 follows a course in which the distal end 54 of pin 50 initially encounters facet 71 and enters launching area 78, the "highest" or shallowest portion of ramp 52. A wall 92 on relief area 71 aids in guiding the distal end 54 to the launching area 78. Pressure is continuously applied to the cassette body 20 until the distal end 54 encounters a wall 80 that prevents further travel in such a direction. As the pressure is released, the compression of tube 22 recoils the removable

cassette 6 in a reverse direction launching the distal end 54 over facet 72 from the launching area onto a seating area 82 and into a seat 84, thus securing the removable cassette 6 within the cassette housing 12.

As the distal end 54 of pin 50 enters area 70 of the ramp 52, the contact of the distal end 54 with the area 70 of the ramp 52 causes the pin 50 to move in a longitudinal direction toward the cavity 67 of the first brace 40, thus tensioning leaf spring 66 against head 56 and about axis 62. As the distal end 54 moves from areas of higher relief in the ramp 52 to those of lower relief, the leaf spring 66 exerts a force on pin 50 causing the distal end 54 to remain in contact with the ramp 52.

When dismounting the removable cassette 6 from the cassette housing 12 is desired, pressure is again applied to the cassette body 20, with facet 72 preventing "reverse" travel of the distal end 54, and encouraging "forward" travel of the distal end 54 over facet 73, onto landing area 86 as tube 22 is compressed. A wall 88 prevents further compression of the tube 22. As pressure is once again released, the tube 22 exerts a recoil force in the direction opposite to the applied pressure, with the distal end 54 traveling through exit area 90, thus dismounting the removable cassette 6 from the cassette housing 12.

The motions required to mount and dismount removable cassette 6 from the peristaltic pump head 2 may be performed by a single hand of a user and are ergonomically efficient. The pivoting of the pin 50 in aperture 60 allows for lateral travel of the removable cassette 6 during insertion and removal. A user can pivot the dismounted removable cassette 6 to separate the released leg 24 from the first brace 40, and then separate the hook 44 from the second brace 42 to remove the cassette from its support.

Therefore, the presently embodied removable cassette and pump frame allows the user to mount the removable cassette 6 onto the peristaltic pump head 2 by simply applying pressure to the top of the removable cassette 6. The same action allows the user to dismount and remove the removable cassette 6. These actions can therefore be performed simply and quickly and, if required, one after the other or even simultaneously for several of the pump's cassettes.

It should be noted that these operations are accomplished without the user ever touching the tube. These operations use the compressibility and recoil of the tube to define limit positions, which prevent undue action on the tube both during these operations

and when the cassette is in its functional position on the pump head. In particular, there is no risk that the tube will be excessively stressed during these operations. This is particularly important to prolong the lifetime of the tube. Typically, the lifetime of a peristaltic pump tube is directly impacted by the pump's operation. As a result, the lifetime of the peristaltic pump tube may be considerably reduced if overly stressed.

While some embodiments have been illustrated and described, it should be understood that changes and modifications can be made in accordance with ordinary skill in the art without departing from the invention in its broader aspects as defined in the following claims. For example, the relative positions of a hook and a notch may be reversed such that the hook is associated with a brace and the notch is associated with a leg of the removable cassette and/or the relative positions of a pin and a ramp may be reversed such that the ramp is associated with a brace and the pin is associated with a leg of the removable cassette.

The foregoing description of exemplary embodiments of the invention have been presented for purposes of illustration and of description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiments were chosen and described in order to explain the principles of the invention and as practical applications of the invention to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents.

CLAIMS:

1. A peristaltic pump, the peristaltic pump comprising:

a pump frame;

a plurality of rollers configured to mount to the pump frame;

an actuator operably coupled to move the plurality of rollers;

a cassette, the cassette comprising

a cassette frame; and

a cam positioned to compress a tube against the plurality of rollers;

wherein the cassette is mountable to the pump frame by applying a first pressure in a first direction to the cassette frame and is dismountable from the pump frame by applying a second pressure in the first direction to the cassette frame.

2. The peristaltic pump of claim 1, wherein the cassette comprises a hook extending from the cassette frame and further wherein the pump frame comprises a notch configured to receive the hook.

3. The peristaltic pump of claim 1, wherein the pump frame comprises a hook and further wherein the cassette frame comprises a notch configured to receive the hook.

4. The peristaltic pump of claim 1, further comprising a pin mounted to the pump frame, wherein the cassette frame comprises a ramp configured to receive the pin.

5. The peristaltic pump of claim 1, further comprising a pin mounted to the cassette frame, wherein the pump frame comprises a ramp configured to receive the pin.

6. The peristaltic pump of claim 4, wherein the pin comprises:

a cylindrical body; and

a head extending from the cylindrical body at a first end.

7. The peristaltic pump of claim 6, wherein the pin further comprises a parallelepiped housing surrounding a portion of the cylindrical body.

8. The peristaltic pump of claim 7, wherein the pump frame further comprises an aperture configured to accept the parallelepiped housing of the pin.

9. The peristaltic pump of claim 6, wherein the pump frame further comprises an aperture configured to accept the pin.

10. The peristaltic pump of claim 9, wherein the aperture is sized and shaped either to allow sliding of the pin within the aperture, to allow pivoting of the pin within the aperture, or to allow sliding and pivoting of the pin within the aperture.

11. The peristaltic pump of claim 10, wherein the pivoting of the pin is about an axis perpendicular to a direction of sliding of the pin within the aperture.

12. The peristaltic pump of claim 10, wherein the ramp comprises a seat configured to hold the pin during mounting of the cassette to the pump frame.

13. The peristaltic pump of claim 12, wherein the ramp comprises a plurality of levels configured to guide the pin toward the seat during mounting of the cassette to the pump frame.

14. The peristaltic pump of claim 12, wherein the ramp comprises a plurality of levels configured to guide the pin away from the seat during dismounting of the cassette from the pump frame.

15. The peristaltic pump of claim 9, further comprising a biasing member mounted to resist sliding of the pin within the aperture.

16. A method of using a cassette in a peristaltic pump, the method comprising:

positioning a cassette frame of a cassette for mounting to a pump frame of a peristaltic pump;

engaging a hook in a notch to mount a first end of the cassette frame to the pump frame;

sliding a pin in a first direction to accept a second end of the cassette frame;

sliding the pin along a ramp; and

holding the pin in a seat of the ramp to mount the cassette to the peristaltic pump.

17. The method of claim 16, further comprising:

applying pressure to the cassette frame in a second direction thereby releasing the pin from the seat;

sliding the pin along the ramp; and

disengaging the hook from the notch to dismount the cassette from the peristaltic pump.

18. The method of claim 17, wherein the second direction is generally perpendicular to the first direction.

19. The method of claim 16, wherein the cassette comprises the hook which extends from the cassette frame and further wherein the pump frame comprises the notch.

20. The method of claim 16, wherein the pin mounts to the pump frame and further wherein the cassette frame comprises the ramp.

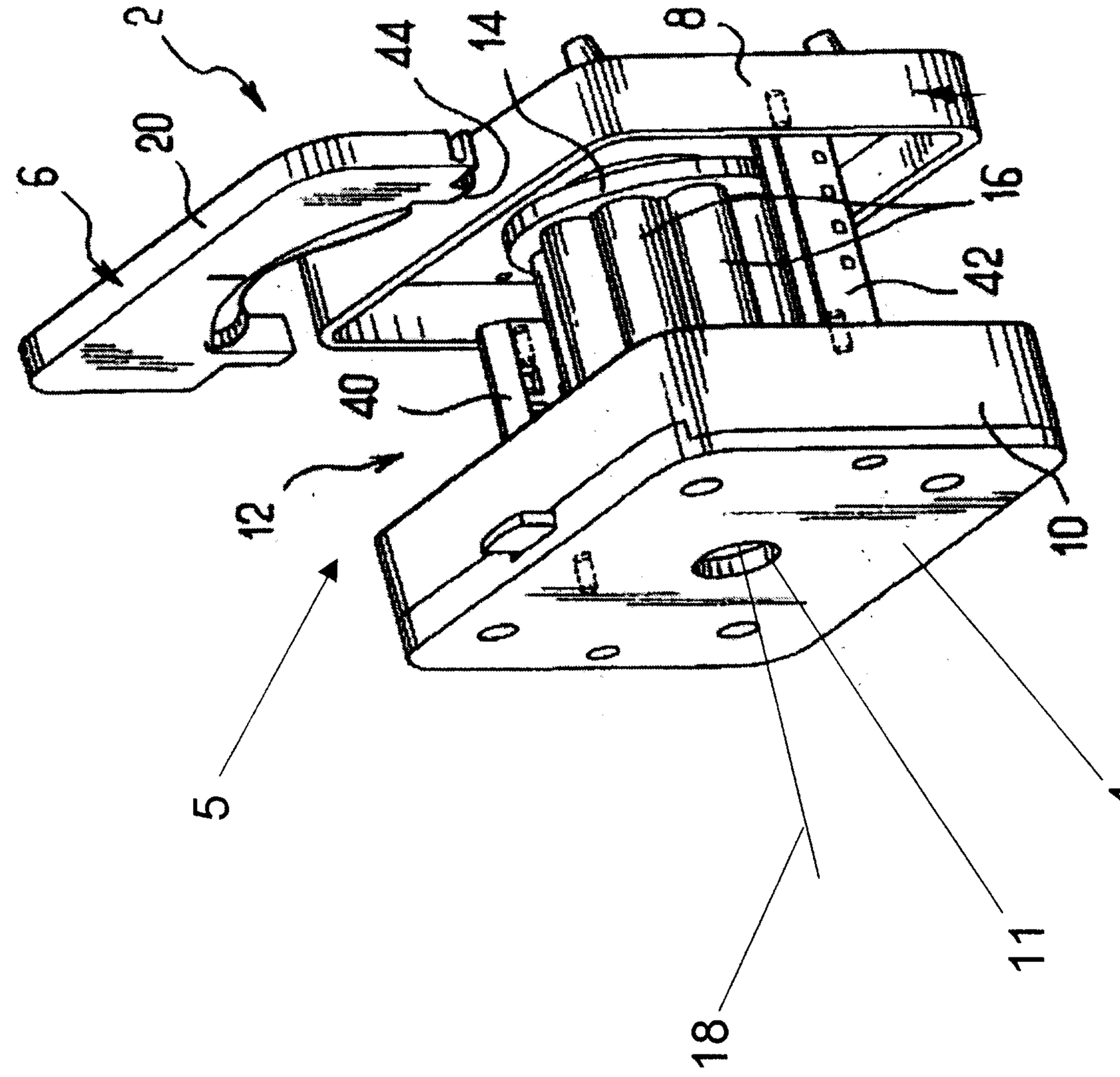


FIG.1

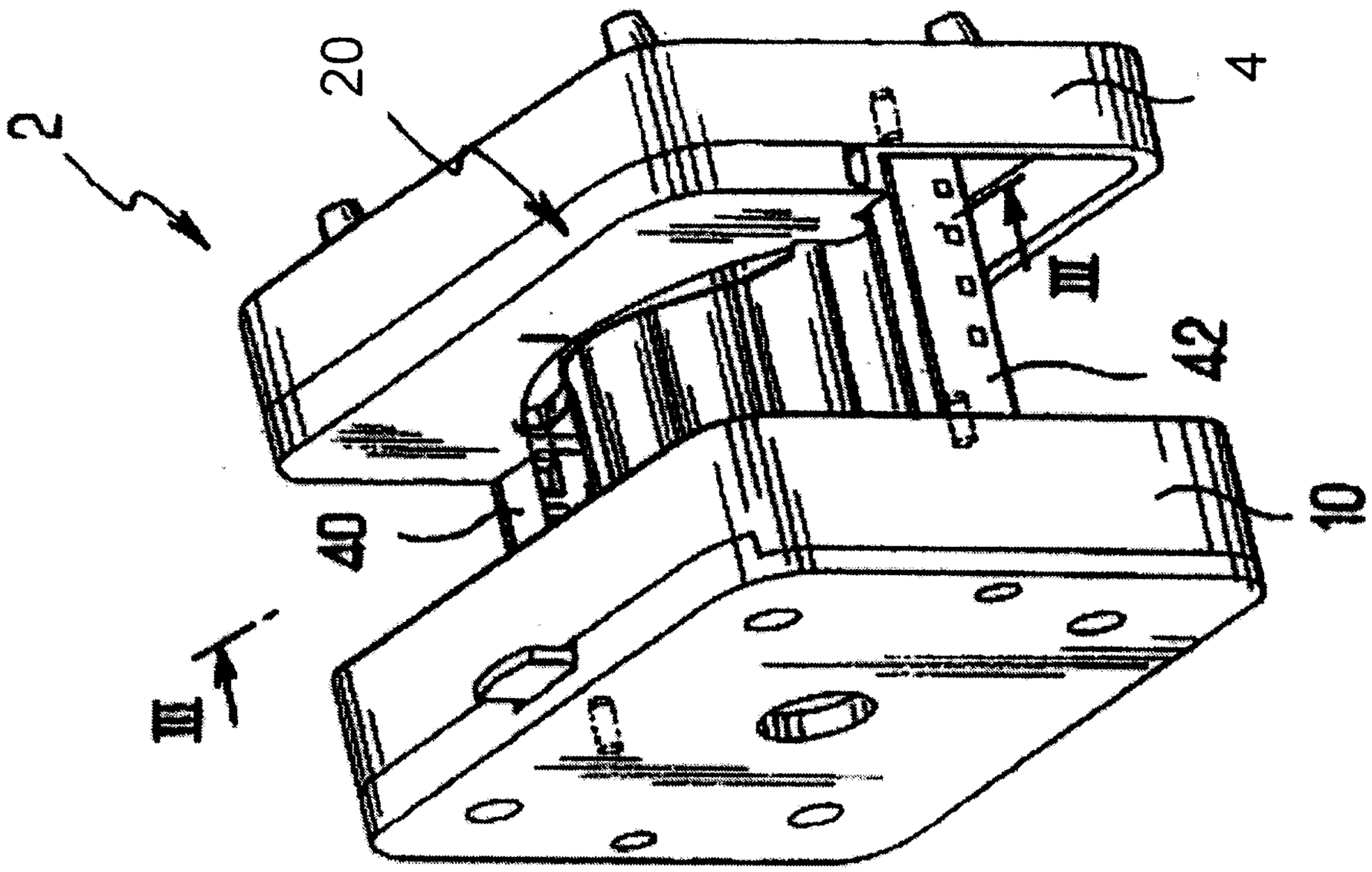


FIG.2

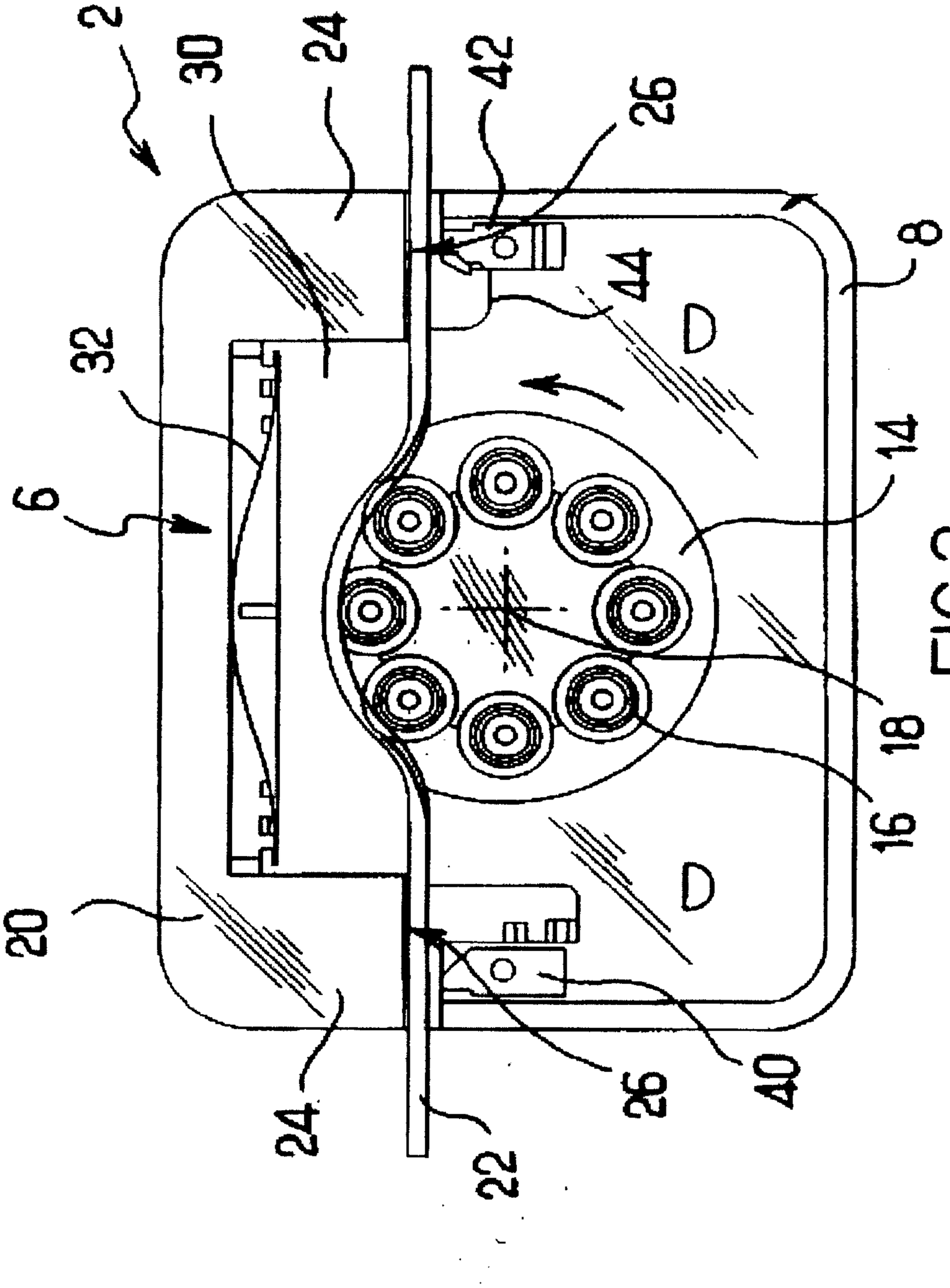


FIG.3

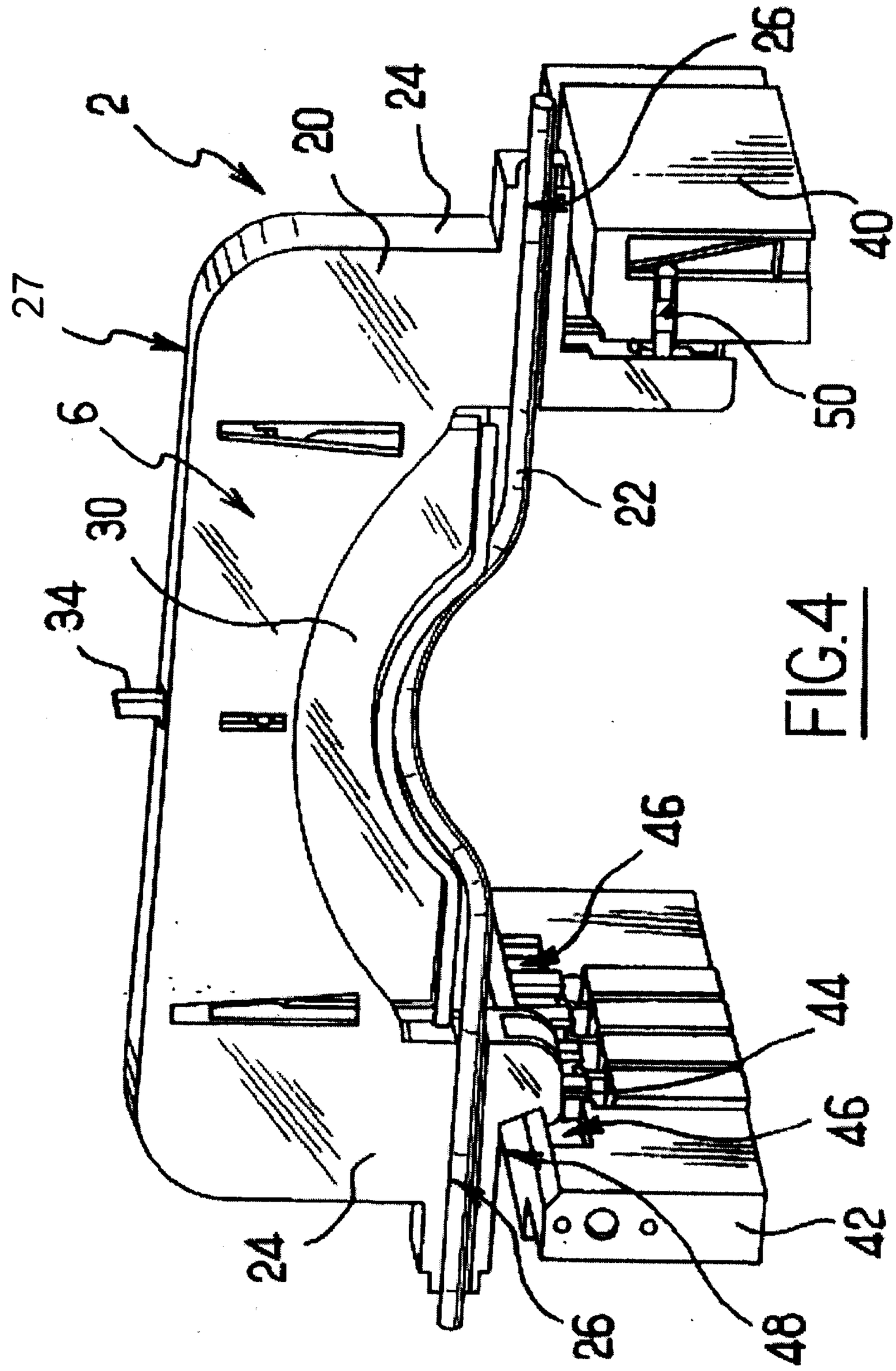


FIG.4

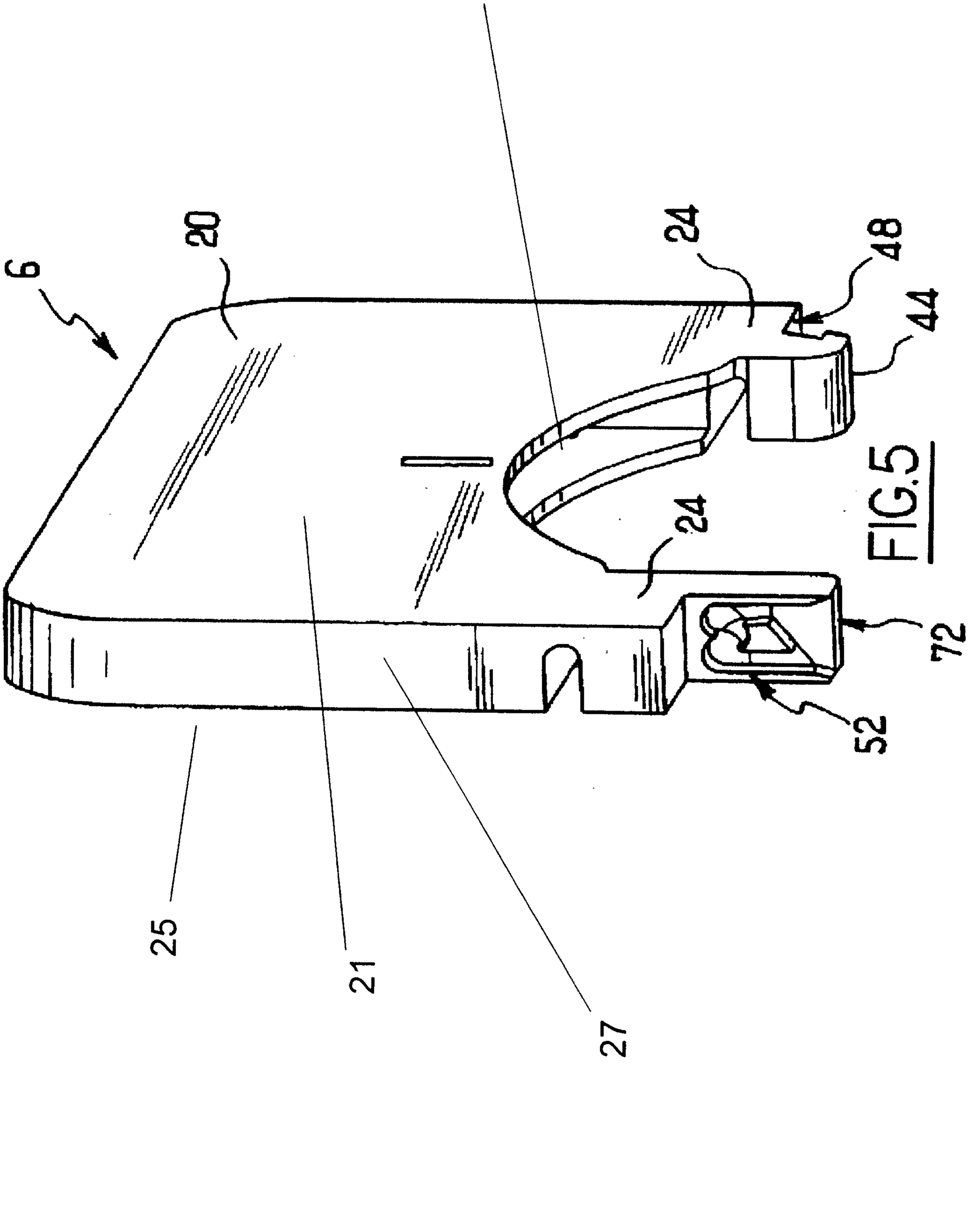


FIG.5

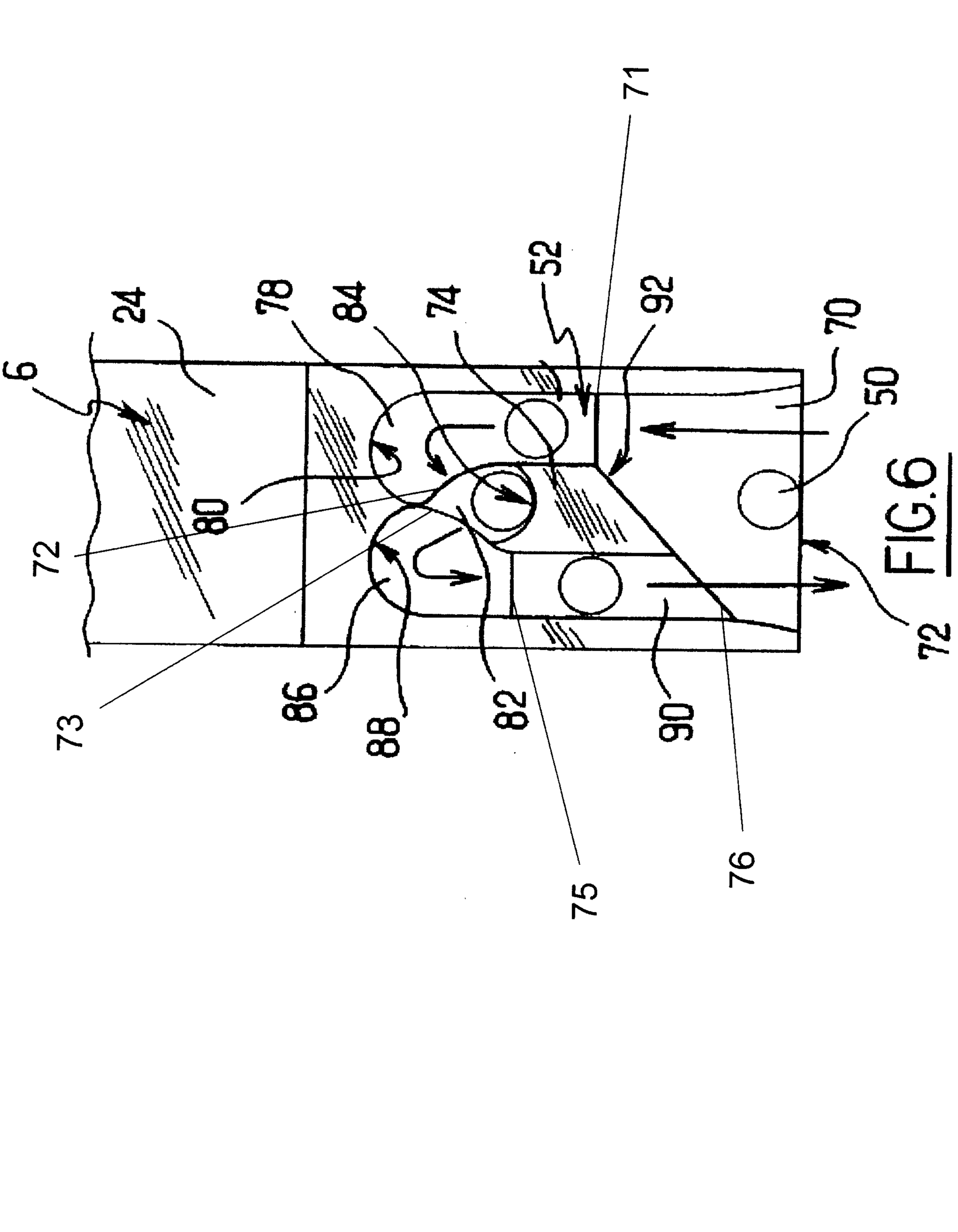
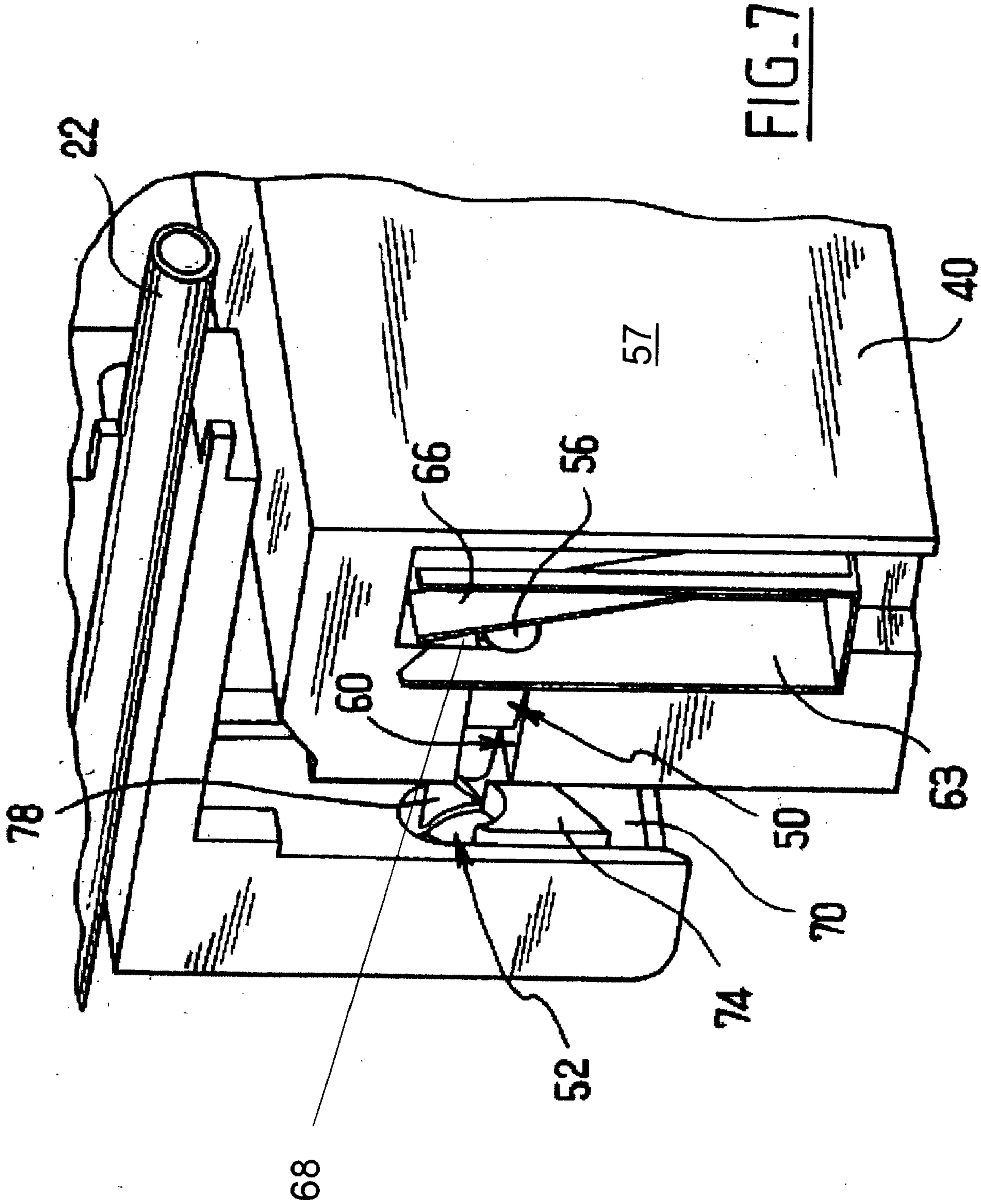


FIG.6

FIG.7



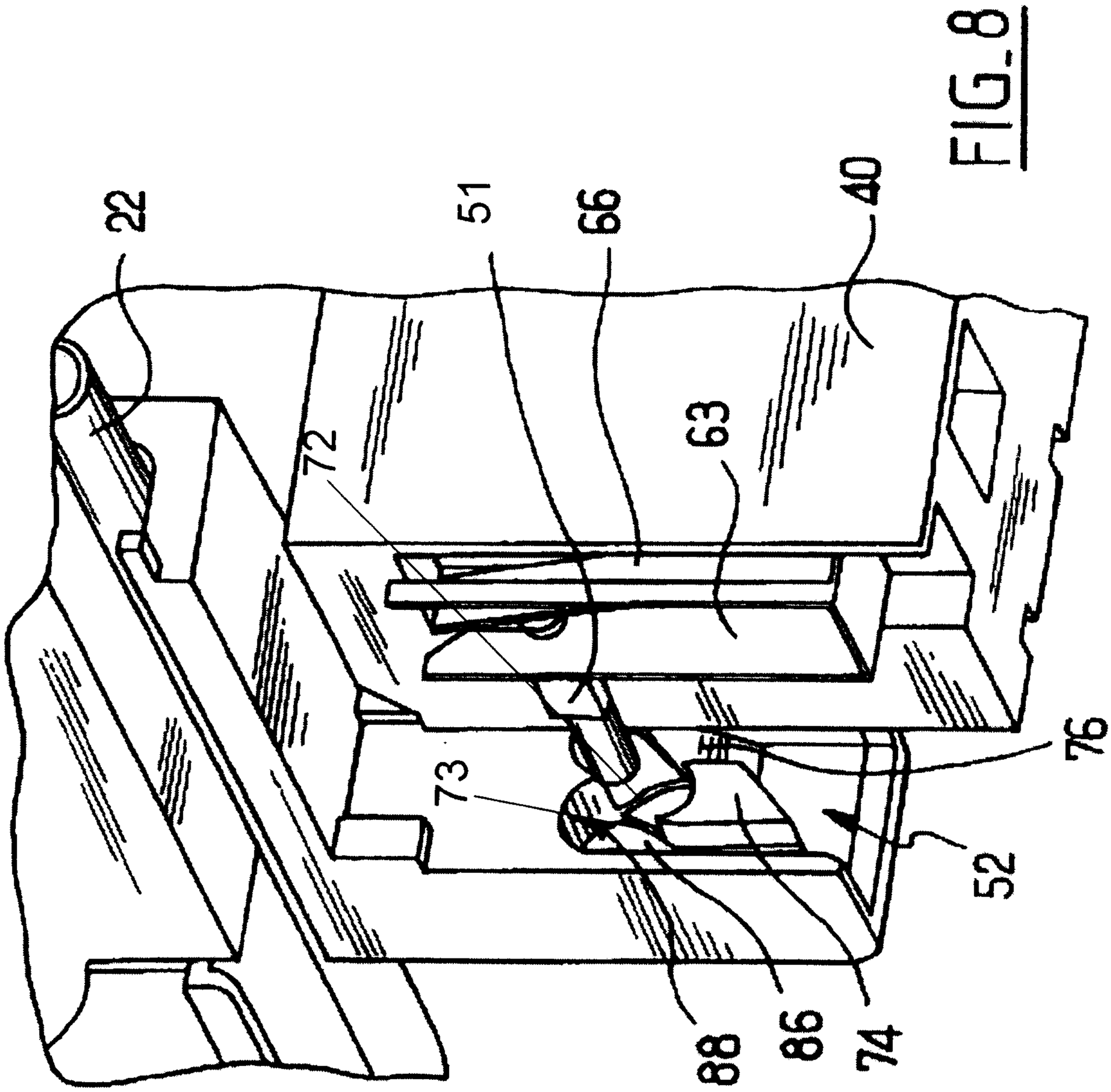


FIG_8

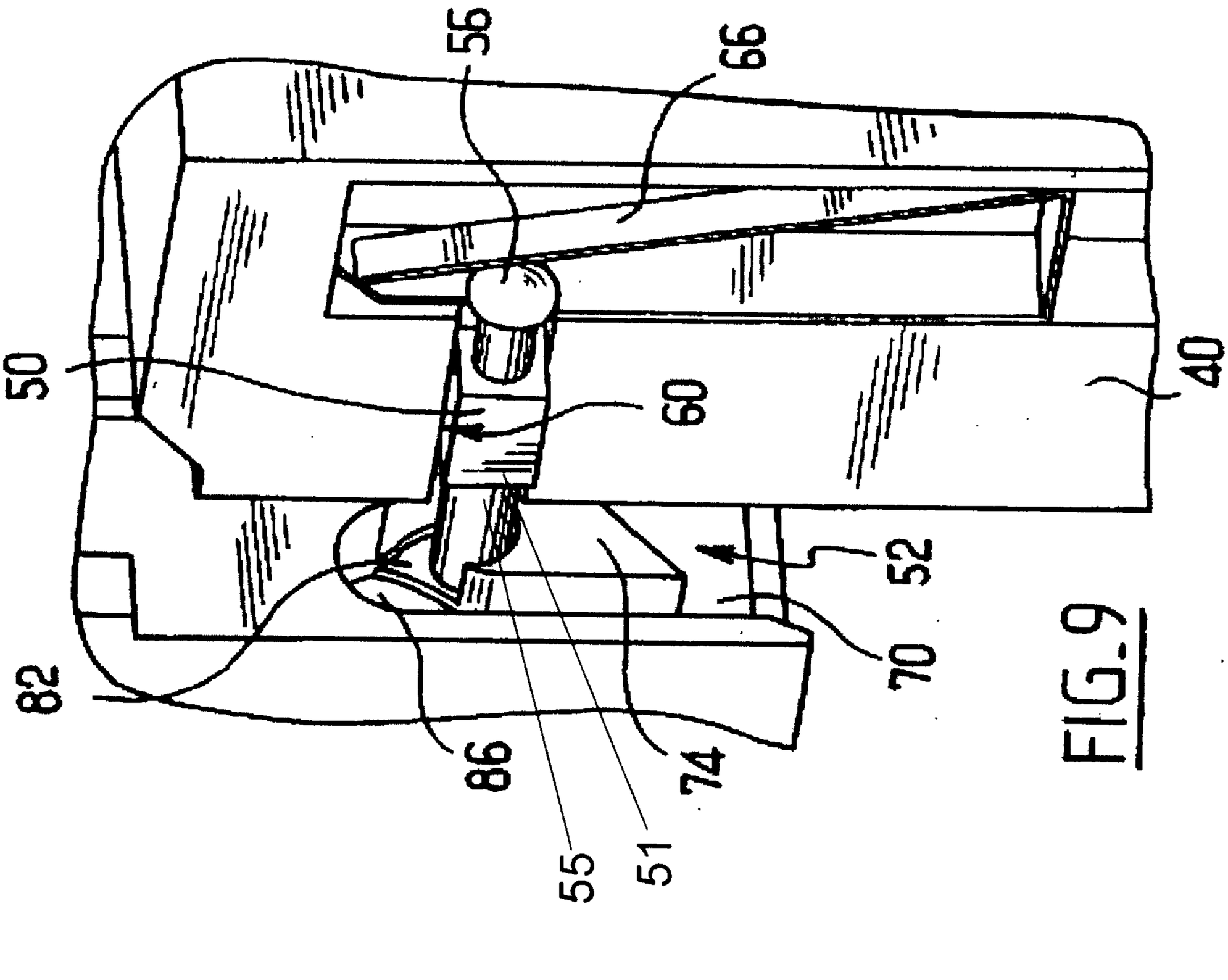


FIG.9

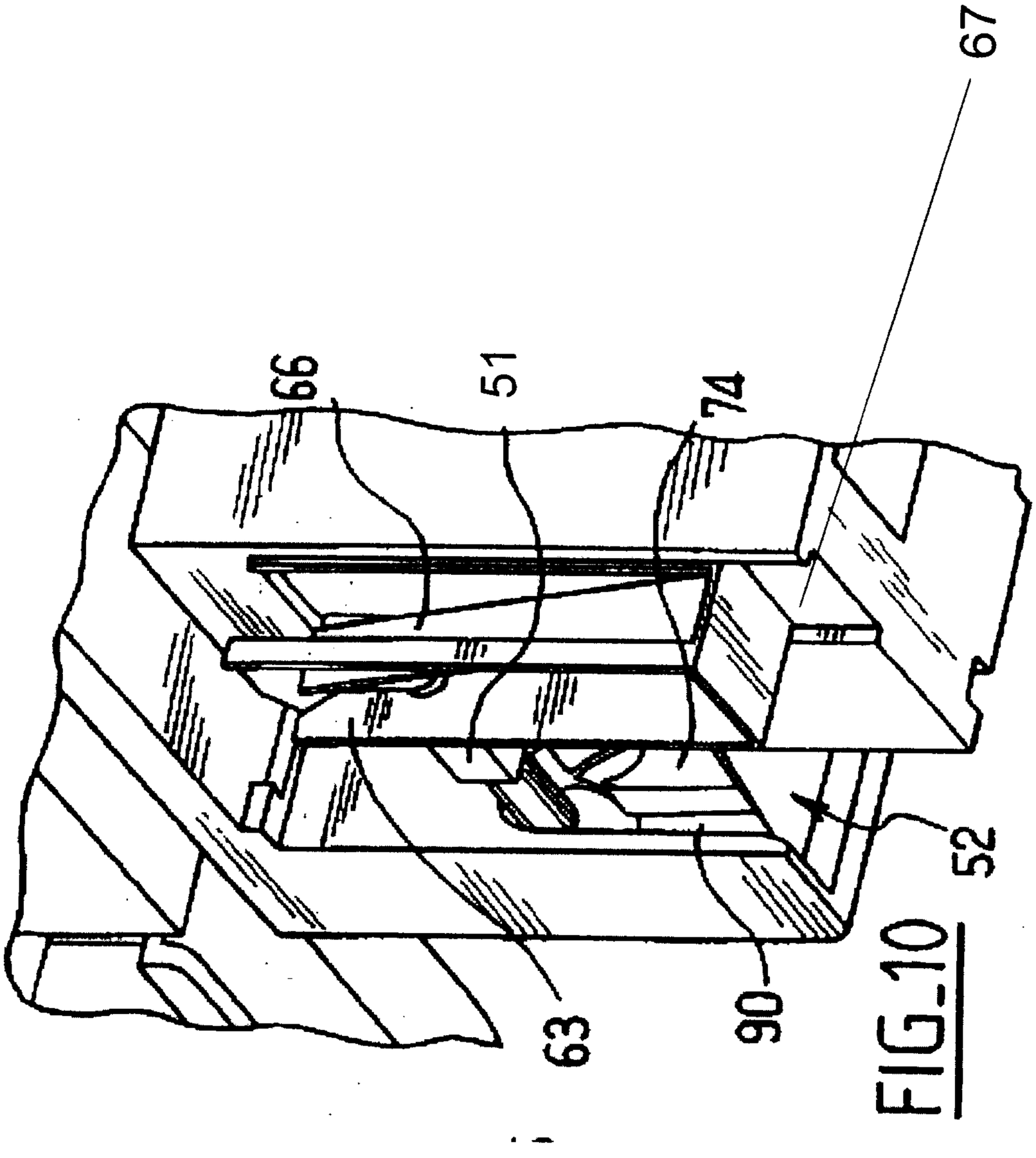


FIG_10

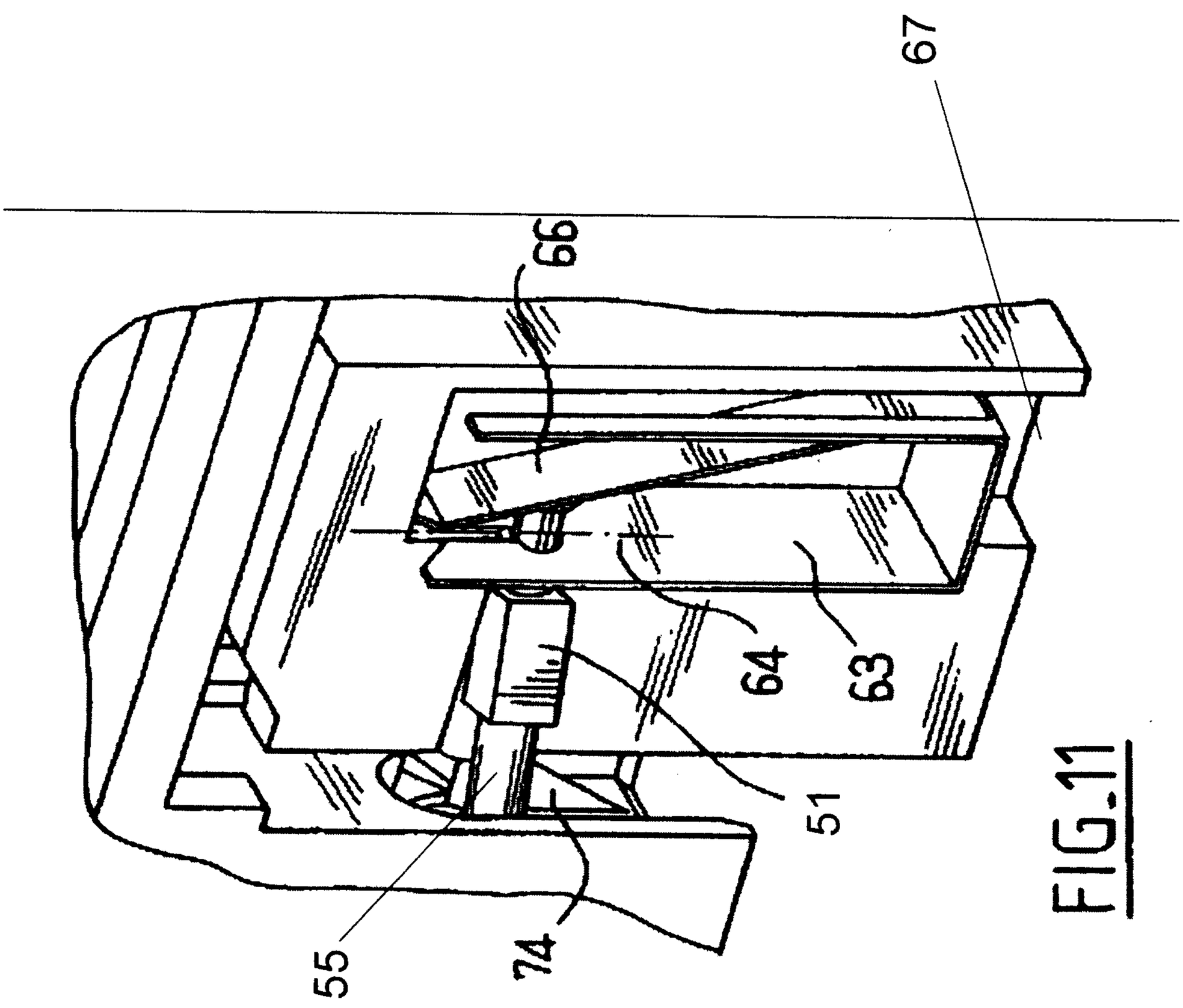


FIG.11

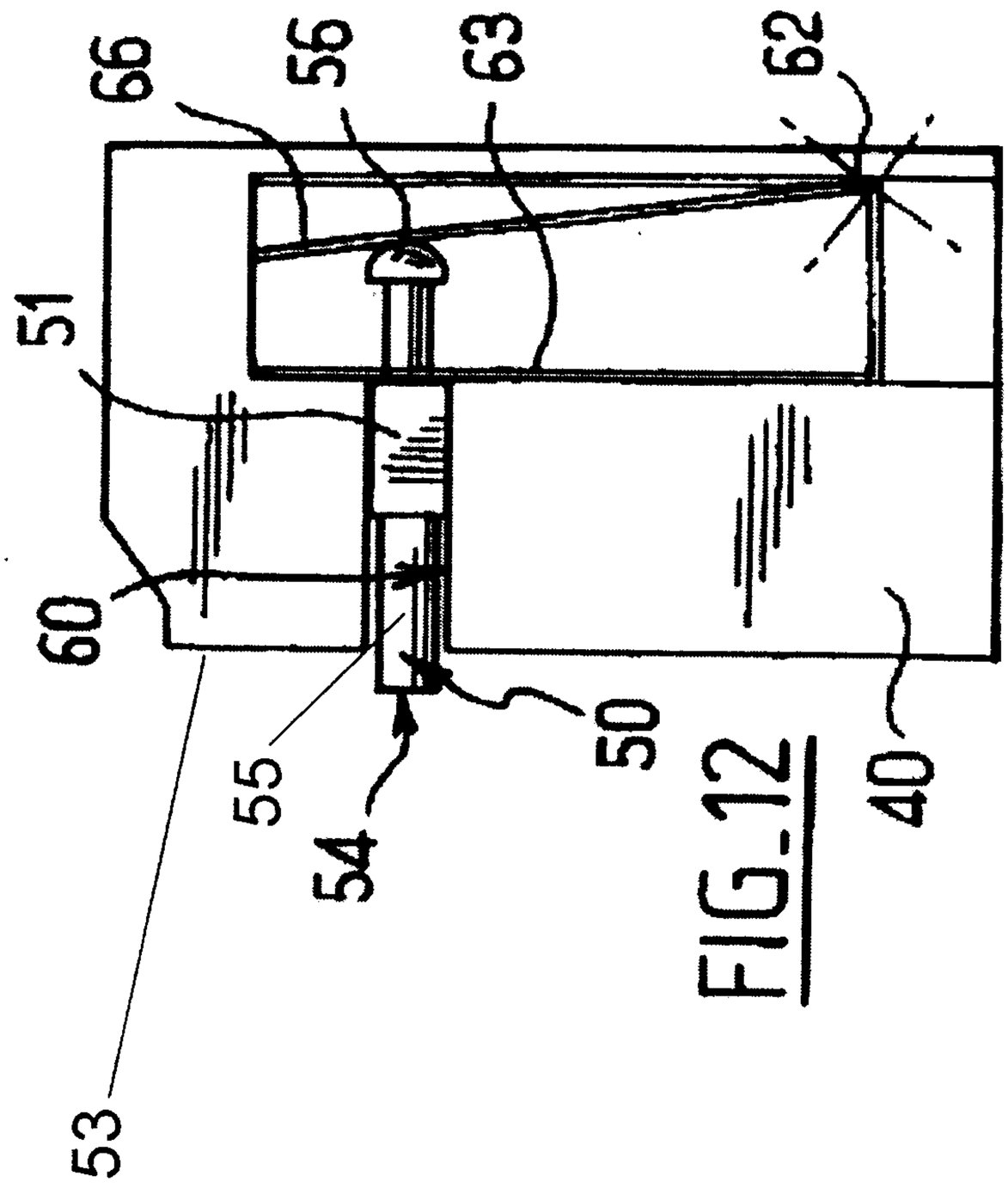


FIG.12

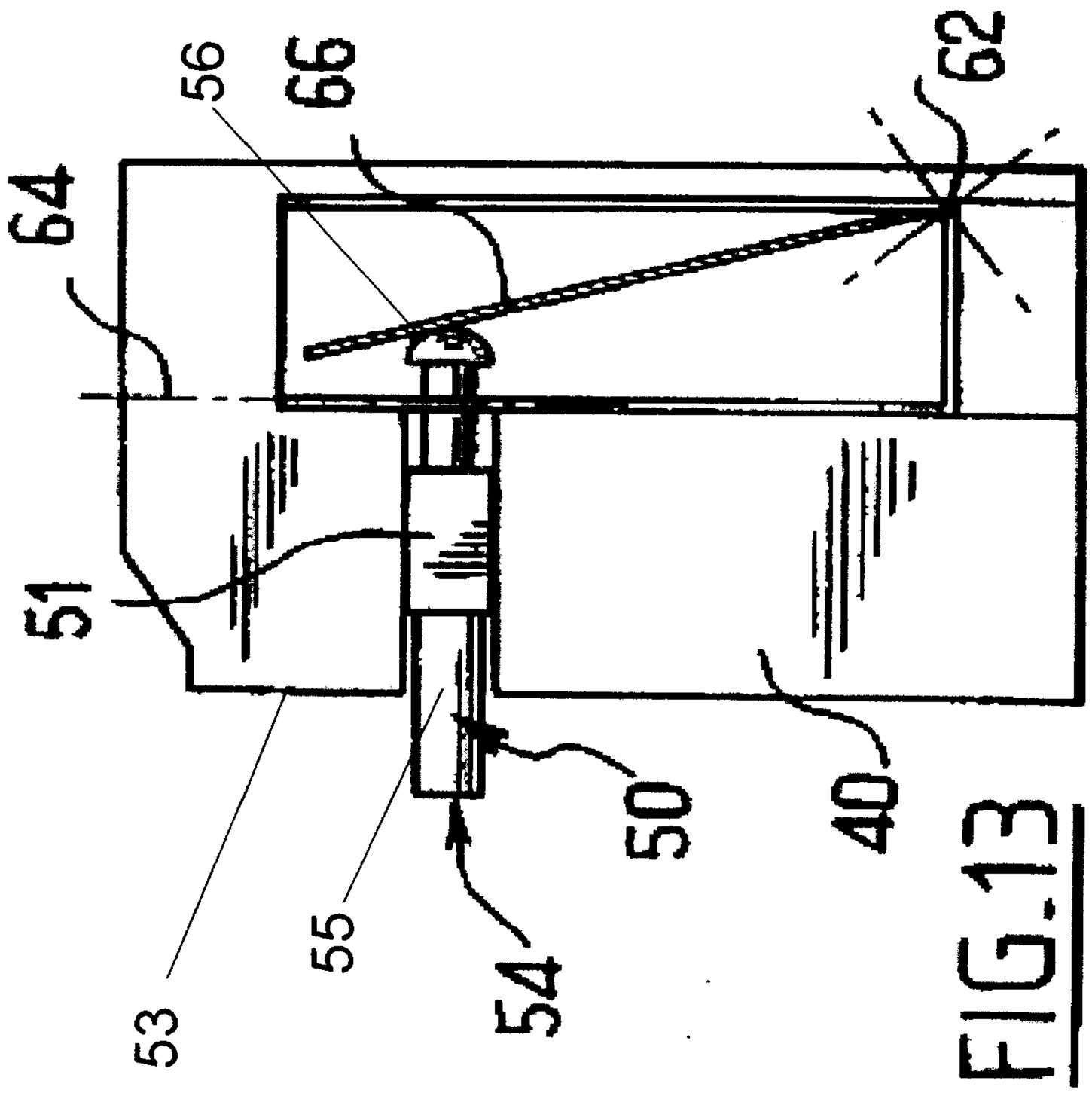
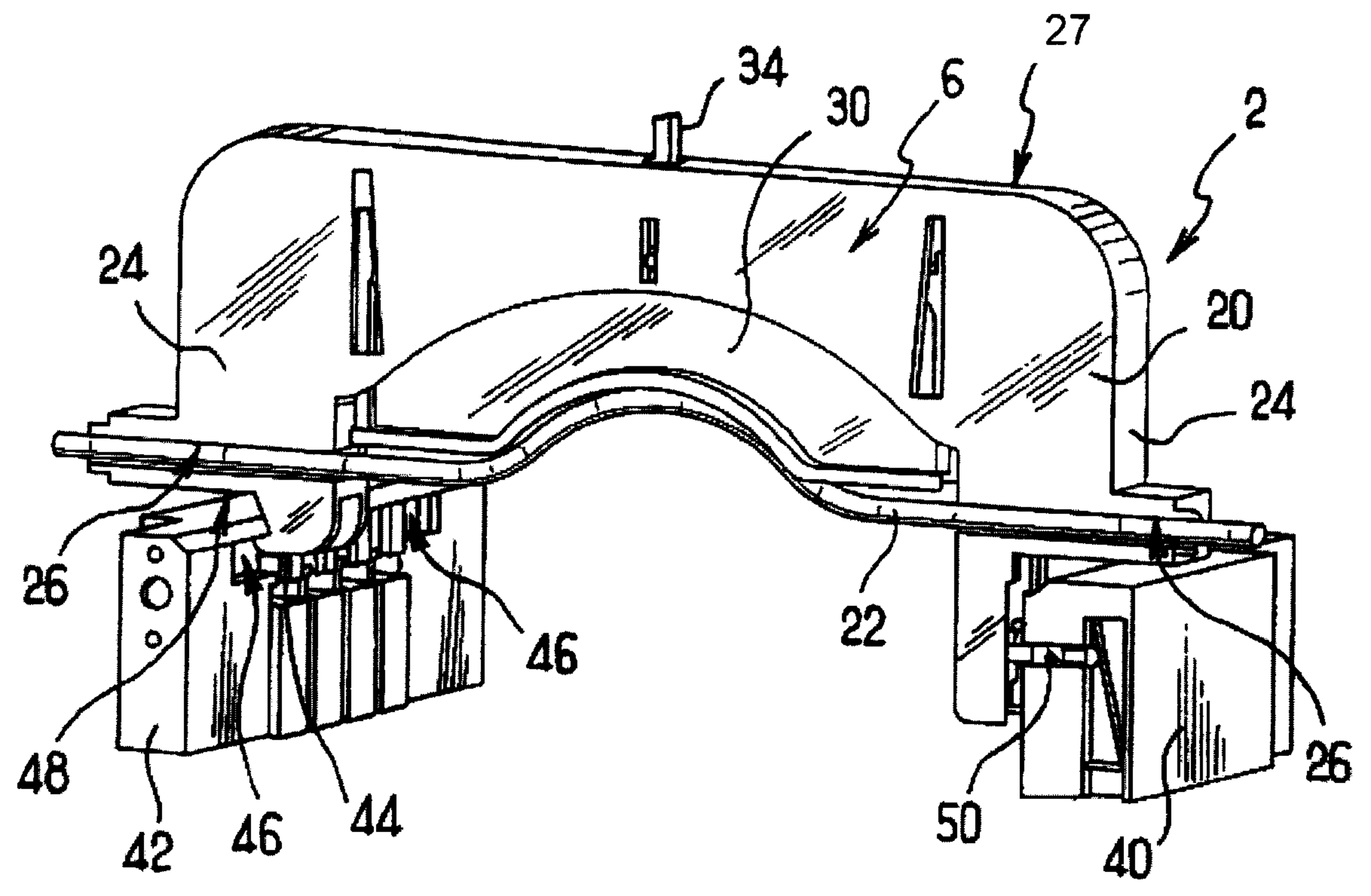


FIG.13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