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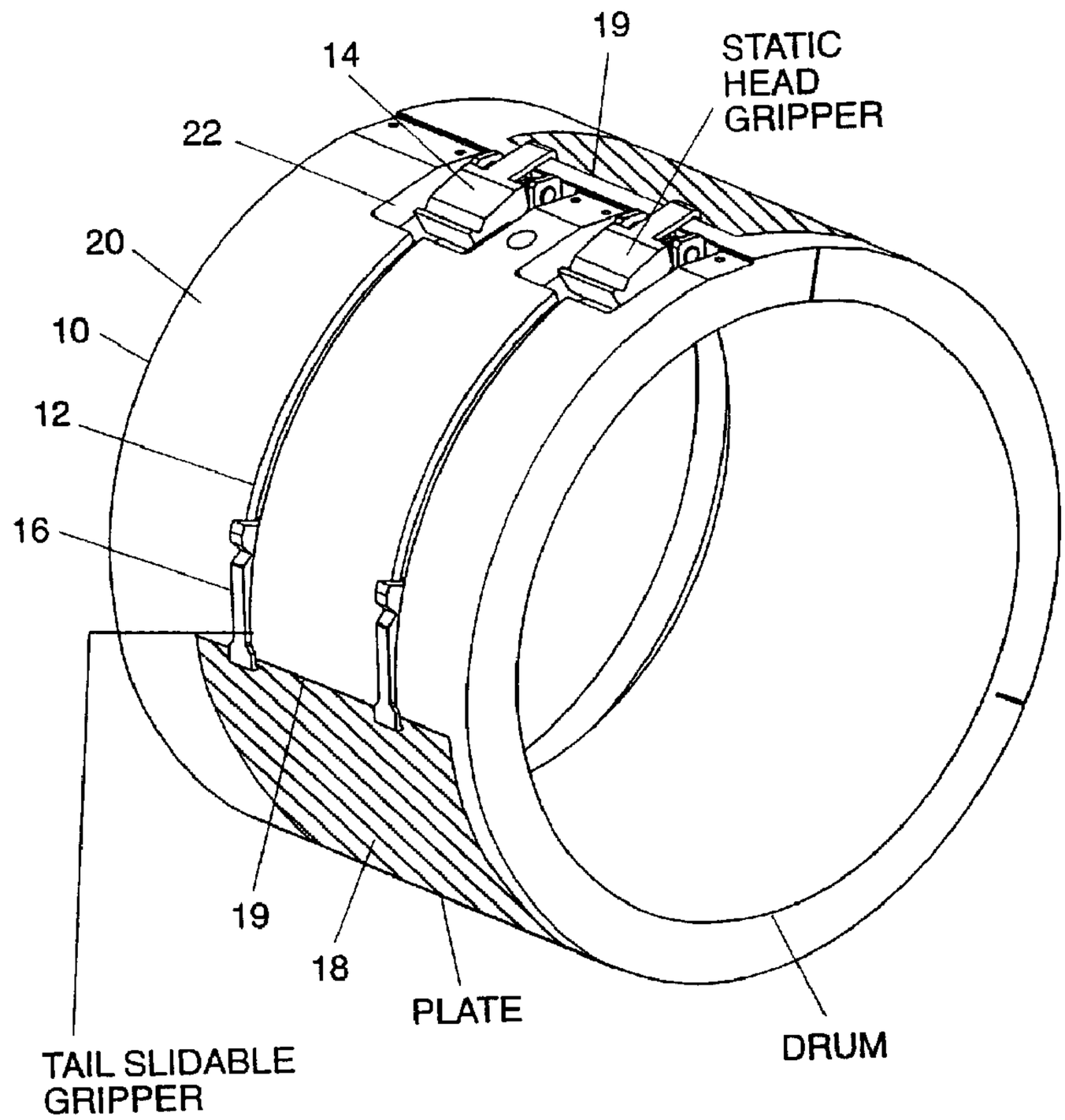
(54) Titre : SYSTEME DE FIXATION DE PLAQUES A DES DISPOSITIFS EXTERNES DE TAMBOUR, BASE SUR DES PINCES MOBILES

(54) Title: SYSTEM FOR ATTACHING PLATES TO EXTERNAL DRUM DEVICES, BASED ON MOVABLE CLAMPS



(57) Abrégé/Abstract:
A system for loading and clamping one or more plates onto the cylindrical surface of a rotatable drum, such as used in a platesetter for printing, and for unloading the plates from the drum. The system is characterized by clamps that are movable over the surface,

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preferably along circumferential tracks, enabling the attachment of multiple plates, end-to-end and/or side-by-side, each plate having any of a wide range of sizes. The clamps are preferably of the dynamic type, whereby the clamping force increases with rotational speed. Also disclosed is a method for mounting and unmounting plates, using the movable clamps, such that allows flexible and convenient arrangement of loading- and unloading stations.

ABSTRACT

A system for loading and clamping one or more plates onto the cylindrical surface of a rotatable drum, such as used in a platesetter for printing, and for unloading the plates from the drum. The system is characterized by clamps that are movable over the surface, preferably along circumferential tracks, enabling the attachment of multiple plates, end-to-end and/or side-by-side, each plate having any of a wide range of sizes. The clamps are preferably of the dynamic type, whereby the clamping force increases with rotational speed. Also disclosed is a method for mounting and unmounting plates, using the movable clamps, such that allows flexible and convenient arrangement of loading- and unloading stations.

APPLICATION FOR PATENT

Inventor: Nir Halup, Yehuda Barnes Solomon and Moshe Beres

Title: System for attaching plates to external drum devices, based on movable clamps

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to attaching a plate to a rotatable drum and, more particularly, to conveniently attaching plates of various sizes to the drum of a so-called external-drum imagesetter or platesetter, by means of movable dynamic clamps, such that enable it to operate even at very high rotation speeds.

Imagesetters, namely marking engines for plotting images on plates or sheets of film, of the so-called external-drum type, are known in the art. Typically, a sheet is attached to the outer surface of a rotating drum and held in contact with the surface by a vacuum system, which has orifices distributed over the surface. Often, such an imagesetter is required to handle sheets of various sizes. U.S. Pat. No. 5,383,001 to Bosy addresses such a need, by providing a suitable design of the vacuum system.

External-drum platesetters are a particular category of external-drum imagesetters, wherein the image is plotted on a printing plate. Printing plates are generally made of metal and therefore they are stiffer than films and their mass per unit area is much higher. Thus, when a plate is attached to the drum, it requires a greater force to keep it in contact with the drum's surface at any given rotational speed, to counteract the centrifugal force, than is required by a film. Consequently, a vacuum system to hold plates on the rotating drum must be more efficient and more powerful than that used for holding films. However, even with a powerful vacuum system, there is a danger of failure, due to a bend or a bulge at the edge of the plate or

due to a failure in the vacuum system itself. Moreover, above a certain rotational speed the centrifugal force per unit area may exceed the difference between atmospheric pressure and the actual vacuum pressure (which, in turn, has a practical lower limit), thus rendering such a plate attachment system, solely based on vacuum, ineffectual. In such a system failures may cause the entire plate to fly off the drum by centrifugal action - which would be disastrous for the entire machine. Therefore platesetters require mechanical attachment means - either to assist the vacuum system and guard against drastic failure, or as the main holding means, possibly still aided by vacuum. One common and useful such means is clamps mounted on the drum and operative to hold down the edges of the plate.

Clamps and grippers for holding a plate onto a rotatable drum have been known in the art. For example, clamps (also called grippers) are generally used in offset printing presses to hold the printing plate onto a cylinder. During operation, centrifugal forces act to cause a pulling force on each edge of the plate, such that tends to pull the edge from the clamp. Therefore in printing presses, clamps are designed to exert enough gripping force to exceed that required for countering the centrifugally induced pulling force, at maximum expected rotational speed, by a safety margin. Additionally, the gripping force of the clamps must exert a positive stretching force on the plate, in order to assure contact between the plate and the cylinder over its entire surface, as well as to counter the drag forces exerted on the plate by external rollers and cylinders that are in contact with it during the printing operation. Such clamps are disadvantageously cumbersome for mounting on platesetters and, moreover, difficult to activate (i.e. to open for accommodating the plate), because they must include either a heavy bolting or leveraging mechanism or a very strong spring-loading mechanism.

U.S. Pat. No. 3,203,074 describes an improved clamp, in which the gripping and stretching forces increase by centrifugal action in proportion to the rotational speed. A clamp with such

a centrifugal action (also termed dynamic clamp) may overcome the disadvantages discussed in the previous paragraph. U.S. Pat. No. 4,250,810 discloses a further improved clamp with centrifugal action, whereby the gripping and stretching forces can be independently adjusted.

It is noted that in platesetters, there usually is also a vacuum system, which assures contact between the plate and the drum over its entire surface, and that therefore no stretching force, but only a gripping force, is required at the edges of an attached plate. U.S. Pat. No. 5,335,046 discloses a clamp for the drum of a platesetter with a mechanism that centrifugally induces a gripping force. There is a row of such clamps for the leading edge and another one for the trailing edge. The mechanism includes a weight, connected to the clamp by a rod, located inside the drum near the opposite surface. The clamp may be opened by means of a piston and cylinder assembly, activated by supplied pressurized air. The clamp mechanism of the '046 patent has two serious drawbacks: (1) It is relatively complicated, with a relatively large number of parts, and thus is expensive to manufacture. (2) It does not conveniently accommodate plates of various sizes. The secondly listed drawback also applies to other types of clamps of prior art, such as those discussed hereabove. The '046 patent does disclose the possibility of providing a row of trailing edge clamps for each plate size; however, such an arrangement is even more expensive and, furthermore, does not accommodate small variations in plate size; moreover, it does not provide for mounting a plurality of plates peripherally around the drum, in the case of small plates, thus detracting from productivity.

Associated with the manner of clamping plates to the drum is the manner of loading them onto the drum and of unloading them following the plotting operation -- whether manually or by automatic mechanisms. Most systems of prior art are limited in the loading- and unloading configurations practically possible, generally enabling loading only upon, say, clockwise rotation of the drum and, correspondingly, unloading – only upon counterclockwise

rotation of the drum. This places constraints on the design of loading- and unloading mechanisms and on their placement within the machine. More freedom in such design and placement may, in many cases, be advantageous.

There is thus a widely recognized need for, and it would be highly advantageous to have, a clamping system, for attaching a plate to a rotatable drum, that is adaptable to any plate size, possibly allowing the attaching of multiple plates, of various sizes, and that enables loading and unloading plates upon rotation of the drum in either direction.

SUMMARY OF THE INVENTION

The present invention successfully addresses the shortcomings of the presently known configurations by providing a an inexpensive dynamic clamping system, for attaching plates of various sizes to a rotatable drum, such as that of a platesetter, so that they are firmly gripped at any rotational speed.

EP-A-0881074 discloses an apparatus for recording an image on a sheet of flexible media, the sheets of media having a leading edge and a trailing edge, the apparatus comprising a rotatable drum, having an outer cylindrical surface for attaching a sheet of flexible media thereto; a plurality of circumferential grooves cut into said cylindrical surface; a media loading assembly and a media unloading assembly, both positioned in the vicinity of said drum; and a plurality of clamps, each movable along a respective one of said grooves and operable by an external activation mechanism to a clamp or release state, said clamps arranged as at least one pair of sets of clamps each set including at least one clamp, all clamps in a first set of each of said at least one pair being operative to clamp a sheet of media at a leading edge thereof onto said cylindrical surface and all clamps in the second set of each of said at least one pair being

operative to clamp a sheet of media at a trailing edge thereof onto said cylindrical surface.

The present invention is characterized in that the drum is rotatable in a first direction and a second direction, and the apparatus is operative to load a sheet of media, leading edge first, from said loading assembly onto said cylindrical surface while said drum rotates in said first direction or said second direction, and to unload a sheet of flexible media, from said cylindrical surface onto said unloading assembly while said drum rotates in said first direction or second direction.

According to further features of the second aspect of the invention, only the first set of clamps clamp the plate during loading and only the second set of clamps clamp the plate during unloading, and each clamp is switchable between two states - a clamping state and a released state - and circumferentially movable, with respect to the surface of the drum, while in the released state.

According to still further features of the invention, the plate loading assembly and the plate unloading assembly are positioned substantially at one and the same side of the drum or at the same level. In certain configurations of the invention, there are at least two pairs of sets of clamps and the apparatus is further operative to similarly load at least one other sheet of media from the loading assembly and to attach them to the drum in circumferentially tandem positions, and a sheet of media may have any of a plurality of widths and any of a plurality of lengths.

Also disclosed is a method for loading at least one sheet of flexible media onto the cylindrical surface of a rotatable drum, clamping said sheet of media thereto and unloading said sheet of media therefrom, the sheets of media having a leading edge and a trailing edge, the method comprising:

(a) providing a drum rotable in a first direction and a second direction;

(b) providing a media loading assembly and a media unloading assembly and positioning them in the vicinity of the drum;

(c) providing, for each of the media to be clampable to the drum, a pair of sets of clamps, each set including at least one clamp, and attaching them to the surface of the drum so that each clamp is movable along a circumferential line, whereby each clam is switchable between a clamping sate and a released state and being operative, while in the clamping state, to clamp an edge of a sheet of media engaged thereto onto the surface of the drum;

(d) p; providing a clamp activation mechanism not attached to the drum;

(e) feeding a sheet of media from said loading assembly until its leading edge engages a first set of a corresponding pair of said sets of clamps, while all clamps thereof are in the released state;

(f) switching each said clamp of said first set, while engaged by the sheet of media, to the clamping state, then slowly rotating the drum in one of said first or second directions so as to pull the sheet of media from said loading assembly and to wrap it around the drum;

(g) moving each said clam of the second set of said pair, while in the released state, until they engage the trailing edge of the sheet of media wrapped in step (f), the switching them to the clamping state;

(h) for unloading each clamped sheet of media, switching each said clamp of the corresponding first or second set to the released state and moving them away from the released edge, then slowly rotating the drum in one of said first or second directions so as to push the released edge of the sheet of media onto said unloading assembly;

(i) switching each said clamp of the corresponding other set to the released sate, to allow said unloading assembly to pull the sheet of media, released in step (h) from the drum.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is an isometric drawing, schematically showing a drum with the clamping system of the present invention;

FIG. 2 is a cross-sectional view of the system of Fig. 1;

FIG. 3 is an isometric drawing, schematically showing a portion of the drum of Fig. I with slidable clamps according to the present invention;

FIG. 4A is a side view and cross-sectional view of a slidable clamp according to the present invention;

FIG. 4B is a top view and sectional side view of the slidable clamp of Fig. 4A;

FIG. 5 is an isometric view of a stationary clamp according to the present invention;

FIG. 6 is a schematic isometric drawing of a platesetter illustrating operation of the clamping system of the present invention.

FIG. 7 is an isometric drawing, schematically showing an alternative configuration of the clamping system of the present invention.

FIG. 8 is a schematic end view of the clamping system of Fig. 6, with all clamps being slidable.

FIG. 9 is an end view of an alternative configuration of the system of Fig. 8, schematically showing two pairs of clamps and plates clamped by them.

FIG. 10 is an isometric drawing of a system similar to those of Figs. 8 and 9, showing an arrangement of multiple plates side-by-side.

FIGS. 11A and 11B are schematic end views of the clamping system of Fig. 9, illustrating loading- and unloading plates according to a first configuration.

FIGS. 12A and 12B are similar to Figs. 11A and 11B, but illustrate a preferred configuration of plate loading- and unloading.

FIG. 13 is an isometric drawing of a clamping system of a configuration alternative to that of Figs. 8 to 10.

FIGS. 14A and 14B is a schematic isometric drawing of a clamping system, showing additional slidable clamp types.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is of a dynamic clamping system, for attaching one or more plates to a rotatable drum and for enabling loading and unloading of the plates to- and from the drum upon its rotation in either direction.

Specifically, the present invention can be used to easily attach a plate, or a plurality of plates, of any size to the drum of a marking engine, such as a platesetter, so that the plate is firmly gripped at any rotational speed. The clamping system is characterized by being operable for loading and unloading plates with the drum rotating in either sense. While the preferred embodiment is concerned with attaching a printing plate to the drum of a platesetter (i.e. a device for plotting images from digital sources onto printing plates), it will be understood that the present invention is applicable to attaching also any other types of plates and sheets of any media, such as film, paper or plastic foils, to any rotatable drum for any other purpose. The preferred embodiment also includes clamps, or grippers, of a particularly advantageous design, as described and claimed in a copending patent application. It should, however be understood that also other types of clamps and grippers may be used, such as those relying entirely on springs, or on magnets, to provide the gripping pressure or centrifugally actuated grippers of other designs – all coming within the scope of the present invention.

The principles and operation of a clamping system according to the present invention may be better understood with reference to the drawings and the accompanying description.

Referring now to the drawings, Figure 1 is an isometric view, and Figure 2 - a cross-sectional view, of a drum with a preferred embodiment of the clamping system of the present invention. There is shown a drum **10**, with outer surface **20**. Surface **20** is cut by two (generally - several) grooves **12** running circumferentially and extending over a considerable portion of the drum's circumference. Each groove **12** has an undercut profile, to be described

herebelow. At one end of each groove **12** is a stationary clamp **14**, fixedly attached to drum **10**. Stationary clamp **14** is attached preferably within a depression **22**, cut into surface **20**, in order to keep the extent of the clamp above surface **20** to a minimum, so as to clear a writing assembly (not shown) suspended a distance above the surface. In each groove **12** there is a slidable clamp **16**, to be described herebelow. Stationary clamp **14** and slidable clamp **16** are operative to grip a plate **18** near its end edges **19**. Drum **10** is preferably provided with a vacuum system, operative to press the entire surface of plate **18** onto surface **20**.

Referring now to Figure 5, there is shown the construction of stationary clamp **14**. It consists essentially of two parts - a base **24** and a gripper **26** - mutually attached by a hinge **28**, which, for example includes a cylindrical pin **30**, whose axis forms the pivot axis **32** of the hinge. Gripper **26** is formed so as to have a relatively large body **34**, extending to one side of pivot axis **32**, and a relatively short tongue **36**, extending to the other side of pivot axis **32**. Body **34**, preferably has a flat top surface, with a notch **37** cut across it. Tongue **36** has a tip **40**. It is noted that base **24** serves to join hinge **28** to the drum and could also be regarded as part of the hinge structure; other structures and other means for such joining may be provided. The assembly of stationary clamp **14** also includes a spring, such as coiled spring **38**, disposed around hinge pin **30**.

Stationary clamp **14** is attached to drum **10** by fastening base **24** to the drum, for example - by means of screws, preferably inside a depression **22** (Fig. 1), so that tongue **36** points in a circumferential and so that tip **40** lies beyond the depression (that is, in contact with surface **20**). Spring **38** acts to lift body **34** away from the drum and thus press tongue **36** toward the drum. The tip **40** of tongue **36** preferably has a friction pad or one or more small protrusions thereon, facing the drum. Normally, tip **40** is pressed against drum surface **20**. Spring **38** acts to make this pressure strong enough to grip the edge of a plate, which has been inserted

between the tip and the drum surface, under static conditions. All stationary clamps **14** are attached to drum **10** so that they are aligned along a line that, preferably, is parallel to the drum's axis and are all pointing in the same direction.

When drum **10** rotates, centrifugal force on body **34** tends to lift it away from the drum. This force is translated by the pivoting action into a radially inward force of tip **40**, which thus increases its pressure against drum surface **20** and consequently also the gripping force on the edge of a plate therebetween. The centrifugal force is essentially -

$$CF = M \times \omega^2 \times R$$

where M is the mass of gripper **26**, ω is the angular speed of the drum and R is the distance from the drum's axis of rotation (not shown) to the center of mass **42** of gripper **26**. The force at tip **40** is essentially -

$$TF = CF \times D1/D2$$

where D1 is the distance from pivot axis **32** to center of mass **42** and D2 is the distance from pivot axis **32** to the middle of tip **40**. Clearly, it is desirable, at any rotational speed, to make TF large enough to grip the edge of the plate firmly enough to prevent its being pulled out. This can be achieved, for any given design of tongue **36** and tip **40** (which also fixes D2), by making the moment of centrifugal force, CF x D1, to be of sufficient magnitude. This, in turn, is obtained, for a given drum radius R and any angular speed ω, by making the moment of mass of gripper **26** with respect to pivot axis **32**, M x D1, to have sufficient magnitude. The moment of mass may be made sufficiently large by appropriate construction of body **34**; for example, M may be made large enough by making the body's volume large and/or fabricating it out of a high-density substance, while a sufficient complementary value for D1 may be obtained by shaping the body so as to extend sufficiently far from hinge **28**.

We now refer to figure 4A, which shows slidable clamp **16** in a side view and in a cross-sectional view and figure 4B, which shows the same in a length-sectional view and a top view. Slidable clamp **16** is, in principle, similar to stationary clamp **14** - both in its construction and in its mode of action, except for some essential details, to be described herebelow. It consists of base **44** and a gripper **46**, joined by a hinge, which includes, for example, pivot pin **48**. Gripper **46** is formed to have, on one side of pivot pin **48**, an elongated massive body **50** and, on the other side of that pin, a short tongue **52**, which ends with a tip **60**. A spring **51**, preferably of the compression type, is disposed between base **44** and body **50**. When clamp **16** is mounted on drum **10** (as will be described herebelow), spring **51** acts to push body **50** radially outwards and, by the pivoting action, to press tip **60** radially inwards. When the edge of a plate lies under tip **60**, the latter then presses against it. When the drum rotates, the centrifugal force virtually acting on body **50** is added to the push of spring **51** and thus the pressure of tip **60** on the plate underneath it is increased -- all in a manner similar to that described hereabove with respect to stationary clamp **14**. Clearly, again, it is desirable to make the mass of body **50** of gripper **46** as large as possible. This can be done by making it of dense material and/or by making any of its dimensions as large as possible. In the preferred embodiment described herein, body **50** is shaped to be narrow and relatively tall (i.e. with large dimension in the radial direction), but also other shapes are possible. According to this embodiment, base **44** has a central slot sunk into its upper surface over most of its length, the width of the slot being slightly greater than the width of body **50**. Thus base **44** can partially accommodate body **50** during the latter's motion about pivot **48**.

Referring now to Figure 3, which shows a section of drum **10** with corresponding segments of two grooves **12** (one of them shown cut open) and a slidable clamp **16** mounted inside each groove, it is noticed that each groove **12** is undercut into the wall of drum **10**; that

is, the groove is relatively narrow near surface **20** of the drum and wider under the surface, inside the wall. Preferably, the profile shape of the wide portion **54** of groove **12** is rectangular. Base **44** of slidable clamp **16** is formed to conform to wide portion **54** and to easily slide therealong. Body **50** of gripper **46** is formed to be slightly narrower than the narrow portion **56** of groove **12**, so that it is slidable through that narrow portion whenever base **44** slides through wide portion **54**. Preferably, body **50** of gripper **46** is also formed, and clamp **16** assembled, so that in its normal position, body **50** protrudes from groove **12** beyond surface **20**. The top surface of body **50** preferably has a depression, such as notch **58**, cut into it (to be engaged by an activation pin, as described herebelow).

Slidable clamps **16** are mounted each in a groove **12** so that tip **60** of tongue **52** of gripper **46** points circumferentially in a direction that is opposite the direction in which the fixed clamps point. As will be described herebelow, during normal operation, the (preferably) trailing edge of plate **18**, mounted on drum **10**, lies underneath tip **60** and is pressed by the latter. Tip **60** is preferably substantially wider than narrow portion **56**, thus bridging the latter and pressing the plate directly against drum surface **20.** It is also preferably provided, on its side facing plate **18**, with one or more small protrusions or with a friction pad. These are operative, under the aforementioned pressure by the tip on the plate against surface **20**, to firmly grip the edge of the plate.

The bottom surface of base **44** is preferably coated with a glide pad, which operates to ease its sliding on the bottom surface of wide portion **54** of groove **12** whenever pushed against it. The top surface of base **44** has preferably attached thereto one or more friction pads **62** (figs. 4), positioned so as to be able to contact the top surface of wide portion **54** of groove **12**. The gripping force of tip **60** on the plate (due to the action of spring **51** and, during drum rotation, due to centrifugal force on body **50**) is countered by an upward pressure of the portion of base

44 that lies underneath (opposite) tongue **52**. The base is thus pressed against the top surface of wide portion **54**, preferably through pads **62**, thereby inhibiting any sliding motion therebetween. During drum rotation, additional upward pressure is exerted by the entire base **44**, due to centrifugal forces on itself - which adds to its friction with the top surface of wide portion **54**.

Looking at the action of slidable clamps **16** from a different point of view, the clamps may be regarded as forcefully clamping together the plate (at its edge) and the outer shell of the drum (being between the top surface of wide portion **54** and drum surface **20**) - simultaneously anchoring the plate and base **44** to the drum. The clamping force is increased by centrifugal action on body **50**. In the case of stationary clamps **14**, the clamping action is on the plate alone - between tip **40** and drum surface **20**.

It is noted that the construction of the clamps of the present invention, of both types, is inherently simple and involves a very minimal number of components. Such clamps are therefore advantageously inexpensive to fabricate.

Typical operation of the clamps will now be explained with reference to Figure 6. There is shown, by way of example, an activation mechanism, positioned at a plate loading station, in relation to the drum and the clamps thereon. It includes a bar **64**, subtending the length of drum **10** and suspended, parallel to its axis, at a certain distance from surface **20**. In bar **64** are pins **66**, one pin essentially coplanar with each groove **12**, which are movable radially. The pins may be moved by any of a variety of means, such as solenoids, pneumatic actuators or a cam. In an alternative configuration, bar and pins may be replaced by a direct activation mechanism, such as a cam or a manually operable lever assembly. Mounting of a plate, to be subsequently plotted, onto drum **10** typically proceeds as follows:

1. Initially all slidable clamps are preferably aligned along a common line, parallel to the drum's axis and circumferentially just far enough from the stationary clamps to freely accommodate the full length of the plate; the latter condition can be arrived at by moving all slidable clamps in a manner similar to that described in steps 7 and 8 herebelow, whereas initial alignment along a line can easily be performed manually

2. The drum is rotated to a position (shown in the illustration) such that notch **37** on body **34** of each stationary clamp **14** is directly under a corresponding one of pins **66**.

3. Pins **66** are pushed inwards, pressing on bodies **34** against the force of spring **38** (Fig. 5) and causing tips **40** to lift off surface **20**.

4. A new plate (not shown) is introduced tangentially to the drum (from top right, in the illustration) and registered thereon (preferably by means of registration pins provided thereon) so that preferably its leading edge is positioned under tongues **36** of all relevant clamps **14,** a certain distance behind corresponding tips **40**.

5. Pins **66** are withdrawn, freeing all grippers **26** to grip the edge of the plate, in a manner explained hereabove.

6. The drum is slowly rotated forward (counter-clockwise in the illustration) while the plate is being gradually wrapped around its surface, for example by means of rollers (not shown); if a vacuum system is included, the vacuum may be applied at this step.

7. Rotation stops when notches **58** on bodies **50** of slidable clamps **16** are positioned directly below pins **66**; the pins are then pushed inwards, pressing on bodies **50** against the forces of springs **51** (Figs. 4) and causing tips **60** to lift off surface **20**; they also cause bases **44** to be pushed against the bottom surfaces of grooves **12**

8. The drum is slowly rotated backwards (clockwise in the illustration) while clamps **16**, which are held stationary by pins **66** engaging notches **58**, slide along their respective grooves **12**.

9. The backward rotation stops when the other (preferably trailing) edge of the plate becomes positioned under tongues **52** of the relevant clamps, a certain distance behind corresponding tips **60.**

10. Pins **66** are withdrawn, freeing all grippers **46** to grip the trailing edge of the plate, in a manner explained hereabove.

11. The drum is accelerated to normal operational speed and plotting proceeds in the usual manner.

Demounting of the plate, after plotting, proceeds in a similar manner, though essentially in a reverse order. For this operation, another bar, similar to activation bar **64** with pins **66**, but positioned at an unloading station, may be used.

It is noted that during normal (fast) drum rotation, the clamps firmly grip the plate, through the pressure of the tips of the tongues against the drum surface, and simultaneously each slidable clamp is, in effect, anchored in its position, through friction (preferably by means of the friction pads) between the top surface of its base and the top surface of the wide portion of the groove -- all assisted by centrifugal effects, as explained hereabove.

It is also noted that the position of each slidable clamp along its respective groove is infinitely variable, within a range determined by the circumferential length of a groove, and that therefore the length of a plate that can be gripped by it may assume an infinite number of values within a corresponding range. It is likewise noted that operating the clamps (both in gripping a plate and in positioning a slidable clamp) is relatively easy, whether done manually

or by an activation mechanism such as described hereabove. It is further noted that even if only a single length of plates need ever be accommodated, the configuration with slidable clamps advantageously eases the process of gripping plates during mounting and releasing them during demounting (all -- by the use of reverse rotation).

It will be appreciated that other means and procedures, including manual ones, for mounting a plate on the drum, or demounting it therefrom, and for operating the clamps and moving the slidable clamps along the grooves, are possible - all coming within the scope of the present invention. It will also be appreciated that a drum may be provided with any number of stationary clamps and any number of grooves, each groove with one or more slidable clamps, but not all clamps need be engaged; in particular, if a plate substantially narrower than the length of the drum is mounted, only a corresponding number of the clamps would be engaged in gripping it. Although, in the preferred embodiment, each stationary clamp is paired, and axially aligned, with a groove and a corresponding slidable clamp, it will be appreciated that such pairing and/or alignment is not essential and that the number of stationary clamps need not be equal to the number of slidable clamps. In such a case, the activating mechanism of Fig. 6 may include additional pins - for any stationary clamps that are not aligned with corresponding grooves. It is noted that, with a plurality of clamps and grooves, it is possible to mount a plurality of plates, side by side along the drum; moreover, the plates thus mounted may variably be of any width (limited, of course, by the total width having to be less than the drum's length) and of any length (within the maximum length that can be accommodated between the clamps). Furthermore, in the case of multiple slidable clamps in any one groove, these may be paired with each other, clamps of any one pair facing each other and operable to hold a plate between them; in particular, if their number is odd,

one slidable clamp is made to face the stationary clamps, while the others are mutually paired; such a configuration is similar to that described in the next paragraph.

Another configuration is shown schematically, in an end view of the drum, in Figure 8. This configuration is similar to that of Fig. 6, except in that all clamps are of the slidable type. Here are disposed in each groove (not shown) around drum **10** a pair of slidable clamps **50**, with the tips **60** of each pair circumferentially facing each other. The operation of this configuration is similar to that of Fig. 6; however, in this configuration there is freedom in choosing the set of clamps to be operated first during plate mounting and, independently, the set of clamps to be operated first during plate demounting. This freedom is advantageous in the context of the loading and unloading arrangement, as will be explained herebelow.

A variation of the configuration of Fig. 8 is shown in Figure 9. Here are disposed in each groove around drum **10** two pairs of slidable clamps **50**. It is then possible to mount two plates around the drum's circumference, such as plates **18**, whereby each plate may independently have any length (subject, of course, to the total of the lengths not exceeding that which can be accommodated between the clamps at maximal intra-pair separation). This configuration advantageously provides a high degree of equipment utilization, while permitting flexibility in plate sizes. It is noted that the two plates may also be of different widths. Furthermore, as with the previously described configurations, it is also possible to mount additional plates side by side, by providing sufficient grooves (at least two per plate across) and corresponding pairs of clamps. Thus, for example and as illustrated in Figure 10 (where only half of the clamps are viewable), it is possible to mount four plates **18**, all of the same or different sizes, in a generally two across by two circumferential arrangement, using eight pairs (or more) of slidable clamps **16** in four (or more) grooves **12**. Clearly, the number of pairs of clamps in each groove can also be greater than two -- allowing mounting more

than two plates circumferentially. It is appreciated that also in the configurations of Figs. 8 and 9 one set of clamps may be of the stationary type, whereby one slidable clamp in each groove is replaced by a fixed clamp; this case will, however, not manifest the advantage of the flexibility in loading arrangements, explained herebelow.

It is noted that the arrangements of slidable clamps discussed hereabove and illustrated in Figs. 8-10 are also possible if the clamps are not of the dynamic type, as described herein (that is - if the clamping force is not derived from centrifugal action), or of a different dynamic type than that disclosed herein. In other words, any clamps that are movable along respective tracks and fixable at a plurality of positions therealong would enable attaching multiple plates of various sizes and would thus come within the scope of the present invention. Moreover, the clamps need not be isolated clamps, each moving along its own track and operable separately, as described herein, but may, for example, also be grouped into assemblies of clamps, each assembly joined by a bar and moving and operable in common, as sketched in Figure 14B. Another example of clamps admissible by the present invention is sketched in Figure 14A, showing a single wide clamp, attached to the drum at a plurality of tracks; alternatively, there may be a plurality of such wide clamps – one for each clampable plate across the drum. It is noted that Figs. 14A and 14B show only one clamp along each circumferential groove, its matching clamp (as well as circumferentially additional pairs of clamps) being hidden from view. The dynamic slidable clamps disclosed herein, such as clamps **16** in Figs. 4, are, however, particularly advantageous since they provide strong clamping force at any speed of drum rotation and relatively easy and convenient way of releasing them and of moving them along their grooves, as well as fixing each clamp at any of an infinite number of positions along its track (i.e. groove); furthermore, their being operable individually allows grouping of adjacent clamps to accommodate plates of various widths

(whereby, for example, two clamps across would be used for a narrow plate and three or more clamps across for a wider plate).

The operations of mounting and demounting plates on a drum with slidable clamps, and its relation with loading- and unloading stations will now be further explained with reference to Figures 11A, 11B, 12A and 12B, which are schematic end views. There is shown schematically in Figs. 11A and 11B an exemplary arrangement of a plate feeder **72** and a first examplary arrangement of a plate stacker **74**, in relation to drum **10** and to activation bar **64**, associated with a loading station **71**, and to activation bar **64'**, associated with an unloading station **73**. As shown in these views, plate feeder **72** is generally disposed above and to the right of the drum, while plate stacker **74** is below and to the left of the drum. For loading, depicted in Fig. 11A, a plate **18** is fed from feeder **72** (manually or by a mechanism, not shown), extended leftward, tangentially to drum **10**, and mounted onto the drum according to the enumerated procedure hereabove. In particular, its leading edge **76** is clamped to drum **10** by a first row of clamps **16**, when released by activation bars **64** (steps 4 and 5) and the drum then rotates slowly counterclockwise (step 6) until the plate's trailing edge **78** reaches the vicinity of loading station **71**, at which point it is clamped to the drum by a second set of clamps **16'**, which are slidable (steps 7-10). For unloading, illustrated in Fig. 11B (which is similar to 11A, except that the drum is shown in a different orientation), the second set of clamps, **16'**, is first brought to unloading station **73**, where they are released by activation bar **64'**, then, through slight CCW rotation of the drum, trailing edge **78** of the plate is freed from the clamps. The drum is then slowly rotated CW, pushing the plate (with its trailing edge, **78**, now leading) left toward stacker **74**, until the first set of clamps, **16**, reaches unloading station **73**. At that point the clamps are released, by activation bars **64'**, and the plate becomes free to be pulled (manually or by a mechanism, not shown) onto stacker **74**.

It is noted that in the configuration of Figs. 11 the first set of dynamic clamps (**16**) may be of the fixed type, but the second set (**16'**) must be of the movable type. It is further noted that in this configuration the first set of clamps (**16**) may be of any fixed type, not necessarily of the dynamic type (as described hereabove) and thus would be activatable and releasable by a mechanism other than activation bar 64. This configuration, which is typified by CCW drum rotation during loading and CW rotation during unloading (or vice versa), has some disadvantages for the overall design and operation of the machine, since either the feeder or the stacker may thus be difficult to reach by the machine's operator. In an alternative arrangement of this configuration, the feeder and stacker are placed near each other, e.g. both at the top right, and thus may be more conveniently reachable, but they present mutual space constraints.

An alternative preferable, and generally more advantageous, configuration of plate loading and unloading is such that both operations occur with the drum rotating in the same sense (either CW or CCW). Two exemplary arrangements of this configuration are illustrated in Figures 12A and 12B, in both of which plate loader **72** is, again, above and to the right of drum **10**. In the arrangement of Fig. 12A stacker **74** is below and to the right of the drum, while in the arrangement of Fig. 12B stacker **74** is above and to the left of the drum. Clamp activation bars **64** and **64'** are, again, positioned with respect to their corresponding stations. Under this configuration all dynamic clamps must be of the movable type and are preferably disposed in circumferentially running grooves. Operation is similar for all arrangements. Loading and mounting operation is identical to that under the configuration of Fig. 11A, as described hereabove, using activation bar **64**, with plate mounting occurring under CCW drum rotation. However demounting and unloading proceeds as follows: First, the drum is rotated to place the first set of clamps (**16**) under activation bar **64'**, which is then activated to

keep them open. The drum is then rotated slightly CW, to release leading edge **76** of the plate from under clamps **16**. Thereafter, the drum is rotated CCW, letting leading edge **76** of the plate proceed toward stacker **74**. When the second set of clamps **16'** becomes positioned under activation bar **64'** (which is the situation depicted in Figs. 12A and 12B), the drum stops and the mechanism is activated to release the clamps, whereupon the plate is pulled away to stacker **74**.

It is noted that the arrangement of Fig. 12A may be advantageous when it is desirable to access both the loader and the stacker from one side of the machine. The arrangement of Fig. 12B may be advantageous when it is desirable to access both the loader and the stacker from above the machine. The latter arrangement has a further advantage in that a single activation bar may be used for both the mounting and the demounting operations.

It is also noted that, for proper operation of the configuration of Figs 12, slidable clamps **16** and **16'** need not be mounted in a groove, as in the preferred embodiment, but could be circumferentially movable in any other way; such other ways could also be associated with a clamp activation and –release mechanism that is different from activation bar **64** (or **64'**) and could even be attached to the drum. However, if the extent of such motion is limited, the other advantages of the preferred embodiment, namely the ability to accommodate plates of various lengths, would be lost.

It is further noted that slidable clamps **16** and **16'** need not be of the dynamic type (i.e. with clamping force derived from centrifugal action), as described further above or of any other dynamic type, nor need they be activated or released by an activation bar, such as bar **64**, to come within the scope of the present invention. However, dynamic slidable clamps, as disclosed herein, are particularly advantageous, since they are of simple design, yet exert strong clamping force and are easily movable during loading and unloading, especially in

conjunction with an activation bar as described. It will be appreciated that the configurations described hereabove may be similarly operated for each plate when a plurality of plates are to be mounted on the drum, whether in a circumferential sequence or side-by-side, as described hereabove.

It is still further noted that additional pairs of clamps may be mounted around the drum, such as clamps **17** and **17'**, shown in Figures 11A to 12B. Such clamps may be used to attach additional plates around the drum, using the same respective loading- and unloading mechanisms and procedures as those used with respect to clamps **16** and **16'**, as described hereabove.

In other alternative configurations of dynamic clamps on the drum, which are basically similar to ones described hereabove, there may be additional clamps, preferably of the slidable type, disposed on the drum so that they can operate to grip a plate **18** along its side edges. A preferred embodiment of such a configuration is illustrated in Figures 7 and 13. Here a number of grooves **12'**, similar to grooves **12,** are cut into surface **20** of drum **10** in a direction generally parallel to the drum's axis. Pairs of slidable clamps **16'**, similar to **16,** are mounted in grooves **12'**, the tips of members of each pair facing each other. One or more plates **18** are mounted on the drum and each held, at one end, by stationary clamps **14** or slidable clamps **16** and, at the other end, by slidable clamps (not shown). Slidable clamps **16'** are then operated, in a manner to be described, to grip the side edges of a mounted plate and thus offer additional safety and holding power; they may be particularly advantageous in holding down a plate on a drum that lacks a vacuum system. It is noted that plates of any width (up to nearly the length of the drum) may thus be gripped.

Activation of clamps **16'** is effected by means of corresponding activation mechanisms **64"**, shown in Figure 13, which are similar to activation bar **64**, except that they are movable

parallel to the drum's axis. In order to activate several clamps simultaneously, a number of such mechanisms may be disposed at appropriate mutual circumferential distances around the drum. Moving a clamp **16'** within its groove is then effected by bringing the corresponding groove (through drum rotation) to under an appropriate pin **66**, then moving the respective activation mechanism **64"** until its pin **66** engage notch **58** of the appropriate clamp **16'**, then causing (Figs. 4) pin **66** to push the body of the clamp and to thus release it and further moving the respective activation mechanism **64"**, to slide the clamp onto or off the edge of plate **18**, as the case may be.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

CLAIMS:

1. Apparatus for recording an image on sheets of flexible media (18), the sheets of media having a leading edge (76) and a trailing edge (78), the apparatus comprising:

a rotatable drum (10), having an outer cylindrical surface (20) for attaching a sheet of flexible media (18) thereto;

a plurality of circumferential grooves (12) cut into said cylindrical surface (20);

a media loading assembly (71) and a media unloading assembly (73), both positioned in the vicinity of said drum (10); and

a plurality of clamps (16, 17), each movable along a respective one of said grooves (12) and operable by an external activation mechanism (64,64') to a clamp or release state, said clamps arranged as at least one pair of sets of clamps each set including at least one clamp (16,17), all clamps (16,17) in a first set of each of said at least one pair being operative to clamp a sheet of media (18) at the leading edge (76) thereof onto said cylindrical surface (20) and all clamps (16, 17) in the second set of each of said at least one pair being operative to clamp a sheet of media at the trailing edge (78) thereof onto said cylindrical surface (20)

characterised in that the drum (10) is rotatable in a first direction and a second direction,

and the apparatus is operative to load a sheet of media (18), leading edge (76) first, from said loading assembly (71) onto said cylindrical surface (20) while said drum (10) rotates in said first direction or said second direction, and to unload a sheet of flexible media (18), from said cylindrical surface (20) onto said unloading assembly (73) while said drum (10) rotates in said first direction or said second direction.

2. Apparatus as claimed in claim 1, wherein each clamp (16,17) is switchable between two states - a clamping state and a released state - and movable along a respective one of said grooves (12) while in the released state.

3. Apparatus as claimed in claim 1, further comprising said activation mechanism, not attached to said drum (10) and operative:

to activate any of said clamps (16,17), while in an appropriate position,

to switch an engaged clamp (16,17) between said two states, and

to cooperate with an engaged clamp, while in a released state, to cause it to slide along the respective one of said grooves (12) in reaction to a rotation of said drum (10).

4. Apparatus as claimed in claim 3, wherein each of said clamps is a dynamic clamp (16,17), whereby the force at which it clamps the media (18), when in the clamping state, consists of a constant component and a dynamic component, which is derived from centrifugal action and is essentially proportional to the rotational speed of the drum (10).

5. Apparatus according to any one of claims 1 to 4, wherein said media loading assembly (71) and said media unloading assembly (73) are positioned substantially at one and the same side of said drum (10).

6. Apparatus according to any one of claims 1 to 5, wherein said media loading assembly (71) and said media unloading assembly (73) are positioned on opposite sides of said drum (10).

7. Apparatus as claimed in any one of claims 1 to 6, wherein said media loading assembly (71) and said plate unloading assembly (73) are positioned substantially at the same level.

8. Apparatus as claimed in claim 1, wherein any of said clamps (16,17) is a dynamic clamp, operative to anchor itself to the respective one of said grooves (12) and to clamp the media(18) to said surface, both operations being with a force that consists of a constant component and a dynamic component, which is derived from centrifugal action and is essentially proportional to the rotational speed of said drum (10).

9. Apparatus according to any one of claims 1 to 8, wherein said at least one pair of sets of clamps (16,17) is at least two pairs of sets of clamps, the apparatus being further operative to similarly load at least one additional sheet of media (18) from said loading assembly (71) onto said cylindrical surface (20), thus loaded sheet of media becoming attached to said surface and clamped by respective ones of said clamps (16,17) in circumferentially tandem positions.

10. Apparatus according to any one of claims 1 to 9, wherein said at least one pair of sets of

clamps (16, 17) is at least two pairs of sets of clamps, the apparatus being further operative to similarly load at least one additional sheet of media (18) from said loading assembly (71) onto said cylindrical surface (20), thus loaded sheet of media becoming attached to said surface and clamped by respective ones of said clamps (16, 17) in circumferentially parallel positions.

11. Apparatus as claimed in any one of claims 1 to 10, wherein said clamps (16/17) are movable circumferentially, whereby sheets of media of a plurality of lengths may be accommodated.

12. Apparatus as claimed in any one of claims 1 to 11, wherein the sheet of flexible media (18) is a printing plate.

13. Apparatus as claimed in any one of claims 1 to 11, wherein the sheet of flexible media is a film.

14. Apparatus as claimed in any one of claims 1 to 11, wherein the sheet of flexible media is one or more of a film, paper or plastic foil.

15. A method for loading at least one sheet of flexible media (18) onto the cylindrical surface of a rotatable drum (10), clamping a sheet of media (18) thereto and unloading said media therefrom, the sheet of media having a leading edge (76) and a trailing edge (78), the method comprising:

(a) providing a drum (10) rotatable in a first direction and a second direction;

(b) providing a media loading assembly (71) and a media unloading assembly and positioning them in the vicinity of the drum;

(c) providing, for each sheet of media (18) to be clampable to the drum (10), a pair of sets of clamps, each set including at least one clamp (16,17), and attaching them to the surface (20) of the drum (10) so that each clamp (16,17) is movable along a circumferential line, whereby each clamp (16,17) is switchable between a clamping state and a released state and being operative, while in the clamping state, to clamp an edge of a sheet of media engaged thereto onto the surface of the drum (10);

(d) providing a clamp activation mechanism not attached to the drum (10);

(e) feeding a sheet of media (18) from said loading assembly (71) until its leading edge engages a first set of a corresponding pair of said sets of clamps (16,17) while all clamps thereof are in the released state;

(f) switching each said clamp (16,17) of said first set, while engaged by a sheet of media (18), to the clamping state, then slowly rotating the drum (10) in one of said first or second directions so as to pull the sheet of media from said loading assembly and to wrap it around the drum (10);

(g) moving each said clamp (16,17) of the second set of said pair, while in the released state, until they engage the trailing edge of the sheet of media wrapped in step (f), then switching them to the clamping state;

(h) for unloading each clamped media, switching each said clamp of the corresponding first or second set to the released state and moving them away from the released edge, then slowly rotating the drum (10) in one of said first or second directions so as to push the released edge of the sheet of media (18) onto said unloading assembly (73);

(i) switching each said clamp (16,17) of the corresponding other set to the released state, to allow said unloading assembly to pull the sheet of media (18), released in step (h), from the drum.

16. The method of claim 15, further comprising the step of providing a plurality of grooves (12), cut into the surface (20) of the drum (10) along circumferential lines, and whereby in step (c) attaching a clamp (16/17) includes mounting it in one of said grooves (12) so that it is slidable therealong and in steps (g) and (h) moving any clamp comprises sliding the clamp along the respective groove.

17. The method of claim 15, wherein in steps (f) to (i):

switching any clamp (16,17) to a released state, or having it in a released state, includes activating it, or having it activated, respectively, by said activation mechanism, and

switching any clamp (16,17) to a clamping state includes releasing it from said activation mechanism; and

whereby in steps (g) and (h), moving of any clamp includes slowly rotating the drum (10) while the clamp remains engaged by said activation mechanism.

18. The method of claim 15, wherein any clamp is a dynamic clamp, operative to clamp sheet of media (18) with a force that consists of a constant component and a dynamic component, which is derived from centrifugal action and is essentially proportional to the rotational speed of the drum (10).

19. The method of any one of claims 15 to 18 wherein the sheet of flexible media (18) is a printing plate.

20. The method of any one of claims 15 to 18 wherein the sheet of flexible media (18) is a film.

21. The method of any one of claims 15 to 18 wherein the sheet of flexible media (18) is one or more of a film, paper, or plastic foil.

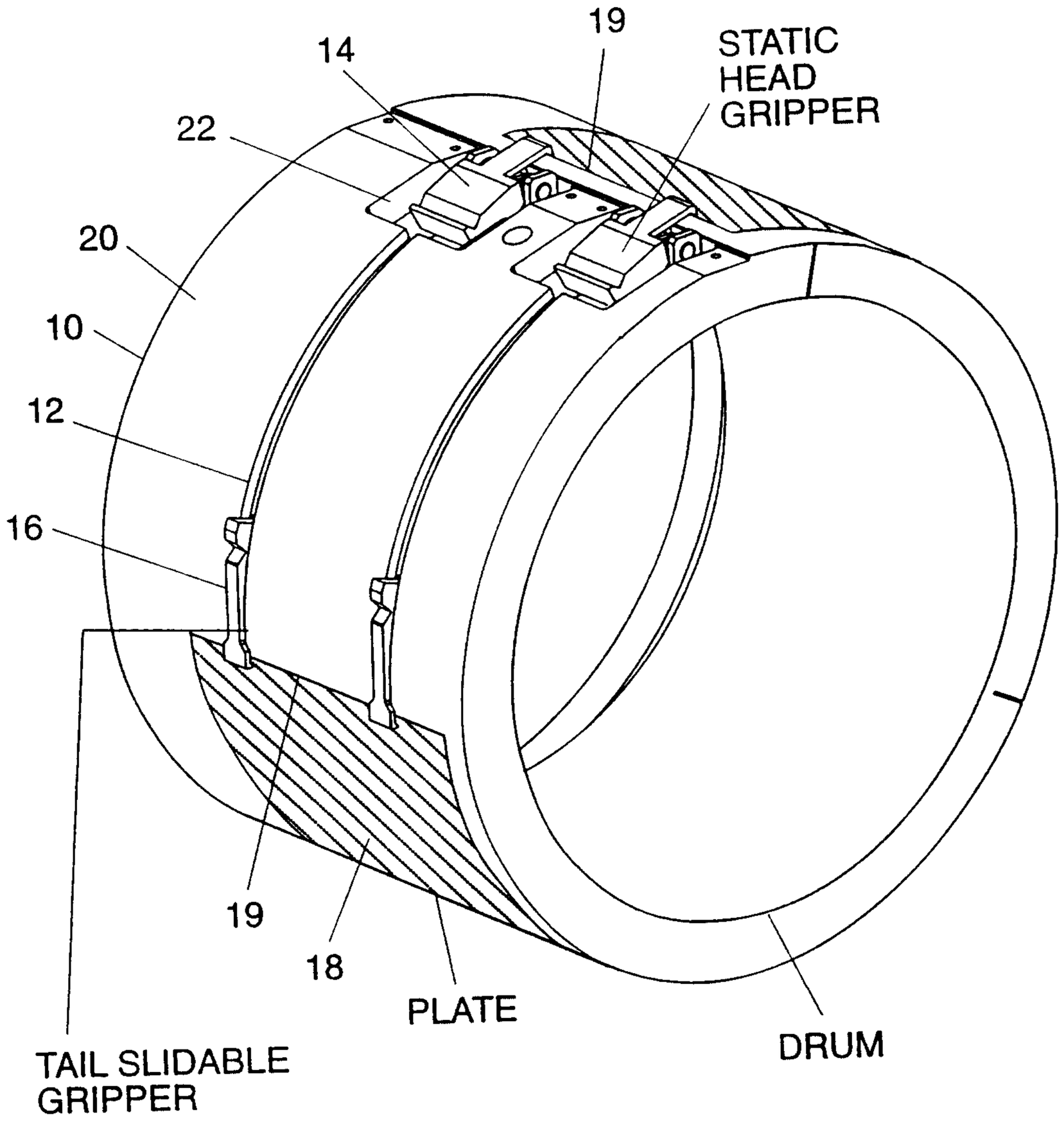

14
19
STATIC
HEAD
GRIPPER
22
20
10
12
16
19
18
PLATE
DRUM
TAIL SLIDABLE
GRIPPER

FIG. 1

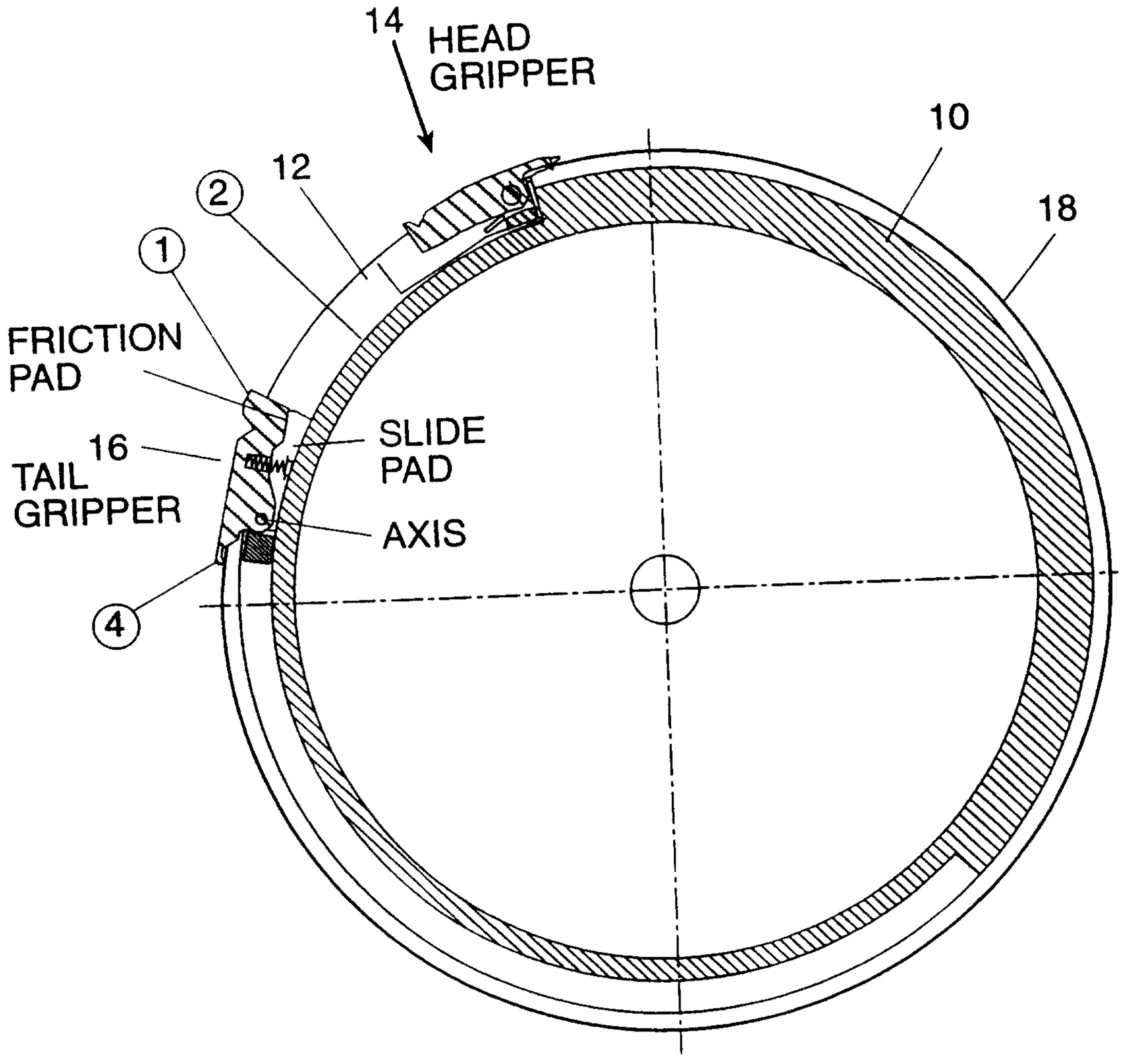

14
HEAD
GRIPPER
10
12
2
18
1
FRICTION
PAD
SLIDE
PAD
16
TAIL
GRIPPER
AXIS
4

FIG. 2

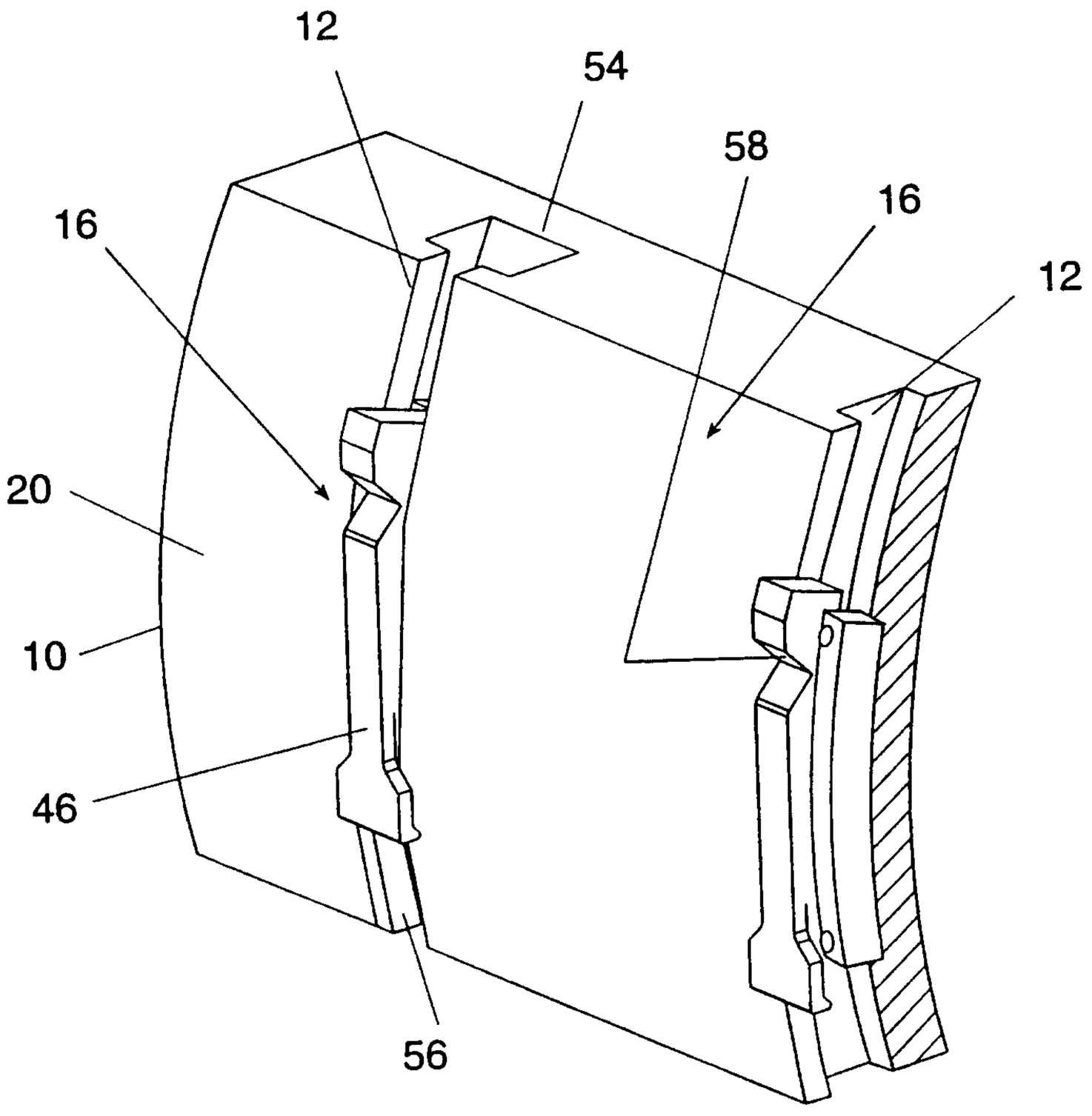


FIG. 3

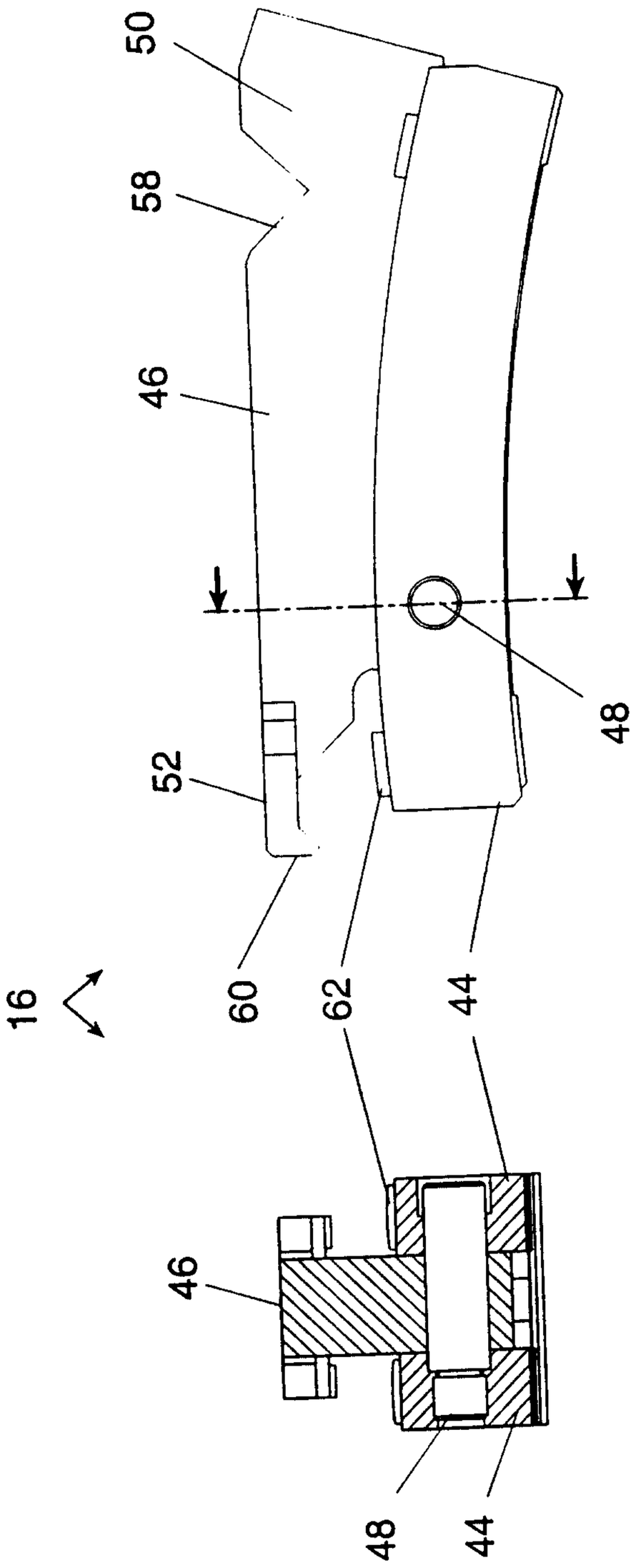


FIG. 4A

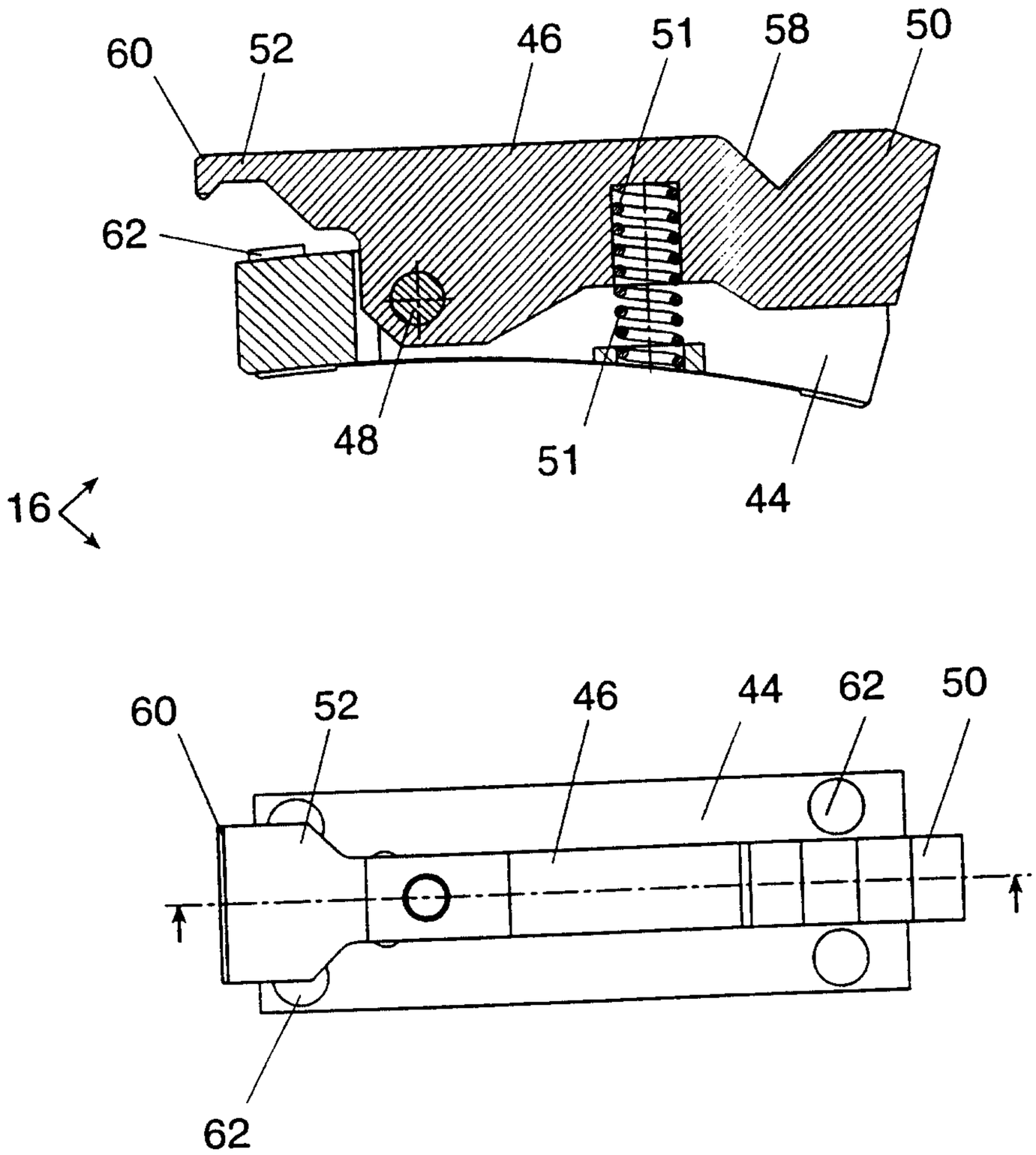


FIG. 4B

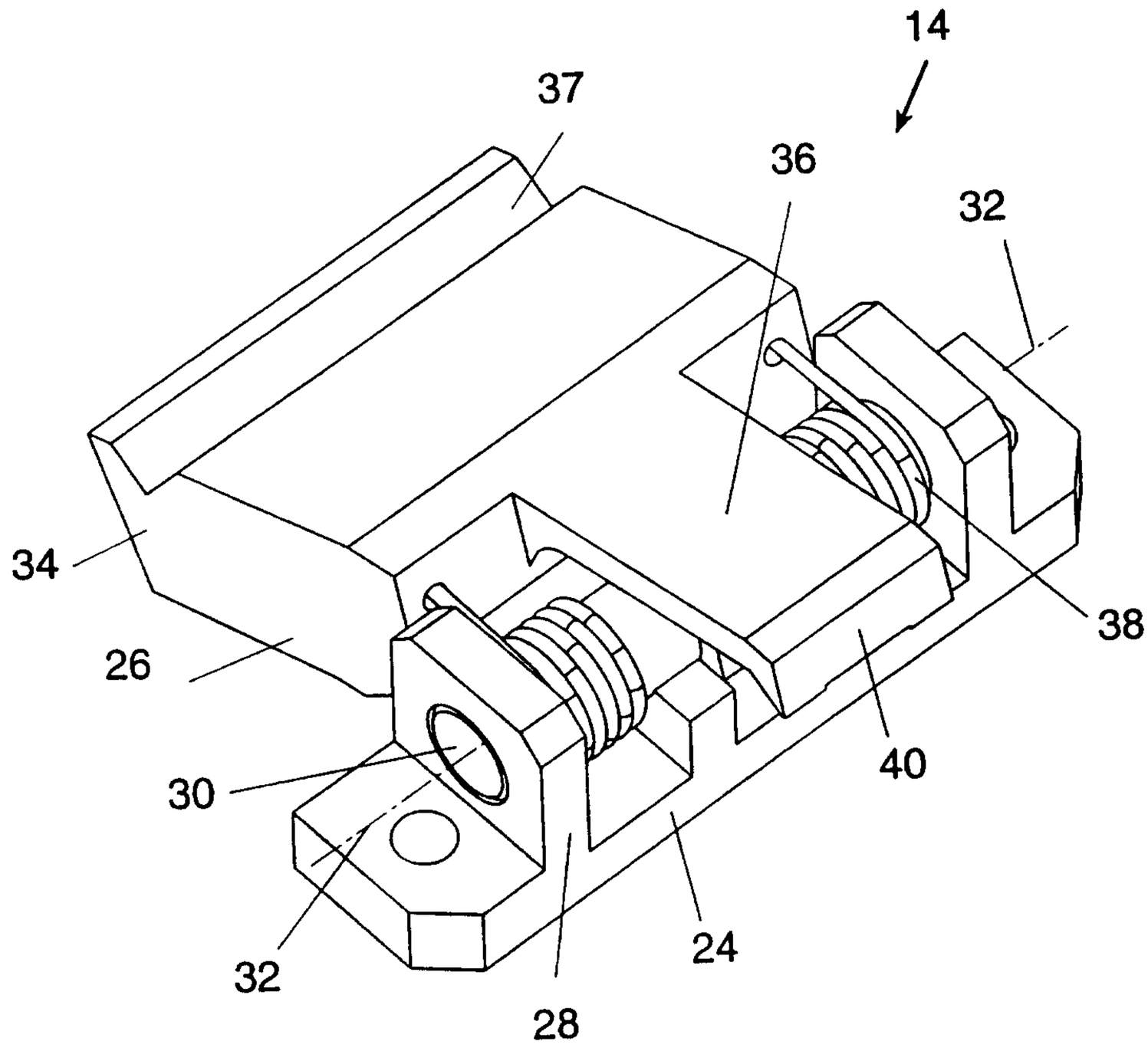


FIG. 5

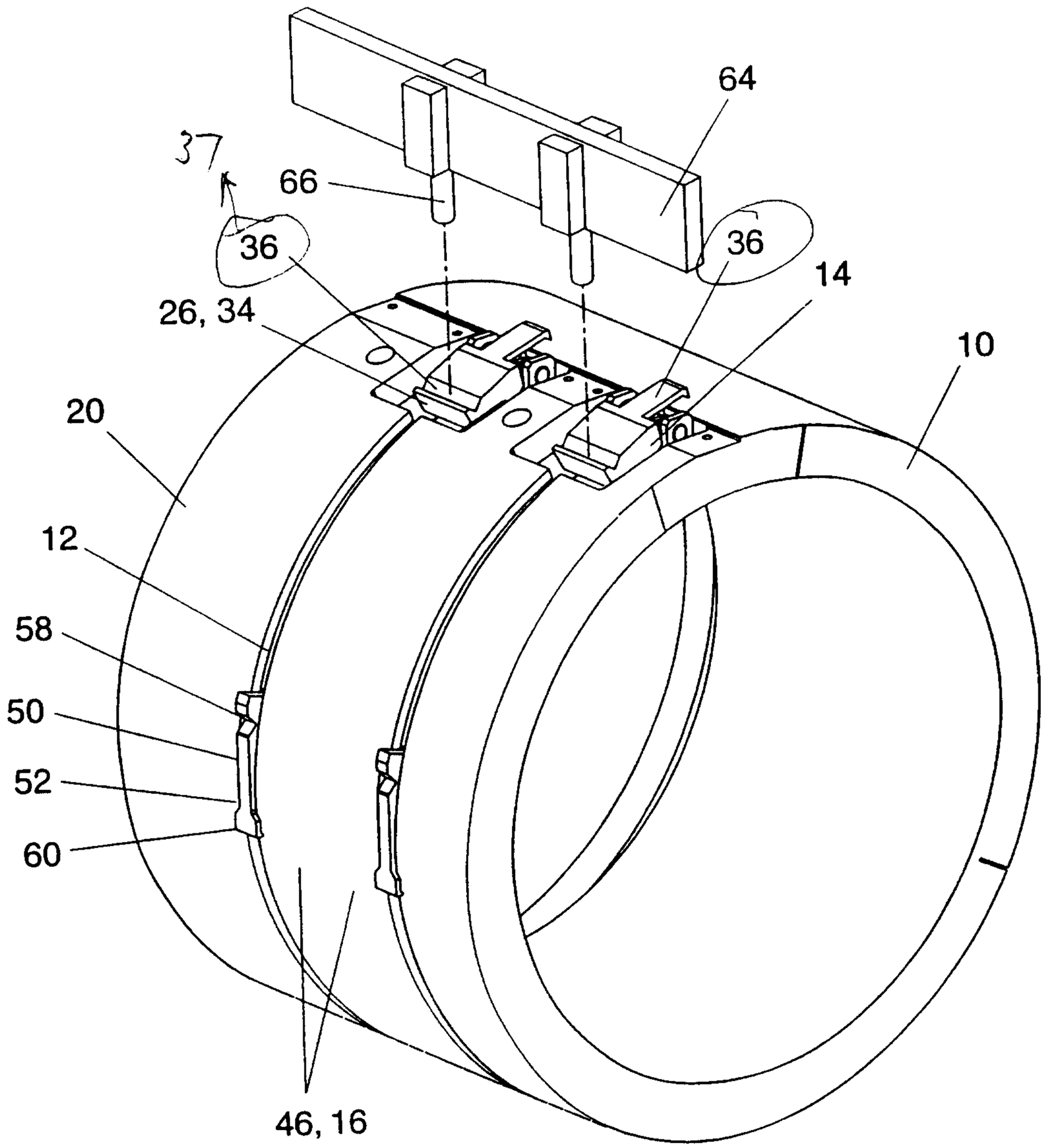


FIG. 6

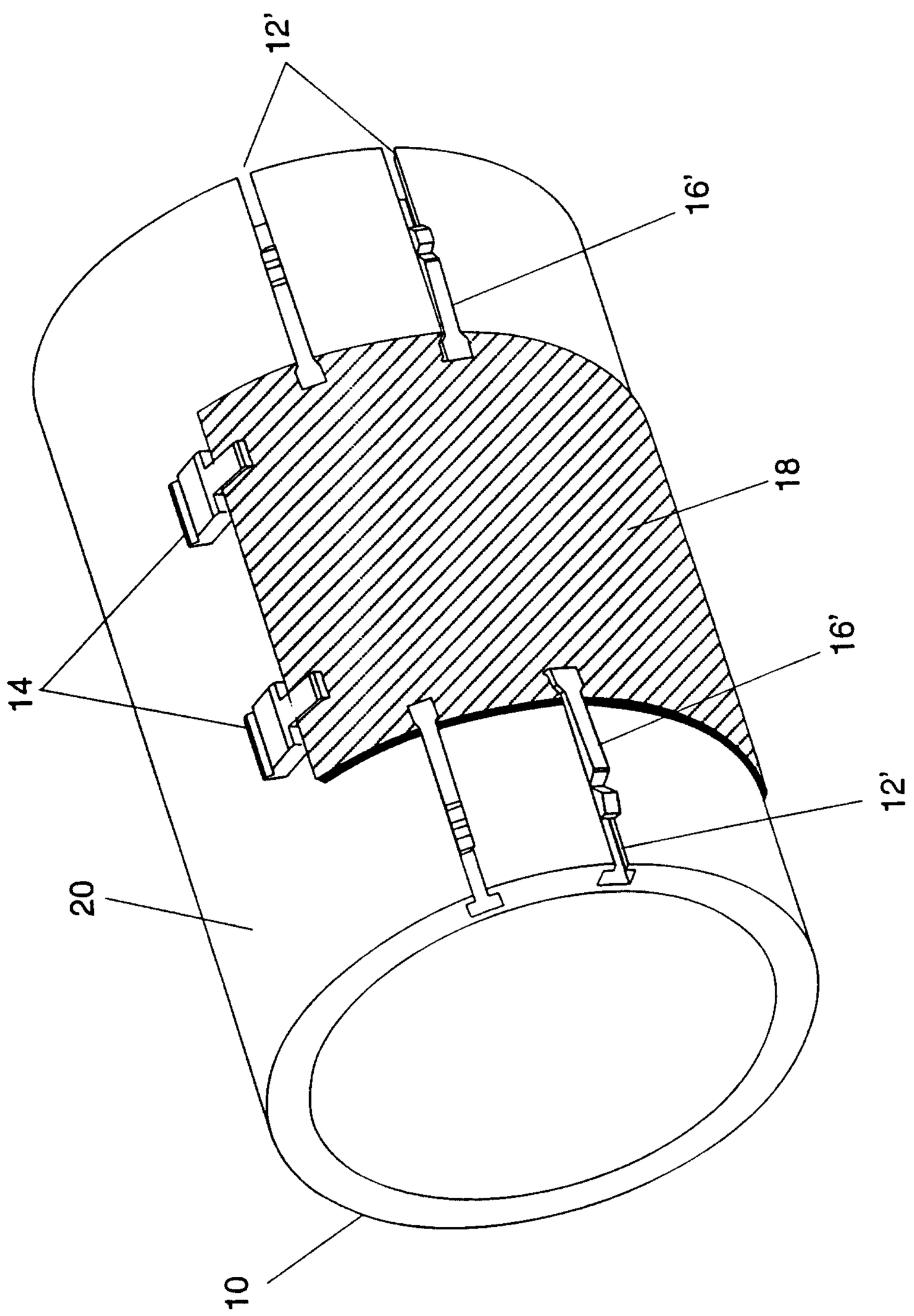


FIG. 7

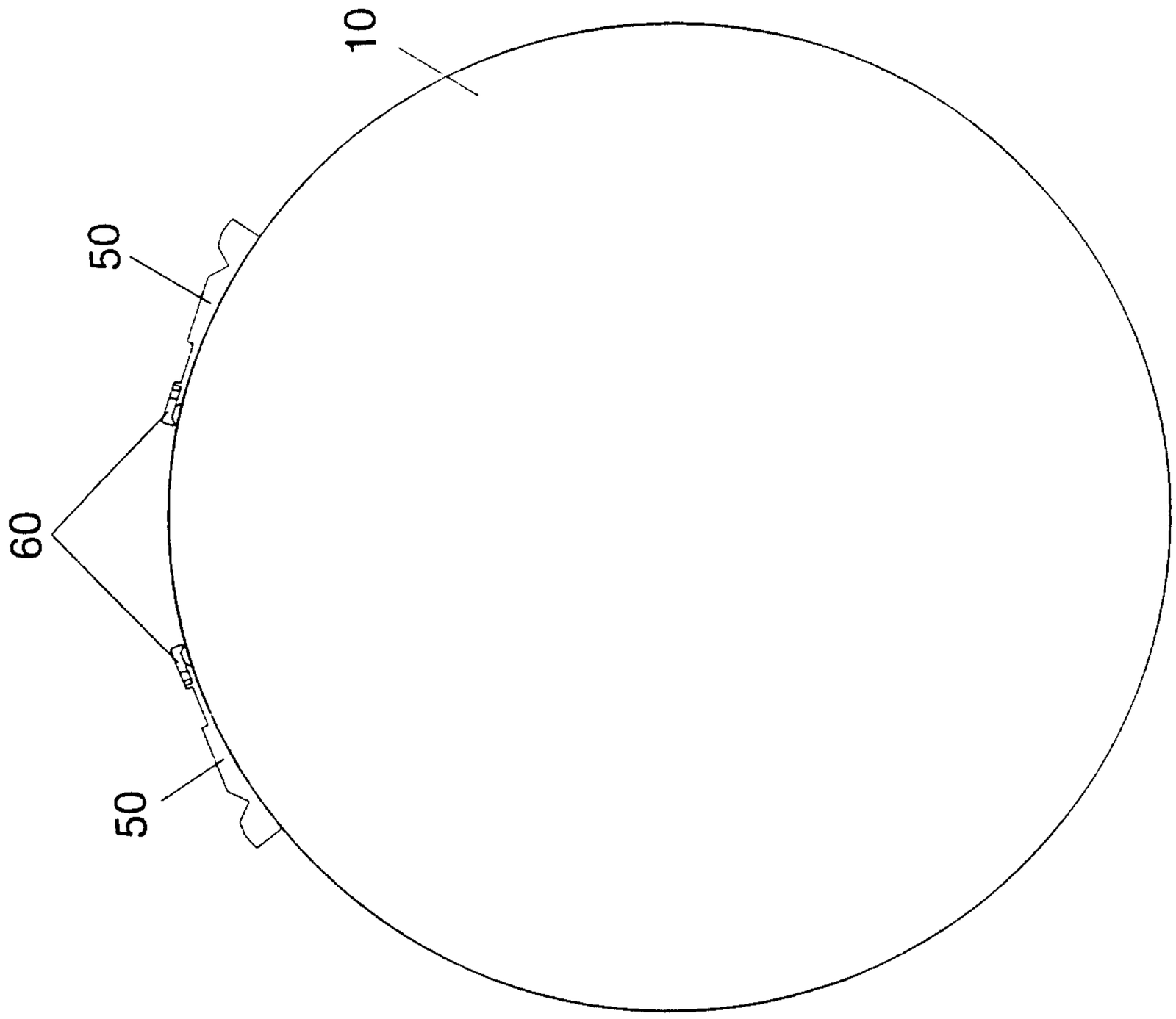


FIG. 8

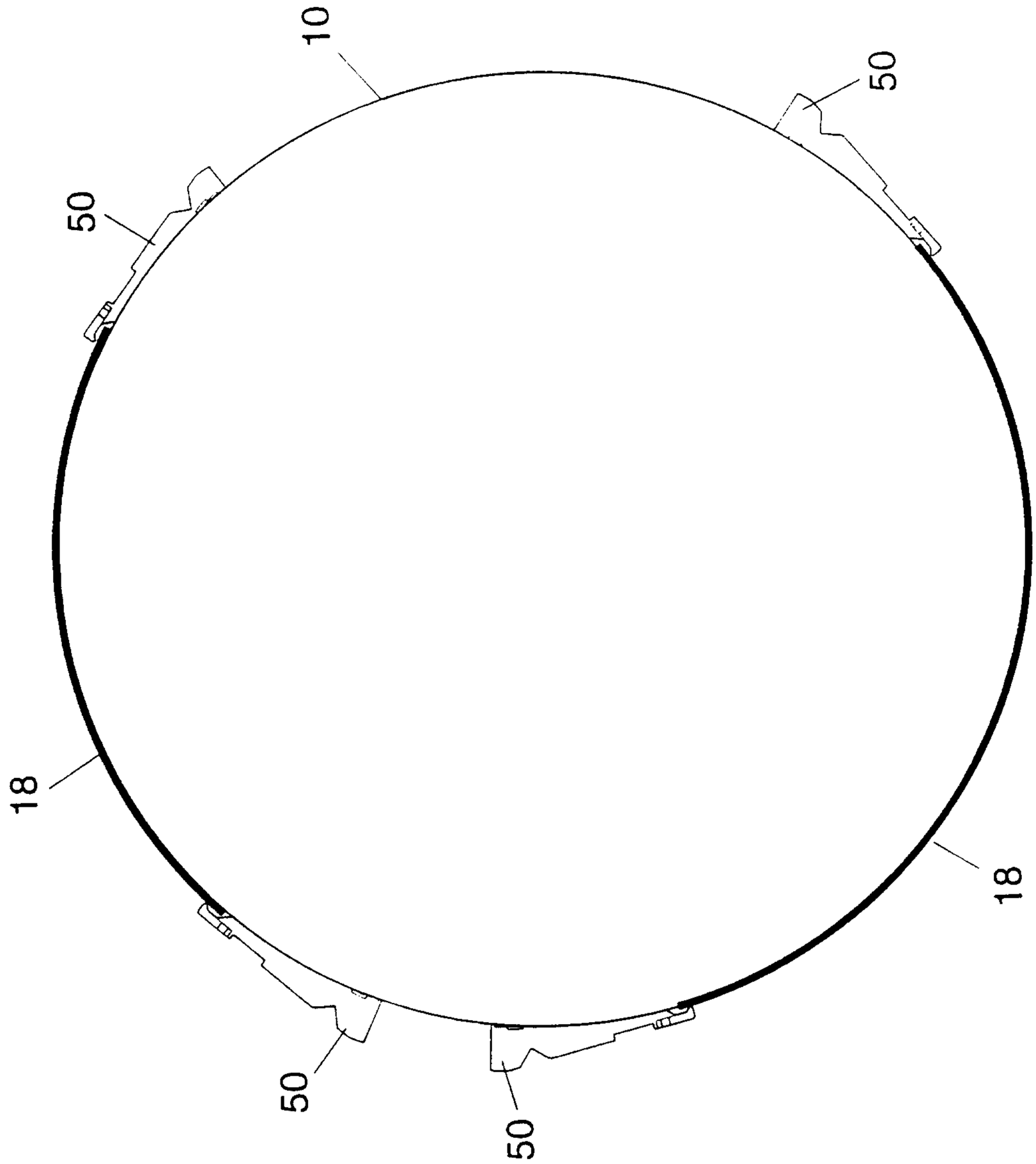


FIG. 9

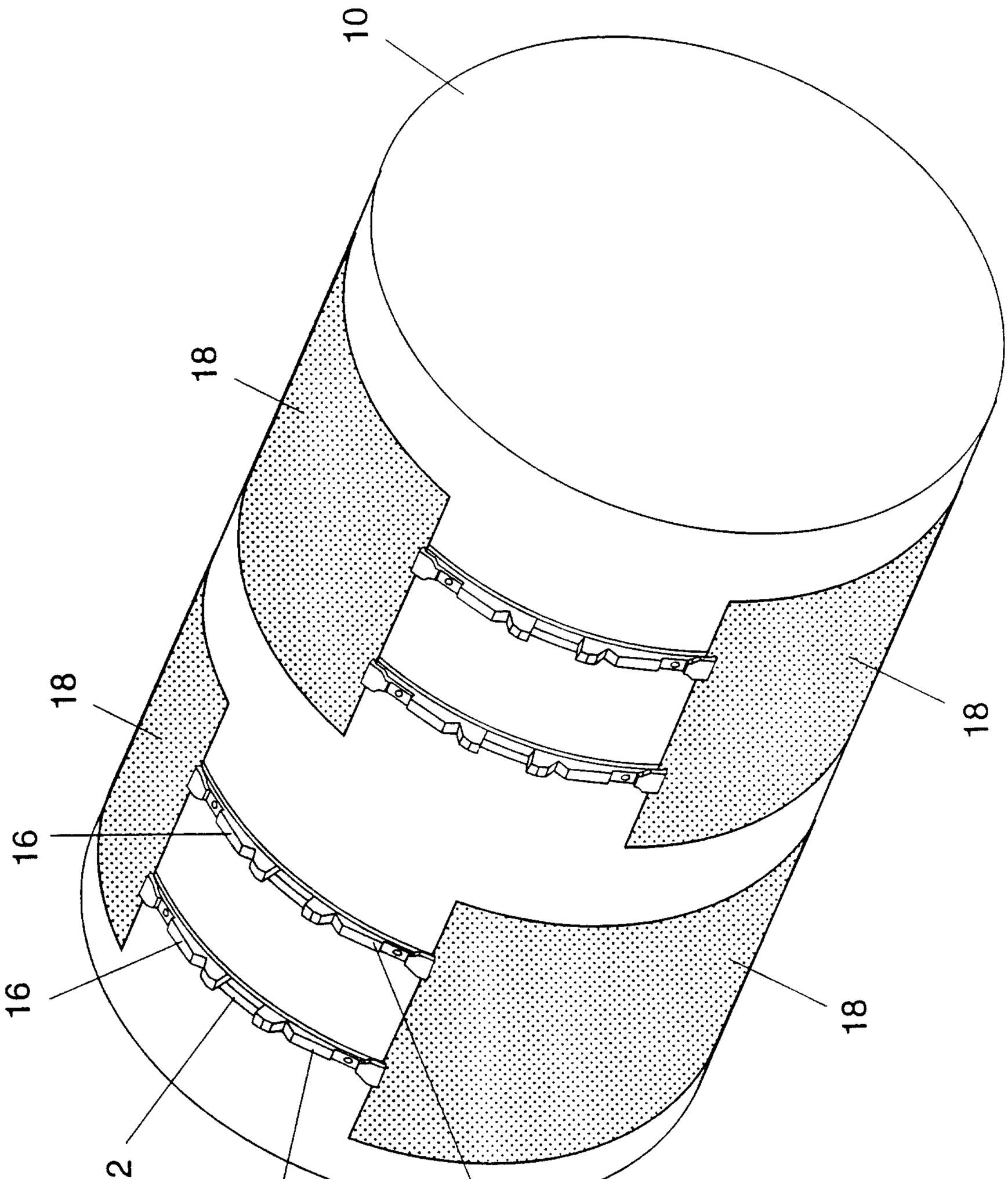


FIG. 10

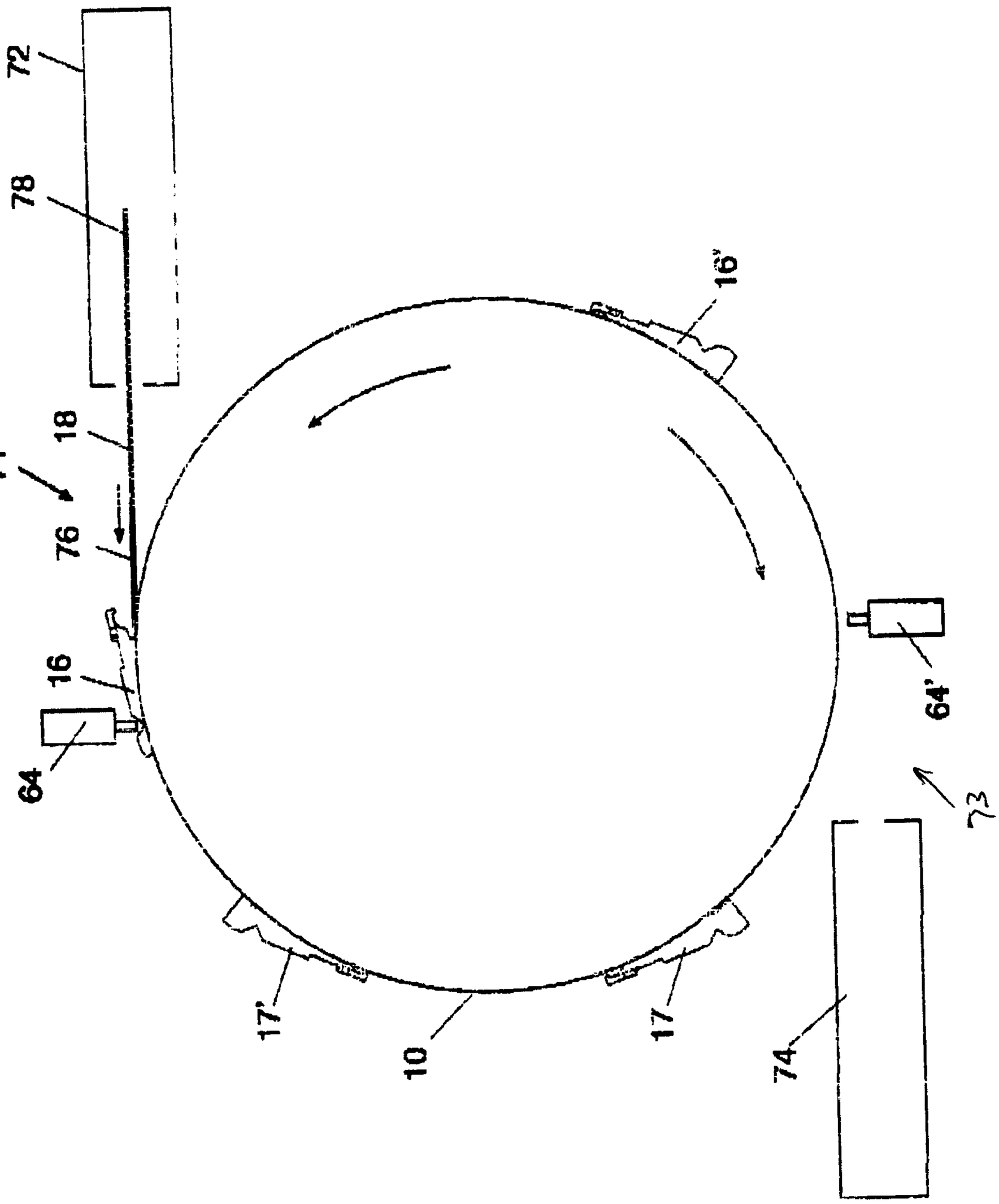


FIG. 11-A

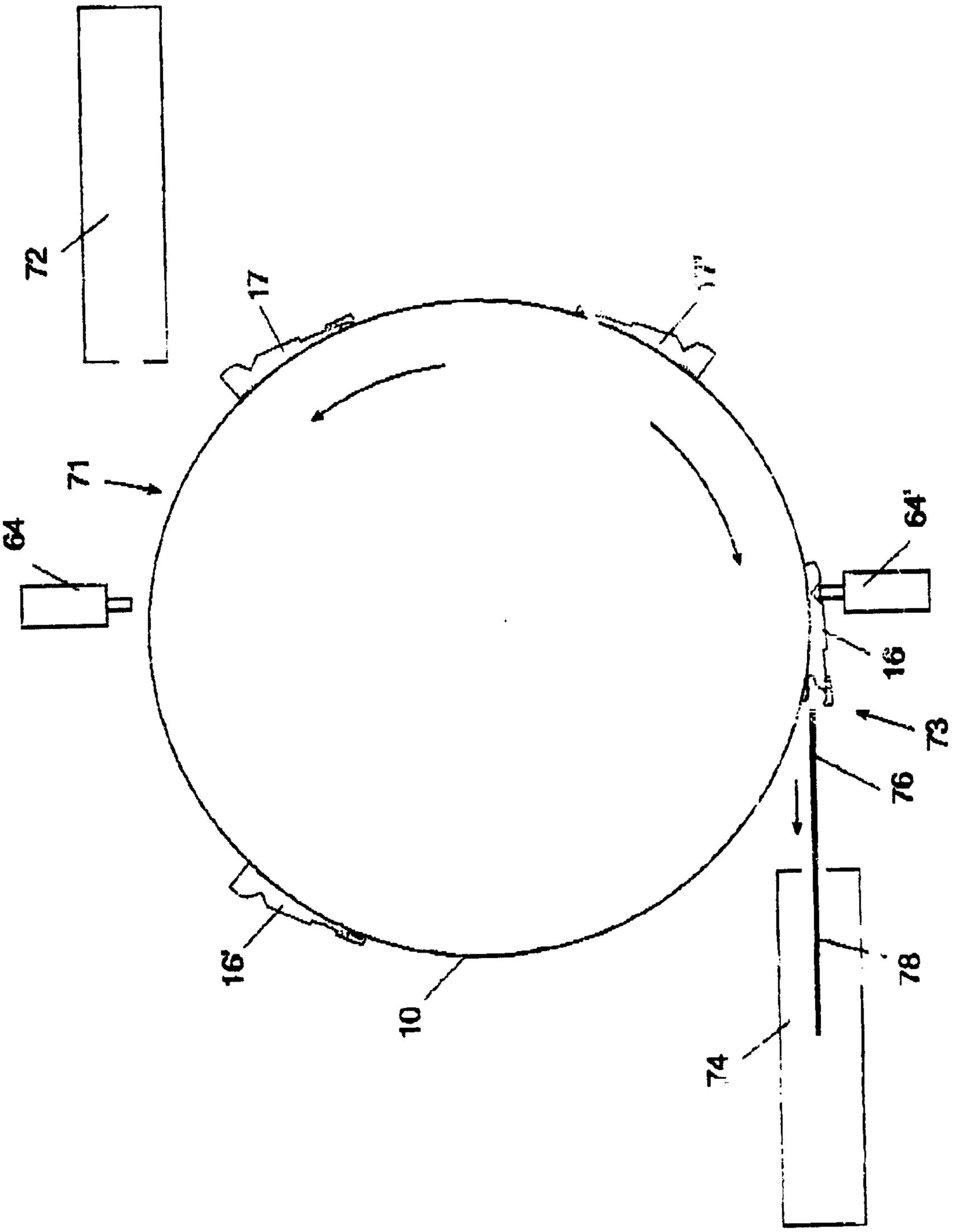


FIG. 11-B

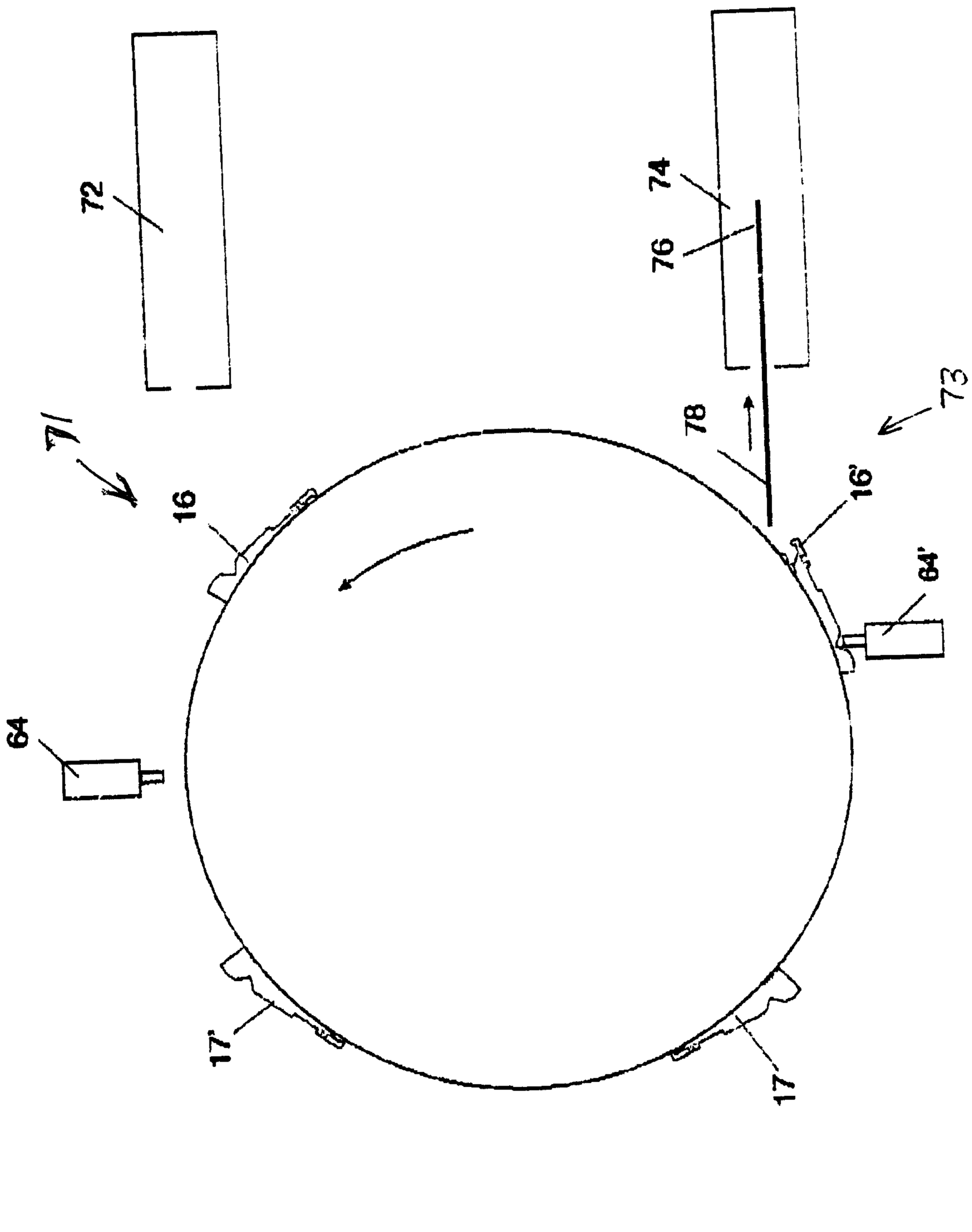


FIG. 12-A

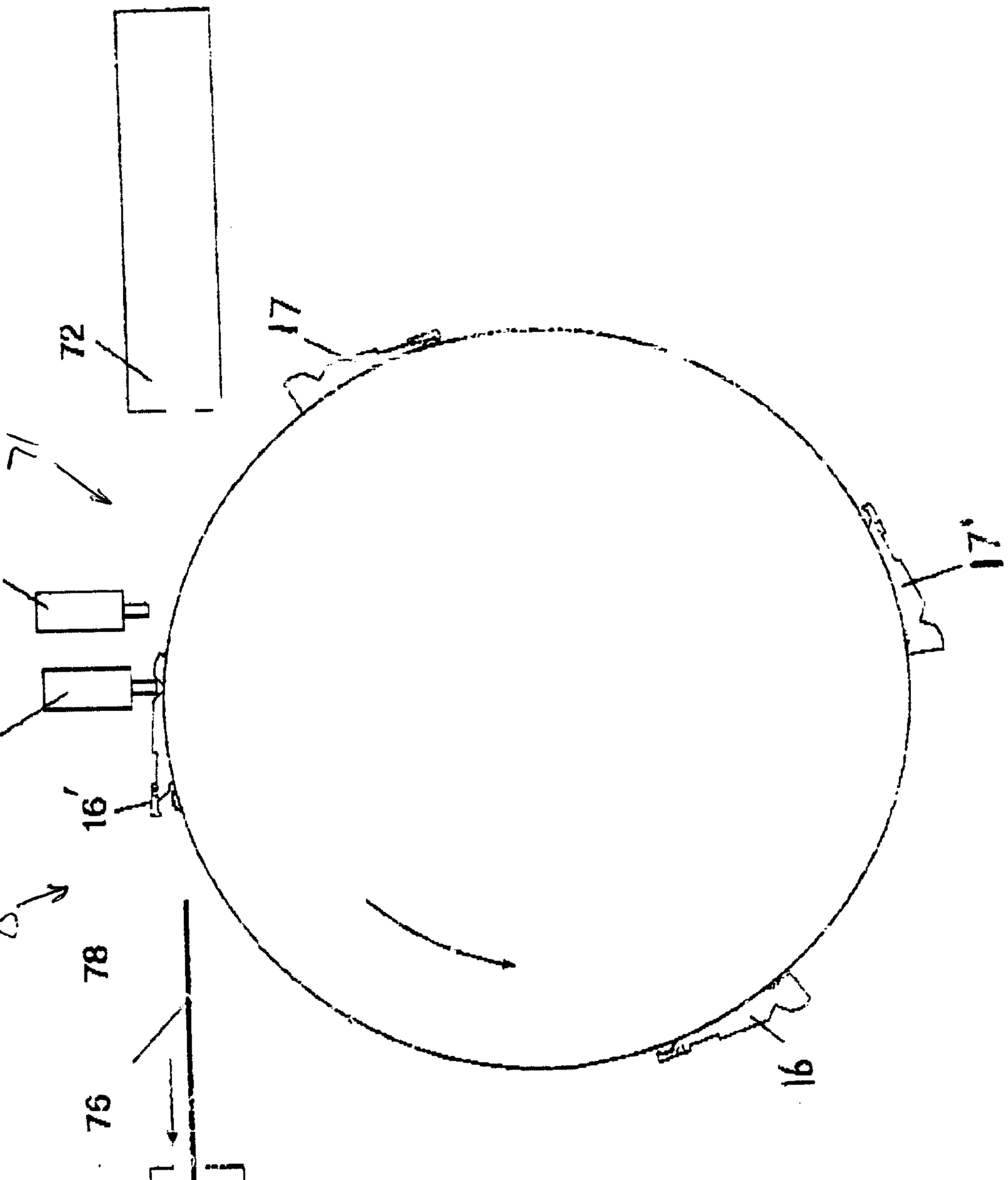


FIG. 12-B

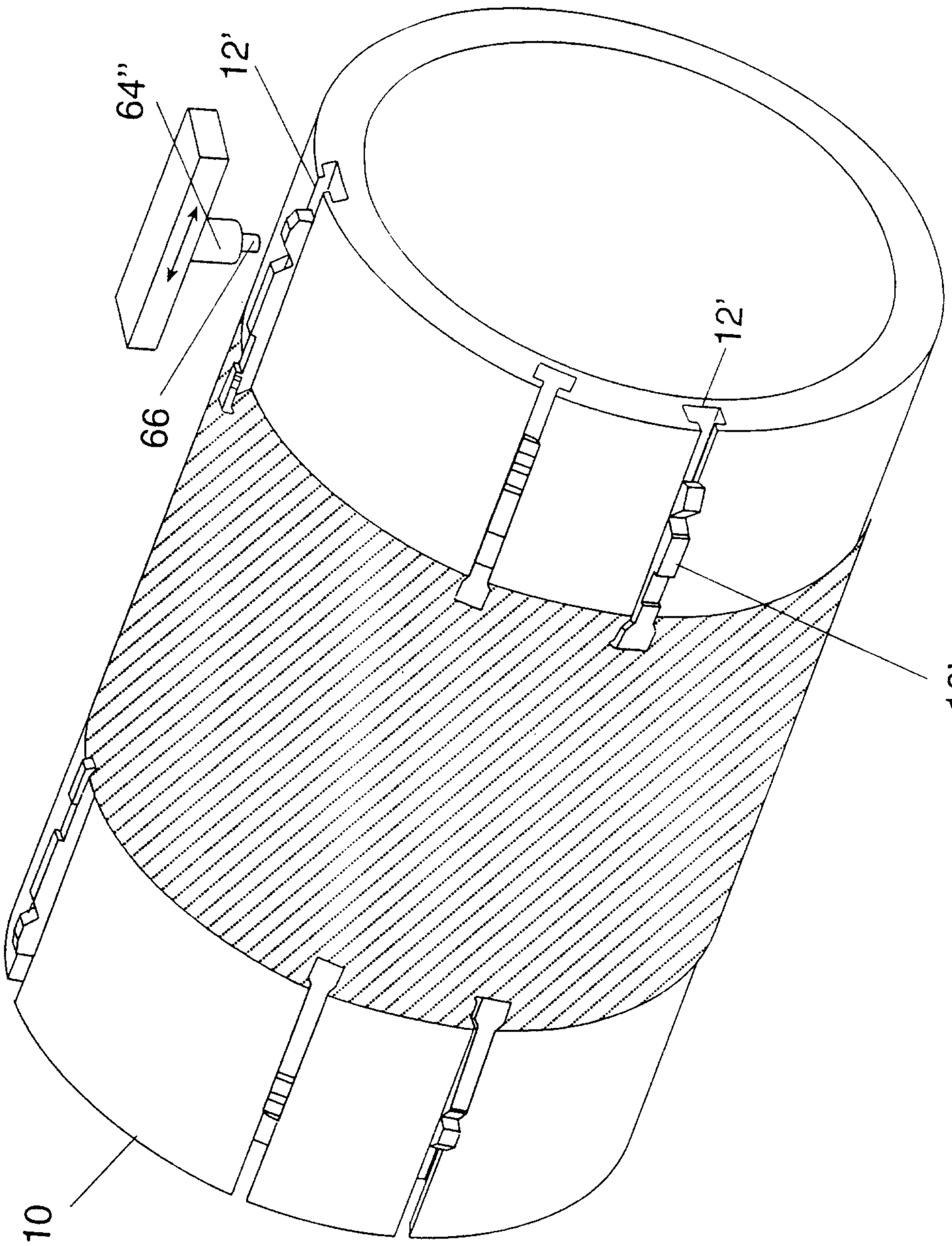


FIG. 13

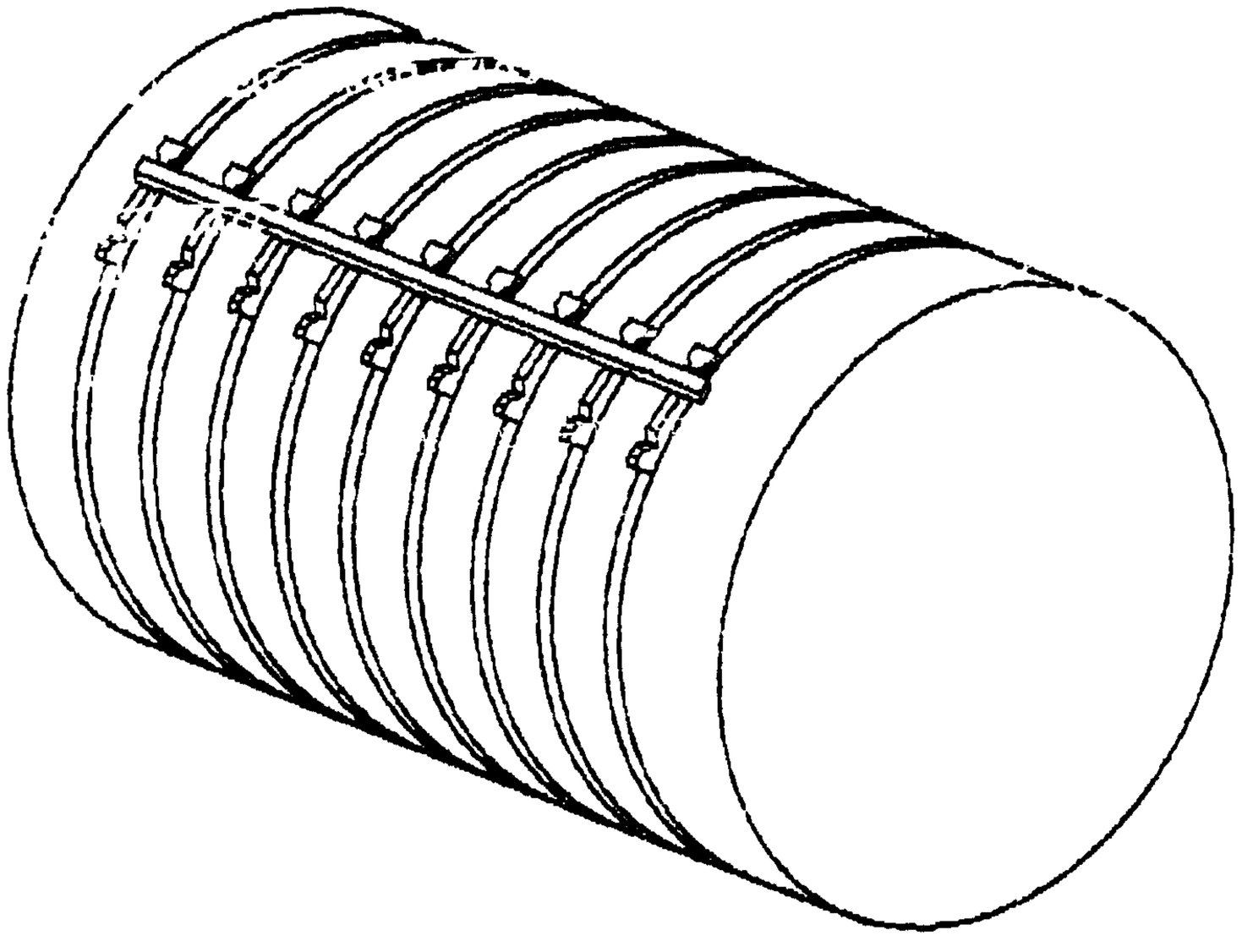


FIG. 14A

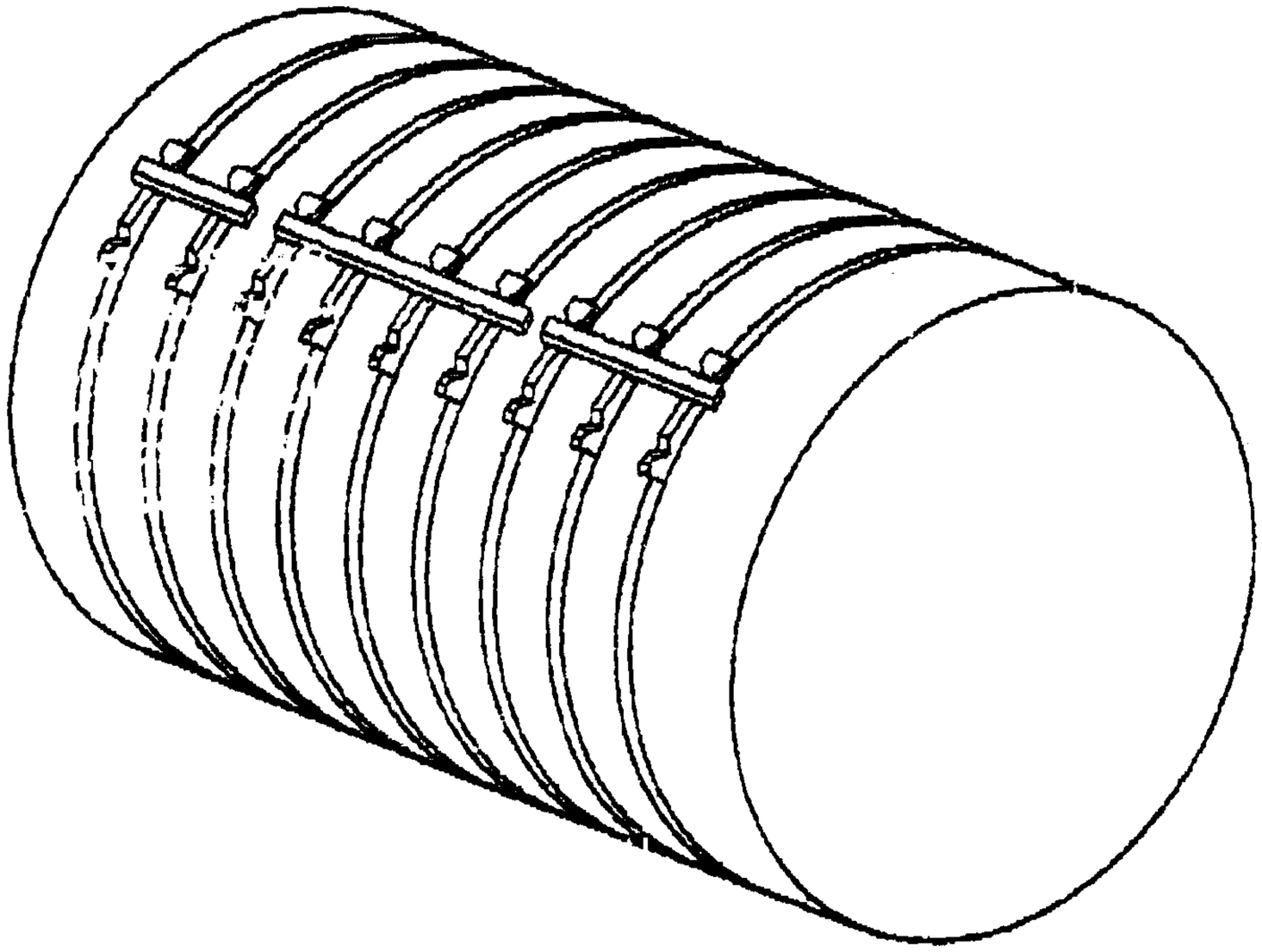
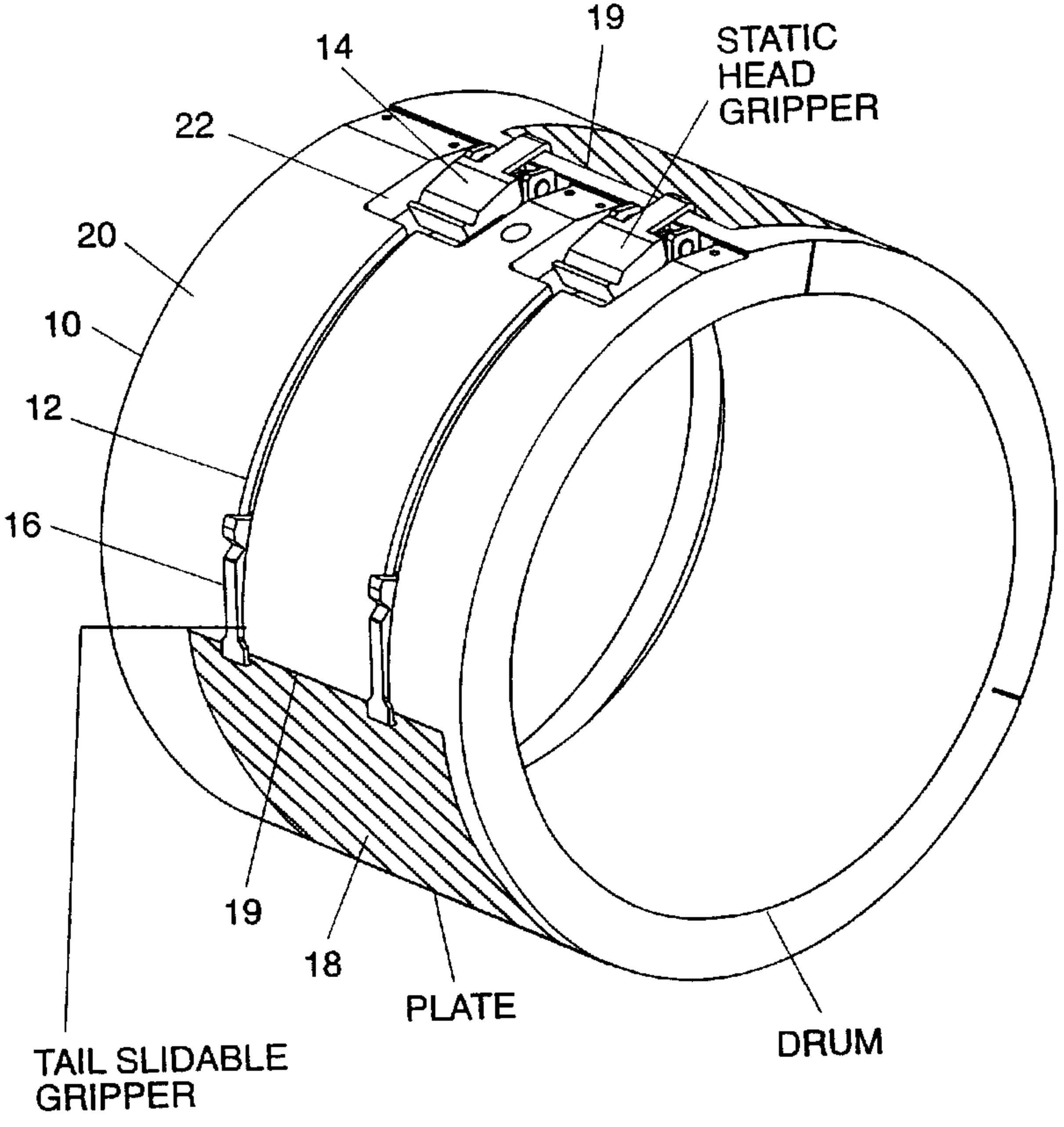


FIG. 14B


19
14
STATIC
HEAD
GRIPPER
22
20
10
12
16
19
18
PLATE
DRUM
TAIL SLIDABLE
GRIPPER