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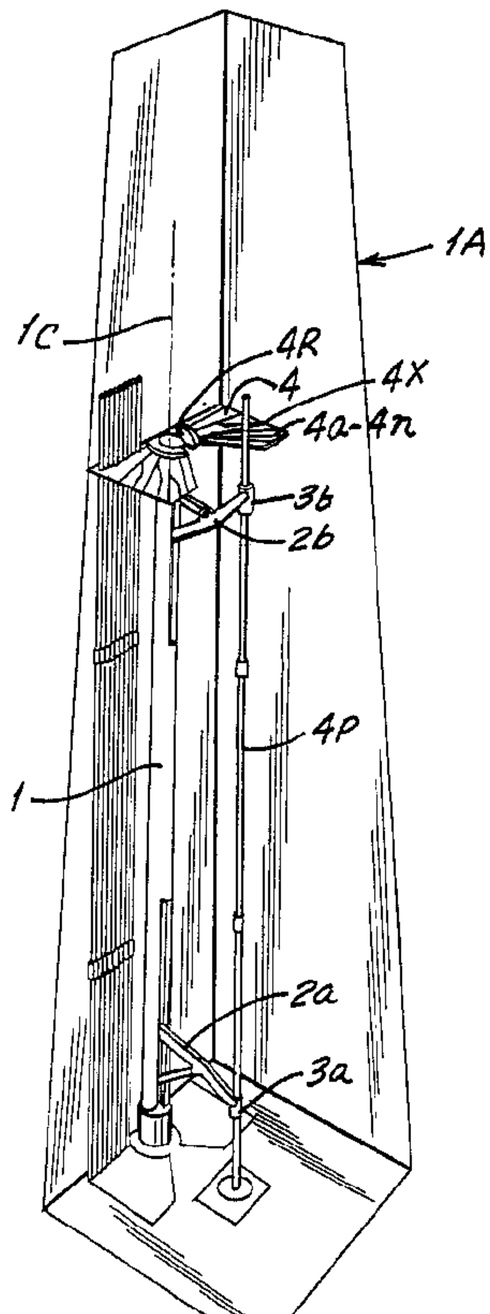
(54) Title: ARRANGEMENT IN A PIPE HANDLING SYSTEM



(57) Abrégé/Abstract:
The invention relates to an arrangement in a pipe handling system, especially for handling pipes (4P) in connection with a derrick (1A), wherein the arrangement comprises a tower (1) and two preferably individually controlled operating arms (2a, 2b). The pipe handling system operates favourably in connection with a fingerboard (4) in which all fingers (4a, 4n) are pointing towards the center of the pipe handling system and especially towards a disc-shaped locking unit (4R) mounted on the top of the tower (1), and in connection with a side-step retraction system designed for use with a top drive drilling system.

Abstract

The invention relates to an arrangement in a pipe handling system, especially for handling pipes (4P) in connection with a derrick (1A), wherein the arrangement comprises a tower (1) and two preferably individually controlled operating arms (2a, 2b). The pipe handling system operates favourably in connection with a fingerboard (4) in which all fingers (4a, 4n) are pointing towards the center of the pipe handling system and especially towards a disc-shaped locking unit (4R) mounted on the top of the tower (1), and in connection with a side-step retraction system designed for use with a top drive drilling system.

Arrangement in a Pipe Handling System

This application is a division of co-pending Canadian Application Serial No. 2,055,482 filed on May 9, 1990.

Technical Field

The present invention relates to a pipe handling system for use with a top drive drilling system.

Background of the Invention

US patent specification 3,682,259 (Cintract et al.) discloses a pulley block which is specifically illustrated in Figures 1 and 5 therein, which pulley block may be displaced with the help of a jack, so as to occupy a first position in the axis of a drill hole. The pulley block is also capable of being shifted to another position by activation of the jack, the displacement taking place along a slide bar mounted on a support cart of the pulley block, the cart moving with the aid of vertical guide rails and a cable being used for moving the pulley block vertically.

Cintract et al. provides no method to simultaneously shift the wires of the cable in which the pulley block is suspended together with the shifting of the cart of the pulley block. Cintract et al. also does not disclose how such a shifting of the wires at the top block level could be effected to change directions of the wire closest to the vertical centre line of the derrick.

Summary of the Invention

An object of the present invention is to provide an arrangement in a pipe handling system for use with a top drive drilling system, wherein a drill block with connected equipment is retracted to give space for a new drill pipe section, in an effective and safe manner.

Another object of the present invention is to provide an arrangement in a pipe handling system for use with a top drive drilling system, which will bring the drill block

sideways away from the central area over the drill pipe for thereby allowing the possibility of connecting new drill pipe sections even before the drill block is retracted to the upper position.

Still another object of the present invention is to provide an arrangement in a pipe handling system for use with a top drive drilling system, which arrangement creates less moment forces and demands less space than conventional methods, wherein the drill block is retracted between guide rails and the drill pipe towards the outer limits of the derrick.

In accordance with one aspect of the present invention there is provided an arrangement in a pipe handling system for use with a top drive drilling system provided with a wagon supported on a first hydraulic cylinder of a skid mechanism characterized in that it comprises a sidestep retraction system forming a second hydraulic cylinder skid mechanism and including a wire guide apparatus located in the area of a top block mounted in a standard derrick provided with a drill block which can be retracted by wires running to and from said top block and through joint connections connected to said top block to transport equipment units on the wagon guided by vertical guide rails, and said drill block being retractable from its central position over drill pipe and laterally shiftable on said second hydraulic cylinder skid mechanism and said wire guide apparatus activating said wires by pressure to move said wires in the same direction as said drill block.

Brief Description of the Drawings

Fig. 1 is a schematic perspective view illustrating an embodiment of an arrangement in a pipe handling system according to the present invention.

Figs. 2A and 2B are side views of a pipe handling machine included therein.

Fig. 3 is a top view of a pipe handling fingerboard included therein.

Fig. 4a illustrates a prior art fingerboard.

Figs. 4b-4d illustrate alternative fingerboards according to the invention.

Figs. 5a-5d depict the principle function of the pipe handling according to the present invention, i.e.:

Fig. 5a illustrates pipe handling machine grips pipe at well center.

Fig. 5b illustrates pipe handling arm retracted for bringing pipe into finger locking ring groove.

Fig. 5c illustrates pipe handling arm rotating to select finger.

Fig. 5d illustrates pipe handling arms extended for bringing pipe into fingers.

Figs. 6a-6c are various views of the locking ring of the fingerboard according to the present invention.

Figs. 7a-7d illustrate the principles of the operation of the sidestep retraction system according to the present invention.

Fig. 8 is a side view of a derrick equipped with a drill block in accordance with the invention, shown centrally placed over the drill pipe.

Fig. 9 is a side view where the drill block is retracted from the central position to have connected thereto additional drill pipe sections.

Fig. 10 shows the arrangement in same position as Fig. 9, but where the drill block and connected equipment are in upper position.

Fig. 11 shows the arrangement in plan view and horizontal section.

Description of Embodiments

One embodiment of the invention is characterized in that it comprises, in addition to a first hydraulic skid mechanism, a sidestep retraction system forming a second hydraulic cylinder skid mechanism and including a wire guide apparatus located in the area of a top block mounted in a standard derrick provided with a drill block which can be retracted by wires running to and from said top block and through joint connections connected to said top block to transport equipment units on a wagon guided by vertical guide rails, said wagon being supported on a first hydraulic cylinder skid mechanism, and said drill block being retractable from its central position over the drill pipe and parallelly shiftable sideways on said second hydraulic cylinder skid mechanism, and said wire guide apparatus activating said wires by pressure to move said wires in the same direction as said drill block.

Appropriately, said first hydraulic cylinder skid mechanism can be arranged between the drill block and the wagon for equipment units.

In a preferred embodiment the wire guide apparatus may include a guide roller connected to said second hydraulic cylinder skid mechanism by a joint arm that is connected to the second hydraulic cylinder and to the top block.

Further features and advantages related to the present invention will appear from the following description taken in conjunction with the appended drawings.

The pipe handling system and the machine included therein will be built to fit into the derrick or rig floor design 1A. The main principles of the design are illustrated especially in Figs. 1 and 2A and 2B. The machine is based on a tower 1 built from for example 700 mm diameter pipe with two operating arms 2a, 2b built into the tower 1. This gives a very clean outside design. The tower 1 will be fixed in a position in the derrick and rig floor to handle all pipe operations between the well center - fingerboard - mouse hole.

The main load is taken on the rig floor. The pipe is handled by the two independently operated arms 2a, 2b, which may be compared with scissor arms.

The scissor arm principle used gives a horizontal in-out movement. This principle is easy to control with regard to position accuracy.

Using the scissor arm principle gives a very controlled extended reach. The forces imposed on the tower/arm/carriages are less than on other designs, by using this principle.

All drives are preferably based on A.C. motors with disc brakes driving through gear boxes, which operate on rack and pinion, driving the arms up and down - in and out. The A.C. motors are speed controlled by invertors. Proposed supplier of motor, brake, gear box, invertors is S.E.W. Eurodrive, using standard components. Using A.C. motor drives will give a controlled high speed and a very clean pipe handling machine (no hydraulic leaks).

The pipe handling machine is an independent unit not mechanically connected to the iron roughneck. This has caused problems in other designs including too much downtime due to units connected together. Prior designs also required the pipe handling and iron roughneck work to be carried out very close to the well center, including potential clash problem in pipe handling with top drive/block. An independent unit, only connected together with the other machines through the control system, iron roughneck, top drive is a better solution.

The upper and lower arms 2a, 2b are generally of the same design. They are, in the illustrated embodiment, not mechanically connected together, only electrically by the control system. The arms can be operated as independent arms if so required. They can operate at different angles relative to the pipe. (Other designs have problems with connected arms, as they can only be operated mechanically and are very limited).

A preferred embodiment may be based on a 5" pipe claw 3a with 2 tons lift. The pipe handling machine is designed for high speed tripping of drillpipe. For handling drill collars the machine will only position the drill collars in the set-back using the drawworks to lift the load. This will give a faster pipe handling for more than 95% of the operating time.

Based on 2 tons lift at 2.5 m, it is estimated that the total weight of the machine with supports and fingerboard will be 14,403 Kg.

The claw design is based on a slip principle with an air operating cylinder. This is a fail-safe device. The load has to be removed before the slips can operate. Only the bottom claw 3a holds the load. The top claw 3b is only

used to hold the pipe into position. A load cell is built into the pipe handling machine to give the operator and control system information on weight in the claw. The claws 3a, 3b will also have a sensor for sensing pipe inside claw.

The control system may be based on a Siemens robotic control system "SIROTEC RMC™" and a "SIMATIC S 51354™" for operator communication and interfacing with other systems (e.g., iron roughneck, fingerboard, top drive, block position, slips, etc.).

The pipe handling machine is designed to work in a robotic semiautomatic mode with one operator. The operator can also operate in a remote manual mode if so required. The control system is designed for high accuracy, high operating speed, high security - with very good control over interface between other systems.

Maintenance equipment has been considered by using standard motor/gear box/rack and pinion drives, so as to give the rig mechanics and electricians a rapid understanding of the equipment.

The design will reduce the number of personnel working close to the drill pipe 4P. The operator will have a very good communication with the driller. With all pipe positions programmable, the pipe handling controls are very easy to operate. This leads to less work and lower stress which, in turn, increases the safety and efficiency of the operation.

The overall design provides an improved automatic unit compared with existing pipe handling units which are in operation today. The present invention provides especially a favourable combination of electrical and

mechanical equipment and control systems to make an effective automatic pipe tripping machine.

Figs. 3-6 illustrate star fingerboard concept, in which the top element 4 includes fingers 4a, 4n which are all pointing towards the center of the pipe handling machine 1.

The reason for orientating the fingers 4a - 4n in this manner, is to have the pipe handling machine 1 mounted in a fixed position with a minimum of movements, the machine 1 will turn around its "stationary" vertical axis of rotation 1c, and thus manoeuvre its arms 2a, 2b towards the well center or towards the actual finger, the arms 2a, 2b then being manoeuvred straight into and out of the pipe holding finger slots 4x.

The star fingerboard concept will fit into all types of derricks or masts and the benefits thereof can be listed as follows:

- The star fingerboard concept allows a fixed position of the pipe handling machine 1.

  A fixed position provides benefits as to:

  a) Less movements, easy control
  b) Slim design, due to less forces, less weight, less space
  c) Faster and safer pipe handling

- The wide roots 4 will give a good racking capacity.
- Locking of fingers will be done very easy with a locking ring 4R around the top of the pipe handling tower 1.

  d) The fingers 4a-4n will be strong with slim tips 4T and wide root 4
  e) The star fingerboard will also be easy to operate manually

Fig. 4a illustrates a prior art fingerboard, in which a mobile unit or wagon 4M must be used for handling the pipes.

Figs. 4b-4c illustrate various embodiments of fingerboards adapted to various pipe types and dimensions.

Figs. 5a-5d depict the principle function of the pipe handling according to the present invention, i.e:

Fig. 5a illustrates pipe handling machine arm 2b grips pipe 4P at well center.

Fig. 5b illustrates pipe handling arm retracted for bringing pipe 4P into finger locking ring groove 4G.

Fig. 5c illustrates pipe handling arm rotating to selected fingers or finger slot 4x.

Fig. 5d illustrates pipe handling arm 2b extended for bringing pipe 4P into fingers.

Figs. 6a-6c illustrate details of a locking ring 4R.

In Figs. 7-11 there is illustrated a sidestep retraction system which is designed for use with a top drive drilling system.

A top drive drilling system is functioning with a wire block system in the top of the drilling tower. It serves the purpose of lifting and lowering various equipment. An example of such equipment is a drilling machine for the drill pipe to be rotated, which equipment is connected through a joint to the block taking the form of a wagon which is guided by vertical guide rails.

When drilling for water, gas or crude oil it is necessary to bring the drilling block with connected equipment up and down while the drill pipe maintains its drilling position.

Today this problem is solved by retracting the block with equipment between the guide rails and the drill pipe.

This is space consuming and results in unwanted wire bend. The moment of force will, while drilling, become larger and create larger stress factors. This results in increased dimensioning.

This invention can solve some of these problems and make it possible to design a smaller space demanding derrick. It will reduce the moment of force on the guide rails as well as

avoid the bended wires when retracting from a symmetric position over the drill pipe.

This is achieved primarily by arranging the drill block off-center and designed as explained below.

By the off-centered design of the drill block, the retracting operation will demand less space. It is of greater importance in space critical area and will result that the construction can be dimensionally significantly reduced compared with previous methods. With this invention the wires will not have negative stress factors.

With reference to enclosed drawings and descriptions, the following will describe an embodiment of a sidestep retraction system.

On the drawings 7-11 the reference number 11 is a drill block in the derrick. The drill block 11 is through a joint link 12 connected with the equipment unit 13, for example a drilling machine for drilling of the drill pipe 14. The equipment 13 is by a wagon 15 guided by vertical guide rails 16.

In drilling position the drill block 11 with connected equipment 13 are kept in a central position over the drill pipe 14.

To and from the top block 18 in the top of the derrick there are connected wires 17.

To the drill block 11 there is connected a first hydraulic cylinder of the skid mechanism 19, which in turn is mounted on the wagon 15.

In order to change directions of the wire closest to the vertical centerline of the derrick, the top block 18 comprises a guide roller 20, which by a joint arm 21 is connected to the top block 18. A skid system is arranged by guiding the guide roller 20 with a second hydraulic

cylinder 22 connected with a top block 18. The top block 18 and the guide roller 20 can exert pressure on the adjacent wire, so that when the guide roller 20 is moved towards the wires 17, the wires 17 that are in contact with the guide roller 20 are moved to a new position that is offset relative the position when the guide roller is in its idle position. This is particular so when the drill block 11 is in retracted position, see Figs. 9 and 10, and in dotted position Fig. 11.

When the drill block 11 with connected equipment 13 is retracted to give space for a new drill pipe section 14', the first hydraulic cylinder 19 is activated and will bring the drill block 11 laterally away from the central area over the drill pipe. This opens the possibility to connect new drill pipe sections 14' even before the drill block 11 is retracted to upper position.

In order to also move the wire 17 in the same direction as the drill block 11 and bring this also sideways away from the central area in the derrick, the second hydraulic cylinder 22 at the top block 18 moves the guide roller 20 against the adjoining pair of wires 17.

When the drill block 11 with connected equipment including wire 17 is brought to a retracted position, the parts shown in Fig. 9 and Fig. 10 will take the position as shown by dotted line position in Fig. 11.

Fig. 11 illustrates the platform deck 23, the derrick 24 and the fingerboard 25 where drill pipe sections are stored in a vertical position. The various drill pipes can be transported between the fingerboard 25 and the mouse hole with the use of the pipe handling machine previously discussed, and with a fingerboard arrangement as illustrated in Figs. 5a-5d.

In accordance to the invention the retracted drill block 11 is off-centered, which means that the center axis of the drill block 11 and the wires 17 running from the drill block 11 are laterally moved.

This movement, as shown in Fig. 11, will take place by moving the drill block 11 parallel to the guide rails 16 as well as the fingerboard slots 25'.

This system creates less moment forces and demands less space than conventional known methods where the drill block 11 is retracted between the guide rails 16 and the drill pipe 14 towards the outer limits of the derrick 24.

Claims:

1. Arrangement in a pipe handling system for use with a top drive drilling system provided with a wagon supported on a first hydraulic cylinder of a skid mechanism characterized in that it comprises a sidestep retraction system forming a second hydraulic cylinder skid mechanism and including a wire guide apparatus located in the area of a top block mounted in a standard derrick provided with a drill block which can be retracted by wires running to and from said top block and through joint connections connected to said top block to transport equipment units on the wagon guided by vertical guide rails, and said drill block being retractable from its central position over drill pipe and laterally shiftable on said second hydraulic cylinder skid mechanism and said wire guide apparatus activating said wires by pressure to move said wires in the same direction as said drill block.

2. Arrangement in a pipe handling system according to claim 1 wherein the first hydraulic cylinder of the skid mechanism is arranged between the drill block and the wagon for transporting equipment units.

3. Arrangement in a pipe handling apparatus according to claim 1 wherein the wire guide apparatus includes a guide roller connected to the second hydraulic cylinder skid mechanism by a joint arm that is connected to the second hydraulic cylinder and to the top block.

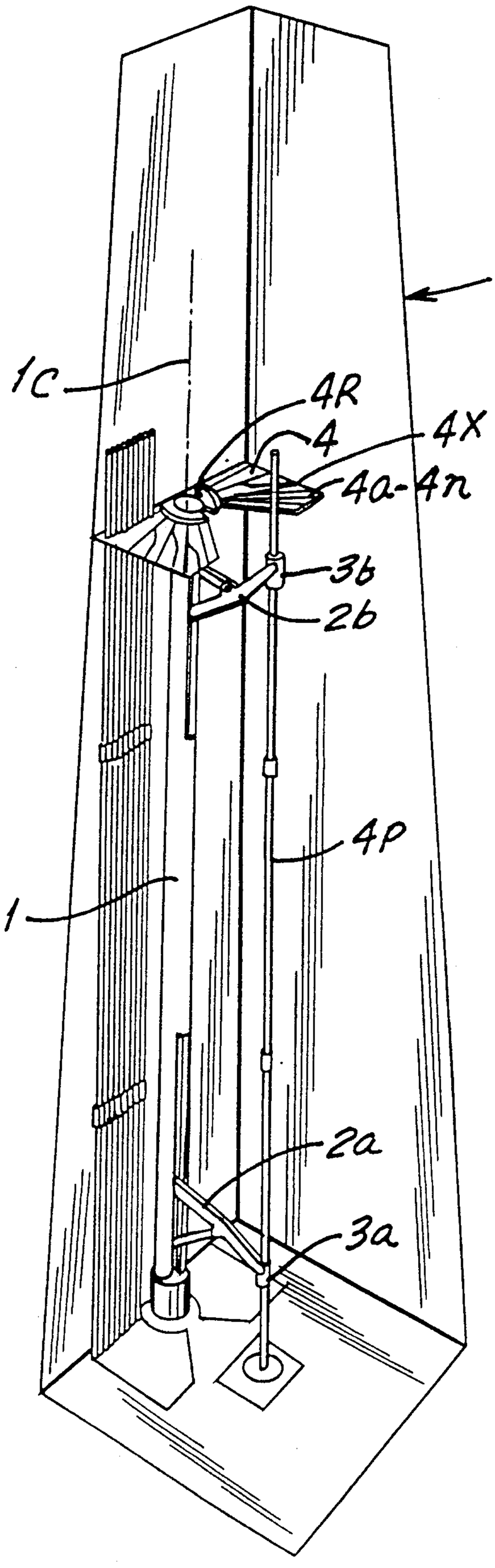


FIG. 1

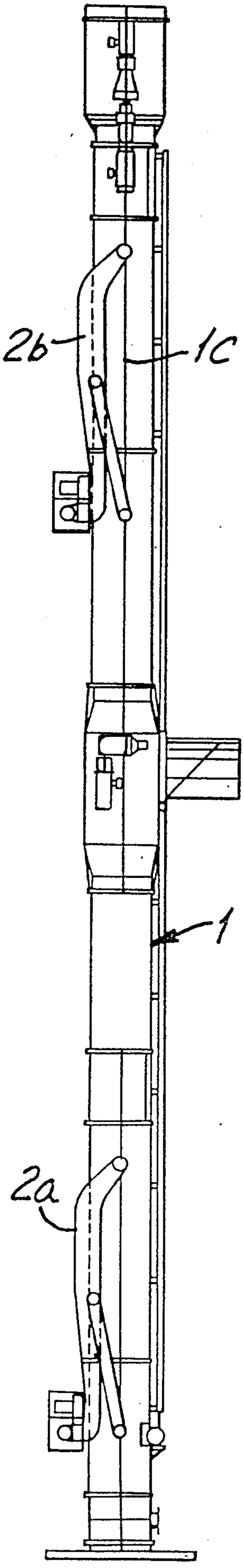


FIG. 2A

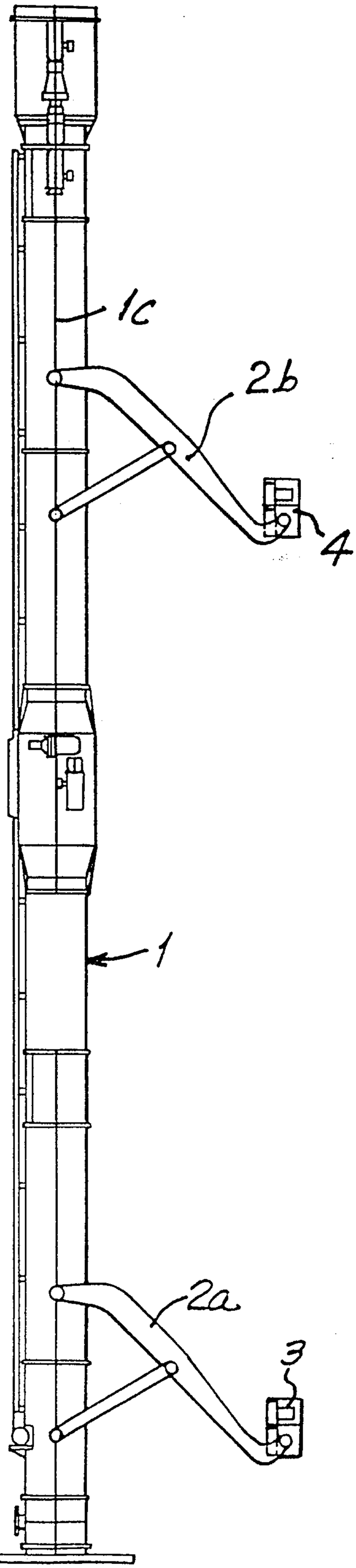


FIG. 2B

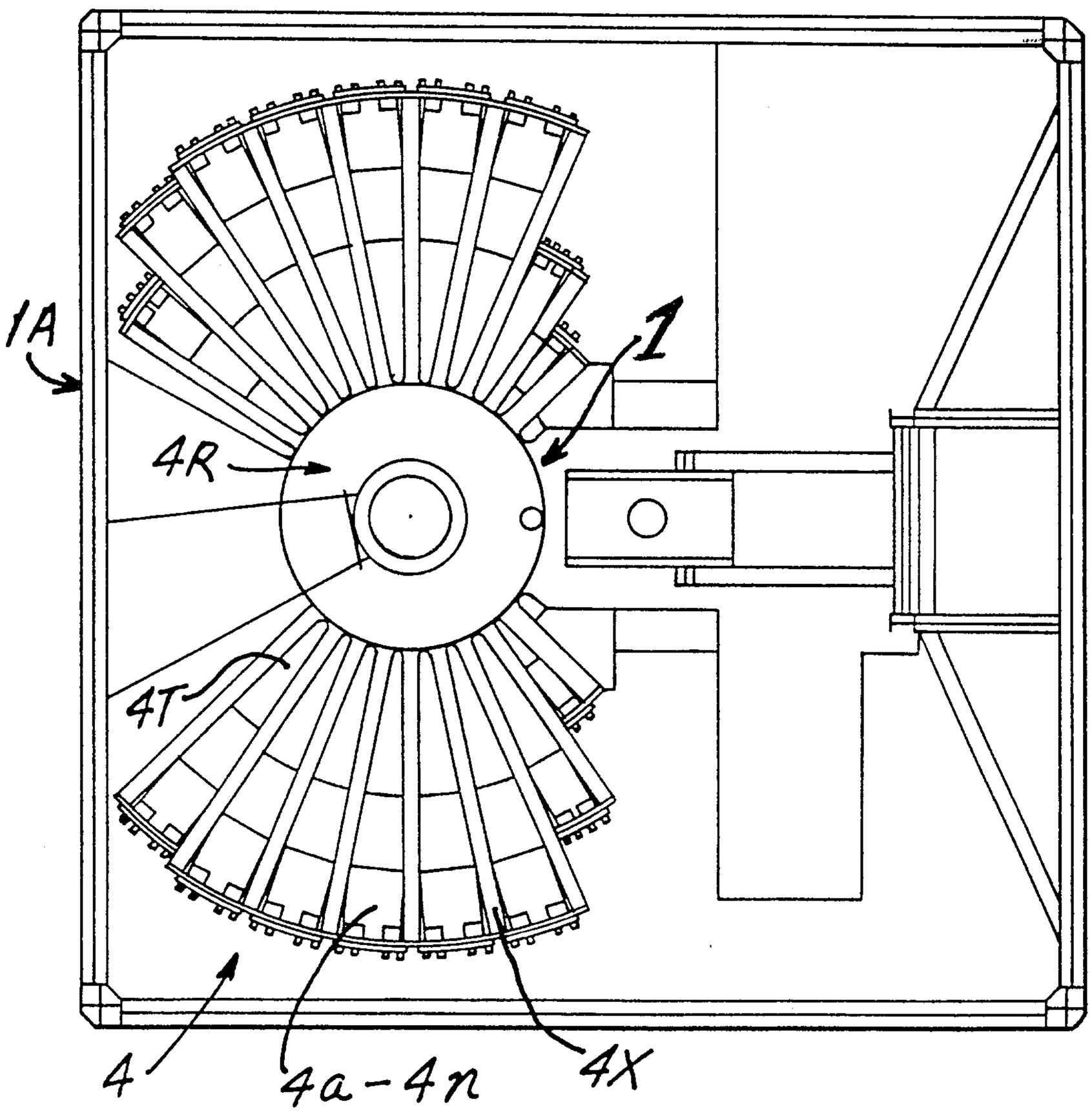


FIG.3

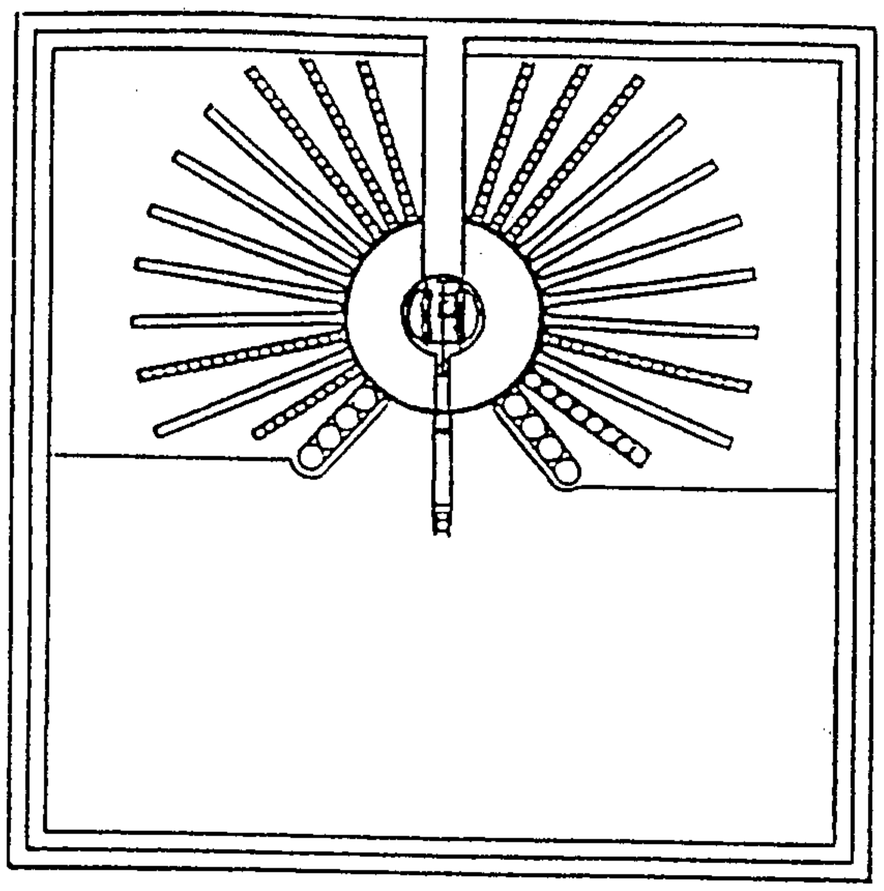


FIG.4c

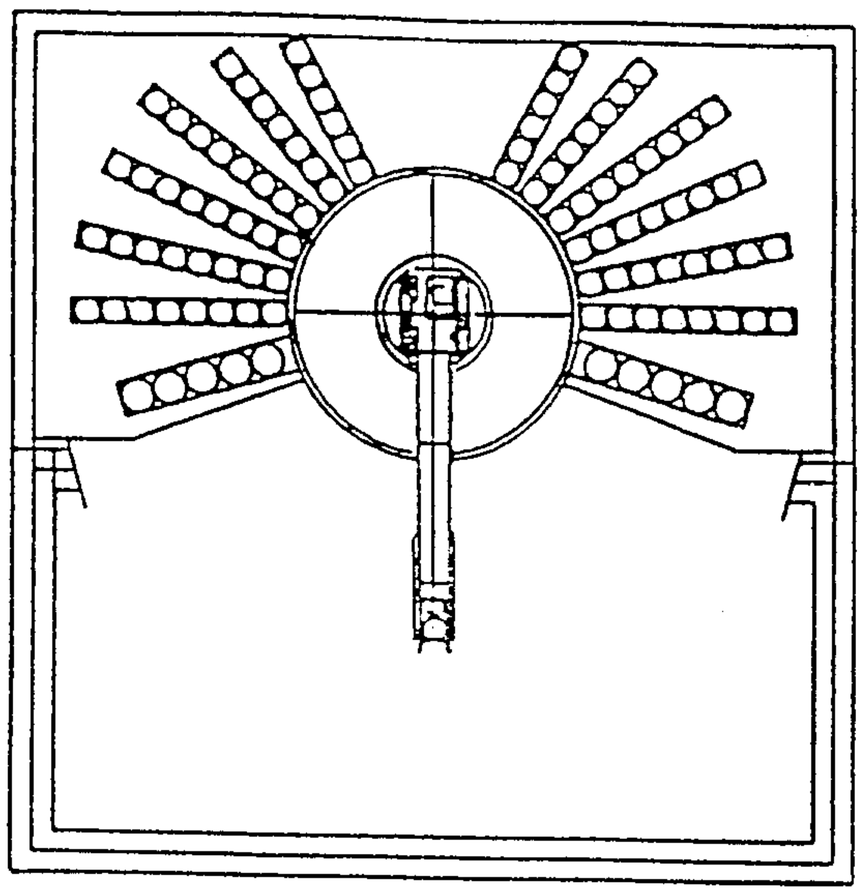


FIG.4d

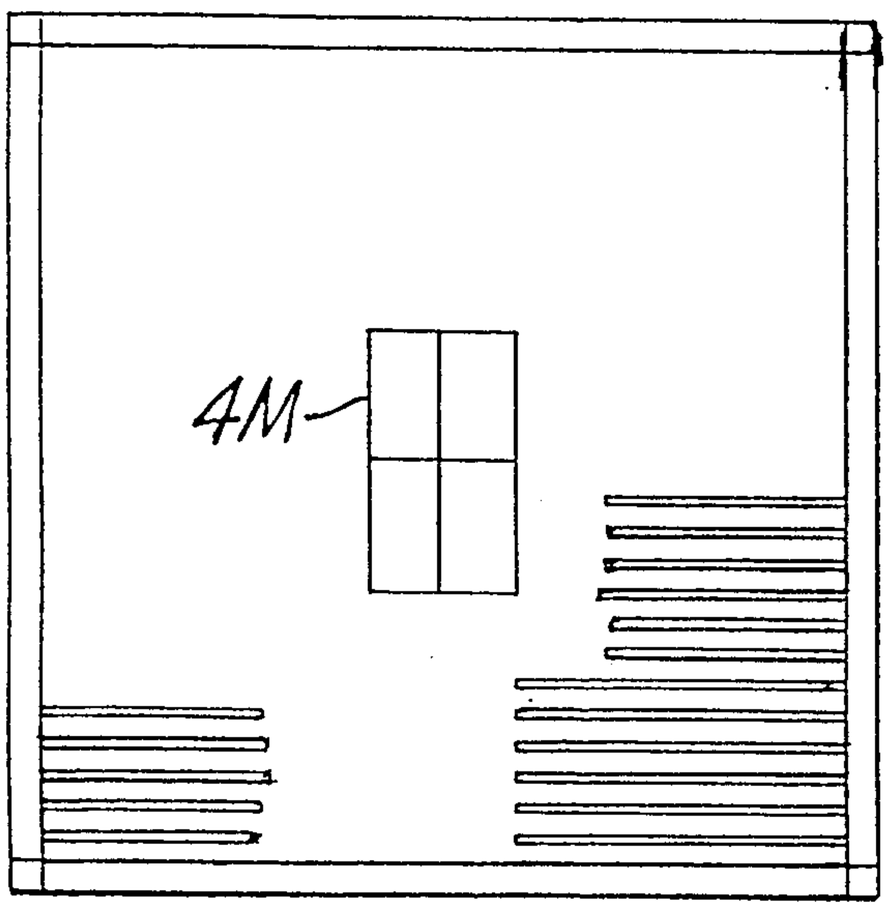


FIG.4a

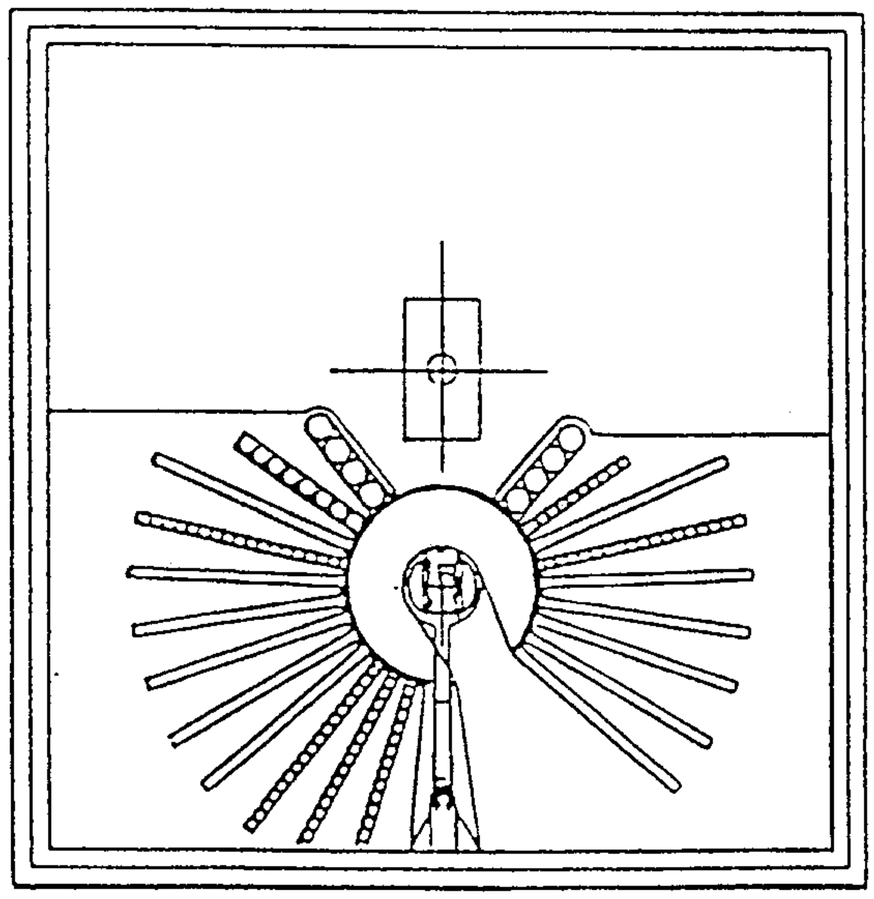


FIG.4b

PRIOR ART

FIG. 5a

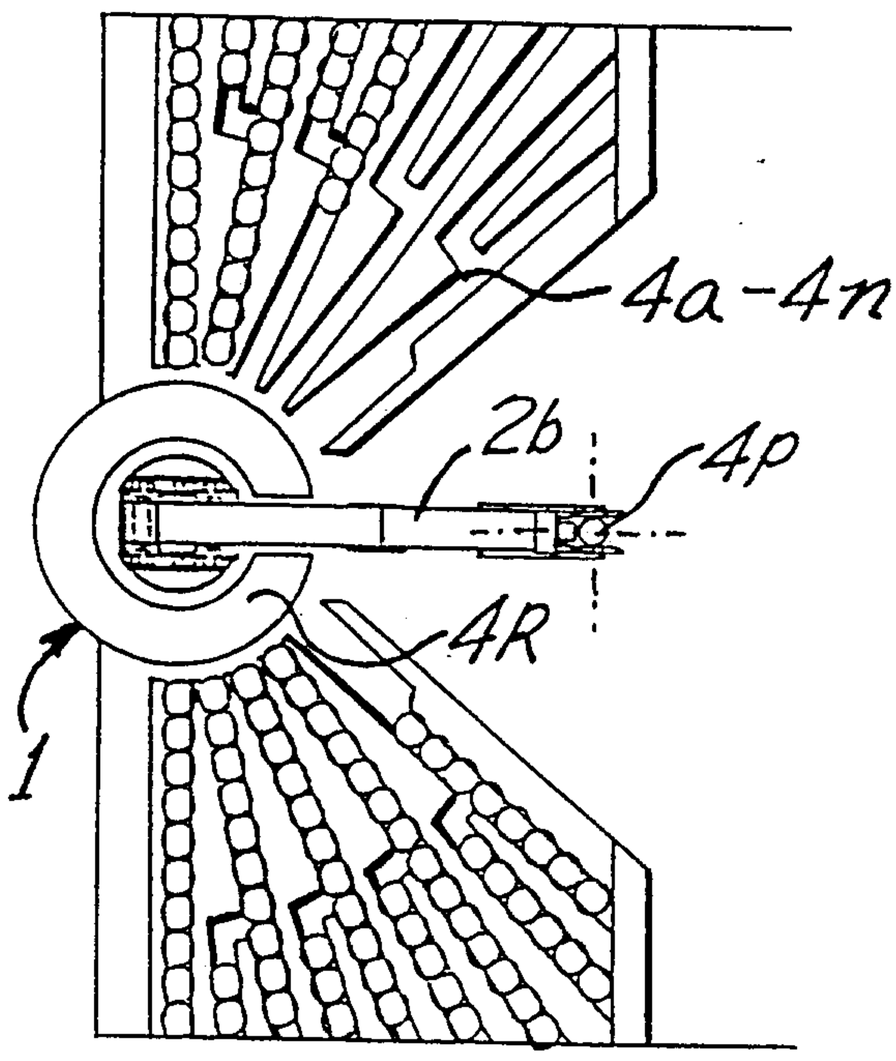
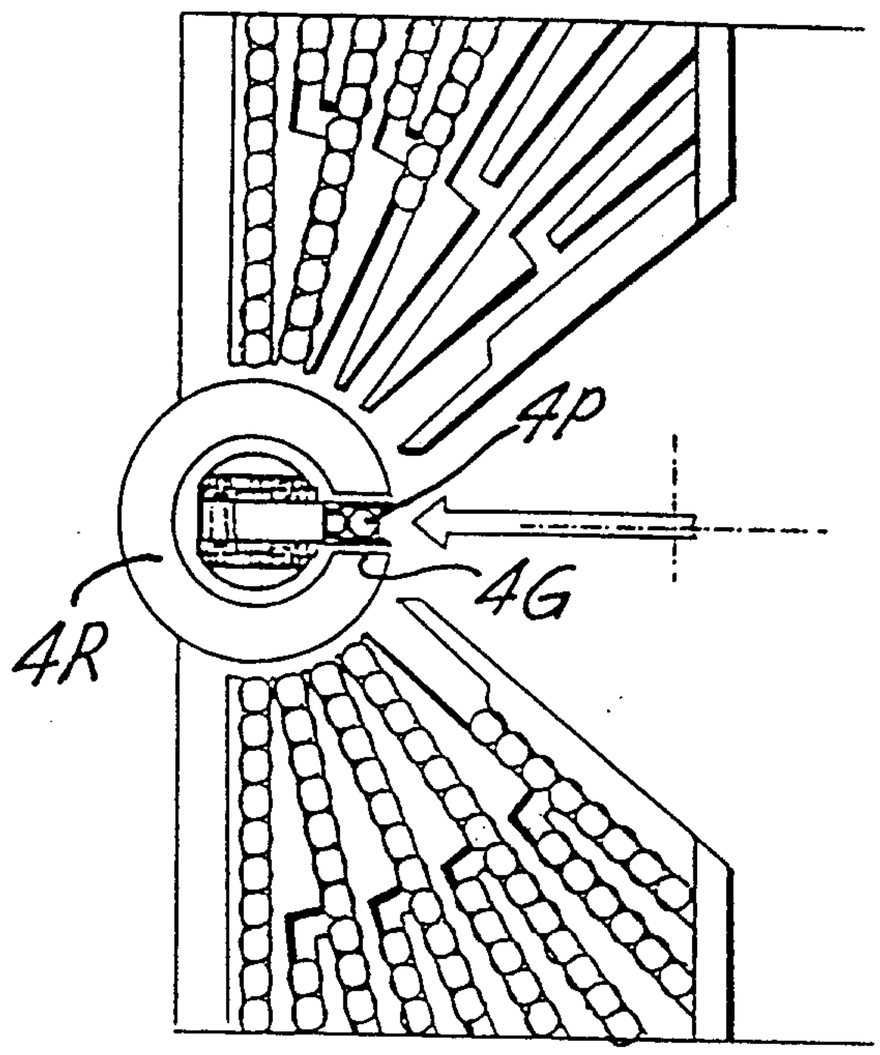


FIG. 5b



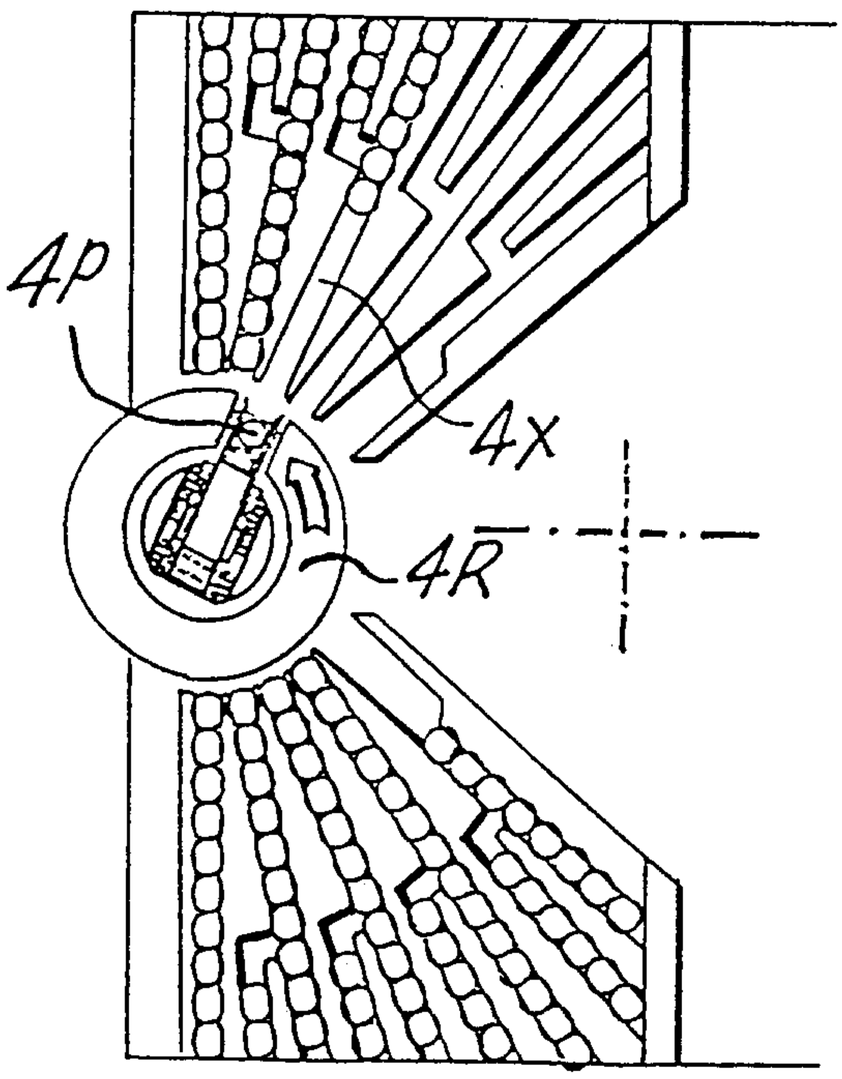


FIG. 5c

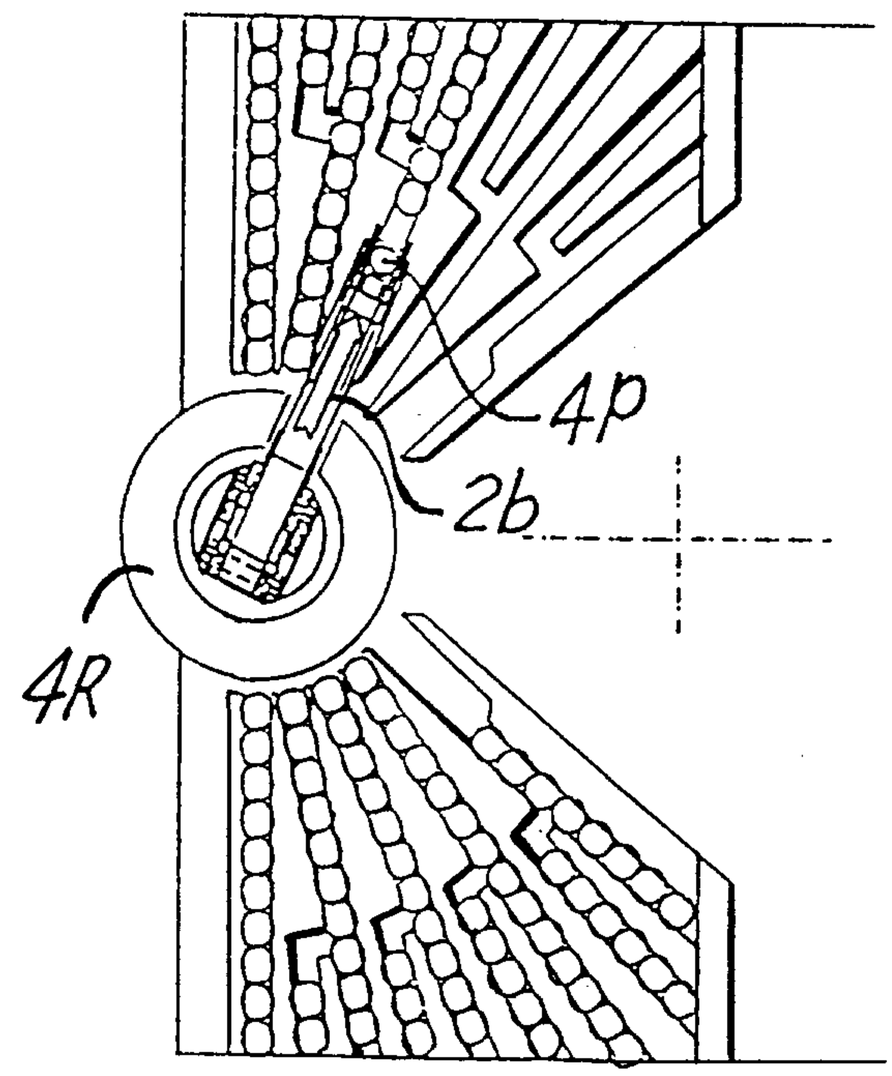


FIG. 5d

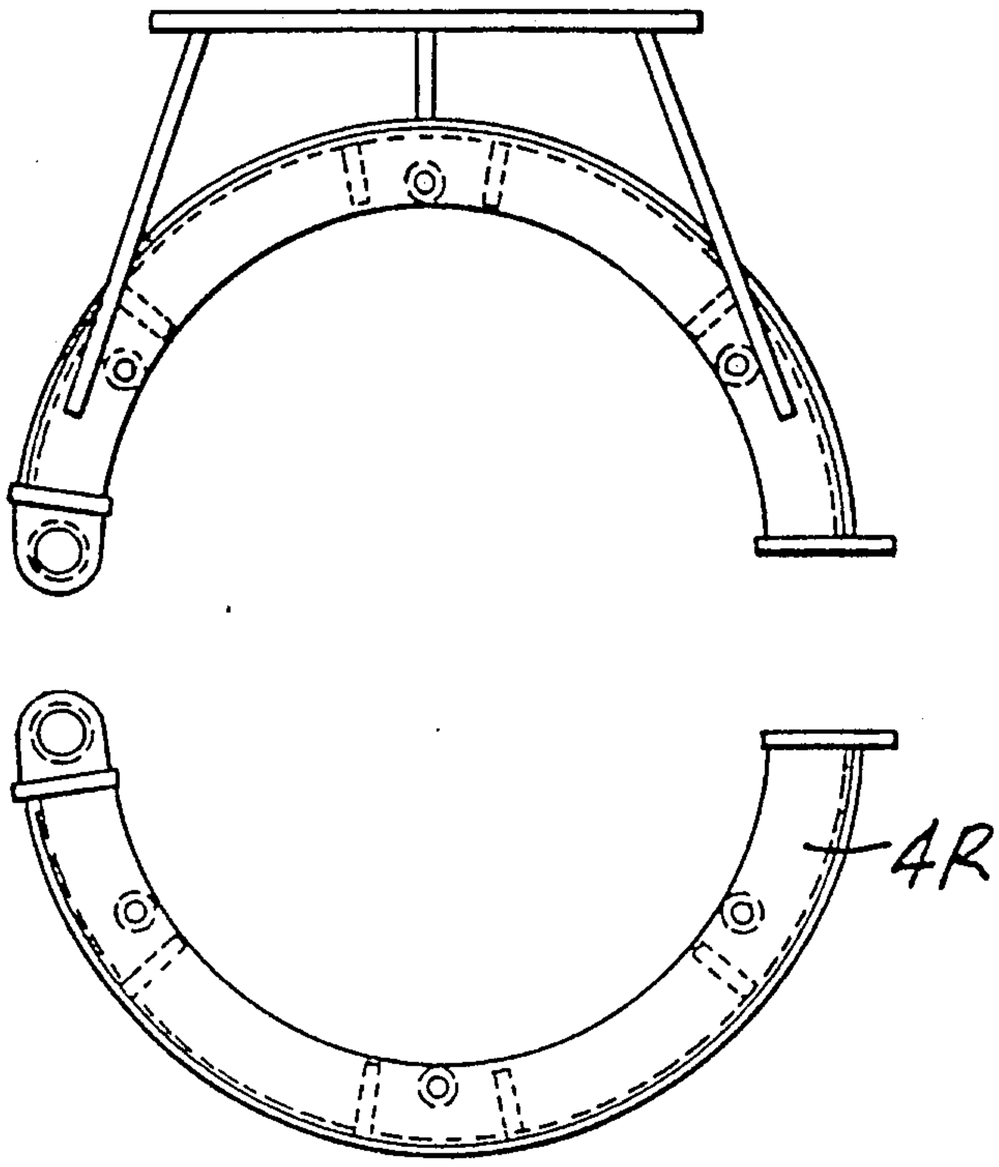


FIG. 6a

FIG. 6b

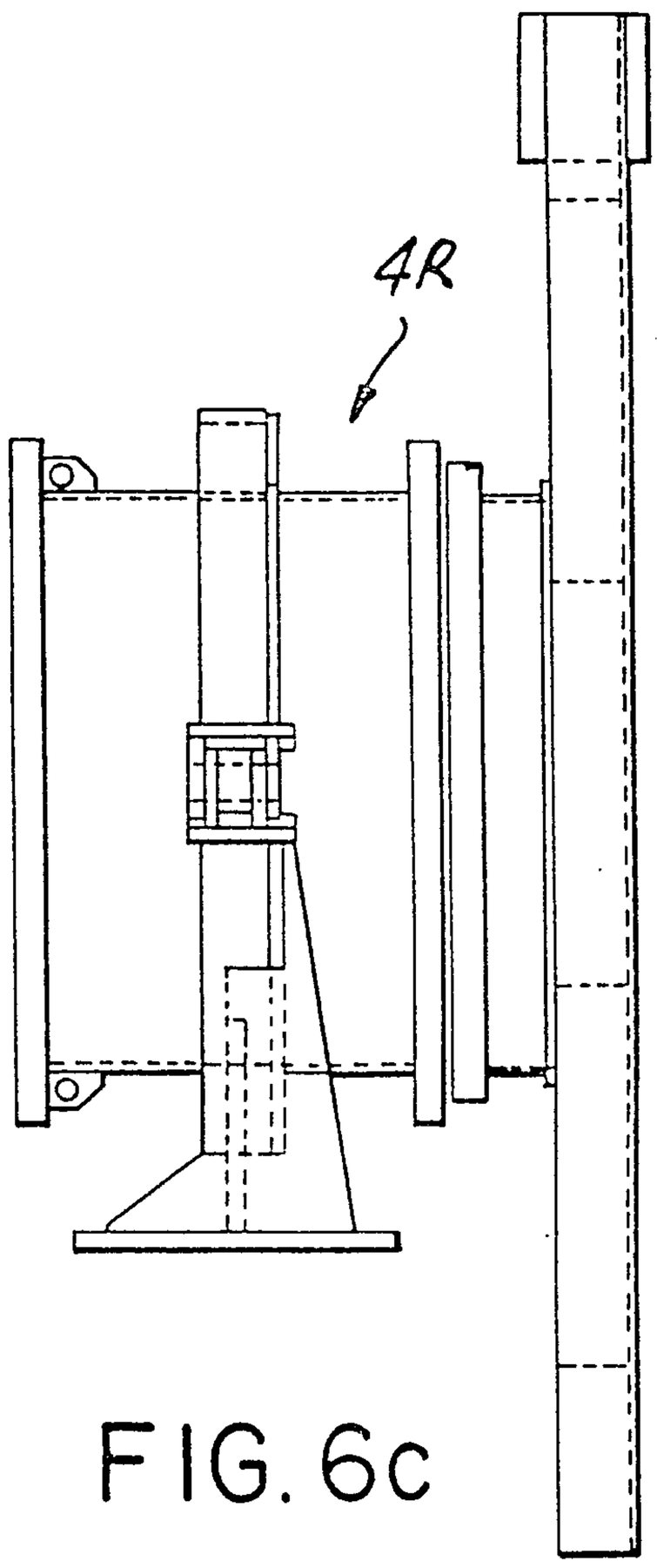


FIG. 6c

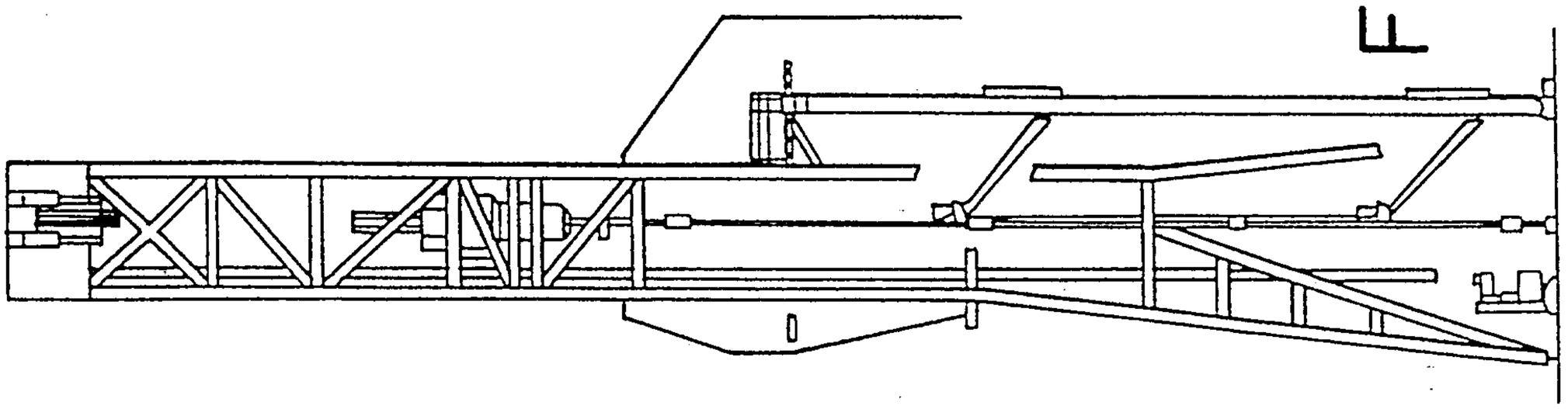


FIG. 7d

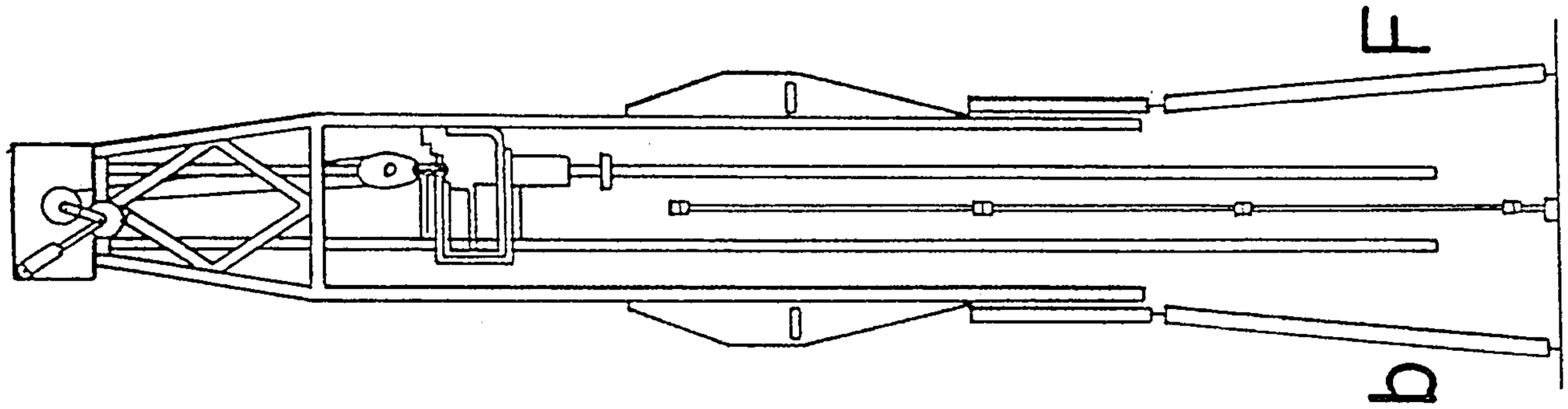


FIG. 7c

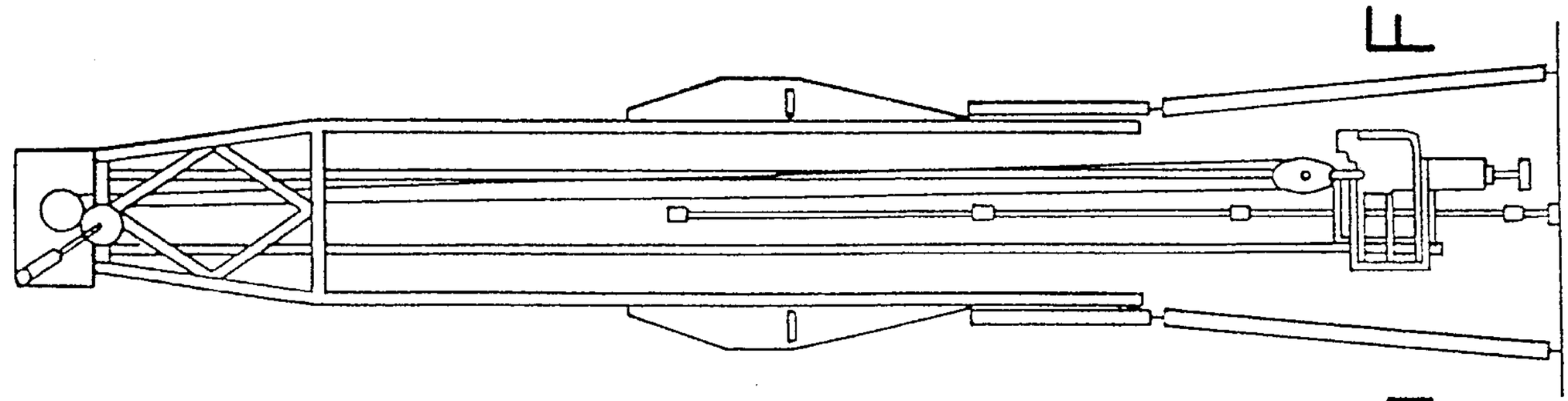


FIG. 7b

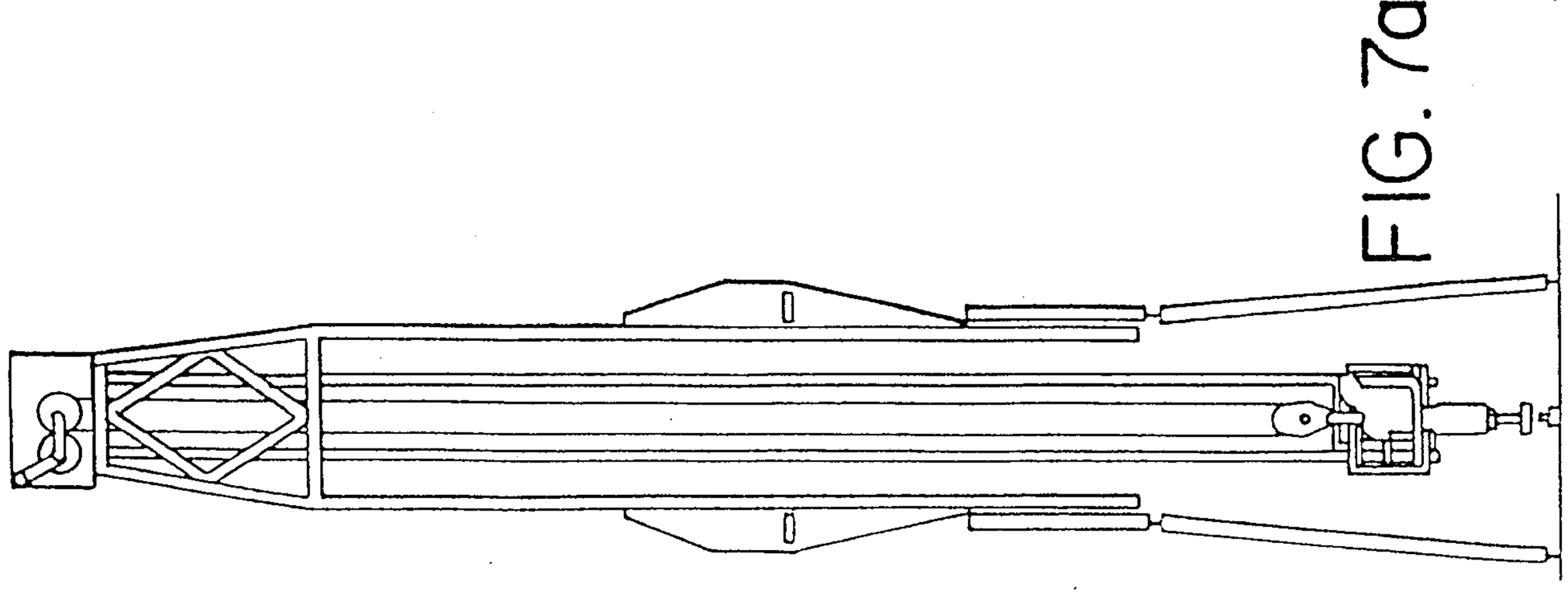


FIG. 7a

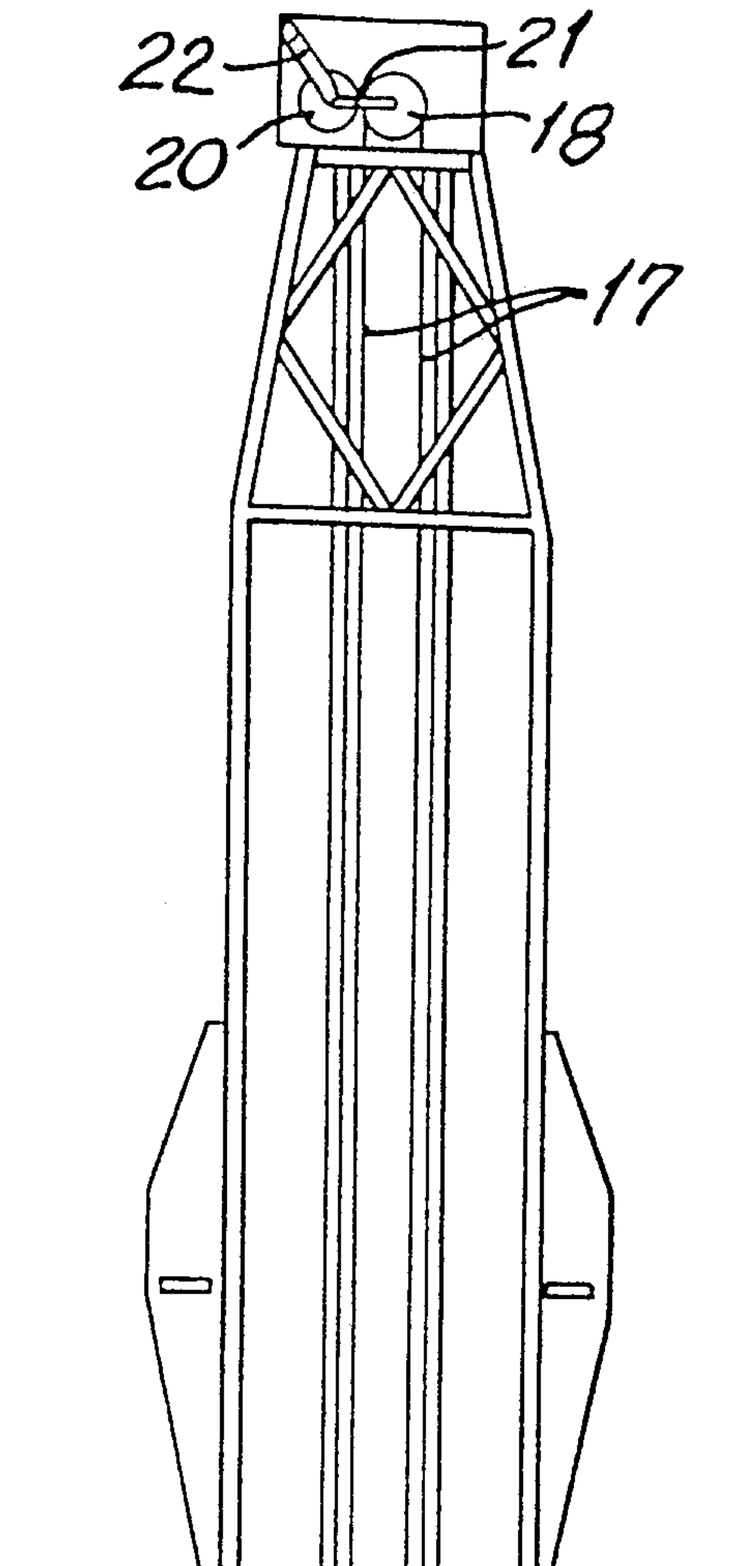

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FIG. 8

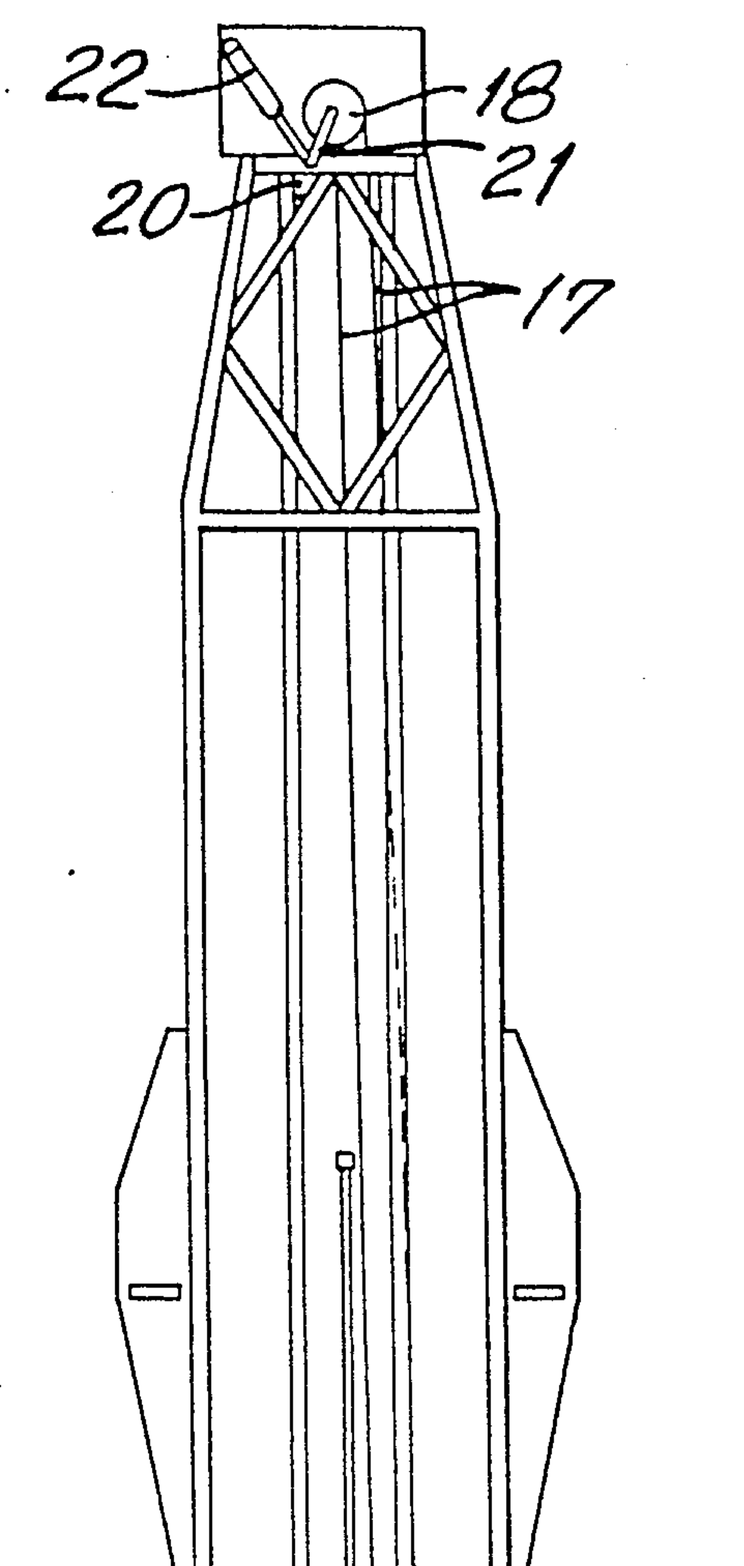
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FIG. 9

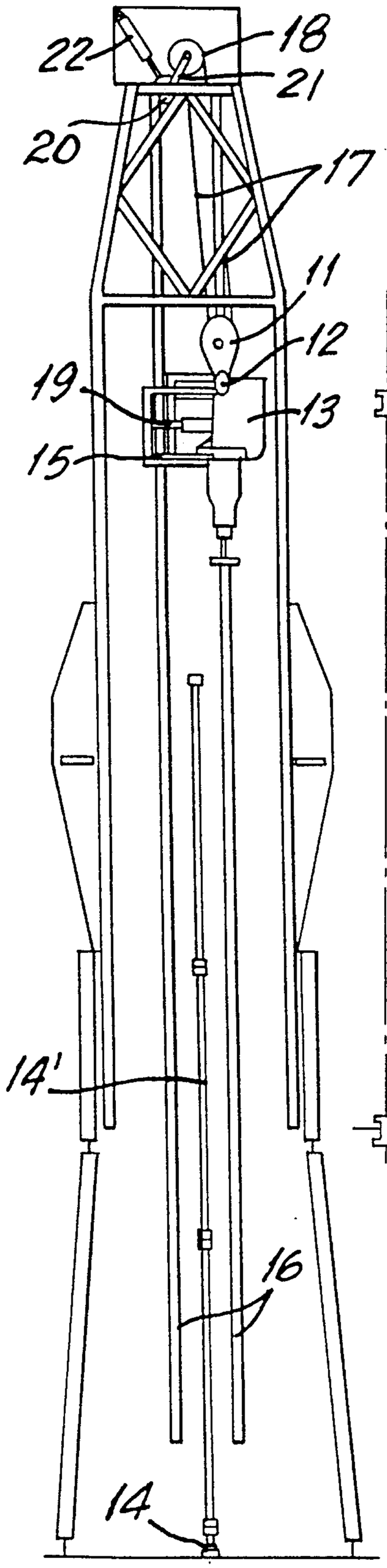
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FIG. 10

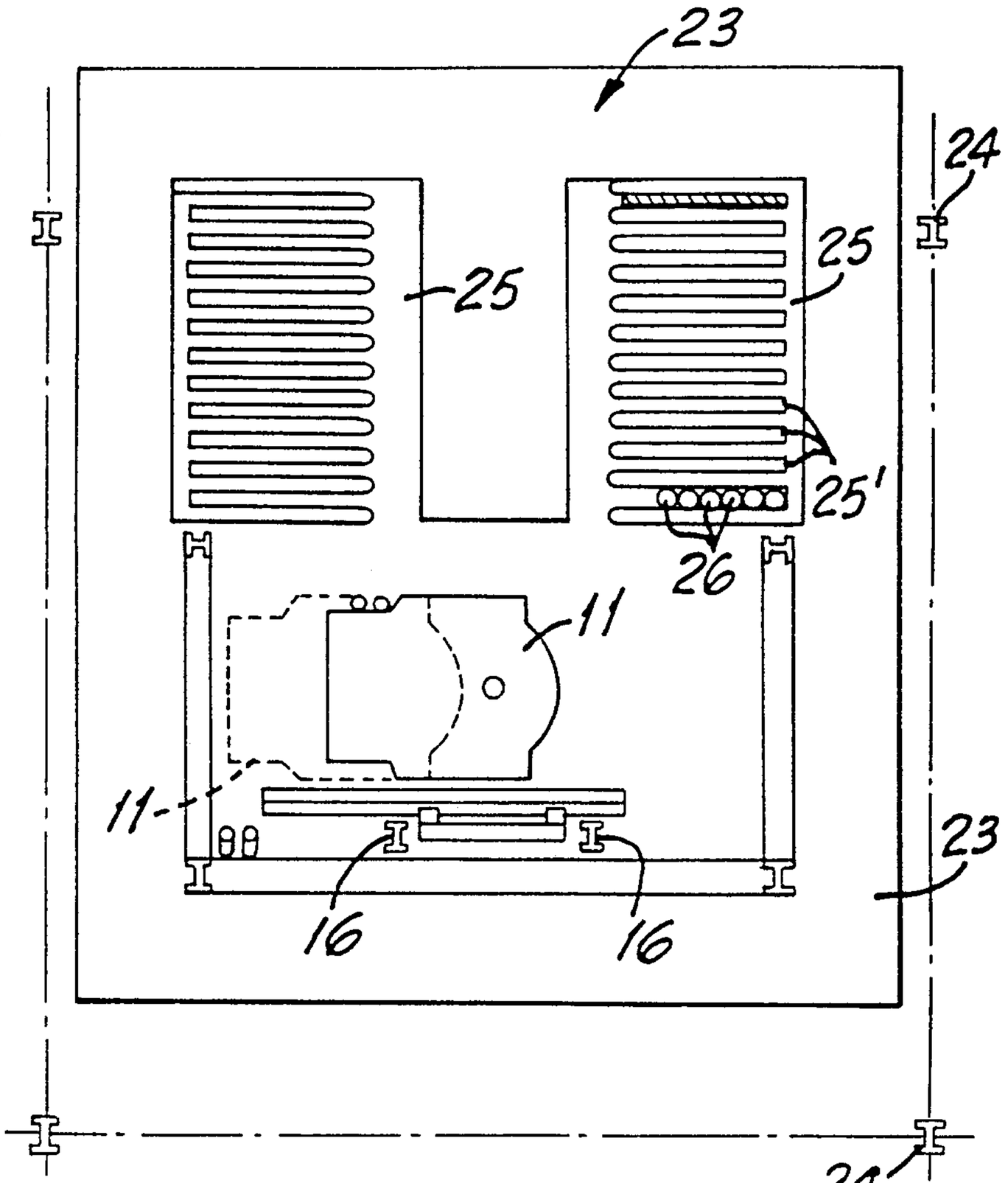
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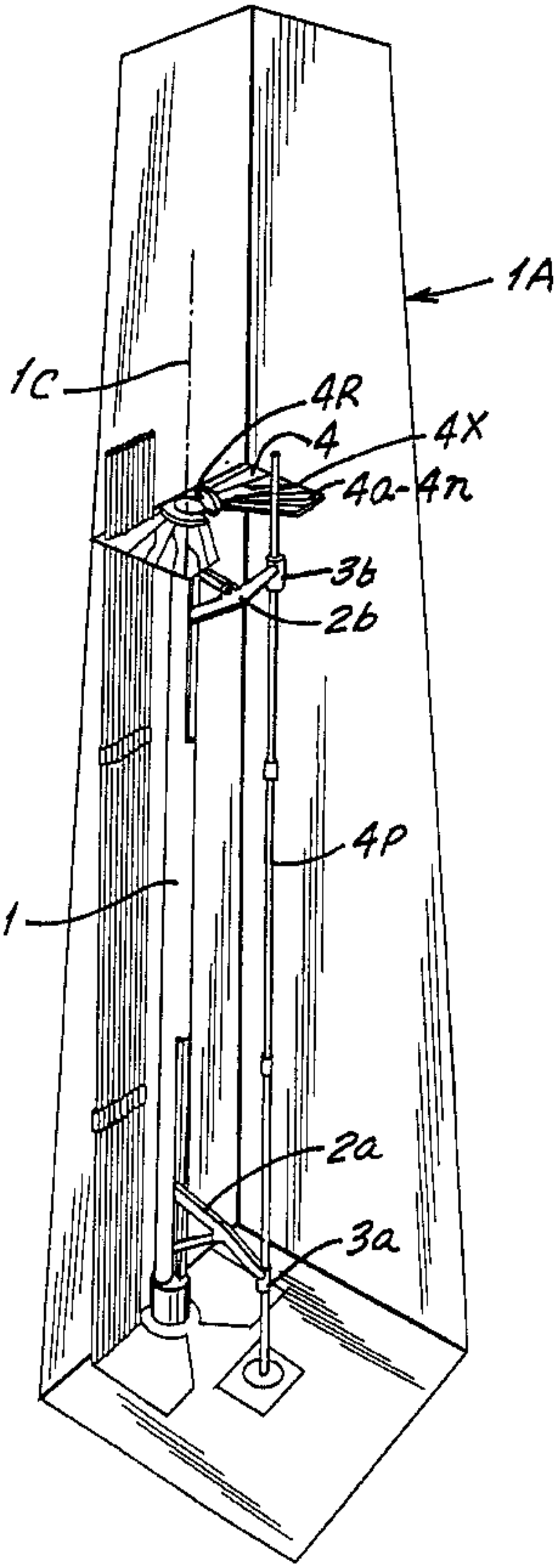
FIG. 11


1A
1C
4R
4
4X
4a-4n
3b
2b
4P
1
2a
3a