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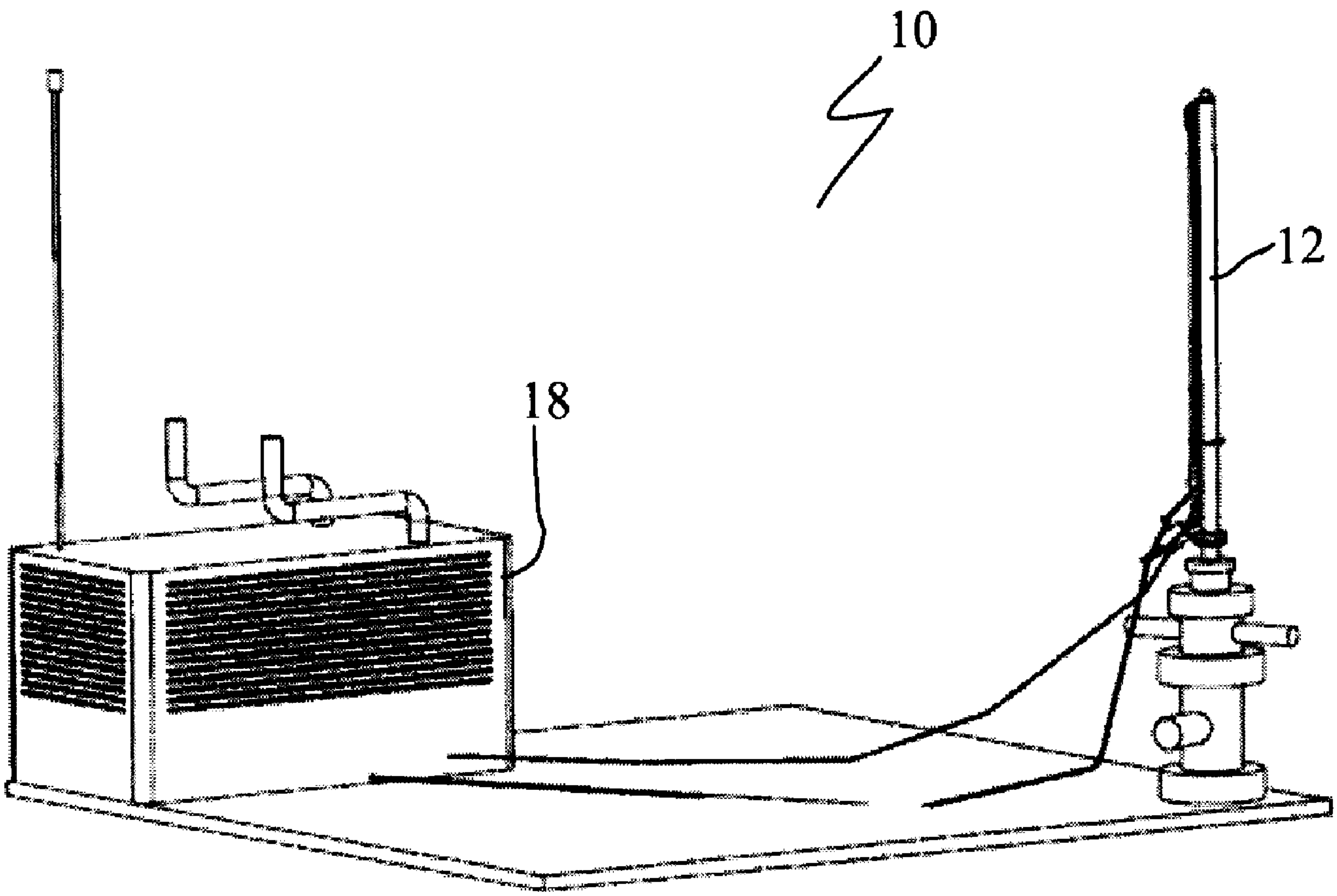
(54) Titre : ENSEMBLE DE COMMUTATION POUR CHEVALET DE POMPAGE HYDRAULIQUE
(54) Title: SWITCHING ASSEMBLY FOR A HYDRAULIC PUMP JACK



(57) Abrégé/Abstract:
A switching assembly for a hydraulic pump jack includes a non-magnetic cylinder having an exterior surface, and an interior surface that defines an interior bore. A piston is reciprocally movable within the interior bore of the cylinder. The piston has

(57) Abrégé(suite)/Abstract(continued):
circumferential sealing means to engage the interior surface of the cylinder. A magnetic element is carried by the piston. A fluid source supplies a working fluid to the cylinder, wherein the piston is moved by injecting working fluid into the cylinder. An array of magnetically triggered sensors are mounted to the exterior surface of the cylinder at axially spaced regular intervals. A controller is provided that receives signals from the magnetically triggered sensors as the magnet element carried by the piston comes in proximity with and influences the magnetically triggered sensors. The controller controls piston positioning by selectively controlling the working fluid supplied by the fluid source to the cylinder.

ABSTRACT OF THE DISCLOSURE

A switching assembly for a hydraulic pump jack includes a non-magnetic cylinder having an exterior surface, and an interior surface that defines an interior bore. A piston is reciprocally movable within the interior bore of the cylinder. The piston has circumferential sealing means to engage the interior surface of the cylinder. A magnetic element is carried by the piston. A fluid source supplies a working fluid to the cylinder, wherein the piston is moved by injecting working fluid into the cylinder. An array of magnetically triggered sensors are mounted to the exterior surface of the cylinder at axially spaced regular intervals. A controller is provided that receives signals from the magnetically triggered sensors as the magnet element carried by the piston comes in proximity with and influences the magnetically triggered sensors. The controller controls piston positioning by selectively controlling the working fluid supplied by the fluid source to the cylinder.

TITLE

[0001] Switching Assembly For A Hydraulic Pump Jack

FIELD

[0002] The present switching assembly is intended for use with a hydraulic pump jack to improve switching by more accurately determining piston position and speed.

BACKGROUND

[0003] Switching assemblies presently used for hydraulic pump jacks consist of two axially spaced ports equipped with fittings in which are positioned electric over hydraulic switches. The positioning of these ports determines the upper limit and the lower limit of the piston stroke. The electric over hydraulic switches are tied into an electrically controlled hydraulic spool valve. Variations in hydraulic pressure at the ports results in the switches causing the hydraulic spool valve to reverse the direction and flow of hydraulic working fluid.

SUMMARY

[0004] There is provided a switching assembly for a hydraulic pump jack which includes a non-magnetic cylinder having an exterior surface, and an interior surface that defines an interior bore. A piston is reciprocally movable within the interior bore of the cylinder. The piston has circumferential sealing means to engage the interior surface of the cylinder. A magnetic element is carried by the piston. A fluid source supplies a working fluid to the cylinder, wherein the piston is moved by injecting working fluid into the cylinder. An array of magnetically triggered sensors are mounted to the exterior surface of the cylinder at axially spaced regular intervals. A controller is provided that receives signals from the magnetically triggered sensors as the magnet element carried by the piston comes in proximity with and influences the magnetically triggered sensors. The controller controls piston positioning by selectively controlling the working fluid supplied by the fluid source to the cylinder.

[0005] It is preferred that the cylinder has a lower end and an upper end; with the upper end being higher than the lower end. This allows the working fluid to raise the piston from the lower end toward the upper end, and gravity to return the piston from the upper end to the lower end.

[0006] It is preferred that each of the magnetically triggered sensors have a unique sensor value. This allows the controller to determine precise piston positioning based upon the unique sensor value of the signals received. The unique sensor value of each of the magnetically triggered sensors in the array varies incrementally. In the embodiment which will hereinafter be described the unique sensor value used is a resistance value.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] These and other features will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to be in any way limiting, wherein:

[0008] **FIG. 1** is a perspective view of a switching assembly for a hydraulic pump jack.

[0009] **FIG. 2** is a front elevation view of the hydraulic pump jack from the switching assembly of **FIG. 1**.

[0010] **FIG. 3** is a rear elevation view, in section, of the hydraulic pump jack from the switching assembly of **FIG. 1.**

[0011] **FIG. 4** is a circuit diagram of the switching assembly.

[0012] **FIG. 5** is a rear elevation view, in section, of the upper portion of **FIG. 3.**

DETAILED DESCRIPTION

[0013] A switching assembly for a hydraulic pump jack generally identified by reference numeral 10, will now be described with reference to **FIG. 1** through **3**.

Structure and Relationship of Parts:

[0014] Referring to **FIG. 1,** a switching assembly for a hydraulic pump jack 10 includes a non-magnetic cylinder 12 in combination with a control unit 18 that includes an electronic controller and a hydraulic fluid source (concealed within control unit 18). Referring to **FIG. 3**, positioned within non-magnetic cylinder 12 is a piston 14. Referring to **FIG. 5**, a magnetic element 16 is mounted on piston 14. Referring to **FIG. 3,** an array of externally mounted magnetically triggered sensors 20 extend along the length of non-magnetic cylinder 12, magnetically triggered sensors are responsive to the position of piston 14. Referring to **FIG. 5,** this is due to the proximity to magnetic element 16 which is carried by piston 14.

Referring to **FIG. 1,** control unit 18 receives signals from the magnetically triggered sensors 20 and, as is hereinafter further described, is able to determine the position of piston 14.

[0015] Referring to **FIG. 2**, the non-magnetic cylinder 12 has an exterior surface 24, a lower end 30 and an upper end 32 that is higher than the lower end 30. Referring to **FIG. 3,** the non-magnetic cylinder includes an interior surface 26 that defines an interior bore 28. Piston 14 is reciprocally movable within the interior bore 28 of the cylinder 12

[0016] Referring to **FIG. 5**, piston 14 has circumferential seals 34 to engage the interior surface 26 of the cylinder 12. Referring to **FIG. 1**, the hydraulic fluid source within control unit 18 supplies a hydraulic working fluid to the cylinder 12. Referring to **FIG. 3**, the hydraulic working fluid causes the piston 14 to be raised from the lower end 30 toward the upper end 32 by an injection of working fluid 36 into the cylinder 12. The piston 14 returns from the upper end 32 to the lower end 30 by force of gravity.

[0017] Referring to **FIG. 3**, array of magnetically triggered sensors 20 is mounted to the exterior surface 24 of the cylinder 12 in axially spaced regular intervals. Each of the magnetically triggered sensors 20 has a unique sensor value or resistance value. The unique sensor value of each of the magnetically triggered sensors 20 in the array vary incrementally from the lower end 30 to the upper end 32. A sensor bar houses 10 - 6 inch long circuit boards. Each circuit board holds 2 electronic reed switches and a 100-ohm resistor. Each circuit board is stacked end to end and the signal out of the previous board is attached to the signal in of the next board. Therefore the resistance of any switch = 100 + n*100 where n is the switch number. I.e. switch 1 = 200 ohms, switch 5 = 600 ohms and switch 20 = 2100 ohms. The bar spans the full length of the non-magnetic stainless steel cylinder. An electronic instrument is wired to this sensor bar and reads the resultant resistance changes as the magnet passes by each reed switch and closes it. The electronic controller in control unit 18 reads the switch-input line 120 times per second. It looks for the first time the reed switch closes and waits 25 ms and reads the resistance to determine which switch is closed. Referring to **FIG. 4,** the circuit board layout for the magnetically triggered sensors is disclosed.

[0018] Referring to **FIG. 3**, the magnetically triggered sensors 20 are excited as the magnetic element 16 carried by the piston 14 comes in proximity with and influences the magnetically triggered sensors 20. This enables electronic controller within control unit 18 to determine precise piston positioning based upon the unique sensor value of the signals received and control movement of piston 14 by selectively controlling the working fluid supplied to the cylinder 12. Within 8 inches of movement the electronic controller knows where the piston is in its travel and because it now has a time and distance equation between two switch closures it now can adjust the supply of hydraulic fluid to speed up or slow down to the programmed strokes per minute. The stroke length can be programmed to start and stop anywhere between 3 switch points along the length of cylinder 12

Operation:

[0019] Referring to **FIG. 3**, hydraulic working fluid supplied by the hydraulic fluid source within control unit 18, enters the cylinder 12 causing the piston 14 to rise towards the upper end 32 of the cylinder 12, away from the lower end 30. As the piston 14 moves upwards, the magnetic element 16 (best shown in **FIG. 5)** interacts with the array of magnetically triggered sensors 20, exciting the circuit illustrated in **FIG. 4.** Signals from the magnetically triggered sensors 20 are sent to a electronic controller within control unit 18. The electronic controller determines precise piston positioning and controls movement by selectively controlled the working fluid supplied to the cylinder 12. At the termination of each stroke, the force of gravity is used to move the piston 14 downwards towards lower end 30 and away from upper end 32.

Advantages:

[0020] To increase or decrease the speed of the cylinder with prior art devices is a complicated process of adjusting the flow of the pump and timing the strokes by watching a pressure gauge. When the pressure goes high, the time clock is activated and when the pressure goes low it is stopped. The time elapsed is then used to calculate the speed of the cylinder. This can be a time consuming process, of adjusting and waiting for the desired results.

[0021] The present system has a lot of very undesirable features. First and foremost is the potential of the hydraulic cylinder to leak at any of the locations along its length where the ports are located. The electric over hydraulic switches are prone to failure, and their life span is very limited due to the fact that they are a mechanical switch. The operator also has to uncouple and recouple these switches manually and put them into the positions required for the desired stroke length. There is also a danger of spilled hydraulic fluid any time this is done.

[0022] The present system does not require pressure ports through which fluids could leak. The present system enables the operator to know the position and the speed of the hydraulic cylinder within 8 inches of stroke travel. The present system is intrinsically safe. There would not be enough voltage or amperage at the well head to produce a spark. Thus eliminating well head explosions.

[0023] 99% of all hydraulic cylinders are manufactured using a steel outer tube with steel piston rod and steel piston. In magnetics it is known that steel acts as a shunt, this is to say that magnetic lines of flux will not pass through steel. With the present system, the outer cylinder tube was manufactured out of non-magnetic stainless steel, the piston out of non-magnetic aluminum and the piston rod out of high quality steel. The aluminum piston houses a rare earth neomidium iron boron magnet with high strength magnetic characteristics. A sensor bar houses 10 - 6 inch long circuit boards. Each circuit board holds 2 electronic reed switches and a 100-ohm resistor. Each circuit board is stacked end to end and the signal out of the previous board is attached to the signal in of the next board. Therefore the resistance of any switch = 100 + n*100 where n is the switch number. I.e. switch 1 = 200 ohms, switch 5 = 600 ohms and switch 20 = 2100 ohms. The bar spans the full length of the non-magnetic stainless steel cylinder. An electronic instrument is wired to this sensor bar and reads the resultant resistance changes as the magnet passes by each reed switch and closes it. The instrument reads the switch-input line 120 times per second. It looks for the first time the reed switch closes and waits 25 ms and reads the resistance to determine which switch is closed.

Within 8 inches of movement the electronic instrument knows where the piston is in its travel and because it now has a time and distance equation between two switch closures it now can adjust the hydraulics to speed up or slow down to the programmed strokes per minute. The stroke length can be programmed to start and stop anywhere between 3 switch points along the length of the hydraulic cylinder.

[0024] Traditional electric over hydraulic switches used on most hydraulic strokers utilize a diaphragm which, when hydraulic pressure pushes against this diaphragm it either opens or closes a mechanical toggle switch. Because of the mechanical nature of this design it is limited to the number of times it can be activated. On a high quality switch the number of cycles is about 2 million cycles. The electronic reed switch, which is used on the sensor bar, has a life expectancy of 20 million cycles. This amount of cycles is 10 times that of the traditional electric over hydraulic switch, thus life expectancy of the present system is greatly increased over traditional hydraulic strokers. The first boards signal in is connected to the amphanol plug pins A and B at the base of the sensor bar. The sensor bar is then installed to the cylinder using 4 – stainless steel corban gear clamps. This type of mounting allows for the sensor bar to be rapidly mounted and dismounted. This greatly enhances field serviceability.

[0025] In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements.

[0026] The following claims are to be understood to include what is specifically illustrated and described above, what is conceptually equivalent, and what can be obviously substituted. Those skilled in the art will appreciate that various adaptations and modifications of the described embodiments can be configured without departing from the scope of the claims. The illustrated embodiments have been set forth only as examples and should not be taken as limiting the invention. It is to be understood that, within the scope of the following claims, the invention may be practiced other than as specifically illustrated and described.

What is Claimed is:

1. A switching assembly for a hydraulic pump jack, comprising in combination:

a non-magnetic cylinder with an exterior surface, and an interior surface that defines an interior bore;

a piston reciprocally movable within the interior bore of the cylinder, the piston having circumferential sealing means to engage the interior surface of the cylinder;

a magnetic element carried by the piston;

a fluid source supplying a working fluid to the cylinder, wherein the piston is moved by injecting working fluid into the cylinder;

an array of magnetically triggered sensors mounted to the exterior surface of the cylinder at axially spaced regular intervals; and

a controller that receives signals from the magnetically triggered sensors as the magnet element carried by the piston comes in proximity with and influences the magnetically triggered sensors, the controller controlling piston positioning by selectively controlling the working fluid supplied by the fluid source to the cylinder.

2. The switching assembly of Claim 1, wherein the cylinder has a lower end and an upper end, the upper end being higher than the lower end, the working fluid serving to raise the piston from the lower end toward the upper end, and gravity serving to return the piston from the upper end to the lower end.

3. The switching assembly of Claim 1, wherein each of the magnetically triggered sensors has a unique sensor value, wherein the controller determines precise piston positioning based upon the unique sensor value of the signals received.

4. The switching assembly of Claim 3, wherein the unique sensor value of each of the magnetically triggered sensors in the array varies incrementally.

5. The switching assembly of Claim 3, wherein the unique sensor value is a resistance value.

6. A switching assembly for a hydraulic pump jack, comprising in combination:

a non-magnetic cylinder with an exterior surface, an interior surface that defines an interior bore, a lower end and an upper end that is higher than the lower end;

a piston reciprocally movable within the interior bore of the cylinder, the piston having circumferential sealing means to engage the interior surface of the cylinder;

a magnetic element carried by the piston;

a fluid source supplying a hydraulic working fluid to the cylinder, wherein the piston is raised from the lower end toward the upper end by an injection of working fluid into the cylinder;

an array of magnetically triggered sensors mounted to the exterior surface of the cylinder in axially spaced regular intervals, each of the magnetically triggered sensors having a unique sensor value, the unique sensor value of each of the magnetically triggered sensors in the array varying incrementally from the lower end to the upper end; and

a controller that receives signals from the magnetically triggered sensors as the magnet element carried by the piston comes in proximity with and influences the magnetically triggered sensors, the controller determining precise piston positioning based upon the unique sensor value of the signals received and controlling piston movement by selectively controlling the working fluid supplied by the fluid source to the cylinder.

6. The switching assembly of Claim 5, wherein the unique sensor value is a resistance value.

7. The switching assembly of Claim 5, wherein the piston returns from the upper end to the lower end by force of gravity.

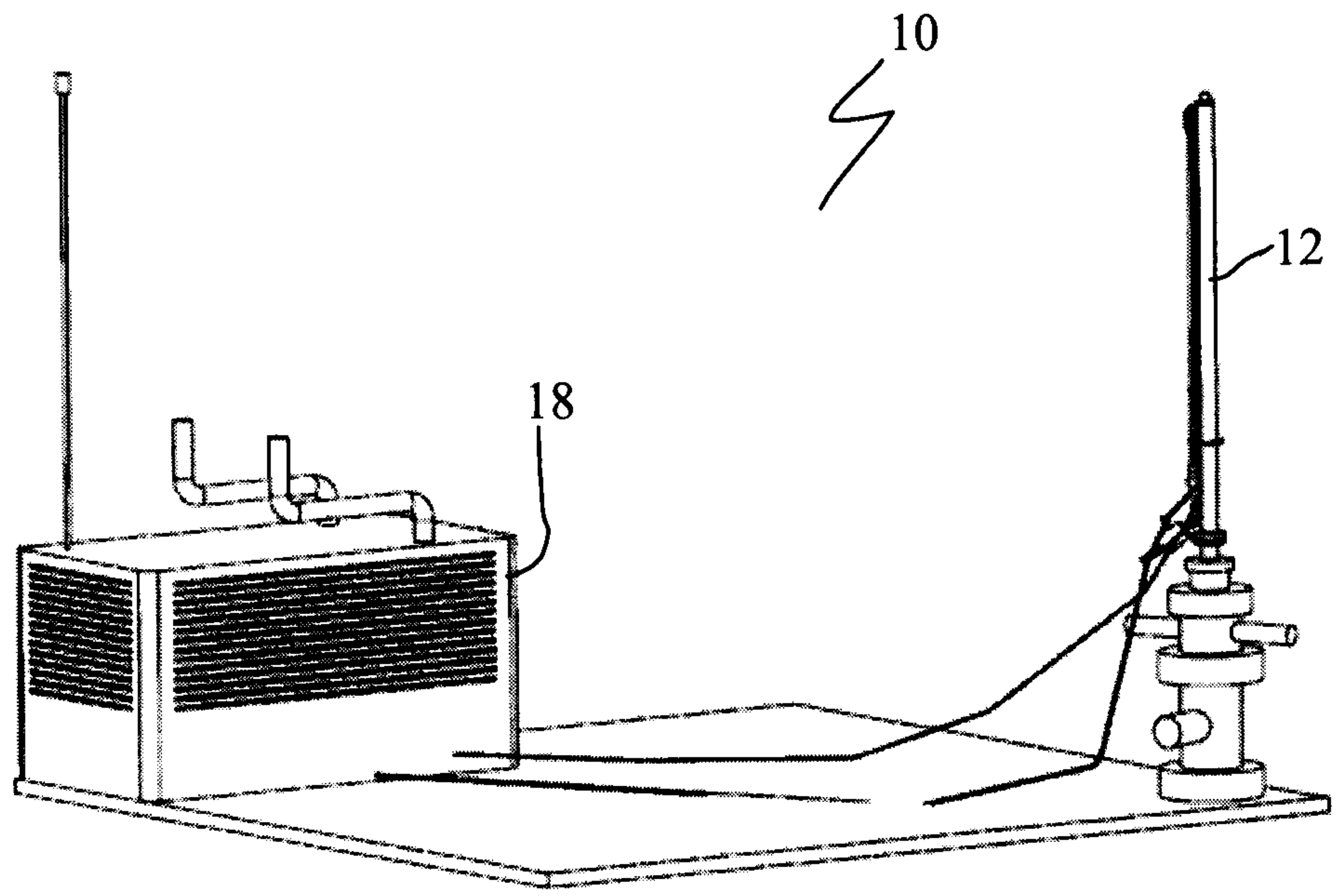


Fig. 1

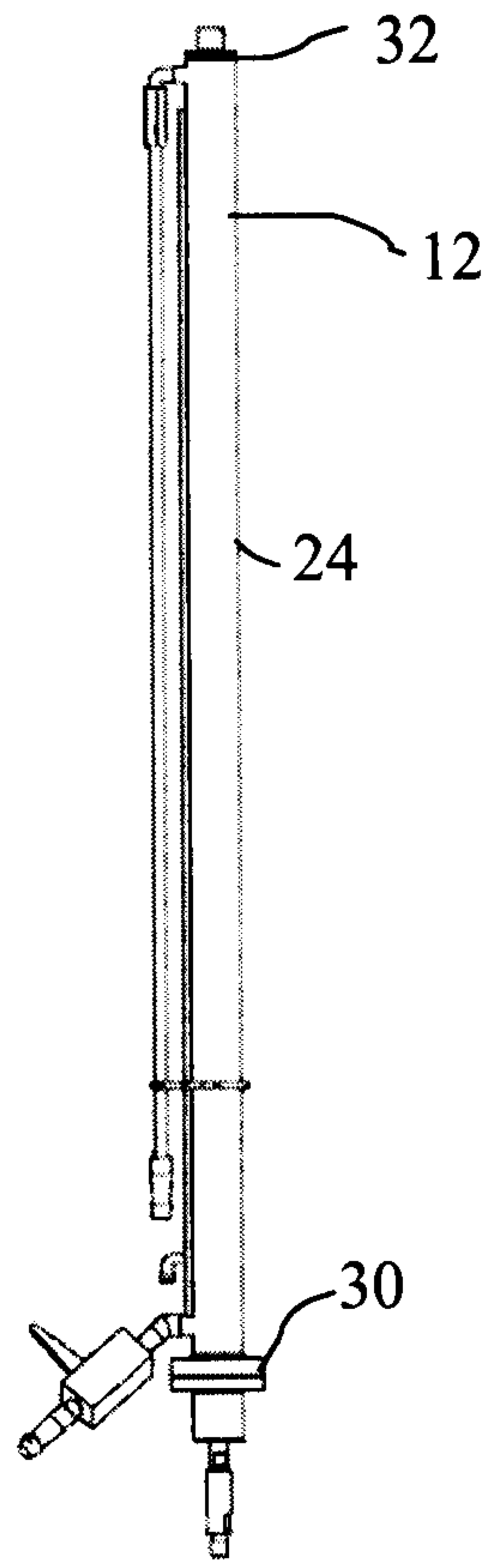


Fig. 2

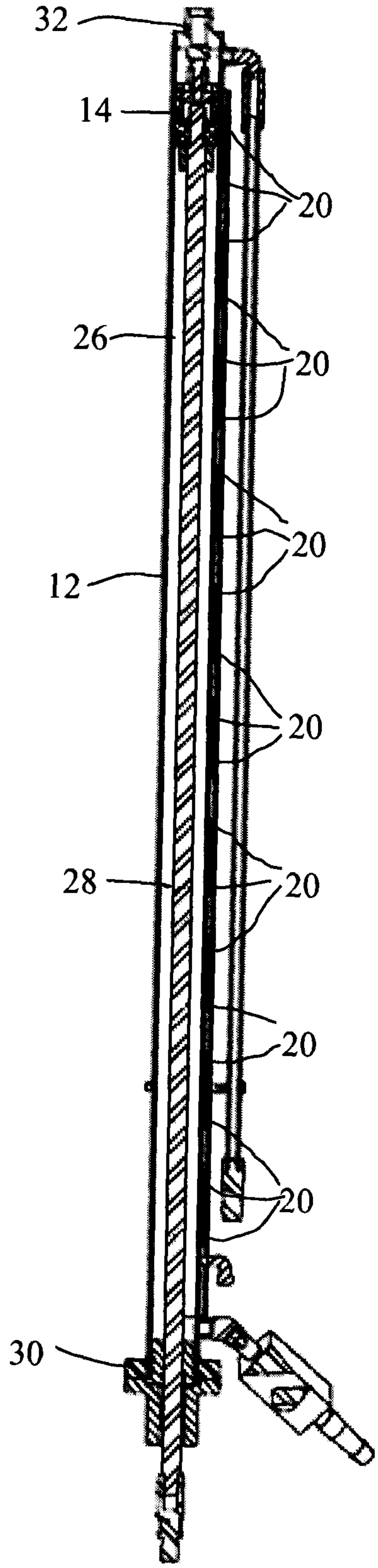
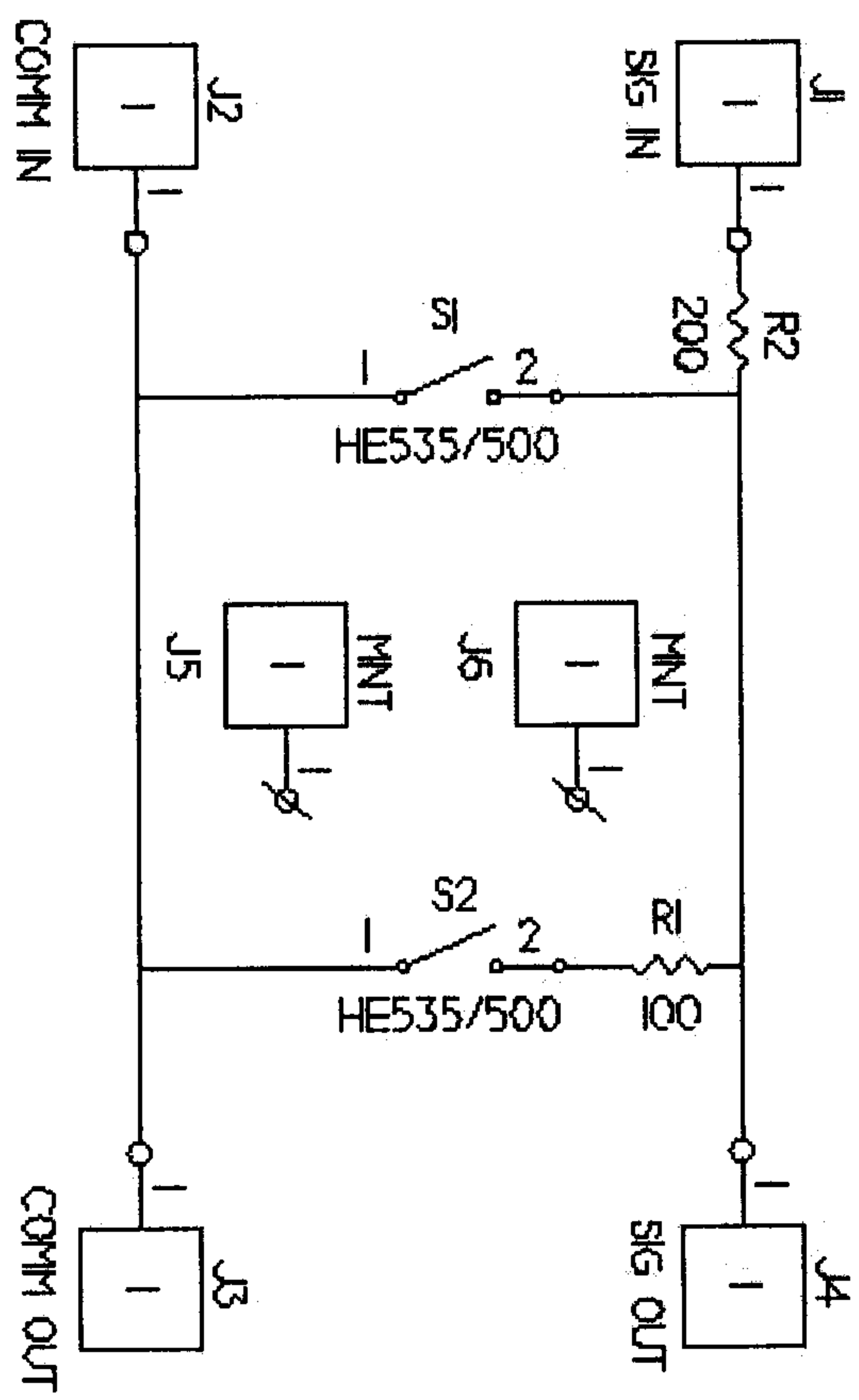


Fig. 3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J2
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S1
HE535/500
R2
200
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COMM OUT
J4
SIG OUT

Fig. 4

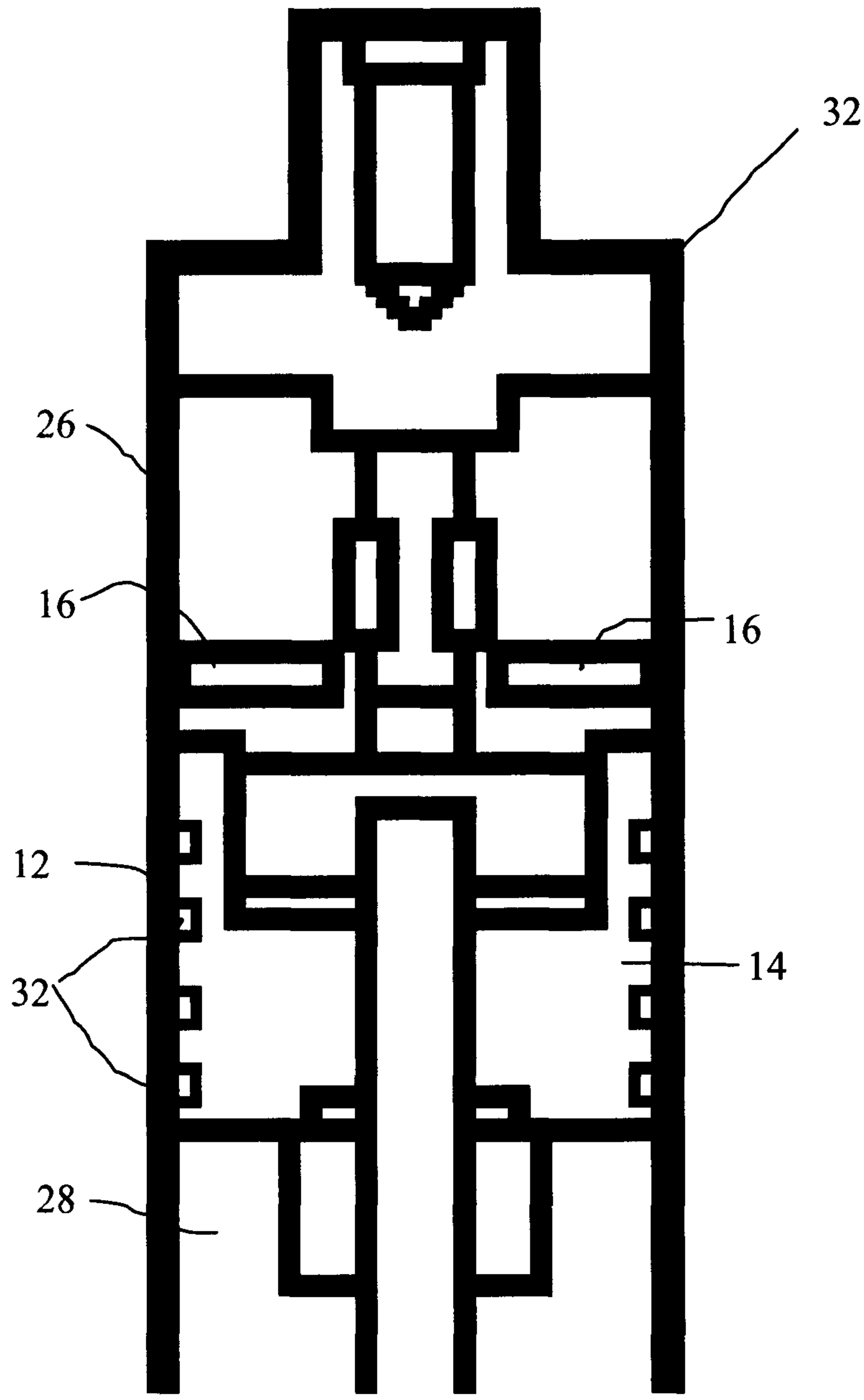
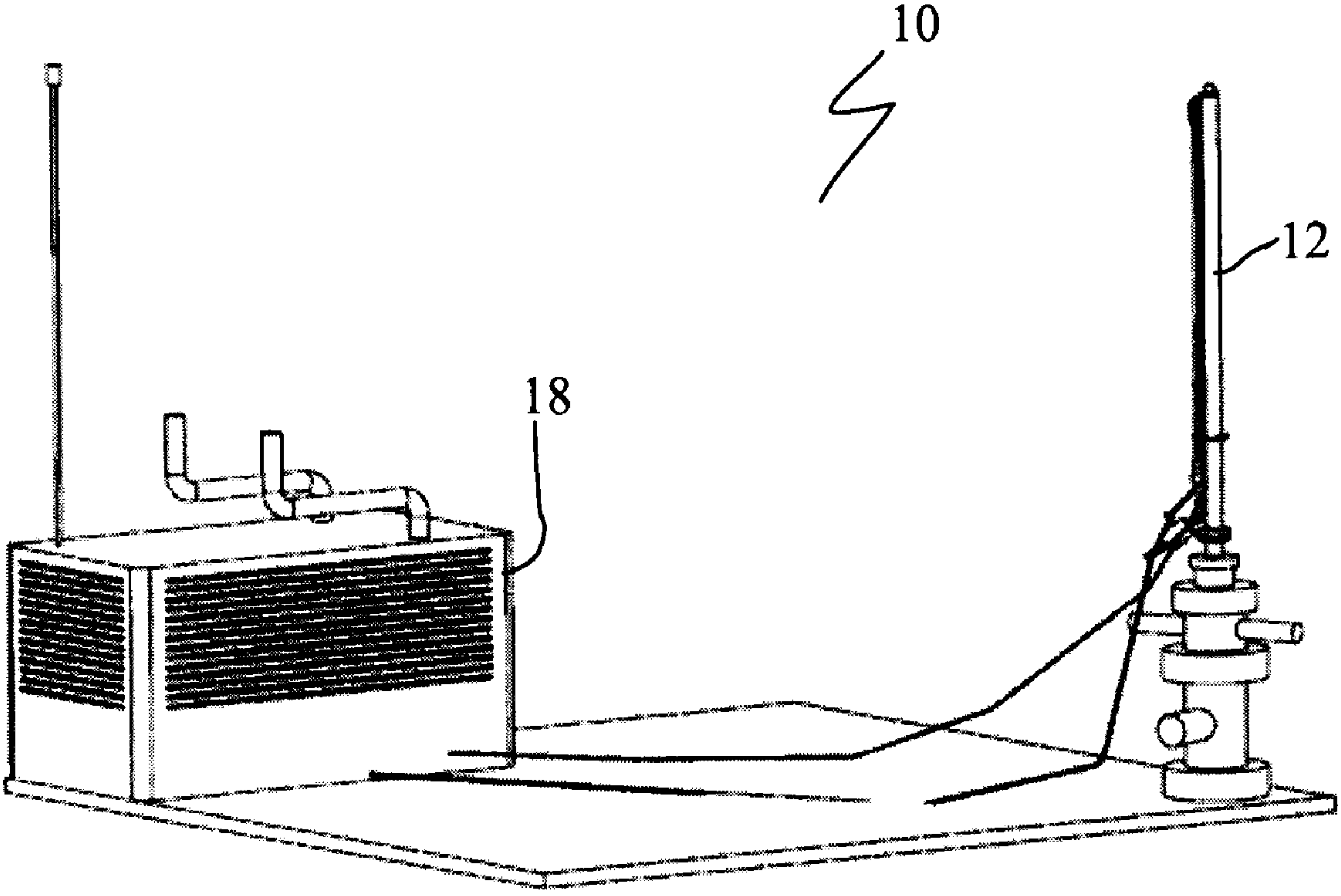


Fig. 5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