

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) **A1**

(22) Date de dépôt/Filing Date: 2000/04/17

(41) Mise à la disp. pub./Open to Public Insp.: 2001/10/17

(51) Cl.Int.⁷/Int.Cl.⁷ B65H 59/00, B65H 59/04, H02G 7/02

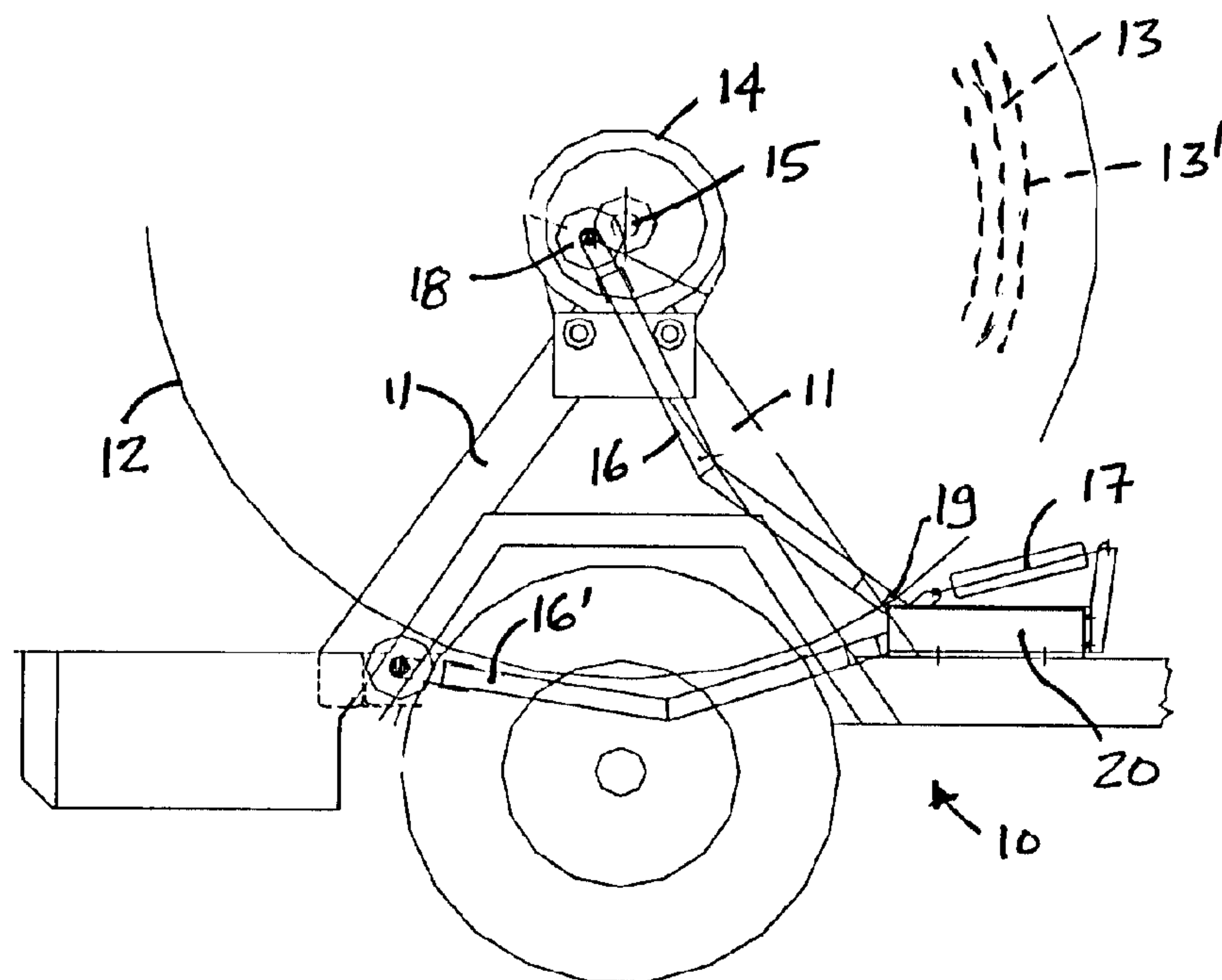
(71) Demandeur/Applicant:
DEL TECHNOLOGIE, CA

(72) Inventeurs/Inventors:
RAYNAULD, ROGER, CA;
DESLOGES, MARC, CA

(74) **Agent:** SWABEY OGILVY RENAULT

(54) Titre : SYSTEME DE REGULATION AUTOMATIQUE DE LA TENSION DES CABLES POUR UN TENDEUR-
DEROULEUR

(54) Title: AUTOMATIC CABLE TENSION CONTROL SYSTEM FOR A PULLER/TENSIONER MACHINE



(57) Abrégé/Abstract:

A cable tension control system for maintaining a substantially constant tension on a cable being wound or unwound from a support spool is described. The tension control system comprises a hydraulic motor for driving a spool support shaft. A hydraulic pressure circuit is connected to the motor and has a controllable pressure relief valve for controlling the operating hydraulic pressure fed to the motor. A diameter sensing mechanism is provided for monitoring the change in the diameter of the cable wound about the spool. The diameter sensing mechanism is connected to a valve control linkage for controlling the pressure relief valve in relationship to the diameter of the cable present about the spool and thereby varying the operating hydraulic pressure of the motor to control a resistance drive force applied to the spool support shaft to control the tension on the cable being wound or unwound.

- 13 -

AUTOMATIC CABLE TENSION CONTROL SYSTEM
FOR A PULLER/TENSIONER MACHINE

ABSTRACT

A cable tension control system for maintaining a substantially constant tension on a cable being wound or unwound from a support spool is described. The tension control system comprises a hydraulic motor for driving a spool support shaft. A hydraulic pressure circuit is connected to the motor and has a controllable pressure relief valve for controlling the operating hydraulic pressure fed to the motor. A diameter sensing mechanism is provided for monitoring the change in the diameter of the cable wound about the spool. The diameter sensing mechanism is connected to a valve control linkage for controlling the pressure relief valve in relationship to the diameter of the cable present about the spool and thereby varying the operating hydraulic pressure of the motor to control a resistance drive force applied to the spool support shaft to control the tension on the cable being wound or unwound.

- 1 -

AUTOMATIC CABLE TENSION CONTROL SYSTEM
FOR A PULLER/TENSIONER MACHINE

TECHNICAL FIELD

5 The present invention relates to a cable tension control system for maintaining a substantially constant tension on a cable being wound or unwound from a spool on which the cable is wound when stringing said cables on arial supports.

10

BACKGROUND ART

 Systems currently on the market for stringing wires on arial supports, and particularly systems utilizing puller/tensioner devices, utilize operators to operate the winding or unwinding of cables wound on a drum and these operators have no knowledge of the mechanical tension at which they are installing the cable. The operators know that they are installing cables in a known range of tension, for example 0 to 2000 lbs. of tension on the cable and the rating of these puller/tensioner devices are established as a maximum mechanical tension that the machine is able to reach at maximum hydraulic pressure (and bare drum). The actual tension in the cable depends upon the hydraulic pressure at which the pump is operating and the reel diameter of the cable on the drum. However, the operator of the machine does not have any knowledge of what the mechanical tension is in the cable being installed at any moment.

 In order to have an idea of this tension, with prior art technology, the operator had to evaluate the diameter of the reel, that is to say the cable wound about the spool, and refer to a chart using the hydraulic pressure. In most of the cases, these charts are not available. It is then a matter of judgment or "feeling" based on the operator's experience to gauge the actual mechanical tension at which the machine is operating.

- 2 -

All these uncertainties create hazardous conditions for the operator and the equipment. For example, when the cable installation process stops, the operator has no idea of what is going on. For example, did the puller reach its maximum mechanical capacities? If not, what are the chances of an accident occurring if the operator decides to raise the mechanical tension in the cable? Will it brake down an isolator or a cross arm of the arial support? Is the tensioner putting too much brake on the system? If not, what will happen if the operator gives more loose to the cable? Will it eventually touch the ground?

The above are all possibilities of what can happen with existing puller/tensioner equipment. Thus, there is a need on the market for a system capable of managing the actual mechanical tension of the cable in the process of being installed. Furthermore, with the advent of fiber optic cables, it can be appreciated that because of the fragile aspects of such cables, it is becoming essential to control mechanical tension during installation of these.

With reference now to some prior art patents, examples of existing systems will be described. It is pointed out that all known tensioning mechanisms are not incorporated with the spool support shaft to control mechanical breaking through the control of a hydraulic motor. For example, as shown in U.S. Patent 3,326,528, a tension or resisting force in a cable being wound or unwound is controlled by an independent system or tensioning equipment which consists of wheels about which the cable passes and is wound several times to provide tension in the cable.

In U.S. Patent 4,372,535, a special tension pulley is provided on a shaft which extends coaxially with the drum shaft but not connected thereto. The tension pulley is connected to a brake control mechanism which is operated by an operator. In U.S. Patent 4,596,380, there is shown a hydraulic system for pulling light cables such as optical

- 3 -

fiber cables. The system only controls maximum tension and it is not a practical design as the shaft of the take-up reel assembly would have to be very large to handle large diameter cables. Accordingly, this makes the system
5 unpractical for stringing heavy steel cables. U.S. Patent 2,999,655 also uses braking systems which are mechanically adjusted by the operator and relies on friction between the cable and drums to provide resistance.

10 SUMMARY OF INVENTION

It is therefore a feature of the present invention to provide a cable tension control system for use with a cable spool on a puller/tensioner machine and which substantially overcomes the above-mentioned disadvantages of
15 the prior art.

Another feature of the present invention is to provide a cable tension control system whereby the operator may select on a console, and by the use of a control arm, a desired tension at which he wants to wind or unwind the
20 cable about the spool.

Another feature of the present invention is to provide a cable tension control system which utilizes only mechanical and hydraulic devices to control the tension in the cable, making the system highly reliable.

25 Another feature of the present invention is to provide a cable tension control system for use with a cable spool on a puller/tensioner apparatus providing control of cable tension and safety to the operator and to the apparatus and the cable.

30 According to the above features, from a broad aspect, the present invention provides a cable tension control system for maintaining a substantially constant tension on a cable being wound or unwound from a support spool. The tension control system comprises a hydraulic
35 motor for driving a spool support shaft. A hydraulic pressure circuit is connected to the motor and has a

- 4 -

controllable pressure relief valve for controlling the operating hydraulic pressure fed to the motor. Diameter sensing means monitors the change in diameter of the cable wound about the spool. The diameter sensing means is
5 connected to valve control means for controlling the pressure relief valve in relationship to the diameter of the cable present about the spool and thereby varying the operating hydraulic pressure of the motor to control the resistance drive force applied to the spool support shaft to
10 control the tension on the cable being wound or unwound.

BRIEF DESCRIPTION OF DRAWINGS

A preferred embodiment of the present invention will now be described with reference to the accompanying
15 drawings in which:

FIG. 1 is a simplified, partly fragmented, schematic side view showing a portion of a puller/tensioner apparatus incorporating the cable tension control system of the present invention in association with a spool on which a
20 cable is wound;

FIG. 2 is a simplified top view illustrating the construction of the spool diameter sensing arm;

FIG. 3A is a schematic view of the hydraulic motor and associated hydraulic pressure circuit and its
25 connection to the spool support shaft;

FIG. 3B is a schematic side view of the spool showing a cable being dispensed from the spool;

FIG. 4 is a plan view of the valve control linkage secured to an end of the spool diameter sensing arm;

30 FIG. 5 is a side section view along section lines A-A of Figure 4;

FIG. 6 is a side section view along section lines B-B of Figure 4; and

FIG. 7 is a front view of a control panel
35 associated with the puller/tensioner apparatus of the present invention and incorporating the control lever which

- 5 -

selects the desired tension value of a cable being wound or unwound on a spool.

DESCRIPTION OF PREFERRED EMBODIMENTS

5 The cable tension control system of the present invention provides a system which permits the operator to select a desired cable tension by simple means of the displacement of a lever arm on a console. It is also pointed out that the selected tension has no effect on the
10 speed of the drum. The operator selects the desired tension in the cable, for example from 0 to 2000 lbs. Then the operator decides whether he wants to reel or unreel the cable and at what speed he wants this to happen. As he engages the system, the drum slowly begins to rotate at the
15 specific characteristics chosen by the operator.

 As companies are striving to adopt the ISO-9000 quality assurance specifications, the growing issue of control is a necessity. In order to fully control the installation of a cable, one has to know the mechanical
20 strain that will be placed on the network. Safety is also an obvious issue when it comes to handling steel cables with mechanical tensions of up to 2000 lbs. Not only safety to the operator but also safety for the equipment and for the material under the cable distribution network. Today, very
25 few systems provide safety features. Some existing systems use constant tensions and operate via a microprocessor and an optic detector, such systems being considered to be very fragile. In field applications where heat, rain and vibration are often present, this electronic technology is
30 considered unreliable. The cable tension control system of the present invention uses only mechanical and hydraulic devices to control the tension in the cable thereby increasing the reliability of the system.

 Referring now to the drawings, and more
35 particularly to Figures 1 and 2, there is shown at 10 a portion of a puller/tensioner apparatus which is provided

- 6 -

with a spool support frame 11 for supporting a spool 12 about which a cable 13 is wound. A hydraulic motor 14 is secured to the spool support shaft 15. A spool diameter sensing arm 16 is urged against the outer diameter 13' of the cable 13 wound about the spool by two biasing springs 17. As hereinshown, the arm 16 is displaceable from a position illustrated at 16' when a cable completely fills the spool 12 to its position as shown at 16 where the cable is fully dispensed from the spool.

10 The spool diameter sensing arm 16 is provided with a contact roller bearing 18 at a free end thereof which consists of a smooth wheel rotatable against the outer diameter 13' of the cable 13 as it is being wound or unwound from the spool depending on the direction of drive imparted by the hydraulic motor 14. The springs 17 bias the roller bearing 18 against the outer diameter 13' of the cable. The lower end 19 of the spool diameter sensing arm 16 is secured to a valve control means or linkage which is housed in the housing 20 and which varies the hydraulic pressure fed to the motor to control the resistance force applied to the spool support shaft as it is rotated by the motor to control the tension on the cable being wound or unwound about the spool. A gear box 9 may interface the motor and the support shaft 15, as shown in Figure 2.

25 Referring now to Figures 3A and 3B, there will be briefly described the function of the cable tension control system. The valve control linkage, as will be described later with reference to Figures 4 to 6, controls a pressure relief valve 21 which is connected in parallel with the hydraulic motor 14 and a hydraulic pressure circuit 22 whereby to control and adjust the pressure differential ΔP across the hydraulic motor 14. The hydraulic motor 14 may be connected to the spool support shaft 15 through the gear box 9. The maximum pressure differential ΔP that can be reached, depends on the winding radius R identified by reference numeral 23, as shown in Figure 3B, which is the

- 7 -

distance to the outer diameter 13' of the cable 13, in order to maintain a constant tension T in the cable 13 during unwinding or winding of the cable on the spool 12. The desired tension is selected by the operator by positioning a lever 24, see Figure 7, on a console 25 supported on the puller/tensioner apparatus 10 at an operator station (not shown). It is pointed out that the operator does not have to adjust the pressure differential according to the winding radius of the cable on the spool, since the constant tension mechanism, that is to say the valve control means, does it automatically.

Referring now to Figures 4 to 6, there will be described the operation of the valve control linkage. As shown in Figure 4, the lower end 19 of the diameter sensing arm 16 has a sleeve coupling 23 whereby to immovably secure same to a cam displacement rod 24 whereby to rotate the cam displacement rod 24 about its longitudinal axis 25 when the diameter sensing arm 16 is moved in and out from the center of the spool 12 as the cable is being wound or unwound therefrom. As better seen in Figure 6, a cam 26 is secured to the cam displacement rod 24 and aligned with a cam follower member 27. A spring 28 urges the contact head 29 of a cam follower member 27 against the cam profile 30 of the cam 26. As the cam is rotated by the displacement of the rod 24 secured to the sensing arm 16, the cam follower member 27 will be displaced axially in the direction of arrow 31.

As better seen in Figure 4, the cam follower member 27 is secured at a rear end 32 to a pivotal valve control arm 33 by means of a shoulder screw 34. The pivotal valve control arm 33 pivots on a pivot pin 35. The pivot pin 35 is a displaceable pivot pin which is secured to a displaceable carriage 36. By displacing the carriage, the pin is displaceable axially within a slot 37 provided on top of the pivotal valve control arm 33, as better seen in Figure 5. The carriage displacement is controlled by a

- 8 -

control cable assembly 38 which houses a control wire 39 secured to the carriage 36. The lever arm 24 provided on the console 25, shown in Figure 7, actuates the control cable wire 39 to displace the carriage 36 along an axis transverse to the longitudinal axis 40 of a control rod or piston 41 of the stationary pressure relief valve 21. As previously described, the piston rod 41 of the pressure relief valve 21 is biased against an abutment portion 33' of the pivotal valve control arm 33 by its internal spring pressure and the hydraulic pressure in the valve.

When the pivot pin 35 is displaced in line with the longitudinal axis 40 of the valve piston rod 41, the valve piston rod 41 is at full extension and $\Delta P = 0$ psi. The valve stays at this position at any position of the pivotal valve control arm 33 which is connected to the diameter sensing arm 16 of the spool. The further the pivot pin 35 is positioned in the slot 37 away from the piston rod 41 of the pressure relief valve 21, the greater is the stroke of the piston and the greater is the ΔP .

With reference again to Figure 7, the tension selection lever 24 is moved into the gauge slot 45 to a desired cable tension marking 46 to select a desired cable tension to be automatically maintained. This selection displaces the pivot pin 35 with respect to the piston rod end 41 of the pressure relief valve 21. As the cable is wound on the spool or dispensed from the spool, the diameter sensing arm 16 pivots the cam displacement rod 24 which in turn displaces the cam 26 and pivots the pivotal valve control arm 33 via the cam follower 26 to vary the hydraulic pressure ΔP fed to the hydraulic motor 14 by the use of the pressure relief valve 21. Accordingly, the braking force or resistance drive force exerted on the spool support shaft 15 is automatically controlled by the diameter of the wire on the spool and in proportion to the desired tension value that was selected by the operator by the set position of the lever 24 on the console. The console 26 also has other

- 9 -

levers, gauges and switches to operate a gas engine, cable guide pulleys, a small spool which does not require cable tension control and monitoring equipment for the hydraulic system. The lever 47 sets the direction of rotation of the
5 hydraulic motor 14 for winding or unwinding the spool.

It is within the ambit of the present invention to cover any obvious modifications of the preferred embodiment described herein, provided such modifications fall within the scope of the appended claims.

CLAIMS,

1. A cable tension control system for maintaining a substantially constant tension on a cable being wound or unwound from a support spool, said tension control system comprising a hydraulic motor for driving a spool support shaft, a hydraulic pressure circuit connected to said motor and having a controllable pressure relief valve for controlling the operating hydraulic pressure fed to said motor, diameter sensing means for monitoring the change in diameter of said cable wound about said spool, said diameter sensing means being connected to valve control means for controlling said pressure relief valve in relationship to the diameter of said cable present about said spool and thereby varying the operating hydraulic pressure of said motor to control a resistance drive force applied to said spool support shaft to control the tension on said cable being wound or unwound.

2. A cable tension control system as claimed in claim 1 wherein there is further provided selective adjustment means connected to said valve control means for presetting said valve control means to a desired selected tension value for said cable being wound or unwound.

3. A cable tension control system as claimed in claim 2 wherein said diameter sensing means is a spool diameter sensing arm having a contact end biased against said cable wound about said spool, said sensing arm being connected at an opposed end to said valve control means, said valve control means being a valve control linkage.

4. A cable tension control system as claimed in claim 3 wherein said valve control linkage comprises a cam secured to a cam displacement rod, said displacement rod being secured to said opposed end of said sensing arm and axially rotated by the displacement of said sensing arm, a cam

- 11 -

follower secured to a pivotal valve control arm, said cam follower being biased in frictional contact with said cam and axially displaceable to thereby displace said pivotal valve control arm on a pivot, said pivotal control arm having an abutment portion in contact with a contact end of a control rod of said pressure relief valve to control the hydraulic pressure fed to said hydraulic motor, said control rod being biased against said pivotal lever abutment portion by its internal spring and hydraulic charge pressure.

5. A cable tension control system as claimed in claim 4 wherein said pivotal control arm is a spring biased arm biasing said cam follower against said cam.

6. A cable tension control system as claimed in claim 4 wherein said pivotal control arm has a displaceable pivot pin secured to a displaceable carriage which is connected to a control cable, said control cable being a push-pull cable secured to a displaceable lever which constitutes said selective adjustment means, said lever being pivotally displaced and extending through a gauge slot in a control console and having cable tension markings to select said desired tension value, said pivot pin being displaced along a slot of said pivotal control arm to and away from said contact end of said control rod of said pressure relief valve to vary the displacement of said abutment portion of said pivotal control arm and accordingly the amount of displacement of said control rod of said pressure relief valve dependent on the diameter of cable present on said spool and detected by said sensing arm.

7. A cable tension control system as claimed in claim 6 wherein said sensing arm is provided with a contact roller bearing element at said contact end, said bearing element being biased by a spring force exerted on said sensing arm by a pulling action of one or more springs secured between said sensing arm and a stationary member.

- 12 -

8. A cable tension control system as claimed in claim 6 wherein said valve control means automatically adjusts the maximum pressure differential (ΔP) that can be reached according to the winding radius of said cable wound on said spool (R) to maintain said desired selected tension (T) in said cable during said winding or unwinding, and wherein

$$T = \frac{\Delta P \times C_t}{R}$$

where C_t is a constant dependent on the displacement of the hydraulic motor and an associated gearbox, if present.

9. A cable tension control system as claimed in claim 8 wherein said displaceable pivot pin when positioned axially aligned with said contact end of said control rod of said pressure relief valve results in 0 psi pressure applied to said hydraulic motor, said pressure applied to said motor increasing to a maximum pressure of said circuit as said pivot pin is displaced way from said contact end.

10. A cable tension control system as claimed in claim 1 wherein said system is associated with a puller/tensioner apparatus for stringing cables on arial supports.

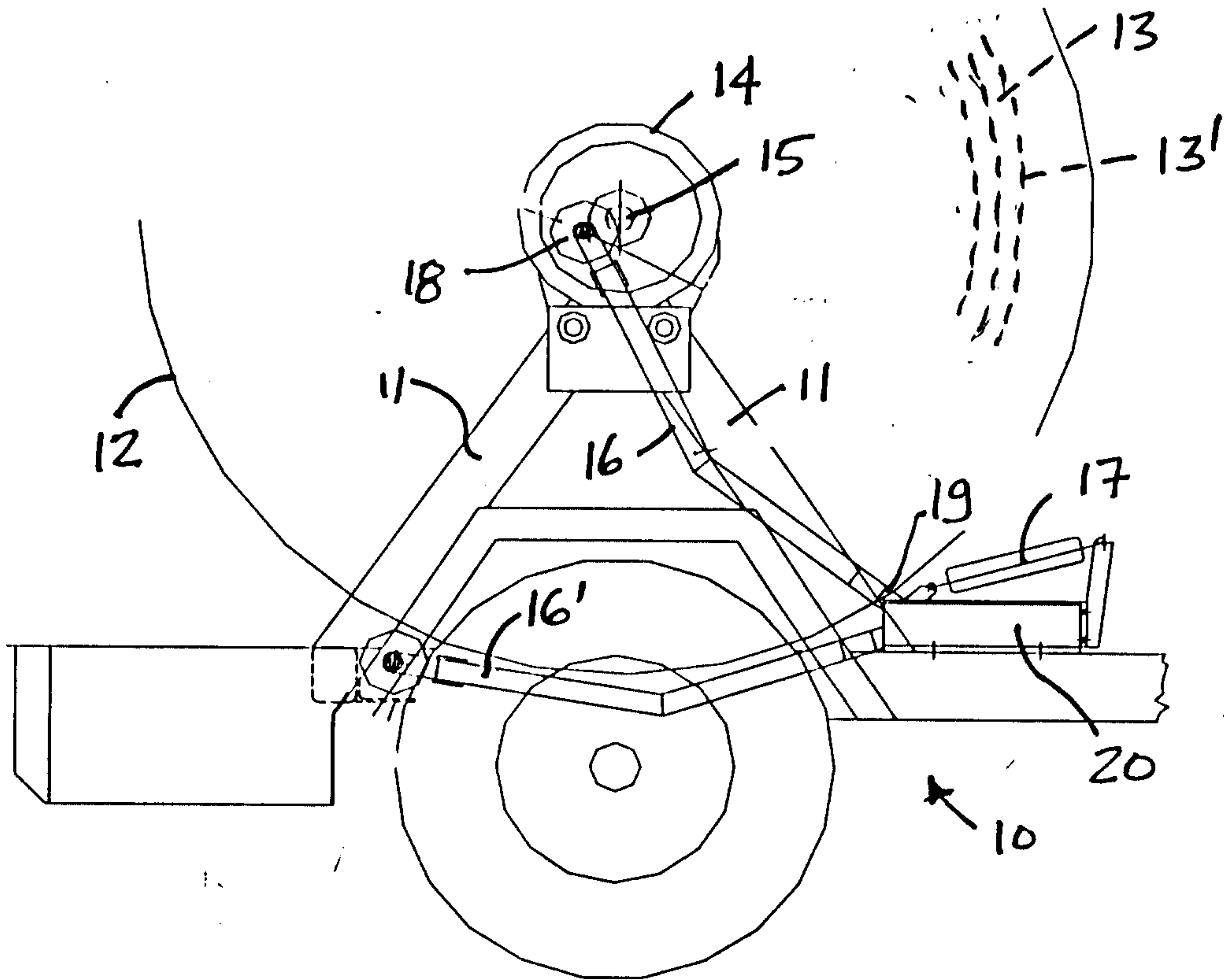


FIG. 1

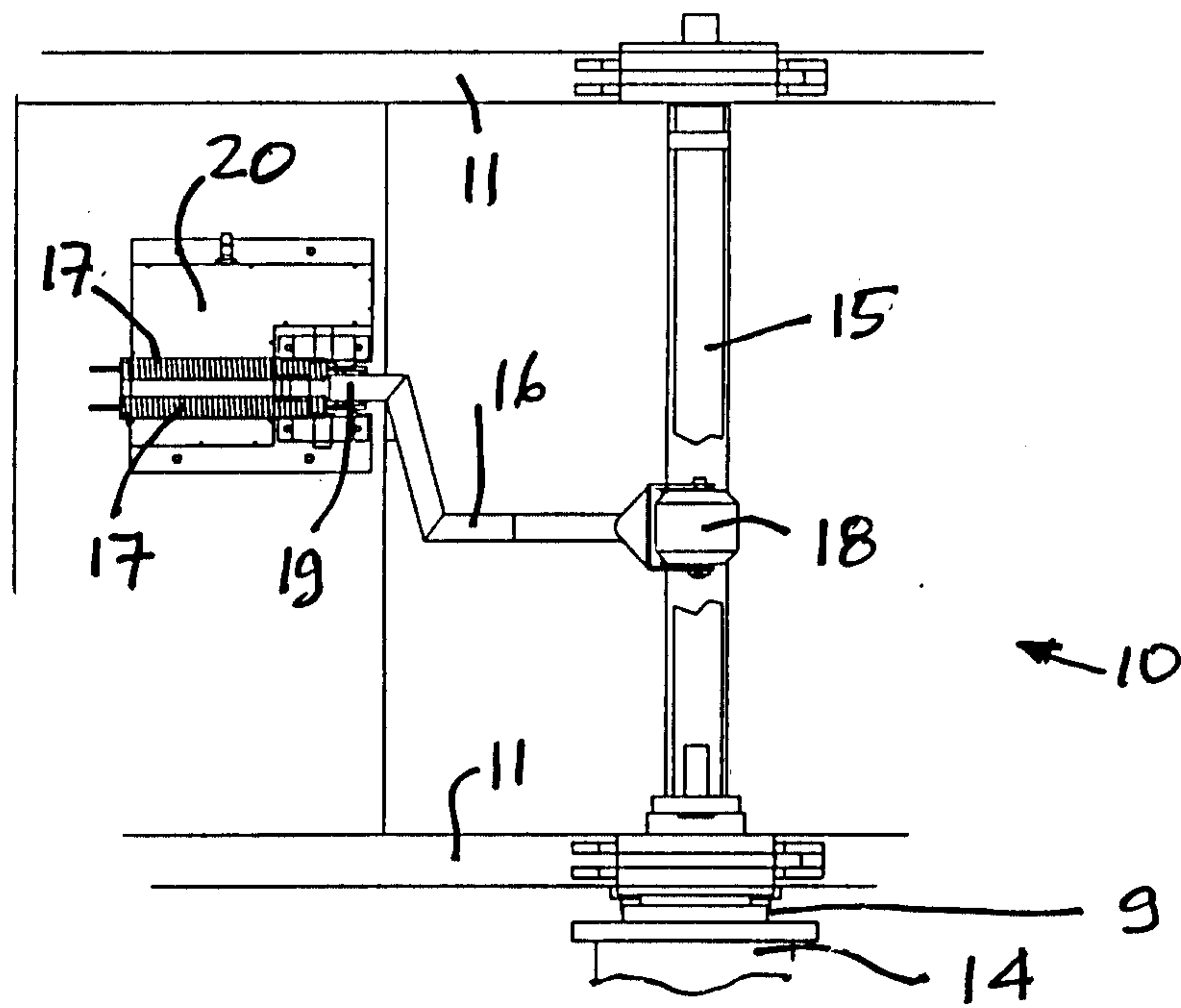


FIG. 2

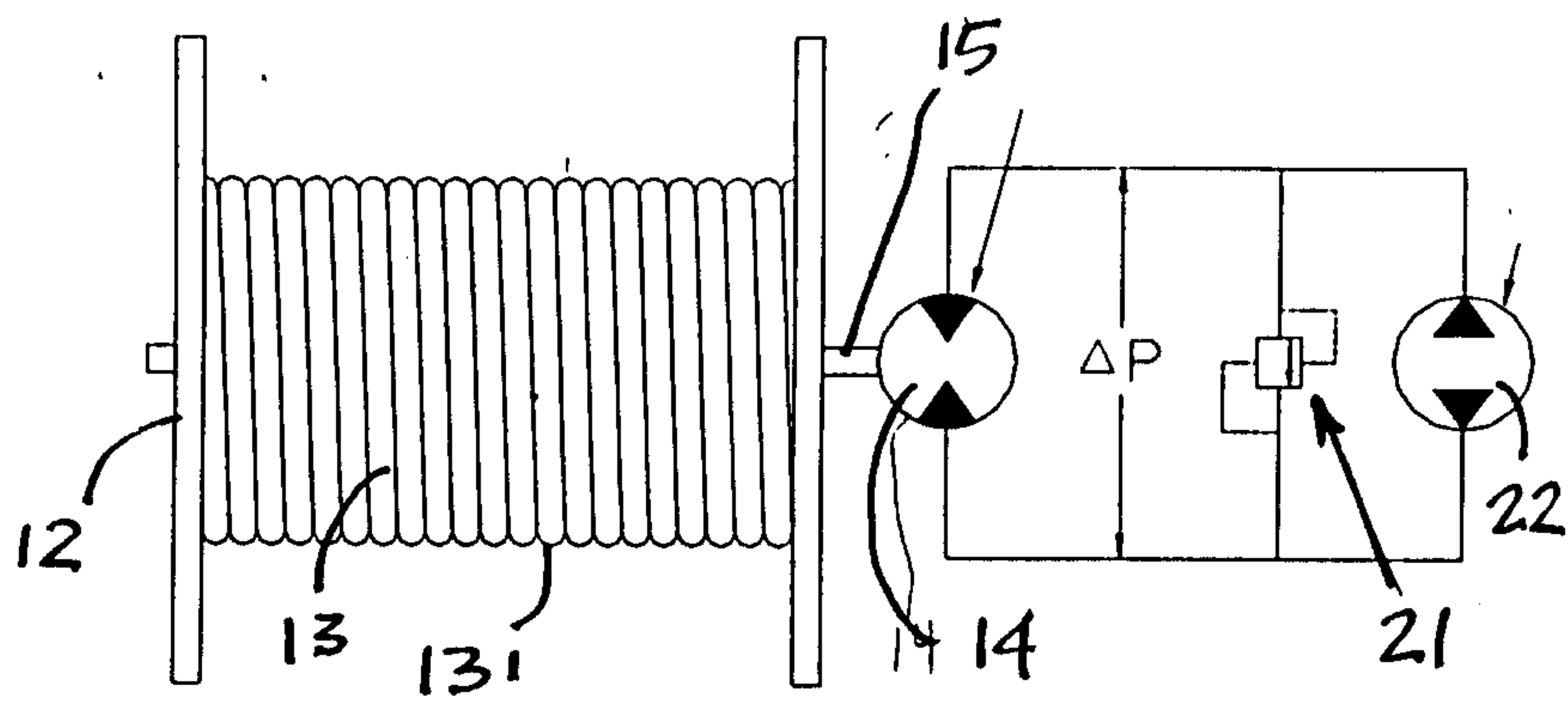


FIG. 3A

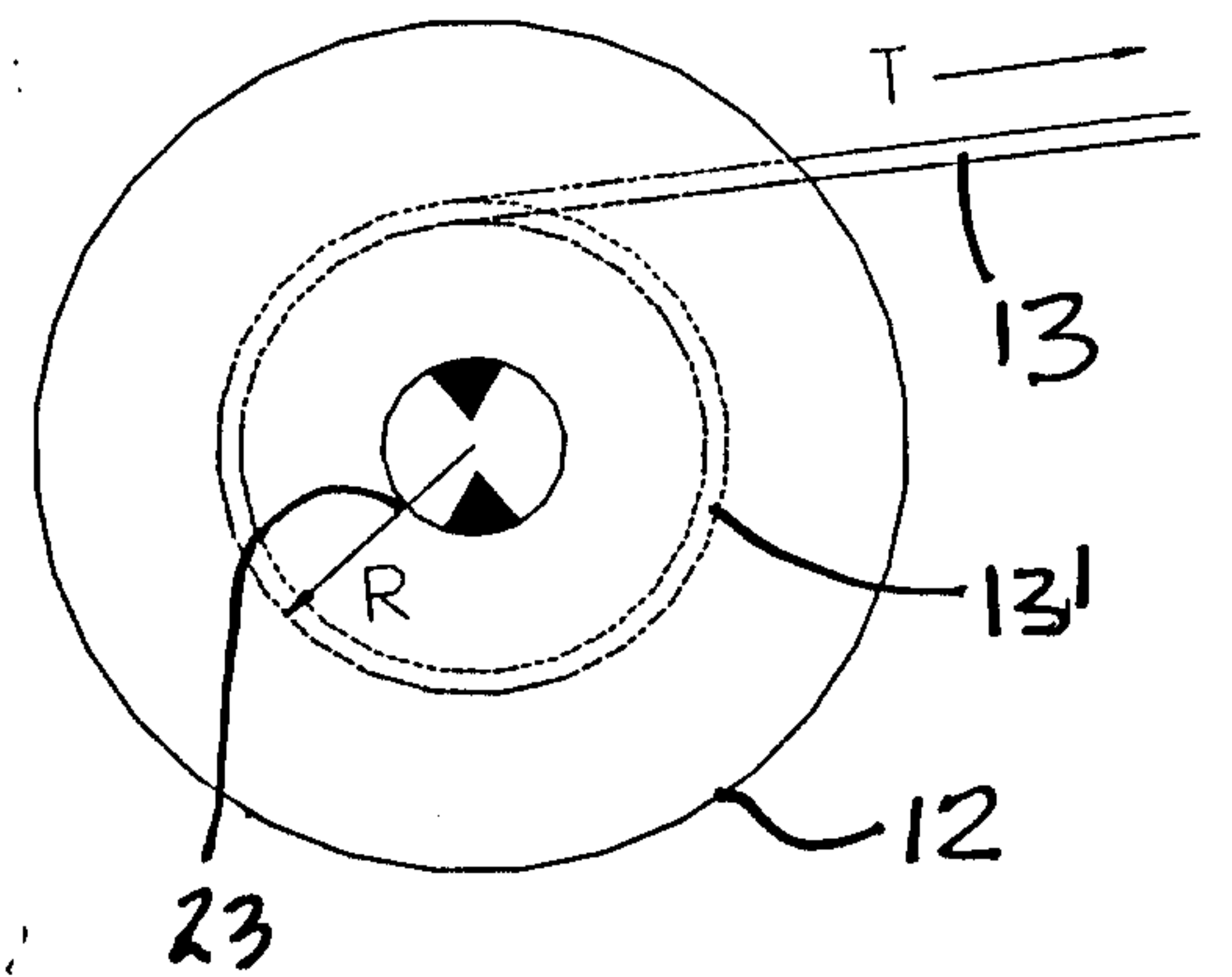


FIG. 3B

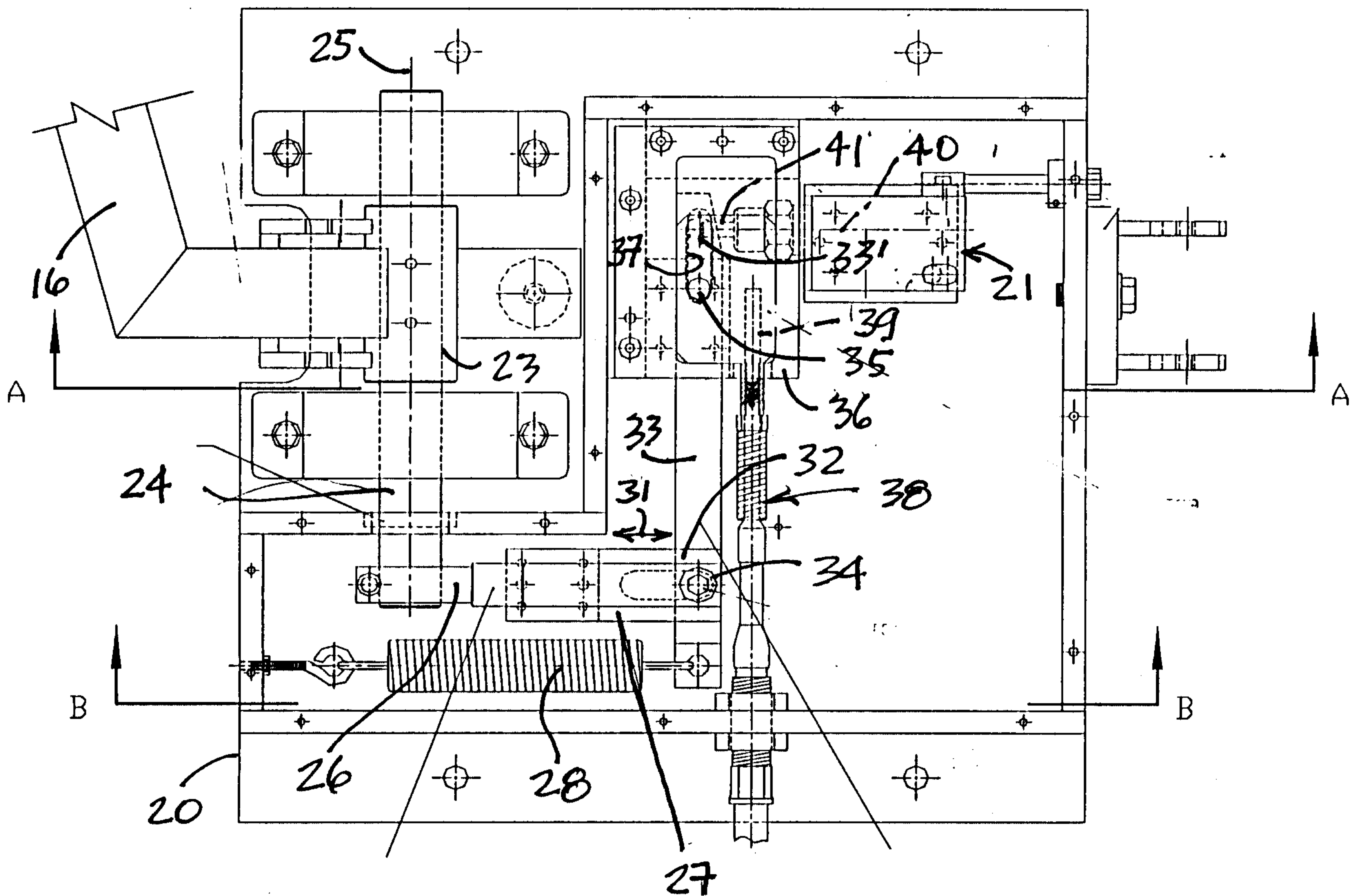


FIG. 4

