United States Patent [19]

Rupert

[11] **3,843,095**

[45] **Oct. 22, 1974**

[54] **HYDRAULIC CROWD CABLE TAKE-UP SYSTEM**

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[22] Filed: **Dec. 22, 1971**

[21] Appl. No.: **210,709**

[52] **U.S. Cl.** ..... **254/173 B,** 254/174, 214/138

[51] **Int. Cl.** **B66d 1/48**

[58] **Field of Search** ..... 214/138; 254/173 R, 173 B, 254/174, 175; 104/117

[56] **References Cited**

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[57] **ABSTRACT**

A hydraulic crowd cable take-up system for the crowd mechanism of an excavator shovel includes a hydraulic actuator that urges a cable support means against the crowd cable. In a first embodiment operating fluid is supplied to the blind end of the actuator via a stop valve that is automatically or manually activated to control the take-up of the cable automatically. In a second embodiment operating fluid is also supplied to the rod end of the actuator.

4 Claims, 3 Drawing Figures

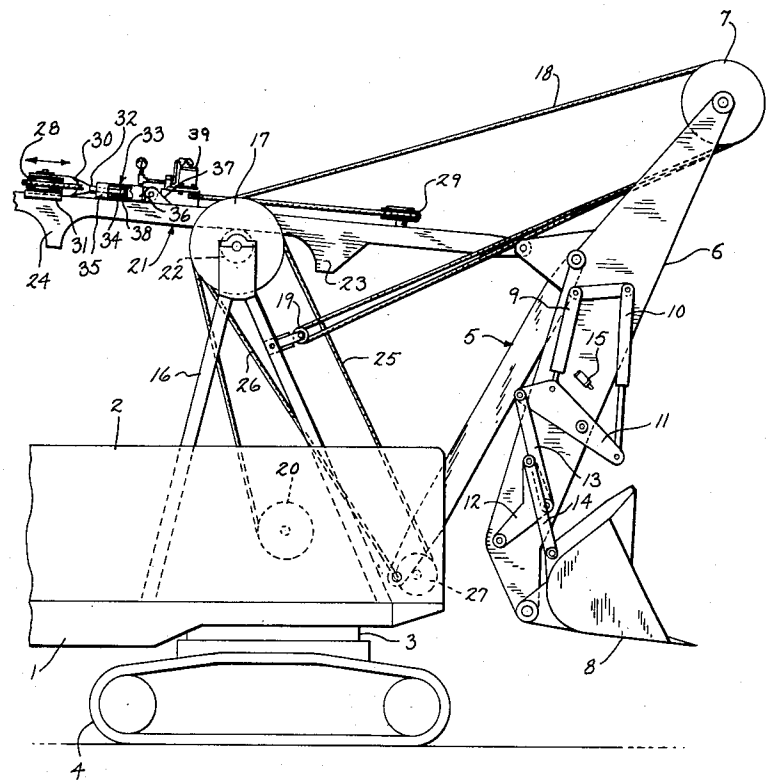

Fig. 1

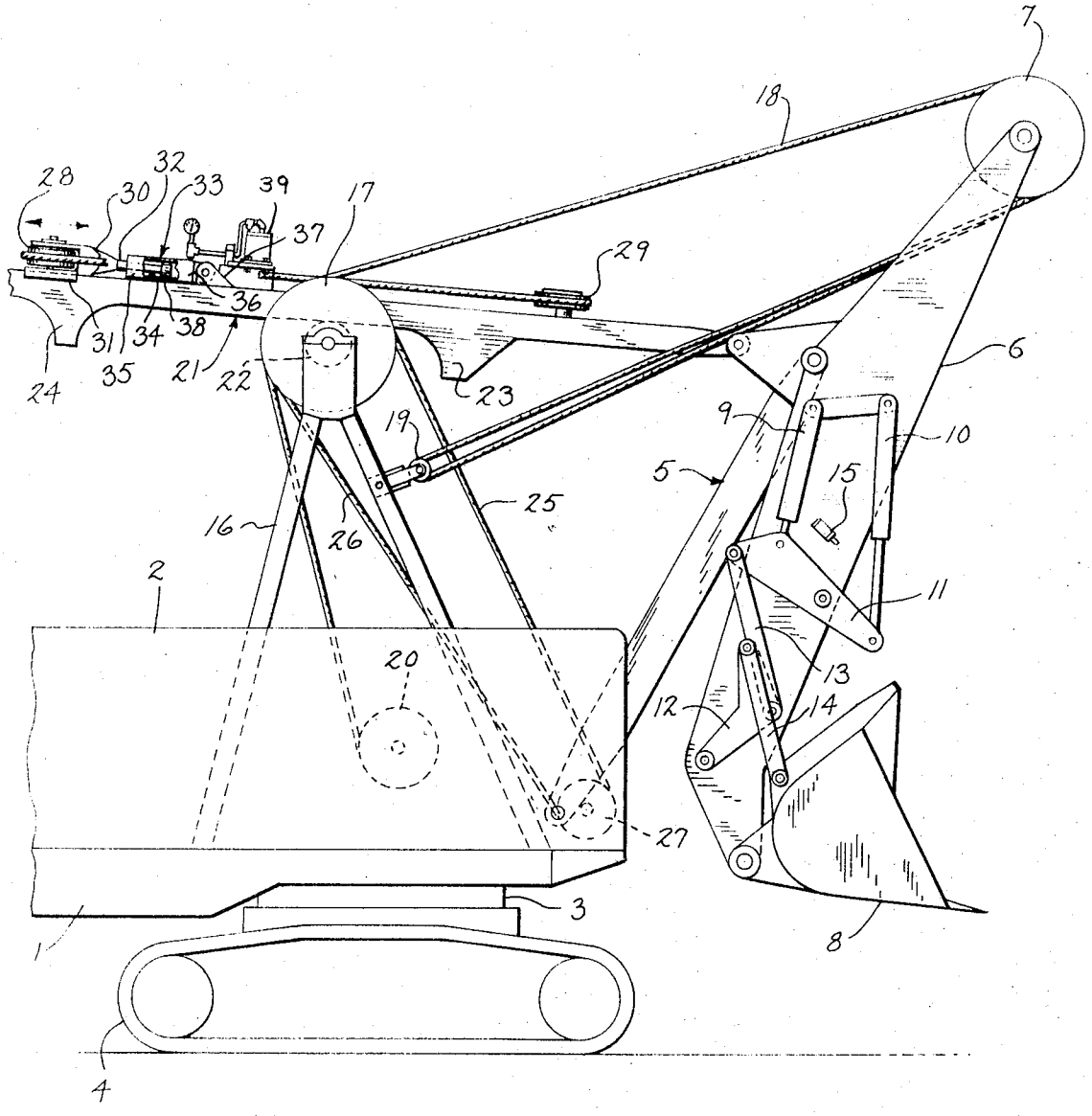

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Fig. 2

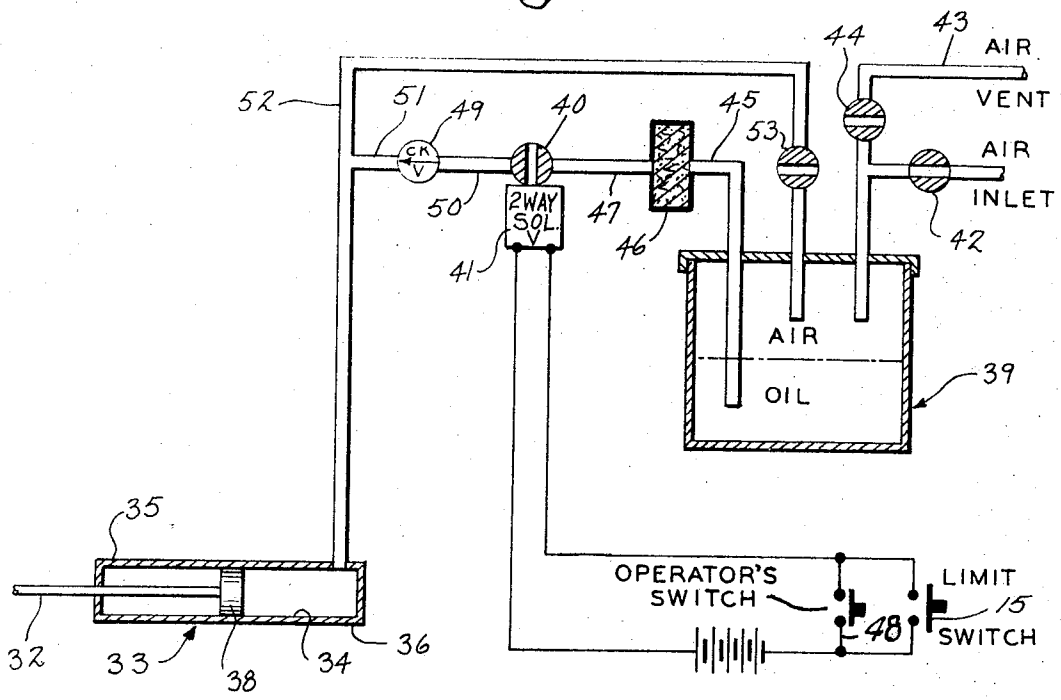
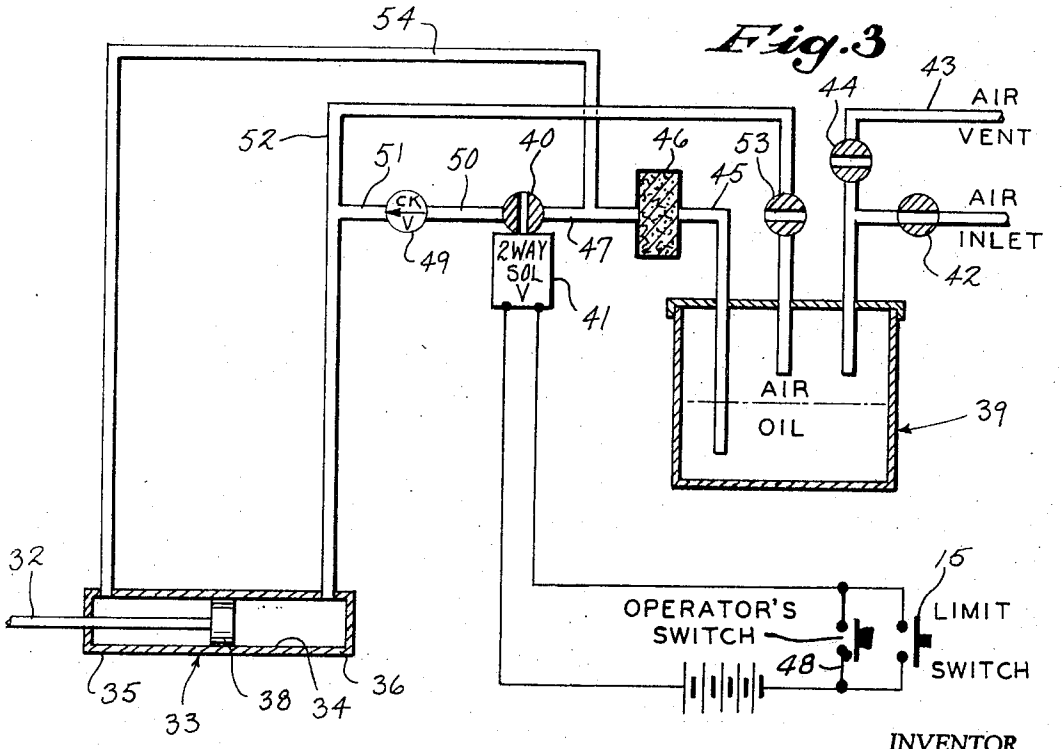


Fig. 3



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HYDRAULIC CROWD CABLE TAKE-UP SYSTEM

BACKGROUND OF THE INVENTION

The present invention prevents excessive slack from developing a crowd cable mechanism for large excavator shovels such as described in U.S. Pat. Nos. 3,506,145, 3,465,903 and 3,452,890. Such shovels have a bucket handle to which a bucket and a crowd handle is attached. The crowd handle is reciprocally translatable forward and backward to provide crowd and retract movement of the bucket. A rope crowd mechanism is employed to power the crowd handle through its reciprocal motion. These shovels are of such a large size that extremely high tensions must be exerted on the ropes of the crowd mechanism to extend and retract the crowd handle, which results in temporary stretching of the crowd ropes. Once the extending or retracting tension is removed, the crowd ropes return substantially to their original length. However, over a period of time a certain amount of slack develops in the ropes. This slack must be removed periodically to prevent backlash that creates damaging stress in the crowd mechanism.

In the past, the rope slack that developed in a large number of shovels employing rope crowd mechanisms was removed by periodically manually adjusting the tension of the ropes. This procedure was extremely bothersome since often the shovel operator was not allowed to make such adjustments and the shovel would have to be shut down for unnecessary amounts of time while the person that made such adjustments was getting to the shovel. Thus, there was a substantial need for an automatic type slack take-up system. One assembly designed to satisfy this need is the system described in U.S. Pat. No. 3,481,489, disclosing a take-up system utilizing a screw-threaded gear and screw assembly in conjunction with a maximum torque motor that drives the assembly to translate the screw in a direction to take up any excess slack that may have developed in the crowd rope mechanism. However, the system disclosed is quite complicated with numerous components; consequently, a less complex take-up system has been sought.

The present invention provides a slack take-up system that employs a relatively small number of components but yet efficiently and effectively removes excess slack in the crowd ropes.

SUMMARY OF THE INVENTION

The present invention relates to a hydraulic slack take-up system for maintaining a minimum tension on a cable; and more specifically, the invention resides in the combination of a cable support means, a fluid actuator urging the cable support means against the cable, a source of operating fluid under pressure, and a stop valve that connects said source of fluid to said actuator and allows the actuator to be driven only when the stop valve is open to fluid flow.

As a result, structures embodying the present invention manifest advantages heretofore unavailable with take-up systems known to the prior art. Specifically, the salient objects and advantages of the present invention as set forth above may be summarized as follows:

To provide a hydraulic slack take-up system for automatically maintaining a minimum tension on a crowd cable of an excavator shovel to reduce backlash of the crowd cable.

To provide a hydraulic slack take-up system for automatically maintaining a minimum tension on a crowd cable of an excavator shovel without producing excessive tension in the crowd cable;

To provide a hydraulic slack take-up system for automatically maintaining a minimum tension on a crowd cable of an excavator shovel to reduce shut down time of the shovel for maintenance purposes;

To provide a hydraulic slack take-up system for automatically maintaining a minimum tension on a crowd cable of an excavator shovel by the use of a hydraulic circuit that utilizes relatively low pressure operating fluid but yet will maintain the minimum tension on the crowd cable, even though a pressure many times greater than the circuit pressure acts on the system;

To provide a hydraulic slack take-up system for automatically maintaining a minimum tension on a crowd cable of an excavator shovel by automatically checking the tension in the line periodically and thereby relieving the shovel operator of slack take-up responsibilities during operation of the shovel; and

To provide a hydraulic slack take-up system for automatically maintaining a minimum tension on a crowd cable of an excavator shovel that may be actuated by the operator whenever desired to begin its automatic operation.

In the attached drawings, which form a part of the description of this invention, and in the description which follows, there are disclosed two embodiments of the present invention which compose the best modes presently contemplated by the inventor for carrying out his invention. The invention is described in full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected to make and use the same. However, the embodiments described and disclosed here in detail are not to be considered the invention itself. The subject matter which the inventor does regard as his invention is particularly pointed out and distinctly claimed in the claims at the conclusion of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates in side elevation an excavator shovel employing the present invention,

FIG. 2 is a schematic representation of one embodiment of the invention,

FIG. 3 is an adaptation of the embodiment shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, in FIG. 1 there is shown one type of excavator shovel on which the present invention may be employed. The shovel has a revolving base frame 1 mounting a cab 2 in which the engines (not shown) that provide power for the excavator are housed and the shovel operator sits. The base frame 1 is seated atop a swing mechanism 3 supported by a crawler type running gear 4. The swing mechanism 3 permits rotation of the base frame 1 with respect to the running gear 4.

A boom 5 is pivotally connected at its inner end to the front of the base frame 1 to project outward from the base frame 1, and connect at its outer end to a bucket handle 6. Hoist pulleys 7 are disposed in the top

of the bucket handle 6. A scoop bucket 8 is pivotally mounted to the bottom of the bucket handle 6. Tilt mechanisms for controlling the pivotal movement of the bucket 8 are mounted on each side of the bucket handle 6. A pair of cylinders 9 and 10, lever arms 11 and 12 and connecting links 13 and 14 make up one of the tilt mechanisms. A limit switch 15 is fixed on the bucket handle 6 directly above the lever arm 11.

An A-frame 16 is mounted behind the boom 5 to project upward from the base frame 1 and hoist sheaves 17 are fastened in the top of the A-frame 16. A hoist cable 18 extends from a power driven hoist cable drum 20 supported on the base frame 1, over the hoist sheaves 17 in the top of the A-frame 16, about the hoist pulleys 7 on the top end of the bucket handle 6, and about a fixed pulley 19 fixed on the front of the A-frame 16. The cable 18 serves to hoist the bucket 8 by pivoting the bucket handle 6 about its connection to the boom 5.

A crowd mechanism crowds the bucket 8 horizontally and includes a crowd handle 21 which is supported on rollers 22 mounted in the top of the A-frame 16. The crowd handle 21 is pivotally connected at its front end to the bucket handle 6 and is reciprocally translatable forward and backward. Front and back stroke limiting abutments 23 and 24 respectively protrude downwardly from the crowd handle 21. A rope crowd drive shown in U.S. Pat. No. 3,482,890 and assigned to the same assignee as the present application is employed and reference may be had to that application for the details of the structure of that crowd mechanism. For present purposes it will suffice to point out that the crowd mechanism has a crowd rope 25 and a return rope 26 that both run from a power driven crowd cable drum 27 to pass over crowd pulleys (not shown) mounted in the top of the A-frame 16. From the crowd pulleys the crowd rope 25 extends to and about a crowd sheave 28 mounted on the upper rear portion of the crowd handle 21. The return rope 26, in similar fashion, extends to and about a return sheave 29 mounted on the top front portion of the crowd handle 21.

The crowd and return ropes 25 and 26 respectively are steel cables that are wound around the cable drum 27 in opposite directions so that rotation of the drum 27 in one direction unwinds the return rope 26 and winds in the crowd rope 25 to crowd the handle 21 forward. Rotation of the drum 27 in the opposite direction reverses this action to retract the crowd handle 21. During the crowd and retract motions of the crowd handle 21 the crowd rope 25 and the return rope 26 respectively are placed under such high tension that they are stretched beyond their normal lengths. After this high tension is relaxed the ropes 25 and 26 substantially return to their prestretched lengths, but over a period of time, the ropes 25 and 26 develop a certain amount of slack. If this slack is not removed serious damage to the crowd mechanism could result from the backlash effect that slack in the ropes 25 and 26 produces on the crowd handle 21.

The present invention is designed to provide a take-up system that automatically maintains a minimum tension on the crowd rope 25 to prevent slack from developing. As shown in FIG. 1, the crowd sheave 28 is mounted in a block 30 slidably disposed atop the crowd handle 21 in order that the block 30 can be adjusted in a direction lengthwise of the crowd handle 21. The block 30 has a bottom 31 with side flanges which define a channel that serves to position the block 30 in proper longitudinal alignment with the crowd handle 21. The front of the block 30 is pinned to the end of a piston rod 32 of a linear slack take-up actuator 33 that is hydraulically controlled. The actuator 33 has a cylindrical bore 34 with a rod end 35 through which the piston rod 32 protrudes, and a blind end 36 that is pinned to a lug 37 protruding from the top of the crowd handle 21. The piston rod is connected at its inner end to a piston 38 reciprocally mounted in the cylinder bore 34. A fluid reservoir 39 is mounted atop the crowd handle 21 to supply the actuator 33 with operating fluid. Extension of the actuator piston rod 32 increases the tension on the crowd rope 25 to remove slack and, correspondingly retraction of the piston rod 32 decreases crowd rope tension.

FIG. 2 schematically illustrates a first embodiment of the circuit that controls the take-up actuator 33. The circuit has a source of fluid under pressure which is comprised of the reservoir 39 and a 2-way stop valve 40 controlled by an electrical solenoid 41. The reservoir 39 is filled with a supply of operating fluid and pressurized air to form an air over oil system. A source of pressurized air (not shown) furnishes the reservoir 39 with air pressure at a predetermined relatively low pressure through a manually controlled, normally open stop valve 42. By pressurizing the reservoir in this fashion, there is no need for a pump in the circuit to place the operating fluid under pressure. An air vent 43 is also connected to the reservoir 39 through a manually controlled, normally closed stop valve 44 so that the reservoir 39 may be exhausted of air pressure when desired. A line 45 extends from the reservoir 39 to a filter 46 which is connected to the solenoid operated stop valve 40 by a line 47. The stop valve 40 is normally shut and is opened by energizing the solenoid 41 through the actuation of a switch 48, controlled by the operator, or the actuation of a remote activating means, depicted in the form of the limit switch 15.

Leading from the stop valve 40 to a check valve 49 is a line 50. The check valve 49 allows fluid flow only in the direction away from the stop valve 40 into a line 51. Connecting with the line 51 is a line 52 extending between the blind end 36 of the actuator 33 and a normally closed, manually operated stop valve 53 that normally prevents fluid flow back into the reservoir 39. During slack take-up, the line 52 carries operating fluid to the actuator blind end 36 so that the piston 38 will be impelled forward and, accordingly, the piston rod 32 which projects from the piston 38 will be extended outward to increase tension on the crowd rope 25.

Under normal operating conditions the limit switch 15 automatically initiates the take-up process. However, it is possible for the operator to attempt to take up slack at any time desired, through the operator's switch 48; but, it is desirable that slack take-up be attempted only at certain times. If take-up is attempted while crowding of the handle 21 is occurring there will be no slack to take up in the crowd rope 25. On the other hand, if take-up should be attempted during return movement of the handle 21, excessive cable tension will be produced. This is due to the temporary stretching of the return rope 26 during the return movement of the handle 21, which results in greater slack in the crowd rope 25. Take-up of the slack in the crowd rope 25 at such time will result in excessive ten-

sion in the crowd and return ropes **25** and **26** respectively because there will not be sufficient slack left in the crowd rope **25** to permit the return rope **26** to substantially regain its original prestretched length.

Therefore, take-up preferably should be performed only when the crowd handle **21** is in a static position and the crowd rope **25** is under the least amount of tension. It has been found that generally these conditions occur simultaneously when the bucket is raised and dumped. Accordingly, the limit switch **15** is mounted on the bucket handle **6** in such fashion that as the tilt mechanisms are operated to piot the bucket **8** to a dump position, the lever arm **11** engages the limit switch **15,** which is thereby actuated by this engagement. This completes the electrical circuit to the control solenoid **41** to open the stop valve **40.** Since the fluid in the reservoir **39** is continually kept under the predetermined pressure by the air source, pressurized fluid will then be supplied to the check valve **49** via the stop valve **40.** If, at this time the tension in the crowd rope **25** is such that the pressure in the actuator blind end **36** is less than the pressure in the reservoir **39,** operating fluid will flow through the check valve **49** and into the actuator blind end **36** until the pressure therein reaches the pressure of the reservoir **39.** As operating fluid is delivered to the actuator blind end **36** the piston rod **32** will be extended sufficiently to increase the tension on the crowd rope **25** and remove any slack.

When the bucket is returned from its dump position the limit switch **15** deactuates and the stop valve **40** closes, ending the take-up cycle. The fluid in the actuator blind end **36** is trapped therein as the check valve **49** and the manual stop valve **53** prevent fluid flow back to the reservoir **39.** As a result, although the operating fluid is under relatively low pressure to take up the slack in the crowd rope **25,** the take-up circuit will not allow the piston rod **32** to be retracted even though tremendous pressure is applied inward on the piston rod **32** when the crowd rope **25** acts to crowd the handle **21.** If it is ever necessary to drain the operating fluid from the actuator **33** to change the crowd rope **25,** or for some other purpose this can be accomplished quite simply by opening the manual stop valve **53** that opens to the reservoir **39.**

The second embodiment of the circuit that controls the actuator **33** is a modification of the first embodiment and contains all of the components of the first embodiment. However, in addition the second embodiment has a line **54** that communicates with line **47** and directly leads to the rod end **35** of the cylinder bore **34.** Therefore, the pressure in the rod end always substantially equals the pressure of the reservoir **39.** The primary advantage that this embodiment provides over the first embodiment is that without fluid in the rod end **35,** moisture tends to collect therein, producing rusting of the cylinder bore **34.**

There has thus been described preferred embodiments of the present invention. By utilizing the hydraulic actuator **33** to provide tension on the crowd rope **25** a highly efficient system is obtained that insures that there will generally be no less than a predetermined minimum tension on the crowd rope **25,** in spite of the fact that extremely large pressures may act on the actuator **33** to oppose its tensioning effect. Through the use of the limit switch **15,** the circuit that controls the actuator **33** is automatically actuated only at the optimum times for taking up slack to increase the efficiency of the system, but yet the operator's switch **48** permits the operator to also activate the system whenever it is so desired. Due to the fact that the take-up cycle is initiated by the limit switch **15** when the least amount of tension is on the crowd rope **25,** a relatively low operating force is all that is necessary to properly perform the take-up operation and, thereby, excessive tensioning of the crowd rope **25** is avoided.

The present invention may be employed in many variations of the embodiments shown here, as will be readily appreciated by those skilled in the art. Therefore, the foregoing description is not to be taken as definitive of the scope of the invention; but rather that which is regarded as the invention is set forth in the following claims.

I claim:

1. In a crowd mechanism of an excavator of the type that utilizes a crowd cable about sheaves to act upon a handle and having at least one sheave on a linearly adjustable mounting for taking-up slack in said crowd cable, the combination with said one sheave of

a single acting linear hydraulic actuator mounted between an excavator structure and said linearly adjustable mounting of said sheave to linearly adjust said sheave and having a cylinder bore with a blind end and a rod end, a piston reciprobably mounted in said cylinder bore with a piston rod projecting from said rod end of said cylinder;

a reservoir of operating fluid connected to a source of pressurized air to maintain said operating fluid under pressure;

a slack take-up stop valve connected by conduit between said operating fluid under pressure and said blind end of said cylinder bore, said slack take-up stop valve being normally closed;

and a controller for opening and closing said slack takeup stop valve at predetermined times to connect and disconnect said blind end of said cylinder bore with said operating fluid under pressure.

2. The combination as set forth in claim **1** wherein

a check valve is connected between said slack take-up stop valve and said blind end of said cylinder bore and is oriented to permit said operating fluid to flow only from said slack takeup stop valve to said blind end of said cylinder bore;

and a drain stop valve is connected by conduit between said reservoir and said blind end of said cylinder bore in parallel with said slack take-up stop valve, and said drain stop valve is also normally closed.

3. The combination as set forth in claim **2** wherein

said controller for said slack take-up stop valve is a solenoid connected to a power source by a limit switch and a manually operated switch connected in parallel.

4. The combination as set forth in claim **2** wherein

said rod end of said cylinder bore is connected by a conduit to said fluid under pressure in said reservoir.

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