Jan. 27, 1970 A. E. PI 3,491,905

APPARATUS FOR PREVENTING EXCESSIVE TENSION IN ELECTRICAL CONDUCTORS REEVED IN UPRIGHTS

Filed June 12, 1967 4 Sheets-Sheet 1

FIG. 1

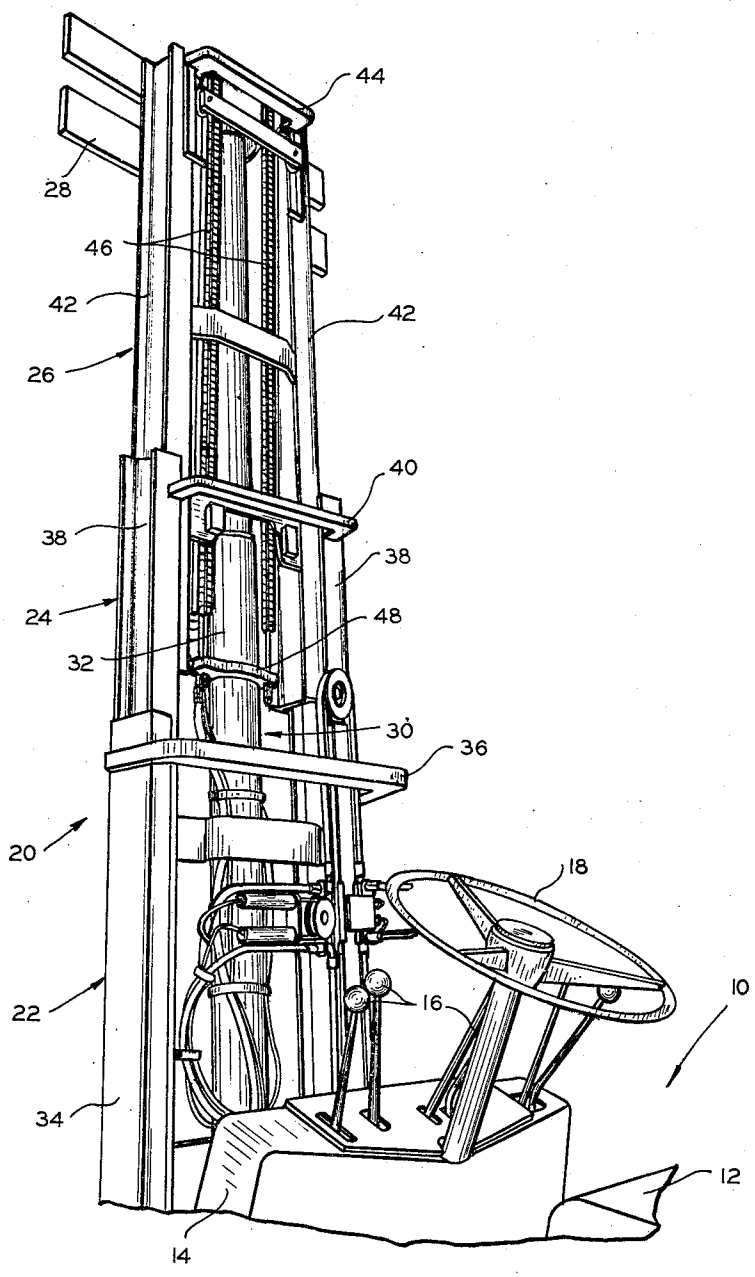

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FIG. 2

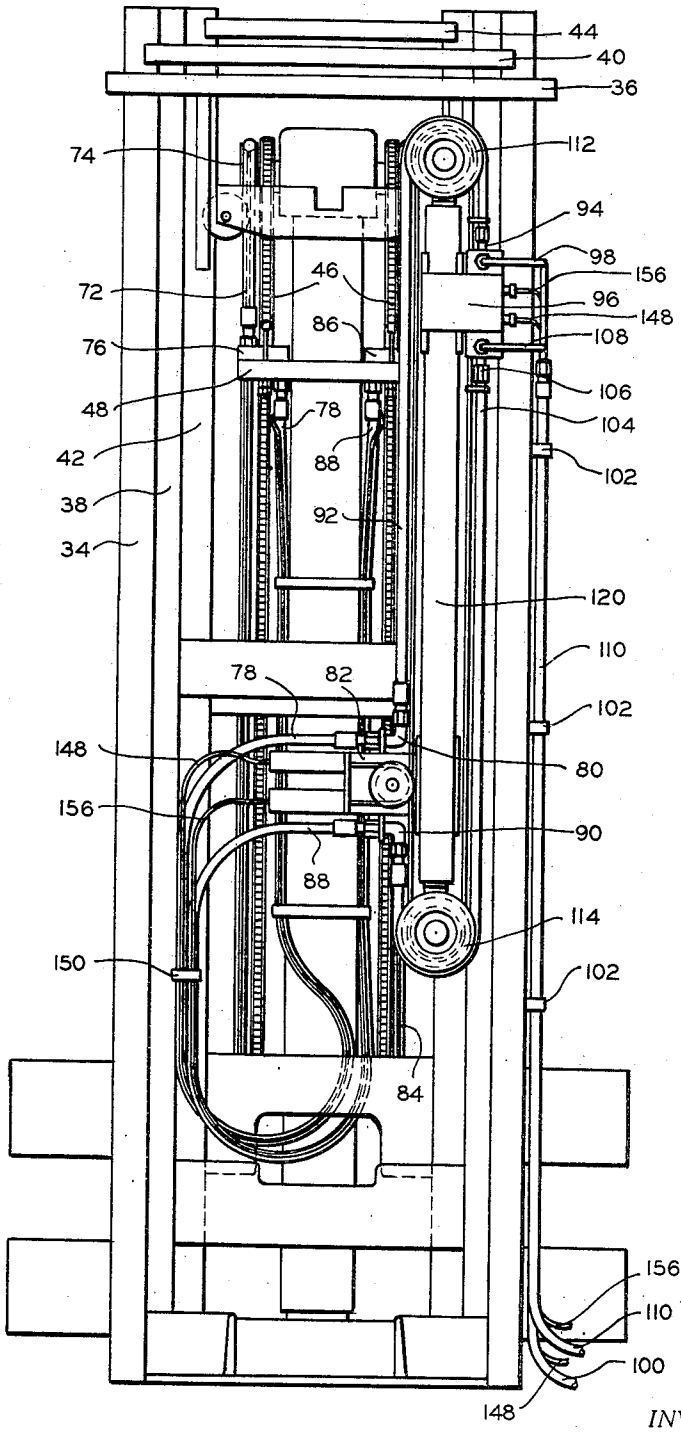

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FIG. 3

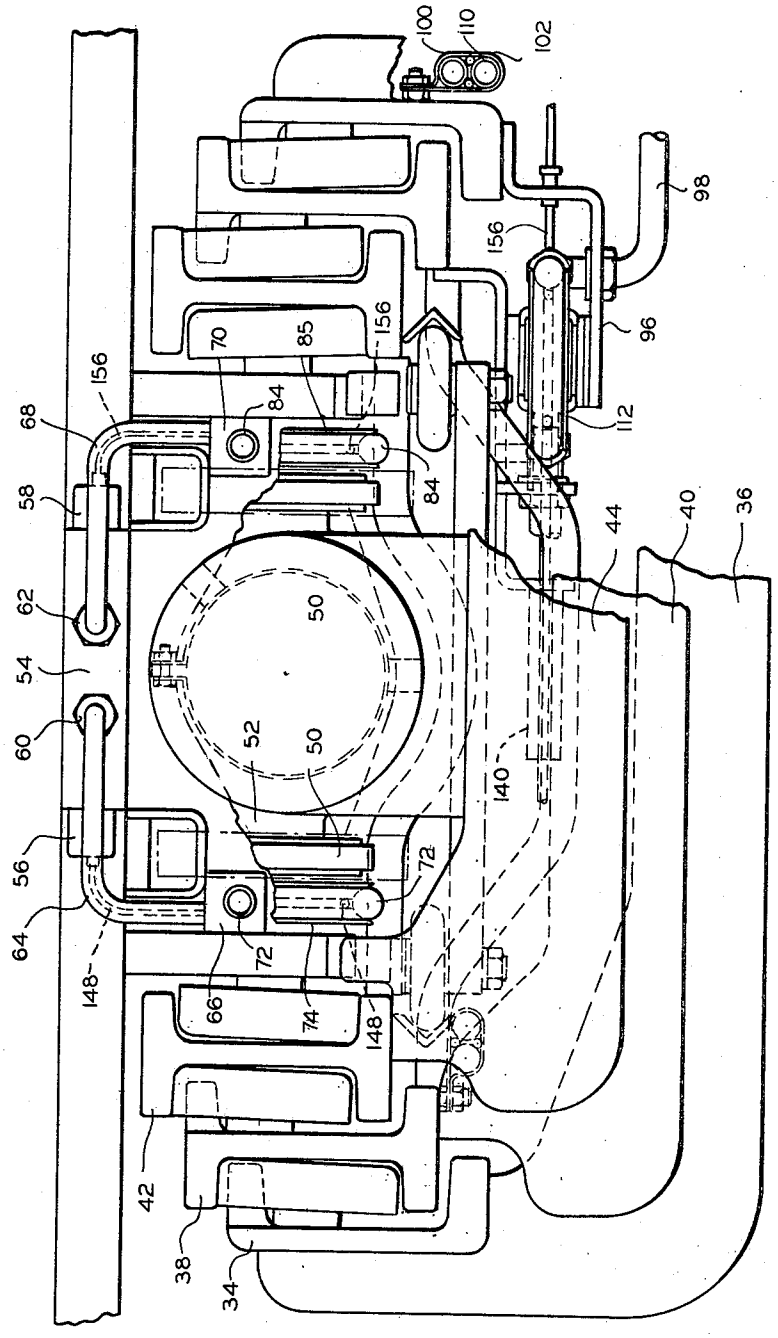

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FIG. 4

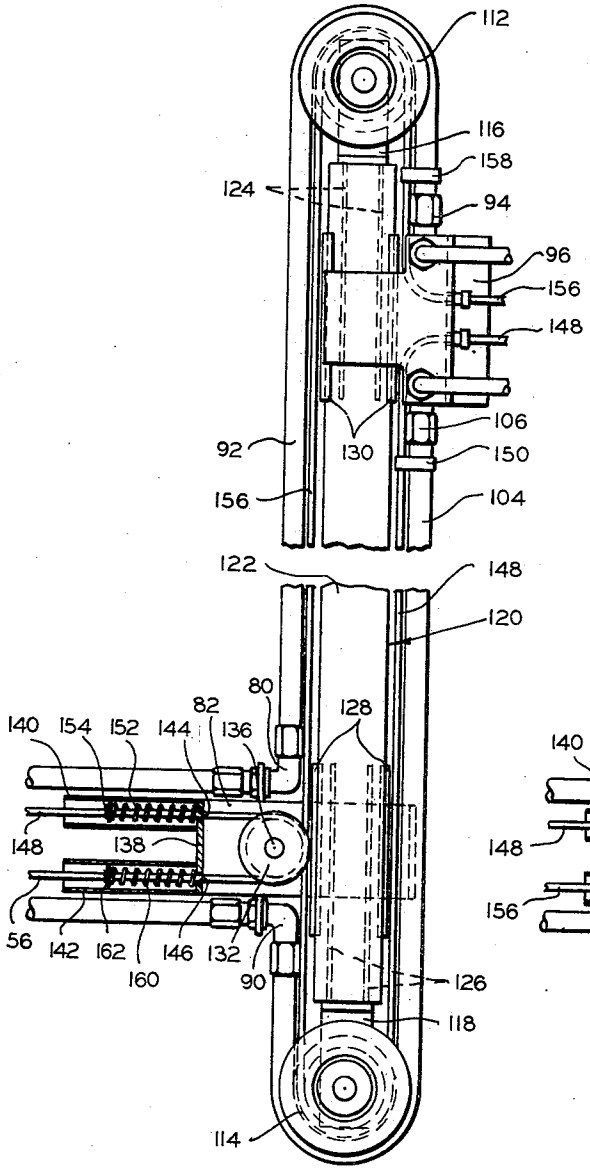
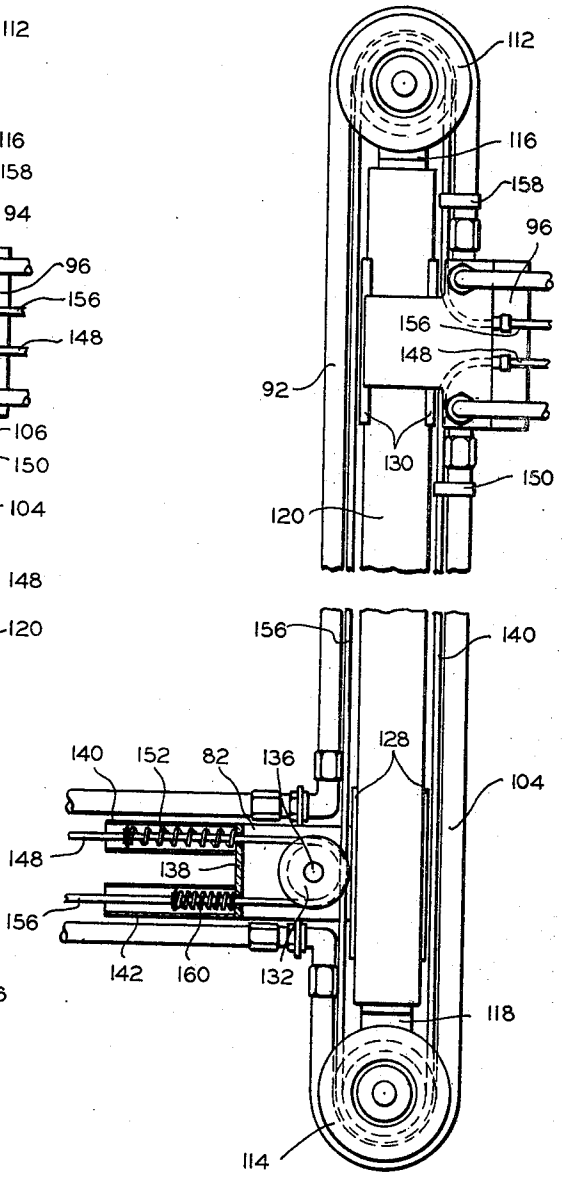


FIG. 5



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3,491,905

APPARATUS FOR PREVENTING EXCESSIVE TENSION IN ELECTRICAL CONDUCTORS REEVED IN UPRIGHTS

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Int. Cl. B66f 9/06, 9/18
U.S. Cl. 214—620 10 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for preventing excessive tension being exerted on electrical conductors reeved between the mast and an attachment mounted on the carriage of two or three-stage extendible uprights.

Background of the invention

The field of art to which the invention pertains includes elevators, and more specifically portable elevators.

Some attachments mounted on extendible uprights include, for example, three fluid-operated motors. One arrangement for operating these fluid motors utilizes a pair of fluid conduits reeved between the mast and carriage, a three-position valve, a pair of solenoids for shifting the valve and a pair of electric conductors for energizing the solenoids. It is desirable from the standpoint of compactness, simplicity and minimization of the number of parts required to have the electrical conductors follow generally the fluid conduits. However, the fluid conduits are elastic, and so shorten by approximately four per cent when carrying pressurized fluid. This presents a problem in regard to the electrical conductors because they are substantially non-stretchable. Thus, an object of my invention is to provide apparatus to accommodate electrical conductors reeved with elastic fluid conduits to changes in length of the fluid conduits.

Summary of the invention

In carrying out my invention in a preferred embodiment thereof, I provide a sheave, a pair of electrical conductors fixed at one of their ends and trained around the sheave in opposite directions and a pair of springs, each spring being connected to a different one of the electrical conductors for maintaining tension on the respective conductor.

The above and other objects, features and advantages of my invention will be more readily understood by persons skilled in the art when the detailed description is taken in conjunction with the drawing.

Brief description of the drawing

FIGURE 1 is a rear-quarter perspective view of a portion of a lift truck with the upright extended and showing to advantage my invention,

FIGURE 2 is an elevational view from the rear of a three-stage upright in the fully collapsed position and embodying my invention,

FIGURE 3 is a fragmentary plan view on an enlarged scale of the upright,

FIGURE 4 shows in enlarged detail the apparatus and arrangement for reeving the fluid conduits and electrical conductors between the mast and intermediate slide of the upright, and

FIGURE 5 is similar to FIG. 4, except that the lower run of fluid conduit has been supplied with pressurized fluid.

Description of the preferred embodiment

Referring to FIG. 1, the reference numeral **10** denotes generally a portion of a lift truck which includes a seat **12**, a cowl **14**, a plurality of control levers **16** mounted on the cowl and a steering control wheel **18** also mounted on the cowl.

Referring now also to FIGS. 2 and 3, an extendible upright **20** is mounted on lift truck **10** forwardly thereof. Upright **20** includes a mast **22**, an intermediate slide **24** telescoped in mast **22** and movable longitudinally thereof, an inner slide **26** telescoped in intermediate slide **24** and movable longitudinally thereof, a carriage **28** mounted on inner slide **26** and movable longitudinally thereof, and a multiple ram fluid motor **30** which includes an outer cylinder **32** connected to intermediate slide **24**. Mast **22** includes a pair of C-shaped channels **34** connected by a plurality of cross braces **36** to form a rigid unitary structure. Intermediate slide **24** includes a pair of I-beams or rails **38** connected by a plurality of cross braces **40** to form a rigid unitary structure, and similarly inner slide **26** includes a pair of I-beams or rails **42** connected by a plurality of cross braces **44** to form a rigid unitary structure. Also, a pair of chains **46** are connected at one of their ends to carriage **28** and at the other of their ends to an anchor plate **48** on outer cylinder **32** of fluid motor **30** and reeved over a pair of sprockets **50** which are mounted for rotation on a cross arm **52** that is connected to motor **30**.

When upright **20** is in the fully collapsed position with carriage **28** in the lowermost position (FIG. 2) and pressurized fluid is supplied to motor **30**, the motor extends to cause cross arm **52** to move upwardly until inner slide **26** is engaged by the cross arm. At this point carriage **28** has been raised about 18 inches in the particular upright shown. Further extension of motor **30** then causes inner slide **26** to move upwardly also while carriage **28** continues to move upwardly along the inner slide. When carriage **28** has reached the top of inner slide **26** the inner slide is fully extended. If additional pressurized fluid is supplied to motor **30** from the condition in which the inner slide **26** has been fully extended out of intermediate slide **24**, fluid motor **30** is extended at the bottom thereof so that intermediate slide **24** is pulled vertically outwardly of mast **22** by inner slide **26** to its full extension.

While no attachment has been shown mounted on carriage **28**, it will be understood that there are available a great many types of attachments which can be mounted on the carriage. Some of these attachments, such as a rotating roll clamp mounted on a side shifter require three fluid motors for operation. Lift truck **10** is provided with a pump which draws fluid from a reservoir and pressurizes the fluid. Obviously, means must be provided for supplying the pressurized fluid to the fluid motors of the attachment and then returning the fluid to the reservoir.

Mounted on carriage **28** is a valve **54** which, although it is shown mounted on carriage **28**, could just as well be mounted on an attachment carried by the carriage. Valve **54** includes a spool which is actuatable from a first position to a second or third position by means of a pair of solenoids **56** and **58**. Valve **40** also includes a pair of ports **60** and **62** and three pairs of motor ports. Thus, by shifting the valve spool between the three positions thereof ports **60** and **62** can be connected to the three different pairs of motor ports so that the three separate fluid motors of the attachment can be operated independently of each other from a single pair of fluid supply and return conduits. Of course, if an attachment is being used which embodies only two separate fluid motors, then a valve having a spool shiftable to only two positions is all that is required, and so only a single

solenoid would be necessary in conjunction with such a valve.

A rigid fluid conduit **64** is connected to port **60** at one end and is connected at the other end to a junction block **66** on carriage **28** which is mounted as shown in FIG. 3. Similarly, a rigid conduit **68** is connected to port **62** and to a junction block **70**.

Connected at one end thereof to junction block **66** and hence conduit **64** is a flexible fluid conduit **72** which is reeved over a dual sheave assembly **74** that is mounted on cross arm **52** outwardly of the adjacent sprocket **50** and connected to another junction block **76** which is mounted on anchor plate **58**. Another flexible fluid conduit **78** is connected at one end to junction block **76** and hence conduit **72** and connected at the other end thereof to a fitting **80** mounted on a bracket **82** which is connected to one of the rails **38** of intermediate slide **24**.

Likewise, a flexible fluid conduit **84** is connected at one end thereof to junction block **70** and hence conduit **68**, reeved over a dual sheave assembly **85** mounted for rotation on cross arm **52** outwardly of adjacent sprocket **50** and connected to a junction block **86** which is mounted on anchor plate **48**. Another flexible fluid conduit **88** is connected at one end thereof to junction block **86** and hence conduit **84** and connected at the other end thereof to a fitting **90** mounted on bracket **82**.

The reeving of conduits **72**, **78**, **84** and **88** which has been described thus far accommodates the relative movement between carriage **28** and inner slide **26** and the relative movement between inner slide **26** and intermediate slide **24**.

In order to accommodate the relative movement between intermediate slide **24** and mast **22** a conduit reeving which is different from that just described is used. This arrangement, referring now also to FIGS. 4 and 5, includes a flexible fluid conduit **92** connected at one end to fitting **80** and hence conduits **78** and **72**, looped between intermediate slide **24** and mast **22** and connected at the other end to a fitting **94** which is mounted on a bracket **96** connected to one of channels **34** of mast **22**. Also connected to fitting **94** and hence conduit **92** is a short length of rigid conduit **98** which in turn is connected to another flexible conduit **100** that is fastened to the adjacent channel **34** by a plurality of clips **102** and run down to the lower right-hand corner of mast **22** where it is run over to truck **10** and connected to a control valve, not shown, mounted on the body of truck **10**. Also, a flexible conduit **104** is connected at one end thereof to fitting **90** and hence conduits **88** and **84**, looped between intermediate slide **24** and mast **22** and connected at the other end thereof to a fitting **106** mounted on bracket **96**. A short length of rigid fluid conduit **108** is connected at one end thereof to fitting **106** and hence to conduit **104** and at the other end thereof to a flexible conduit **110** is fastened to mast **22** by clips **102** and in turn is connected to the aforementioned control valve, the same as conduit **100**. By proper manipulation of the control valve the operator may direct pressurized fluid to either conduit **100** or **110** while the other conduit is then connected to the fluid reservoir, or supply pressurized fluid to neither of the conduits.

As can be seen from viewing FIGS. 4 and 5 especially, the loops formed by flexible conduits **92** and **104** are oriented oppositely to each other. This is accomplished by reeving conduit **92** over a dual sheave assembly **112** and reeving conduit **104** under a dual sheave assembly **114**. Again, a dual sheave assembly suitable for use here is disclosed and claimed in the aforementioned U.S. patent application. Sheave assembly **112** is connected for rotation to a bracket **116**, and similarly sheave assembly **114** is connected to a bracket **118**. Brackets **116** and **118** are connected to a bar **120** which is made up of a pair of parallel plates **122** that are connected by two pairs of spacers **124** and **126**.

Bar **120**, together with sheave assemblies **112** and **114**, is restrained from movement away from mast **22** and intermediate slide **24** and guided for movement longitudinally thereof by means of a pair of U-shaped guides **128** connected to bracket **82** and hence intermediate slide **24**, guides **128** engaging the edges of one of plates **122** of bar **120**, as shown, and a pair of U-shaped guides **130** which engage the edges of the other plate **122**, as shown, and which are connected to bracket **96** and hence mast **22**. It will be noted that bracket **82** and guides **128** are disposed on one side of bar **120** and that bracket **96** and guides **130** are disposed on the other side of bar **120**, each pair of guides engaging different ones of plates **122** so that during extension of intermediate slide **24** there is no interference between the brackets and guides as they pass each other. Thus, when intermediate slide **24** is raised, the ends of conduits **92** and **104** which are connected to fittings **80** and **90** move upwardly with intermediate slide **24** since the fittings are connected to bracket **82** which in turn is connected to intermediate slide **24**. Upward movement of conduits **92** and **104** also causes bar **120**, together with sheave assemblies **112** and **114**, to shift upwardly.

Referring especially to FIGS. 4 and 5, there is connected to bracket **82** a sheave or wheel **132** which is mounted for rotation on a shaft **136**. Located adjacent sheave **132** and extending rearwardly from bracket **82** is a plate **138** to which a pair of open ended tubes **140** and **142** are connected. Extending through plate **138** and communicating with the interior of tubes **140** and **142** are a pair of openings **144** and **146**. The function of this structure will be explained shortly.

Returning now to valve **54** it will be recalled that a pair of solenoids **56** and **58** were connected thereto for actuating the valve spool to connect ports **60** and **62** with various pairs of motor ports so that more than one fluid motor can be operated from a single pair of supply and return conduits. Obviously, solenoids **56** and **58** must be connected by electrical conductors to a control switch which in turn opens and closes a circuit between each solenoid and a source of electrical power, such as a battery or a generator.

Connected to solenoid **56** is an electrical conductor **148** which is reeved over sheave assembly **74**, fastened to intermediate slide **24** by means of a clip **150**, run through tube **140** and opening **144** in plate **138**, around sheave **132**, under sheave assembly **114**, fastened to conduit **104** adjacent fitting **106** by a clip **152**, run down alongside conduits **100** and **110** to a lower corner of mast **22** and then to an on-off switch (not shown) on truck **10**. Also, conductor **148** passes through a helical compression spring **152** disposed in tube **140** between plate **138** and a stop **154** connected to conductor **148**. Stop **154** is disposed so that spring **152** is under compression at all times, whereby conductor **148** is maintained under tension and taut at all times.

Connected to solenoid **58** is an electrical conductor **156** which is reeved over sheave assembly **85**, fastened to intermediate slide **24** by means of clip **150**, passed through tube **142** and opening **146**, trained around sheave **132**, reeved over sheave assembly **112**, fastened to fluid conduit **92** adjacent fitting **94** by a clip **158** and then run down along one side of mast **22** to a lower corner thereof and to an on-off switch, not shown, mounted on truck **10**. It will be noted that conductor **156** passes through a helical spring **160** which is disposed in tube **142** between plate **138** and a stop **162** which is fastened to conductor **156**. Stop **162** is located so that spring **160** is under compression at all times, whereby conductor **156** is maintained under tension and taut at all times.

The various fluid conduits, including conduits **92** and **104**, are made of an elastic material. Consequently, when pressurized fluid is supplied to one of the conduits the conduit tends to swell and as a result of this the conduit also shortens by approximately four percent. In other

words, as the cross section of the conduit varies the length of the conduit varies inversely. Thus, FIG. 4 shows the condition of conduits **92** and **104** and the apparatus associated therewith when pressurized fluid is supplied to neither of these conduits. If pressurized fluid, for example, is supplied to conduit **104** causing it to shorten, then bar **120**, together with sheave assemblies **112** and **114**, shifts upwardly causing conduit **92** to stretch slightly. Since electrical conductor **156** is substantially nonstretchable, upward movement of sheave assembly **112** pulls on conductor **156** in order to gain additional length to compensate for upward movement of sheave assembly **112**, thereby compressing spring **160** further. At the same time the length of conductor **148** necessary to extend between plate **138** and clip **150** decreases so that spring **152** expands, thereby compensating for the additional length of conductor **148** which is available. As a result both conductors **148** and **156** are maintained taut and excessive tension is prevented from being exerted on the conductor which must in effect lengthen between plate **138** and the clip to which it is attached to the adjacent conduit.

Although only a single preferred embodiment of my invention has been disclosed in the foregoing detailed description, it will be understood that the description is intended to the illustrative only, and that my invention is subject to various modifications and changes by persons skilled in the art which nonetheless would fall within the scope and spirit of my invention.

I claim:

1. The combination comprising a first member, a second member movable relative to the said first member, first and second elastic fluid conduits looped between and connected to the said members, first and second flexible electrical conductors looped between and connected to the said members, means engaging the said conduits and conductors for orienting the loops of the said first conduit and first conductor generally oppositely to the loops of the said second conduit and second conductor, guide means connected to one of the said members intermediate said conduits and engaging the said conductors for guiding the conductor immediate adjacent a said conduit in an opposite direction, and resilient means connected between each of the said conductors and the said one member for maintaining tension on each of the said conductors.

2. The combination as set forth in claim **1** wherein the said orienting means includes a bar, first and second sheave assemblies mounted for rotation on the said bar and means connected to at least one of the said members for guiding and restraining the said bar, the said first sheave assembly engaging the loops of the said first conduit and first conductor and the said second sheave assembly engaging the loops of the said second conduit and second conductor.

3. The combination as set forth in claim **1** wherein the said guide means includes a pair of sheaves.

4. The combination as set forth in claim **3** wherein the said sheaves are mounted for independent rotation on the said one member and are disposed coaxially relative to each other and the said electrical conductors are trained in opposite directions around different ones of the said sheaves.

5. The combination as set forth in claim **1** wherein the said tension maintaining means includes a plate through which the said conductors pass, a first stop connected to the said first conductor, a compression spring disposed between and abutting the said plate and first stop, a second stop connected to the said second conductor and a compression spring disposed between and abutting the said plate and second stop.

6. The combination as set forth in claim **3** wherein the resilient tension maintaining means includes a plate through which the said conductors pass, a first stop connected to the said first conductor, a compression spring disposed between and abutting the said plate and first stop, a second stop connected to the said second conductor and a compression spring disposed between and abutting the said plate and second stop.

7. The combination as set forth in claim **6** wherein the said sheaves are mounted for independent rotation on the said one member and are disposed coaxially relative to each other and the said electrical conductors are trained in opposite directions around different ones of the said sheaves.

8. The combination as set forth in claim **2** wherein the said guide means includes a pair of wheels disposed coaxially relative to each other and mounted for independent rotation on said one member, the said first conductor running in one direction around one of the said wheels and the said second conductor running in the opposite direction around the other of said wheels.

9. The combination as set forth in claim **8** wherein the resilient tension maintaining means includes a plate through which the said conductors pass, a first stop connected to the said first conductor, a compression spring disposed between and abutting the said plate and first stop, a second stop connected to the said second conductor and a compression spring disposed between and abutting the said plate and second stop.

10. The combination comprising a first member, a second member movable relative to the said first member, a first flexible fluid conduit having a variable cross section and a length which varies inversely relative to the cross section thereof, the said first conduit being looped between and connected to the said members, a second flexible fluid conduit having a variable cross section and a length which varies inversely relative to the cross section, the said second conduit being looped between and connected to the said members, the said conduits shortening when pressurized fluid is supplied to them, a first flexible electrical conductor having a substantially fixed length, the said first conductor being looped between and connected to the said members, a second electrical conductor having a substantially fixed length, the said second conductor being looped between and connected to the said members, means engaging the said conduits and conductors for orienting the loops of the said first conduit and the said first conductor generally oppositely to the loops of the said second conduit and the said second conductor, and means for preventing excessive tension being applied to one of the said conductor loops when pressurized fluid is supplied to the conduit loop which is oriented generally oppositely to the said one conductor loop, the said excessive tension preventing means including wheel means connected to one of the said members, the said conductors being reeved in opposite directions around the said wheel means and in opposite direction relative to an adjacent conduit, resilient means connected between the said first conductor and the said one member for maintaining tension on the said first conductor and resilient means connected between the said second conductor and the said one member for maintaining tension on the said second conductor.

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214—650