Dec. 1, 1959 D. B. GIBSON 2,914,922

HYDRAULIC SYSTEM FOR EXTENDING AND RETRACTING AN ANTENNA MAST OR THE LIKE

Filed April 6, 1956 3 Sheets-Sheet 1

FIG. 5.

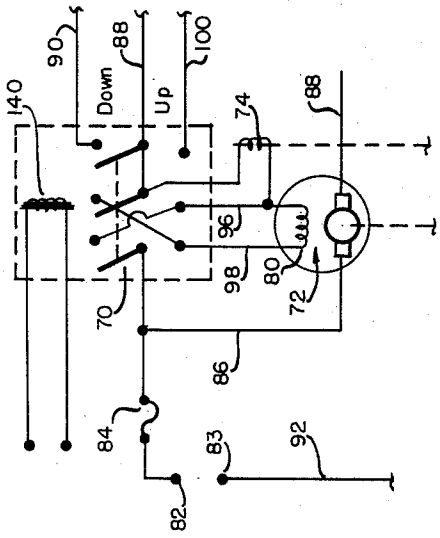


FIG. 1.

INVENTOR

DAVID B. GIBSON

BY Ralph B. Stewart

ATTORNEY

Dec. 1, 1959 D. B. GIBSON 2,914,922

HYDRAULIC SYSTEM FOR EXTENDING AND RETRACTING AN ANTENNA MAST OR THE LIKE

Filed April 6, 1956 3 Sheets-Sheet 2

FIG. 4.

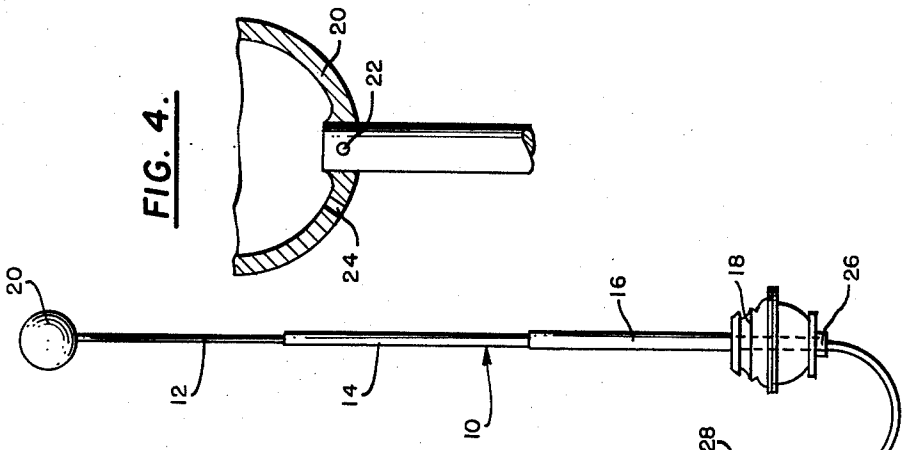
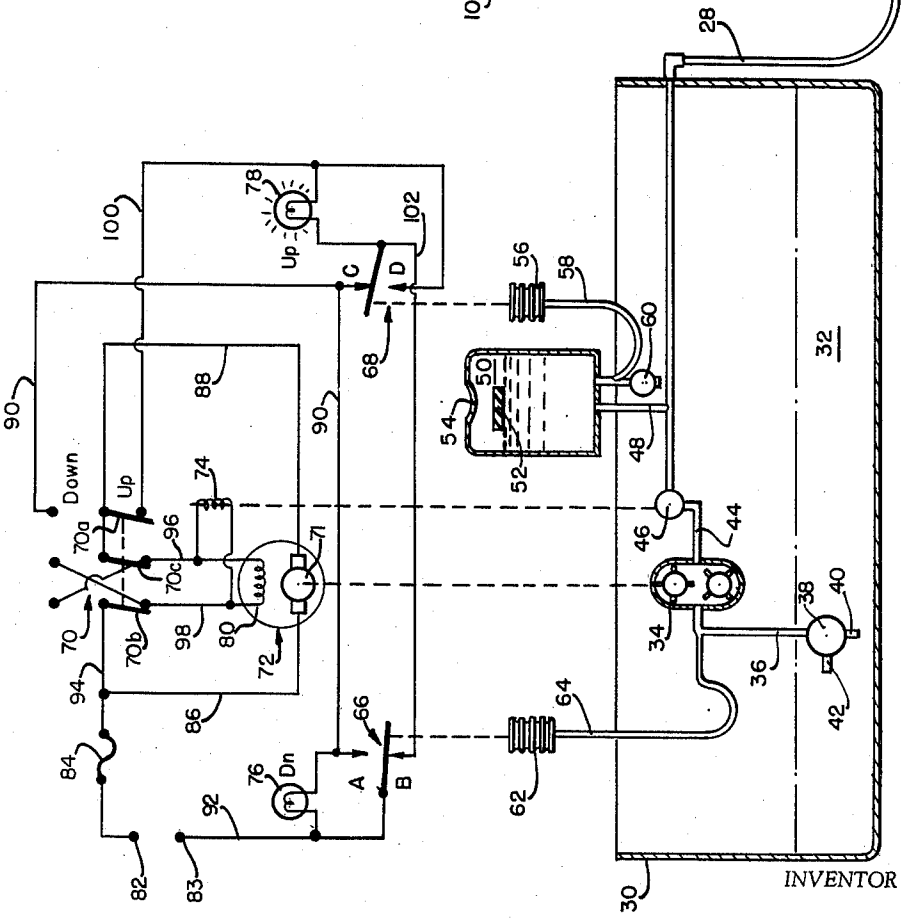


FIG. 2.



INVENTOR

DAVID B. GIBSON

BY Ralph B. Stewart

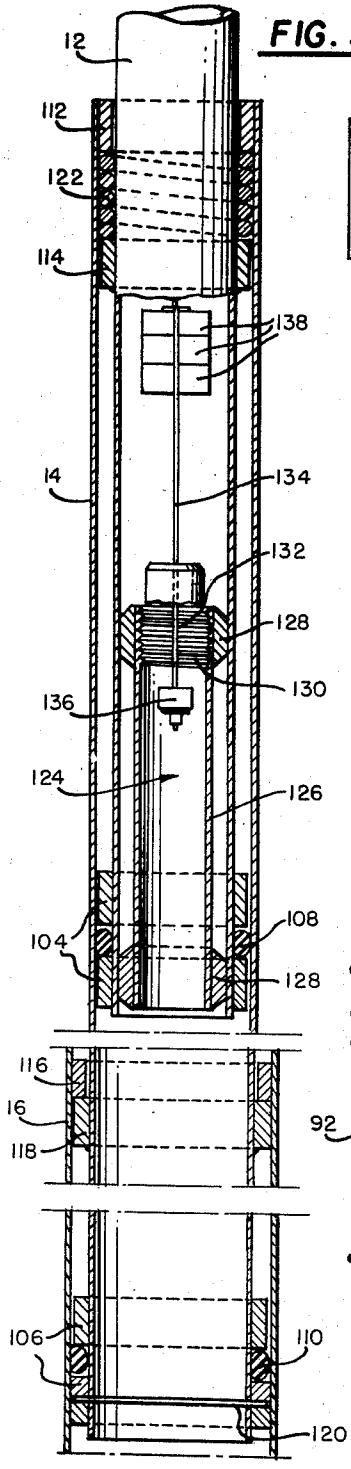
ATTORNEY

Dec. 1, 1959 D. B. GIBSON 2,914,922

HYDRAULIC SYSTEM FOR EXTENDING AND RETRACTING AN ANTENNA MAST OR THE LIKE

Filed April 6, 1956 3 Sheets-Sheet 3

FIG. 3.



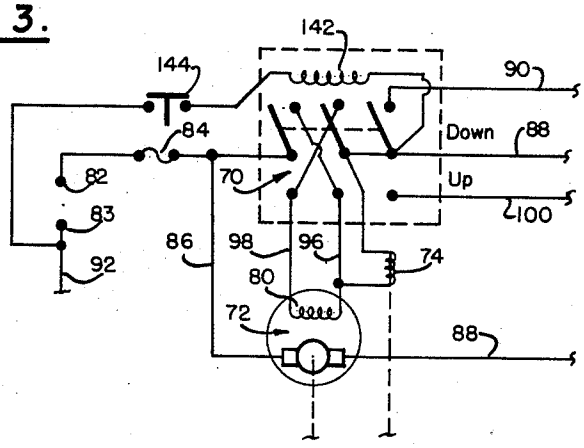
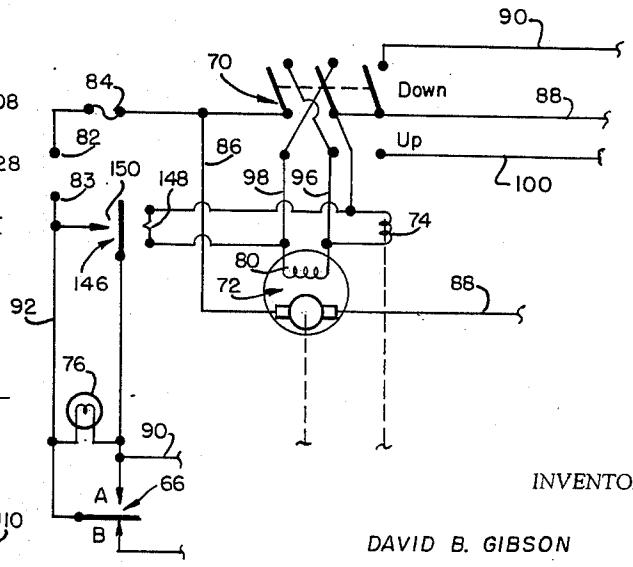


FIG. 6.

FIG. 7.



INVENTOR

DAVID B. GIBSON

BY Ralph B. Stewart

ATTORNEY

United States Patent Office 2,914,922 Patented Dec. 1, 1959

2,914,922

HYDRAULIC SYSTEM FOR EXTENDING AND RETRACTING AN ANTENNA MAST OR THE LIKE

David B. Gibson, Dade City, Fla., assignor to Unitron Corporation, Orlando, Fla., a corporation of Florida

Application April 6, 1956, Serial No. 576,730

10 Claims. (Cl. 60—51)

This invention relates to apparatus for extending and retracting a mast, such as an antenna mast, and more particularly to an electrically controlled hydraulic motive power system for effecting such operation.

The invention is intended primarily for use in marine ship-to-shore radio-telephone installations in small and medium sized commercial and pleasure craft, where the advantages of a remotely controlled retracting antenna to facilitate passage under bridges and similar low obstructions are readily apparent. The invention is, however, equally adaptable to other types of fixed and mobile installations wherein a power operated retractable mast is desired and in fact is applicable to systems in which the ultimate load device to be extended and retracted is something other than a mast or antenna.

While electrically actuated hydraulically motivated extensible antennae are known in the prior art, by far the majority of such devices are rudimentary in construction and lack the flexibility and reliability required for long term use under practical working conditions. Those devices in the prior art which purport to offer a solution to the problem of antenna extension and retraction are, in fact, impractical because they are unreliable and/or unduly complicated and consequently uneconomical to produce. The present invention is intended to overcome the defects of the prior art devices and to provide apparatus which will perform its function over protracted periods under adverse conditions and with a minimum of supervision.

Accordingly, a primary object of the invention is to provide unique apparatus for the extension and retraction of a mast or the like.

Another primary object of the invention is to provide a unique electro-hydraulic system for the controlled extension and retraction of a movable load device.

A further object of the invention is to provide a novel system for extending and retracting the element of a telescopic antenna and for ensuring electrical continuity of the antenna elements.

An additional object of the invention is to provide apparatus of the aforesaid type which accommodates pressure changes due to temperature variation or wear.

Yet another object of the invention is to provide a system of the aforesaid type in which positive extension and retraction of the mast is ensured and in which the elements of the telescopic antenna retract in accordance with a prescribed sequence.

A still further object of the invention is to provide apparatus of the aforesaid type which affords flexibility in the choice and location of control means.

An additional object of the invention is to provide a system of the aforesaid type in which the condition of the system is monitored by suitable indicators.

A further object of the invention is to provide a system of the aforesaid type which is instantly responsive to changes in control by the operator.

A still further object of the invention is to provide apparatus for extending a mast in which the motion of the

mast is arrested when the mast meets an obstruction and continues automatically when the obstruction is removed.

An additional object of the invention is to provide a system for extending and retracting a mast, the system being de-energized automatically upon full extension or retraction of the mast.

A still further object of the invention is to provide hydraulic apparatus for a system of the aforesaid type in which air is vented from the system automatically as required.

Yet another object of the invention is to provide a system of the aforesaid type which is unresponsive to momentary pressure surges.

An additional object of the invention is to provide hydraulic apparatus for a system of the aforesaid type including valves which continue to operate positively over long periods of use.

A further object of the invention is to provide a unique system for energizing and de-energizing an electrical device.

Another object of the invention is to provide a unique control circuit for the hydraulic apparatus.

Yet another object of the invention is to provide a novel circuit for reversibly energizing a motor and for de-energizing the motor automatically.

A still further object of the invention is to provide a circuit which is interrupted automatically by virtue of the insertion of a high impedance indicator device that is energized upon its insertion.

These and other objects of the invention will become more readily apparent in the following detailed description of the invention taken in conjunction with the accompanying drawings wherein:

Figure 1 is a schematic, partially diagrammatic view of a preferred form of the invention shown with the antenna fully retracted;

Figure 2 is a similar view with the antenna shown fully extended;

Figure 3 is a partly sectional elevation of a preferred form of telescopic antenna and bleeder valve in accordance with the invention.

Figure 4 is a partly sectional view of a detail of the antenna;

Figure 5 is a partial schematic diagram of a modification of the control circuit of Figures 1 and 2;

Figure 6 is a partial schematic diagram of another modification of the control circuit; and

Figure 7 is a partial schematic diagram of still another modification of the control circuit.

Briefly, the apparatus of the present invention comprises a tubular telescopic mast arranged to be extended by the pressure of a hydraulic fluid and to be retracted by gravity and a negative hydraulic pressure or vacuum. A pump is arranged to feed the hydraulic fluid from a reservoir to the mast during extension, and to return the fluid to the reservoir during retraction. Pressure-sensitive switches, one of which is operated through a hydraulic accumulator, are utilized to provide automatic operation of the system once it has been actuated. The electrical circuit of the system includes the pressure-sensitive switches, a reversible pump motor, a solenoid valve coil, a pair of high impedance indicator lamps, and a master control switch.

Referring to Figures 1 and 2 of the drawings, reference numeral **10** designates generally a vertical mast which is to be extended and retracted and which forms the ultimate load of the system. As shown in Figure 2, the mast may comprise several telescoping sections **12**, **14**, **16** of a tubular antenna mast supported on an insulator base **18**. Where the antenna is employed on marine craft for ship-to-shore communication, for example, the insulator base **18** will normally be mounted at a location high on the superstructure of the craft. The uppermost element **12**

of the antenna may be provided with electrical loading at its upper end, such as a ball **20** which may constitute capacitive loading, or a combination of inductive and capacitive loading elements may be provided, as may be desired. In the form shown, the mast elements are hollow, and the uppermost element **12** is secured to the ball **20**, as by a pin **22** (see Fig. 4). In addition to its other functions, the ball serves as a rain cap for the antenna and is provided with a vent **24** which releases air from the hydraulic system in a manner to be described. In accordance with conventional practice, the electrical length of the antenna may be made one-quarter wave length when fully extended.

The base of the lowermost mast element **16** is closed and is provided with a connector or nipple **26** which receives one end of a length of tubing **28**. In order to isolate the mast electrically from the hydraulic system when the mast is used as an antenna, tube **28** is formed of insulating material. A suitable connector (not shown) may be provided for connecting the lower end of the antenna mast to communication apparatus.

The hydraulic apparatus of the present invention includes a reservoir **30** which contains a suitable hydraulic fluid **32**, such as Sacony-Mobil Teleo AA, a petroleum base oil of good insulating quality. A reversible pump **34**, which in the preferred form of the invention comprises a positive displacement gear unit, is arranged to feed the hydraulic fluid to the antenna mast during extension thereof, and to return the fluid to the reservoir during retraction. The input tube **36** of the pump is provided with a check valve **38** having an inlet port **40** and a metered or constricted by-pass or outlet port **42**, both ports being well below the minimum fluid level. The output tube **44** of the pump communicates with tubing **28** through a solenoid valve **46**. Tube **44** is also connected to a branch tube **48** which communicates with a hydraulic accumulator chamber **50**. Valve **38** permits fluid to flow from supply **32** to pipe **36** through port **40**, but prevents flow through port **40** in the opposite direction.

The accumulator chamber **50** is provided with a free floating check valve disc **52** which, in its lowermost position, seals the opening between tube **48** and the accumulator chamber. Disc **52** is formed of a bouyant material and rises as hydraulic fluid is admitted to the accumulator chamber. A rib **54** or other suitable structure, such as a screen (not shown), may be provided near the top of the accumulator chamber to prevent disc **52** from sticking to the top of the chamber by capillary action.

The accumulator chamber communicates with a pressure-sensitive switch-actuating element **56**, which may be of the bellows type, through a section of tubing **58** connected to the chamber through the bottom wall thereof. A spring loaded check valve **60**, which opens to the atmosphere, may also communicate with tubing **58**. Another pressure-sensitive switch-actuating element **62** communicates with intake tube **36** through a tube **64**. Switch-actuating element **62** is arranged to actuate a single-pole double-throw switch **66**, while switch actuating element **56** actuates a single-pole double-throw switch **68**.

Switches **66** and **68** form a part of the electrical circuit of the invention. This circuit includes a three-pole, double-throw master switch **70**, a reversible pump motor **72**, a solenoid **74** which opens valve **46** when energized, and a pair of high impedance indicator lamps **76** and **78**. The motor is preferably of the shunt field type and includes an armature **71** and a field coil **80**. By using a shunt field motor, racing at the end of the mast retracting cycle, when the pump no longer receives fluid, is prevented. Electrical power is supplied to the system at a pair of terminals **82**, **83**, and the system may be fused as indicated at **84**.

With master switch **70** closed on its "down" position, a circuit for the energization of the armature **71** of motor **72** may be traced from supply terminal **82** through fuse **84**, conductor **86**, through the armature **71** to conductor **88**, switch blade **70***a*, conductor **90**, contact A of switch **66** and conductor **92** to supply terminal **83**. Energization circuits for the field coil **80** and the solenoid coil **74**, which are connected in parallel, may be traced from supply terminal **82** through fuse **84**, conductor **94**, switch blade **70***b*, conductor **96**, through **74** and **80** in parallel to conductor **98**, switch blades **70***c* and **70***a* to conductor **90**, and back to supply terminal **83** as above. As illustrated in Figure 1, however, the antenna is fully retracted, and the motor and solenoid valve coil are de-energized because switch **66** is closed to position B, placing the high impedance of bulb **76** in series with the energization circuit. Lamp **76** is lit to indicate that the antenna is retracted.

With master switch **70** in the "up" position as illustrated in Figure 2, an energization circuit for the armature **71** of motor **72** may be traced from terminal **82**, through fuse **84**, conductor **86**, armature **71**, conductor **88**, switch blade **70***a*, conductor **100**, contact D of switch **68**, conductor **102**, contact B of switch **66**, and conductor **92** back to terminal **83**. As illustrated in Figure 2, however, the antenna is fully extended and the armature **71** of motor **72** is not energized because the high impedance of lamp **78** is in series with the energization circuit. Lamp **78** is lit to indicate that the antenna is in its extended position. Energization circuits for the field coil **80** and the solenoid coil **74** may be traced in the same manner as the motor armature circuit, except that conductors **96** and **98** are substituted for conductors **86** and **88**.

The operation of the apparatus of the invention will now be described. Referring to Figure 1, to extend the antenna into operating position, master switch **70** is moved to its "up" position from the position illustrated. Lamp **76** is extinguished because the circuit through conductor **90** is broken, and a circuit is completed to energize solenoid coil **74** and motor **72**. Lamp **78** is shorted by closure of switch **68** on contact D. Energization of motor **72** causes pump **34** to rotate in the proper direction to feed the hydraulic fluid **32** to the antenna **10**. Check valve **38** opens to allow a full flow of hydraulic fluid to enter port **40** at approximately zero gauge pounds pressure and to flow through tube **36** to the pump. Suction created in tube **64** and bellows **62** by the operation of the pump allows switch **66** to remain in position B throughout the operating cycle. Hydraulic pressure is developed in tube **44**, and since valve **46** has been opened by solenoid coil **74**, this pressure is transmitted through hose **28** to the telescoping sections of the antenna mast, causing them to extend upwardly.

In the usual installation of the system of the invention, the base **18** of the antenna is located above the level of the fluid in reservoir **30**. Any air trapped in the system during prior operating cycles collects at the base of the antenna and rises ahead of the fluid flowing into the antenna mast. This air is vented through opening **24** in the ball **20** by virtue of a bleeder valve to be described hereinafter.

Simultaneously with the build-up of pressure in tube **44**, hydraulic fluid flows through tube **48** into the accumulator chamber **50**, compressing the air in the upper portion of the chamber and at the same time lifting the buoyant check valve disc **52**. When the pressure in the hydraulic accumulator chamber reaches a predetermined level, for example, 40 gauge pounds, the bellows **56**, which is connected to the accumulator chamber through tube **58**, acts to trip switch **68** into position C. Opening of contact D on switch **68** deenergizes solenoid **74** and releases solenoid valve **46**, and also deenergizes motor **72** to stop pump **34**. Pilot lamp **78** simultaneously is lit to indicate that the antenna is in its operating position. The apparatus is then in the position illustrated in Figure 2. The operating cycle is thus complete, and the hydraulic fluid level in reservoir **30** is at a minimum

level but remains well above the level of the check valve 38.

In normal operation, the mast will attain full height well in advance of the tripping of switch 68 to position C. For example, the mast may be fully extended at about 15 gauge pounds while the bellows pressure switch assembly may be set to trip at 40 gauge pounds. This ensures positive electrical contact throughout the length of the antenna mast, as set forth more fully hereinafter, thus giving negligible mast resistance.

Should the antenna remain in its extended position for long periods, and the pressure at tubes 44 and 48 fall, due to major temperature drops or to slight fluid leakage caused by wear, switch 68 will reclose to position D under the actuation of bellows 56, thereby extinguishing lamp 78 and reenergizing the solenoid coil 74 and the motor 72 to rebuild the pressure to the required level. When this has been accomplished, the system is again deenergized automatically, and pilot lamp 78 is relit. It should be noted that if, through operator error, the antenna is raised while under some obstruction too low for clearance, the top of the antenna, upon striking the obstruction, will cause the system pressure to rise. When the pressure reaches the predetermined level, the power to the motor and solenoid valve will be cut off in the manner described above. Should the obstruction be removed, the antenna will resume its upward travel.

To retract the antenna from its operating position, the master switch 70 is moved into the "down" position, from the position illustrated in Figure 2 to that of Figure 1. Pilot lamp 78 goes out and a circuit is completed to energize solenoid 74 and open valve 46, and to excite motor 72 to drive the hydraulic pump 34 in the opposite direction so as to return the hydraulic fluid to the reservoir 30. The solenoid valve preferably opens in opposition to the pressure in the hydraulic feed line to the antenna, thus ensuring positive seating and preventing bleeding. Check valve 38 quickly closes its port 40, leaving the only escape for the fluid the metered bypass port 42. This causes a positive pressure build-up in pipes 36 and 64 to approximately 35 gauge pounds, for example, in the order of two seconds. Bellows 62 expands, actuating switch 66 to open contact B and close on position A. The energization circuit for the motor and solenoid valve remains completed, however, through conductor 90 instead of conductor 102. The pressure in pipes 44 and 28 and in the antenna mast begins to fall rapidly from its normal level (40 pounds gauge) because of the pumping action of the hydraulic pump 34. About 5 seconds after the master switch is tripped to the "down" position, the pressure at pipe 48 has dropped to approximately 25 gauge pounds, whereupon the bellows switch actuator 56 trips switch 68 into position D. The circuit through the solenoid valve and motor continues to remain completed through conductor 90, because switch 66 was tripped to position A about 3 seconds previously. The drop in pressure at pipe 48 and in the antenna mast continues downwardly through zero to a nominal negative value, such as 8 pounds gauge, under normal operating conditions. The telescoping sections of the mast are thus sucked downwardly with a force which adds to the weight of the mast.

Check valve disc 52 in the accumulator chamber, being a free floating buoyant disc of sufficient diameter to seal off the opening where pipe 48 enters the accumulator chamber regardless of the disc position on the bottom of the chamber, closes the accumulator chamber when it is empty of fluid so that no air will escape from the accumulator chamber into the system, and no vacuum will be induced in the accumulator chamber by the negative pressure in pipe 48. Check valve 60 may be employed to allow air to enter the accumulator chamber near the end of the retraction cycle to compensate for absorption of air in the fluid. The valve disc 52 does not cover the opening for pipe 58 and check valve 60.

When the antenna has completed its lowering cycle, no further fluid can flow, since the accumulator chamber has long since been emptied of fluid and sealed off; the positive pressure on pipe 64 drops rapidly from approximately 35 gauge pounds to zero gauge, tripping switch 66 into position B to light pilot lamp 76, deenergize solenoid 74 and close valve 46, and stop the motor and pump assembly. This completes the lowering cycle. It will be noted that if a pilot lamp 76 or 78 should burn out, the system will fail safe, since the high impedance of the lamp circuit will be maintained.

The bellows units 56 and 62 may be fixed-differential adjustable range units. The diameter and length of tube 64 betweent pump 34 and bellows 62 are properly proportioned to create a slight time delay action on the bellows. This prevents minor pressure surges in pipe 36, which may occur during the retracting cycle, from prematurely tripping switch 66. Bellows 56 is connected directly to the accumulator chamber 50, and the chamber thus acts as a snubber to prevent premature operation of switch 68 during the upward cycling of the antenna mast.

Figure 3 illustrates a preferred construction of the antenna mast construction. The mast sections may be formed of a conductive corrosion-resistant metal, such as Monel, arranged so that the upper sections telescope completely into the base section 16. Bronze rings 104 and 106, which may be soldered to antenna sections 12 and 14, respectively, serve as guides and as retainers for O ring seals 108, 110. Bronze rings 112, 114 soldered, respectively, to sections 14 and 12, and bronze rings 116, 118 soldered, respectively, to sections 16 and 14 serve as stops to limit the travel of the mast sections and as contact rings to provide an electrical connection between individual sections when the mast is extended. When the antenna is fully extended, the expanding force in the telescoping sections caused by the pressure of the hydraulic fluid is sufficient to creat a contact pressure between the contact rings of about 100 to 150 pounds per square inch. Fluid leakage between the adjacent sections is prevented by the O rings 108 and 110.

A cross pin 120 mounted in the extreme lower end of section 14 serves as a stop to prevent the upper section from telescoping beyond limits during the retracting cycle. The use of a compression spring 122 between rings 112 and 114 overcomes any roughness in operation which might be brought about by a tendency of the O rings to stick to the adjacent metal tubing when the antenna has been extended for a protracted period. Spring 122 ensures that section 12 will telescope into section 14 initially for each retracting cycle.

A hydraulic bleeder valve 124, which may be located at the bottom of the uppermost antenna section 12, is utilized to vent entrapped air automatically. This valve may include a short section of metal tubing 126 located in the lower end portion of section 12 and which may be soldered at its lower end to section 12 as indicated at 128 and which serves as the support for a valve seat member 130 threaded in the upper end thereof. Member 130 has a central bore 132 through which a thin valve stem 134 passes with substantial free play. Stem 134 carries a valve disc 136 at its lower end and one or more buoyant valve discs 138 at its upper end. During the extension of the mast, any air entrapped ahead of the hydraulic fluid passes through bore 132 in the space around the valve stem 134 and lifts the discs 138 off of the upper surface of valve seat member 130 sufficiently to allow the air to escape through the tube 12 and out of the vent 24 in the ball 20, as shown in Figure 4. The hydraulic fluid which follows buoys the upper discs 138, causing the lower disc 136 to close the valve by seating against the lower surface of member 130. Further flow of fluid through the valve is thus prevented. During the

retracting cycle of the antenna, the fluid which buoys the upper discs 138 is partially drawn down through the hole surrounding the valve stem 134, thus lowering the fluid level and causing the upper discs 138 to close off against the upper surface of member 130. Thus the entrance of air into the system is prevented. The weight and buoyancy of the valve members must, of course, be adjusted to eliminate "pumping action" with repeated cyclings and the consequent accumulation of hydraulic fluid in the section 12 of the mast above the bleeder valve.

Figure 5 illustrates an alternative scheme for energizing the coil 74 of the solenoid valve 46 and for tripping the master switch 70. In this embodiment the solenoid valve coil 74 is connected to conductors 88 and 96 so that the coil will be shorted and thus not energized when the antenna is being cycled into its extended position, and the valve 46 will operate simply as a check valve, allowing fluid to flow to the mast but preventing back-flow. This method of connecting coil 74 of valve 46 offers the advantage of less system pressure drop in the antenna mast at the end of the mast extending cycle, because any "time lag" in the closing of the solenoid valve is eliminated. During the antenna retracting cycle, valve 46 operates as a conventional solenoid valve as described for Figures 1 and 2.

The addition of a relay coil 140 to control the operation of switch 70 allows remote control of the apparatus, and the relay coil may be energized either as a voltage or a current coil by a radiotelephone power supply, for example. The relay is preferably connected so that the coil is energized to place the antenna into extended position and deenergized to cause the antenna to retract.

Figure 6 illustrates another embodiment of the control circuit, in which master switch 70 is used in conjunction with a coil 142 to form an impulse relay so that each consecutive impulse or energization reverses the position of the switch. Actuation of the relay coil 142 may be controlled by a normally open push button switch 144, which may be remotely located. In the form shown, coil 142 is connected in series with switch 144 between conductor 88 and conductor 92. Momentary closing of switch 144 will effect operation of the apparatus through one half-cycle, and further closing of the switch has no effect until completion of the half-cycle operation and switches 66 and 68 are in proper operating sequence for recycling.

Figure 7 illustrates a modification of the control circuit in which a thermal relay 146 is employed. The relay includes a heater 148 connected to conductors 98 and 88 so that the heater is energized only during the time that the antenna is being cycled into its operating position. The normally open contacts of the switch 150 of the relay 146 are connected across the indicator lamp 76 and are closed during the aforementioned portion of the cycle to complete a circuit around the blade and contact A of switch 66. Thus, in the event that control switch 70 is suddenly tripped into the "down" position while the antenna is still advancing into its extended position, reversal of operation will take place immediately through the closed contacts of switch 150. After the pressure-sensitive switch 66 trips into position A to resume normal switching sequence, the heater 148 cools off to open switch 150.

While certain embodiments of the invention have been illustrated and described, it will be apparent to those skilled in the art that many modifications and changes may be made in such embodiments without departing from the principles and spirit of the invention, the scope of which is set forth in the appended claims. Accordingly, the embodiments shown and described are to be taken as illustrative rather than restrictive, and those modifications which lie within the meaning and range of equivalency of the appended claims are intended to form a part of the invention.

What I claim as my invention is:

1. In a system of the type described, a load device having an element movable between two positions under the control of hydraulic fluid, a reservoir for said fluid, a pump connected to pump fluid from said reservoir to said load device and being reversible to pump fluid in the opposite direction, means restricting the fluid output of said pump on reverse operation, and means responsive to the output pressure of said pump on reverse operation when all the fluid has been pumped in said opposite direction for stopping the operation of said pump when said output pressure drops below a predetermined value.

2. In a system of the type described, a load device having an element movable between two positions under the control of hydraulic fluid, a reservoir for said fluid, a pump connected to pump fluid from said reservoir to said load device and being reversible to pump fluid in the opposite direction, a check-valve connected between said pump and said load device and normally preventing flow of fluid from said device to said pump, means for reversing the operation of said pump and simultaneously opening said check-valve, means restricting the fluid output of said pump on reverse operation, and means responsive to the output pressure of said pump on reverse operation when all the fluid has been pumped in said opposite direction for stopping the operation of said pump when said output pressure drops below a predetermined value.

3. In a system of the type described, a load device having an element movable between two positions under the control of hydraulic fluid, a reservoir for said fluid, a fluid passage between the reservoir and said load device, a reversible pump for feeding said fluid through the passage between said reservoir and said device, an electrically actuable valve in said passage, an electric motor for driving said pump, a source of electric power for said motor and said valve, switch means operable to two different positions for completing a circuit between said motor and said source to drive said pump in opposite directions and for actuating said valve to open when said pump is driven in at least one direction, check-valve means in said passage for admitting fluid from said reservoir to said pump and preventing the return of said fluid to said reservoir, and constricted by-pass means in said passage for passing said fluid from said pump to said reservoir, second switch means in the circuit, and means responsive to the pressure built up by the by-pass means for operating said second switch means to maintain energization of the motor until all the fluid has returned to the reservoir.

4. A system according to claim 3 wherein said first mentioned switch means actuates said valve to open when said pump is driven in either direction.

5. A system according to claim 3 wherein said first mentioned switch means actuates said valve to open only when said pump is driven in one direction, said valve being operable as a check-valve when the pump is driven in the other direction.

6. Apparatus for causing hydraulic fluid to flow between a reservoir and a remote point, comprising a reversible pump, an electric motor for driving said pump in opposite directions, a pair of terminals adapted for connection to a source of power for said motor, master switch means for completing a circuit between said motor and said terminals to drive said motor in opposite directions, first switch actuator means responsive to the pressure of said fluid between said reservoir and said pump, second switch actuator means responsive to the pressure of said fluid between said pump and said remote point, a pair of switches operable, respectively, by said actuator means, a pair of high impedance indicators associated with said switches, respectively, and means interconnecting said switches and said indicators for inserting one of said indicators in series with said circuit when said

pump has built up a predetermined pressure between said pump and said remote point and for inserting the other of said indicators in series with said circuit when said pump has returned said fluid to said reservoir to deenergize the motor.

7. A system for extending and retracting an antenna of the type having telescoping sections forming a fluid motor, comprising a reservoir for hydraulic fluid, a reversible pump, a first pipe connecting one side of said pump to said reservoir, a second pipe connecting the other side of said pump to the lowermost section of said fluid motor, a solenoid valve in the second pipe, a metered by-pass check-valve near the reservoir end of said first pipe, a first pressure-sensitive switch actuator connected to said first pipe, a second pressure sensitive switch actuator connected to said second pipe, an electric motor for driving said pump, an electric circuit for energizing said electric motor and said solenoid valve, and a pair of switch means in said circuit responsive to said actuators, respectively, for controlling the energization of said electric motor, the actuator connected to the first pipe being responsive to substantially zero pressure in said pipe when the pump is driven in one direction to deenergize said electric motor and the actuator connected to the second pipe being responsive to high pressure above a predetermined value when the pump is driven in the opposite direction, to deenergize said electric motor.

8. The system of claim 7, wherein said second actuator is connected to said second pipe through a hydraulic accumulator chamber, and including check-valve means for admitting air to said chamber when it is substantially drained of hydraulic fluid, and bleeder-valve means in the furthermost extensible section of said fluid motor for venting air from said fluid motor to the atmosphere but preventing the escape of said hydraulic fluid.

9. In combination, an electric device having a pair of input terminals, a pair of power terminals, a first single pole double throw switch having a pair of spaced contacts and a common blade, master switch means for connecting said input terminals between a first power terminal and a first contact on said first switch, and alternatively but reversely between said first power terminal and the second contact on said first switch, a second single pole double throw switch having a pair of spaced contacts and a common blade, the first contacts of said single pole switches being interconnected and the blade of said first switch being connected to the second contact of the second switch, the blade of the second switch being connected to the second power terminal, a first high impedance indicator connected between the blade and second contact of said first switch, a second high impedance indicator connected between the blade and first contact of said second switch, and means controlled by said electric device upon energization thereof for operating said first and second switches to selectively engage and disengage the switch blades with their first and second contacts.

10. A system for extending and retracting an antenna of the type having telescoping sections forming a fluid motor, comprising a reservoir for hydraulic fluid, a reversible pump, a first pipe connecting one side of same pump to said reservoir, a second pipe connecting the other side of said pump to the lowermost section of said fluid motor, a solenoid valve in the second pipe, a metered by-pass check-valve near the reservoir end of said first pipe, a first pressure-sensitive switch actuator connected to said first pipe, a second pressure sensitive switch actuator connected to said second pipe, an electric motor for driving said pump, an electric circuit including a pair of power terminals for energizing said electric motor and said solenoid valve, a pair of single-pole double-throw switches in said circuit, each having a movable blade and two stationary contacts, the blade of a first switch connected to one power terminal, switching means for selectively connecting one stationary contact of the second switch to the other power terminal, a stationary contact of the second switch being connected to a stationary contact of the first switch, the other contact of the first switch being connected to the blade of the second switch, the blades of the first and second switches being respectively actuated by said first and second actuators.

References Cited in the file of this patent

UNITED STATES PATENTS

256,702	Johnson et al.	Apr. 18, 1882
1,517,874	Van Emon	Dec. 2, 1924
1,725,489	Stratton	Aug. 20, 1929
2,096,574	Denny	Oct. 19, 1937
2,134,859	Collins	Nov. 1, 1938
2,157,219	Salentine	May 9, 1939
2,330,739	Piron	Sept. 28, 1943
2,347,379	Teeter	Apr. 25, 1944
2,364,741	Merchant	Dec. 12, 1944
2,467,509	Trautman	Apr. 19, 1949
2,527,428	Kemerer	Oct. 24, 1950
2,592,180	Parsons	Apr. 8, 1952
2,683,967	Gosline	July 20, 1954
2,694,999	Sullivan	Nov. 23, 1954