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[54] **AERIAL LIFT MECHANISM**

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[52] **U.S. Cl.** **52/115,** 52/118, 52/121

[51] **Int. Cl.** **B66f 11/04**

[58] **Field of Search** 52/111, 113–121; 182/2, 141, 145, 211; 292/50, 229; 254/148; 212/55

[56] **References Cited**

UNITED STATES PATENTS

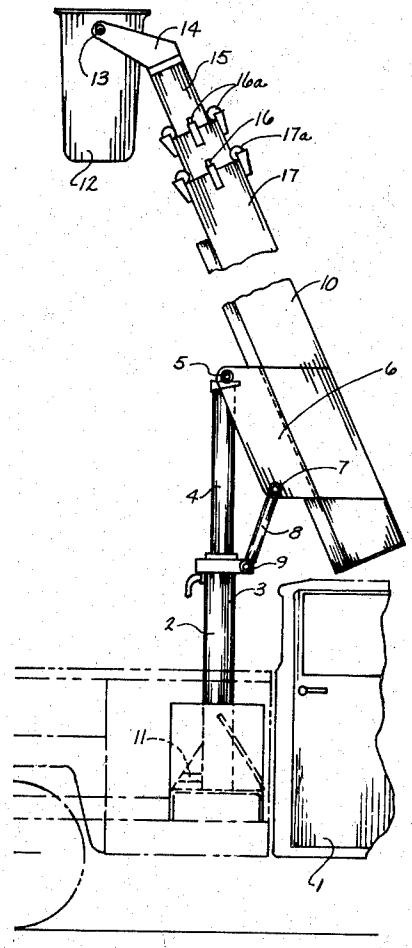
2,684,159	7/1954	Oldenkamp	212/55
2,920,725	1/1960	Emmons	52/118
3,093,248	6/1963	Winter	212/55
3,285,432	11/1966	Stauffer	212/55
3,301,346	1/1967	Verrell et al.	182/2
3,467,217	9/1969	Zwight	182/2
3,572,467	3/1971	Hall	182/2
3,605,358	9/1971	Bentey	212/55

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[57] **ABSTRACT**

The aerial lift mechanism disclosed includes a telescopic boom arrangement, involving a plurality of rectangular tubular sections having therewithin hydraulic piston and cylinder means connected to operate such sections inwardly and outwardly, one of such sections being extendable and retractable at substantially greater rate than another, means being provided for controlling the movement of such sections, in the elevation of the boom, such means including circuitry in which suitable elements are employed to operate the parts in chosen sequence and simultaneously with certain of the elements including instrumentalities common to the respective systems.

6 Claims, 7 Drawing Figures



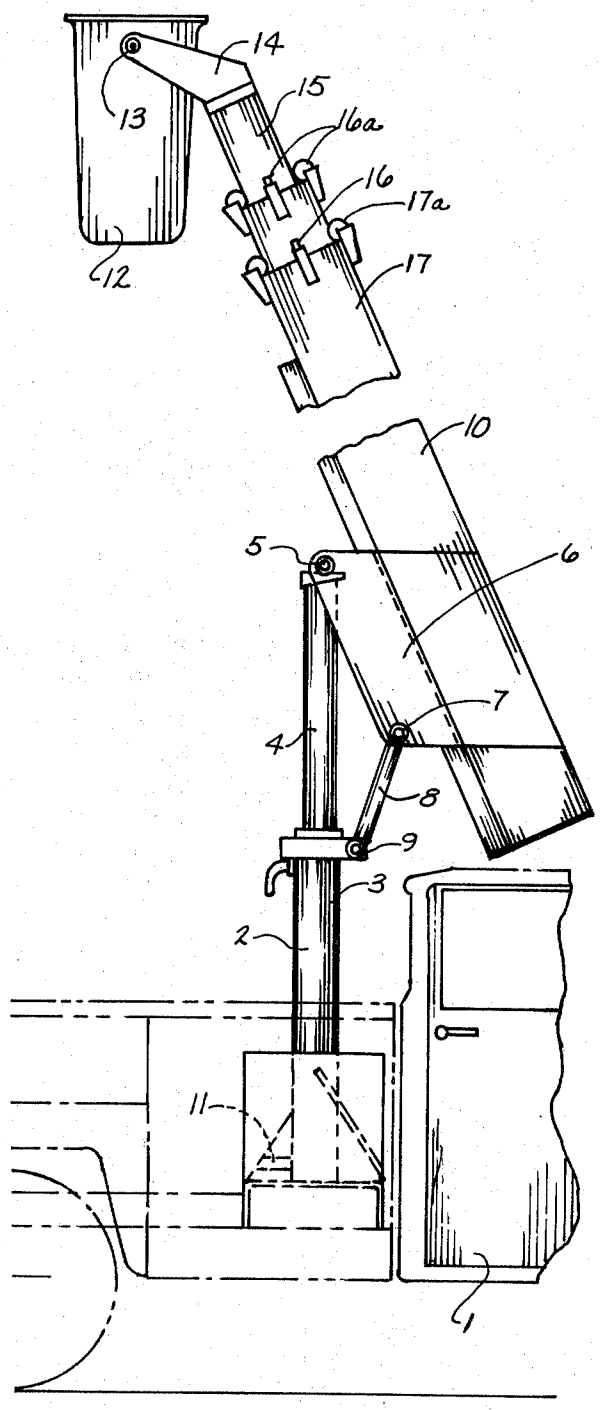


FIG. 1

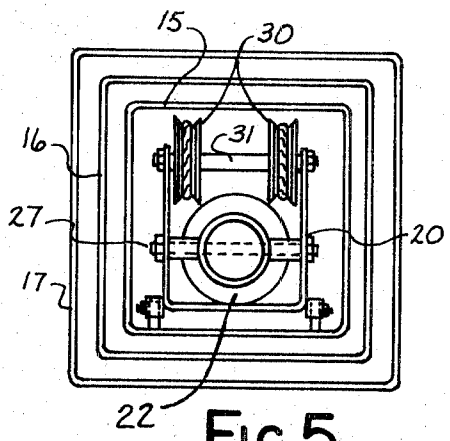


FIG. 5

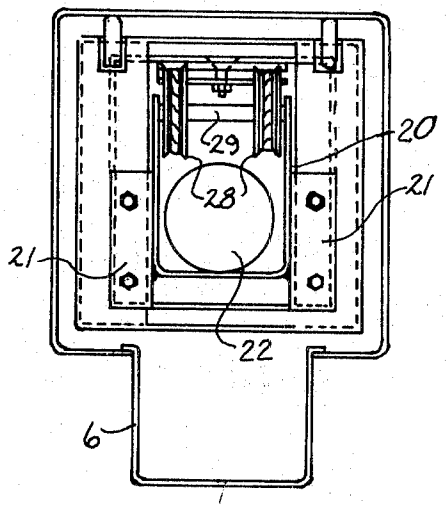


FIG. 4

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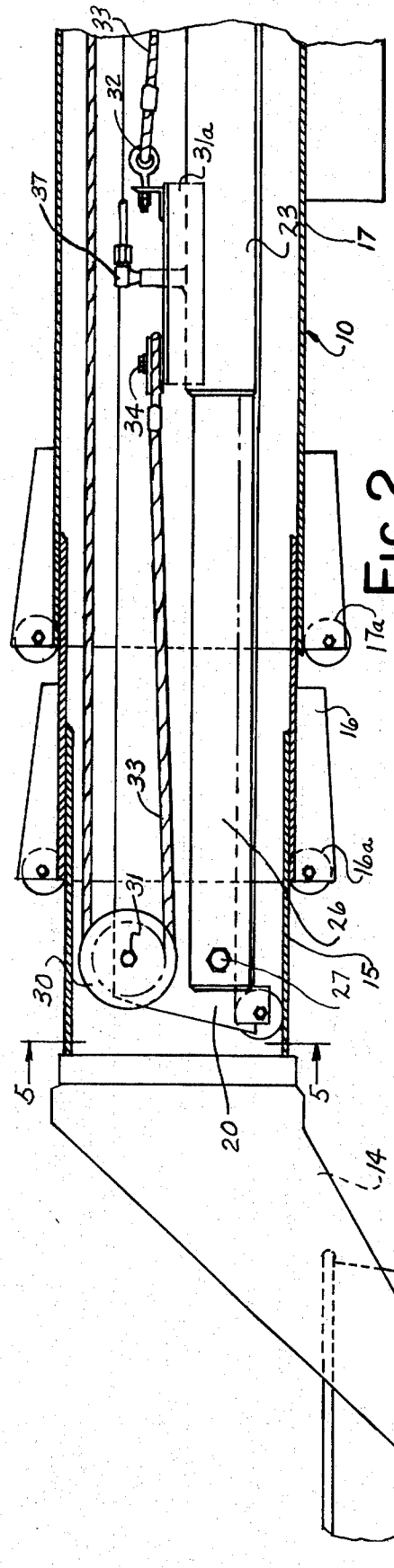


FIG. 2

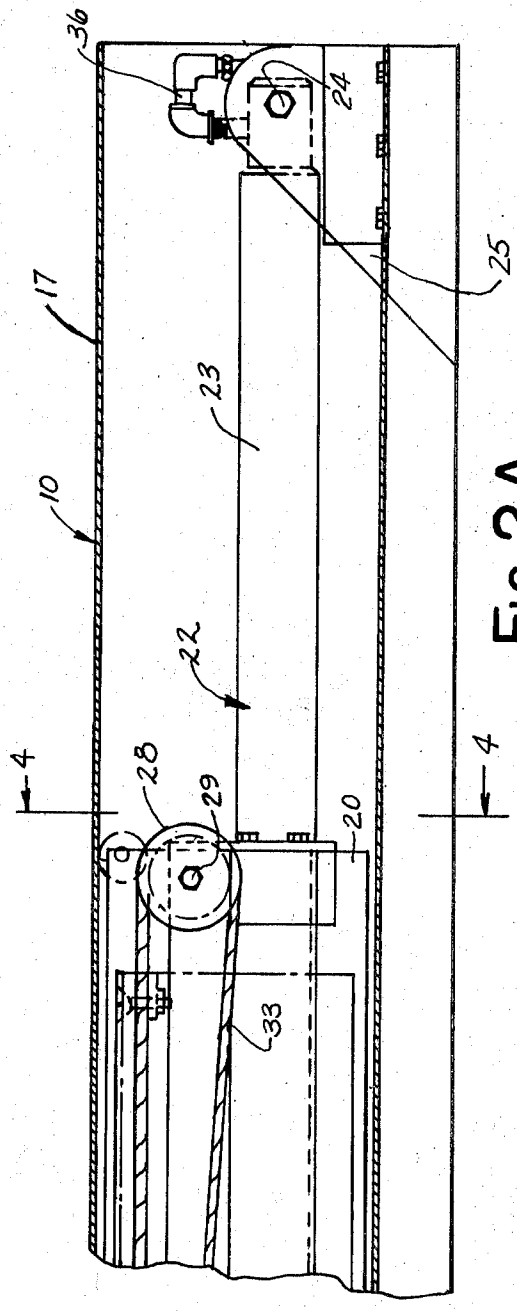


FIG. 2A

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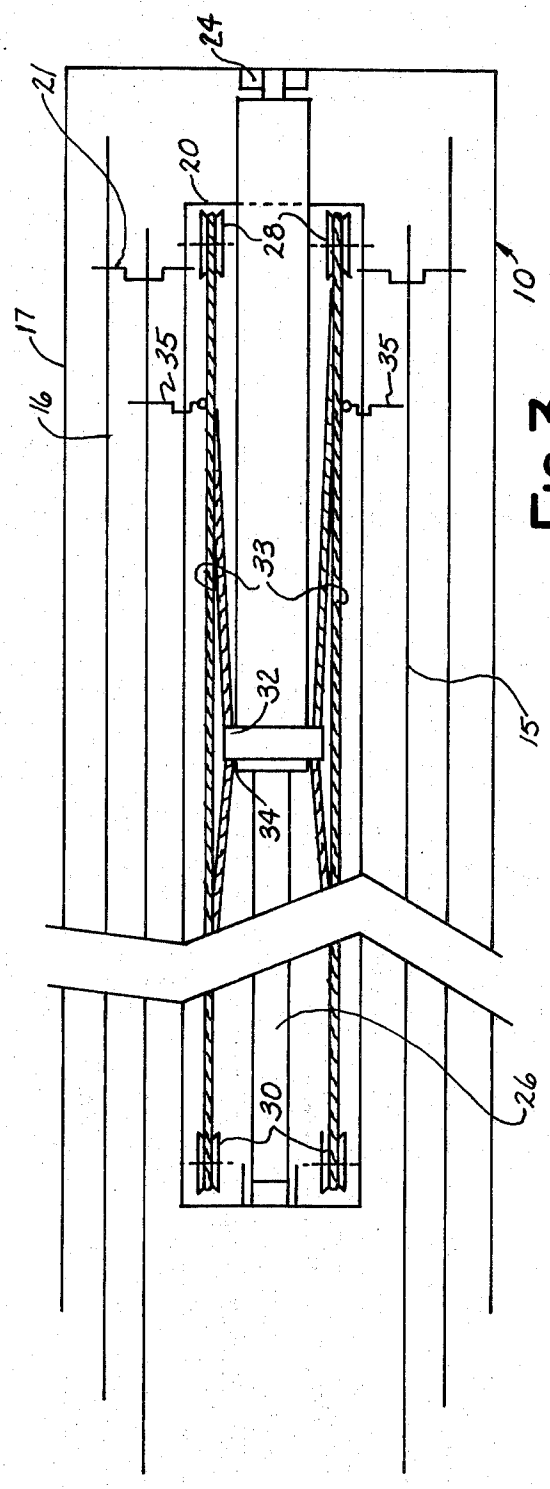


FIG. 3

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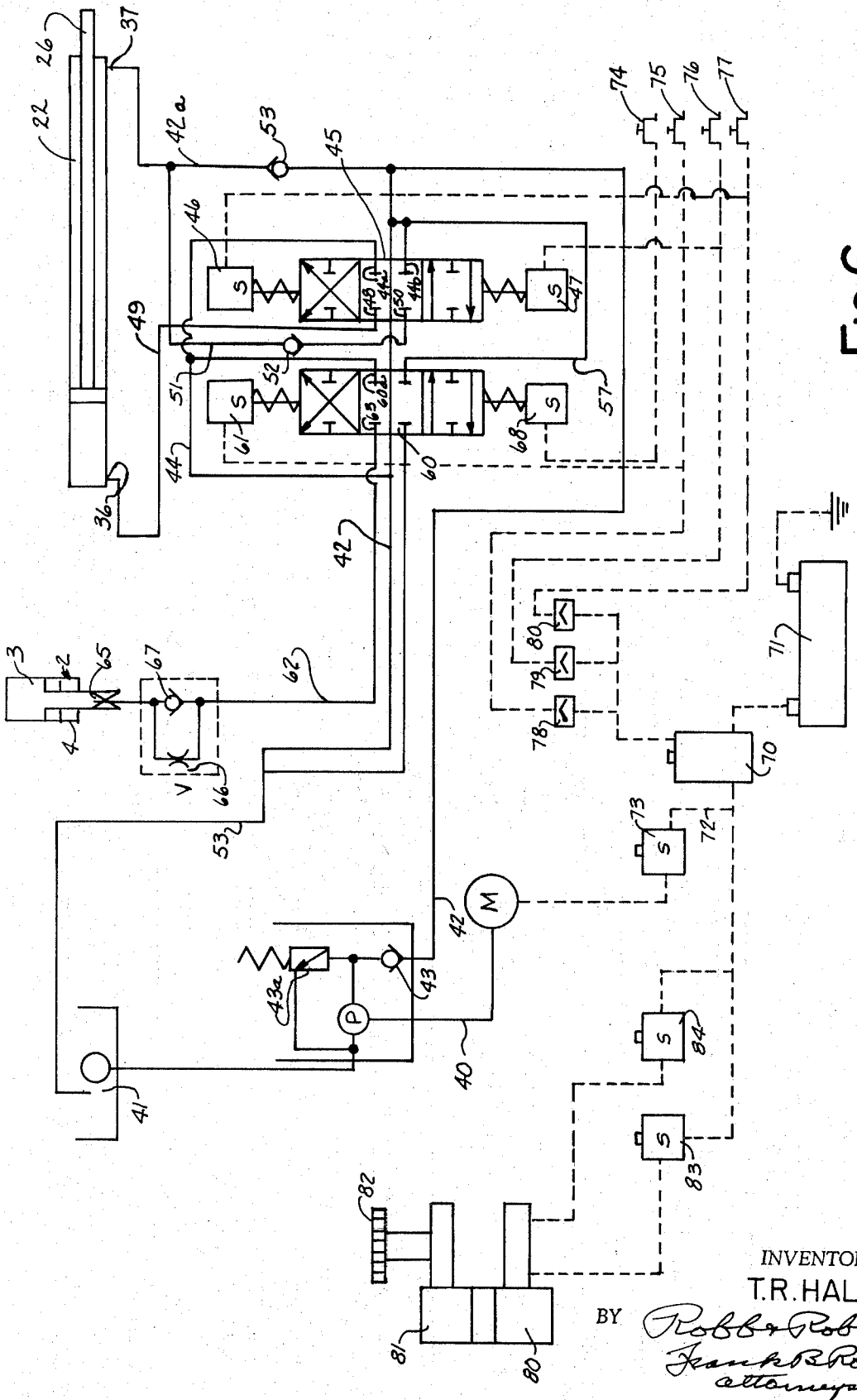


FIG. 6

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AERIAL LIFT MECHANISM

OBJECTS OF THE INVENTION

A principal object of this invention is to provide a simplified form of aerial lift mechanism, and particularly the boom and controlling means therefor in which a main vertical support and actuating unit is provided which may be suitably mounted upon a truck or the like to transport the mechanism, such unit comprising first hydraulic piston and cylinder means suitably connected to the boom assembly to raise and lower the same, the boom assembly including a main boom member in which is provided a middle boom unit telescopically mounted with respect thereto and an inner boom in turn telescopically mounted within the middle boom, with interconnections between the respective parts so that extension and retraction of the boom sections will take place at one speed with respect to one of the boom sections and at a greater speed with respect to the innermost boom section which is provided at its end with a personnel basket for example, in which an operator may stand and be projected and positioned in accordance with conventional practice in general.

Another object of the invention is to provide a boom assembly wherein a single hydraulic piston and cylinder arrangement is mounted to actuate directly one of the boom members and by suitable cable and pulley arrangement actuate another one of the boom members and denominated the inner boom by means of the reeling of the cable at a greater rate of inward and outward speed than is the case with the middle boom unit within which the same is mounted.

Another and further object of the invention is to provide a boom assembly which is rigid and easy to operate, compact in configuration with operating elements arranged with respect to one another to most efficiently cause the telescoping action to take place with respect to the parts, and control of the respective parts to be effected in circuitry of simple nature and by reason of certain elements included therein, avail of a common operating circuit which nevertheless permits selective manipulation of the respective parts either in sequence or simultaneously as the case may be.

Another object of the invention is to provide circuit means in an hydraulic piston and cylinder circuit arrangement which will effectively operate solenoids to in turn regulate the movement of valves to direct hydraulic fluid to the respective parts in sequence or simultaneously, with a minimum amount of duplication of electric wiring otherwise required without certain of the fundamental elements provided herein.

Other and further objects of the invention will be understood from a consideration of the specification appended hereto, and disclosed in the drawings wherein:

FIG. 1 is a fragmentary side view, partly in section, disclosing a typical lift mechanism hereof as to the principal parts incorporated therein.

FIG. 2A and FIG. 2 taken together, show in somewhat greater detail and partly in section, the general construction of the boom assembly as to the respective main boom member, middle boom unit and inner boom with their interconnection and hydraulic piston and cylinder located therewithin.

FIG. 3 is a diagrammatic view, generally in plan, illustrating the interconnection of the respective parts of the boom assembly, including the main boom member, middle boom unit and inner boom to indicate the manner of the operation of these respective members.

FIG. 4 is a vertical sectional view, taken about on the line 4—4 of FIG. 2A, looking in the direction of the arrows.

FIG. 5 is a view taken about on the line 5—5 of FIG. 2 looking in the direction of the arrows, and illustrating the cross section thereof.

FIG. 6 is a purely diagrammatic view showing the hydraulic and electric circuits involved, the hydraulic circuit portions being indicated in solid line, with the electric circuit primarily being illustrated in dash lines.

DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, the aerial lift mechanism of this invention is shown as being mounted on a truck generally designated 1, and comprising the main vertical support and actuating unit generally indicated at 2, incorporating as it does hydraulic piston and cylinder instrumentalities therein, the cylinder being designated 3 with the piston operating therein and piston rod being designated 4.

Suitably connected to the piston rod at a pivot point 5 at the outer end thereof is a saddle member generally designated 6, this member in turn being pivotally connected at 7 to a link 8 which is pivotally connected at 9 to the upper end of the cylinder 3.

The saddle 6 is suitably engaged with the boom assembly generally designated 10 and more specifically described hereinafter.

It should be understood that suitable actuation of the hydraulic piston and cylinder means 3 and 4 as by introduction of fluid through a suitable line 11 will cause the piston rod 4 to move outwardly and upwardly in turn effecting pivotal movement of the boom assembly 10 into a position such as suggested in FIG. 1, or other positions intermediate the same from a vertical position substantially.

This aspect of the invention is only generally disclosed, and it will be understood that by suitable rotating of the cylinder housing 3 by means to be subsequently referred to, rotation of the assembly may be effected in accordance with desired adjustment practices.

The boom assembly 10 is designed to support a personnel basket 12 at the outer end thereof, suitably connected at 13 to a yoke 14 which is integral with the inner boom 15, the inner boom 15 in turn being telescopically positioned within a middle boom unit 16 the latter in turn being telescopically positioned in the main boom member 17.

Suitable guide rollers and their mounting means such as 16a and 17a are preferably provided to position the respective boom parts 15 and 16 with respect to one another, and in turn with respect to the main boom member 17.

Referring now to FIGS. 2, 2A and 4 and 5, the main boom member 17 is generally rectangular in cross section as suggested and of course suitably engaged with the saddle 6 as previously generally suggested.

This main boom member is of substantial length, designed to receive within its outline the middle boom unit 16 which is basically a similar rectangular tubular member, which however is in turn provided with a channel unit 20 of generally U-shaped configuration in cross section as suggested in FIGS. 4 and 5 particularly.

This channel unit **20** is connected to the middle boom member **16** so as to move therewith, such connections being suggested at **21** in FIG. **4** and in the form of angle parts.

This channel unit **20** is designed to receive therewithin, when the boom assembly is in fully retracted position, the hydraulic piston and cylinder unit generally designated **22** and for this purpose called the second hydraulic piston and cylinder means, that including the cylinder **3** and piston **4** previously mentioned being designated as the first hydraulic piston and cylinder means.

The second hydraulic piston and cylinder means **22** includes a cylinder **23** suitably fixed pivotally at **24** to the main boom member **17** as suggested in FIG. 2A by the members **25.**

The outer end of the means and specifically of course the piston section thereof, including the piston rod, the piston section being designated **26,** is connected at **27** to the channel unit **20,** its connection **27** being illustrated likewise in FIG. **5,** so that movement of the piston **26** in the usual manner of hydraulic piston and cylinder units, mainly in an extending and retracting action, will effect corresponding movement of the channel unit **20** and of course the middle boom unit connected therewith and of which the channel unit **20** is a part.

The channel unit **20** includes spaced pairs of pulleys **28** at the inner end of the boom assembly, as shown in FIGS. **2A** and **4,** suitably mounted on the transversely extending axle **29** with a corresponding pair of pulleys designated **30** mounted on a transverse axle **31** at the outer end of the channel unit **20.** Hence the pulleys will move as a unit as the channel **20** moves responsive to the action of the piston rods **26** moving the channel **20** and in moving as a unit the distance between the axes of the pulleys **28** and the axes of the pulleys **30** remain the same.

Fixed to the outermost extremity of the cylinder **23** is a saddle **31***a* which is designed to connect at its inner end by means of adjustable eyes **32,** a pair of cables **33** reeved about the pulleys **28** and **30,** with the other end of the pair of cables **33** being connected at **34** to the saddle **31***a* previously mentioned.

It will therefore be seen that as both the pair of pulleys **28** and the outer pair of pulleys **30** are carried inwardly and outwardly during movement of the piston **26** of the piston and cylinder means **22,** movement of the cables will be correspondingly effected.

Referring now to FIG. **3,** it will be seen from the diagram thereof the main boom member is diagrammatically illustrated in the same manner at **17,** the middle boom unit **16** is similarly diagrammatically illustrated as being connected by the connection designated **21** to the channel unit **20.** Thus, by virtue of this connection, the middle boom member will be positively moved the same distance that the piston rod **26** moves, since the channel member **20** is mounted on the piston rod **26.**

The channel unit **20** carrying the pulleys **28** and **30** thereon, with a pair of cables **33** reeved thereover and dead ended as indicated, a pair of suitable connections from the cables **33** designated **35** extend to the inner boom **15.** This inner boom **15** being a rectangular tubular member like the main boom member **17** and middle boom **16** will be caused to move at a corresponding rate to that of the movement of the cables during extending action of the piston **26** because of this connection of the inner boom **15** to the cables.

By reason of the leverage provided in this arrangement, any point on the cable **33** will move at a rate twice that of the rate of movement of the pulleys, hence the inner boom **15** by virtue of its connection to the cables **33** will move at substantially twice the rate of movement of the middle boom unit, which is connected to the channel carrying the pulleys, both in extending and retracting action.

In order to effect the movement of the piston and cylinder means **22** suitable hydraulic connections such as **36** and **37** are provided in accordance with conventional practice, leading to a source of hydraulic pressure to effect the in and out action suggested by the construction.

To summarize the movement, the outer boom **17** mounts the piston **24,** and is relatively non-movable axially. A channel member **20** is provided which directly connects the piston rod **26** and middle boom **16** and will thus move the middle boom telescopically with respect to the outer boom a distance and rate equal to the distance and rate of movement of the piston rod **26.** The channel **20** also mounts a pair of spaced pulley means which move therewith. The pulley means have reeved thereover cable means, dead ended at both ends on the piston **24** and connected to the inner boom **15.** Because of the pulley and cable arrangement any point on the cable moves twice the distance and twice the rate of that of the pulleys and hence the inner boom, being connected to the cable, will move at twice the rate and distance of that of the middle boom **16** since the middle boom is connected to the channel **20** and the pulleys. Also, because of this positive connection the movement is positively performed in both the extension and retraction direction.

In order to explain another aspect of the invention which is unique, reference is made to FIG. **6,** the diagrammatic disclosure of the hydraulic and electric circuits, with corresponding numbers being used as is the case in the previously referred to figures where possible. In this instance, the source of hydraulic power is a pump and motor unit generally designated **40** which is supplied from a tank **41,** and in turn directs the pressure fluid through a main line **42** incorporating a check valve **43** therein, a relief valve **43***a* being provided in this circuit around the pump of the pump and motor unit **40.**

The main line **42** leads to a branch **44** connecting the same to inlet port **44***a* of a four-way valve **45,** the valve **45** including a solenoid **46** and a solenoid **47** for actuating such valve to direct fluid to the respective outlet ports thereof.

The valve **45** includes an outlet port **48** connected to a line **49** which in turn leads to the inner end of the piston and cylinder means **22,** by the connection **36** previously described.

The valve **45** also includes an inlet port **44***b* and an outlet port **50** which is connected in turn to a line **51** having a check valve **52** therein, the line **51** extending to the outer end of the piston and cylinder means **22** at the connection **32** previously described.

When the solenoid **46** is actuated, the valve **45** is in turn operated to direct fluid to the outlet port **48** thereof, and thus to the inner end of the piston and cylinder means **22,** causing the piston rod **26** thereof to move outwardly and carry the pulleys **30** and cable

reeved thereover outwardly for actuation of the inner boom 15 to which the same is connected. During this extension movement, fluid standing in the piston and cylinder means 22 is directed through the connection 37 and through a line 42*a* and check valve 53 into the system.

In order to retract the boom members, the solenoid 47 is actuated and in turn operates the valve 45 so as to direct fluid from line 42 to inlet port 44*b* and thence to outlet port 50. Pressure fluid passes through line 51 and check valve 52 therein to connection 37, causing piston rod 26 to be retracted. In this case, fluid forced out of connection 36 passes back into system through line 49 and ports 48 and 44*a*.

Another four-way valve 60 is provided to regulate the operation raising and lowering of the boom assembly 10, having reference to the piston and cylinder means designated 2, incorporating the cylinder 3 therein and piston 4 connected as is illustrated in FIG. 1.

In this instance, the actuation of the four-way valve 60 by the solenoid 61 for example, will direct fluid to the single acting lift cylinder by pressurizing the line 62 from the outlet port 63 in the valve. The pump and motor unit 40 will supply pressure fluid through line 44 to inlet port 60*a* and thence to port 63.

A fixed orifice 65 is provided in the piston and cylinder means 2 to control the downward movement of the boom assembly depending upon the weight thereof to effect the same. This rate can be controlled by a suitable adjustable valve at 66 to bypass the check valve 67 if required to increase or reduce such rate.

By actuating the solenoid 68, valve 60 is operated to permit fluid to return through orifice 65 and into system without corresponding operation of the pump and motor unit 40 as was the case when raising was effected.

Since the operation of the various hydraulic instrumentalities depends in turn upon the operation of the pump and motor unit 40, control of this unit is essential and effected in the following manner by initially actuating the master solenoid 70 to direct power from a battery 71 to a line 72 connected to a control solenoid 73.

Operation of the solenoid 73 will effect operation of the pump and motor unit 40, and thus pressurize the various hydraulic lines for control by the valves 45 and 60 as the case may be.

In this instance, energization of the solenoids previously described and of the solenoid 73 is effected by a series of contact members 74 and 75 to lower and raise respectively the boom in a manner to be set forth, and 76 and 77 to retract and extend the respective parts of the boom.

In order to raise the boom, the contact 75 is actuated which in turn will act upon the solenoid 73 to operate the same and thus initiate actuation of the pump and motor unit 40 which of course in turn pressurizes the lines leading therefrom. In this instance, the solenoid 61 is actuated and this in turn operates the valve 60.

When the valve 60 is operated, fluid is directed to the port 63 thereof, and to the line 62, passing to the piston and cylinder unit 2 and operation thereof is thus effected.

As long as the contact 75 is maintained, fluid is directed to the piston and cylinder means 2, and raising operation takes place until a bypass point is reached in accordance with generally accepted practice.

Thereafter, operation of the solenoid 68 by the contact 74 may take place to move the valve 60 in such a manner as to permit the return flow of fluid through the line 62 and through the valve and thence back through port 63 and into the system. Since the pump and motor unit is not in operation during this return flow, it is not necessary to include other piping for the returning fluid.

Assuming after the boom assembly is raised into the position of FIG. 1 for example, that it is desired to extend the inner boom 15 and middle boom unit 16, the extend contact 77 is completed and the solenoid 46 actuated thereby, in turn operating the valve 45 to direct fluid through the port 48.

Since the same signal is directed to the solenoid 73, the pump and motor unit 40 is started into operation simultaneously and causes the fluid to pass through the valve 45 to the line 49 to the piston and cylinder means 22 at the connection 36 at the inner end.

In turn, when it is desired to retract the boom, the retract button or contact 76 is completed, actuating valve 45, and fluid is directed through port 50 and line 51 to the connection 37 since the pump and motor unit 40 is simultaneously actuated.

As will be understood, if it were not for some other features of the invention, it would be possible that the signals would all operate at once to direct the valves 45 and 60 to simultaneously operate, and thus cause some problems as well as to raise and lower the boom when it was not desired so to do.

In this instance, by the provision of suitable diodes designated 78, 79 and 80 in the circuit, all being substantially identical, such diodes act to prevent the signal given to operate more than one element or unit at a time.

In other words, conceivably if the raising contact 75 was completed without the diodes in the circuit, that signal could in turn pass through the solenoid 73 as well as the valve 60 when it was not really desired so to do. However, since the diode 78 is present, no signal can be directed to the solenoid 61 without specific action as by operating the contact 75.

The same thing applies with respect to the other diodes 79 and 80, these preventing any cross signals to be delivered to the respective solenoids and thus in effect possibly cancelling one signal or duplicating signals when it is not desired

Rotation of the boom assembly may be effected when desired, rotating means in the form of an electric pump and motor unit 80 being provided. This unit 80 drives an hydraulic motor 81 which in turn operates a spur gear 82 suitably connected to the upright boom assembly mechanism 2.

Solenoids such as 83 and 84 are provided to energize the unit 80, current being supplied from the battery 71 for this purpose.

I claim:

1. In an aerial lift mechanism of the class described, in combination, a main vertical support and actuating unit comprising first hydraulic piston and cylinder means, a boom assembly connected to the unit for raising and lowering movement thereby, said assembly including an outer boom member, a middle boom member telescopically mounted with respect to the outer boom member, an inner boom member mounted for telescopic movement with respect to said outer and middle boom member, a second hydraulic piston and

cylinder means mounted on said outer boom member and together therewith constituting an outer boom unit, said second hydraulic piston having a rod means, means directly interconnecting the middle boom member to said rod of said second piston for moving said middle boom member a distance equal to the distance of movement of the piston rod in both the extension direction and the retraction direction thereof and constituting with said middle boom member a middle boom unit, and cable and pulley means interconnecting said outer boom unit and said middle boom unit and said inner boom member to positively drive said inner boom member at a rate twice the rate of movement of the middle boom member responsive to either extension or retraction movement of said piston, said pulley means including a pair of spaced pulleys mounted on said middle boom unit, and said cable means being reeved around said pulley means and both ends deadended on the outer boom unit with an intermediate portion thereof between the pulleys connected to the inner boom member, whereby the inner boom is extended and retracted at substantially twice the rate of that of the middle boom unit with respect to the outer boom unit, and control means for such movement.

2. The combination as claimed in claim **1,** wherein the middle boom unit includes a channel assembly having a channel part therein, the hydraulic piston and cylinder means operate within the outline thereof.

3. The combination as claimed in claim **1,** wherein the main boom member is a first rectangular tube connected to the support and actuating unit for pivotal raising and lowering movement thereby, the middle boom unit includes a second similar tube guidingly mounted within the first tube, the inner boom is a third tube similar to the second tube, and operably guided for reciprocation with respect to the first and second tubes, the means interconnecting the main boom unit and inner boom unit comprise a channel assembly mounted within the middle boom unit, and operable within the outline of the inner boom, a single hydraulic piston and cylinder means actuates said middle boom unit and inner boom, and the control means regulates the movement of the support and actuating unit, middle boom unit, and inner boom.

4. The combination as claimed in claim **1,** wherein the control means comprises solenoid operated valves, a single pressure pump supplies fluid under pressure to the first and second hydraulic piston and cylinder means through said valves in accordance with the operation thereof, a solenoid operates said pressure pump, common instrumentalities actuate all of said solenoids, and include means to regulate such actuation in chosen sequence and simultaneously.

5. The combination as claimed in claim **4,** wherein the means to regulate actuation include separate contact parts, all said contact parts being arranged to operate the pressure pump solenoid through a common circuit, and diodes are positioned intermediate said parts and circuit to facilitate selective operation of said pump solenoid and thus the pump controlled thereby.

6. The combination as claimed in claim **4,** wherein certain of the valves comprise a pair of four-way valves, one valve regulating operation of the first hydraulic piston and cylinder means for the vertical support and actuating unit, to raise and lower the boom assembly, the other valve regulating operation of the second hydraulic piston and cylinder means, to extend and retract the boom assembly member, unit and inner boom, the respective valves being actuated by the solenoids thereof to effect such movements, the pressure pump being simultaneously operated to in turn provide fluid under pressure as required, and the elctric circuits are arranged to effect the operation stated, and include means to prevent interfering actuation of the solenoids.

* * * * *