The present invention relates to a hydraulic crane, and is particularly concerned with an improvement upon the invention disclosed and claimed in my co-pending application Serial No. 687,619 filed August 1, 1946 for Hydraulic Crane, now Patent 2,446,596 issued August 10, 1948. In the type of crane in which a telescopic boom is capable of being powerfully elongated, the outer end of the boom being tethered to a mast, where-by elongation of the boom results in elevation of the outer end of the boom, it will be obvious that the efficiency of the elevating mechanism will depend to some extent upon the difference in elevation between the outer end of the boom and the point on the mast to which it is tethered. The higher the latter point is located, the more efficient will be the operation of the crane as a whole. However, the mounting of a tall mast upon a truck or other automotive vehicle is impractical, because of the necessity for clearing road obstructions, doorways, and the like. Therefore, in order to attain the operating advantages of a tall mast, while providing for ample clearance, I have conceived the provision of a telescopic mast, together with means, automatically operable during elevation of the boom, for progressively increasing the effective height of the mast; and the primary object of the present invention is to provide such means.

In relatively light installations, constructed in accordance with the present invention, the sole power means for the crane may be that means which acts upon the telescopic boom elements to increase the effective length of the boom; and the mast will be elongated as the boom is elongated. In heavier installations, however, it may be desirable to provide power means operating upon the mast, instead of, or as well as, power means operating upon the boom element; and a further object of my invention is the provision of fluid pressure means, suitably controlled by valve means, for acting upon the telescopic boom and upon the telescopic mast, simultaneously to effect a desired operation of the crane as a whole.

Further objects of the invention will appear as the description proceeds.

To the accomplishment of the above and related objects, my invention may be embodied in the form illustrated in the accompanying drawings; attention being called to the fact, however, that the drawings are illustrative only, and that change may be made in the specific construction illustrated and described; so long as the scope of the appended claims is not violated.

Fig. 1 is a side elevation of a truck upon which my improved crane is erected;

Fig. 2 is a fragmental view, upon an enlarged scale, showing the boom in transverse section, substantially on the line 2—2 of Fig. 1, and showing the mast in rear elevation;

Fig. 3 is a horizontal section taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is a still further enlarged, longitudinal sectional view through a valve mechanism incorporated in the illustrated embodiment of the invention;

Fig. 5 is a horizontal section taken substantially on the line 5—5 of Fig. 4; and

Fig. 6 is a plan view, upon a reduced scale, of my crane and the vehicle upon which it is mounted.

Referring more particularly to the drawings, it will be seen that I have illustrated a truck 10 having a frame 11 upon which is mounted a rectangular bed 12 and a cab 13. The truck is provided with the usual prime mover, which, through a transmission 14, drives the power wheels of the vehicle; and said transmission includes a power take-off operatively connected to drive a pump 15.

Mounted upon the bed 12, and preferably at one corner thereof adjacent the cab 13, is a mast indicated generally by the reference numeral 16, and comprising an upstanding, hollow cylindrical element 17, having a bore 18, open at its upper end for the telescopic reception of a plunger 19. The elements 17 and 19 constitute a fluid motor, and the plunger 19 will preferably be provided, at its inner end, with a sealing cup 20 of known construction. Upon its upper end, the plunger 19 will preferably carry a platform 21, mounting a winch, indicated generally by the reference numeral 22, said winch being of any desired construction, and being either manually or power operated.

A ring or sleeve 23 is suitably mounted upon the element 17 for oscillatory movement about the axis of said element, but is held against axial movement relative thereto by suitable stop rings 24 and 28. Said sleeve carries a radially projecting bracket 25 upon which is pivotally mounted the inner end of a boom 26, indicated generally by the reference numeral 27.

The boom 27 comprises a cylinder member 28 and a piston member 29, the inner end of said member 28 being closed and the outer end thereof being open for the telescopic reception of the plunger piston 29; and preferably, the inner end of said piston will carry a sealing cup 30. The
inner closed end of the member 28 is received between the opposite furcations of the bracket 26 and is pivotally secured thereto by means of a pivot pin 31, so that the boom is oscillable, relative to the bracket 25, about a substantially horizontal axis.

Two tension members 32 are connected to the outer end of the boom piston member 29 at 33, and to the plunger 19, adjacent the upper end thereof at 34. Thus, the outer end of the boom piston member 29 is so tethered to a fixed distance between the points 33 and 34, at all times. The proportions of the parts are such that, when the boom 27 is in a horizontal position, its effective length is substantially equal to the distance from the mast 16 to the diagonally opposite corner of the truck bed 12. Consequently, goods supported upon the crane may be deposited relatively accurately at substantially any point on the bed 12.

A compression beam 35 is pivoted at 36 to a bracket fixed on the boom cylinder member 29, and at 37 to a bracket fixed to the plunger 19, near the upper end thereof. This connection is such as to maintain, at all times, a fixed distance between a point on the boom cylinder member and a point on the plunger. Preferably, a sheave 38 will be mounted on the outer end of the boom piston member 29, and a cable 39 wrapped upon the drum of the winch 52, passes over said sheave and carries, at its outer end, a cargo hook 49.

It will be apparent from the above description that the geometry of the connected elements is such that, when the boom piston member 29 is driven outwardly, the tension members 32 will swing upwardly, maintaining a fixed distance between the points 33 and 34, thereby causing the boom to swing upwardly about its pivotal mounting 31. Such movement of the boom will act, through the compression member 38, to lift the plunger 19, thereby progressively moving the pivot point 34 for the tension members 32, higher and higher to maintain an effective work angle between said tension members 32 and the boom 25.

It will be clear from the drawings that the mast elements may be so proportioned that the winch 52 may be protected above the cab 13 when the boom is in horizontal, inactive position, so that the crane will not present a problem in connection with road and doorway clearances; and yet the plunger may be projected well above the cab top, during operation, as the boom 27 is lifted.

While the parts may be pneumatically controlled, I prefer to control them hydraulically, and have so illustrated my invention. A liquid reservoir 41, suitably supported on the vehicle, is connected by piping 42 with the intake of the pump 15; and a pipe 43 leads from the exhaust port of said pump upwardly to penetrate the body of the vehicle. A flexible conduit 44 connects the upper end of the pipe 43 with a control valve indicated generally by the reference numeral 45. In the illustrated embodiment of my invention, the valve 45 comprises a casing 46 having a valve chamber 47, and an inlet port 48, to which the conduit 44 is connected; an exhaust port 49, which may preferably be diametrically opposite the port 48, but axially displaced therefrom; an outlet port 50, displaced 90 degrees from the ports 49 and 45 and axially offset, in the opposite direction, from the port 48; and an outlet port 51, diametrically opposite the port 50, and preferably aligned therewith. Reciprocably mounted in the chamber 47 is a valve body 52 formed with two axially spaced lands 53 and 54, and having a stem 55 axially projecting from the chamber. A spring 52 resiliently retains the valve body in its illustrated position, in which the lands 53 seals the ports 50 and 51 against fluid flow, and in which the ports 48 and 49 are open for direct flow therethrough. An actuating lever 56 is pivotally mounted at 51 outside the casing, and may be rocked to depress the valve 52 against the influence of the spring 52. Depression of the valve body moves the land 54 across the port 49 to reduce the effective area of said port, and ultimately to close the same. It will be readily perceived that the valve is so proportioned and designed that the ports 48 and 50 are progressively opened as the port 49 is progressively closed, and vice versa. Thus, a very delicate control of flow may be maintained, any desired proportion of the flow being directed through the ports 50 and 51, while the remaining portion thereof continues to bleed through the port 49.

Connected to the port 49 is a pipe 58 leading to a three-way fitting 59 from another branch of which leads a flexible conduit 60 connected to piping 61, projecting through the bed 12 and communicating with the storage reservoir 41. Thus, so long as the port 49 is open, and the pump 15 is being driven, fluid will be circulated from the reservoir through the pump, through the ports 48 and 49, through the fitting 59 and the conduits 50 and 51, back to the reservoir 41.

A flexible conduit 62 leads from the port 50 to an inlet port 63 formed in the lower portion of the upstanding element 17 and communicating with the bore thereof. A pipe 64 leads from the port 51, through a check valve 65, to the interior of the boom cylinder member 28, near the inner closed end thereof. Thus, as the valve 52 is depressed, fluid will be directed to the chamber within the element 17 and to the chamber within the element 28 to elevate the mast plunger 19 and to project the boom piston 28. The check valve 65 operates not only to prevent reverse flow of fluid from the interior of the member 28 toward the valve 45, but also to prevent the flow of fluid, at a pressure less than a predetermined minimum, to the cylinder member 28.

An exhaust port 66 provided in the base of the element 17, is connected by a flexible conduit 67 with a port 68 of a valve mechanism 69, similar in construction to the valve mechanism 45. Similarly, a pipe 71 provides communication between the interior of the boom cylinder member 28 and a port 70 of the valve mechanism 69, diametrically aligned with the port 68. The valve stem 72 of the mechanism 69 projects from the valve casing and may be depressed by oscillation of a lever 73 pivotally at 74 on said casing. With the valve in its normal position, the ports 68 and 70 are closed; but when said valve is depressed, communication between said ports and a third port 75 is established, said port 75 being connected, by a pipe 76, with the third branch of the fitting 59.

I claim as my invention:

1. A crane comprising a mast including a substantially vertically arranged hollow base and a plunger reciprocably received therein, a boom hingedly associated with said base and comprising a hollow member and a second member telescoped in said hollow member, means for maintaining a fixed distance between a point on said hollow member and a point on said plunger, means for maintaining a fixed distance...
between a point on said second member and a point on said plunger, and means for varying the distance between said point on said hollow mem-
ber and said point on said second member.

2. The crane of claim 1 in which said plunger and the hollow in said base are cylindrical, the axis of the hinged connection between said base and said boom is substantially horizontal, and said axis is connected to said base for peripheral movement thereabout.

3. A crane comprising a mast unit of variable length including a substantially vertically ar-
ranged hollow base and a plunger reciprocably received therein, a boom unit of variable length hingedly associated with said base and comprising a hollow member and a second member tele-
scopically received in said hollow member, means for maintaining a fixed distance between a point on said hollow member and a point on said plunger, means for maintaining a fixed distance between a point on said second member and a point on said plunger, and means for enforcing telescopic elongation of one of said units of var-
iable length.

4. A fluid operated crane comprising a mast including a substantially vertically arranged hollow member and a plunger reciprocably received therein, a boom hingedly associated with said hollow member and comprising a second hollow member and a second plunger tele-
scopically received in said second hollow member, the inner end of one of said plungers being provided with means establishing a sliding fluid seal with the walls of its associated hollow member, a source of fluid under pressure, means for controlling the flow of fluid from said source to the interior of said associated hollow member, means for controlling the flow of fluid from the interior of said associated hollow member, means for maintaining a fixed distance between a point on said second hollow member and a point on said first-named plunger, and means for maintaining a fixed distance between a point on said second plunger and a point on said first-named plunger.

5. A fluid operated crane comprising a mast including a substantially vertically arranged hollow base and a plunger reciprocably received therein, a boom hingedly associated with said base and comprising a hollow member and a second member telescopically received in said hollow member, the inner ends of said plunger and said second member being provided with means establishing fluid seals with the walls of said base and of said hollow member, respectively, a source of fluid under pressure, valve means for controlling the flow of fluid from said source to the interiors of said base and said hollow member, valve means for controlling the flow of fluid from the interiors of said base and said hollow member, means for maintaining a fixed distance between a point on said hollow member and a point on said plunger, and means for maintaining a fixed distance between a point on said second member and a point on said plunger.

6. A crane comprising a mast and a boom, said mast comprising an upstanding hollow cylindrical base and a cylindrical plunger reciprocably received in said base, a sleeve swivelly supported on said base, means retaining said sleeve against substantial axial movement relative to said base, a bracket fixed to said sleeve, said boom compris-
ing a hollow elongated member, means at one end of said member connecting said member to said bracket to swing with respect thereto about a substantially horizontal axis, and a second mem-
er having one end telescopically received in the open free end of said hollow member, means tethering the opposite end of said second mem-
er to a point on said plunger, means establishing a fixed distance between a point on said hollow member and a point on said plunger, and means for effecting telescopically elongating movement of said second member relative to said hollow member.

7. A hydraulic crane comprising a mast and a boom, said mast comprising a cylinder member and a piston member telescopically associated therewith, a sleeve swivelly supported on one of said mast members and held against axial move-
ment relative thereto, said boom comprising a cylinder member and a piston member tele-
scopically associated therewith, means pivotally connecting one of said boom members to said sleeve for movement relative thereto about a substantially horizontal axis, means tethering the remote end of the other of said boom members against movement away from a fixed point in the other of said mast members, means establishing a fixed distance between a point on said one boom member and a point on said other mast member, a source of fluid under pressure, and means for controlling fluid flow from said source into one of said cylinder members, and out from said one cylinder member.

8. A hydraulic crane comprising a mast and a boom, said mast comprising a cylinder member and a piston member telescopically associated therewith, a sleeve swivelly supported on one of said mast members and held against axial move-
ment relative thereto, said boom comprising a cylinder member and a piston member tele-
scopically associated therewith, means pivotally connecting one of said boom members to said sleeve for movement relative thereto about a substantially horizontal axis, means tethering the remote end of the other of said boom members against movement away from a fixed point in the other of said mast members, means establishing a fixed distance between a point on said one boom member and a point on said other mast member, a source of fluid under pressure, and means for controlling fluid flow from said source into said cylinder members and out from said cylinder members.

9. The device of claim 7 including a sheave carried at the remote end of said other boom member, a winch carried on the upper end of said other mast member, and a cable member on said winch and passing over said sheave.

10. For use with an automotive vehicle having a bed, a cab, a prime mover, and a power take-off, a fluid operated crane comprising an upstanding hollow cylindrical member mounted on said bed and projecting thereabove a distance not ex-
ceeding the height of said cab above said bed, a plunger reciprocably received in the open upper end of said hollow element, a sleeve swivelly mounted on said element for oscillation about the axis thereof, a boom comprising a cylinder member and a piston member telescopically received in said cylinder member, one end of one of said members being pivotally mounted on said sleeve for sliding movement relative thereto about a substantially horizontal axis, a tension member connect-
ing the other of said boom members to said plunger, a compression member connecting said one boom member to said plunger, and fluid pres-
sure means for controlling relative reciprocation of said boom members.
11. For use with an automotive vehicle having a rectangular bed, a cab, a prime mover, and a power take-off, a fluid operated crane comprising an upstanding hollow cylindrical element mounted near one corner of said bed adjacent said cab and projecting above said bed a distance not in excess of the height of said cab above said bed, a plunger reciprocably received in the open upper end of said hollow element, a sleeve swivelly mounted on said element for oscillation about the axis thereof, a boom comprising a cylinder member and a piston member telescopically received in said cylinder member, one end of one of said members being pivotally mounted on said sleeve for swinging movement relative thereto about a substantially horizontal axis, a tension member, having an effective length substantially equal to the horizontal distance from said upstanding element to the diagonally-opposite corner of said bed, connecting the other of said boom members to said plunger, a compression member connecting said one boom member to said plunger, and fluid pressure means for controlling relative reciprocation of said boom members.

12. The device of claim 10 in which said fluid pressure means comprises a pump, means connecting said power take-off to drive said pump, conduit means connecting said pump to supply fluid under pressure to said cylinder member, valve means controlling flow through said conduit means, and other valve means controlling fluid flow from said cylinder member.

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