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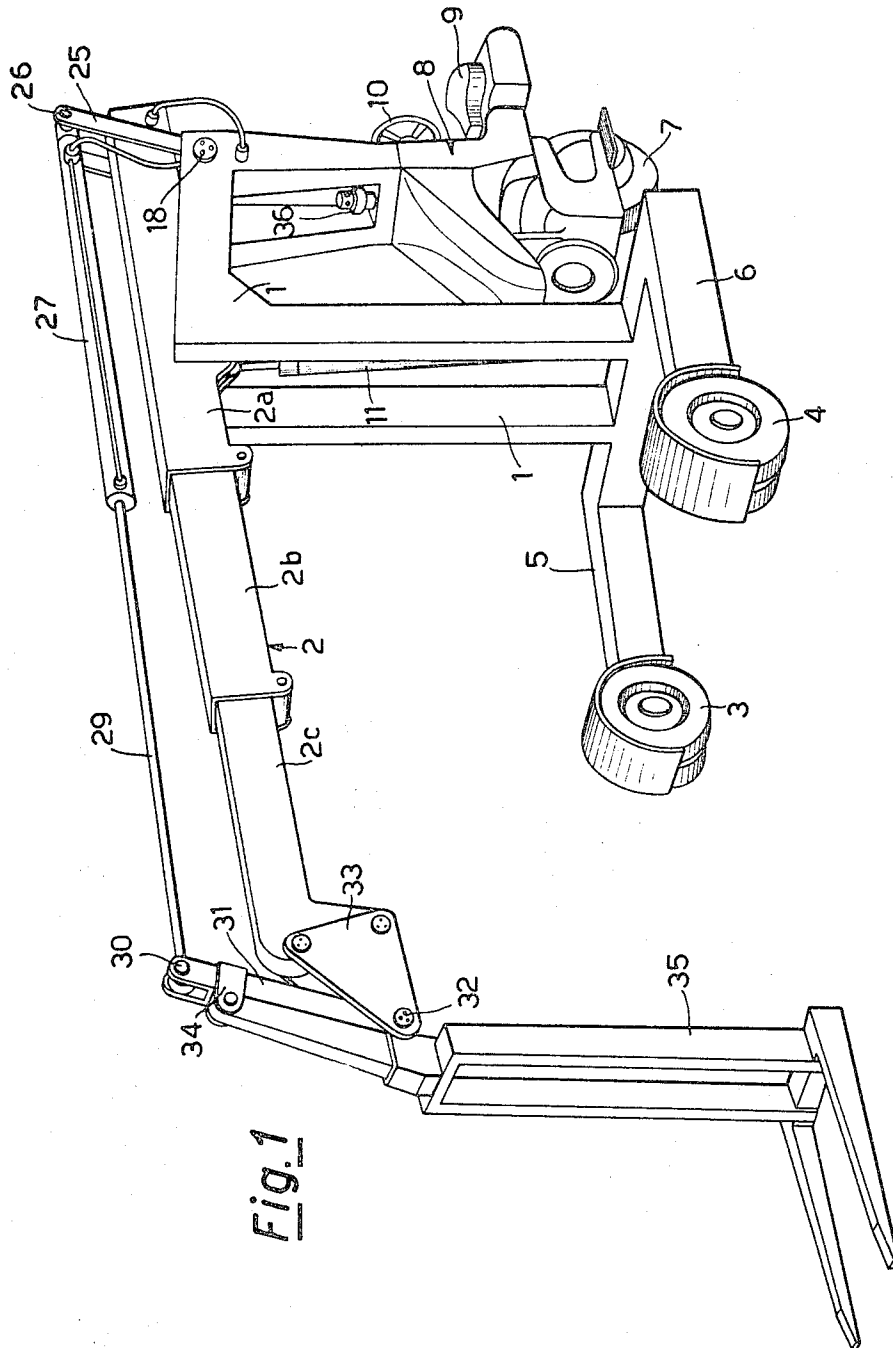
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3,407,947

MATERIAL-MOVING DEVICE FOR MOVING OBJECTS

Filed Dec. 19, 1966

4 Sheets-Sheet 1



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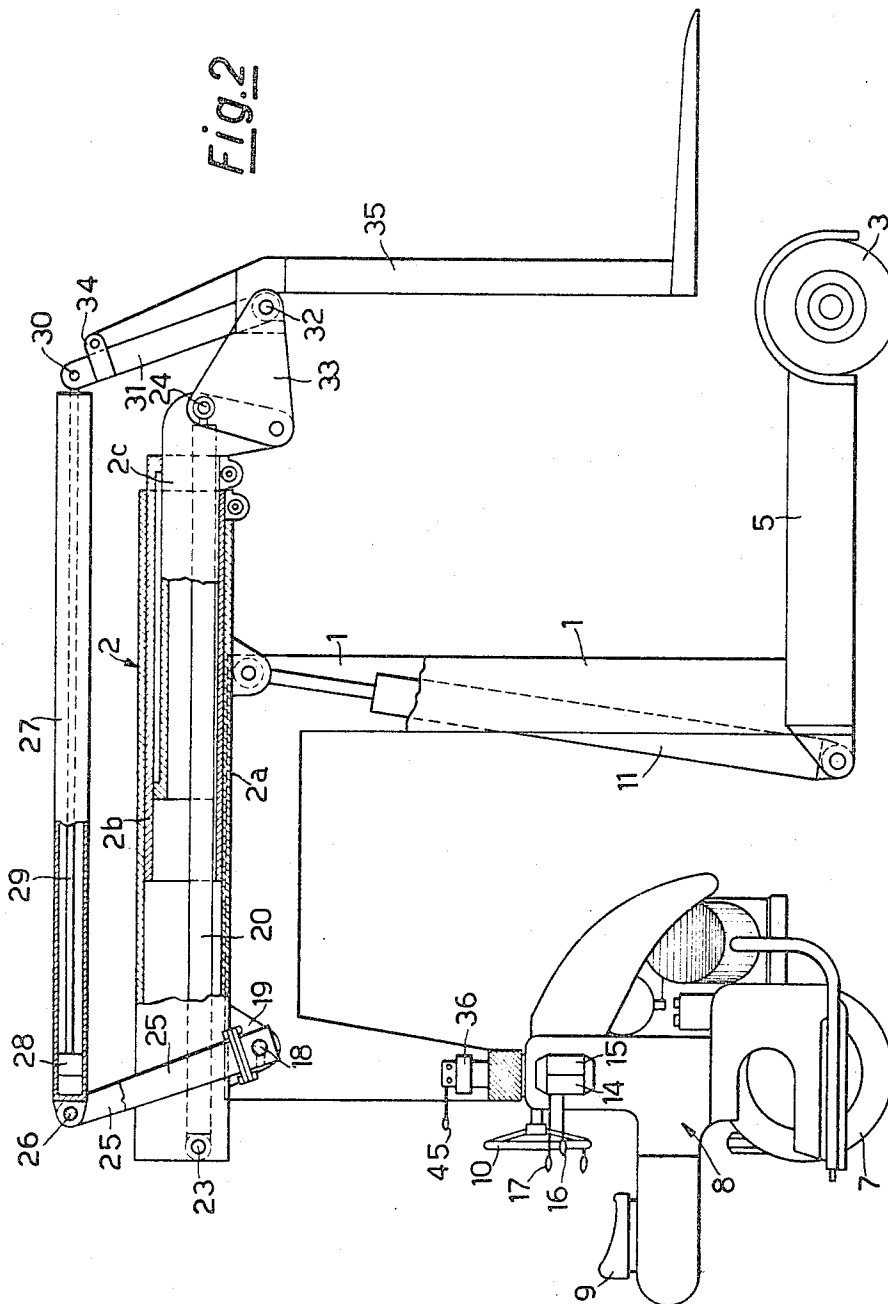
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MATERIAL MOVING DEVICE FOR MOVING OBJECTS

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4 Sheets-Sheet 2



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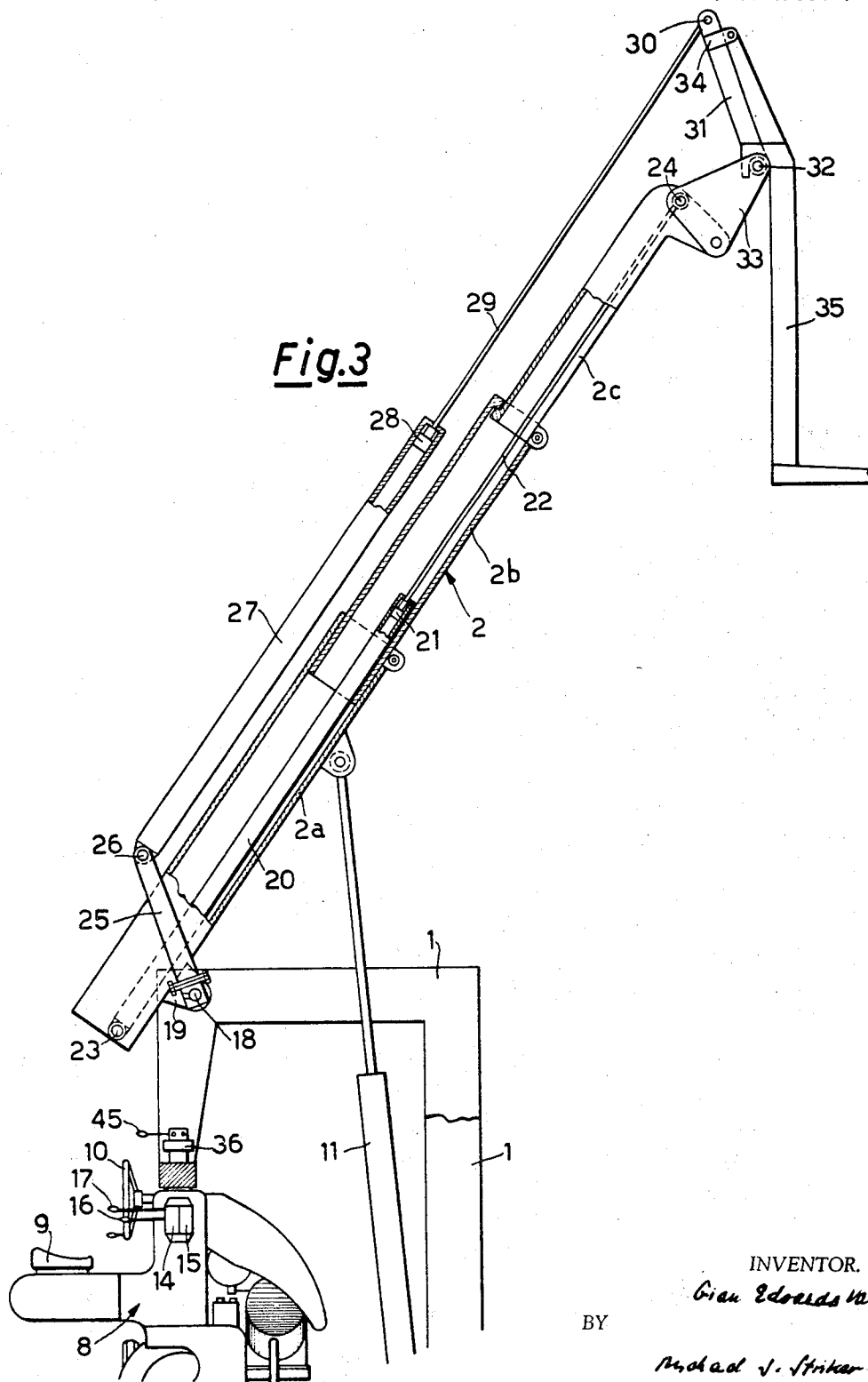
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MATERIAL MOVING DEVICE FOR MOVING OBJECTS

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4 Sheets-Sheet 3



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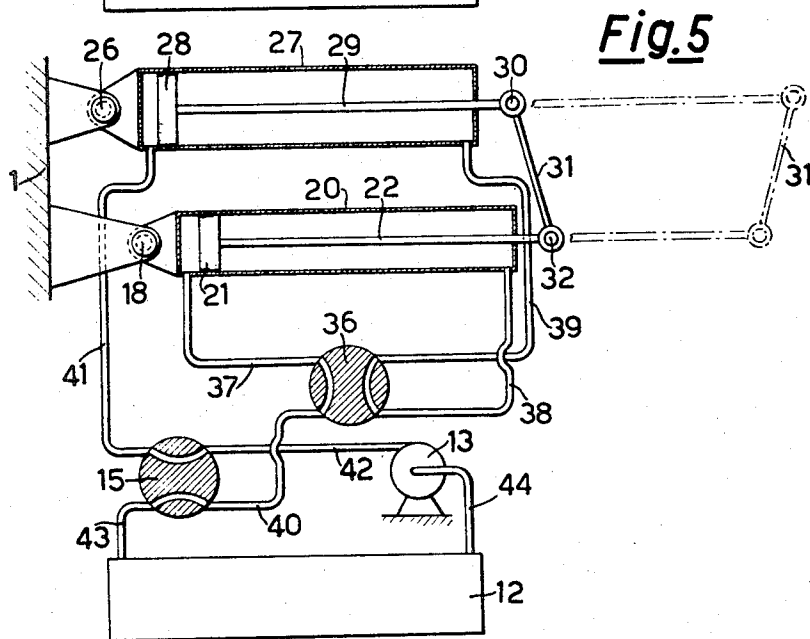
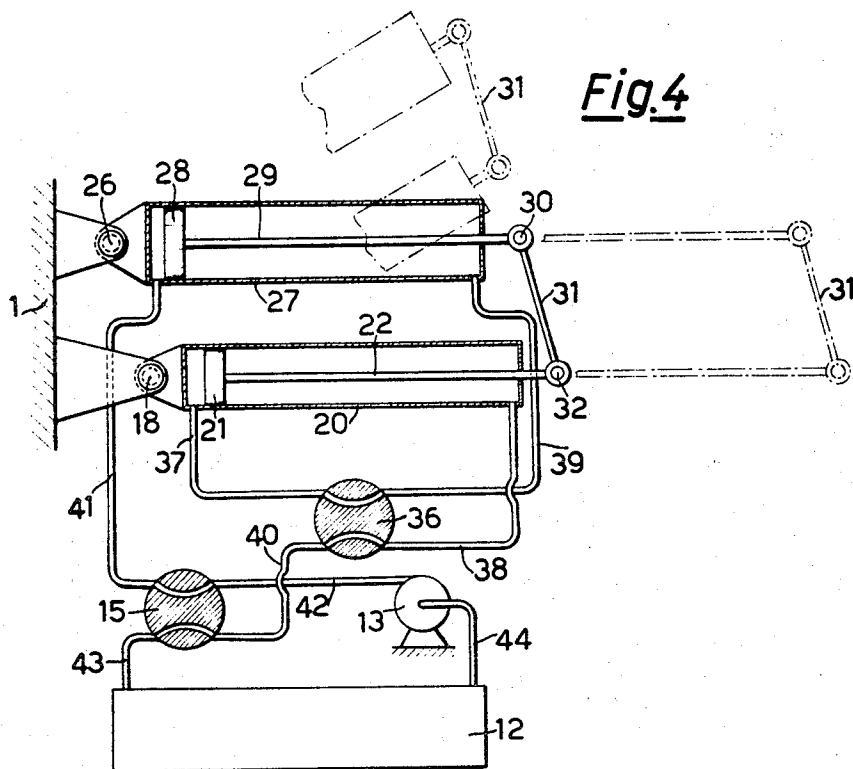
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MATERIAL MOVING DEVICE FOR MOVING OBJECTS

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4 Sheets-Sheet 4



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3,407,947
**MATERIAL-MOVING DEVICE FOR
MOVING OBJECTS**

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12,618/65
5 Claims. (Cl. 214—141)

ABSTRACT OF THE DISCLOSURE

A material-moving device having a tool on an extendable and tiltable boom, wherein orientation of the tool can be maintained irrespective of length and angle of tilt of the boom or can be varied at will. The device comprises two double-acting ram-piston hydraulic assemblies, one assembly acting between the ends of the boom, the other assembly having its ends pivoted on the framing of the device and respectively on one end of a tool-carrying rod whose other end is pivoted on the free end of the boom. Means are provided for connecting said assemblies to a source of pressurized fluid, to an outlet and in series to each other so that the two pistons are displaced in the same or selectively in opposite directions.

This invention relates to a device for moving objects and more particularly to a device having a boom which can be extended and tilted by hydraulic control members. More particularly, this invention is concerned with an apparatus of the kind described in my U.S. copending patent application Ser. No. 485,765, filed Sept. 8, 1965 and issued as Patent No. 3,303,940.

In these devices, the free end of the extendable and tiltable boom has a tool or body of any desired shape, such as for example a fork such as that of a lift truck, an excavating shovel and/or a loading shovel, a cage for lifting objects, people, animals or the like.

In many an instance of application of the devices referred to above, there is the necessity of maintaining the orientation of the resting plane of the tool or body carried by the boom irrespective of variations of the length and angle of tilt of said boom, while the necessity of varying said orientation is also frequently experienced.

An object of the invention is thus to provide a device having an extendable and tiltable boom in which the aforementioned requirements are fulfilled with simple, easy to manipulate, means.

More particularly, an object of this invention is to ensure that the lifting plane of the tool or body carried by the boom of the device is kept unaltered irrespective of the tilt and length of said boom.

Another object is to permit that the orientation of the tool or body carried by the boom be changed at will so as to obtain comparatively wide angles of rotation of said tool or body with comparatively small displacements and so as to be enabled to tilt the tool or body on a vertical plane without considerably varying the spatial position thereof.

A further object is to provide a movable device having an extendable and tiltable boom for lifting a tool or body of the kind referred to above, in which the controls for extending and tilting said boom and for varying, if so desired, the orientation of the tool carried thereby are easily accessed to and actuable by an operator seated on a control and command unit connected to the framing of the device and rotatable through full 360° about a vertical axis, as disclosed in my previous U.S. copending application Serial No. 485,765.

It is thus an object of this invention to provide a material-moving device comprising a framing, a boom mounted on said framing for being moved about a substantially horizontal axis and consisting of a plurality of mutually displaceable sections, a first jack on said framing for moving said boom about said axis, a first and a second assembly of double acting hydraulic ram and piston, whose axes lie on the same substantially vertical plane, one assembly acting between the end sections of said boom, the other assembly being mounted with an end on said framing to be moved about an axis parallel to said substantially horizontal axis, a rod pivoted at its ends to the free end of said boom and to the free end of said other ram and piston assembly, respectively, said boom, said other ram and piston assembly, said rod and the segment connecting the pivotal points of said boom to said frame and of said other ram and piston assembly to said framing forming an articulated quadrilateral, a four-way valve, three pipings to connect said valve to the chambers of the first and the second side of said first ram and to the chamber of the second side of said second ram, respectively, a piping connected to the chamber of the first side of said second ram and a fourth piping connected to said four-way valve, means for connecting at will either of said two last-named pipings to a source of pressurized fluid and the other to an outlet, control means for said valve to bring it in either of two operative positions so that in one position the chamber of the second side of said second ram is put in communication with the chamber of the first side of said first ram and the chamber of the second side of said first ram is put in communication with said fourth piping, whereas in the second position of said valve, the chamber of the second side of said second ram is put in communication with the chamber of the second side of said first ram and the chamber of the first side of the first ram is put in communication with said fourth piping, the active area of the piston in the chamber of the second side of said second ram being equal to that of the piston in the chamber of the first side of the first ram, and a tool carried by said rod.

An apparatus constructed according to the invention will be described in more detail in the following with reference to the accompanying drawings which are illustrative of an exemplary and non-limiting embodiment thereof.

In the drawings:

FIGURE 1 is a perspective view of a wheelable device whose boom carries a tool in form of a lifting fork.

FIGURE 2 shows the apparatus of FIG. 1 in side elevation a few portions being shown in cross-sectional view.

FIGURE 3 shows the device of FIG. 2 but with the boom lifted, and

FIGURES 4 and 5 are two hydraulic layouts of the means intended to carry out the extension of the boom and to vary the orientation of the tool carried thereby, in two different operational stages.

Referring to FIGS. 1 to 3, it can be seen that the subject device essentially comprises a framing 1 on which is mounted, turnably about a substantially horizontal axis, a boom 2 consisting of a few sections, in the case in point three sections, viz, 2a, 2b and 2c, movable with respect to one another. The framing 1 is movable on three wheels, two of which, 3 and 4, are mounted at the ends of two overhanging prongs 5 and 6, respectively, the third wheel 7 being simultaneously a driving and a steering wheel and forming an integral part of a driving and control unit 8. Said unit 8 is connected to the framing 1 so as to be rotated without angle limitations about a vertical axis and comprises, in addition to the engine and the speed gear and all the necessary control members, a

seat 9 for the operator, in front of a steering wheel 10. A hydraulic jack 11 is provided between the framing 1 and the boom 2 for lifting the latter.

The unit 8 also carries an oil tank 12, a pump 13, a double distributing unit formed by two discrete bodies 14 and 15 with their attendant control levers 16, 17 and related connection pipings, the whole as more detailedly disclosed in my U.S. copending application Serial No. 485,765 aforementioned.

The operation of the hydraulic circuitry, of the distributors 14 and 15 with their attendant control levers 16 and 17 as well as the connections between the parts mounted on the rotatable unit 8 and the parts mounted on the framing 1 are identical to those disclosed in the application aforementioned, to which specific reference is made in this particular respect.

The present invention is specifically related to the means for extending the plural-section boom 2, as will be described more in detail hereinafter.

The pivot, having a substantially horizontal axis and about which the boom 2 is rotatable, is indicated at 18.

This pivot 18 is affixed to the framing 1 and carries the first section, 2a, of the boom 2 by means of lugs 19 solid with said first section. Between the first section 2a and the end section 2c of the boom 2 is active a first ram-piston hydraulic assembly, of the double-acting type, comprising a cylinder 20, a piston 21 and a stem 22, the end of the cylinder 20 being affixed at 23 to the section 2a, the end of the stem 22 being affixed at 24 to the section 2c.

Solid to the framing 1 is provided a rod 25 and, to the free end of the rod, is pivoted, by means of a pivot 26, a second ram-piston double-acting hydraulic assembly comprising a cylinder 27, a piston 28 and a stem 29. To the free end of said stem 29 is pivoted, by a pivot 30, a movable rod 31 whose other end is connected by a pivot 32 to a twin-plate 33 solid with the section 2c of the boom 2. To the movable rod 31 is connected, via a hinge 34, a fork 35 resting on the pivot 32.

The longitudinal axes of the two ram-piston assemblies lie on the same substantially vertical plane and the second of said assembly together with the boom 2 and the rods 25 and 31 makes up an articulated quadrilateral. FIGURES 4 and 5 are illustrative of the hydraulic layout of the two ram-piston assemblies. It is to be noticed that the fixed rod 25, in these figures, is symbolized by two supports solid to the framing and, moreover, for simplifying the showing, the fourth side of the articulated quadrilateral is symbolized as being altogether formed by said first ram-piston assembly (cylinder 20, piston 21 and stem 22).

The hydraulic circuitry comprises a four-way valve 36. A piping 37 connects said valve 36 to a first chamber between the piston 21 and the pivotally connected end of the cylinder 20, a second piping 38 connects the valve to the second chamber at the other end of cylinder 20, a third piping 39 connects said valve with the second chamber between the piston 28 and the free end of the cylinder 27, and a fourth piping 40 connects the valve 36 with a distributor 15. The latter, in turn, is connected, through a piping 41 to the first chamber at the connected end of the cylinder 27. A piping 42 connects the distributor 15 to the delivery side of a pump 13 and a piping 43 connects the distributor 15 to the oil tank 12. The pump 13 draws oil from the tank 12 through a pipe 44. The four-way valve 36 is mounted on the framing 1 (see FIGS. 1 to 3) and can be controlled by a lever 45.

It should be noticed that the active area of the piston 21 facing the connected end of the cylinder 20 equals the active area of the piston 28 facing the free end of the cylinder 27.

The operation of the device in order to cause the boom 2 to be extended or contracted and to vary the slope of the rod 31 is as follows.

If it is desired that the movable rod 31 and the tool, the fork 35 in the case in point, retain their orientation in the first lifting plane of the boom 2 unaltered irrespec-

tive of the length and the tilt of said boom, the movable rod 31 should be brought to the position in which it is parallel to the fixed rod 25 and the four-way valve 36 should be brought to its operational position as shown in FIG. 4, wherein the piping 37 is connected to the piping 39, and the piping 38 with the piping 40. Under these conditions, the second chamber of the cylinder 27 is in serious connection with the first chamber of the cylinder 20. It is understood that all the chambers of the cylinders and all the connection pipings are filled with oil.

By feeding now pressurized oil either through the conduit 41 into the cylinder 27, or through the conduit 40 into the cylinder 20, the other of the two conduits 40, 41 being connected to the outlet 43 (consistently with the positioning of the distributor 15), it is possible to extend simultaneously the two stems 22 and 29 of their attendant cylinders thus extending the boom 2, or to cause the two stems 22 and 29 to enter the respective cylinders simultaneously, thus causing the boom 2 to be contracted.

It is ensured, in both cases, that the strokes of the two stems 22 and 29 are exactly equal since the volume generated in the chamber of the second side of the cylinder 27 is the same as that generated in the chamber of the first side of the cylinder 20.

Thus, the movable rod 31 is always parallel to itself, irrespective of the positions of the pistons 21 and 28 within their attendant cylinders 20 and 27.

The same is obviously true irrespective of any tilt of the boom 2 with respect to the framing 1.

FIGURE 4 shows in dotted lines two different length configurations and inclinations, respectively, of the articulated quadrilateral.

It should be noticed that the distributor 15 can be brought, by means of the control lever 17, into three different positions: in one position (as shown in FIG. 4) the extension of the boom 2 is obtained in another position, shifted 90° apart, the boom 2 is caused to contract, and in a third position, the neutral one, the boom is maintained in the position it had.

When, contrarilywise, it is desired to vary the inclination of the movable rod 31 and, therewith, the orientation of the tool in the lifting plane, the control lever 45 of the four-way valve 36 should be shifted to the second operation position of said valve, as shown in FIG. 5.

In such position of the valve 36 the piping 37 is connected to the piping 40, and the piping 38 with the piping 39.

Also under these circumstances, the two cylinders 20 and 27 are serially connected, but now the second chamber of the cylinder 27 communicates with the second chamber of the cylinder 20.

By feeding now pressurized oil, either through the conduit 41 into the cylinder 27, or through the conduit 40 into the cylinder 20, and connecting the other one of the conduits 40, 41 to the outlet 43 (according to the position of the distributor 15) the stems 22 and 29 of the attendant cylinders are displaced in opposite directions and with different strokes, since the volume generated in the chamber of the second side of the cylinder 27 is different from the one generated in the chamber of the second side of the cylinder 20.

Thus, the movable rod 31 changes its slope and thereby also the orientation of the tool carried thereby is varied. It should be noted that, by virtue of the simultaneous motion in opposite directions of the two stems 22 and 29 there are relatively small strokes of the stems, which are conductive to comparatively wide variations of the slopes of the rod 31.

Moreover a tool, such as a shovel or the like, carried by the rod 31, can be swung on a vertical plane without appreciably varying its position in the space, since such a swinging movement can be brought about a point placed in the vicinity of the center of the tool, or just thereat. Said possibility can prove very advantageous in many practical cases.

FIGURE 5 shows in dotted lines a possible alternative

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second inclination the movable rod 31 can take. It is obvious that, to be reverted to its initial conditions, in which the rod 31 retains its slope unaltered irrespective of any inclination and length of the boom 2, the rod 31 should be restored to the position in which it was parallel to the fixed rod 25.

The invention has been described and illustrated in connection with a particular exemplary embodiment thereof, no limitation being implied, it being understood that the same inventive ideas can be profitably employed in other countless applications to devices for moving materials, such as loaders, excavators and other like machines.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A material-moving device comprising, in combination, support means; a pair of double-acting cylinder and piston means having parallel axes and each including an elongated cylinder connected at one end thereof to said support means at a point spaced from the one end of the other cylinder and projecting in transverse direction from said support means, a piston movable in the respective cylinder and dividing the interior of the latter in a first chamber between said one end of said cylinder and said piston and in a second chamber between said piston and the other end of said cylinder, and a piston rod projecting from said piston in a sealed manner through the other end of the cylinder, the active area of the piston of one of the cylinder and piston means and facing the one end of its cylinder being equal to the active area of the piston of the other cylinder and piston means facing the other end of its cylinder; a rigid member articulatedly connected to the free ends of said piston rods and forming with the pair of cylinder and piston means and the part of the support means between said one ends of said cylinders an articulated quadrilateral; a tool fixed to and projecting from said rigid member; a source of pressure fluid; conduit means communicating with opposite ends of each cylinders; and valve means connected to said source of pressure fluid and said conduit means and operable to selectively connect said first chamber of one of said cylinder and piston means with said source of pressure fluid, said second chamber of said one cylinder and piston means with said first chamber of the other cylinder and piston means while permitting flow of fluid out of said second chamber of said other cylinder and piston means so that said rigid member is moved away from said support means without changing its inclination with respect thereto; to connect said second chamber of said other cylinder and piston means to said source of pressure fluid and to permit flow of fluid out from said first chamber of said one cylinder and piston means while

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leaving said first chamber of said other cylinder and piston means connected to said second chamber of said one cylinder and piston means so that said rigid member is moved toward said support means without changing its inclination with respect thereto; to connect said first chamber of said one cylinder and piston means to said source of pressure fluid and said second chamber of said one cylinder and piston means to said second chamber of said other cylinder and piston means while permitting outflow of fluid from said first chamber thereof to thereby tilt said rigid member in one direction with respect to said support means; and to connect said second chamber of said other cylinder and piston means to said source of pressure fluid while permitting flow of fluid out of said first chamber of said one cylinder and piston means and while leaving said second chamber of said one cylinder and piston means connected to said second chamber of said other cylinder and piston means so as to tilt said rigid member in a direction opposite to said one direction.

2. A device as defined in claim 1, and including a boom comprising a plurality of telescopically arranged sections connected at one end to said support means and projecting therefrom, one of said cylinder and piston means being located in said boom with said one end of the cylinder of said one cylinder and piston means connected to said one end of said boom and the free end of the piston rod of said one cylinder and piston means connected to the other end of said boom.

3. A device as defined in claim 2, wherein said support means includes an upright, and wherein said boom and said one end of said other cylinder and piston means are pivotally connected to said upright for tilting movement about substantially horizontal axes, and including extensible and collapsible means pivotally connected at opposite ends thereof to said support means and said boom spaced from said one end of the latter.

4. A device as defined in claim 3, wherein said extensible and collapsible means is constituted by a hydraulic jack.

5. A device as defined in claim 1, wherein said source of pressure fluid includes a fluid reservoir and a pressure pump connected with said reservoir, and wherein said valve means includes a pair of four-way valves in said conduit means each movable between at least two positions.

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HUGO O. SCHULZ, *Primary Examiner*.