April 22, 1958 G. W. WAY 2,831,589

ARTICULATED BOOM FOR MOBILE CRANE

Filed Feb. 28, 1956 2 Sheets-Sheet 1

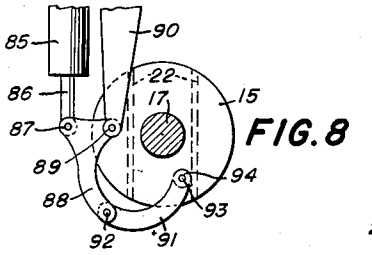

FIG. 8

FIG. 1

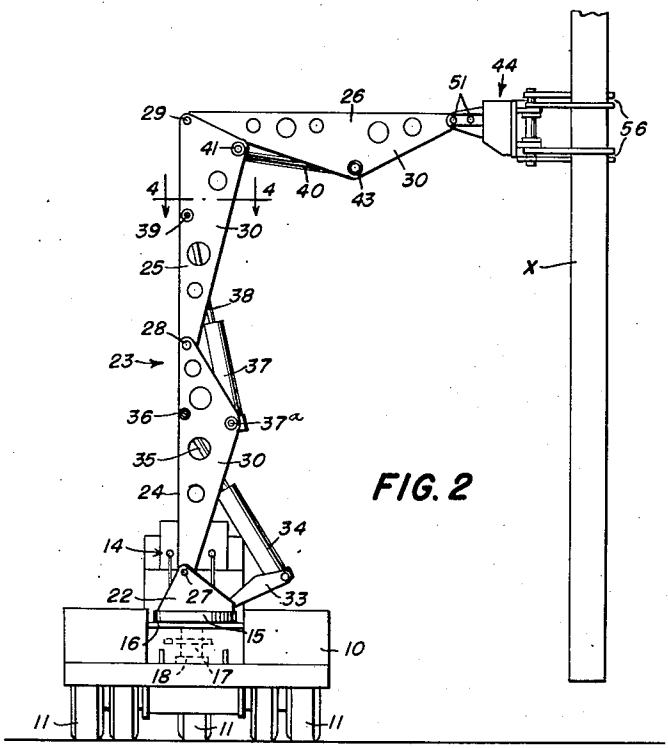

FIG. 2

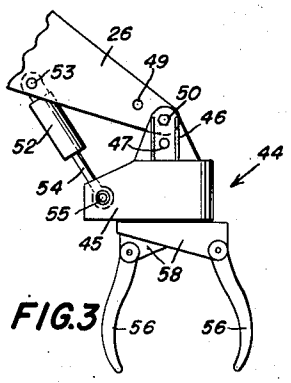

FIG. 3

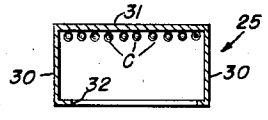

FIG. 4

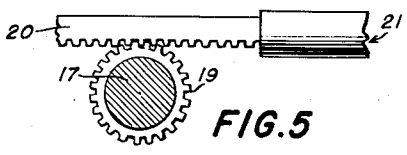

FIG. 5

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April 22, 1958 G. W. WAY 2,831,589

ARTICULATED BOOM FOR MOBILE CRANE

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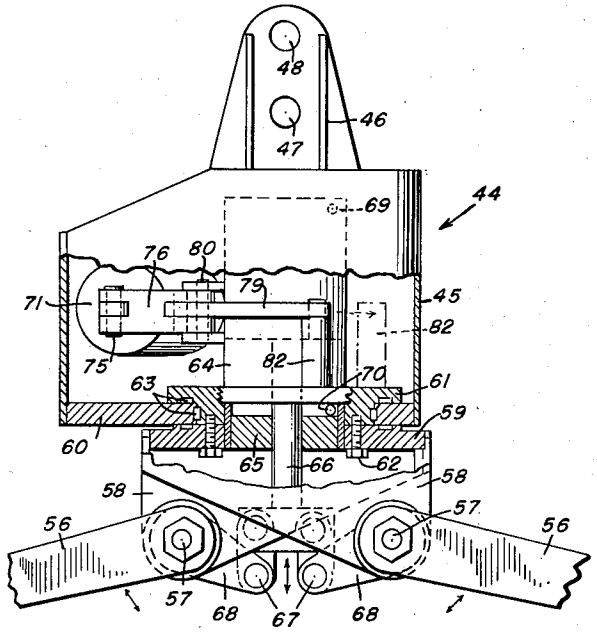

FIG. 6

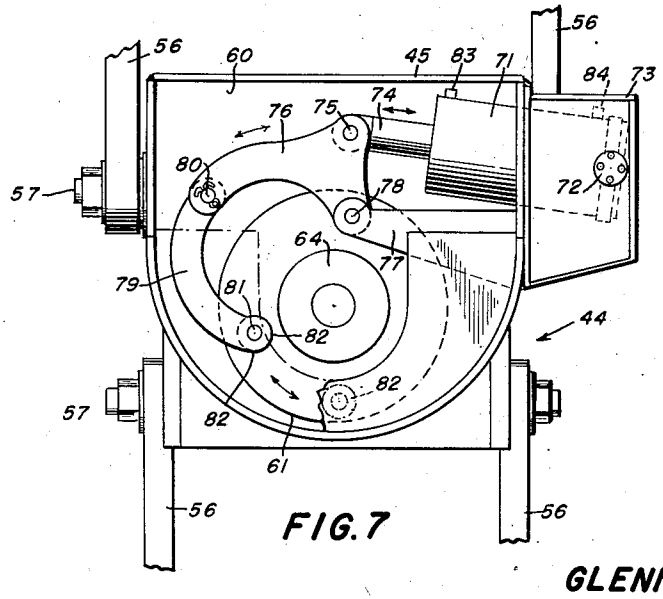

FIG. 7

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United States Patent Office 2,831,589 Patented Apr. 22, 1958

2,831,589

ARTICULATED BOOM FOR MOBILE CRANE

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Application February 28, 1956, Serial No. 568,208

4 Claims. (Cl. 214—147)

This invention relates to mobile cranes and consists more particularly in new and useful improvements in an articulated boom adapted to be mounted on a mobile crane or other vehicle and operated by a conventional hydraulic power system with which the crane is normally provided.

The primary object of the invention is to provide an articulated boom which will substantially simulate the angular and rotary movements of a human arm and wrist to thereby provide a versatility of use not heretofore possible in equipment of this character.

Another object of the invention is to provide an articulated boom comprising a series of sections pivotally jointed in end to end relation for relative movement about parallel horizontal axes, one end of said series being pivotally mounted on a turntable carried by a crane or like body and the opposite end of said series carrying a pivotally mounted grapple or material handling element, rotatable about an axis which is perpendicular to said last named pivotal mounting.

A further object of the invention is to provide an articulated boom of the type described, the base of which is pivotally mounted at a relatively low elevation with respect to the turntable, to facilitate the effective tilting movement of the boom in the handling of materials.

A still further object of the invention is to provide an articulated boom adapted to be actuated by a series of hydraulic rams or other fluid responsive means, individually operable to separately control the pivotal movement of the various sections, the rotary movement of the boom at its mounting end, and the rotary movement of the grapple member at the opposite end, as well as the gripping action of the grapple per se.

Still another object of the invention is to provide an articulated boom comprising a series of pivotally mounted sections, each of which is substantially U-shaped in cross-section to form a box-like protecting shield for the various hydraulic fluid lines embodied in the mechanism.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

Referring to the drawings in which numerals of like character designate similar parts throughout the several views,

Figure 1 is a view in side elevation showing the improved articulated boom mounted on the forward end of a suitable crane body.

Figure 2 is a front elevational view of the crane body shown in Figure 1, but with the various elements of the articulated boom in shifted position.

Figure 3 is a fragmentary detail, showing in elevation, a modified form of grapple mounting.

Figure 4 is a transverse sectional view taken on line 4—4 of Figure 2, but on an enlarged scale.

Figure 5 is a fragmentary detail illustrating one means for rotating the turntable upon which the base end of the boom is mounted.

Figure 6 is an enlarged view in side elevation, partly broken away, to illustrate the means for rotating the grapple element on its mounting, and for actuating the grapple jaws.

Figure 7 is a transverse sectional view of the grapple mounting, taken at right angles to Figure 6 and showing the rotating mechanism in plan, and

Figure 8 is a diagrammatic view showing a modified form of boom slewing means.

In the drawings, **10** represents a crane body having the usual wheels **11**, seat **12**, steering gear **13**, and hydraulic control mechanism generally indicated at **14**. The crane for supporting the boom may be of any conventional design wherein sufficient weight is embodied to counteract the weight of the boom when loaded. However, I preferably employ a crane of the nature shown and described in my copending application Ser. No. 358,466, filed May 29, 1953, wherein a frameless crane body is formed of heavy sheet metal to provide the necessary counter weight. The forward end of the body **10** is provided with a horizontal turntable **15**, supported on a bed **16** and having secured thereto a coaxial cylindrical shaft **17** which is vertically mounted for rotary movement in any suitable base **18**. As seen in Figure 5, the periphery of the shaft **17** is provided with a concentric gear **19**, the radial teeth of which are adapted to mesh with complementary teeth on a rack bar **20**, adapted to be reciprocated by a hydraulic means generally indicated at **21**. The details of this hydraulic mechanism are omitted in the interests of simplicity but it will be understood that upon the reciprocation of the rack bar **20**, a corresponding rotation of the shaft **17** will be affected to cause the desired rotation of the coaxial turntable **15**. While I have shown a hydraulically operated rack and gear mechanism for rotating the turntable **15**, I do not intend to limit the invention in this respect. Any suitable structure may be employed for this purpose, such for example as an adaptation of the rotating mechanism for the grapple unit shown in Figures 6 and 7, to be described later.

On the top face of the turntable **15** there are provided a pair of vertically extending, parallel mounting brackets **22** which are transversely spaced to receive therebetween the mounting end of the articulated boom generally indicated at **23**. It will be noted that the vertical extent of the brackets **22** is relatively short so that the mounting end of the boom **23** is substantially close to the turntable **15**, for the purpose hereinafter described.

The boom **23** comprises a series of longitudinally connected sections **24**, **25** and **26**, the base section **24** being pivotally mounted on a horizontal axis **27** between the spaced brackets **22**. The opposite end of the base section **24** is pivotally connected to the adjacent end of an intermediate section **25**, on a horizontal axis **28** and likewise the section **25** is pivotally connected to the end section **26**, on a horizontal axis **29**. As best seen in Figure 4, each of the sections **24**, **25** and **26** is substantially U-shaped in cross-section, having vertical sidewalls **30** and a connecting web **31**, the free longitudinal edges of the legs of the U being preferably inturned as at **32** to afford added strength. The side walls **30** of the various sections are preferably triangular in shape as shown in Figures 1 and 2, to facilitate the performance of their desired functions and to provide mounting means for the respective hydraulic ram mechanisms as will be later described.

Between the spaced brackts **22**, the upper face of the turntable **15** carries an angularly projecting radial arm **33** to which is pivotally mounted one end of a hydraulic cylinder **34**, within which is reciprocably mounted a suitable piston (not shown). Operatively connected to the piston in cylinder **34** and projecting longitudinally therefrom is a piston rod **35**, which is pivotally connected to a medial point on the base section **24** of the boom, as at **36**. A second hydraulic cylinder **37** is pivotally mount-

ed at one end as at 37*a* between the apexes of the side walls of the base section 24 and the projecting end of its piston rod 38 is pivotally connected at 39 to a medial point on the succeeding section 25. Similarly, one end of a third hydraulic cylinder 40 is pivotally connected at 41 to the apex of said section 25, but, unlike the hydraulic connections just referred to, the projecting end of the piston rod 42 of cylinder 40 is connected at 43 to the apex of the side walls of the end section 26.

The hydraulic power for actuating the cylinders 34, 37 and 40 is derived from the conventional hydraulic source with which the crane 10 is normally provided and the hydraulic lines leading to and from the cylinders have been omitted for the purpose of clarity. However, it will be understood that these cylinders and pistons operate in the usual manner, projecting their respective pistons upon the application of pressure in one end of the cylinders and retracting them upon the application of pressure to the opposite ends of said cylinders. Likewise, the particular hydraulic control mechanism generally indicated at 14, is not specifically illustrated for the reason that various types of controls may be employed within the spirit of the present invention. However, it may be stated that the preferred form of control comprises the subject matter of my co-pending application Serial No. 568,207, filed February 28, 1956, wherein individual control levers, upon being manipulated to varying positions, regulate the actions of a series of valves respectively connected to the various cylinders.

Returning now to the boom, the free end of section 26 carries the grapple assembly generally indicated at 44. The invention contemplates two forms of mounting for the grapple assembly, respectively shown in Figures 1 and 3, the former being manually adjustable and the latter controlled by hydraulic means, as will hereinafter appear.

Referring first to the embodiment shown in Figure 1, it will be seen that the grapple assembly comprises a head 45 in the form of a semi-cylindrical housing, the top of which is provided with a pair of transversely spaced, vertically projecting brackets 46. The brackets 46 are provided with two sets of vertically spaced, axially aligned openings 47 and 48, adapted to register with correspondingly spaced apertures in the free end of the outer section 26, one of which apertures is shown at 49 while the other is obscured by the bracket 46. In the manually adjustable form shown in Figure 1, the grapple head 45 is swingably supported in the apertures in the extreme end of section 26, by means of a pivot pin or shaft 50 and when thus supported, the grapple assembly automatically maintains a vertically depending position regardless of the movement of the boom sections and swings freely on its axis 50. When it is desired to lock the grapple assembly in a fixed projected position with respect to the section 26, as shown in Figure 2, the two openings 47 and 48 are adjusted to register with the corresponding openings in the end of section 26 and a pair of pins 51 are inserted in the respective openings to maintain a rigid connection between the section 26 and the grapple assembly.

In Figure 3 I have shown a generally similar grapple assembly mounted for hydraulic control. Here it will be seen that a hydraulic cylinder 52 is pivotally mounted at 53, between the side walls of section 26 and the projecting end of the piston rod 54 is pivotally mounted at 55 at a suitable point on the grapple head 45, to cause the latter to swing about the axis 50 upon manipulation of the hydraulic mechanism. Here again the particular hydraulic control mechanism is not shown but it will be understood that such control may be effected from the same source as those previously referred to.

The grapple assembly and the means for actuating the jaws and rotating the assembly about its axis, are shown in detail in Figures 6 and 7. Referring first to Figure 6, the grapple jaws 56 are arranged in opposed pairs, respectively pivotally mounted on transverse shafts 57 extending through depending brackets 58 which are carried on the underside of a rotatable plate 59. The bottom 60 of the housing 45 is provided with an intermediate opening adapted to receive the reduced neck of a second plate 61 to which the plate 59 is secured by screws or bolts 62. The top plate 61 is extended radially beyond its neck and overlies the bottom 60, suitable bearings 63 being provided to facilitate the rotary movement of the composite plate 59—61 with respect to the housing 45, as will be later described in detail.

A hydraulic cylinder 64 is supported vertically within the housing 45, extending through the composite plate member, its lower end being closed by a block 65. A piston rod 66, extending from a piston (not shown) within the cylinder 64, extends through an opening in the block 65 and its lower end is operatively connected by linkage assemblies 67 and lever arms 68, to the respective pairs of opposed jaws 56. Suitable hydraulic connections 69 and 70 are provided at opposite ends of the cylinder 64 for the introduction and exhaust of hydraulic pressure within the cylinder to control the action of its piston. Thus, the introduction of hydraulic pressure into the lower end of the cylinder through connection 70, causes the piston to rise within the cylinder with a resultant upward pull on the piston rod 66. Through the linkage and operating levers 67, 68, the respective pairs of jaws 56 are caused to close. The introduction of hydraulic pressure through the upper connection 69 causes the reverse action, or opening of the jaws.

As previously stated, the plate assembly 59—61 is rotatably mounted on the bottom 60 of the housing 45. A horizontally disposed hydraulic cylinder 71 is pivotally mounted at one end as at 72 (Figure 7) in a housing extension 73, fixed to the housing 45. A piston rod 74 extending from a piston (not shown) within the cylinder 71, is pivotally connected at its projecting end as at 75, to a substantially triangular lever member 76 which in turn is pivotally mounted on a fixed support 77, as at 78. A link 79 is pivoted at 80 to one end of the lever 76 and its opposite end is pivoted at 81 to an upstanding post 82, fixed to the top face of the upper plate 61. The link 79 and the arm of lever 76 connected thereto, are curved in a plane perpendicular to axis of the rotary plate 61 and in the direction of rotation of said plate, as shown in Figure 7 and the connecting post 82 is radially offset with respect to the axis of the rotatable plate assembly so that, as the piston rod 74 is projected from the cylinder 71, the lever 76 rotates about its offset axis 78 and through the connecting link 79, causes the rotation of the composite plate 59—61 about the axis of the latter. This rotary movement is shown in dotted lines in Figure 7, where it will be seen that due to the curvature of the lever 76 and link 79, these elements clear the periphery of cylinder 64 as the post 82 progresses counterclockwise around the axis of the plate 61. Suitable hydraulic connections 83 and 84 are provided at opposite ends of the cylinder 71 which, together with the vertical cylinder 64 may be operated from the conventional hydraulic system of the crane 10.

Thus, by manipulation of the hydraulic cylinder 71, the grapple unit suspended from the composite plate 59—61 may be rotated about the vertical axis of the housing 45 to any desired position.

As previously stated, an arrangement similar to that just described for rotating the grapple unit, may be employed for slewing the boom, the structure shown in Figure 5 being simply one example of means for accomplishing this purpose.

Figure 8 illustrates an adaptation of this principle for causing the boom to rotate about the vertical axis of the turntable 15, a horizontally disposed hydraulic cylinder 85 is pivotally mounted at one end (not shown) on an adjacent portion of the crane body. A piston rod 86 extends from a piston within the cylinder, and is

pivotally connected at its projecting end as at 87, to a substantially triangular lever member 88, which in turn is pivotally connected as at 89, to a fixed support 90 carried by the crane body. A link 91 is pivoted at 92 to the lever 88 and its opposite end is pivoted at 93 to a supporting post 94 depending from the underside of the turntable 15. As in the case of the grapple rotating structure previously described, the lever arm 88 and link 91 are curved as shown in the drawing and the connecting post 94 is radially offset with respect to the axis of the rotatable turntable 15 so that, as the piston rod 86 is projected from the cylinder 85, the lever 88 rotates about its offset axis 89 and through the connecting link 91, causes the rotation of the turntable 15 about the axis of the latter. Thus the turntable and boom mounted thereon may be caused to rotate either in clockwise or counterclockwise direction, depending upon the action of the piston and cylinder which controls its operation.

Returning to the grapple rotating and actuating mechanism, while I have shown and described this as hydraulically controlled, it should be noted that I do not intend to limit myself to this arrangement. Any fluid pressure responsive means may be employed for rotating and actuating the grapple structure, such for example as a device controlled by air pressure or vacuum.

It will be apparent that by this construction of the articulated boom which is rotatably mounted at its base at a relatively low point with respect to the crane body 10, the grapple end of the boom may be maneuvered into extremely close proximity to the crane body or into a position a considerable distance therefrom, within the limits of the length of the boom. By connecting all sections of the boom including the grapple assembly, for pivotal movement on parallel horizontal axes, the maneuverability of the boom is greatly increased and by adding to this articulated structure, the rotary base mount and the rotary grapple assembly, the utility of the device is practically limitless.

For example, a log or timber X may be picked up by the grapple jaws 56, from a horizontal position in front of the crane body 10 as shown in Figure 1, elevated by projecting the articulated sections of the boom and rotated through the operation of the hydraulic cylinder 71 to a vertical position as shown in Figure 2, all under the control of one operator.

Another advantageous feature of the invention lies in the boxlike structure of the individual sections of the boom whereby the hydraulic conduits C (Figure 4) are protected from damage by the enclosing walls 30, 31 of the boom sections. This boxlike structure also adds great strength and rigidity to the boom sections.

From the foregoing it is believed that the invention may be readily understood by those skilled in the art, without further description, it being borne in mind that numerous changes may be made in the details of construction, without departing from the spirit of the invention as set forth in the following claims.

I claim:

1. Material handling apparatus comprising a rigid bed, a base mount supported on said bed for rotary movement about a vertical axis, an articulated boom consisting of a series of sections pivotally connected in endwise relation, one of said sections being pivotally mounted at one end, on said base mount, said sections being substantially U-shaped in transverse cross-section to provide enclosure walls of a boxlike housing structure, the axes of said pivotal connections being horizontal and parallel to one another, hydraulic rams underlying respective sections and connecting a medial portion of said one section to a radially offset point on said mount and respectively connecting medial portions of succeeding sections, the points of connection of said rams lying within the confines of said enclosure walls, a grapple support pivotally mounted on the free extremity of the endmost section, on a horizontal axis parallel to those of said previously mentioned pivotal connections, a grapple member rotatably mounted on said support on an axis perpendicular to said pivotal connections, a source of hydraulic pressure fluid, fluid lines leading from said source to said rams, said fluid lines lying within the confines of said U-shaped sections, means for rotating said grapple member on its support, means for actuating said grapple member, and manually actuated means for selectively controlling the application of pressure fluid to respective rams and to said means for rotating and actuating said grapple member.

2. Material handling apparatus as claimed in claim 1, including a hydraulic ram connecting said grapple support to a medial portion on the adjacent section, said last named hydraulic ram underlying said adjacent section and its connection thereto lying within the confines of said section, said ram being under the selective control of said manually actuated means.

3. In an articulated boom, including a series of sections pivotally connected in end to end relation, a grapple unit comprising a base member, a housing overlying and connected to said base member, a pair of spaced ears fixed to the upper extremity of said housing, two sets of respectively coaxial openings in said ears, said sets of openings being longitudinally spaced on said ears and adapted to selectively register with corresponding spaced openings in the endmost section of said series, and means projectable through said registering openings for locking said grapple assembly to said endmost section in fixed position, at least one pair of opposed grapple jaws pivotally connected on the under side of said housing, hydraulic means within said housing for actuating said jaws, and separate hydraulic means within said housing for rotating said jaws with respect to said housing.

4. In an articulated boom, including a series of sections pivotally connected in end to end relation, a grapple assembly comprising a housing pivotally connected to the endmost section, a rotatable support in said housing, grapple jaws hingedly connected to the under side of said support, a common hydraulic cylinder in said housing, fixed concentrically on said support, a piston in said cylinder, a piston rod depending through said support, a linkage system operatively connecting said piston rod to respective jaws, a hydraulic ram pivotally connected to said housing at a point laterally offset with respect to said support and operable in a plane parallel with that of said support, a substantially triangular crank arm, means pivotally mounting one end of the base of said crank arm at a fixed point in said housing, on an axis parallel with that of said rotatable support and laterally offset with respect to said hydraulic cylinder, the opposite end of the base of said crank arm being connected to said hydraulic ram, and a link pivotally connecting the apex of said crank arm to an eccentric point on said support, the adjacent portions of said crank arm and link being curved in a plane perpendicular to the axis of said support and in the direction of rotation of the latter, whereby upon the pivotal movement of said crank arm, said curved portions of the crank arm and link accommodate said cylinder as they approach the latter and avoid its interference with their maximum movement in rotating said support.

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