

[54] **MULTIPLE STAGE CRANE BOOM**
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[58] Field of Search **212/55**

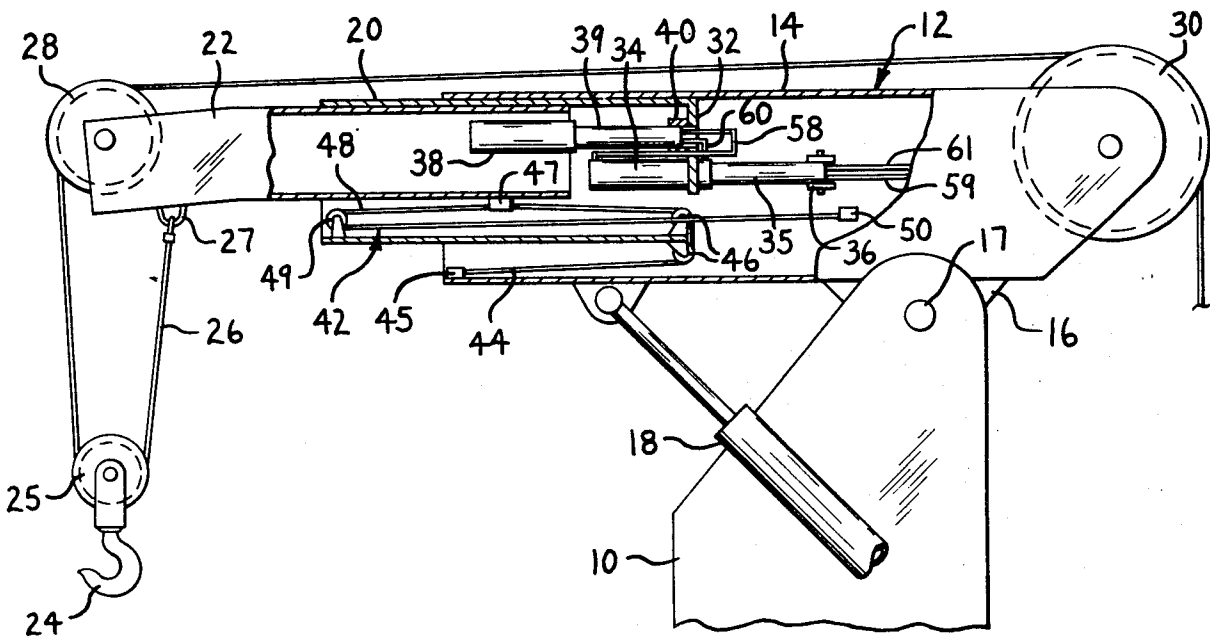
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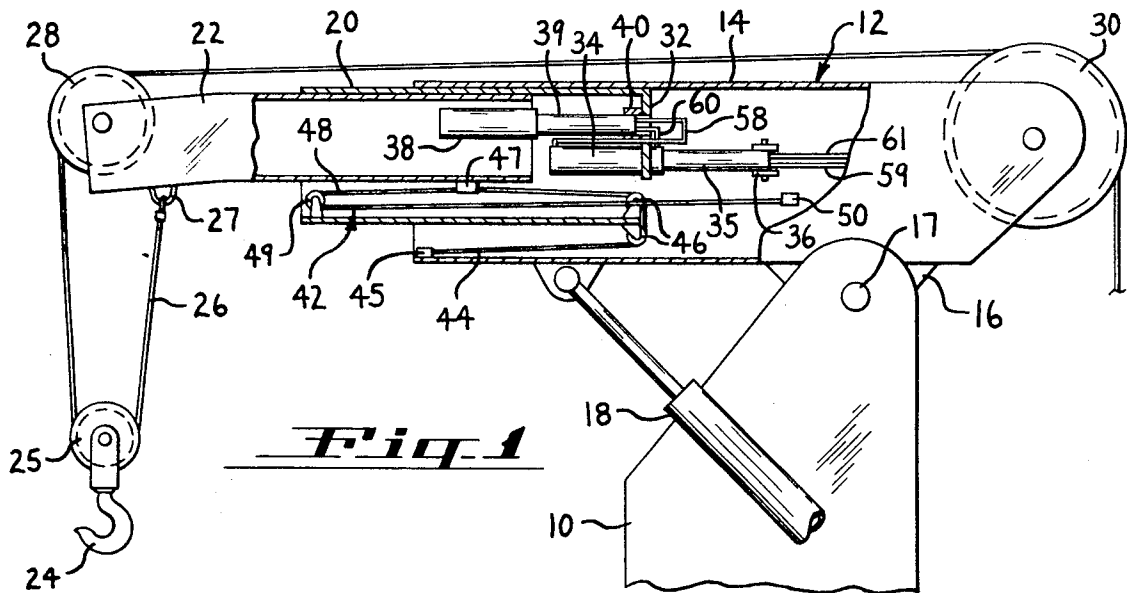
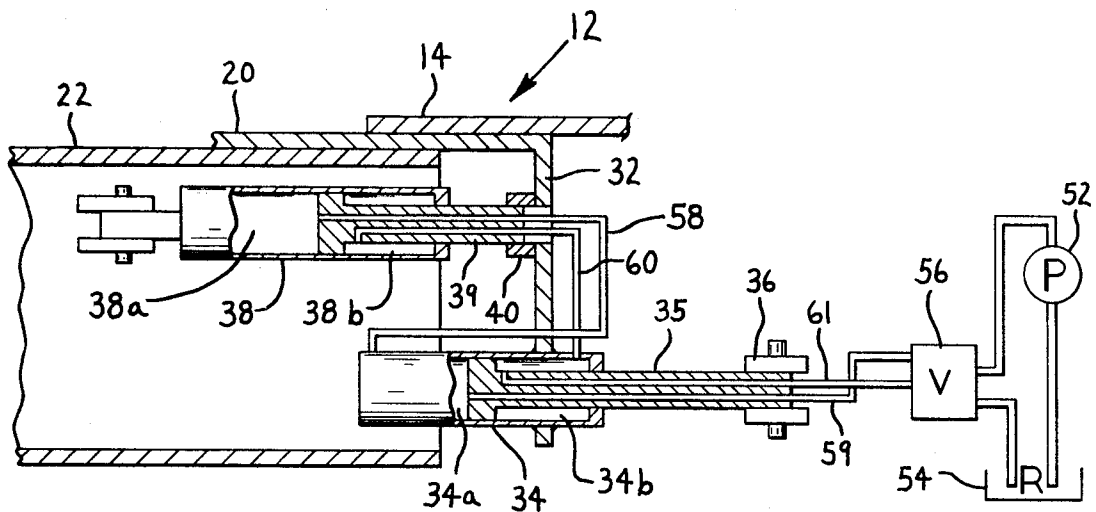
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[57] **ABSTRACT**

A multiple stage crane boom has a vertically pivotable outer stage, a movable intermediate stage telescoping within the outer stage and a movable inner stage telescoping within the intermediate stage. A material-handling device is raised and lowered with respect to the outer end of the inner stage by a winch-powered cable. The boom is extended and retracted through simultaneous extension and retraction of the intermediate and inner stages by separate but simultaneously energized hydraulic cylinders. These cylinders are mounted and hydraulically interconnected in a manner which eliminates the need for extensible hydraulic hoses between the cylinders and the fluid pressure source. A cable-phasing arrangement interconnecting the stages provides in conjunction with the cylinders a boost to ensure proper phasing movement of the movable stages upon extension and retraction should friction tend to restrain one of such stages upon application of hydraulic power to the cylinders.

1 Claim, 2 Drawing Figures





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MULTIPLE STAGE CRANE BOOM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to multiple stage booms, and more particularly to the means for extending and retracting the movable stages of such a boom having at least two movable stages.

2. Description of the Prior Art

Booms having multiple movable stages are commonly extended and retracted entirely hydraulically as typified by Nansel U.S. Pat. No. 3,250,182 and Przybylski U.S. Pat. No. 2,984,373. In such prior arrangements, each movable stage is extended relative to its outwardly adjacent stage by a hydraulic cylinder connected between such stages.

In multiple stage booms it is also desirable to extend the movable stages relative to their respective outwardly adjacent stages simultaneously or in predetermined sequencing to relieve the smallest stages of unnecessary stress when the boom is not fully extended. This phasing movement of the movable stages has most commonly been attempted in the past hydraulically through the use of flow dividers which equalize flow to the crowd cylinders for the various movable stages. However, because of internal stresses, and friction and gravity forces, such hydraulic phasing attempts have been only marginally successful in the past.

Other prior attempts at boom phasing have involved the use of a motor to move only one of the movable stages and a cable rigging arrangement to move the other movable stages upon powered extension of the one powered movable stage. Such an arrangement is typified by the system of Haulotte U.S. Pat. No. 3,469,712 and Bopp U.S. Pat. No. 3,307,713. However, because a single motor is relied upon to provide the power for extending and retracting several movable stages, failure of either the cable system or the motor renders the entire boom extension system substantially inoperable.

SUMMARY OF THE INVENTION

In accordance with the present invention, the foregoing need is met by providing multiple motors for moving the multiple movable stages of a boom in combination with a cable phasing arrangement interconnecting the various boom stages in a manner to ensure proper phasing movement of the stages upon the application of power to the stages. In this manner the cable arrangement acts as a boost to aid the motors in ensuring simultaneous extension and retraction of the movable stages.

An advantage of this arrangement is that relatively small hydraulic cylinders mounted within the boom stages can be used to power the individual stages while at the same time eliminating the problems that separately powered stages encountered in the prior art.

A further advantage of the invention is that it ensures accurate phasing movement of the movable stages without the use of large, high-powered motors for moving such stages.

A further advantage of the system of the invention is that it utilizes the best features of both the prior art power extended stages and the prior art cable extended stages while eliminating the disadvantages of both such prior systems.

A primary object of the invention is to eliminate the misphasing and consequential overstressing of any of the movable boom stages.

An important feature of the invention is the specific mounting and fluid routing arrangement for the hydraulic cylinders which power the movable stages. In accordance with this feature the hydraulic cylinder for moving the inner stage is mounted within the inner stage and its piston rod connected to the intermediate stage. The cylinder for powering the intermediate stage is mounted within the intermediate stage and its piston rod connected to the outer stage. The extension and retraction sides of these cylinders, respectively, are interconnected. Furthermore, pressure fluid from the pressure source is routed into the opposite sides of the cylinders through their piston rods. This arrangement minimizes the need for extensible interconnecting flexible hydraulic hoses and their associated coiling apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the present invention will become more apparent from the following detailed description which proceeds with reference to the accompanying drawing wherein:

FIG. 1 is a schematic side view of a multiple stage boom in accordance with the invention, shown partly in section; and

FIG. 2 is a schematic diagram of the hydraulic circuitry and associated boom components of the invention.

DETAILED DESCRIPTION

Referring to FIG. 1, a crane boom assembly in accordance with the invention includes a boom support member 10 commonly carried by a turntable of a crane carrier vehicle (not shown). A boom assembly 12 includes an outer first boom section or stage 14, usually of generally rectangular cross section. Outer stage 14 has adjacent its inner end a downward projection 16 pivoted by a pin 17 to boom support 10 for movement in a vertical plane by a hydraulic cylinder 18.

A second, intermediate boom section or stage 20 is mounted for telescoping movement within outer boom stage 14.

A third, inner stage 22 telescopes within intermediate stage 20. A material-handling means, such as hook 24 pivoted to pulley wheel 25, is suspended by a winch cable 26 from the outer end of inner stage 22. Cable 26 is fixed at one end 27 to an outer end portion of inner stage 22 and thence is trained about pulley 25 and a boom sheave 28 before passing rearwardly to a powered winch drum 30 carried by the rear end of outer stage 14.

A rear end wall 32 of intermediate stage 20 carries a hydraulic cylinder 34 for extending and retracting the intermediate stage relative to outer stage 14. Cylinder 34 includes a piston rod 35 pivotally connected by clevis 36 to an inner wall portion of outer stage 14.

A second boom extension cylinder 38 is mounted within an inner end portion of inner boom stage 22 for extending and retracting inner stage 22 relative to intermediate stage 20. For this purpose the piston rod 39 of cylinder 38 is pivotally connected to the inner end of intermediate stage 20 at 40. Thus when cylinders 38 and 34 are energized simultaneously, they have the capability of extending and retracting the two movable

stages 20 and 22 simultaneously, with intermediate stage 20 moving relative to outer stage 14 as inner stage 22 moves relative to intermediate stage 20.

However, as previously suggested, without more, it is possible that one or the other of the intermediate and inner stages would tend to resist movement and actually bind up despite energization of its power cylinder because of undue friction, stressing or loading of the stages, thereby producing improper phasing.

To guard against improper phasing, a cable phasing means indicated generally at 42 interconnects the three boom stages in a manner which tends to aid the cylinders in moving the stages. More specifically, the cable-phasing means includes a first flexible length of cable 44 anchored at one end at 45 to an outer end portion of the inner wall of outer stage 14. From such anchor, cable 44 passes over a sheave 46 at the inner end of intermediate stage 20 and then to a second anchor point 47 where its opposite end is anchored to an inner end portion of inner boom stage 22.

A second length of cable 48, or if desired a continuation of the first-mentioned cable 44, is also anchored at one end 47 and then passes about a second sheave 49 inside and adjacent the outer end of intermediate stage 20. From such sheave, cable 48 passes along the inside of intermediate stage 30 and beyond its inner end to an anchor point 50 on an inside wall portion of outer stage 14.

OPERATION OF PHASING ARRANGEMENT

Assuming that crowd cylinders 34 and 38 are energized so as to tend to extend stages 20 and 22 simultaneously, outward movement of either one of such stages will cause the cable-phasing means to cooperate in boosting the extension of the other stage. For example, should inner stage 22 start to move but intermediate stage 20 tend to hang up, outward movement of stage 22 exerts a pulling force on fixed length cable 44, thereby exerting an outward boosting force on intermediate stage 20 and tending to drag such section outwardly relative to outer stage 14.

Similarly, should intermediate stage 20 start moving and stage 22 hang up, movement of stage 20 exerts a pulling force through cable 48 to anchor point 47, tending to drag inner boom section 22 outwardly relative to intermediate boom section 20.

Cable lengths 44 and 48 will have a similar boosting effect upon retraction of the inner and intermediate boom stages.

HYDRAULIC CIRCUIT

Referring to FIG. 2, the hydraulic system for extending and retracting the intermediate and outer boom stages includes a pressure source, or pump, 52 supplied with fluid from reservoir 54 and delivering fluid to a directional control valve 56.

For extending the intermediate and outer stages, cylinders 34 and 38 are hydraulically connected with pump 52 by hydraulic fluid supply passages 58, 59. Passages 58, 59 extend axially respectively through piston rods 39, 35 of cylinders 38, 34 and into the extension sides 38a, 34a of such cylinders. Passage 58 also interconnects the extension sides of the two cylinders. Simultaneously fluid is exhausted from the retraction sides 38b, 34b of such cylinders through exhaust fluid passages 60, 61. Fluid passage 60 extends axially through piston rod 39 into communication with the re-

traction side of cylinder 34. Exhaust passage 61 extends axially through piston rod 35 of cylinder 34 to valve 56. Valve 56 connects line 61 with the reservoir 54. Thus upon extension of cylinders 38, 34, the exhaust sides of such cylinders are connected via passage 61 with reservoir 54.

Upon retraction of the cylinders to retract the boom stages, fluid passages 60 and 61 are connected with pump 52 by valve 56 and thus become the supply lines to the retraction side of cylinders 34 and 38. Similarly, lines 58 and 59 connecting with the extension sides of such cylinders are connected by valve 56 to reservoir 54 and thus become the exhaust lines.

The foregoing hydraulic circuit arrangement minimizes the number of lines extending from the pressure source to the two cylinders. In fact there are only two such lines 59, 61, both leading into stationary piston rod 35. Thus the specific cylinder mounting within the boom and the axial feeding of pressure fluid through the piston rods of such cylinders eliminates the need for extendible hydraulic hoses and their attendant hose reeling. Accordingly, the illustrated hydraulic circuit arrangement becomes an important adjunct of the combined hydraulic and cable arrangement for ensuring proper phasing movement of the boom stages.

Having illustrated and described a preferred form of my invention, it should be apparent to those skilled in the art that the same permits of modification in arrangement and detail. I claim as my invention all such modifications as come within the true spirit and scope of the following claims:

I claim:

1. A multiple stage extensible and retractable boom for a crane comprising:
 - a first outer boom stage,
 - a second intermediate boom stage extendible and retractable relative to said and telescoping within said first boom stage,
 - a third inner boom stage extendible and retractable relative to and telescoping within said second boom stage,
 - a first reversible fluid cylinder means for extending and retracting said second boom stage relative to said first stage,
 - a second reversible fluid cylinder means for extending and retracting said third boom stage relative to said second stage,
 - said first and second cylinder means being operable at the same time for simultaneous extension and retraction of said second stage relative to said first stage and said third stage relative to said second stage,
 - and flexible cable-phasing booster means interconnecting said first, second and third stages in a manner so as to ensure that upon simultaneous operation of both said cylinder means to extend said second and third stages and upon extension of one of said second and third stages, the other of said second and third stages will also extend at the same time,
 - said first and second cylinder means having their extension sides hydraulically interconnected and their retraction sides hydraulically interconnected, with the extension and retraction sides of said first cylinder means only being directly connectable to a source of fluid pressure,

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said first cylinder means having a piston rod connected to said first stage and a cylinder portion connected to said second stage,
said second cylinder means having a piston rod connected to said second stage and a cylinder portion 5 connected to said third stage,
a first fluid passage means leading from selective communication with said source and extending axially through the piston rod of said first cylinder means into communication with the retraction side 10 of said first cylinder means,
a second fluid passage means extending from the retraction side of said first cylinder means axially through the piston rod of said second cylinder means and into communication with a retraction 15 side of said second cylinder means,
third fluid passage means extending from selective communication with said source axially through

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the piston rod and into communication with an extension side of said first cylinder means,
fourth fluid passage means extending from the extension side of said first cylinder means axially through the piston rod of said second cylinder means into communication with the extension side of said second cylinder means,
said cable-phasing means including flexible cable means fixed at one point to an outer portion of said first stage, then in succession passing over a sheave means on an inner end portion of said second stage, fixed to said third stage at a second point inwardly of the outer end of said second stage, passing over a second sheave at an outer end portion of said second stage and fixed at a third point to said first stage.

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