A three-part boom for a crane or the like has the usual pair of hydraulic cylinders, one for the forward boom section and one for the intermediate boom section. Fluid connections for the forward cylinder is through the rear piston rod and cylinder so as to use no hose reel. Extension of the forward section only when desired is achieved by a solenoid valve between cylinders, the electric cord for which requires only a small reel.
INTRODUCTION

The invention of which the present disclosure is offered for public dissemination in the event that adequate patent protection is available relates to the extending and contracting of telescopic booms for cranes and the like. There has long been recognition that with a telescopic boom having three or more parts, it is undesirable to extend the forward weaker part out from the intermediate part before the intermediate part has been extended out from the stronger base part.

Numerous inventions have been provided for avoiding this improper sequencing. The improper sequencing should be avoided because the successive stepping of size of the boom sections to telescope one within the other results in having a forward section which is considerably weaker than the intermediate section. With mobile cranes and proper engineering the forward section has enough strength for the loads which can be lifted without upending the supporting vehicle, when both sections are fully extended. However, with less extension heavier loads can be lifted, and these heavier loads could cause collapse of the lighter boom section if it were fully extended while the intermediate section remained retracted. There is no such danger when the intermediate section is fully extended and the lighter section retracted within the intermediate section.

Of course, each section is controlled by a hydraulic cylinder which, with its piston, is coupled between it and the next section rearward. The old conventional control is to have a manual valve for each cylinder so that the operator can crowd by operating first the valve for the rearmost cylinder and then the valve for the forward cylinder. Usually the valve handles are side by side so that if the operator chooses, he can grasp both the handle knobs in one hand, and operate both valves simultaneously. This two-valve system necessitates the use of high pressure hoses, wound and paid out by hose reels, for the hydraulic connection to the two ends of the forward cylinder.

There has long been a recognized desire to avoid such hose reels. By giving up the selectivity resulting from two valves, it was possible to avoid the hose reels by using the piston rods, or one of them, for carrying the hydraulic fluid through passages within the piston rods. But this heretofore has either lost the selectivity desired as to order of sequencing, or has lost some aspects of this selectivity.

According to the present invention, all selectivity desired in the sequencing of the cylinders is provided with a single valve and without hose reels by providing a solenoid valve between the cylinders. A small light reel for the connecting cord for controlling the solenoid is the only reel required.

Additional objects and advantages will be apparent from the following description and from the drawings.

DESIGNATION OF FIGURES

FIG. 1 illustrates a mobile crane with a three-part boom with which the present invention is especially likely to be used.

FIGS. 2, 3 and 4 are somewhat diagrammatic views of the three-part boom fully retracted in FIG. 2 and fully extended in FIG. 4, with FIG. 3 showing the forward section fully retracted within the fully extended intermediate section.

FIG. 5 is a partially diagrammatic view showing the hydraulic and electrical connections, including the key solenoid valve, according to the present invention.

INTENT CLAUSE

Although the following disclosure offered for public dissemination is detailed to ensure adequacy and aid understanding, this is not intended to prejudice that purpose of a patent which is to cover each new inventive concept therein no matter how others may later disguise it by variations in form or additions or further improvements. The claims at the end hereof are intended as the chief aid toward this purpose, as it is these that meet the requirement of pointing out the parts, improvements, or combinations in which the inventive concepts are found.

BACKGROUND DESCRIPTION

Mobile hydraulic cranes such as illustrated in FIG. 1 have been very popular for a number of years. Some of these cranes have three-part booms as illustrated with a base section 11, an intermediate section 12 which may telescope within the base section 11, and a forward section 13 which may telescope within the intermediate section 12. Of course a sheave head 14 is carried by the forward portion 13, and includes one or more sheaves from which a line 16 hangs, the line 16 carrying the load and being wound or paid out by a hydraulic reel 17 near the base of base section 11. The base section can usually be swung up and down and from side to side.

It is apparent from FIG. 1 that with such three-part booms, section 13 is lighter in cross section than section 12 and section 12 is lighter in cross section than section 11. The appropriateness of this is evident from FIG. 1, for in that position the forward section 13 need only withstand the torque arm represented by its length, whereas the intermediate section 12 must withstand a torque arm all of the way from the line to the base of the intermediate section 12, and the base section 11 must withstand the same weight on a still greater torque arm.

When it is desired to raise a heavier load than can be raised with the boom in the FIG. 1 condition without danger of upending the vehicle chassis 18, the vehicle moves closer to the load, and its boom is retracted (or swung upwardly) so that the depending line 16 hangs closer to the boom and the maximum torque arm is decreased. With the boom fully retracted, the line 16 hangs down from only a small distance ahead of the sturdy base 11 and both because of the strength of this base and the nearness to the vehicle, very heavy loads can be raised. Often the loads which can thus be raised are too great for the strength of relatively slim forward boom section 13, if fully extended at anything like the angle shown, so that the torque arm about its rear portion lying within intermediate section 12 is comparable to its full length.

Because of these considerations, the safest method of operating a boom with three sections is to make a practice of keeping the forward section fully telescoped within the intermediate section except when more boom length is required than full extension of the intermediate section will provide. Some operators may have
a preference (especially if the forward cylinder is of smaller cross-section and hence moves faster) for operating both the crowd cylinders at once, but will still usually be careful not to have the forward section extending from the intermediate section more than the intermediate section extends from the base section. FIGS. 2, 3 and 4 represent the safest practice. Thus with sections 11, 12 and 13 initially fully telescoped within one another, the operator (with two reversing valves or with this invention) will supply pressure fluid only to cylinder 21, so that the only telescopic action is between base section 11 and intermediate section 12, until the condition of FIG. 3 is reached or approached. Here the intermediate section 12 is fully extended, but the forward section 13 is still fully retracted within the intermediate section 12. At this point, or perhaps slightly before so that there will be no pause between sections, oil under pressure will be supplied to the forward cylinder 22 so that it will extend the forward section 13 outwardly from the intermediate section 12 until eventually the full extension shown in FIG. 4 is reached.

SELECTIVITY ACCORDING TO THE PRESENT INVENTION

Cylinder 21 has a piston 23 with a piston rod 24. Cylinder 22 has a piston 26 with a piston rod 27. Each cylinder is carried somewhat floatingly by a ring 28 carried by the boom section which it controls, and each piston is connected by a horizontal pin 29 to the next rearward boom section.

When crowd control handle 31 is pressed forwardly, it actuates conventional reversing valve 32 to supply oil to crowd line 33. This leads, through such flexible and perhaps swivel connections as may be needed, to crowd passage 34 in piston rod 24. This passage extends through the head of piston 23 to open into crowd chamber 35, so that the hydraulic fluid exerts its great force toward producing forward movement of cylinder 21 and its associated intermediate section 12. A line 36 leads toward passage 37 in forward piston rod 27 and this passage again extends through the head of piston 26 into crowd chamber 38 so that the fluid pressure can also urge forwardly the cylinder 22 and its associated forward boom section 13. However, an important feature of the present invention is the inclusion of valve 39 in line 36 so that this line may be kept initially closed. If it were not closed, there would be equal oil pressures in chambers 35 and 38 (except for fluid friction losses). This is essentially a connecting of two cylinders in hydraulic parallel in that the oil may choose to expand either chamber 35 or chamber 38, depending upon which chamber will expand at the lower pressure, i.e., which has the least load compared to its effective area.

According to an important feature of the present invention, the valve 39 is a solenoid valve which remains closed all the time except when a button 41 on handle 31 is pressed. Accordingly when the operator initially thrusts handle 31 forwardly without pressing button 41, valve 39 prevents flow of oil to chamber 38 and hence the oil can only expand chamber 35. Therefore intermediate boom section 12 is the first to be extended, of course carrying forward boom section 13 with it, but fully retracted within it.

When greater boom extension is required than can be achieved merely by extending intermediate section 12, the operator presses button 41 while retaining handle 31 thrust forwardly. This connects a circuit through cord 42 and reel 43 on which cord 42 is wound to solenoid 44, thereby opening valve 39. Now oil may flow through passage 37 to chamber 38, expanding this chamber, and extending forward boom section 13 out from intermediate boom section 12.

For retraction, the operator will draw handle 31 rearwardly, and if forward boom section 13 is extended, he will simultaneously press button 41. Handle 31 operates reversing valve 32 to supply pressure fluid to retract line 46 which leads to passage 47 in piston rod 24 and opens adjacent to the head of piston 23 into retract chamber 48. A line 49 leads from the rear end portion of cylinder 21 to retract passage 51, in piston rod 27, which opens into retract chamber 52 of forward cylinder 22. Thus the hydraulic fluid acts in parallel, urging both cylinders to retract.

It will be understood, of course, that the terms "crowd" and "retract" for the lines and passages are used for convenient identification. The retract lines and passages serve as return lines during crowding, and the crowd lines and passages serve as return lines during retraction. Thus during retraction of cylinder 22 oil is forced from chamber 38 through passage 37 through the valve 39 which is maintained open by holding the button 41 depressed, through line 36 through chamber 35 through passage 34, and through line 33 which is connected by valve 32 to discharge line 53 leading to reservoir 54.

In retraction, it is desirable that forward boom section 13 retract fully into intermediate boom section 12 before the retracting movement of boom section 12 begins. Fortunately this usually results from the fact that boom section 13 is only partly extended and boom section 12 is fully extended. When boom section 12 is fully extended it exerts maximum torsional or cantilever force on its bearing pads 56 and 57 which will at this time be relatively close together. This gives these bearing pads maximum frictional resistance to resist premature retraction of boom section 12. Since boom section 13 will usually not be fully extended, the torsional or cantilever pressures on its bearing pads 58 and 59 will be relatively less, and the resulting resistance to retraction of forward boom section 13 will be relatively less, so that this boom section will retract first.

When a load is already supported by the boom at the time retraction begins, the mere premature retraction of intermediate boom section 12 will not place any additional strain on the extended boom section 13, so that there will usually be no danger to this boom section in its failure to retract first. If no load is supported, and a heavy load is to be picked up, special attention by the operator may be required. If forward boom section 13 did not fully retract, the safest operation can be achieved in a very short time by drawing back handle 31 with button 41 depressed to fully retract both boom sections, then thrusting handle 31 forwardly without depressing button 41, so as to extend only boom section 12 until the proper length of boom is achieved.

If the failure of forward boom section 13 to retract first should occur often enough to be significant, various expedients could be adopted to prevent premature retraction of intermediate boom section 12. Such possibilities are diagrammatically indicated by a recess 60 in the slide surface which engages bearing pad 57, so that bearing pad 57 would engage this recess at the end of the extending movement of intermediate boom section.
12 and act as a detent to prevent retraction of intermediate section 12 until relatively high oil pressure had been built up in retraction cylinder 42. Instead of such a detent action, it would be quite simple to provide a solenoid actuated lock which would not interfere with extension of boom section 12 but would lock it in its outermost position. This could be power actuated to locking position and energized whenever solenoid 34 is connected. There might then be two electrical reels 43. One would be carried by intermediate boom section 12 so as to provide a connection to the locking solenoid, and the other could be reel 43 as shown but connected through the first-mentioned reel, or merely extending its connection in parallel to the solenoid 44.

In any event, it is preferred that reel 43 be carried by the moving element and positioned to pay out its cord 42 along a supporting surface with respect to which the cord would be stationary. Thus although the reel 43 has been shown adjacent to solenoid 44 for illustrative convenience, it would more likely be positioned near the bottom of the cross section of boom section 13. Then as boom section 13, fully collapsed within boom section 12, moves jointly with boom section 12 as boom section 12 is extended and retracted, the cord 42 would be laid out along the bottom inner surface 61 of base boom section 11 during extension, and during retraction would be reeled in from this surface. Such electrical reels, spring actuated to maintain a suitable tension on the cord they pay out or reel in, are already well known. Of course the wire in cord 42 is connected through a slip-ring connection to a wire 62 leading to the solenoid. There may be two wires and two slip rings instead of using a ground connection, the ground connection being illustrated for simplicity.

VARIATIONS

Results somewhat similar to the preferred form of the invention, but perhaps lacking full operator's choice, can be achieved with the same hosereel-less hydraulic system by variations of valve 39. For example, there could be an unloading valve instead of or parallel to valve 39 which, in response to attaining a given maximum oil pressure in chamber 35, would open to connect also chamber 38. This pressure would normally only be attained when cylinder 24 had reached the limit of its expansion of chamber 35. To avoid power loss this valve, once opened, could remain open until the extending action through it ceased.

The valve 39 can be bypassed by a check valve permitting retraction flow while valve 39 is closed, so that button 41 need not be depressed during retraction. It should be understood that customary safety valves, not shown, would presumably be provided, although in theory valve 39, if not bypassed as mentioned in the previous paragraph, could replace one of them.

ACHIEVEMENT

From the foregoing it is seen that adequate selectivity in the sequencing of the extending actions of the two crowd cylinders is achieved. The forward weaker boom section 13 will never be extended from the more sturdy boom section 12 except when the operator presses the button 41, which he will normally do when the intermediate boom section 12 is fully extended, or is about to be. At the same time, the use of hose reels for connecting the forward cylinder 22 is avoided. This avoidance of the hose reels is made acceptable by the use of valve 39 which provides proper selectivity without a separate reversing valve for cylinder 22, which would require separate lines for cylinder 22 and hence hose reels.

CARRYING THE INVENTION FORWARD

This invention lends itself to booms of more than three parts. Any number of cylinders can be connected in succession through the next precedence cylinder and piston combination, without hose reels, and through its own solenoid or automatic valve, with each such valve controlled separately to a degree. Ideally, there would be automatic sequencing of these valves to open another when needed, without closing any more rearward valve.

It should be mentioned that the passages in the piston rods are shown only diagrammatically. Usually the piston rod would be a tube with a relatively small tube within. One passage would be inside the smaller tube. The inner tube would be small enough to provide the other passage around it.

Reference to a single manual reversing valve does not exclude companion valves for delivering fluid from another pump to the same line for increased speed.

I claim:

1. A boom with base, intermediate and forward sections successively telescoping within one another and of successively reduced structural strength, a rear cylinder and piston combination connected between the intermediate and base sections, and a forward cylinder and piston combination connected between the forward and intermediate sections, each piston including a piston rod; hydraulic circuitry for the two cylinders including a single manual reversing valve controlled by an actuator means at an operator's position, the rear cylinder and piston combination having two pairs of ports, one leading through the piston rod to the opposite faces of the piston and the other from the opposite ends of the cylinder, one of said pairs of ports being connected to the reversing valve through nonextending lines at the base section and communicating through the other pair of ports through nonextending lines leading to the forward cylinder and piston combination, whereby the single control valve can pass hydraulic fluid to and from at least the rear cylinder and piston combination for extension of it, whether or not the other extends; and a solenoid valve in a connection between the two cylinder and piston combinations, located remotely from the operator and controlled by a circuit-closer located at the operator's position to be operable by the operator at will for selecting the time at which oil directed to the rear cylinder by the manual reversing valve is permitted to flow to the forward cylinder.

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