June 8, 1965 R. J. BUSHONG ETAL 3,187,906

CRANE WITH PNEUMATICALLY EXTENSIBLE GANTRY MAST

Filed Jan. 25, 1963 4 Sheets-Sheet 1

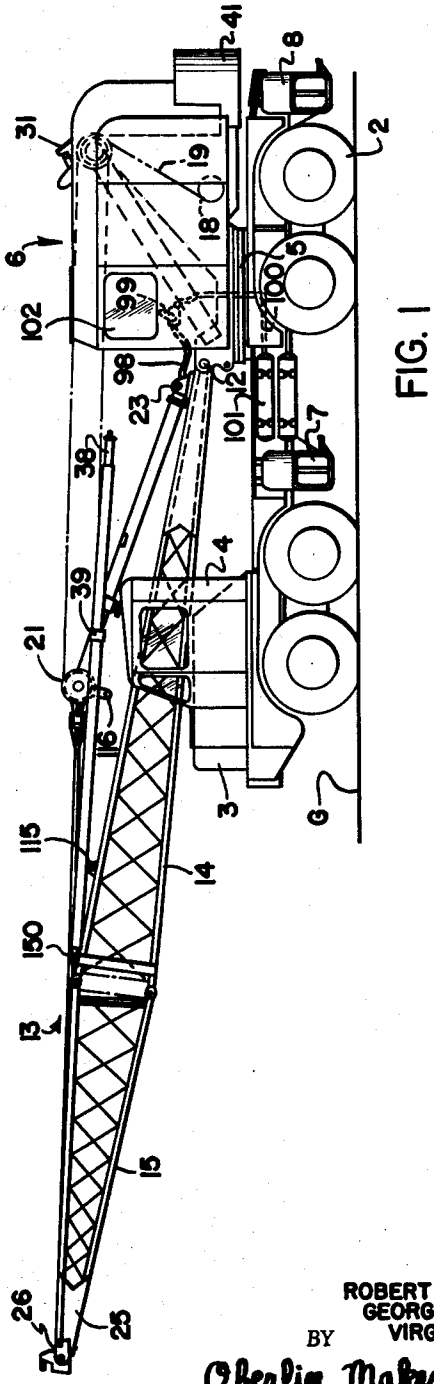


FIG. 1

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CRANE WITH PNEUMATICALLY EXTENSIBLE GANTRY MAST

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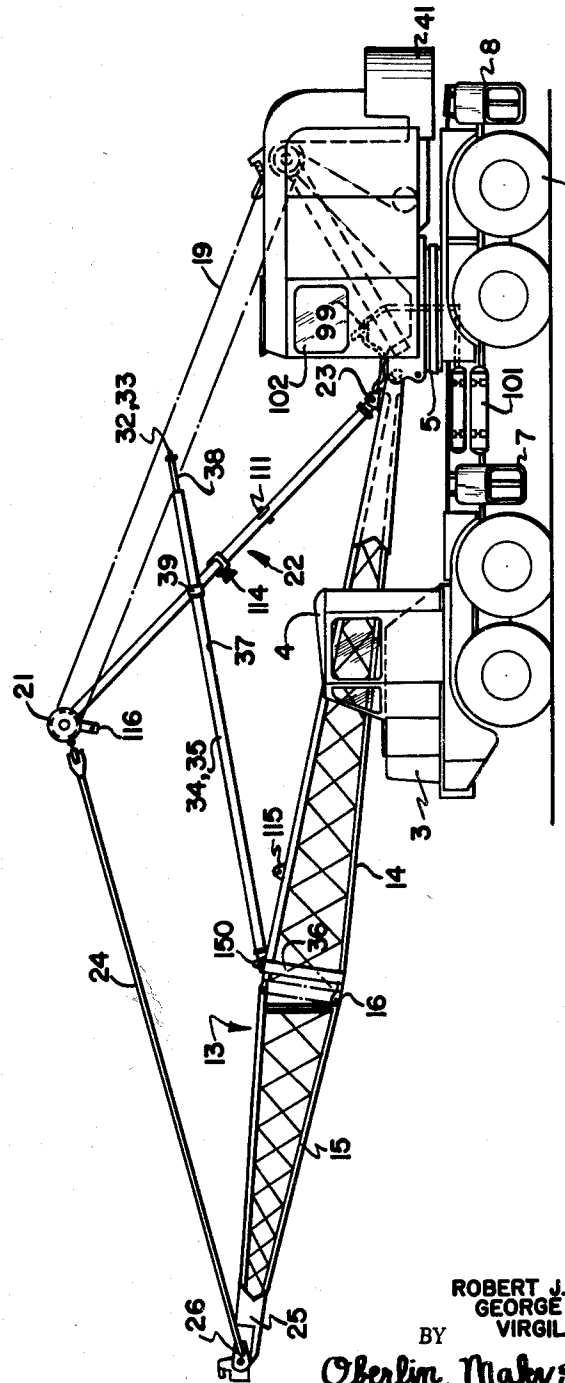


FIG. 2

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CRANE WITH PNEUMATICALLY EXTENSIBLE GANTRY MAST

Filed Jan. 25, 1963 4 Sheets-Sheet 3

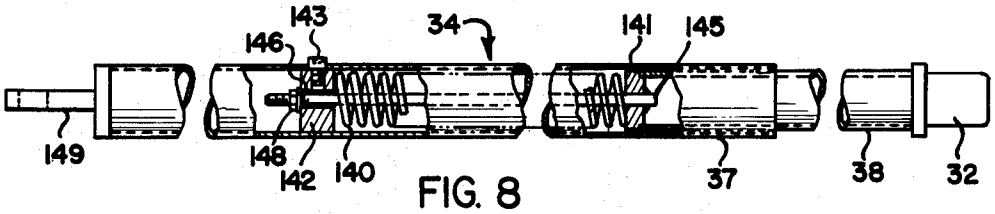


FIG. 8

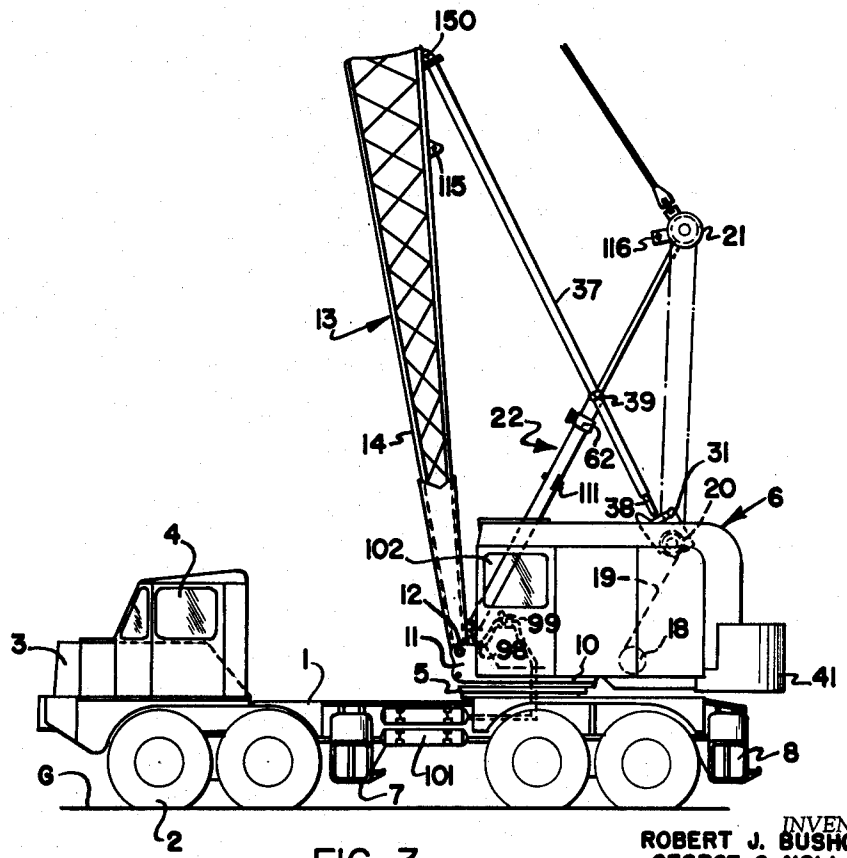


FIG. 3

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Filed Jan. 25, 1963 4 Sheets-Sheet 4

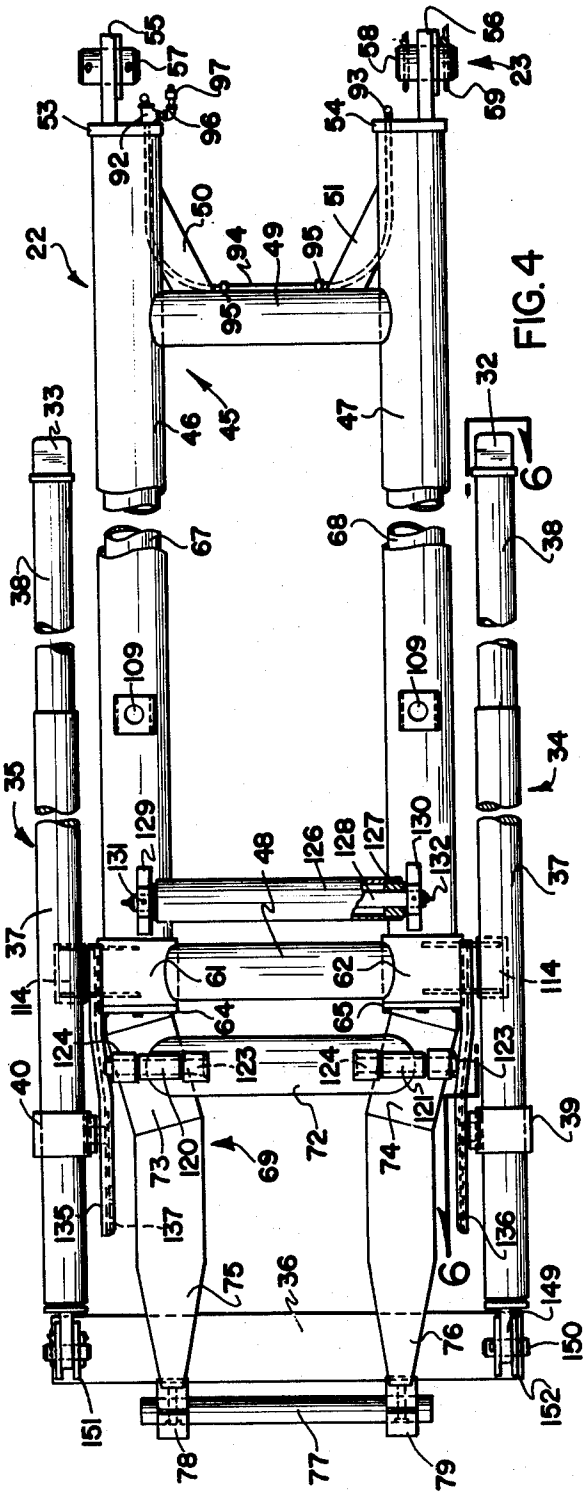


FIG. 4

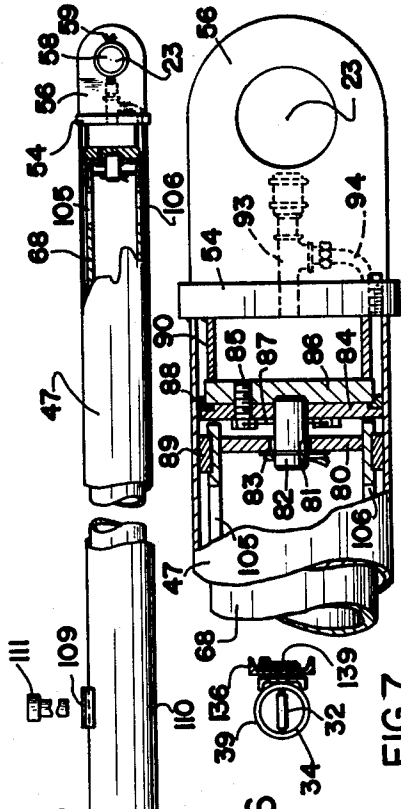


FIG. 7

FIG. 6

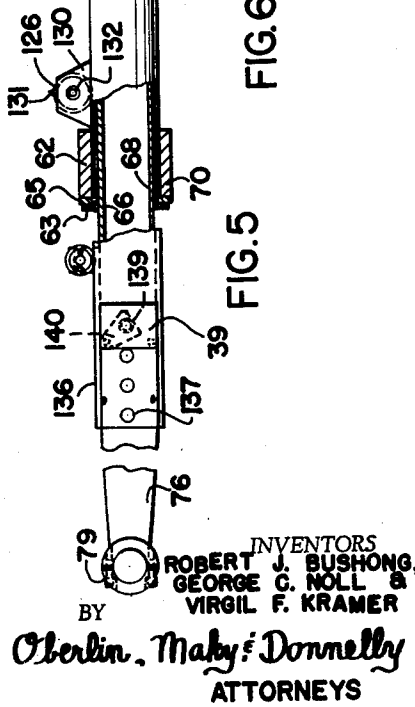


FIG. 5

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3,187,906

CRANE WITH PNEUMATICALLY EXTENSIBLE GANTRY MAST

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Filed Jan. 25, 1963, Ser. No. 253,948
7 Claims. (Cl. 212—59)

This invention relates generally, as indicated, to a retractible mast and boom stop and more particularly to certain improvements in the highly mobile crane incorporating the features of both a retractible mast and a boom stop as disclosed in the copending application of Robert J. Bushong et al., Serial No. 105,145, filed April 24, 1961, entitled "Retractible Mast and Boom Stop," now Patent No. 3,076,560.

In power cranes, shovels and the like, masts are employed to obtain a high angle of incidence between the boom pendants and the boom thereby to obtain maximum lifting capacities. When such cranes are mounted on a truck or carrier chassis for highway movement, the mast is still employed to support the boom in its travel position, but such generally constitutes an obstacle in that the mast exceeds the overall height of the machine and the machine will thus not clear highway bridges, overhead wires and the like. Accordingly, the mast must be retracted for highway travel and extended for crane operation. In such prior copending application, heavy relatively expensive spring mechanisms are employed to extend the mast to working position and considerable pull on the derricking cables is required to compress such spring mechanism to telescope the relatively movable mast section to retract the same for highway travel. With the present invention, the telescoping of the mast can be accomplished by the pull of the derricking lines with little or no resistance and the mast may be extended to working position without the aforementioned heavy spring mechanism.

Moreover, with the present invention, mechanical boom stops carried by the boom and guided by the mast are provided which will contact the machinery A-frame limiting the upward movement of the boom. Such boom stops are provided with spring cushioned end sections which will produce an increasing resistance to the elevation of the boom as it approaches its maximum elevated position. These shock absorbers not only cushion the elevation of the boom but absorb undue shock loading. The force absorbed by these spring cushions can also be employed to move the boom from its position of maximum elevation. Finally, the mounting of the boom stops on the mast is such that the boom can be mounted at different positions on the machinery frame and such cushioned mechanical stopping of the boom can still be obtained.

It is accordingly a principal object of the present invention to provide a retractible mast for a crane and the like incorporating therein a mechanical spring loaded boom stop.

It is another main object to provide a simplified retractible mast for cranes and the like enabling such crane more quickly and easily to be prepared for highway travel.

Still another main object is the provision of such a retractible mast for cranes and the like which can very simply be extended to working position.

A further object is the provision of a retractible gantry mast for cranes and the like which can be extended by fluid pressure and retracted by the boom derricking lines.

A still further object is the provision of a retractible gantry mast for cranes and the like which will adjustably support a positive boom stop guiding the same into contact with the machinery A-frame regardless of the mounting of the boom on such frame.

Yet another object is the employment of boom stop springs which can be compressed and then released to assist the movement of the boom from a position of maximum elevation.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

FIG. 1 is a side elevation of a rubber tired carrier mounted crane in accordance with the present invention with the boom extending over the front end of the carrier in highway travel position;

FIG. 2 is a side elevation of the crane of FIG. 1 with the gantry mast extended;

FIG. 3 is a fragmentary side elevation similar to FIGS. 1 and 2 illustrating the position of the gantry mast and boom stop in the maximum position of elevation of the boom;

FIG. 4 is an enlarged fragmentary top plan detail view partially broken away of the retractible gantry mast and boom stop;

FIG. 5 is a fragmentary side elevation of such gantry mast with the boom stop broken away;

FIG. 6 is a detail sectional view of the end of the boom stop taken substantially on the line 6—6 of FIG. 4;

FIG. 7 is an enlarged fragmentary detail view partially broken away of the proximal end of the gantry mast structure; and

FIG. 8 is a fragmentary detail view of the telescoping members of one of the boom stops broken away illustrating the spring cushion mechanism therein.

Referring now to the annexed drawings and more particularly to FIGS. 1, 2 and 3, there is illustrated a crane in accordance with the present invention. In FIG. 1, the gantry mast is shown retracted and the boom in a substantially horizontal travelling position. In FIG. 2, the gantry mast is shown extended with the boom still in its substantially horizontal position. FIG. 3 shows the gantry mast extended, the boom in its maximum position of elevation, and the boom stops engaging the crane superstructure.

Such crane comprises a chassis or truck carrier frame 1 mounted on rubber tired wheels 22 which are driven by a prime mover in compartment 3 which can be operated from cab 4 at the front of the chassis frame. The front wheels are also steered from such a cab to provide the requisite highway mobility for the crane carrier. Mounted on the bed of the chassis frame is a turntable 5 which supports a crane superstructure generally shown at 6 for revolving movement about the vertical axis of such turntable. Outriggers 7 and 8, of the type preferably including curved outrigger beams which may be extended laterally of the frame 1 by means of hydraulic piston-cylinder assemblies, are mounted on the chassis frame 1 to provide a wider and firmer operating base support for the turntable 5 and the crane superstructure 6 mounted thereon.

The turntable bed 10 of the superstructure 6 is provided at its forward end with a boom foot 11 to which is pivotally mounted at 12 the foot of boom 13. As shown in FIGS. 1 and 2, such boom 13 comprises a base section 14 and a peak section 15 pin-connected together as at 16.

Whereas only a peak and base section of the boom are shown, it will readily be understood that the intermediate boom sections may be interposed between such peak and base sections to provide a boom of longer length. The boom 13 is raised and lowered by means of a hoisting drum 18 in the crane superstructure 6 and a boom derricking line 19 is wrapped around such drum and extends about a reeving in a harness 20 and about similar reeving in a harness 21 mounted on the distal end of retractible gantry mast 22.

Such gantry mast 22 is pivoted to the back of the boom base section 14 as indicated at 23. Boom pendants 24 connect the harness 21 at the peak of the gantry mast and the peak frame member 25 on the peak of the boom 13 as shown at 26. The boom derricking line then extends from the drum 18 about a sheave in the harness 20, then about a sheave in the harness 21 and back about a sheave in the harness 20 and then back about a sheave in the harness 21, etc., and is anchored on one or the other harness. Thus a pull on the derricking cable will move the harnesses 20 and 21 toward each other exerting a pull on the boom pendants 24 which in turn exerts a pull on the peak of the boom to elevate the boom about its foot or pivot 12.

The harness 20, which may include as many as four sheaves for the boom derricking line 19, is mounted at the peak of an A-frame 30 in the crane superstructure 6 and such superstructure includes two spaced boom stop contact members 31 adapted to engage the distal ends 32 and 33 of boom stops 34 and 35. Such boom stop members 34 and 35 are connected to a strap or plate 36 which is secured about the upper portion of the base section 14 of the boom 13. Each of the boom stop members comprises telescoping inner and outer tubular members 37 and 38 with the outer member 38 being slide guided in trunnions 39 and 40 mounted on special brackets on the gantry mast 22. Thus both the boom stop members and the gantry mast are pivotally connected to the boom base section and both will be elevated and lowered with the boom. A counterweight 41 is positioned at the back of the A-frame and such will counterbalance the weight of the boom, mast and stop assembly, and the load carried thereby about the axis of the turntable 5.

Referring now to FIGS. 4, 5 and 7, it will be seen that the gantry mast 22 may comprise a bottom section 45 comprised of two parallel 6 inch O.D. tubes 46 and 47, approximately 9 feet, 3 inches long. Such outer bottom tubes are interconnected by transverse tubing 48 and 49 with gusset plates 50 and 51 being employed with the latter to rigidify the entire bottom section 45. The lower ends of such tubes 46 and 47 are closed by circular end plates 53 and 54 to which are secured projecting apertured plates 55 and 56, respectively, accommodating pins 57 and 58 which are employed with cotter pins 59 to pin-connect the proximal end of the retractible gantry mast to the top of the boom base section 14 near the boom foot 11.

The transverse tubular framing member 48 at the distal ends of the tubes 46 and 47 extends between collars 61 and 62 which enclose the upper ends of such tubes. Secured to the ends of the collars by screws 63 are lock rings 64 and 65 which retain annular seals 66 surrounding the exterior of tubes 67 and 68 of the upper movable section 69 of the retractible gantry mast. The retaining rings 64 and 65 retain not only the seals 66, but bushings 70 between each retaining ring and the end of the outer tubular members 46 and 47. The bushings then provide a sliding bearing for the inner tubular members 67 and 68 within the outer tubular members 46 and 47.

The upper or movable section 69 of the retractible gantry mast comprises essentially the inner tubular members 67 and 68 which are joined together by a tubular cross brace 72 connecting angularly inwardly directed portions 73 and 74 of such tubes 67 and 68 respectively. The outer more closely spaced distal ends of the tubes 67 and 68 are flared as shown at 75 and 76 and support a transverse axle 77 for the sheaves of harness 21 by means of removable caps 78 and 79.

As seen perhaps more clearly in FIG. 7, the inner ends of each of the inner tubes 67 and 68 are closed by means of an end plate 80 having a central aperture 81. Through such aperture there is provided a spacer pin 82 held on the inner side of the end plate 80 by a cotter pin 83. The pin 82 is welded to a plate 84 which is in turn secured by screws 85 to a follower cup 86. The screws 85 may be wire-locked together as shown at 87. Held between the plate 84 and the follower cup is an annular sliding packing 88. The end of the tube 68 is recessed to accommodate a bushing 89 providing a sliding bearing support for the inner end of the tube 68 within the outer tube 47. A relatively short stop tube 90 is secured to the end plate 54 limiting the inward movement of the tube and packing assembly with respect to the outer tube. The structure of the inner tube 67 within the tube 46 will be exactly the same as that shown in connection with the tubes 68 and 47.

Each of the end plates 53 and 54 is provided with a tapped air aperture in which are secured a T 92 and a fitting 93, respectively. The T and fitting are interconnected by a length of air tubing 94 which, as seen in FIG. 4, extends along the outside of the tube 46 and across the tubular brace 49, being held thereto by clamps 95, and then along the tube 47 to the fitting 93. Secured to the T 92 is an elbow 96 which in turn has secured thereto a quick-disconnect coupling 97.

As seen in FIGS. 1, 2 and 3, an inflation hose 98 may be connected to such coupling 97 and such hose extends to a valve 99 of the three-way type, i.e., open, closed, exhaust, which is in turn connected by air tubing 100 to air reservoir 101. The carrier air reservoir tanks 101 will normally be employed to provide the air pressure require to extend the gantry mast 22 and it will be understood that the valve 99 may be situated in the operator's cab 102, as shown, or may be provided on the carrier itself. When the valve is situated in the operator's cab 102, the line 100 will normally extend through a rotary seal in the turntable 5. It can now be seen that the operator can quickly supply the proximal end of the retractible gantry mast with air under pressure, at preferably about 90 pounds per square inch, by simple manipulation of the valve 99, and this air pressure will be sufficient to cause the outer section of the mast 69 to telescope outwardly of the inner section 45.

As the air pressure forces out the upper mast section 69, the operator will pay out the derricking cable 19 until holes 105 and 106 in the inner tubes 67 and 68 are aligned with holes 109 and 110 in each of the outer sections 46 and 47. Locking pins 111 may then be inserted through such aligned apertures. Such locking pins will preferably be held in place by lock washers, cotter pins, or the like and the gantry mast 22 is thus locked in its extended position. The mast will have then moved from the FIG. 1 to the FIG. 2 position as the derricking cable 19 is payed out. The derricking cable can now be operated to raise the gantry mast and boom to the working position. The valve 99 may then be turned to exhaust the air within the tubes 46 and 47 to atmosphere and the hose 98 may be disconnected from the coupling 97.

To place the booms 13 in a travel position, this is accomplished simply by lowering the boom 13 to a horizontal position on supports or with the boom peak 25 resting on the ground G. This can be done over the side or rear of the carrier. The operator then slacks off on the derricking cable 19 until the mast 22 rests on the boom and the pendants and cables are slack. The hose 98 is then connected to the coupling 97, the valve 99 being closed.

The operator then removes both locking pins 111 and commences to pay in the derricking line 19. The force of the derricking line will then telescope or retract the upper mast section 69 into the lower mast section 45. When the derricking cables become taut, the operator

then may set valve 99 either to return air to the reservoir 101 or to exhaust air to atmosphere. Continued reeling in of the derricking cable 19 will not only retract the upper mast section, but will also take up the slack in the pendants 24. When such slack is taken up, the boom will then be picked up and at the proper height may be swung to travel position adjacent the carrier cab as seen in FIG. 1. When in such travel position, the retracted mast 22, as seen in FIG. 1, will not project above the normal height of the boom and crane superstructure to constitute an obstruction for highway travel. The inflation hose 98 can then be removed and the crane is ready for highway travel.

If it is desired to travel with the base section of the boom only, the boom can be lowered to supports or the ground as in the preceding procedure. The derricking cable 19 is payed out to lower the fully extended and locked mast structure to rest on top of the boom base section. Supports 114 on hubs 61 and 62 are provided properly to space the mast and boom. The operator will then remove all of the top sections of the boom and the appurtenant bom pendants. The operator may then insert an erecting pin through lifting eyes 115 on the base boom section and through apertures in the distal ends of links 116 on the harness 21 at the distal end of the mast 22. The mast in its extended position will then be pin-locked to the base boom section 14 and the operator may employ the derricking cable 19 to raise the boom base section to travel height and then swing the assembly into travel position. To return to operation, the above steps are, of course, reversed.

When the mast 22 is parallel to the boom base section 14, the derricking cable 19 passing about the sheaves in the harness 21 will require to be deflected in order to clear the transverse tubular framing member 48 and the hubs 61 and 62. For this purpose, roller mounting brackets 120 and 121 are provided on the end portions of the transverse frame 72 of the outer mast section 69. Each of the brackets supports an elongated pin 123 which projects from both ends of the brackets supporting rollers 124 on such ends. There are thus four relatively small cable support rollers provided by such brackets which will be aligned with the sheaves on the axle 77 adjacent the mast support caps 78 and 79.

A further elongated roller 126 is mounted on bushings 127 in turn mounted on shaft 128 extending between shaft supports 129 and 130 mounted on the exterior tubular frame members 46 and 47, respectively, of the inner mast section 45. The shaft 128 may be held in such supports by screws 131 and grease fittings 132 are provided to lubricate the bushing-shaft bearing surface. The roller 126 together with the four rollers 124 serve to deflect the derricking cable 19 when the mast 22 is substantially horizontal.

Brackets 135 and 136 are secured to the outside of the hubs 61 and 62 and project longitudinally outwardly along the outer tubular portions 75 and 76 of the outer mast section 69. As seen in FIG. 6, the sectional configuration of the brackets 135 and 136 is in the form of a channel beam with the flanges extending inwardly or toward each other. Each channel shape bracket is provided with four equally spaced apertures 137 as shown in FIG. 5. Anyone of these apertures may serve as the mounting for the pivot pins 138 for trunnions or boom stop guides 39 and 40. Such pins may be held in place by keepers 140. When the crane is in operation, the trunnion or boom stop guides 39 and 40 will be mounted a fixed distance from the pivot 23 on the top of the room base section 14. These will serve to guide or float the boom stops 34 and 35 into A-frame contact position at the position of maximum boom elevation.

For some cranes, however, it may be desirable to employ a tower boom adapter and accordingly the pivot 12 for the boom on the superstructure 6 may be shifted slightly. Reference may be had to the copending application of Erwin C. Brekelbaum et al., entitled "Crane," Serial No. 211,282, filed July 20, 1962, for a disclosure of such tower boom adapter. This will require a corresponding shifting of the position of the trunnions 39 and 40 on the mast structure 22 so that the boom stop tips 32 and 33 will contact the back stops 31 of the A-frame. For example, the boom stop pivot point may be in the outermost aperture 137 when the boom is hinged on a tower boom adapter. In any event, the location of the boom stop guides or trunnions 39 and 40 may be adjusted with respect to the pivot 23 and thus with respect to the boom foot pivot 12 properly to cause the boom stops to engage the back stops 31 as the boom is elevated.

As seen in FIG. 8, each of the boom stops 34 and 35 is comprised of inner and outer telescoping tubular members with a spring 140 being interposed between the end 141 of the inner member 38 and an annular block or plug 142 within the outer member 37. Screws 143 may be employed to hold the block 142 longitudinally stationary within the outer tube 37. Although only one is shown in FIG. 8, it is preferred that three be employed firmly to hold the block 142 in the tube 37. The inner tube 38 is retained within the outer tube by means of a rod 145 which extends through and is welded to the end 141 of the inner tube 38. Such rod extends through the spring 140 and freely through an aperture 146 in the center of block 142. The end of the rod 145 projecting through the aperture 146 is threaded and provided with a stop nut 148 which will limit the movement of the inner tube 38 with respect to the outer tube 37. Such stop nut will, however, not preclude the inner tube from telescoping within the outer tube against the compression of spring 140. The proximal end of each of the outer tubular members 37 is closed and provided with an eye plate 149 which is then connected by pins 150 to clevises 151 and 152 on the top of the strap or plate 36 mounted on the top of the boom base section 14.

Thus, as seen in FIGS. 1, 2 and 3, the boom stops 34 and 35 will be slide-guided through the trunnions 39 and 40 which are pivoted on the mast 22 a fixed distance from the boom foot pivot 12 into mechanical engagement with the stopper plates 31 limiting the maximum elevation of the boom and, of course, preventing the boom from pivoting over the back of the machine.

The spring loaded tips of the boom stops not only act as cushions absorbing undue shock as the boom reaches its position of maximum elevation, but they also provide an increasing resilient pressure which will, of course, be at maximum when the boom is in maximum elevation position. Also, it has been found that with retractible gantry masts and boom stops of the type shown herein, the center of gravity of the boom assembly may actually move beyond the vertical plane of the pivot 12 retaining the boom in its maximum position of elevation requiring an external force to pivot the center of gravity back beyond the vertical plane of the pivot 12. Thus the operator may employ the compressed force of the springs 140 to assist in moving the boom structure in a counterclockwise direction as seen in FIG. 3. By reeling in the derricking cable 19, the spring 140 will, of course, be compressed and by releasing such derricking cable the compressed springs will tend to pivot or initially move the boom and mast assembly in a counterclockwise direction about the pivot 12 until the center of gravity moves beyond the vertical plane of the pivot 12. Accordingly, the springs 140 not only serve as cushions, but also as a means to store energy which can then be applied when the derricking cable 19 is released to pivot the boom structure in a counterclockwise direction about the boom foot pivot 12.

With the present invention, it has been found that crane capacities can be markedly increased by means of

a gantry and back stop assembly which can very easily be erected and lowered by the use of the machine air system and the operation of the derricking cable.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We, therefore, particularly point out and distinctly claim as our invention:

1. In combination, a frame, a boom pivoted to said frame for vertical swinging movement about a horizontal axis, a fluid pressure retractible and extensible gantry mast pivotally connected to said boom, hoisting means connected to the peak of said mast for vertically swinging said mast and thus said boom, and a source of air under pressure connected to said mast to extend said mast and whereby said hoisting means is adapted for retracting said mast thereby renewing said source of air under pressure.

2. The combination of claim 1 in which said mast comprises telescoping inner and outer sections with sliding seal means interconnecting said inner and outer sections, and valve means connecting said source of air to said outer mast section, whereby opening of said valve means will supply air under pressure to said outer section to force said inner section longitudinally outwardly thereof.

3. The combination of claim 2 in which said inner section of said mast is closed by an end plate, a follower cup is secured to said end plate, and an annular packing means is positioned between said end plate and said follower cup.

4. The combination of claim 3 in which said end plate is provided with an air aperture, a coupling is attached to said aperture, and an air hose is connected to said coupling to supply air to said valve means.

5. The combination of claim 2 in which said valve means is adapted to supply air for extending said mast, to return air to said air source and to exhaust air to the atmosphere.

6. The combination of claim 2 in which locking means are provided in said mast for locking such in its extended position.

7. In combination, a frame, a boom pivoted to said frame for vertical swinging movement about a horizontal axis, a mast pivotally connected to said boom, a trunnion mounted on said mast a fixed distance from such mast-boom pivot, pendants interconnecting the peak of said mast and the peak of said boom, hoisting means connected to the peak of said mast for vertically swinging said mast and thus said boom, a stop member connected to said boom and slide guided by said trunnion, said stop member comprising two elongated tubular members telescoped one within the other and a compression spring interposed between and connected to said tubular members resiliently urging said inner tubular member to maximum extended position, said stop member engaging said frame and compressing said spring on maximum elevation of said boom, said mast including telescoping inner and outer sections, a source of air under pressure for extending said mast, valve means connecting said source of air to said outer mast section, and sliding seal means interconnecting said inner and outer mast sections, whereby opening of said valve means will supply air under pressure to said outer section to force said inner section longitudinally outwardly thereof and whereby said hoisting means is adapted for retracting said mast thereby renewing said source of air under pressure.

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