Dec. 9, 1952 A. S. MULLGARDT 2,620,930

ADJUSTABLE OBJECT HANDLING CRADLE

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Fig. 1

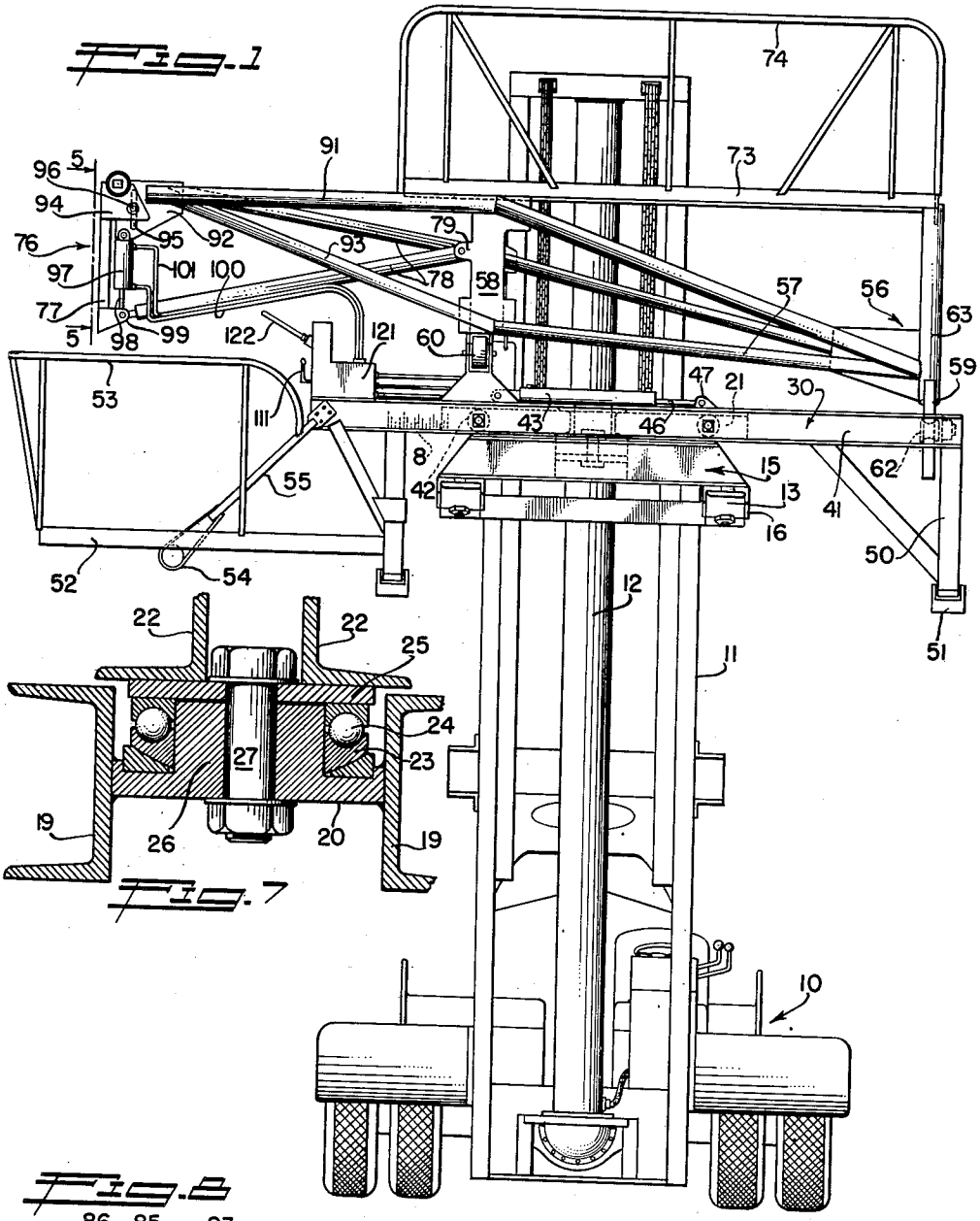
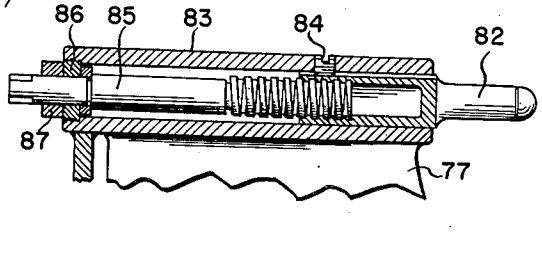


Fig. 7

Fig. 8



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ADJUSTABLE OBJECT HANDLING CRADLE

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Fig. 2

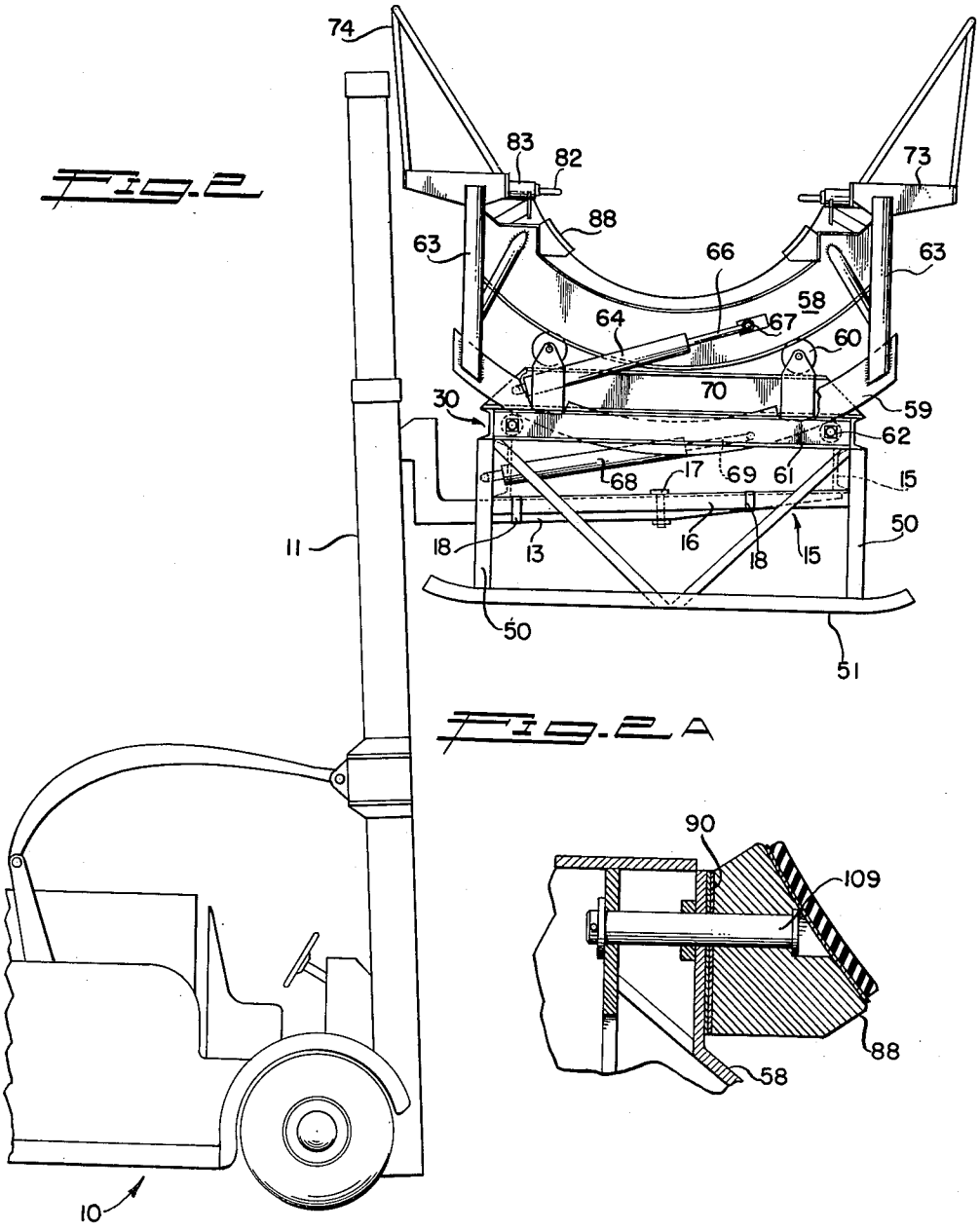


Fig. 2A

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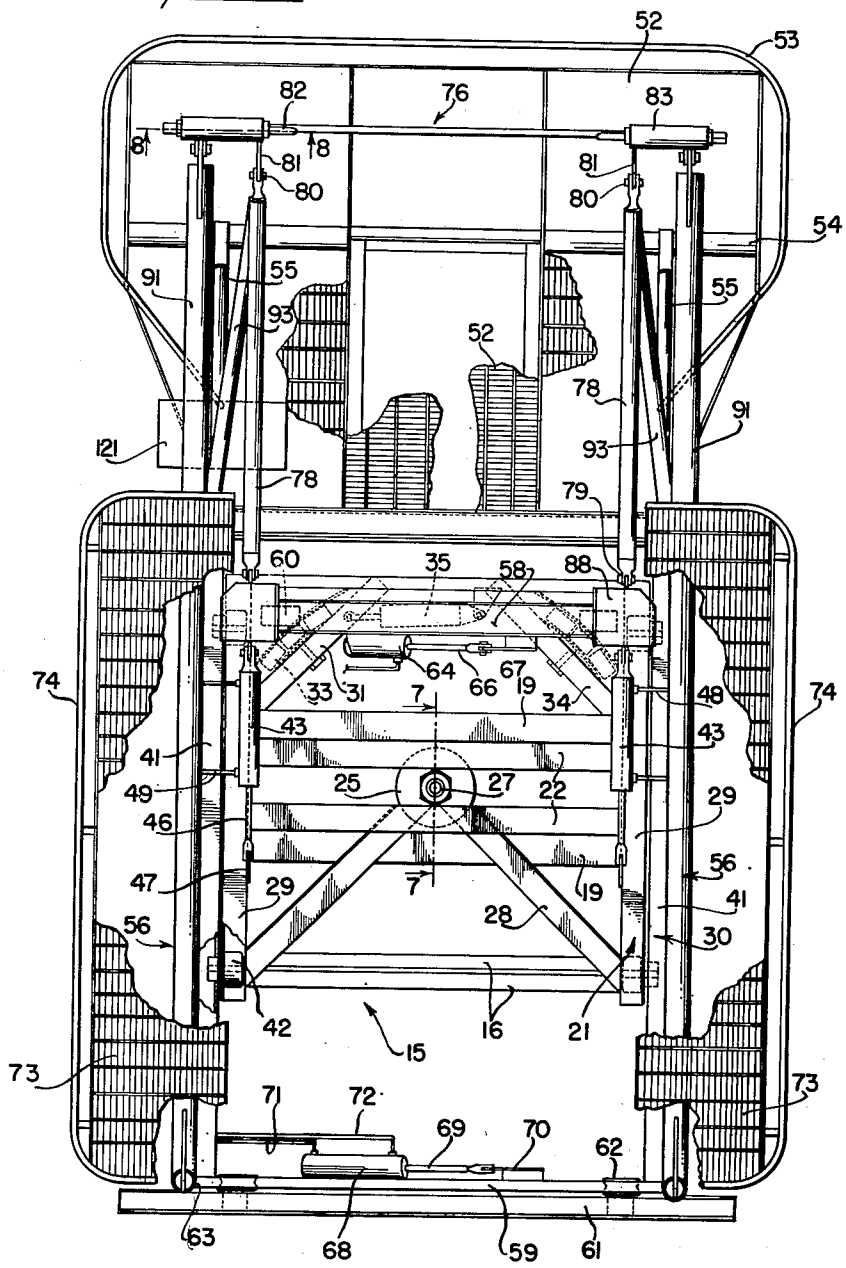
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ADJUSTABLE OBJECT HANDLING CRADLE

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FIG. 3



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ADJUSTABLE OBJECT HANDLING CRADLE

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Fig. 4

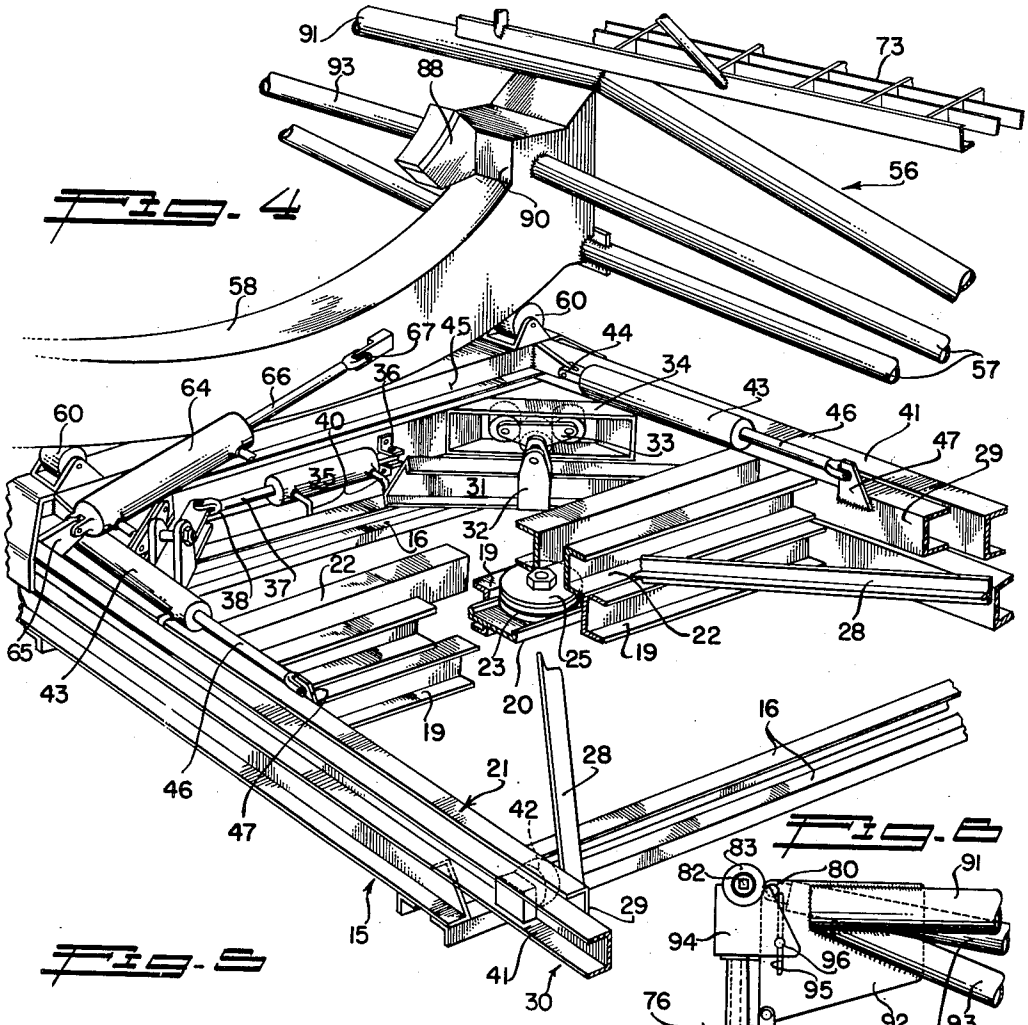


Fig. 5

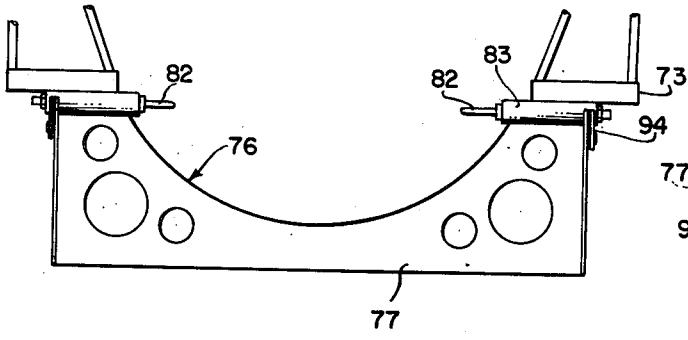
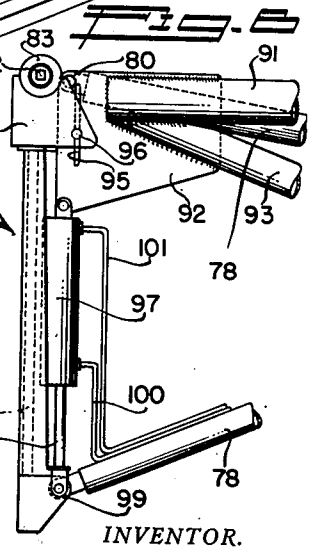


Fig. 6



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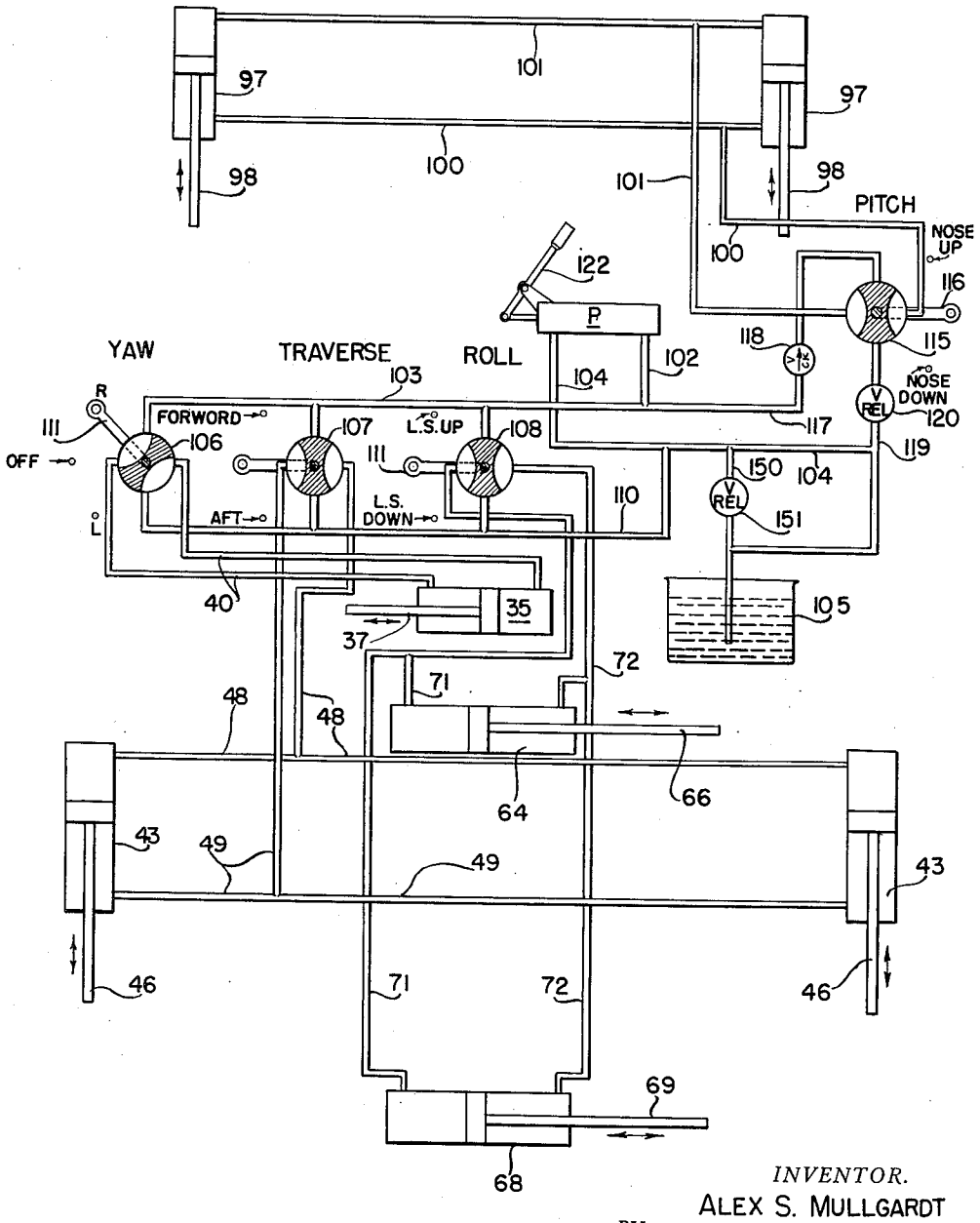
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ADJUSTABLE OBJECT HANDLING CRADLE

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Fig. 9



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Patented Dec. 9, 1952

2,620,930

UNITED STATES PATENT OFFICE

2,620,930

ADJUSTABLE OBJECT HANDLING CRADLE

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Application February 18, 1949, Serial No. 77,214

8 Claims. (Cl. 214—1)

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This invention relates to equipment for handling, servicing and installing heavy and relatively heavy objects and relates, more particularly, to equipment of such character adapted for use with lift trucks and other mobile lift vehicles.

There are many instances when it becomes necessary to install heavy objects and devices in elevated positions and to repair, service and remove the same. Overhead cranes and mobile cranes are not always available for such operations and in many cases such cranes would not be well suited for the work. The present invention is directed to a cradle for receiving and supporting large heavy objects and is constructed in such manner that it may be elevated and lowered on the forks, or the like, of a lift truck whereby horizontal translation in one direction and vertical movement is obtained by operation of the truck and the cradle is further constructed to obtain horizontal translation in the other direction, angular movement about a vertical axis, angular movement about a horizontal axis, and pitching or angular movement about a second horizontal axis normal to the first horizontal axis.

It is, therefore, a general object of the present invention to provide a practical, dependable and conveniently operated device or cradle of the above referred to class. The cradle is articulated to obtain the several motions so that the object or device supported thereby may be readily and accurately positioned with respect to its intended support or safely engaged by the cradle for support thereby upon detachment from its normal support. The several motions are separably obtainable and are reversible, permitting full control and a wide range of adjustment or variation in the position of the cradle and its load.

Another object of the invention is to provide a cradle of the character mentioned incorporating power means in the nature of fluid pressure actuated cylinder and piston mechanisms for effecting the several movements of the supported object, with a control system for the several actuating mechanisms governed from a single station. One workman or operator may control the various actuating mechanisms and thus direct the motion of the object supported by the cradle and the control system is such that the movement may be accurately accomplished to bring the supported object to exactly the desired position or to bring the cradle into the correct position for assuming the weight of an object intended to be detached from its stationary support. Simple manipulation of valves and the actuation or control of pressure developing or applying means is all that is required to fully control actuation of the movement producing mechanisms of the apparatus.

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Another object of the invention is to provide a cradle of the character mentioned adapted to be engaged on the fork of a lift truck and designed to carry the load in the most favorable position with respect to the truck. The cradle is designed to be raised and lowered on from the fork of the truck and is constructed to maintain the center of gravity of the load in as close proximity to the lift mechanism of the truck as possible. In addition the cradle may be employed to store or carry an engine or nacelle assembly when the cradle is not engaged on the lifting device or truck.

Another object of the invention is to provide a cradle of the class referred to incorporating platforms for the workmen, constructed and arranged so that the workmen may readily service the object carried by the cradle, conveniently secure the object in its permanent mounts or release the object when the same is detached from its normal support, as the case may be.

Other objectives and features of the invention will become apparent from the following detailed description of a typical form, throughout which description reference is made to the accompanying drawings wherein:

Figure 1 is a side elevation of the cradle supported in an elevated position on a lift truck and showing the forward end of the lift truck;

Figure 2 is a front end view of the elevated cradle with the side portion of the truck appearing in broken lines;

Figure 2A is an enlarged fragmentary vertical sectional view illustrating the pivotal mounting of one of the load supporting pads;

Figure 3 is a somewhat enlarged top or plan view of the cradle with certain parts broken away to appear in horizontal cross section and to better illustrate other portions;

Figure 4 is an enlarged fragmentary perspective view of the intermediate portion of the cradle structure;

Figure 5 is an enlarged fragmentary end view illustrating the pitch frame;

Figure 6 is an enlarged fragmentary side elevation of the pitch frame;

Figure 7 is an enlarged fragmentary vertical sectional view taken substantially as indicated by line 7—7 on Figure 3 and illustrating the vertical bearing for the pivot section of the cradle;

Figure 8 is an enlarged fragmentary vertical

sectional view taken substantially as indicated by line 8—8 on Figure 3 illustrating one of the object engaging and supporting pins of the cradle; and

Figure 9 is a schematic flow diagram of the fluid pressure actuating system and control means for the movement producing mechanisms.

In the drawings, I have shown the invention embodied in a cradle intended primarily for installing, removing and servicing the engine and nacelle units of airplanes, such units usually comprising a heavy, costly aircraft engine and the appurtenant nacelle structure. It is to be understood that this is merely one typical form and application of the invention and that the invention may be embodied in cradles for handling other devices and objects. Furthermore, while I have illustrated the cradle used in association with a more or less conventional lift truck, it will be understood that the cradle is adapted for use with other forms of mobile lift devices with or without modification.

The particular lift truck illustrated has a wheeled power-driven body 10 provided at one end with a generally vertical track or guide means 11 for the lift mechanism. The lift mechanism of the truck includes an hydraulic ram 12 which operates through a motion multiplying arrangement to raise and lower the lifting fork 13. The truck, which is, of course, dirigible or directable, and the fork 13, which is movable vertically, are controlled by the operator seated in the truck. The guides 11 and the lifting mechanism associated therewith, incline rearwardly and the angle of these parts is variable while the lift fork 13 usually slopes upwardly and forwardly.

The cradle of the invention includes a lower section or bed 15 to be mounted or secured on the fork 13 of the lift truck to move therewith. The bed 15 is a generally rectangular frame-like assembly of angle stock, channel stock, or the equivalent, and includes two pairs of adjacent parallel members 16 arranged with their open sides facing downwardly to receive the arms of the fork 13 and inclined in a direction to maintain the bed in a generally horizontal position when supported by the inclined forks. Removable pins or bolts 17 may be passed through openings in the members 16 and the forks 13 to act under shear to secure the cradle to the fork. Removable straps 18 may be engaged around the assembled members and fork to resist or prevent vertical separation of the same. The frame-like bed 15 also includes a pair of parallel generally horizontal members 19 extending between and secured to the opposite sides of the bed; see Figures 4 and 7. The members 19 are arranged with their webs in spaced opposing relation. A plate 20 extends between and is welded, or otherwise fixed, to the webs of the members 19 at or adjacent the center of the bed 15. It will be understood that the bed 15 may be of other constructions and materials, as required, and is capable of considerable variation to adapt the cradle for use with lift trucks and the like of various designs.

The cradle further includes a pivot frame 21 arranged directly above the bed 15 and supported thereon for angular movement about a vertical axis. The pivot frame 21 is a generally rectangular assembly of rigidly connected angle stock, channel stock, or the like, including side and end members and further including two transverse horizontal members 22. The members 22 extend directly above the members 19 of the bed 15, as shown in Figure 7. A suitable bearing supports the pivot frame 21 on the plate 20 of the bed. In practice, any appropriate bearing may be employed for this purpose. In the case illustrated in Figure 7, the bearing includes races 23 and a series of balls 24. The race and ball assembly is engaged between the plate 20 and a plate or disc 25 secured to the underside of the members 22. A boss 26 extends upwardly from the plate 20 into the race assembly and a central bolt or stud 27 extends through central vertical openings in the plates 20 and 25 and the boss 26. The pivot frame 21 further includes two diagonal brace members 28, extending from the transverse members 22 adjacent the bearing just described, to two corners of the frame. The side members of the frame 21 are generally horizontal channel parts arranged with their open sides facing outwardly and will herein be termed tracks 29. These tracks 29 serve to support a traversing frame or traveling frame 30, to be described below.

It is preferred to provide outboard supporting means or bogies to assist the above described bearing in supporting the pivot frame 21 on the bed 15. This means includes two diagonally arranged members 31 welded or otherwise fixed to one of the fork receiving channel assemblies 16 and the ends of the bed 15. These members 31 carry brackets 32 which, in turn, are provided with roller assemblies 33. Diagonal tracks 34, which also serve to brace the pivot frame assembly, are secured in the adjacent corners of the frame 21. The rollers 33 engage or operate in the tracks 34 to assist in supporting the frame 21 on the bed 15. If desired, the rollers 33 may cooperate with the ends of the tracks 34 to limit the angular movement of the pivot frame 21 about the generally vertical axis. The structure just described is best illustrated in Figures 3 and 4.

The invention provides a power means or actuating means for moving the pivot frame 21 about the generally vertical axis. This preferably comprises a cylinder and piston mechanism connected between the bed 15 and the frame 21. As best shown in Figure 4, the cylinder 35 of this mechanism is connected with one end or side member of the frame 21 by a pivotal connection 36 and the piston rod 37 of the mechanism is pivotally secured to one of the diagonal tracks 34 at a clevis pivotal connection 38. The fluid pressure lines 40, extending from the opposite ends of the cylinder 35, are controlled by the fluid pressure actuating and control system illustrated in Figure 9 and to be hereinafter described. It will be seen how the cylinder and piston mechanism 35—37 is operable to turn the pivot frame 21 in either direction to provide what I will term yawing motion of the object being handled or supported in the cradle.

The cradle further includes the traversing frame 30 mentioned above which is carried by the pivot frame 21 for generally horizontal translation. The frame 30 is a rectangular assembly having side members 41 lying adjacent and parallel with the outer sides of the above described tracks 29 of the pivot frame 21. Each of the side members 41 carry spaced rollers, preferably incorporating anti-friction bearing means, and these rollers 42 operate in the tracks 29 to support the frame 30 for the translatory movement. Means, preferably in the form of fluid pressure actuated devices, serve to move the frame 30 in either direction. Thus, as best illus-

trated in Figures 3 and 4 of the drawings, cylinders 43 are arranged in parallel relation to the tracks 29 and side members 41 and are anchored at 44 to an adjacent transverse part 45 of the frame 30. The piston rods 46 of the cylinder mechanism are in turn anchored or attached to the tracks 29 of the pivot frame 21 at lugs or brackets 47. The fluid pressure lines 48 and 49 from the opposite ends of the cylinders 43, extend to the actuating and control system to be subsequently described. Calibrations 8 are provided on one of the side members 41 to cooperate with an adjacent part of the frame 21 to indicate the setting or position of the traversing frame 30 and similar calibrations may be provided on the other frames to aid in the employment of the cradle.

In the embodiment of the invention illustrated, the traversing frame 30 is provided with means for supporting the cradle when the latter is not in use, and is further provided with a platform 52 for the workmen. Suitably braced legs 50 are secured to the corner portions of the frame 30 and project downwardly therefrom to carry horizontal skids 51. The skids 51 are disposed in a plane below the lowermost element of the bed 15 so as to rest on the floor and support the bed as well as the other elements of the cradle clear of the floor. The above mentioned platform 52 is secured to the rear legs 50 of the traversing frame 30 and extends rearwardly therefrom. The platform 52 may be a rectangular structure extending across the rear end of the cradle assembly and is provided with a suitable hand rail 53. In addition to being secured to the legs 50 by welding or the like, the platform 52 is braced and supported by a horizontal member 54 connected with the frame 30 by spaced diagonal braces 55. The platform 52 is located so that the workmen standing thereon may conveniently work upon the rear portion of the nacelle and engine assembly or other objects engaged in the cradle. It is preferred to detachably secure the platform 52 to the frame 30 so that the platform may be removed when desired to give freer access to the nacelle and engine assembly.

The cradle further includes what I will term a roll frame 56 supported on the traversing frame 30 to be movable about a substantially horizontal axis. This axis of angular movement or "roll" of the frame 56 preferably intersects an extension of the axis of angular movement of the pivot frame 21 and is coincident with the central longitudinal axis of the traversing frame 30. The frame 56, which is adapted to carry the nacelle and engine assembly or other object for rolling movement, includes longitudinal or side members 57 of tubular stock extending between and secured to arcuate end elements 58 and 59.

The side members 57 may be directly welded or otherwise secured to the element 58 or to plates thereon, while the other ends of the members 57 are rigidly secured to plates and uprights 63 on the element 59. The elements 58 and 59 are in the nature of curved tracks having curved lower faces which are concentric with a common horizontal axis spaced above the roll frame 56. Spaced rollers 60 are mounted on the abovementioned transverse member 45 of the traversing frame 30 and the curved lower edge of the element 58 bears on these rollers. The forward end member 61 of the traversing frame 30 carries two spaced rollers 62 and the rollers are grooved to receive and cooperate with the curved lower edge of the element 59. As shown in Figures 1 and 2, the arcuate track element 59 of the roll frame 56, extends downwardly into the forward portion of the traversing frame 30 to bear on the grooved rollers 62. It is believed that it will be apparent how the structure just described supports the roll frame 56 for angular movement about the abovementioned horizontal axis.

The means for actuating or moving the roll frame 56 includes one or more power applying devices. In the drawings I have shown a cylinder 64 pivotally secured at one end to a bracket 65 on a guide 41 of the traversing frame 30 and a piston rod 66 extends from the other end of the cylinder for pivotal connection with the arcuate track element 58 of the roll frame at 67, as shown in Figure 4. A second cylinder 68 has one end pivotally connected with a leg 50 of the traversing frame 30 and a piston rod 69 extends from the other end of the cylinder for connection with the arcuate track element 59 at 70. The fluid pressure lines 71 and 72 leading to the corresponding ends of the cylinders 64 and 68 are joined or manifolded, as shown in Figure 9, and extend to the fluid pressure control system to be later described.

Platforms 73 extend along the sides of the roll frame 56 being supported by the above described legs 63, the elements 58, and appropriate associated bracing. Hand or safety rails 74 are provided on the platform 73. The platforms 73 are some distance above the rear platform 52 and extend from the forward end of the cradle to points some distance rearward of the arcuate track element 59. The intermediate and forward portions of the nacelle assembly, or other object carried in the cradle, are conveniently accessible to the workmen on the platforms 73.

In order to obtain a pitching movement of the supported object, that is an angular movement of the object about a generally horizontal axis normal to the axis of movement of the roll frame 56, I provide what may be termed a pitch frame 76. The pitch frame 76 is located above the rear platform 52 and is adapted to engage with and support the rear portion of the load at points spaced a considerable distance to the rear of the roll frame 56. In the particular construction illustrated the pitch frame assembly 76 includes a rear plate 77 disposed in a substantially vertical plane and extending across the rear end of the cradle proper. This plate 77 is carried for vertical movement by two pairs of rearwardly divergent arms 78 having their forward ends pivotally secured to lugs 79 on the rear track element 58 of the roll frame 56. The rear ends of the arms 78 have pivotal connections 80 with flanges 81 projecting from the forward face of the plate 77. The axes of the pivotal connections at 78 and 80 are horizontal and the connections are such that the plate 77 may move substantially vertically with little or no arcuate movement.

The plate 77 carries a plurality of parts for engaging with and supporting the object or load being handled. These object engaging parts may be in the nature of studs, sockets, bolts, clamps, adaptors or the like and any desired number of such parts or devices may be employed as found necessary. As best illustrated in Figures 3 and 8, these parts are in the nature of horizontally aligned pins 82 having tubular portions guided in sleeves or tubes 83 welded or otherwise fixed to the upper end of the plate 77. The pins 82 project inwardly from the tubes 83

and their exposed ends are rounded or beveled to readily enter horizontal openings in the engine and nacelle assembly, or other object, to be handled in the cradle. It is desirable to provide for the retraction and advancement of the pins 82 so that they may be more readily engaged in and removed from the openings in the load. The pins 82 are held against rotary or angular movement by keys or plugs 84 secured in radial openings in the tubes 83 and cooperating with flats or grooves in the pins. Screws 85 pass into the outer ends of the tubes 83 and their thread carrying inner portions cooperate with internal threads in the tubular parts of the pins 82. Bushings 86 are screwed or otherwise fixed in the outer ends of the tubes 83 and collars 87 on the screws 85, cooperate with the bushings to hold the screws against longitudinal movement. The screws 85 extend outwardly beyond the tubes 83 and their free ends are hexagonal or otherwise formed for ready engagement by a turning tool or wrench so that the pins 82 may be projected inwardly and retracted as required by merely rotating the screws.

The load or object being handled, in addition to being supported by the pins 82 of the pitch frame 76, is also supported at two horizontally spaced points on the roll frame 56. Thus the nacelle assembly, or other object being carried in the cradle, is supported at four points, namely at the two horizontally aligned pins 82 of the pitch frame 76 and the two horizontally aligned points on the roll frame 56. The rear track element 58 of the roll frame 56 carries two horizontally aligned pads 88. The pads 88 are in the nature of angular blocks having concave upper surfaces faced with an abrasion resistant material for cooperating with the nacelle assembly. It will be understood that the blocks 88 may be shaped and designed to support objects of various configurations. The pads 88 bear against substantially vertical shoulders 90 (see Figure 4) on the element 58 and are preferably supported for angular or pivotal movement about generally horizontal axes so as to remain in full engagement with the load when the pitch frame 76 is moved with respect to the roll frame 56. For this purpose, pins 109 pass through horizontal openings in the pads 88 and are engaged or secured in openings in the shoulder portions of the element 58.

Means are provided for guiding the pitch frame 76 and for actuating or moving the same. These means included two generally horizontal cantilevered arms 91 rigidly secured to the ends or sides of the element 58 of the roll frame 56 and projecting rearwardly to points adjacent the plate 77 of the pitch frame 76. Vertical plates 92 are fixed to the ends of the arms 91 and appropriate braces 93 may extend downwardly and forwardly from the plates 92 to the element 58. The plates 92 are arranged at approximately 90° to the plate 77 and the plate 77 has forwardly projecting wings or flanges 94 which lie at the outer sides of the plates 92. The plates 92 have vertical slots 95 and the flanges 94 carry bolts or pins 96 which operate in the slots 95 to guide the pitch frame 76. The means for adjusting or moving the pitch frame 76 comprises cylinders 97 secured at their upper ends to the relatively stationary plates 92 and the piston rods 98 of the cylinder mechanisms extend downwardly from the cylinders. The piston rods 98 are pivotally connected with lugs 99 on the lower edge portions of the plate 77. The fluid pressure lines 100 and 101 leading from the corresponding ends of the cylinders 97 extend to the fluid pressure control system described below. It will be seen how actuation of the cylinder mechanisms 97 is operable to pivot or swing the pitch frame 76 about its generally horizontal axis of adjustment or movement.

The system for actuating and controlling the several cylinder and piston mechanisms of the device is diagrammatically illustrated in Figure 9 where it will be seen to include a pump P. While I have shown a manually operable pump P it will be understood that any suitable source of fluid under pressure may be employed to supply the cylinder and piston mechanisms. The high pressure line 102 of the pump P delivers the fluid, preferably a liquid, to a manifold line 103. The low pressure line 104 of the pump P extends to a suitable reservoir 105 for the fluid handled in the system. In practice the reservoir 105 may be positioned adjacent the pump P and it is preferred to arrange the pump on the rear portion of the traversing frame 30 to be conveniently accessible to the workmen on the platform 52. The high pressure manifold line 103 delivers the actuating fluid under pressure to three spaced four-way valves 106, 107 and 108. The valve 106 serves to control the cylinder mechanism 35 for moving the pivot frame 21 to obtain a yawing motion of the supported object, the valve 107 serves to control the cylinder mechanisms 43 for moving the traversing frame 30, while the valve 108 operates to control the cylinder mechanisms 64 and 68 for moving or adjusting the roll frame 56. The low pressure line 104 of the pump P has a branch manifold 110 leading to the valves 106, 107 and 108.

The abovementioned lines 40, leading from the opposite ends of the cylinder 35, extend to the valve 106 and the valve is manually operable to selectively and alternatively connect the lines 40 with the pressure supply manifold 103 and the pressure return manifold 110. The three valves 106, 107 and 108 have suitable operating levers 111. The lever 111 of the valve 106 has an "off" position where both lines 40 are closed, a "right" position where pressure is delivered to one line 40 and the other line 40 is connected with the return manifold 110 and a "left" position where the first line 40 is connected with the return manifold 110 and the second named line 40 is in communication with the pressure supply manifold 103. It will be seen that with the pump P in operation the valve 106 may be operated to pivot the frame 21 in either direction to obtain the desired yawing adjustment or motion of the cradle.

The above described pipes or lines 48 and 49 from the opposite ends of the cylinders 43 for adjusting the traversing frame 30, extend to the valve 107. The valve 107 has an "off" position where both lines 48 and 49 are closed and has a forward position where the line 49 is in communication with the high pressure manifold 103 and the line 48 is in communication with the pressure return manifold 110. The valve 107 also has an "aft" position where the line 48 is placed in communication with the high pressure manifold 103 and the line 49 is put in communication with the pressure return manifold 110. Thus with the pump P in operation the valve 107 may be operated or manipulated to move the traversing frame 30 either in the forward direction or the aft direction as required.

The pipes or lines 71 and 72 from the opposite ends of the cylinders 64 and 68 which move

or adjust the roll frame 56, extend to and are controlled by the valve 108. The valve 108 has an "off" position where the pipes 71 and 72 are both closed and has a position where the pipe 71 is placed in communication with the pressure supply manifold 103 and the pipe 72 is put in communication with the pressure return manifold 110 so that the roll frame 56 is adjusted to move the left side of the supported object upward. The valve 108 also has a "left side down" position where the pipe 72 is in communication with the pressure supply manifold 103 and the pipe 71 is in communication with the pressure return manifold 110. It will be seen that simple manipulation of the lever 111 of the valve 108, while the pump P is in operation, serves to roll the frame 56 either to the left or to the right, as the case may be.

The control for the cylinders 97 of the pitch frame 76 includes a four-way valve 115 similar to the valves 106, 107 and 108, described above, and provided with an operating lever 116. An extension or branch 117 of the pressure supply manifold 103 extends to the valve 115 and is provided with a check valve 118 which allows the delivery of pressure fluid to the four-way valve but which prevents a reverse flow. A branch 119 of the low pressure or pressure return manifold 110 also extends to the four-way valve 115 and is equipped with a pressure relief valve 120. The valve 120 is set to prevent the flow of fluid pressure from the valve 115 to the reservoir 105 until a relatively high pressure is developed, The purpose of this valve 120 will be later described. The abovementioned lines 100 and 101 communicating with opposite ends of the cylinder 97, lead to the four-way valve 115. The valve 115 has a closed or "off" position where the four lines 100, 101, 117 and 119 are closed. The valve 115 also has a "nose up" position where the line 100 is connected with the pump pressure line 117 and the line 101 is in communication with the low pressure or return line 119. When the pump P is operated with the valve 115 in the nose up position, fluid under pressure is delivered to the lower ends of the cylinder 97 to move or swing the pitch frame 76 upwardly. On the other hand, when the valve 115 is in the "nose down" position and the pump P is operated, fluid pressure is supplied to the upper ends of the cylinder 97 to swing the frame 76 downwardly. In this connection it will be observed that it is necessary to develop sufficient pressure to overcome or open the valve 120 when the frame 76 is to be swung downwardly. The valve 120 serves as a safety means to prevent unwanted and possibly damaging movement of the frame 76 and its load in the event the lift mechanism of the truck 10 is operated suddenly when the valve 115 is in either of its open positions. In such an event the valve 120, by preventing or resisting the flow of fluid through the line 119, prevents or resists relative movement between the cylinders 97 and the piston rods 98 and thus effectively dampens or resists inertia or acceleration effects which might otherwise cause unwanted movement of the pitch frame and load. The check valve 118 serves a like function in preventing a reverse flow of fluid through the line 117 under such circumstances. The valves 118 and 120 also function to resist static unbalance of the load and pitch frame 76. A by-pass line 150 connects the supply pressure relief valve 151 which protects the overall system against the development of excess fluid pressures.

The above described valves 106, 107, 108 and 115, and the associated manifolds 103, 110, etc., are preferably located adjacent the pump P and may be enclosed in a casing 121 which also contains the pump. The operating lever 122 of the pump and the levers 111 and 116 of the four-way valves may project from the casing 121 to be conveniently accessible to the workmen on the platform 52. Thus there is a single station from which the various cylinder mechanisms of the device may be controlled and operated.

It is believed that the operation of the adjustable cradle will be readily understood from the foregoing detailed description wherein the function and operation of the several principal elements thereof have been fully set forth. As illustrated in Figures 1 and 2, the entire cradle, either with or without its load, may be lifted on the fork 13 of the truck and carried thereon. It is desirable to secure the cradle on the fork 13 by the pins 17 and the straps 18 and to secure the load in proper position in the cradle. The pads 88 serve to support one end portion of the load while the pins 82 may be engaged in appropriate openings in the nacelle assembly, or other load, to support the opposite end portion of the same and to assist in retaining the load in the cradle. It will be observed that the concave upper edges of the elements 58 and 59 and the plate 77 are designed to accommodate the nacelle assembly although these parts may be given other configurations to adapt the cradle for other loads. The workmen may stand on the platforms 52 and 73 to be in position to work upon or service the load or to secure or detach it from the usual supports. In detaching or mounting the load on its normal support, the cradle may be brought to any required position by appropriate operation of the truck and its lift mechanism 12 and the several movable frames 21, 30, 56 and 76 of the cradle. Yawing motion in either direction is obtained by operation of the pump P and valve 106, such operation resulting in turning of the frame 21 and the load about a vertical axis. Operation of the pump P and manipulation of the valve 107 causes turning movement of the frame 21 and the load about a vertical axis while operation of the pump P and valve 108 rolls the frame 56 and load about a horizontal axis. In a like manner, operation of the pump P and control of the valve 111, causes fore and aft pitching movement of the frame 76 and the load. By controlling and relating these several movements the cradle may be brought to the correct position to assume the weight of the nacelle or other object when the same is to be detached from its normal support and to bring the load to position for attachment to its usual mounts.

It is to be understood that while the parts or assemblies 21, 30, 56 and 76 are herein termed frames, these instrumentalities may be varied considerably in design and construction to adapt the cradle to handle loads and objects of various kinds and the term "frame" is not to be construed as limiting the invention to frame or frame-like structures.

Having described only a typical preferred embodiment of my invention I do not wish to be limited to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

I claim:

1. In an object handling cradle, a plurality of articulated frames including a traversing frame,

means supporting the traversing frame for translation in a generally horizontal plane, a roll frame supported on the traversing frame for angular movement about a generally horizontal axis, and a pitch frame supported on the roll frame for angular movement about a generally horizontal axis substantially normal to the first named axis, means on the roll frame and pitch frame for supporting an object, a power means for moving each of said frames, and a manually operable control system for selectively operating said power means.

2. In an object handling cradle, a roll frame, means supporting the roll frame for angular movement about a generally horizontal axis, a pitch frame extending from one end of the roll frame, means for supporting the pitch frame on the roll frame adjacent said end thereof for angular movement about a generally horizontal axis normal to the first named axis, object supporting means on the two frames, and means for imparting said angular movements to said frames.

3. In an object handling cradle, a roll frame, means supporting the roll frame for angular movement about a generally horizontal axis, a pitch frame extending from one end of the roll frame, means for supporting the pitch frame on the roll frame adjacent said end thereof for angular movement about a generally horizontal axis normal to the first named axis, horizontally aligned parts on the pitch frame adapted to have supporting engagement with an object, pivoted pads on the roll frame to assist in supporting the object, and means for selectively imparting said angular movements to said frames.

4. In an object handling cradle for use with a device having a lifting fork, the combination of a bed for attachment to the fork for elevation thereon, a plurality of articulated superimposed frames on the bed including a pivot frame supported on the bed for angular movement about a generally vertical axis, a traversing frame supported on the pivot frame for movement in a generally horizontal plane, a roll frame supported on the traversing frame for angular movement about a generally horizontal axis, a pitch frame extending from an end of the roll frame, means for mounting the pitch frame on said end for angular movement about a horizontal axis normal to the axis of movement of the roll frame, means on the roll frame for supporting an object, means on the pitch frame for assisting in supporting the object, a power means for separately moving each frame, and a manually operable control system for said power means whereby said frames may be selectively moved to adjust the position of the object.

5. An object handling cradle for use on a lift device comprising a bed for arrangement on said device to be carried and elevated thereby, a plurality of superimposed articulated frames carried by the bed including a pivot frame supported on the bed for movement about a substantially vertical axis, a traversing frame supported on the pivot frame for translation in a substantially horizontal plane, a roll frame supported on the traversing frame for angular movement about a substantially horizontal axis parallel with said plane, a pitch frame supported on one end of the roll frame for angular movement about a substantially horizontal axis normal to the axis of movement of the roll frame, means on the roll frame and the pitch frame for supporting an object, power actuated means for moving each of said frames, and a manually operated control system for operating and controlling the power actuated means.

6. An object handling cradle for use on a lift device comprising a bed for arrangement on said device to be carried and elevated thereby, a pivot frame supported on the bed for movement about a substantially vertical axis, a traversing frame supported on the pivot frame for translation in a substantially horizontal plane, a roll frame supported on the traversing frame for angular movement about a substantially horizontal axis parallel with said plane, a pitch frame supported on one end of the roll frame for angular movement about a substantially horizontal axis normal to the axis of movement of the roll frame, means on the roll frame and pitch frame for supporting an object, cylinder and piston means for moving each of said frames, a working platform on the traversing frame, and a fluid pressure system for operating and controlling the cylinder and piston means including manually operable valves accessible from said platform.

7. In an object handling cradle, a roll frame supported for angular movement about a generally horizontal axis, a pitch frame supported on an end of the roll frame for angular movement about a generally horizontal axis normal to the first named axis and to project beyond said end of the roll frame, means on said frames for supporting an object, the said means of the pitch frame being spaced outwardly from said end of the roll frame, cylinder and piston means for moving the pitch frame with respect to the roll frame, a fluid pressure supply line, a fluid pressure return line, valve means for controlling the communication of said lines with the cylinder and piston means, and a pressure relief valve in the return line for preventing unwanted movement of the pitch frame.

8. An object handling cradle for use on a lift device comprising a bed for arrangement on said device to be carried and elevated thereby, a pivot frame supported on the bed for movement about a substantially vertical axis, a traversing frame supported on the pivot frame for translation in a substantially horizontal plane, a roll frame supported on the traversing frame for angular movement about a substantially horizontal axis parallel with said plane, a pitch frame supported on one end of the roll frame for angular movement about a substantially horizontal axis normal to the axis of movement of the roll frame, means on the roll frame and pitch frame for supporting an object, cylinder and piston means for moving each of said frames, a working platform on one of the frames, a fluid pressure system for operating said cylinder and piston means including a manually operable valve for controlling the movement of each frame, and a pump for developing fluid pressure for the actuation of said cylinder and piston means, said valves and pump being carried by one of the frames in a position to be accessible from the platform.

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The following references are of record in the file of this patent:

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