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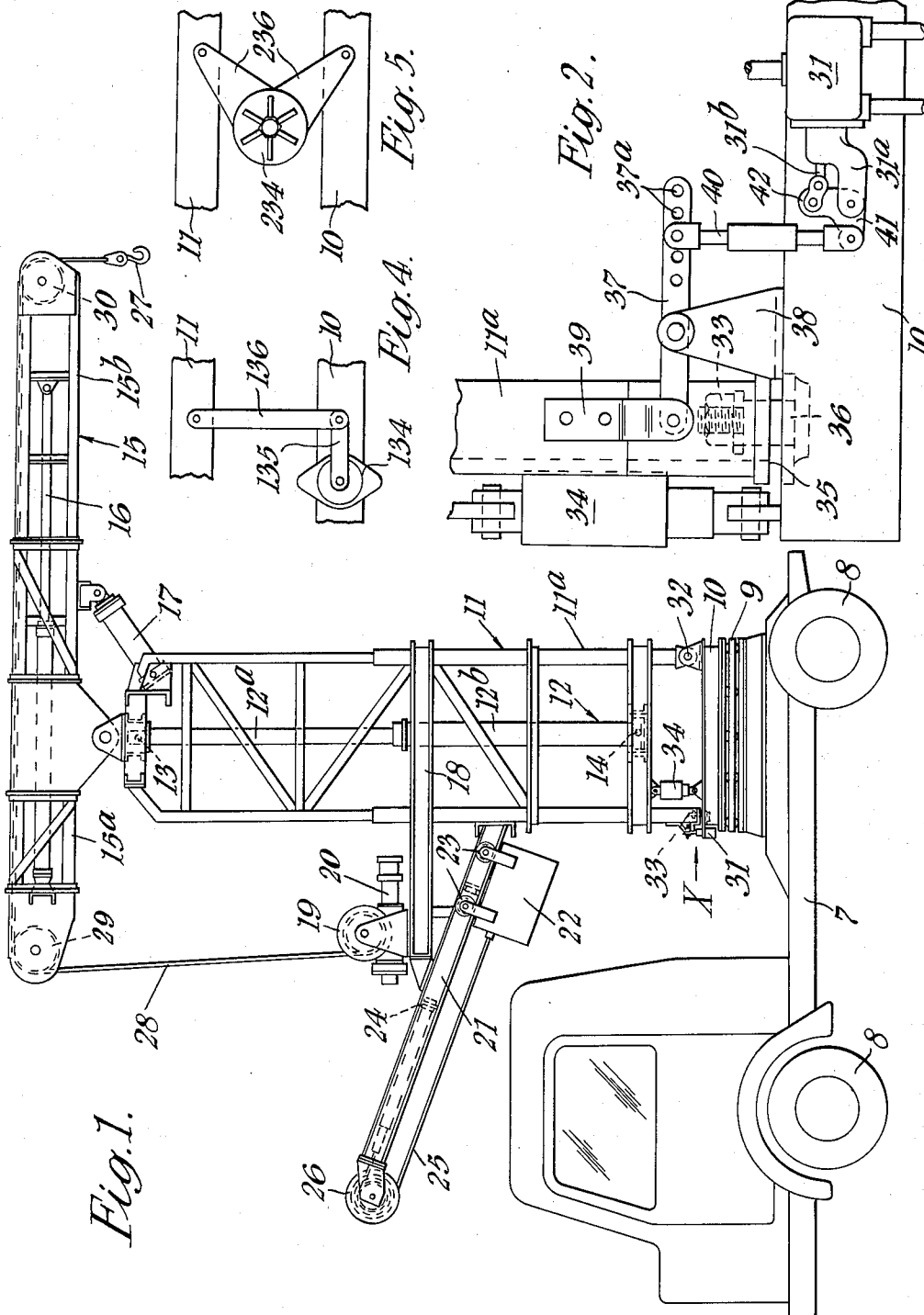
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LOAD RESPONSIVE COUNTERBALANCING CRANE

Filed Feb. 24, 1964

2 Sheets-Sheet 1



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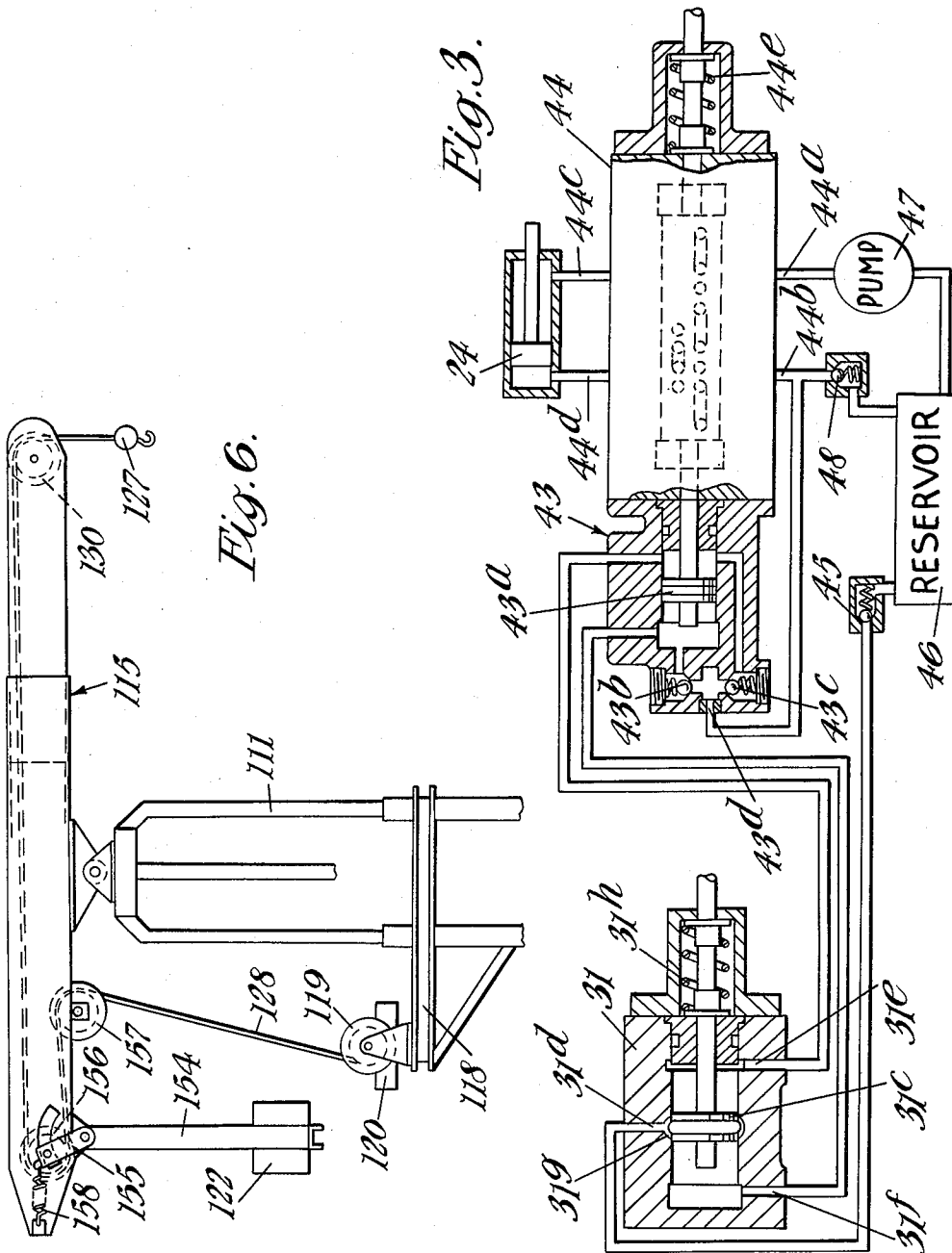
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2 Sheets-Sheet 2



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LOAD RESPONSIVE COUNTERBALANCING CRANE

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This invention relates to mobile cranes of the kind including a supporting vehicle and a jib mounted on the vehicle for angular movement relative thereto about a horizontal axis and about a vertical axis.

It is an object of the invention to provide a mobile crane of the kind specified in a convenient form.

A mobile crane of the kind specified and in accordance with the invention is provided with a movable counterbalance weight and with means for moving said weight in accordance with the load on the jib to counterbalance said load.

The invention will now be more particularly described with reference to the accompanying drawings wherein:

FIGURE 1 is a side view of one example of a mobile crane according to the invention;

FIGURE 2 is an enlarged fragmentary view taken in the direction X in FIGURE 1;

FIGURE 3 is a diagrammatic view showing part of the hydraulic circuit arrangements of the crane of FIGURE 1;

FIGURES 4 and 5 are respectively fragmentary side views of alternative damping devices for the crane of FIGURE 1; and

FIGURE 6 is a somewhat diagrammatic fragmentary view of an alternative form of crane in accordance with the invention.

Referring firstly to the example shown in FIGURES 1 to 3 inclusive, the crane includes a supporting vehicle 7 having ground wheels 8. Supported on a roller bearing 9 at the rear of the vehicle is a turntable 10. The turntable 10 supports a telescopic tower 11 which is constructed of standard sectional steel. The tower 11 is in two parts 11a, 11b of which the part 11a is supported on the turntable 10. The part 11b is connected to the movable part 12a of a lifting ram 12 the cylinder 12b of which is connected to the lower part 11a of the tower. The connection between the ram parts 12a, 12b and the tower parts 11b, 11a are made respectively by pivot pins 13, 14, so that no cross-loading can be applied to the ram 12.

Pivoted on a horizontal axis to the upper part 11b of the tower 11 is a telescopic jib 15 formed in two parts 15a, 15b of which part 15b is supported within part 15a by means of rollers or otherwise. A jib-extending ram 16 is connected between the parts 15a and 15b and a jib-tipping ram 17 is connected between jib part 15a and upper tower part 11b.

Mounted on the tower part 11a is a laterally projecting portion 18 which serves to support a winch 19 and an hydraulic motor 20 therefor. The winch is connected to a hook 27 by means of a cable 28 extending around pulleys 29, 30 mounted respectively on the jib parts 15a, 15b. The portion 18 also serves as a brace for a rail 21 from which a counterbalance weight 22 is slung on rollers 23. The weight 22 is movable along the rail 21 by means of a counterbalance ram 24, the movable part of which is connected to the weight by means of a cable 25 extending around a pulley 26 on the end of rail 21. Retraction of the ram 24 thereby effects outward movement of the weight 22.

The supply of pressurised liquid to the ram 24 is controlled by a pilot valve 31 which is mounted on the turntable 10 and which is operable by movement of the tower 11. As shown in FIGURE 1 the lower tower part 11a is pivoted at 32 to the turntable 10 on an axis perpendicular to the horizontal component of the direction in which the jib 15 projects. Movement of the tower 11 is limited by stop means 33 and is damped by a pair of hydraulic piston and cylinder shock absorbers 34 (of known form) connected between the tower part 11a and the turntable 10.

The stop means 33 is constituted by a pair of flanges 35 on the feet of the tower part 11a and a pair of bolts 36 on the turntable 10 and is arranged to permit limited movement of the tower 11 in either direction from the means position shown in FIGURE 2. A lever 37 is pivoted to a bracket 38 on the turntable 10 and is connected at one end to a lug 39 on the tower 11. The other end of lever 37 is formed with a series of spaced holes 37a with any one of which a link 40 may be engaged. The link 40 is connected to a bell crank lever 41 pivoted on a lug 31a on the pilot valve 31. This bell crank is connected to the stem 31b of valve 31 by a further link 42.

As shown diagrammatically in FIGURE 3 the valve 31 contains a piston-like closure member 31c which, in mid-position covers an outlet port 31d. Movement of the member 31c in opposite directions permits communication of inlet ports 31e and 31f respectively with port 31d. The internal surface of valve 31 is formed with a groove 31g so that when the member 31c is in mid-position liquid can flow past the closure member to port 31d from ports 31e and 31f. The closure member 31c is centered by a spring 31h.

As shown in FIGURE 3 the ports 31e and 31f are connected respectively to opposite ends of a slave cylinder unit 43 which operates a known slide valve 44. The port 31d is connected through a spring-loaded non-return valve 45 to a reservoir 46. The unit 43 includes a piston 43a for moving the slide of valve 44 and a pair of non-return valves 43b and 43c. The valve 43b controls entry of liquid to the end of the cylinder unit 43 connected to port 31f and valve 43c controls entry of liquid to the end of the cylinder unit 43 connected to port 31e.

The valve 44 has an inlet port 44a connected to a pump 47 which draws liquid from the reservoir 46 and an outlet port 44b connected through a spring-loaded non-return valve 48 to the reservoir 46. The valve 48 is arranged to open at a higher pressure than valve 45. The high pressure side of valve 48 is connected to an inlet 43d to cylinder unit 43. The valve 44 has a further pair of ports 44c and 44d connected respectively to opposite ends of the counter-balance ram 24. The slide of valve 44 is loaded by a spring 44e to a mid-position in which ports 44c and 44d are closed and in which liquid is driven through valve 44 from the inlet port 44a to outlet 44b. Movement of the slide in opposite directions causes liquid to be pumped to one end or the other of ram 24 whilst the other end is connected through valves 44 and 48 to reservoir 46.

A relief valve (not shown) is employed to by-pass ram 24 when the piston thereof is brought up against one end of the cylinder.

The automatic counter-balancing device operates as follows:

When there is no load on the job 15, the weight 22 will occupy the position shown in FIGURE 1. When a load is picked up the tower 11 will tend to pivot in a clockwise direction so that the bell-crank lever 41 will turn in an anti-clockwise direction as seen in FIGURE 2. The closure member 31c will thus be moved to the right as

3

seen in FIGURE 3 and flow through valve 31 from port 31e to port 31d will be stopped. Movement of closure member 31c will thus cause the piston 43a to be displaced to the left and liquid will be supplied to ram 24 at the right hand end thereof to retract ram 24.

As the weight reaches a balanced position the closure member 31c will be restored to its mid-position and spring 44e will return valve 44 and piston 43a to their mid-positions. The weight 22 will thus be hydraulically locked in position.

When the load is removed from the jib 15 the reverse sequence of operations will occur and the weight 22 will be restored to its inboard position.

It will be noted that the risk of the weight 22 overshooting its balanced position is minimised by the use of dampers 34. Also the rail 21 is inclined so that the weight 22 is gravitationally biased to its inboard position.

It will be noted that the counterbalance arrangement described above its sensitive to the couple applied to the tower 11 and is not affected by changes of jib inclination or extension. Furthermore, instead of providing the valve 31 with two inlets and one outlet there may be provided (with suitable arrangement of non-return valves) one inlet and two outlets. In this case high pressure liquid from the pump would be led to the valve 31 before passing to the unit 43.

The remaining controls of the crane (namely the controls for an hydraulic motor (not shown) for rotating the tower about a vertical axis, the lifting ram 12, the jib-extending ram 16, the jib tipping ram 17 and winch motor 20) are all very similar to one another. These each include a manually operable pilot valve in the vehicle cab connected through a known type of rotary seal in the tower to a valve similar to valve unit 43 and 44. As shown the winch motor 20 and ram 24 are operatively connected in parallel in the circuit since these two devices will normally be required to operate simultaneously and require a higher liquid pressure than the other devices. To protect the system against overloading a relief valve of known form is included in the circuit and this will be operated when the motor 20 is overloaded or when ram 24 is fully extended or fully retracted. A similar valve is connected in the circuit controlling the remaining devices but is set to operate at a much lower pressure.

FIGURES 4 and 5 show two alternative damping devices which may be substituted for the device 34 in FIGURE 1. Both devices are known in themselves, that of FIGURE 4 being a rotary vane type damper 134 which is secured to the turntable 10 and has its vane connected by an arm 135 and link 136 to the tower 11. The damper 234 in FIGURE 5 is of the friction plate type connected by arms 236 to the tower 11 and turntable 10 respectively.

In the example shown diagrammatically in FIGURE 6, the tower 111 is again extensible and has a laterally projecting portion 118 on which winch 119 and motor 120 are mounted. In this case however the counterbalance weight 122 is suspended from the jib 115. The weight 122 is carried at the end of an arm 154 pivoted to the jib at the end opposite the hook 127. The arm 154 has an extension 155 which carries a pulley 156. A further pulley 157 is mounted on the jib 115 and the cable 128 passes from the winch around the pulley 157 and the pulley 156 before extending along the length of the jib to pulley 130. A spring 158 urges the arm 154 towards the tower 111 and the arrangement of cable 128 is such that the weight 122 will be swung away from tower 111 as the tension in the cable increases. Thus the weight 122 is moved in accordance with the load on the jib to counterbalance the load. This system is not substantially affected by the inclination of the jib but the correct counterbalance will only be obtained when the jib is fully extended. In other respects the crane is sub-

4

stantially as described with reference to FIGURES 1 to 5.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

5 1. A mobile crane comprising a supporting vehicle a structure mounted on said vehicle for angular movement about a vertical axis, a tower pivoted to said structure on a horizontal axis, a jib mounted on the tower and projecting therefrom in a direction perpendicular to said horizontal axis, a means for supporting a load from the end of the jib, a rail mounted on the tower and projecting therefrom in a direction opposite to the direction in which the jib projects, a counterbalance weight supported on said rail, hydraulic means for moving said weight along said rail, and valve means, sensitive to the movement of said tower about said horizontal axis when the load on the jib is varied, for controlling said hydraulic means.

2. A mobile crane comprising a supporting vehicle, a structure mounted on said vehicle for angular movement about a vertical axis, a tower pivoted to said structure on a horizontal axis, stop means for limiting movement of the tower about said horizontal axis, a jib mounted on the tower and projecting therefrom in a direction perpendicular to said horizontal axis, means for supporting a load from the end of said jib, a rail mounted on said tower and projecting therefrom in a direction opposite from that in which the jib projects, a counterbalance weight mounted on said rail, hydraulic means for moving the weight along the rail, a valve means for controlling said hydraulic means and comprising a ported body mounted on said structure, closure means and a stem connected to said closure means, and means operatively connecting said stem to said tower whereby pivotal movement of the tower effects movement of said stem relative to said body.

3. A mobile crane as claimed in claim 2 incorporating clamping means interconnecting said structure and said tower.

4. A mobile crane comprising a supporting vehicle a structure mounted on said vehicle for angular movement about a vertical axis, a tower pivoted to said structure on a horizontal axis, a jib mounted on the tower and projecting therefrom in a direction perpendicular to said horizontal axis, means for supporting a load from the end of said jib, a rail mounted on said tower and projecting therefrom in a direction opposite to that in which the jib projects, a counterbalance weight mounted on said rail, hydraulic means for moving said weight along said rail, valve means for controlling said hydraulic means, said valve means comprising a ported body mounted on said structure, valve closure means, and a stem connected to said valve closure means, a lever pivoted on said structure and connected at one end to the tower, 55 a bell crank lever pivoted on the valve means body and having one arm connected through a link to said stem and a further link connecting said lever to said bell crank lever.

5. A mobile crane as claimed in claim 4 wherein said lever is formed with a series of holes whereby the operative connection between said lever and said stem can be adjusted by changing the hole in which said further link is engaged.

6. A mobile crane comprising a supporting vehicle, a jib, means mounting the jib on the vehicle for movement about a horizontal axis and the jib projecting in both directions from said axis, a cable extending along the jib and having one end adapted to support a load beneath one end of the jib, a winch for winding said cable, an arm pivoted on a horizontal axis to the other end of the jib and depending therefrom, a counterbalance weight mounted on the lower end of said arm, means at the other end of said arm to receive said cable whereby the tension therein effects counterbalancing movement of the arm and weight.

5

7. A mobile crane comprising a supporting vehicle a tower structure mounted on said vehicle, a jib mounted on said tower structure so as to be pivotable on a horizontal axis, said jib projecting from said axis in both directions, a load-supporting cable extending along said jib and having one end adapted to support a load beneath one said of the jib, an arm pivoted to the jib at the other end thereof, a pulley mounted on said arm, a further pulley mounted on the jib, a winch mounted on the tower, said cable extending along the jib and around said pulley and said further pulley before being wound onto the winch, and a counterbalance weight mounted on the end of said arm.

8. A mobile crane as claimed in claim 7 wherein there

6

is also provided resilient means for urging said arm in a direction opposite to that in which it will in use be urged by the cable.

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