

### [54] JOY STICK CONTROLLER FOR TOWER CRANE

[75] Inventor: Eldon F. Cording, Galena, Ill.

[73] Assignee: Heede International, Inc.,  
Greenwich, Conn.

[22] Filed: Feb. 28, 1973

[21] Appl. No.: 336,587

[52] U.S. Cl. .... 212/56, 74/471 XY, 212/1,  
212/63

[51] Int. Cl. .... B66c 23/02

[58] Field of Search ..... 212/56.1, 63; 74/471 XY

### [56] References Cited

#### UNITED STATES PATENTS

|           |        |                   |           |
|-----------|--------|-------------------|-----------|
| 2,762,234 | 9/1956 | Dodd .....        | 74/471 XY |
| 2,828,872 | 4/1958 | Mangel .....      | 212/63 X  |
| 3,076,559 | 2/1963 | Crile .....       | 212/56    |
| 3,095,754 | 7/1963 | Mayon et al. .... | 74/471 XY |

|           |         |                     |             |
|-----------|---------|---------------------|-------------|
| 3,208,299 | 9/1965  | Leonard et al. .... | 74/471 XY   |
| 3,299,731 | 1/1967  | Russell .....       | 74/471 XY   |
| 3,365,975 | 1/1968  | Hathaway .....      | 74/471 XY   |
| 3,537,246 | 11/1970 | Pool et al. ....    | 74/471 XY X |

Primary Examiner—Evon C. Blunk

Assistant Examiner—Jeffrey V. Nase

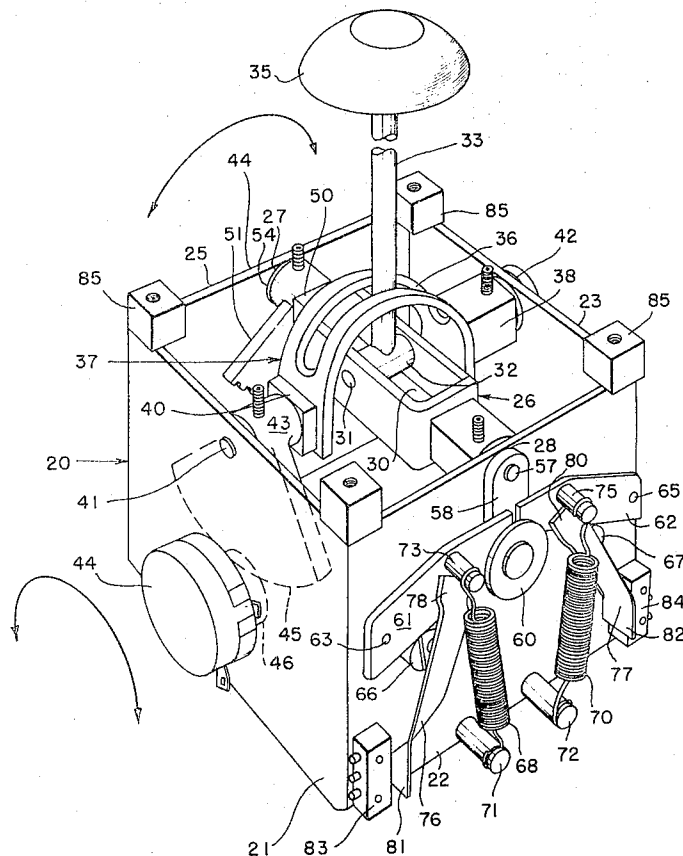
Attorney, Agent, or Firm—Jackson, Jackson &  
Chovanes

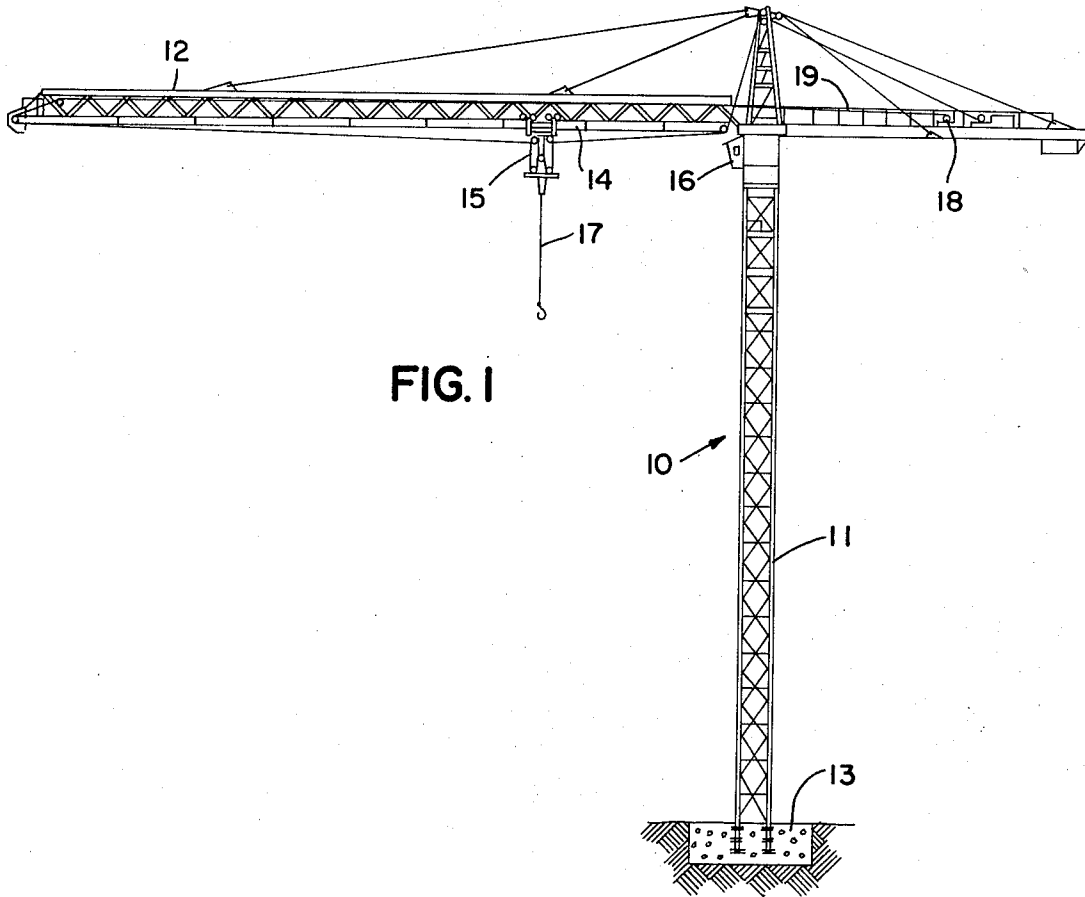
[57]

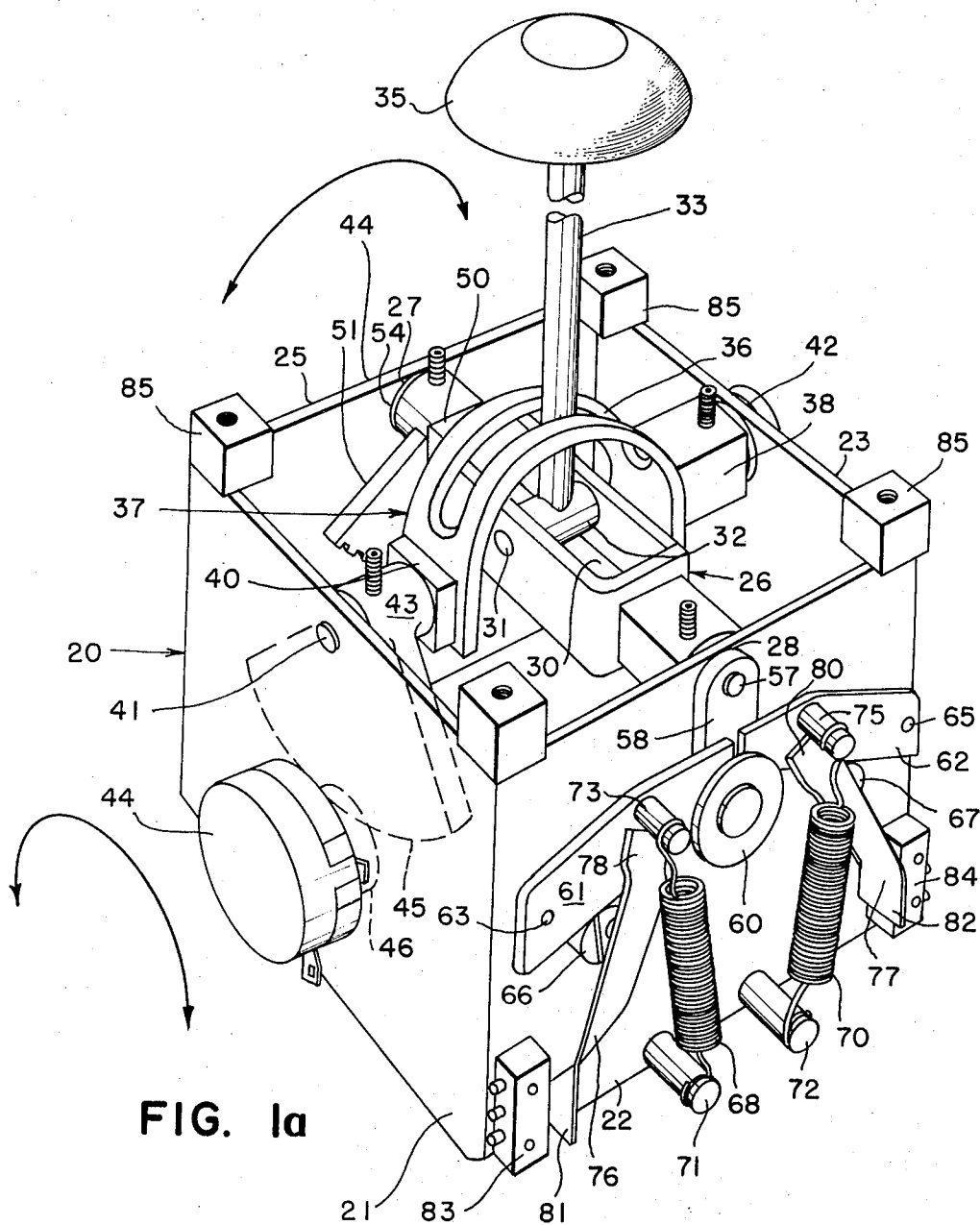
### ABSTRACT

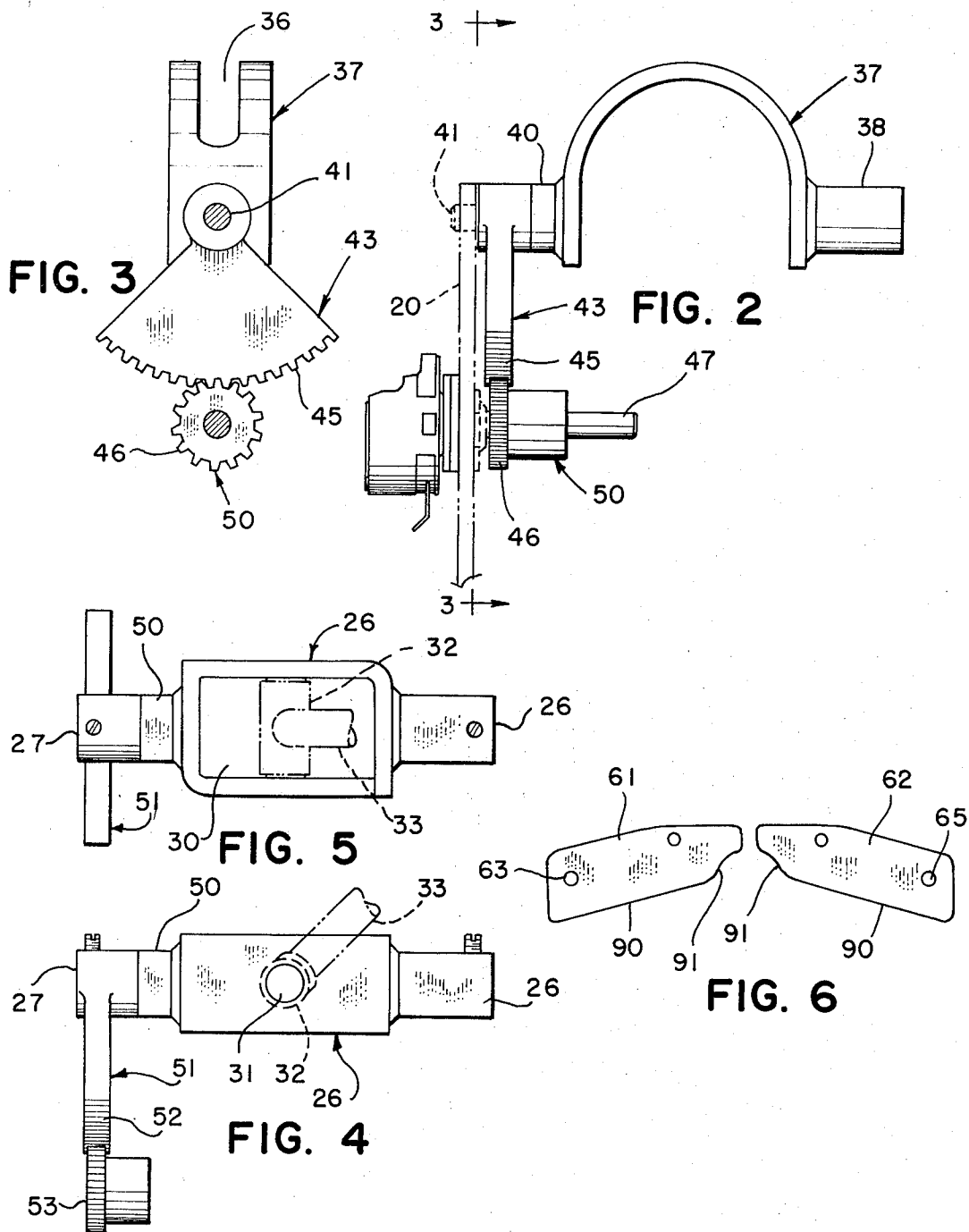
Apparatus for controlling independent actions of a tower crane, including horizontal trolley travel along the boom track, rotation of the boom itself, and vertical travel of the lifting hook, with a lever, or joy stick, in such manner that the resulting movements are smooth, rapid, and reliably controlled. The lever returns to an origin, or dead center position when not under the influence of an external force.

2 Claims, 9 Drawing Figures









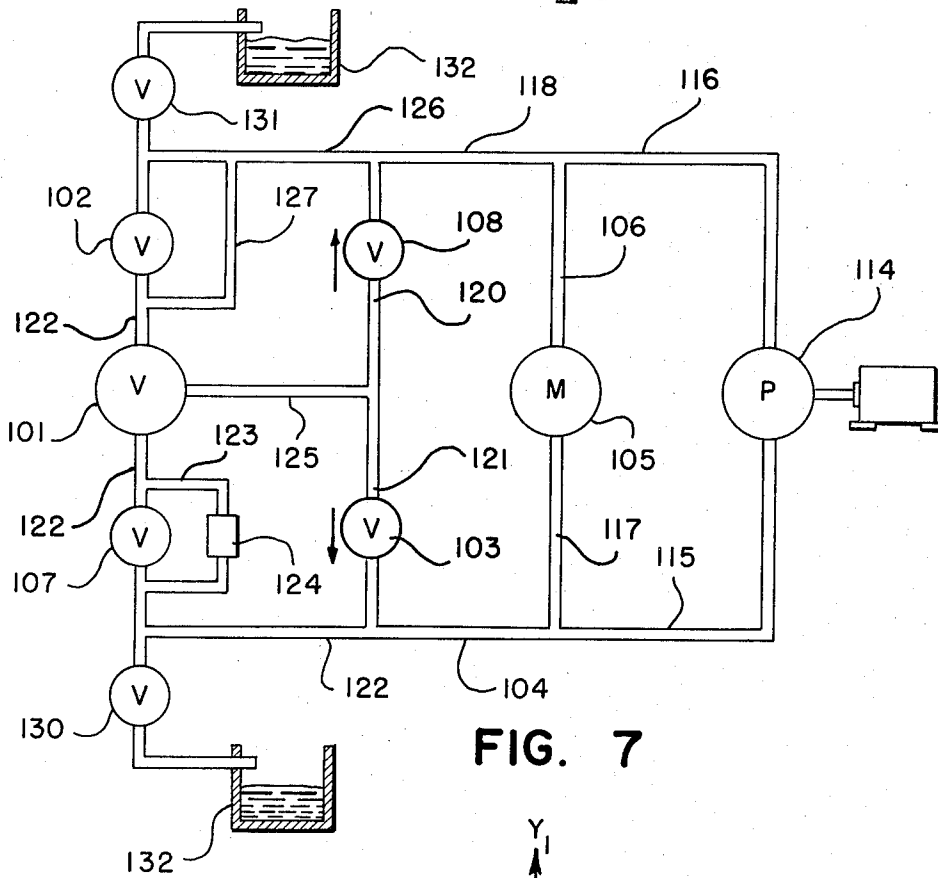


FIG. 7

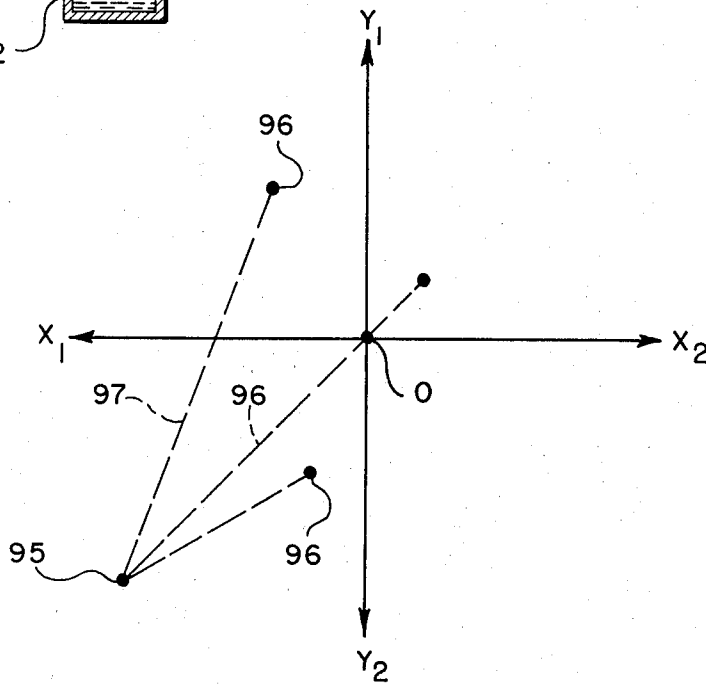


FIG. 8

## JOY STICK CONTROLLER FOR TOWER CRANE

## BACKGROUND OF INVENTION

Construction tower cranes including those of the climbing type have essentially a vertical or mast position and a horizontal boom position which in cantilever manner extends from the mast and rotates thereon. A trolley rides horizontally on the boom which can be, for instance, up to 200 feet in length. A dependent cable extends from the trolley and has attachment means for lifting the load.

An operator located in a cabin within the mast or slightly below the boom controls the swing of the boom, the radial position of the trolley on the boom, and the lift of the cable.

In most prior art tower cranes, to control the swing of the crane, the trolley position and the hook position, the operator manipulated individual levers, mechanisms or switches. For instance, the operator would shift a lever to control the swing of the boom with his left hand and would move another lever to control the trolley on the boom, with his right hand. He would use still other pedals or levers to raise and lower the hook. The ultimate concern of the operator was to position the load being moved by the crane in a most efficient, direct, and safe manner. In many instances, the operator, to compensate for momentum problems created by the huge weights being moved, including the load, and crane components, had to keep movements at relatively low speeds. Also, he was performing the lever and pedal operations individually and this further complicated his tasks.

Efforts were made to combine control of the various crane movements into a single lever device of the type used on planes and referred to as joy sticks. Such prior art joy sticks developed as a result of these efforts were extremely bulky and in many instances occupied so much of the cabin space that they were impractical.

## SUMMARY OF THE INVENTION

The present invention is concerned with a compact and reliable apparatus for crane control having a single lever mechanism or joy stick for reliably performing complete control of two of the cranes' actions. By the use of two lever mechanisms, one for each hand of the operator, the crane can be fully controlled.

The vertical or Y—Y position on the coordinate axis through which the lever moves may be used, for instance, to control boom swing, and the transverse direction, the X—X direction, may be used to control trolley position on the boom track. Another lever may be used for the lift cable, and in the case of travelling cranes, for mast travel. The lever is universally pivoted and movement of the lever is transmitted by pinion drive to potentiometers which transmit electrical signals to position motors, or servo mechanisms. Additionally, lever movement activates throttling action for suitably braking individual crane movements. The joy stick may be moved freely over the entire length of its operation without necessarily passing through dead center or zero coordinate position. Additionally, the apparatus is a fail-safe system, since a release of force from the lever results in the actions being controlled by such lever coming to a halt.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a tower crane involved in the present invention.

FIG. 1a is a perspective view, partly in phantom, showing the device of the invention.

FIG. 2 is an elevational view of the yoke trunion, gear drive and potentiometer of the invention.

FIG. 3 is a view taken on the line 3—3 of FIG. 2.

FIG. 4 is an elevational view of a straight trunion in the assembly of FIG. 1.

FIG. 5 is a view taken on the line 5—5 of FIG. 4.

FIG. 6 is a partial elevational view of the cam assembly.

FIG. 7 is a hydraulic circuit diagram.

FIG. 8 is a schematic sketch showing coordinate positions.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a tower crane 10 has a mast 11 and a boom 12 which is supported in a cantilevered manner from the mast. Mast 11 may be supported from the ground, or other surface 13 and may be of the climbing type wherein sections are added as the need arises. Boom 12 rotates, clockwise or counterclockwise, about the mast. A track 14 of any suitable type has riding thereon a trolley 15, having wheels which ride the track. A lift cable 17 depends from trolley 15.

A trolley cable drive drum 18 driven by a suitable motor, has wound thereon a trolley cable 19. One end of cable 19 extends along mast 11 to and over a suitable change of direction pulley located at the radially outward end of boom 22. The cable is then attached to the trolley 15.

It will be seen that as drum 18 is rotated selectively in either a clockwise or counterclockwise direction, the trolley will be moved either inwardly or outwardly along the boom. An operator within a cabin in the mast at 16 controls the swing of the boom. An operator within a cabin in the mast at 16 controls the swing of the boom, the trolley position on the boom track, and the movement of lift cable 17 from within the cabin. These features are all conventional and well known in the prior art.

The joy stick controller of the present invention controls the swing of the boom, the trolley position on the boom track, and the movement of lift cable.

Referring to the drawings I show the device of the invention having a housing 20 with sides 21, 22, 23 and 25. The housing is open at the top and bottom. Extending across from sides 22 to 25 in the housing, is a trunnion 26 journaled at 27 and 28. The trunnion 26 has an open channel portion 30 as best seen in FIGS. 1 and 5. Fixed transversely within said channel 30 is a shaft 31 having journaled thereon sleeve 32 of lever 33 having knob 35. Knob 35, lever 33, and sleeve 32 are integral, and are free to rotate about shaft 31. Channel 30 has sides wide enough to restrain or guide sleeve 32 during such rotation.

Lever 33 extends upwardly through a slot 36 on curved yoke 37, suitably joined as by welding, to trunnion blocks 38 and 40. Blocks 38 and 40 have extending therefrom pivots 41 and 42 journaled in housing sides 21 and 23 respectively. Extending from trunnion blocks 40 and fixed thereto is gear segment 43 as best seen in FIGS. 2 and 3. Such gear segment 43 has gear

teeth 45 extending over approximately a 90° arc. Gear teeth 45 mesh with pinion 46 having hub 50 fixed on shaft 47 journaled inside 21 of housing 20. The shaft 47 extends through side 21 through a suitable sleeve and has fixed thereon at the outside a standard, conventional type potentiometer 44. Such potentiometer is of a type having around a 340° rotation. Suitable leads from the potentiometer connect with a motor drive for a variable speed hydraulic drive pump.

A gear segment 51 identical to the gear segment 43, is fixed to trunnion 26 at 54. Segment 51 has teeth 52 which engage with a pinion 53 journaled on a shaft extending through side 25, and having fixed thereon a potentiometer identical to potentiometer 44, having suitable output leads. The gear segment and pinion and potentiometer arrangement on trunnion 26 is identical as that described and shown in FIGS. 2 and 3, and will be referred to when necessary by primes on the corresponding numbers.

Fixed on shaft 57 extending from trunnion 26 is crank arm 58 having at its end roller cam 60. Cam followers 61 and 62 pivoted at 63 and 65 engage roller cam 60. Stops 66 and 67 fixed on side 22 prevent downward movement of cam followers 61 and 62 against the bias of helically wound tension springs 68 and 70, respectively, anchored at posts 71 and 72 on the housing, and 73 and 75 on the cam followers. Extension arms 76 and 77 are fixed on cam followers 61 and 62 and 78 and 80. Bearing faces 81 and 82 are formed on arms 76 and 77 which selectively depress the respective contact buttons of miniswitches 83 and 84.

A duplicate set of roller cam, followers, switches and related parts are mounted on the outside of side 23 and are fixed on the shaft extension of trunnion 26. Such duplicate parts are designated by the same numbers primed where necessary. This duplicate arrangement is connected to trunnion block 38.

Suitable mounting blocks 85 are fixed on housing 20, wherein the housing can be bolted, or otherwise affixed on the operator's control desk or other suitable location.

In FIG. 7 I show therein a variable displacement reversing pump 114 of the conventional type which is driven by a constant speed electric motor. Pump 114 can be controlled to vary output and direction by means of a corresponding electrical signal transmitted through electrical leads from a potentiometer on the lever assembly described above. The pump 114 has connecting lines 115 and 116 in a hydraulic loop which connect with lines 106 and 117. Line 117 connects with a hydraulically driven motor 105, as does line 106. Motor 105 drives one of the crane movements, for instance the boom rotation. Line 104 connects with line 115 and line 118 connects with lines 106 and 116. A connecting line 120 and a connecting line 121 connect lines 118 and 104. Check valve 108 is installed in line 120 and check valve 103 is installed in line 121. Line 122 connects with four-way valve 101. Check valve 107 is installed in line 122 and bypass line 123 bypasses check valve 107. A throttling orifice, or a restrictive orifice 124, is installed in bypass line 123. Line 125 connects valve 121 to lines 120 and 121. Line 126 connects valve 101 to lines 118 and 120. Bypass line 127 is installed around check valve 102 installed in line 122. Pressure release valves 130 and 131 are installed

in lines 126 and 122. The relief valves empty into reservoirs 132.

Reference will be made to FIG. 8 to aid in an explanation of the operation. Such figure represents a plan view, that is, looking downward on the device from above, with lever 33 movement related to coordinate axes.

In operation, the device is connected to the crane operating controls so that movement of the stick in one direction, for instance Y—Y, will control for instance the swing of the crane boom, and movement in an X—X direction will control trolley travel inwardly and outwardly along the track. The stick position will normally be at the origin or dead center designated zero in FIG. 8. The stick will revert and maintain itself in such position when no biasing force by the operator is exerted, under the influence of the cam follower and roller cam arrangement at the end of each of the trunnions 26 and 38. Describing the operation of the cam follower and roller cam arrangement on 26, helical springs 68 and 70 bias cam followers 61 and 62 in a downward position. The follower contour of the cam followers as best seen in FIG. 6 has an inclined surface 90 and an abruptly curving face 91. The abruptly curving face 91 corresponds in curvature to roller cam 60 curvature so that the roller cam 60 will be cradled between the curvature 91 of each of the cam followers 61 and 62. If a movement is made in an X<sub>1</sub> direction the roller cam 60 will move against cam 62 against the influence of spring 70. Cam follower 61 will be retained in position by stop 66, when not in contact with roller cam 60. If for instance the operator releases the force on lever 33, helical spring 70 will exert a downward force on cam follower 62 forcing roller cam 60 back to its zero position or dead center position, along inclined surface 90 and then into curved surface 91 where the roller now becomes cradled between followers 61 and 62. It will be seen from this description that movement in the X—X direction either toward X<sub>1</sub> or Y<sub>2</sub> will be subsequently counteracted by the influence of the cam roller and springs as described to an origin or dead center position when the lever is released.

It will be seen that the lever 33 is free to move in an X direction and a Y direction simultaneously in the operation of the device. For instance, referring to FIG. 8 the lever can be taken from its origin position 0 and moved out to a coordinate position designated 95 which would mean that the lever is moving in an X<sub>1</sub> direction and a Y<sub>2</sub> direction simultaneously. This lever movement is shown by the path 96 which represents a direct movement from 0 to 95. From position 95, the operator is free to move to any other coordinate position to achieve the desired crane control by direct movement. For instance, the operator can move directly from 95 to 96 through path 97.

Alternatively, the operator could move within a quadrant itself, for instance moving from 95 to 98 through path 99. The effect of these movements will be described later. It will be seen that the operator thus has great flexibility in achieving positioning of the lever in an infinitely variable number of positions without passing through any predetermined path or lever operating direction.

The lever movement referred to above will be monitored by the mechanism including gear segments 43 and 52 and including the early referred to gear and pinion arrangements and potentiometers. For instance,

movement of lever 33 in the direction from 0 to origin to 95 results in gear segment 43 being rotated so as to drive pinion 46 and correspondingly potentiometer 44 through a number of degrees correspond to twice the degree movement of the lever, or twice the distance of the lever in that half direction. Correspondingly, lever movement from 0 to 95 will be translated in the  $X_1$  direction by the movement of the gear segment 51, pinion 53, and potentiometer on trunnion 26. The output of these potentiometers will be determined by the amount of rotation of the pinions which in turn will rotate the movable arm of the potentiometer a corresponding number of degrees. The potentiometer will then transmit a signal corresponding to such degree of arm movement which in turn corresponds to the degree of lever movement. Thus, where there is movement from the origin to for instance a 95, there will be corresponding signals transmitted both in the  $X_1$  direction and in the  $Y_2$  direction.

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

1. In a tower crane having
  - a. a mast portion extending vertically;
  - b. a boom portion extending horizontally from and rotating about the mast portion;
  - c. a track on the boom having riding thereon a trolley;

- d. a lift cable on the trolley and adapted to lift and lower crane loads; and
  - e. separate driving means for rotating the boom, moving the trolley, and lifting and lower a load;
- 5 a lever pivoted on a pair of axes disposed normal to one another, means on each of the axes for determining a signal proportional to lever movement, and means for transmitting the determined signals to the separate driving means; wherein the lever is pivoted within a first trunnion, and said lever extends within a groove in a U-shaped portion of a second trunnion pivoted normally to said first trunnion, whereby said lever can selectively rotate both said first and second trunnions separately or simultaneously; said device having a gear segment fixed on each of the first and second trunnions; a pinion engaged with each of said segments, potentiometers adapted to be operated by rotation of said pinions, whereby electrical signals proportional to lever movement are determined, and means for returning said lever to an origin, or dead center position, including
    - a. cams on the first and second trunnions;
    - b. cam followers in engagement with the cams, and
    - c. springs biasing the cam followers against the cams.
  - 25 2. The device of claim 1, wherein the driving means include fluid drive means.

\* \* \* \* \*

30

35

40

45

50

55

60

65