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S. W. FOUNTAIN ET AL

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CRANE MECHANISM

Filed Oct. 31, 1962

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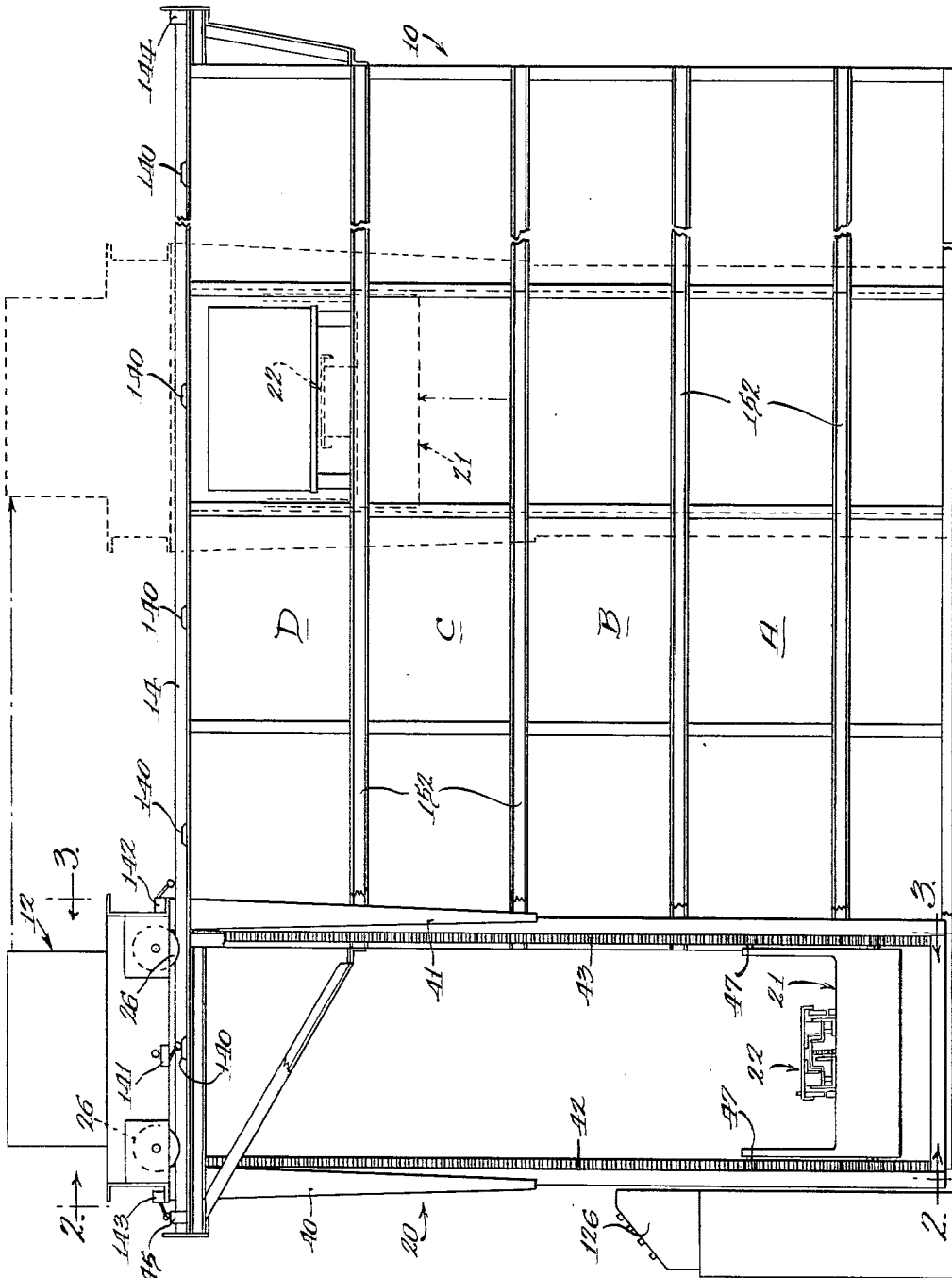


Fig. 1.

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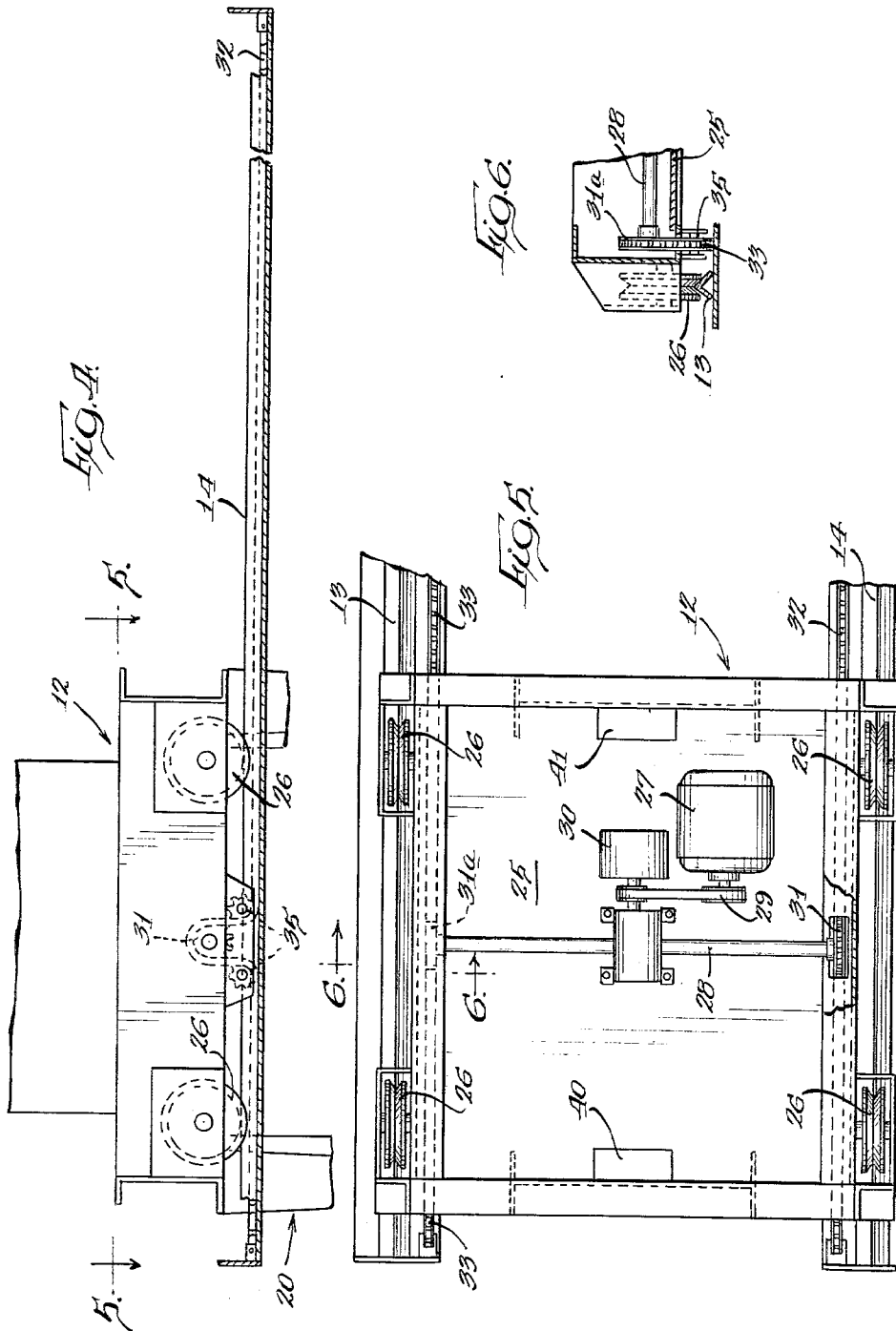
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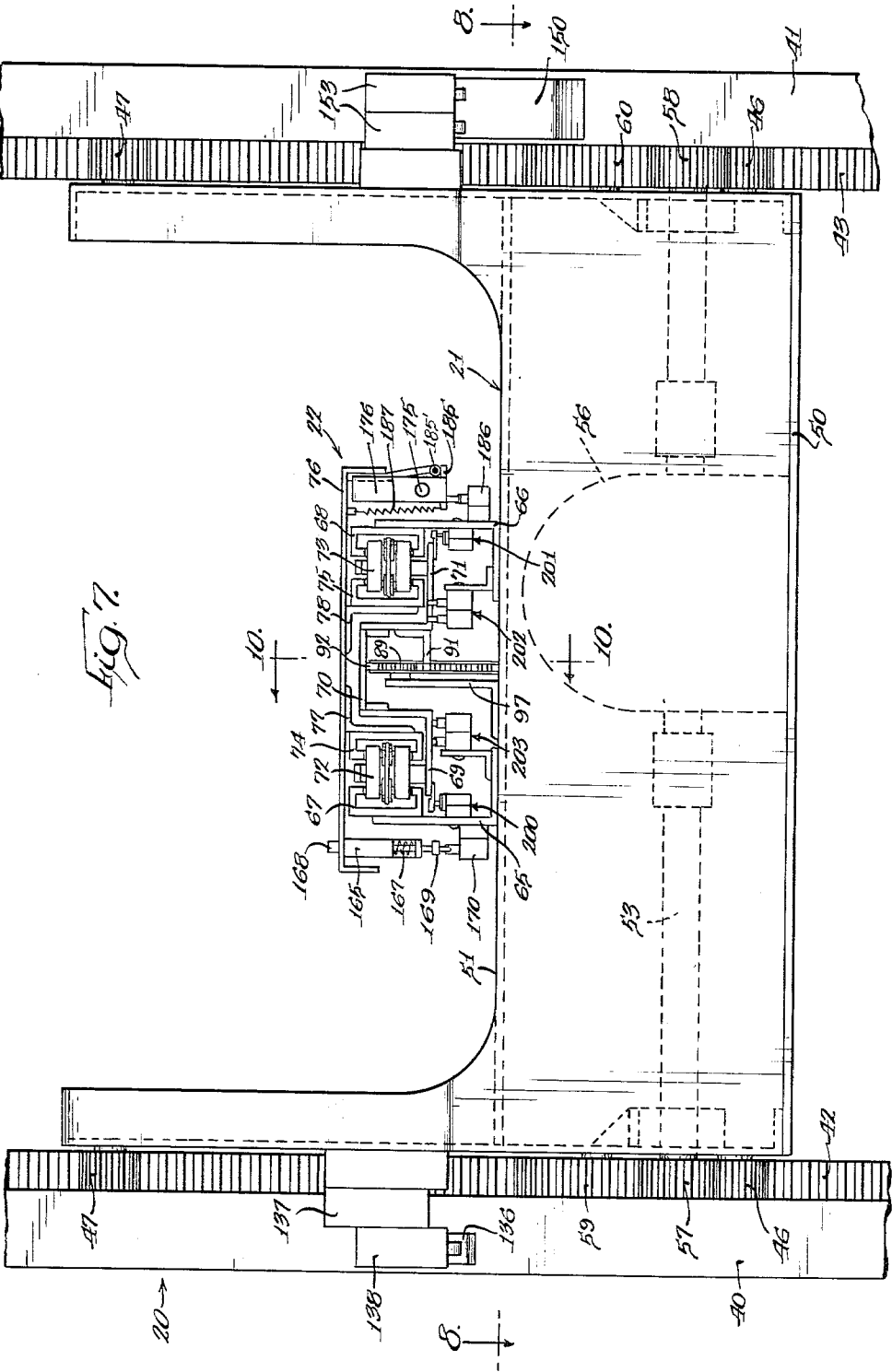
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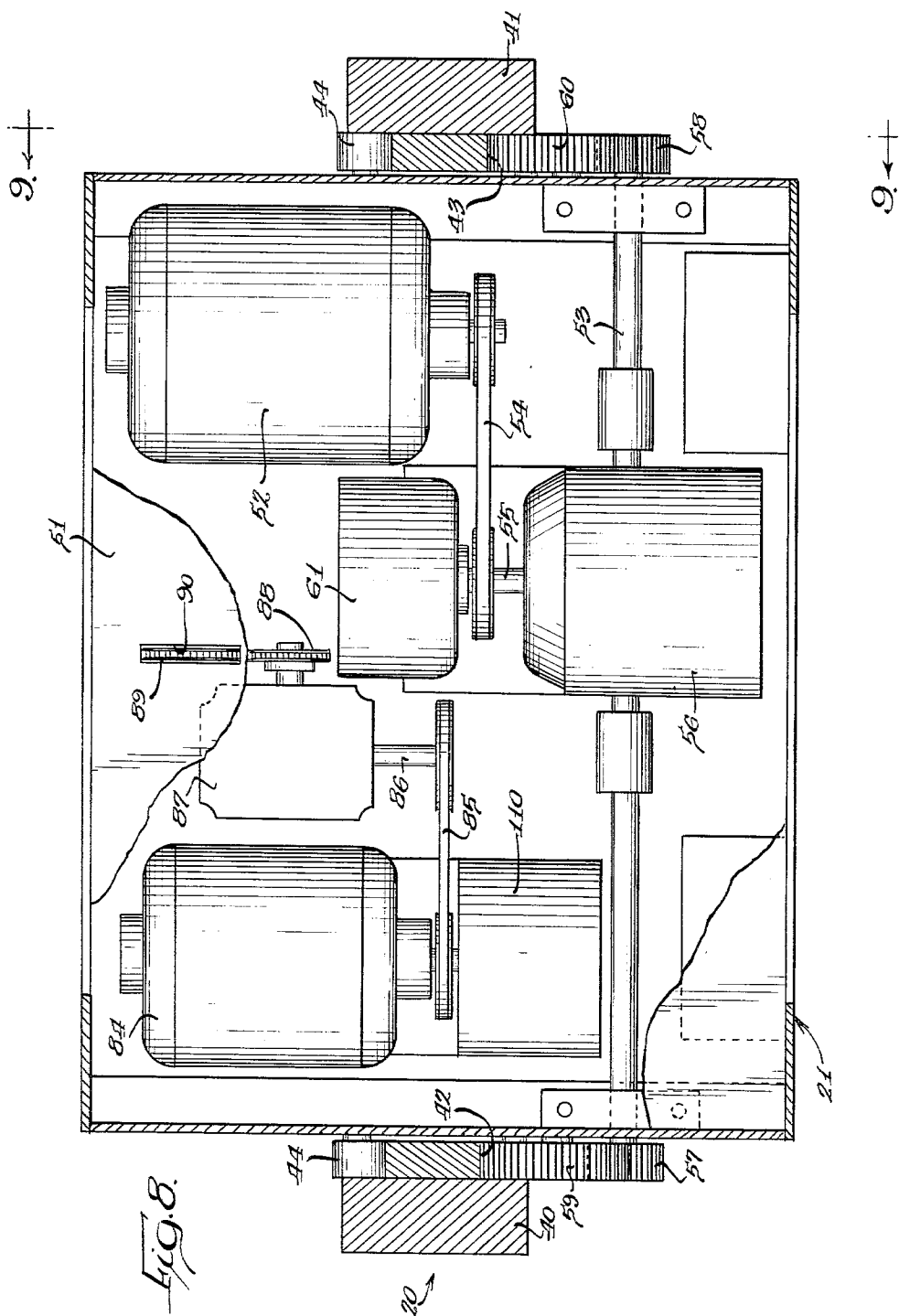
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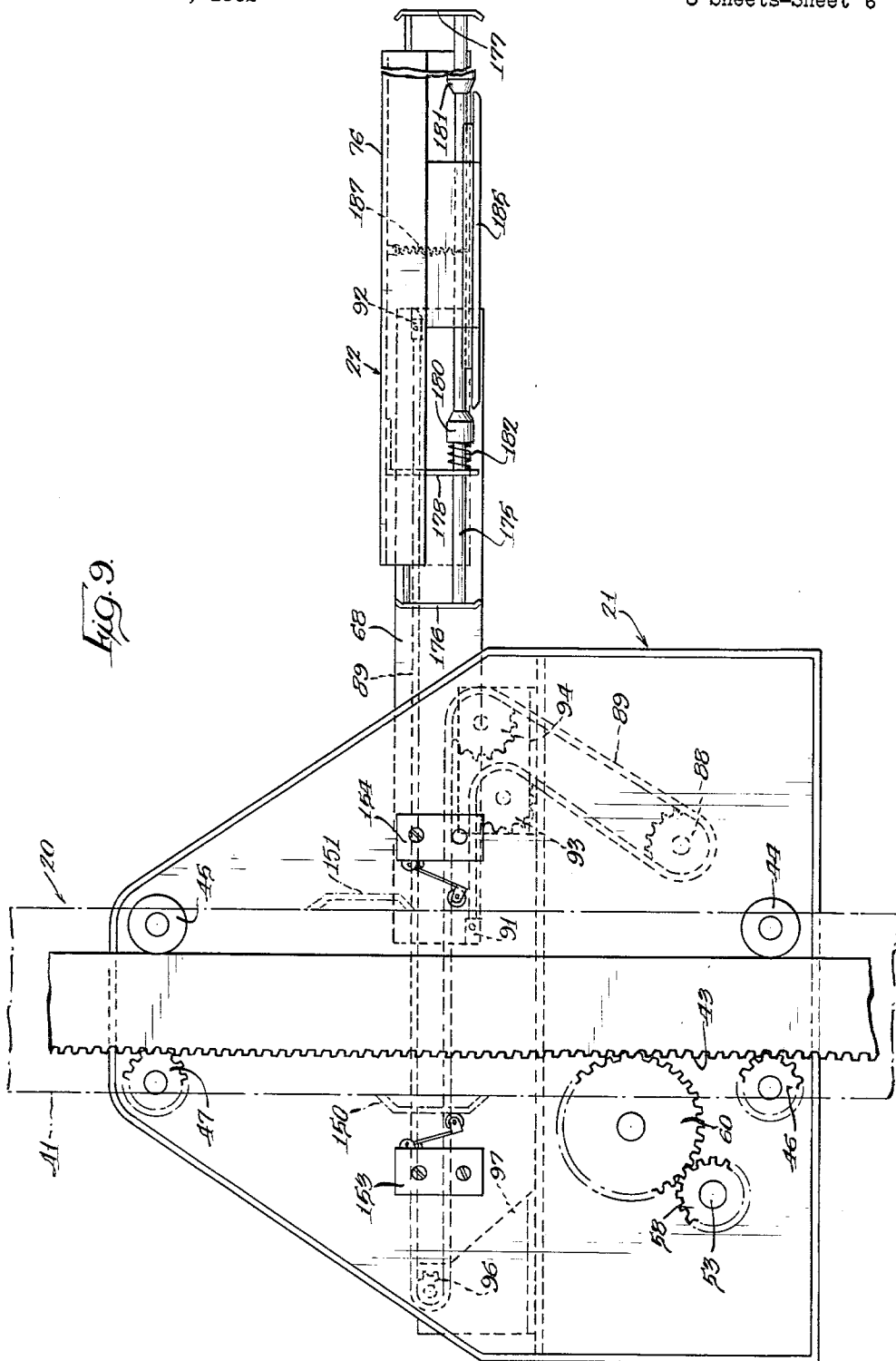
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## CRANE MECHANISM

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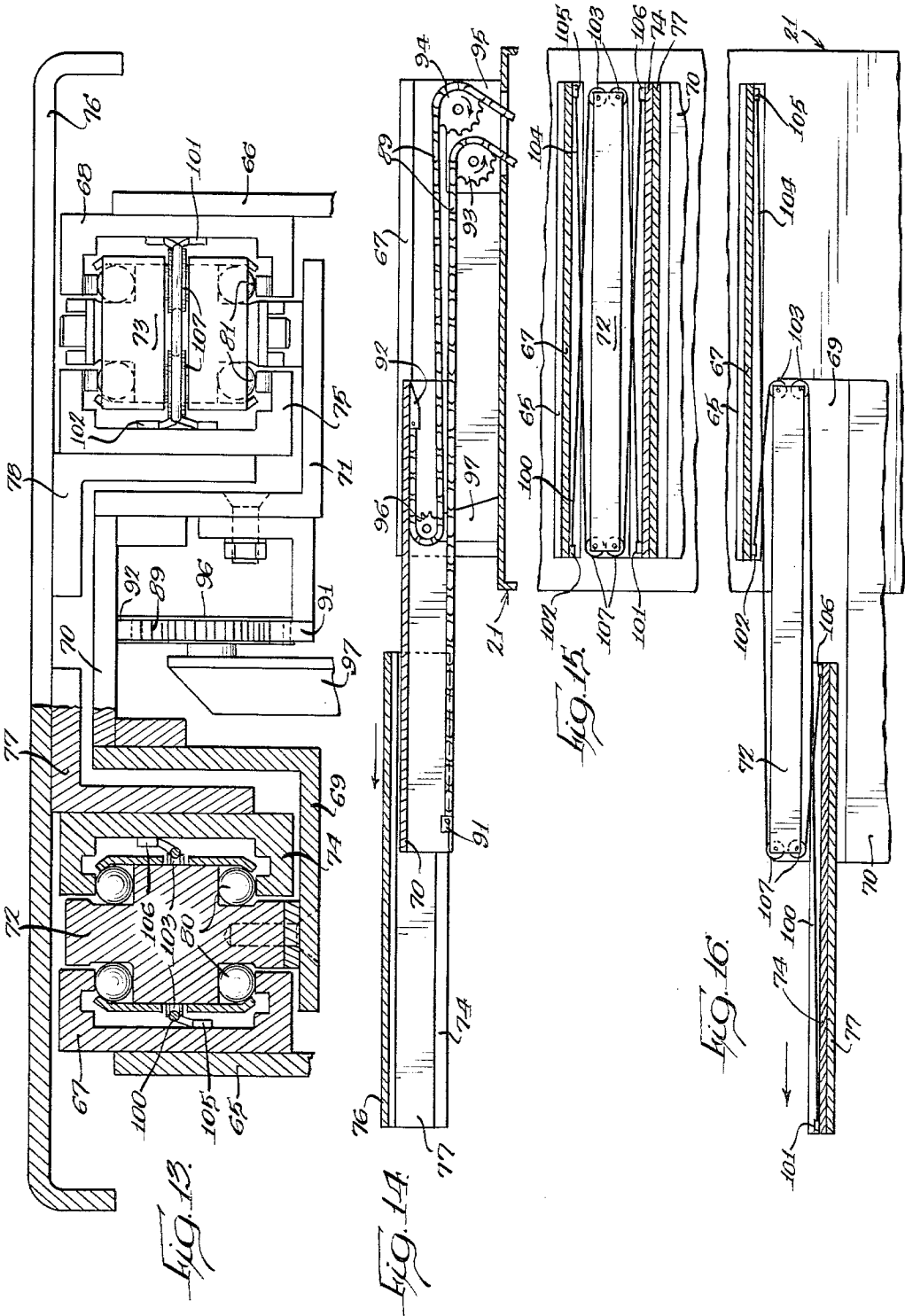
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CRANE MECHANISM

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## CRANE MECHANISM

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3 Claims. (Cl. 214-16.4)

This invention relates to material handling apparatus and, more particularly, to a stacker crane mechanism adapted for automatic operation.

An object of this invention is to provide stacker crane mechanism associated with storage shelves at either side of an aisle along which the crane may travel to and from various storage bins at different heights and distances from a home position with mechanisms carried directly on the crane for indicating the position of the crane.

Another object of the invention is to provide a stacker crane in which a carriage is supported for vertical movement on column means which may travel along an aisle, with lift mechanism shiftable to either side of the aisle for receiving or depositing a load and which has a plurality of extendable sections, with means to determine the length to which the lift mechanism can be extended, means for detecting an already full storage bin, and means for detecting a load on the lift mechanism.

Still another object of the invention is to provide mechanism in which the location of the lift-supporting carriage in elevation is determined by a series of pre-set vertically spaced cams on the carriage supporting column related to the levels of the storage bins and with there being an additional pair of cams associated with each of these cams for controlling the carriage and lift members in movements to either deposit a load in the storage bin or to receive a load therefrom.

Another object of the invention is to provide a mechanism as defined in the preceding paragraph in which the carriage and column may both simultaneously be moved to travel the carriage from one location to another either as straight-line movement or, if required, diagonal movement and in which the carriage supports lift mechanism movable into a bin with the lift member being supported on an intermediate section travelling half as far as the lift member in order to provide for full extension of the lift member into a bin and full support thereof with the lift mechanism having empty bin detector mechanism and load detecting mechanism thereon.

Other objects and advantages will become readily apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevational view of the crane mechanism in association with a storage rack structure;

FIG. 2 is a vertical end elevation taken generally along the line 2-2 in FIG. 1, with the control panel omitted;

FIG. 3 is a vertical section taken generally along the line 3-3 in FIG. 1;

FIG. 4 is a fragmentary vertical section on an enlarged scale and taken generally along the line 4-4 in FIG. 2;

FIG. 5 is a plan section taken generally along the line 5-5 in FIG. 4;

FIG. 6 is a fragmentary vertical section taken generally along the line 6-6 in FIG. 5;

FIG. 7 is a fragmentary view of the lift and carriage mechanism shown in FIG. 1 on an enlarged scale;

FIG. 8 is a plan section taken generally along the line 8-8 in FIG. 7;

FIG. 9 is a vertical section taken generally along the line 9-9 in FIG. 8 with the lift mechanism extended to the right as viewed in FIG. 3;

FIG. 10 is a vertical section taken generally along the line 10-10 in FIG. 7;

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FIG. 11 is a plan view taken generally along the line 11-11 in FIG. 10;

FIG. 12 is a detail view of the load detecting mechanism shown in FIG. 11;

FIG. 13 is a vertical section on an enlarged scale taken generally along the line 13-13 in FIG. 11;

FIG. 14 is a diagrammatic view of the lift mechanism shown in extended position;

FIG. 15 is a fragmentary diagrammatic plan view of one side of the left mechanism to show the actuating mechanism therefor; and

FIG. 16 is a view similar to FIG. 15 with the lift mechanism extended.

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail an embodiment of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiment illustrated. The scope of the invention will be pointed out in the appended claims.

The crane mechanism for warehouse pickup and delivery and the like is shown in FIGS. 1, 2 and 3 in association with storage rack structure embodying a first section of storage bins 10 and a second section, indicated generally at 11, formed of suitable frame structure to provide a series of individual storage bins arranged in an array of spaced apart vertical rows.

The crane mechanism is disposed for travel along the aisle between the storage racks 10 and 11 and for this purpose a bridge or trolley, indicated generally at 12, travels along a pair of rails 13 and 14 supported above the storage racks. The bridge 12 supports the depending column means indicated generally at 20, having a carriage 21 vertically movable thereon, and a lift mechanism indicated generally at 22 mounted on the carriage for movement into any storage bin in either of the storage racks 10 or 11 at opposite sides of the aisle.

Movement of the carriage 21 and lift members 22 along the length of the storage racks 10 and 11 is obtained by powered movement of the trolley 12. The trolley has a framework including the baseplate 25 which rotatably mounts a series of wheels 26 engaging the tracks 13 and 14 for guiding of the trolley along the length of the storage racks. The trolley is powered by a motor 27 (FIG. 5) which drives a transverse shaft 28 through a belt 29 and a gear reducer 30 with this transverse shaft 28 having a pair of sprockets 31 and 31a at the opposite ends thereof which engage a loop in fixed chains 32 and 33, respectively, extending along the length of the storage racks adjacent the tracks 13 and 14. The chains 32 and 33 are guided about sprockets 31 and 31a by a pair of rollers associated with each sprocket. The rollers associated with sprocket 31 are indicated at 35. Alternatively, the shaft 28 can drive wheels which will engage the tracks 13 and 14 to propel the trolley.

As will thus be seen, the supply of power to the motor 27 determines the movement of the bridge or trolley 12 with the motor 27 being reversible to have the bridge 12 travel in one direction or the other along a predetermined path by causing the sprockets 31 and 31a to move relative to the chains 32 and 33 which are fixed.

The column means 20, as shown in FIG. 1, 2 and 3, embodies two depending legs 40 and 41, each of which are provided with a vertically extending rack 42 and 43, respectively, along which the carriage 21 travels in vertical movement. The carriage is guided in vertical movement along the column by two sets of rollers, with rollers 44 and 45 of one set (FIG. 9) rotatably mounted on the carriage and positioned in spaced vertical relation engaging the back side of a column leg and a pair of gear rollers

46 and 47 rotatably mounted on the carriage and engaging the column legs. A similar set coacts with the other column leg.

The carriage 21 has a frame including a bottom plate 50 and a top cover plate 51 on which the lift mechanism 22 is supported. Disposed between these plates is the mechanism for driving the carriage vertically along the column 20. This mechanism comprises a motor 52 (FIG. 8) which drives a transverse shaft 53 by means of a drive belt 54 passing about a pulley shaft 55 which connects into a gear reducer 56 driving the transverse shaft 53. The shaft 53 has a pair of gears 57 and 58 at the opposite ends thereof meshing with gears 59 and 60, respectively, rotatably mounted on the carriage which mesh with the column racks 42 and 43, respectively. The motor 52 is reversible and the pulley shaft 55 has a brake 61 associated therewith which operates to brake the shaft when the motor 52 is deenergized as well known in the art. Operation of the motor 52 in one direction of rotation will result in elevation of the carriage 21 along the column 20 and operation of the motor in the other direction of rotation will result in lowering the carriage 21 on the column.

The lift mechanism 22 is shown particularly in FIGS. 7 and 9-16. The lift mechanism is formed of three sections, with a base section including a pair of spaced apart upstanding elongate channels 65 and 66 secured to the top cover plate 51 of the carriage and mounting a pair of inwardly facing C-shaped channels 67 and 68. Each of these C-shaped channels 67 and 68 support an intermediate section of the lift mechanism with the intermediate section including a central connecting framework formed of parts 69, 70 and 71 with the parts 69 and 71 supporting an elongate block section 72 and 73, respectively (FIG. 13). The block sections 72 and 73 extend along the C-shaped channels 67 and 68 of the base section and also a pair of channels 74 and 75 which form part of the load-supporting section or lift member of the lift mechanism. The lift mechanism has a platform 76 which is connected to the channels 74 and 75 by a pair of channels 77 and 78. The C-shaped channels 67 and 68 of the base section are arranged in parallel and opposed relation with the C-shaped channels 74 and 75 of the load-supporting section with the elongate blocks 72 and 73 disposed therebetween.

With this construction, the intermediate section may move relative to the base section and also the load-supporting platform 76 moves relative to the base section with the platform adequately supported when extended. Also, as later described, the platform is powered to move twice as far and twice as fast as the intermediate section. These relative movements are obtained by having travelling ball bearings associated with the elongate blocks 72 and 73, with the balls 80 being associated with elongate block 72 and the balls 81 with the elongate block 73. These balls are held in association with the elongate blocks by suitable retainers that roll on flanges of the C-shaped channels 67, 68, 74, and 75 and surfaces of the elongate blocks.

The lift mechanism 22 is operated by power obtained from a reversible electric motor 84 mounted within the carriage 21 which drives a belt 85 passing about a pulley shaft 86 and connected to a gear reducer 87 driving an output sprocket 88. The output sprocket drives a chain 89 (FIG. 9) passing upwardly through an opening 90 in the carriage top plate 51. The chain 89 is of determinate length and, as best seen in FIGS. 10 and 14, has an end secured at 91 to one end of plate 70 of the intermediate section of the lift mechanism. The opposite end of the chain is secured, as indicated at 92, to the opposite end of the plate 70. Intermediate the drive sprocket 88 and the connections for the end of the chain, the chain passes about a pair of idler sprockets 93 and 94 rotatably mounted on a plate 95 extending upwardly from the top plate 51 of the carriage and an idler 96 rotatably mounted on a plate 97 extending upwardly from the carriage plate

51. As will be seen in FIGS. 10 and 14, if the sprocket 94 is caused to rotate in a clockwise direction as viewed in FIG. 10, this will shift the intermediate section of the lift mechanism to the left, as viewed in FIG. 14, and this will carry the load-supporting section 76 an even greater distance to the left by connections to be described. Movement of the chain in the opposite direction would result in movement of the lift sections to the right as viewed in FIG. 14.

The means for moving the load-supporting section 76 when the intermediate section moves comprises two pairs of cables located for coaction of a pair with each of the intermediate blocks 72 and 73. As best shown in FIG. 15 and 16, a first cable 100 extends between a fixed connection 101 on the channel 74 of the load-supporting section and a connection 102 on the channel 67 of the base section and between its ends passes about a pair of rollers 103 mounted at an end of the elongate block 72. A second cable 104 connects at one end, as indicated at 105, to the channel 67 of the base section and connects at its other end, as indicated at 106, to the channel 74 of the load-supporting section. An intermediate part of the cable passes about a pair of rollers 107 rotatably supported at an end of the elongate block 72. This structure is found also in association with the elongate block 73 and similar reference numerals have been given to these parts in FIGS. 11 and 13. As the intermediate section is caused to move by the chain 89, the cables 100 and 104 will result in twice the total distance of movement for the load-supporting platform 76.

Included in the drive mechanism for the lift mechanism is a brake 110 (FIG. 8) which operates to brake the chain when the motor 84 is deenergized.

The apparatus disclosed herein may be automatically controlled by sequencing controls utilizing stepping switches and the like which are well known and operated from a control panel indicated generally at 126 (FIG. 1).

In order to determine the position of the carriage 21 relative to a particular storage bin or shelf row which are identified in vertically spaced rows A, B, C and D in FIG. 1, the column leg 40, as indicated in FIG. 2, has a series of vertically spaced cams 130 which are located in vertical relation to the rows of shelves or bins and at a level somewhat above the bottom of a shelf. A limit switch 131 is positioned on the carriage 21 for engagement with these cams as the carriage moves upwardly along the column to, in effect, count the rows as the carriage moves. A cam 132 located near the lower end of the column coacts with a switch 133 on the carriage to indicate when the carriage is in its home position adjacent a pickup station, which is the position of the carriage shown in full line in FIGS. 1, 2 and 3.

The column leg 40 also supports a pair of vertically spaced apart cams 135 and 136 which provide safety limits of travel for the carriage 21 with a switch 137 supported on the carriage engageable with the upper limit cam 135 and a switch 138 positioned on the carriage for engagement with the lower limit cam 136 if the carriage should move to either of the extreme positions.

The travel of the carriage along rows in a generally horizontal direction is controlled by a series of cams 140 supported on the top of the storage rack 10 with these cams being engageable by a switch 141 on the bridge 12. The bridge also supports a pair of switches 142 and 143 for coacting with limit cams 144 and 145, respectively, to provide safety limits of movement for the bridge 12. It will be noted that one of the cams 150 is located at the home position to provide for positioning the carriage 21 at the main pickup station.

There are switches associated with the parts for controlling the position in space of the carriage 21 and all of these switches are mounted on the moving mechanism except for the cams 140 which count the vertical aligned rows of storage shelves.

It is a feature of the position detecting mechanism that

the mechanism may be entirely self-contained to have the lift mechanism 22 either follow a path of movement to enter into a storage bin and lower itself to place a package or load, such as supported on a pallet, on the shelf and then retract. Alternatively, the lift mechanism may go in at a relatively low level to place itself under a package and then raise the package and withdraw it from the shelf. This operation is facilitated by having a series of deliver cams 150 supported along one side of the column leg 41 and the retrieve control by a series of retrieve cams 151 mounted on the opposite side of the column leg 41. These cams and the count cams 130 are related to the channel irons 152 indicating the bottom of each row of storage shelves. The deliver cams 150 are in overlapping height relation with the count cams 130 and extend to the lower level thereof while the retrieve cams 151 are in overlapping vertical relation with the count cams 130 and extend to the upper level thereof. When the desired bin is reached, this is indicated by one of the count cams 130. The actual level for the lift mechanism, depending on load removal or insertion, is then determined by switches associated with cams 150 and 151, after the cams 130 have indicated that the correct overall vertical level (and hence the operative cams 150 and 151 for that level) has been reached.

A pair of switches at the same level are indicated at 153 and are mounted on the carriage in position to engage one of the deliver cams 150, depending on the height level of the carriage and a second pair of switches 154 are mounted on the carriage at the opposite side of the column leg 41 at the same level to selectively engage one of the retrieve cams 151. When the carriage 21 is at the level of one of the shelves as determined by the particular count cam 130, either the switches 153 and 154, which are engaged by cams 150 and 151 respectively, would typically be operative in a control circuit (not shown) in order to control the operation of the motors to either deliver a load or retrieve a load, while at the same time indicating the actual level for the lift mechanism, as will now be explained. In a deliver operation, the switches 153 will first locate at the top of the cam 150, the lift mechanism will move in and then descend, as commenced by switches 200 and 201 until the switches 153 move off the cam 150. In a retrieve operation, the switches 154 will be at the bottom of a cam 151, the lift mechanism will move in and then rise until the switches 154 move off the cam 151.

The foregoing switches and cams detect and indicate the position in space of the carriage 21. The foregoing switches are connected in a suitable circuit with the motor 84. The count cams 130 function to count rows and the main drive is stopped when the proper row is reached. The cams 150 and 151 then become effective and overlap the adjacent count cam 130 whereby a signal will automatically be obtained from one or the other of cams 150 and 151 and the exact location of the carriage will be known. The motor 84 is then operated to move the carriage to proper position and through either a delivery or retrieve cycle.

Additional controls are associated with the lift mechanism 22. The first of these indicates that the lift mechanism has a load supported thereon. The mechanism for this includes a plate 165 (FIGURES 7 and 12) movably mounted on a pair of bolts 166 which extend downwardly from and are secured to the load-supporting platform 76. This plate is urged upwardly by a pair of springs 167 and has a pin 168 extending through an opening in the platform 76 which is engageable by a load. The lower edge 169 of the plate is formed for coaction with a switch 170 supported on the top plate of the carriage to indicate, when the lift mechanism is centered, that there is a load supported thereon. This switch 170 can be connected to any desired control circuit (not shown) which is known in the art and which functions in a modified manner at a desired time in a cycle when the presence of a load

on the lift mechanism is to be detected. For example, the switch 170 can be so connected to the control circuit that it functions only on a delivery cycle.

In order to prevent the lift mechanism operating when there is a load already in a storage bin and prevent depositing of another load therein, an empty bin detector switch mechanism is provided which comprises a rod 175 mounted at one side of the lift mechanism and extending outwardly beyond the ends thereof with paddles 176 and 177 at the ends. This rod is mounted within a pair of mounting brackets 178 and 179, which are fixed to load platform 76, for free movement and has a pair of conical members 180 and 181 facing each other with springs 182 and 183 between the conical members and the mounting brackets tending to yieldably center the rod 175. A plate 185 pivoted at 185', as seen in FIGURE 7, on the platform 76 is positioned to overlie a switch 186 supported on the carriage frame 21 when the lift mechanism is near centered position with this plate having a predetermined length thereto. As the lift mechanism is advanced in either one direction or the other and should a load already be in a storage bin, one of the paddles 176 or 177 will be engaged and will be shifted relative to the lift mechanism so that one of the core members 180, 181 will engage and pivot the plate 185 downwardly against the action of a spring 187 to result in operation of the switch 186 to stop the lift mechanism. As an example, the plate 185 may be 8 inches long so that with two-inch aisle clearance on either side of the carriage there is at least two inches of detection within the depth of the storage bin at either side.

As a condition precedent to either elevation or lowering movement of the carriage 21 in a retrieve or deliver operation, respectively, it is necessary to determine that the lift mechanism 22 is fully extended in one direction or the other. This is determined by a pair of switches 200 and 201 located at opposite sides of the carriage and supported in fixed relation thereto. The plates 69 and 71 of the intermediate section of the lift mechanism carry suitable paddle members to operate one or the other of these switches, depending upon the direction of extension of the lift mechanism when the lift mechanism is fully extended.

Also, it is necessary to determine that the lift mechanism is fully retracted before the carriage 21 can move from one station to another and this is determined by the switches 202 and 203 located in fixed relation to the base section of the lift mechanism and positioned to have one or the other of the switches depressed by the intermediate section of the lift mechanism when it is in a position other than centered.

Faulty operation is substantially prevented by the detection of a load supported on the lift mechanism by operation of the switch 170 and prevention of delivery of a load to a filled storage bin as determined by the empty bin detector mechanism which operates the switch 186. Fast operation is obtained by having the lift mechanism in three sections in which power supplied at a normal rate to the intermediate section results in travel twice as fast and twice as far to the load-supporting platform 76 of the lift mechanism 22.

We claim:

1. A stacker crane comprising, a trolley movable along one path, column means extending from the trolley, a carriage movably mounted on said column means for movement lengthwise thereof whereby the carriage may move along two axes, load supporting lift mechanism on said carriage selectively extendable to either side of said carriage along a path normal to the column means for access to storage areas at either side of the carriage, a plurality of motors one for each of said trolley, carriage and lift mechanism for providing powered movement thereof, a first set of cams on said column means in positions related to the vertical relation of the spaced storage areas, switch means on said carriage actuable by

successive ones of said cams in accordance with the vertical relation of the carriage to the storage areas, a second set of cams on said column means in positions related to the vertical relation of the spaced storage areas and positioned slightly above a corresponding one of said first set of cams, second switch means on the carriage engageable with one of said second set of cams when the carriage is at an elevation to lift a load from the storage area, and a third set of cams on said column means in positions related to the vertical relation of the spaced storage areas and positioned slightly below a corresponding one of said first set of cams, and third switch means on said carriage engageable with one of said third cams when the carriage is at a depressed level to lower a load in the storage area.

2. A stacker crane comprising, traveling column means, a carriage movably mounted on said column means for movement lengthwise thereof whereby the carriage may move along two axes, load supporting lift mechanism on said carriage selectively extendable to either side of said carriage along a path normal to the column means for access to storage areas at either side of the carriage including a base section secured to the carriage, an intermediate section movable on the base section and a load supporting section movable on the intermediate section, means for moving the load supporting section twice as far as the intermediate section, a switch supported on said carriage actuated in response to a load being present in a storage area, a switch actuating member mounted on said load supporting section and extending beyond opposite ends thereof, means mounting said actuating member for yielding lengthwise movement in either direction from a central position, and elongate plate means pivoted on the load supporting section co-acting with said member for transmitting lengthwise movement of the actuating member upon engagement with a load in a storage area when the lift mechanism is extended into operation of said switch.

3. A stacker crane comprising, a trolley movable along

one path, column means extending from the trolley, a carriage movably mounted on said column means for movement lengthwise thereof whereby the carriage may move along two axes, load supporting lift mechanism on said carriage selectively extendable to either side of said carriage along a path normal to the column means for access to storage areas at either side of the carriage, and means for detecting the presence of a load on the lift mechanism including a switch on the carriage, a plate movably mounted on the lift mechanism with a plunger extending thereabove and a switch actuating section adjacent the switch when the lift mechanism is centered, and spring means urging said plate and plunger upwardly away from contact with said switch whereby a load engaging the plunger depresses the plate to operate the switch.

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