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Carpenter et al.

[11] **3,866,713**

[45] **Feb. 18, 1975**

[54] **AERIAL PLATFORM APPARATUS**

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[73] Assignee: **Carpenter and Carpenter,** Lakeport, Calif.

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[52] **U.S. Cl.** **182/2**

[51] **Int. Cl.** **B66f 11/04**

[58] **Field of Search** 182/2, 141, 63; 212/144, 212/12, 17

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Attorney, Agent, or Firm—Flehr, Hohbach, Test, Albritton & Herbert

[57] **ABSTRACT**

Apparatus for moving an operator in three dimensions relative to a work location, such as a fruit bearing tree. A mobile vehicle carries a pair of towers which in turn pivotally and rotatably support extensible booms. An operator platform is mounted through self leveling means on the end of each boom and is provided with foot controls enabling the operator to control platform position while his hands are free for other tasks, such as picking fruit. The control system includes hydraulic actuators adapted to extend, elevate and rotate the boom under influence of vacuum operated hydraulic valves which receive command signals through flexible lines extending along the booms from valves actuated by the foot controls. The towers are offset both transversely and longitudinally of the vehicle to permit the platforms to be positioned on the same or opposite sides for increased work efficiency. A closed chamber is formed in one of the towers to provide a reservoir of fluid for an hydraulic pump. An operator station is provided at ground location on the vehicle with controls for engine operation and steering functions.

3 Claims, 7 Drawing Figures

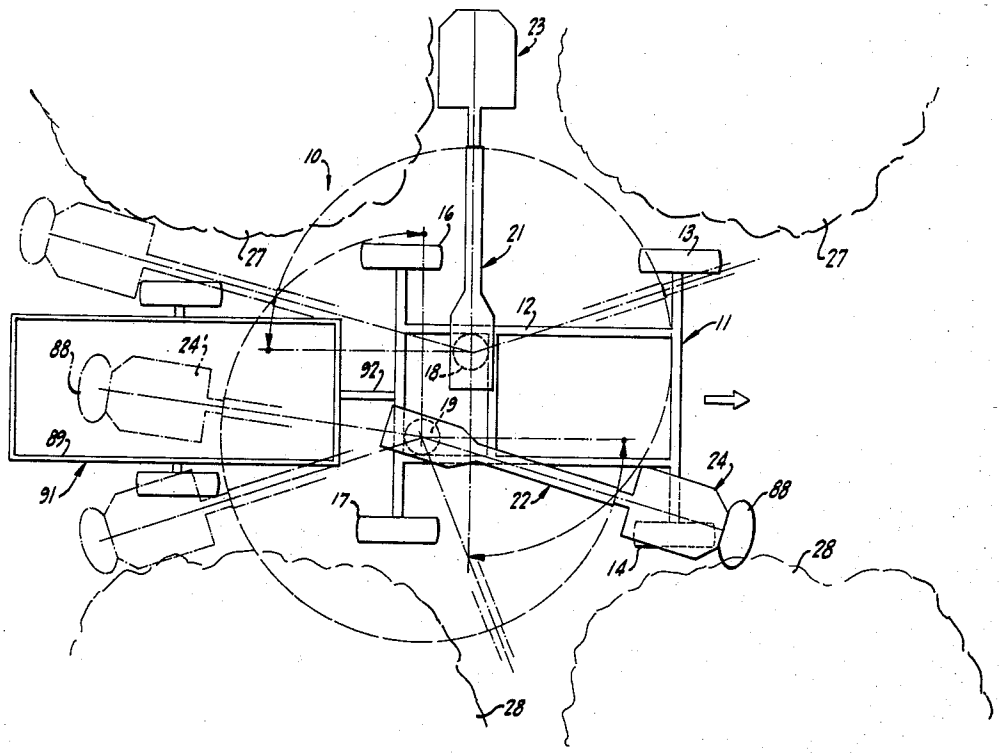
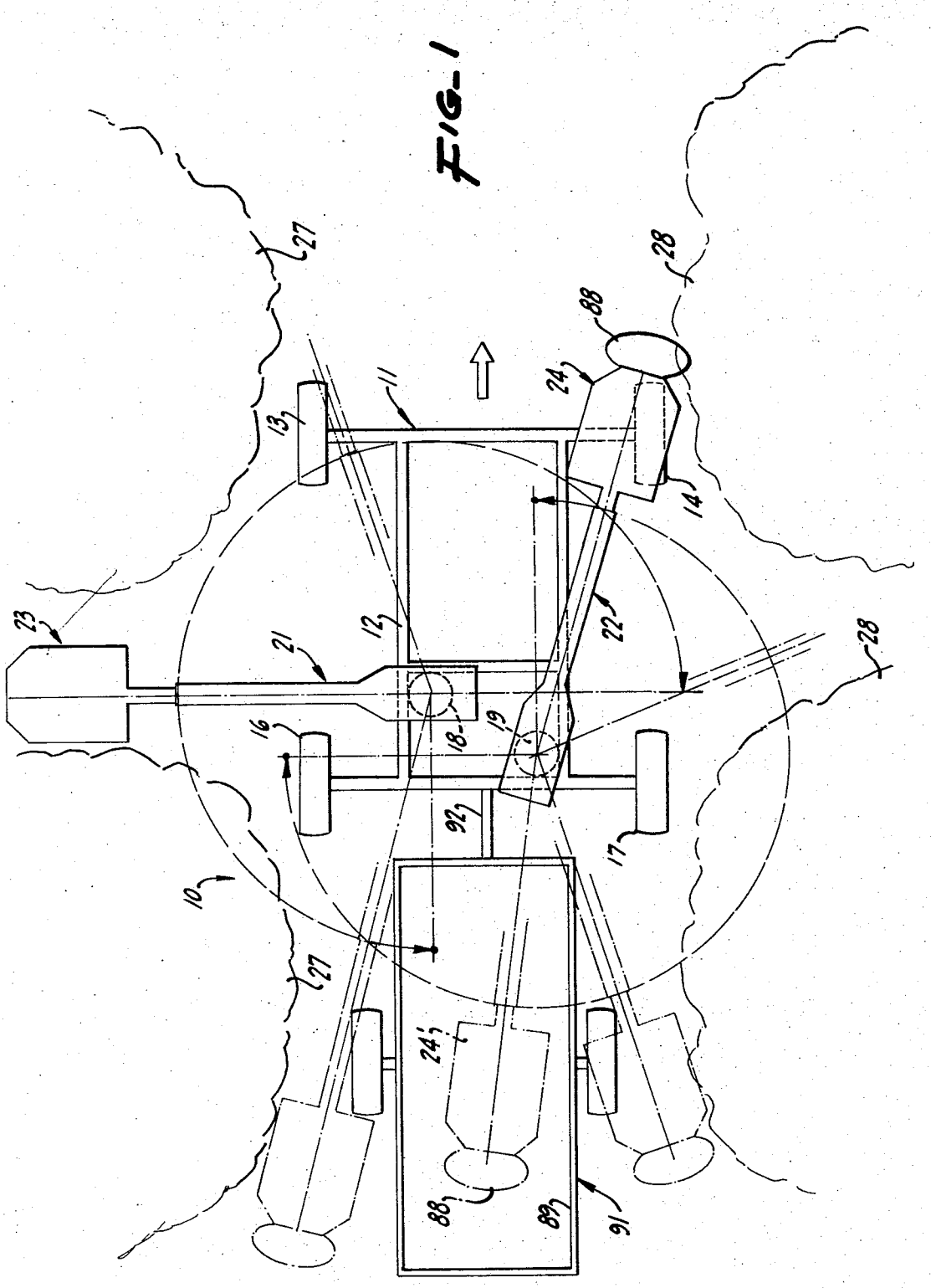


FIG. 1



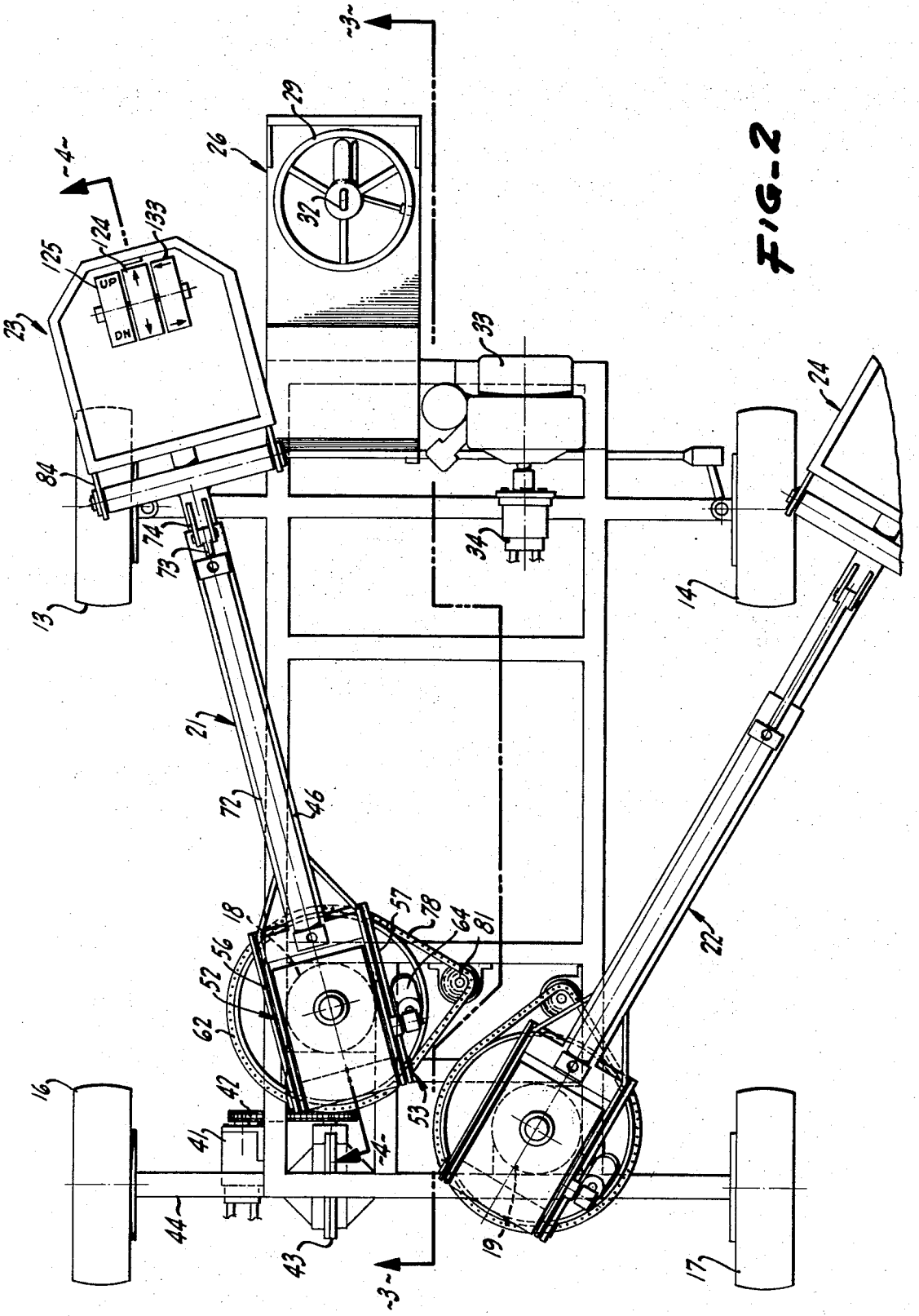

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FIG-2

FIG-3

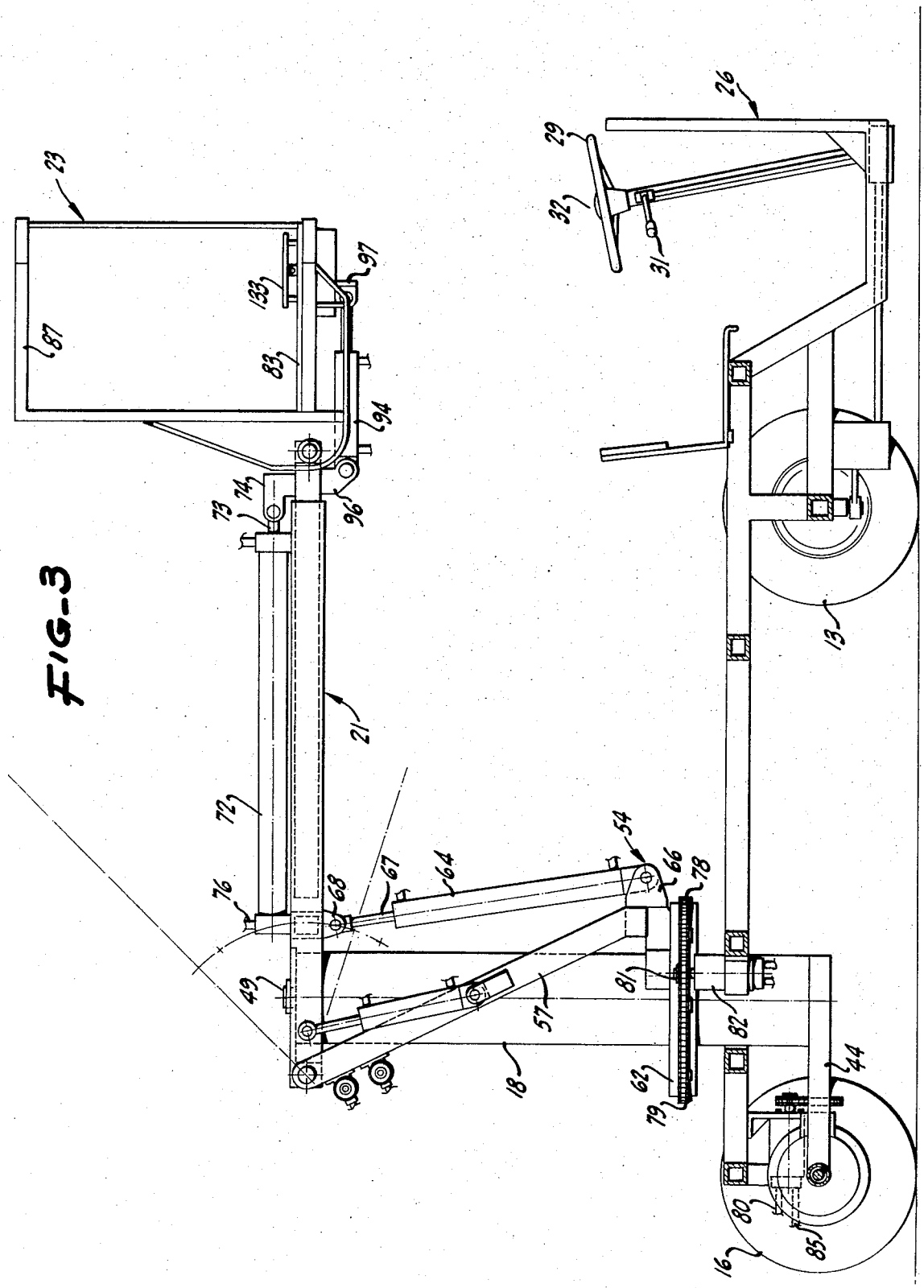

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FIG. 4

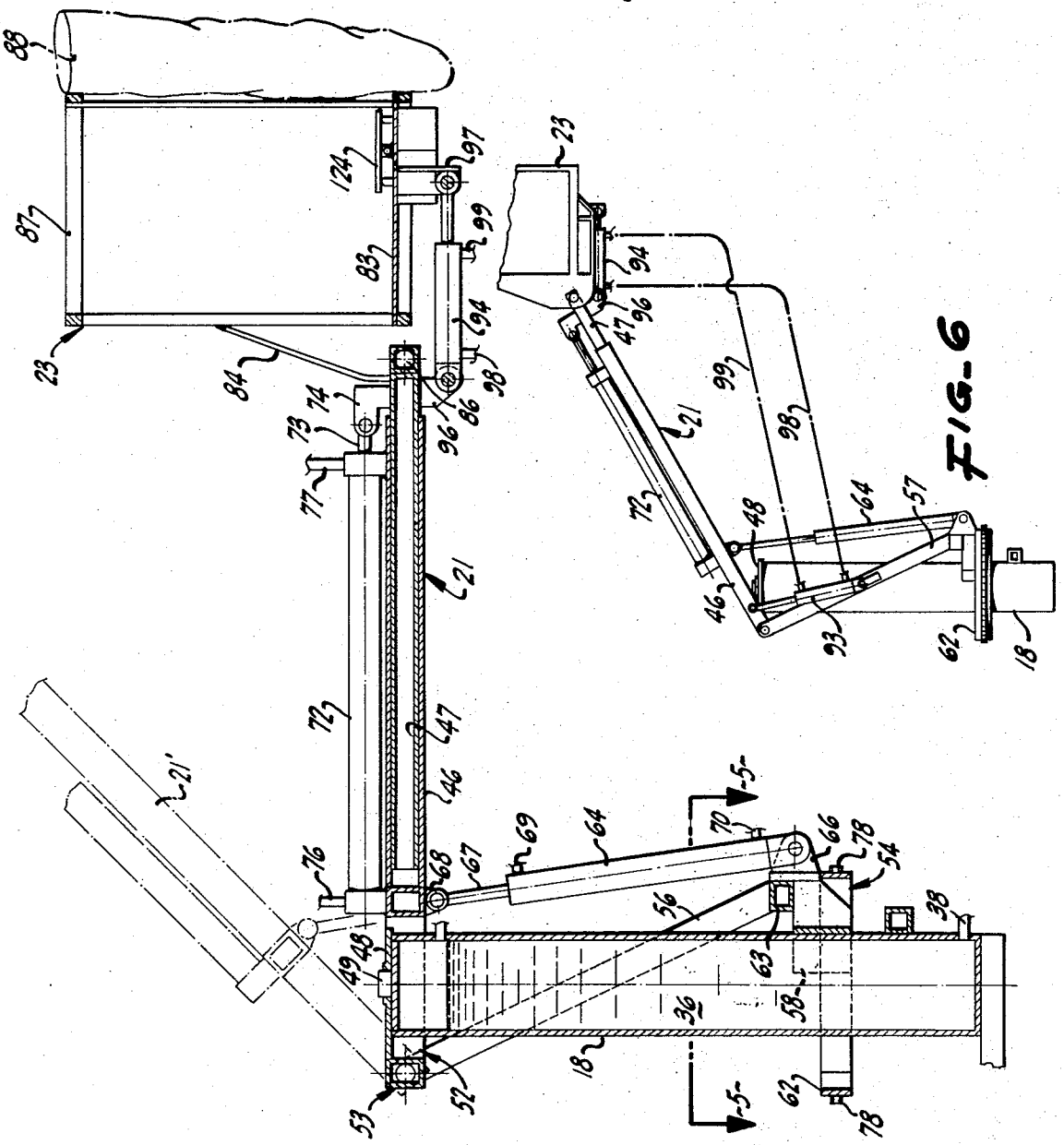


FIG. 5

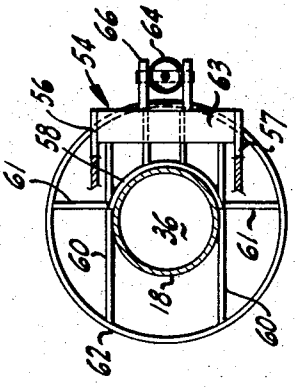
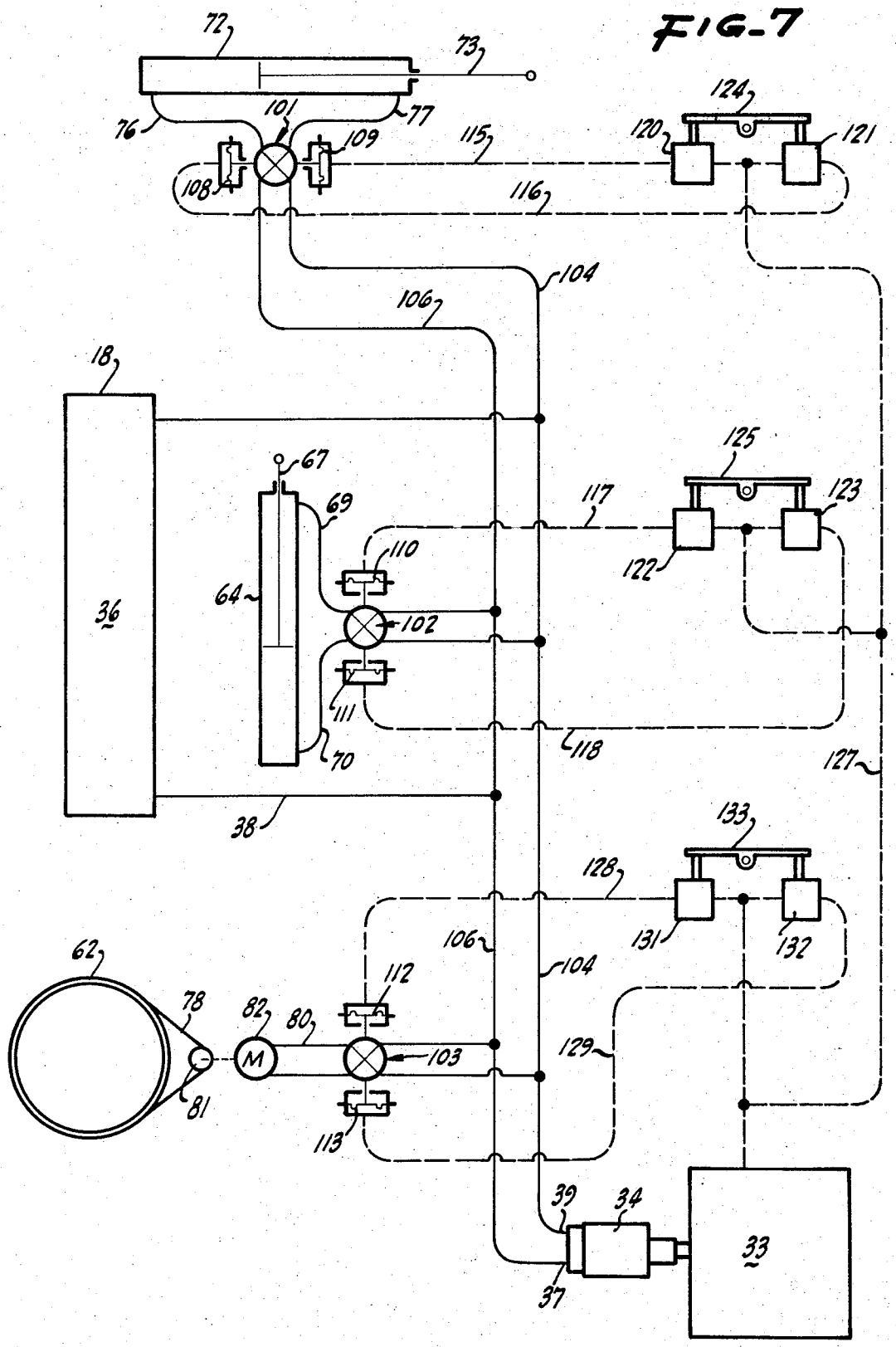


FIG. 6

FIG-7


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AERIAL PLATFORM APPARATUS

BACKGROUND OF THE INVENTION

This invention relates in general to aerial platform apparatus and in particular relates to apparatus for moving an operator or workman in three dimensions relative to a work location, such as a fruit bearing tree or the like.

A number of designs for aerial platform of the type described have been developed in the prior art. These prior art designs include apparatus incorporating platforms carried on either extensible or fixed booms, but the designs present a number of problems and limitations in terms of construction complexity, cost and operating efficiency. It has been recognized that in order to provide maximum work efficiency for the operator, it is desirable to have the boom positioning controls located on the operator platform. Conventional apparatus of this character incorporate an hydraulic control system in which a number of relatively expensive and bulky high pressure hydraulic lines extend along the boom for connection with foot-operated control valves on the platform. It is also desirable to provide an arrangement in which the platform is maintained substantially level throughout all elevated positions of the boom. To achieve this function it is known to mount the platform on a parallelogram linkage boom, but this expedient makes it infeasible to provide an extensible and retraction capability for the platform. At the same time conventional platform leveling arrangements on extensible booms have been relatively complex in design and function. Accordingly, the need has been recognized for a new and improved aerial platform which obviates the foregoing problems and limitations in existing designs, and which is relatively inexpensive and simple in construction and operation.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to provide a new and improved aerial platform which is relatively simple in design and inexpensive in cost, and which affords increased operating efficiency.

Another object is to provide an aerial platform of the character described which enables the platform to be selectively positioned in close proximity to a work location, such as the fruit bearing portion of a tree, under influence of foot-operated controls enabling the operator's hands to be free for other work. The control system includes hydraulic actuators for extending, elevating and rotating the boom, and these actuators are controlled by vacuum operated hydraulic valves which receive command signals through vacuum lines extending along the boom.

Another object is to provide apparatus of the character described in which a mobile vehicle carries a pair of towers positioned in offset relationship in a manner permitting the booms and platforms carried by the towers to be selectively positioned on the same or opposite sides of the apparatus for increased efficiency in operations such as fruit picking.

The foregoing and additional objects and features of the invention are provided by a mobile vehicle carrying a pair of upright towers each of which mounts an extensible boom for pivotal movement about a horizontal azis and for rotary movement about a vertical axis. Operator platforms mounted on the distal ends of the booms are provided with foot operated control valves

for controlling boom extension, elevation and rotation. The boom control system includes hydraulic actuators controlled by vacuum operated hydraulic valves which receive command signals through vacuum lines extending along the boom from the foot-operated valves. A master-slave hydraulic cylinder arrangement is provided to achieve automatic leveling of the platform in all positions of the boom. The two support towers are offset both laterally and longitudinally of the vehicle, with one tower defining a closed chamber containing a reservoir of hydraulic fluid for supplying the pump of the control circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan schematic view of aerial platform apparatus constructed in accordance with the invention and showing various operating positions thereof;

FIG. **2** is a top plan view to an enlarged scale of the apparatus of FIG. **1**;

FIG. **3** is a vertical cross section view taken along the line **3—3** of FIG. **2**;

FIG. **4** is a vertical cross section view taken along the line **4—4** of FIG. **2**;

FIG. **5** is a horizontal cross section view taken along the line **5—5** of FIG. **4**;

FIG. **6** is a partially schematic fragmentary view of one tower with its boom and showing the platform self-leveling arrangement;

FIG. **7** is the control system for the invention illustrated in schematic form.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1** there is illustrated generally at **10** aerial platform apparatus which is specially adapted for use in harvesting tree borne fruit, such as pears, peaches, apricots and cherries or the like. In addition, apparatus **10** will find application in other diverse operations such as tree pruning, blight cutting, thinning or limb tieing. While the invention of the illustrated embodiment will be specially described in association with fruit bearing trees, it is understood that the invention will also have application in other tasks in which an operator is to be moved adjacent to and around a relatively large work location, for example in painting a house.

Apparatus **10** includes a mobile vehicular support **11** defined by a frame **12** provided at its forward end with steerable wheels **13, 14** and at its rearward end with drive wheels **16, 17.** The frame **12** supports a pair of upright towers **18, 19** of cylindrical shell configuration. The towers are offet both longitudinally and transversely of the frame. Telescoping extensible booms **21,** 22 are mounted on respective towers for elevating and rotary motion. Baskets or platforms **23, 24** are mounted on distal ends of respective booms, with each platform carrying an operator or workman.

As best illustrated in FIGS. **2** and **3** an operator's station **26** is provided at the forward end of the frame for a third operator who maneuvers the vehicle to the desired position adjacent a work location such as between the two rows of trees **27, 28.** The third operator may also assist in picking fruit on areas of the trees accessible from the ground. The station **26** includes a steering wheel **29** controlling the wheels **13, 14** a selector lever **31** controlling forward/reverse modes of vehicle movement, and a vehicle speed control **32.**

Power for propelling the vehicle and actuating the booms and auxiliary equipment is provided by an internal combustion engine **33** driving an hydraulic pump **34**, preferably supplying a maximum output on the order of 18 g.p.m. In addition, the intake manifold of the engine provides a vacuum source for boom position control, in a manner to be presently described. The internal volume of tower **18** defines a closed chamber **36** for containing the reservoir of hydraulic fluid supplying the inlet **37** of pump **34** through conduit **38.** Hydraulic fluid under pressure from the pump outlet **39** powers a positive displacement reversable hydraulic motor **41** driving rear wheels **16, 17** through a suitable drive chain **42,** differential **43,** and rear axle **44.** Infinitely variable vehicle speed is achieved by controlling fluid flow rate to motor **41** by means of a conventional flow control valve, not shown, under influence of speed control **32** at station **26.**

The pair of booms **21, 22** with their platforms are substantially identical in construction and operation, and it will suffice to describe the details only of boom **21.** As shown in FIG. **4** boom **21** comprises an elongate support or proximal end **46** of hollow box-section configuration into which a box-section boom distal end **47** telescopes. The boom is carried on the upper end of tower **18** through means of a bearing member comprising a flat circular plate **48** mounted for rotation about a vertical axis by means of a pivot pin **49** fitted within a circular top plate **51** which closes the upper end of the tower. The boom proximal end **46** is pivotally mounted through a bifurcated yoke **52** to the outer edge of bearing plate **48** by a pivot assembly **53.**

The boom is stabilized and rotated about the vertical axis through means of rotary support frame **54** and a pair of spaced-apart brace arms **56, 57** extending diagonally across opposite sides of tower **18.** The brace arms are attached at their upper ends with boom pivot assembly **53** and at their lower ends with support frame **54.** As best illustrated in FIGS. **4** and **5** support frame **54** includes an inner semi-cylindrical bearing plate **58** mounted for sliding, rotary motion about the outer surface of the tower and rigidly connected through cross braces **60, 61** with an outer concentric drive wheel **62.** An elongate, box-section beam **63** rigidly interconnects the two diagonal brace arms **56, 57** with the bearing plate, cross braces and outer drive wheel.

Means for elevating and depressing the boom is provided and includes an extensible hydraulic actuator **64** pivotally mounted at its head end to brackets **66** secured to rotary support **54.** The actuator **64** extends upwardly to the boom where the extensible rod **67** is pivotally mounted to yoke **52** by means of bracket **68.** Conduits **69, 70** fluidly connect the actuator with the control circuit of FIG. **7.**

Means for extending and retracting the boom is provided and includes an extensible hydraulic actuator **72** rigidly mounted above the boom proximal end **46** and with its extensible rod **73** pivotally mounted to a bracket **74** secured to boom distal end **47.** Conduits **76,** 77 fluidly connect the actuator with the control circuit.

Means for rotating the boom back-and-forth, preferably through an arc of 340°, is provided and includes drive chain **78** trained about a circular gear track **79** formed about the outer surface of drive wheel **62.** The chain extends into driving engagement with a pinion gear **81** driven by a reversable hydraulic rotary actuator or motor **82** mounted on the vehicle frame. Conduits **80, 85** fluidly connect this motor with the control circuit.

The basket or platform **23** comprises a flat support or floor **83** pivotally mounted on the boom distal end through brackets **84** and pivot connection **86.** A safety railing structure **87** extends upwardly from the floor to brace the operator while work is performed. A suitable container such as the padded bag **88** is mounted on the forward side of the railing for deposit of fruit which is picked from the tree. After the bag is filled the operator swings the platform rearwardly, as shown at **24'** in FIG. **1,** for dumping the fruit into a collecting bin **89** carried on a trailer **91** hitched at **92** to the rear of the vehicle.

The invention provides a self-leveling mechanism to insure that the platform maintains a level orientation throughout the full range of boom elevation. As best shown in FIG. **6,** this leveling mechanism for boom **21** includes a master hydraulic cylinder **93** pivotally mounted at its head end to a diagonal brace arm **57** and at its rod end to the boom proximal end **46.** A slave hydraulic cylinder **94** is mounted at its head and to a bracket **96** carried by boom distal end **47** and at its rod end to a bracket **97** mounted below the platform floor. The master and slave cylinders are filled with hydraulic fluid and interconnected in a closed circuit such that extension and retraction of the master cylinder effects retraction and extension, respectively, of the slave cylinder. This is achieved by means of conduits **98, 99** which fluidly connect the head and rod ends of the master cylinder with the head and rod ends, respectively, of the slave cylinder. The two cylinders are sized and positioned such that their fluid volumes, as well as the moment arms through which they act about the boom and platform pivot points, result in an equal angular movement of the platform with respect to boom in response to a given angular movement of the boom with respect to the tower. For example, as the boom is elevated, or pivoted through an angle counterclockwise as viewed in FIG. **6,** master cylinder **93** is caused to extend and force fluid from its rod end through conduit **99** and into the rod end of slave cyliner **94.** The slave cylinder thus is caused to retract and pivot platform **23** through the same angle clockwise with respect to the boom.

The control circuit of FIG. **7** includes vacuum operated hydraulic valves **101, 102, 103** associated with the actuators controlling boom movement. As shown in FIG. **3** the pair of valves **101, 102,** which control boom extension and elevation, respectively, are mounted to brace arm **57** immediately below the boom pivot. Fluid under pressure is supplied to these valves from high pressure manifold **104** connected with the pump outlet **39.** Return fluid is directed through return manifold **106** into the reservoir **36** and pump inlet **37.** The valve **101** directs fluid to the head or rod ends of actuator **72** for extending or retracting, respectively, the boom while the valve **102** directs fluid to the head or rod ends of actuator **64** for raising or lowering, respectively, the boom. The hydraulic valve **103** is carried on vehicle frame **12** and is connected with manifold **104, 106** to direct pressurized fluid from the pump into motor **82** for reverse or forward operation to rotate the boom about a vertical axis.

A suitable high pressure by-pass valve and return line, not shown, is provided in the outlet from pump **34** to relieve fluid pressure from the actuators and motors when they reach the ends of their strokes, or should an

obstruction be encountered. For example, the by-pass valve is set to open and relieve fluid pressure should the boom be rotated unintentionally against an adjacent structure or tree so that boom rotation is stopped and damaged to the tree and apparatus is precluded.

The three hydraulic valves **101, 102, 103** are similar in construction and operation and comprise suitable open-center type spool valves urged into their operating positions by axial thrust forces from a pair of vacuum operated diaphragms **108–113** positioned within closed chambers formed at opposite ends of each valve. The command signals for actuating the two valves **101,** 102 comprises a vacuum carried through flexible conduits **115–118** extending from these valves along the boom in connection with control valves **120, 121** and **122, 123** mounted below the platform floor **83.** These valves are selectively operated by pivotal foot treadles **124, 125** projecting above the surface of the floor. With the valves **120–123** operated, a source of vacuum from the intake manifold of engine **33** is connected through vacuum manifold **127** into selected ones of the flexible conduits. With the valves **120–123** inoperative, the flexible conduits are open to ambient atmosphere. Preferably these flexible conduits **115–118** are constructed of a material which is relatively light weight and inexpensive (e.g. a synthetic polymer) as compared to the flexible conduits which otherwise would be required for carrying high pressure hydraulic fluid. The valve **103** is actuated by a vacuum command carried through conduits **128, 129** from the vacuum manifold upon actuation of control valves **131, 132** operated by pivotal foot treadle **133** mounted on the platform floor.

On the platform the treadles are embossed with suitable indicia for rapid visual indication of their function. The treadle **124** is embossed with a pair of arrows oppositely pointing in forward and reverse directions to indicate boom extension and retraction. Treadle **125** is embossed with the symbols "UP" and "DN" to indicate the raising and lowering of the boom. Similarly, the third treadle **133** is embossed with a pair of arrows oppositely pointing in right and left directions to indicate boom rotation about the vertical axis.

In operation, it will be assumed that apparatus **10** is to be used in picking fruit from between the rows of fruit bearing trees **27, 28** of FIG. **1.** At suitable locations along the path of travel the apparatus is stopped so that the operators in each basket are in position to operate and move their platforms adjacent trees on opposite sides of the vehicle. To accomplish this the operator in platform **23,** for example, manipulates the three foot treadles **124, 125, 133** singly or in combination to effect the desired path of movement. Thus, to reach an upper portion of the tree the boom is elevated as the operator pivots treadle **125** forward to actuate valve **122,** which in turn sends a vacuum command signal through conduit **118** for operating valve **102** and thereby extend actuator **64.** At the same time, the operator may swing the boom left and toward the tree by pivoting treadle **133** forward. This actuates valve **133** which sends a vacuum command signal through conduit **129** for operating valve **103** and thereby energizing motor **82.** With the boom at the desired elevation and lateral angle the operator may then extend the boom until the platform is positioned immediately adjacent the tree. This is accomplished by pivoting treadle **124** forward to actuate valve **121** and send a vacuum command signal through conduit **116** for operating valve **101** and thereby extending actuator **72.** At this point the operator's hands are free to pick the fruit and deposit it into bag **88.** As the fruit is picked the operator may reposition the platform to another area of the tree by suitable manipulation of the foot treadles. After the bag is filled the operator manipulates the treadles to rotate the boom rearwardly of the vehicle and lower the platform over the trailer-mounted bin **89** into which the fruit is deposited. The platform is then returned to the tree for further picking.

The third workman is assigned the task of both picking the fruit accesable from ground location and operating the controls at station **26.** After picking is completed at each location, the third workman operates the controls at his station to drive the vehicle forward for picking trees at the next location with the remaining operators riding on the platforms.

The provision in the invention of offsetting the tower locations both laterally and longitudinally of the vehicle achieves increased work productivity. For example, should an operator in a platform on one side of the vehicle finish his work ahead of the other operator at a particular vehicle location, or should there be a missing or dead tree on one side, then the operator may swing his platform completely across the vehicle so that both platforms are positioned for picking from the same side of the vehicle.

While the foregoing embodiment is at present considered to be preferred it is understood that numerous variations and modifications may be made therein by those skilled in the art and it is intended to cover in the appended claims all such variations and modifications as fall within the true spirit and scope of the invention.

We claim:

1. In apparatus for moving an operator relative to a work location, such as a fruit-bearing tree, the combination including a mobile vehicular support, an upright tower carried by the support, a platform for carrying said operator, and an extensible boom having a distal end mounted on said platform and a proximal end, a bearing member mounted on said tower for pivotal movement about a vertical axis, means mounting said boom proximal end on a margin of said bearing member for pivotal movement about a horizontal axis, a support frame mounted on a portion of said tower below said bearing member for rotary movement about said vertical axis, brace means interconnecting said bearing member for rotary movement with said support frame, and rotary actuator means on said mobile support for selectively rotating said support frame about said vertical axis.

2. Apparatus as in claim **1** which includes extensible actuator means to pivot said boom relative to said bearing member about said horizontal axis, said actuator means having an upper end connected with said boom proximal end and a lower end connected with said support frame on a side thereof remote from the side of said tower on which said boom proximal end is connected with said bearing member.

3. Apparatus as in claim **1** in which said tower is formed with an outer cylindrical surface, and said support frame includes an inner cylindrical bearing plate mounted for movement about said tower cylindrical outer surface, an outer cylindrical drive wheel radially spaced from said plate and mounted for movement therewith, and said rotary actuator means is in driving engagement with said drive wheel.

* * * * *