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Darmon

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[54] **GROUND LEVEL CONTROL SYSTEM FOR LIFTING APPARATUS WITH UNIVERSAL TYPE CONTROLLER FOR SWITCH ASSEMBLIES**

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[52] **U.S. Cl.** ..... **200/6 A**, 200/18

[51] **Int. Cl.** **H01h 3/00**

[58] **Field of Search** ..... 200/6 A, 18 R, 18

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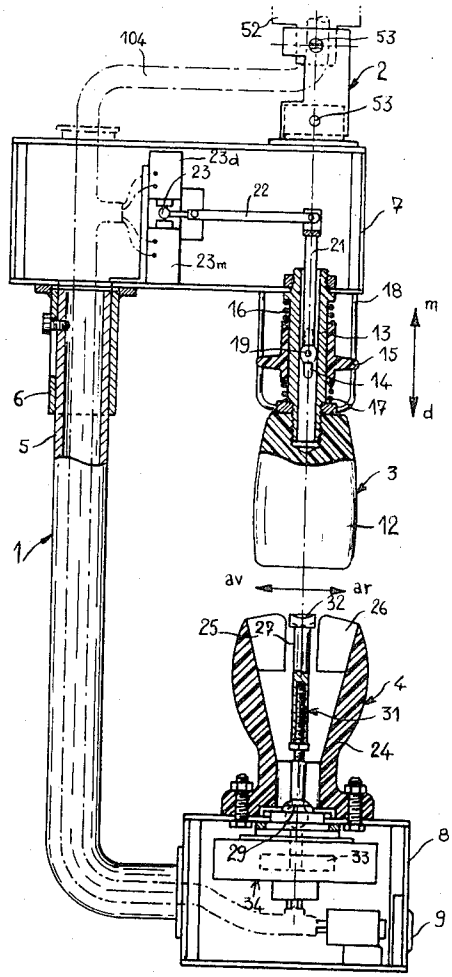
Primary Examiner—J. R. Scott

Attorney—Arthur E. Dowell, Jr. et al.

[57] **ABSTRACT**

A system for controlling from ground level a lifting apparatus which is adapted to move a load in a vertical direction and two horizontal directions comprises an operating support suspended from the lifting apparatus by an antigyratory suspension on which are mounted manipulators controlling switch means causing movement of a load carried by the lifting apparatus, the manipulators being moved to operate switch means in directions parallel to the directions of displacement of the load to be caused thereby and in the same sense of direction.

10 Claims, 11 Drawing Figures



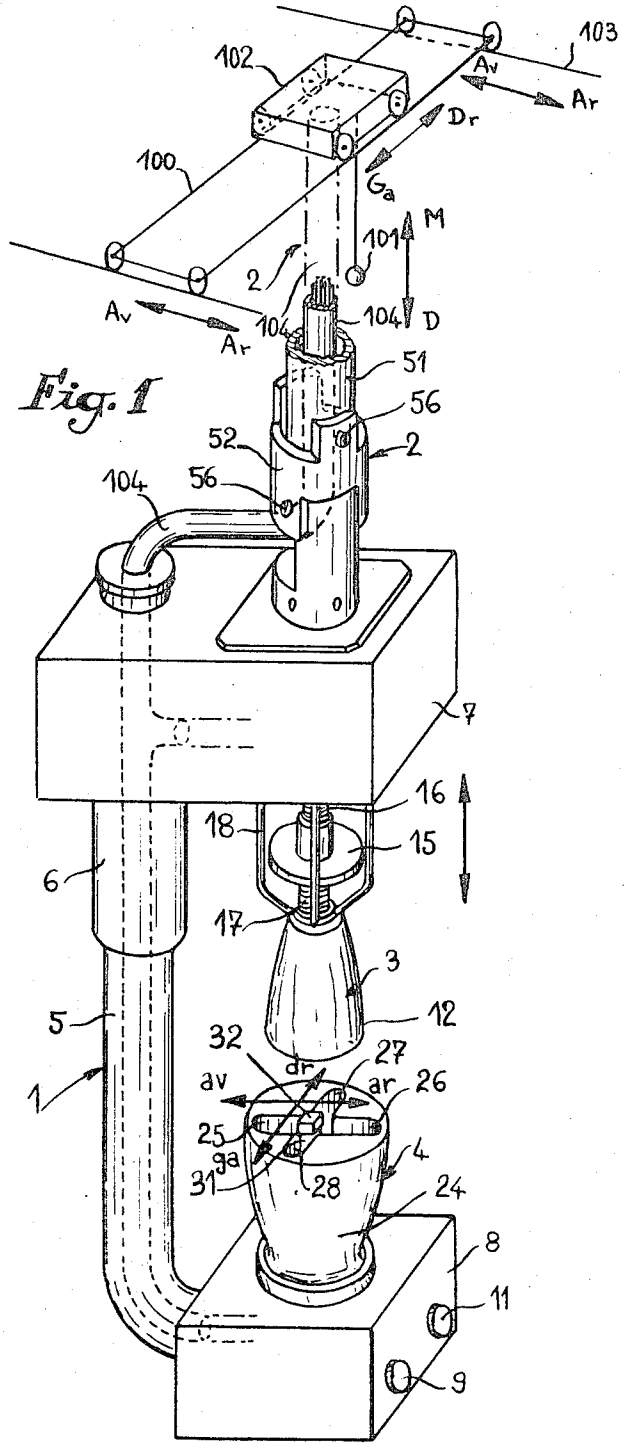

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Fig. 1

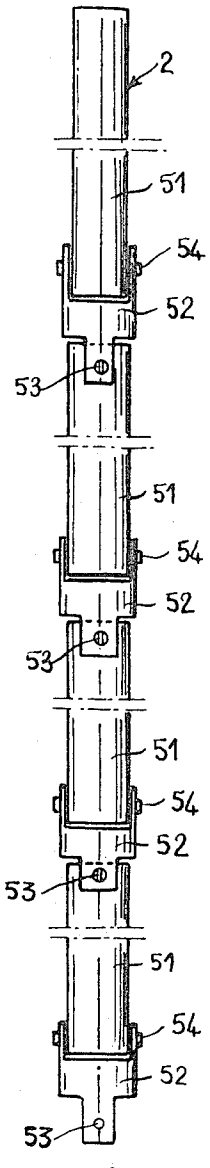
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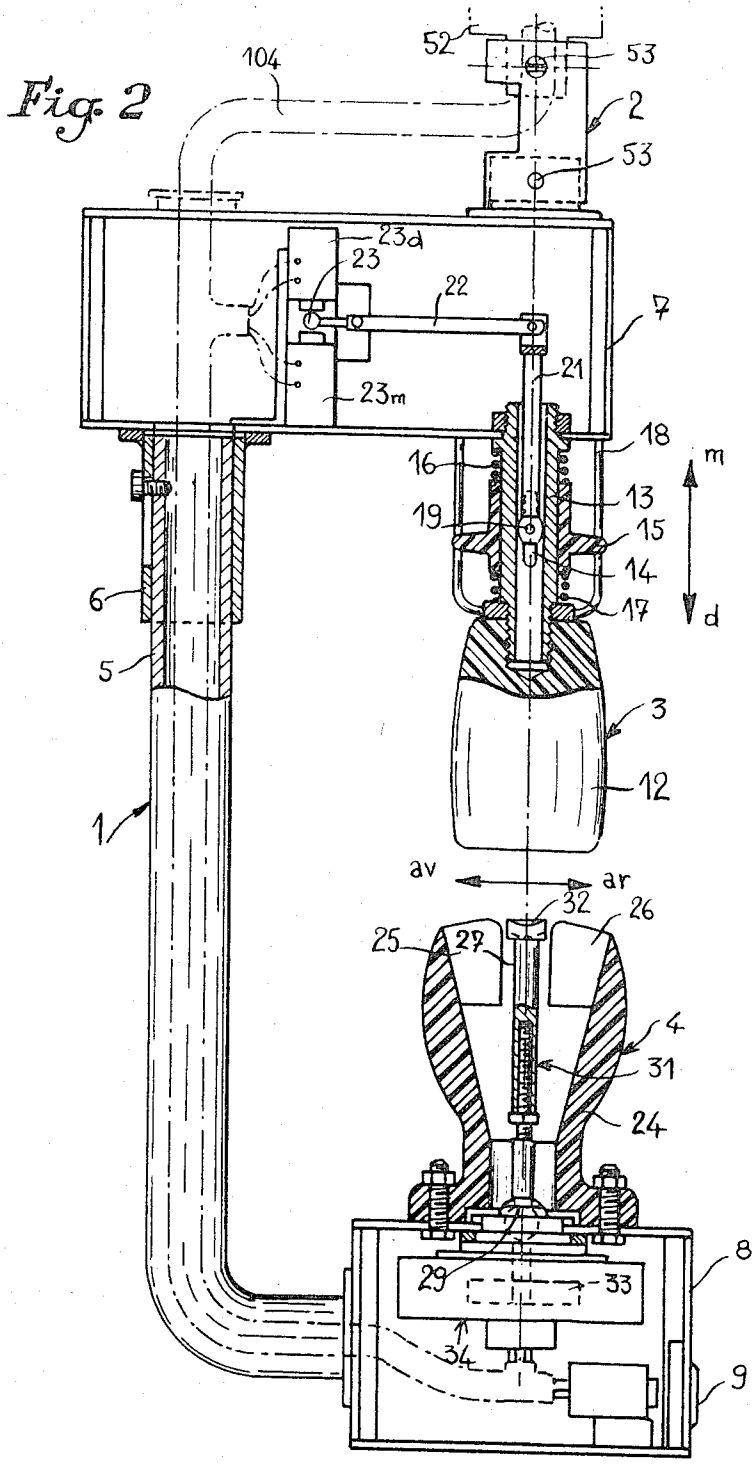
Fig. 3

Fig. 2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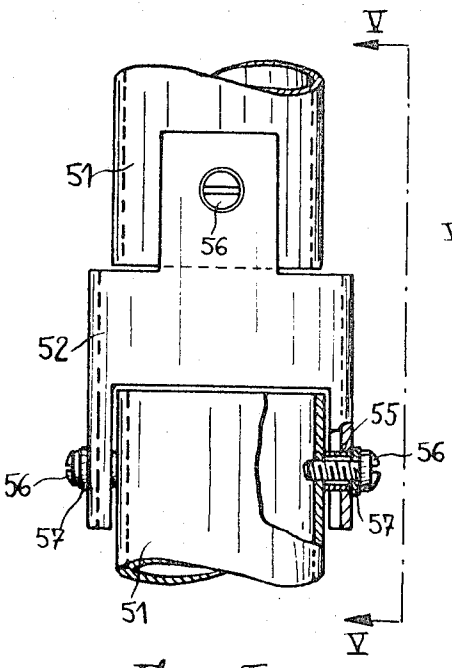


Fig. 4

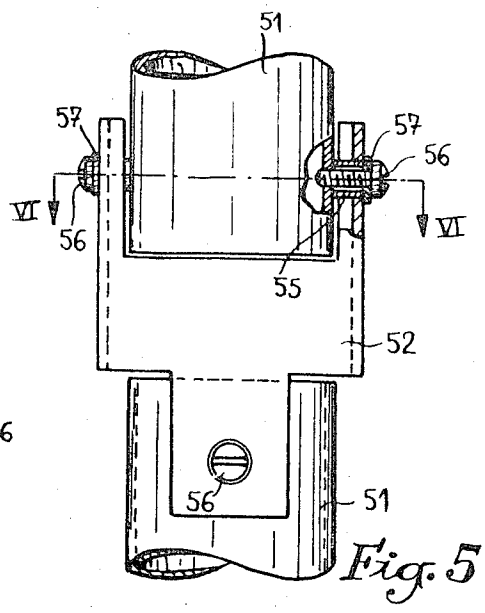


Fig. 5

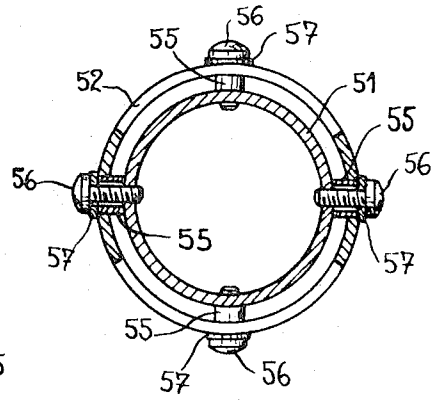


Fig. 6

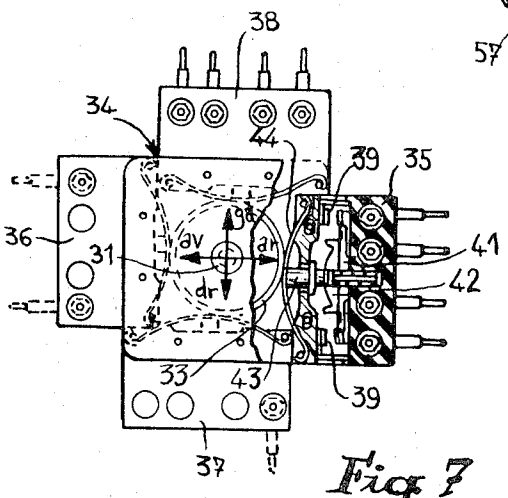
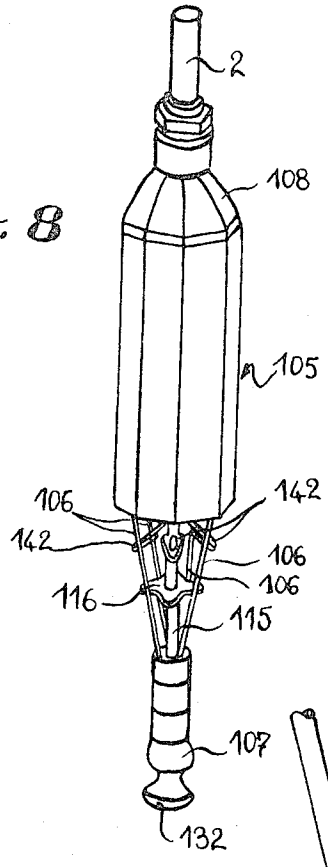


Fig. 7

Fig. 8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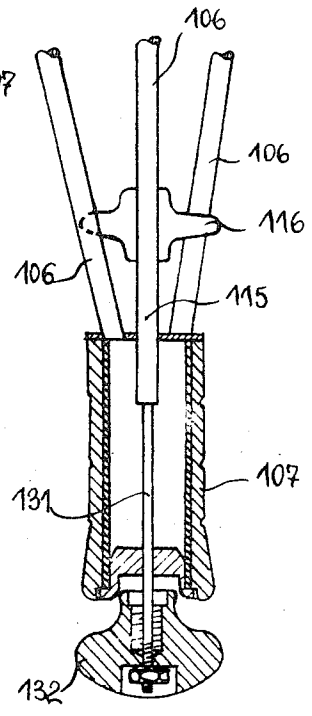
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Fig. 10

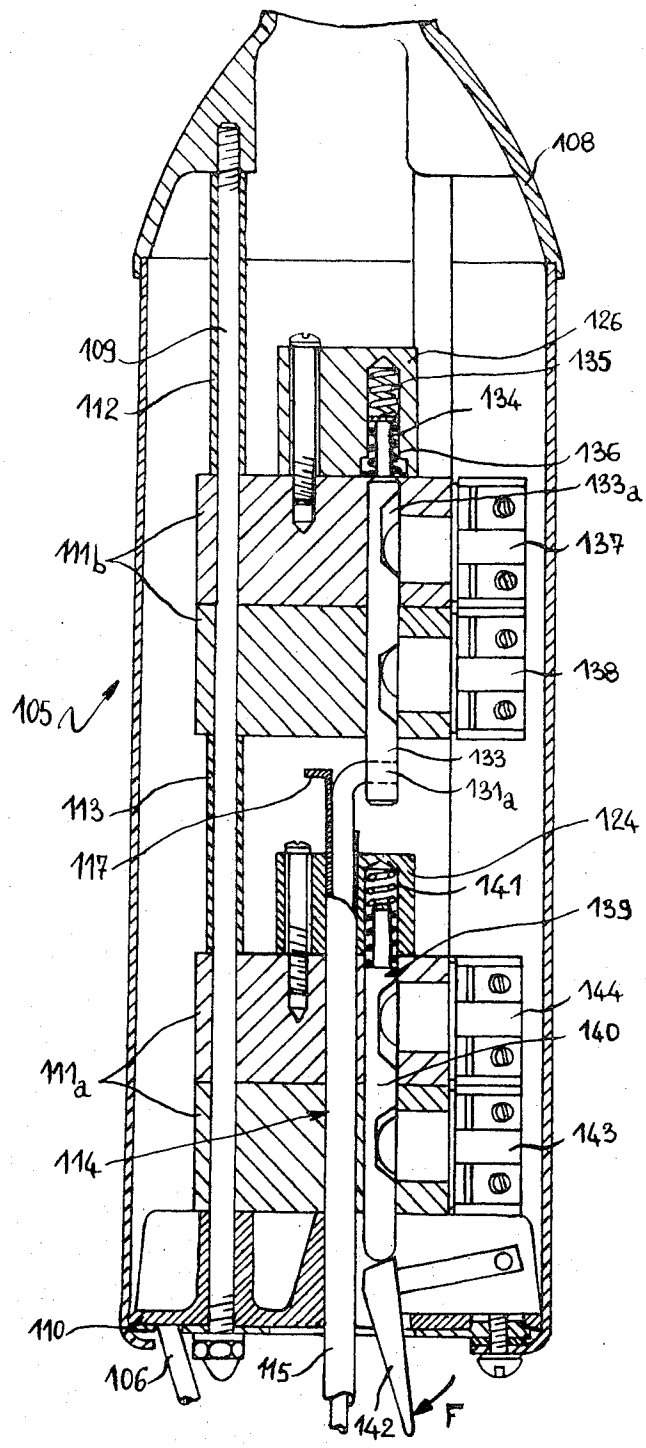
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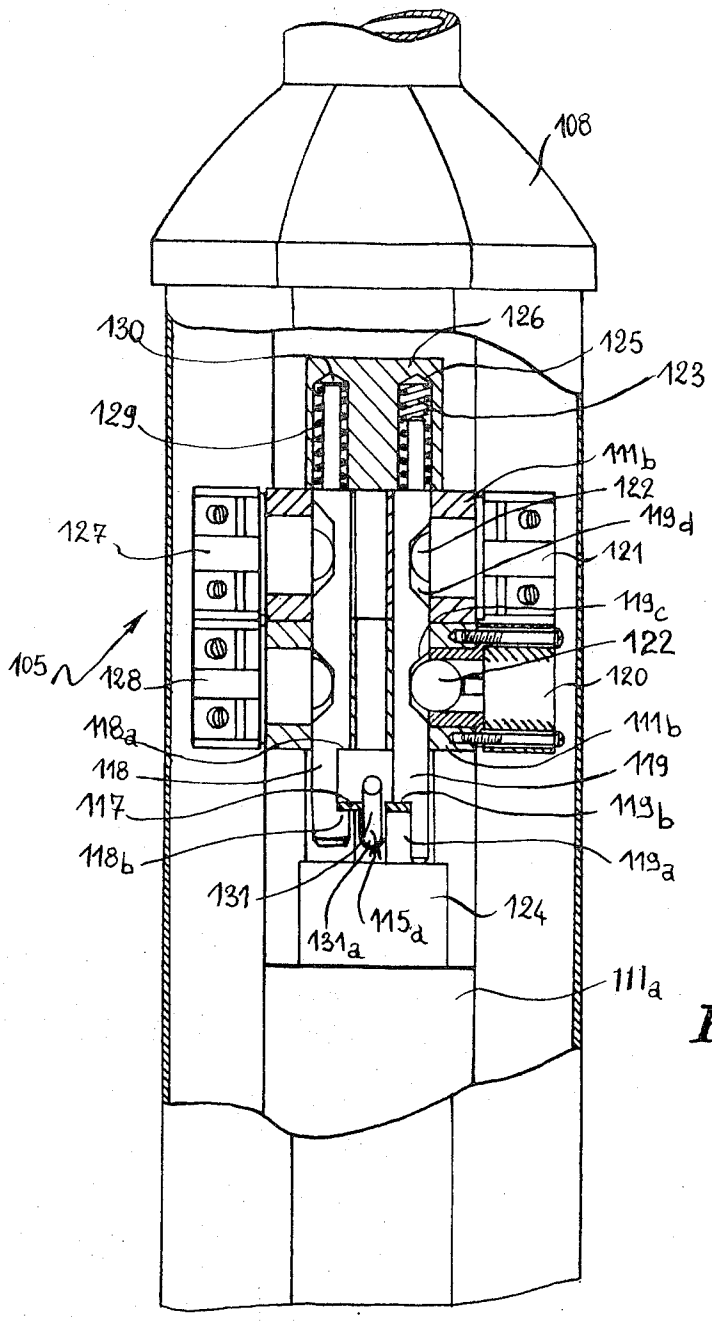
Fig. 9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117
119b
118b
119a
131
115d
124
131a
111a

Fig. 11

GROUND LEVEL CONTROL SYSTEM FOR LIFTING APPARATUS WITH UNIVERSAL TYPE CONTROLLER FOR SWITCH ASSEMBLIES

The present invention refers to a system for controlling from ground level a lifting apparatus such for example as a travelling crane, girder crane, portal or semi-portal crane, pulley block, derrick block, monorail crane or jib crane.

Ground level control systems for such lifting apparatus are known. They generally consist of a pushbutton box hung from the apparatus including a series of buttons controlling respectively starting, stopping, and raising and lowering of the load and its horizontal displacements. For example, in the case of a travelling crane four buttons control respectively the displacements of the crab on the gantry and the displacement of the gantry of its rails.

Such a control system has various disadvantages: it demands reading by the operator of a label set beside each control button, which involves loss of time and requires the attention of the operator at the instant when he ought to be watching the operation he is controlling, it employs both the operator's hands which prevents him from taking any action, e.g., to stop rocking of the load, or it calls upon reflexes of the operator which differ according to the position he and the pushbutton box is in relative to the lifting apparatus. For example, displacement of the crab of a travelling crane to the right of an operator facing the gantry becomes a displacement to the left of an operator with his back to the gantry. This produces confusion which can cause incorrect manoeuvres which can bring in their train material damage and even bodily accidents.

In accordance with the invention there is provided a system for controlling from ground level a lifting apparatus which is adapted to move a load in the vertical direction and at least one horizontal direction, the system comprising switch means operable to cause the apparatus to displace a load in the vertical direction and at least the one horizontal direction, the switch means being controlled by manipulators, at least one of the manipulators having one degree of freedom the direction of which corresponds to one direction of displacement to be communicated to a load and the sense of movement of the manipulator from a neutral position to an operative position, in which a switch means controlled thereby is operated, corresponds to the sense of displacement to be communicated to the load and wherein the manipulators are suspended from the lifting apparatus by an anitgyratory suspension.

The antigyratory suspension is intended to ensure preservation of parallelism between the movements of the or each manipulator controlling the or each horizontal displacement of the member controlled and the movements of the member. Hence, in operation of the system the operator has only to apply to the manipulators movements in the same direction and the same sense as the displacements desired of the member controlled. He does not have to think or to read labels placed near the manipulators. The displacements of the load in the different directions and in the two senses of each direction are controlled in an intuitive manner, whatever the position of the operator relative to the manipulators. Thus mistakes become practically impossible.

In a particular embodiment of the invention the system comprises a manipulator displaceable in a vertical direction and having two active positions vertically separated by a neutral position, the high and low active positions corresponding respectively with raising and lowering of the member controlled and a manipulator displaceable in at least one horizontal direction and having two active positions spaced horizontally with respect to a neutral position. This second manipulator may be displaceable in two horizontal directions at right angles and may have four active positions in pairs spaced apart in the horizontal directions with one common neutral position, the active positions of each pair may be spaced apart by the neutral position.

The antigyratory suspension may comprise a succession of antigyratory articulations consisting of pivotal joints at right angles. One of the advantages of this suspension is that it has a flexibility comparable with that of a flexible cable, which enables the operator in the course of operations to move out of the vertical passing through the point of suspension of the system.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of part of an embodiment of control system according to the present invention;

FIG. 2 is the side elevation of part of the system of FIG. 1, partially sectioned along a central vertical plane;

FIG. 3 is an elevation of a portion of the suspension of the system of FIG. 1;

FIG. 4 is an elevation, partly cut away, of an articulation of the suspension of FIG. 3;

FIG. 5 is an elevation in the direction V—V of FIG. 4;

FIG. 6 is a plan in section along the line of VI—VI of FIG. 5;

FIG. 7 is a schematic view in plan from below, partially cut away, of a manipulator of the system of FIG. 1;

FIG. 8 shows in perspective a part of another embodiment of a control system in accordance with the invention;

FIGS. 9 and 10 are partial longitudinal sections on a larger scale of the control system part shown in FIG. 8, and

FIG. 11 is a side view, partly cut away, of an upper portion of the control system part shown in FIG. 8.

The control system shown in FIGS. 1 to 7 is designed to control the movements of a travelling crane indicated schematically, the electric driving motors of which are provided with contactors (not shown) effecting in a selective manner the raising and lowering of the load 101 in opposite vertical senses M and D respectively, the displacement of the crab 102 along the gantry 100 to the right and left in opposite horizontal senses Dr and Ga respectively and that of the gantry 100 forwards and backwards along the rails 103 in opposite horizontal senses Av and Ar.

The various contactors mentioned above are connected by a multi-conductor cable 104 to a control system.

The control system comprises an operating support 1, suspended from the travelling crane by an articulated shaft 2 which forms an antigyratory suspension as will hereafter become apparent.

The support 1 carries two manipulator supports 3 and 4. The manipulator support 3 supports a manipulator which controls the contactors causing the raising or lowering of the load 101. The manipulator support 4 supports a manipulator which controls both the contactors which cause the displacement of the crab 102 along the gantry 100 and those which cause the displacement of the gantry 100 along the rails 103.

The manipulator on support 3 has a degree of freedom *m-d* in a vertical direction and the manipulator on support 4 has two degrees of freedom *ga-dr* and *av-ar*, in two horizontal directions at right angles and parallel respectively with the directions G*a*-D*r* and A*v*-A*r*.

The sense of movement of the manipulators of the supports 3 and 4 from a neutral position into an active position corresponds with the direction and sense of the displacement intended for the load.

The construction of the foregoing system will now be described in greater detail.

The support 1 has in side elevation the shape of a C of which the vertical arm consists of two telescopic tubular shafts 5 and 6. The horizontal arms of the support 1 comprise respectively an upper housing 7 and a lower housing 8. The supports 3 and 4 are coaxial and mounted respectively underneath the upper housing 7 and on top of the lower housing 8 which carries a starting button 9 and an emergency stop button 11.

The support 3 comprises a vertical-axis grip 12 attached by a tubular shaft 13 to the underside of the housing 7. The tubular shaft 13 is provided with two diametrically opposite axial openings 14. An annular manipulator knob 15 is mounted to slide on the shaft 13 and is subject to the action of two opposed return springs 16 and 17 arranged around the shaft 13 above and below the knob 15 respectively. The clearance zone of this knob is framed in a cage consisting of four rods 18. The knob 15 carries a diametral spindle 19 which passes through the openings 14 and is connected within the shaft 13 to a vertical rod 21. The rod 21 is connected via a lever 22 to a movable contact 23 which operates selectively switches for relays 23*m*, 23*d* causing raising or lowering of the load 101 respectively. The knob 15 and the contact 23 are so arranged that when the knob 15 is in its neutral position of equilibrium between the opposed spring 16 and 17, neither of the switches 23*m*, 23*d* is operated. The upper position of the knob 15 corresponds to operation of the switch 23*m* causing raising of the load and the lower position of the knob 15 corresponds to operation of the switch 23*d* causing lowering of the load 101.

The support 4 comprises a hollow vertical-axis pommel 24 open at the top and mounted on the top of the lower housing 8 directly underneath the grip 12 of the support 3. The pommel 24 has two guide grooves in the form of a cross, the aligned groove arms 25 and 26 of the cross lying in the central vertical plane of the support 1 and the aligned arms 27 and 28 lying in a vertical plane at right angles to the central plane. The groove arms 25, 26 are thus parallel with the directions G*a*-D*r* and A*v*-A*r*. On a ball joint 29 at the bottom of the pommel 24 is mounted a manipulator lever 31 provided with a resilient system (not shown) which tends to return it to its vertical position. The lever 31 is provided with a head 32 which lies flush with the top of the pommel 24 and extends beyond the ball joint. At its lower end it is connected to a disc 33 controlling by a known system the contacts of a quadruple relay 34 (FIG. 7) comprising four switch-blocks 35, 36, 37 and 38 located respectively opposite the groove arms 25, 26, 27 and 28 in the pommel 24. Each of the four blocks 35, 36, 37 and 38 of the relay 34 comprises contact studs 39 and a movable crossbar 41 for electrically connecting two studs 39. The crossbar 41 is controlled by a bow-spring 42 integral with a pushbutton 43 applied by a resilient system against a blade spring 44 which is in contact with the disc 33 carried by the lever 31. The blocks 35 and 36 are connected to the contactors of the gantry 100 controlling its displacement along the rails 103 in the senses A*v*-A*r* and corresponding respectively with the senses of the movement of the lever 31 from its vertical position to inclined positions in the groove arms 25 and 26. The blocks 37 and 38 are connected to the contactors of the gantry 100 controlling the displacement of the crab 102 along the gantry in the senses D*r*-G*a* and corresponding respectively with the sense of the movement of the lever 31 from its vertical position to inclined positions in the groove arms 27 and 28. The disc 33 carried by the lever 31 and the blocks 35, 36, 37 and 38 are arranged so that for the vertical position of the lever 31 no contact of the blocks 35, 36, 37 and 38 is operated and that for the position of the lever in one of the groove arms 25, 26, 27 or 28 the blocks 35, 36, 37 or 38 mounted opposite the respective groove arms 25, 26, 27 or 28, is operated.

The suspension shaft 2 of the operating support 1 comprises members 51 connected by antigyratory articulations 52, each comprising two pivotal joints 53 and 54 at right angles, the axes of the joints 53, 54 being parallel respectively with the directions G*a*-D*r* and A*v*-A*r*. Each joint 53, 54 comprises two rings 55 carried diametrically by the articulation 52, the pivot consisting of two screws 56 provided with washers 57 and extending diametrically through the articulation and the member 51.

The operating support 1 is attached to the suspension shaft 2 and the shaft 2 to the crane so that the mean plane of this support 1 is parallel with the rails 103 of the crane.

An antigyratory suspension system is thus provided in which the upper end and the lower end of the antigyratory suspension are fixed on the lifting apparatus and the support respectively in such a manner that it is not possible to rotate said support with respect to the lifting apparatus.

The above described control system operates as follows:

When the knob 15 and the lever 31 are not being operated by the operator they are held in their neutral positions by their respective return systems. No contactor of the crane is operated and the load 101 remains motionless.

To displace the load 101 vertically the operator grasps the grip 12 and operates the knob 15 in the required sense with his thumb. To displace the load horizontally he grasps the pommel 24 and with his thumb brings the head 32 of the lever 31 into the required groove arm 25, 26, 27 or 28. Because of the arrangement of the supports 3 and 4 and the relays 23 and 34 the load is always displaced in the same direction and the same sense as the knob 15 or the lever 31. As soon as the knob 15 or the lever 31 are no longer operated by the operator, they are returned to their neutral posi-

tions by their return systems and the displacement of the load stops immediately.

When the gantry **100** is displaced along the rails **103**, the operator accompanies the operating supplort **1** so that the latter remains near the vertical axis through its point of suspension. The operator may however be led by obstacles encountered along his path to move the support **1** slightly from this vertical axis. The antigyratory articulations **52** give the suspension shaft **2** a flexibility which allows the operator the freedom of movement necessary whilst maintaining the parallelism between the displacements of the knob **15** and lever **31** and those of the load sufficiently closely for no confusion to be possible.

Thus it is seen that, using the above described system the control of displacements of the load is intuitive; the operator instinctively gives the knob **15** or the lever **31** a displacement in the same direction and sense as that which he wishes to cause the load.

Due to the arrangement of the grip **12** and the pommel **24**, these members are accessible by the operator from all sides, with the exception of the narrow angle masked by the shafts **5** and **6**, and the movement to be made by the operator to operate these members and pass from one to the other is the same, whether he is in front of, behind, or at the side of the support **1**. He never needs to think or to rear anything; no mistake is possible; there is no risk of causing an accident.

The supports **3** or **4** may be held and the knob **15** or the lever **31** may be operated with one hand which can be either the left or the right hand. The other hand therefore remains free, for example for checking rocking of the load.

Because of the closeness of the grip **12** to the pommel **24** the operator's hand passes immediately from the one to the other without his needing to look in making this movement.

The cage consisting of the four rods **18** and the pommel **24** protect the knob **15** and the lever **31** respectively against contact with an obstacle which might displace them and thus cause an accidental movement of the load.

The telescopic mounting of the tubular shafts **5** and **6** enables the distance between the grip **12** and the pommel **24** to be varied according to the size of hand or height of the operator.

The flexibility of the suspension shaft **2** allows the operator all the freedom of movement necessary when the support is carried along by the gantry as it is displaced along its rails. Even when the suspension shaft **2** is not vertical the system preserves its intuitive character without any risk of confusion, due to the articulations **52** which keep the directions *av-ar* and *ga-dr* parallel respectively with the directions Av-Ar and Ga-Dr.

The control system shown in FIGS. **8** to **11** comprises a housing **105** of generally cylindrical shape, the lower end of which is connected by four oblique tie-rods **106** to a vertical grip **107** arranged on the geometric axis of the housing **105**. The housing **105** comprises an upper ferrule **108** having a generally frustoconical shape, into which are screwed the one ends of the tie-rods **109**, the other ends of which are connected to a base **110** from which the tie-rods **106** extend. The tie-rods **109** hold pairs of blocks **111***a* and **111***b* in place respectively against the base **110** and roughly halfway up the housing **105**, by means of distance-pieces **112** and **113**.

The blocks **111***a* have a vertical central hole **114** in which a tube **115** is displaceable, the tube **115** extending into the grip **107**. Between the grip **107** and the housing **105**, the tube **115** is connected to a manipulating or operating member **116** made preferably in the form of a star with four arms which are arranged one between each pair of tie-rods **106**. In this way the tube **115** is effectively immobilized against angular movement whatever its longitudinal position.

The tube **115** has, at its upper portion which is located between the blocks **111***a* and **111***b*, an external transverse collar **117** which extends into notches **118***a* and **119***a* respectively into two pins **118**, **119** (FIG. **11**) each of which can be displaced axially in a vertical bore provided in the blocks **111***b*. In the neutral position of rest of the member **116** the collar **117** abuts against a shoulder **118***b* of the pin **118** and against a shoulder **119***b* on the pin **119**. When the operating member **116** is moved upwardly the pin **119** is moved upwardly while pin **118** is not. When the operating member **116** is moved downwardly the pin **118** is moved downwardly while the pin **119** is not.

In pushing the operating member **116** and pin **119** upwardly a switch **120** associated with the blocks **111***b* is operated first and then a switch **121**, grooves **119***c*, **119***d* provided in the pin **119** causing balls **122** to operate the switches **120**, **121**. When the operator releases the operating member **116** a compression spring **123** pushes the pin **119** back until its lower end comes up against a stop **124** fixed to the upper of the blocks **111***a*. The spring **123** is let into a blind bore **125** in a cap **126** attached to the upper block **111***b* and in alignment with the pin **119**.

Downwards displacement of the pin **118** operates successively two switches **127**, **128** in exactly the same way. The displacement of the pin **118** is effected against the reaction of a compression spring **129** which, when the member **116** is released, brings the upper end of the pin **119** against the bottom of a second blind hole **130** in which the spring **129** is seated and which is arranged on the axis of the pin **118**.

The switch **120** controls raising of a load at low speed whilst switch **121** controls the same movement at high speed.

Similarly the switch **128** controls lowering of a load at low speed and switch **127** controls this displacement at high speed.

A rod **131** passes through the tube **115** and is provided on its lower end with a knob **132** which is located below the grip **107**. The uppr end portion **131***a* of the rod **131** is bent at right angles to form a hook. The upper end portion of the tube **115** has a slot **115***a* in which the hook **131***a* can be displaced vertically. The hook is connected to a pin **133** which can be displaced axially in a vertical bore formed in the blocks **111***b*, the upper end of the pin **133** being located in a bore **134** in the cap **126**. Two compression springs **135** and **136** are arranged to bear on the pin **133** so that, in the rest position of the rod **131**, the pin **133** is in the position shown in FIG. **9**. When the knob **132** is pushed upwardly the notch **133***a* in the pin **133** causes the closing of a switch **137** whose function will be further explained later. When the knob **132** is pulled downwardly a switch **138** is caused to open.

The switch **137** controls the input to a coil of the main contactor controlling the lifting apparatus so that when the switch **137** is closed this contactor closes en-

abling the various electrical control members to function ("On" position). The switch **137** at the same time controls the operation of an audible alarm. Opening of the switch **138** causes interruption of the above-mentioned input which corresponds with the position "Stop." As long as the knob **132** has not been pulled down the lifting apparatus remains in the "On" position. Every time the operator wishes to carry out a movement he can, by pushing the knob **132** upwardly, cause the operation of the alarm to give warning of the intended operation.

The blocks **111***a* are formed with four bores **139** in each of which a pin **140** can be displaced longitudinally against the reaction of a compression spring **141** housed in a bore in the stop **124.** When one of four manipulator triggers **142** is operated in the sense of the arrow F it bears against the bottom end of the corresponding pin **140.** The bores **139** are arranged on a square so that the triggers **142** point in four directions at right angles corresponding to each of the four horizontal movements of the lifting apparatus.

When each pin **140** is displaced upwardly it operates first a switch **143,** then a switch **144,** which control the displacement at low and high speed respectively.

I claim:

1. A system to control from ground level a lifting apparatus, such as a crane, adapted to move a load upwardly and downwardly in the vertical direction and at least in two opposed horizontal directions, comprising in combination:

supporting means;

flexible antigyratory suspension means to connect said supporting means with said apparatus while preventing rotation between same along a vertical axis;

first switch means carried by said support to control upward and downward movement of the load supported by said lifting apparatus;

first actuating means carried by said support and displaceable up and down thereon from an intermediate neutral position;

first connecting means to connect said first actuating means with said switch means in such manner that upward displacement of said first actuating means causes upward movement of said load and that downward displacement of said first actuating means causes downward movement of said load;

second switch means to control horizontal movement of the load supported by said apparatus in one and the other of said opposed horizontal directions;

second actuating means carried by said supporting means substantially along the same vertical axis as said first actuating means, said second actuating means being displaceable in one and the other of said horizontal directions from a position of rest;

and second connecting means to connect said second actuating means with said second switch means in such manner that displacement of said second actuating means respectively in one and the other of said horizontal directions from said position of rest causes said apparatus to move said load in the same horizontal direction as the displacement of said second actuating means.

2. In a system as claimed in claim **1,** said first actuating means being formed of an axially displaceable manipulator comprising a vertically elongated member having an upper end to cooperate with said first connecting means, and an operating knob mounted on said member.

3. In a system as claimed in claim **2,** said upper end of said member having a transverse collar acting on said first connecting means.

4. In a system as claimed in claim **3,** said first connecting means including a first and a second vertically slidable pin associated with said first switch means, said first and second pins being formed with notches to receive said transverse collar, said notches being so arranged that downward movement of said knob from said intermediate neutral position causes lowering of said first pin and that upward movement of said knob from said intermediate neutral position causes rising of said second pin.

5. In a system as claimed in claim **2:**

said elongated member being tubular;

and said system further comprising a rod extending through said tubular member and having an upper end and a lower end, with said upper end being bent laterally and with said lower end extending below said tubular member; a knob at said lower end to permit actuation of said rod; safety switch means to stop said apparatus; and a vertically slidable pin to connect said switch means with said rod, said lastly named pin having a transverse hole to receive the bent upper end of said rod.

6. In a system as claimed in claim **5,** said support means including a housing enclosing said first switch means, said first connecting means, said second switch means, said second connecting means and rod, said vertically displaceable pin and said safety switch means; grip means below said housing; and third connecting means to connect said grip means with said housing, said third means being formed of a plurality of tie-rods; said lower end of said rod passing through said grip means to extend below said grip means.

7. In a system as claimed in claim **1,** said second actuating means being formed of four triggers pivotally mounted on said supporting means and arranged at right angles to each other.

8. In a system as claimed in claim **7,** said connecting means including four vertically slidable pins each having an upper end and a lower end, each of said triggers actuating the lower end of each of said pins to displace same axially; and spring means to urge each of said pins against one of said triggers.

9. In a system as claimed in claim **8,** said second switch means comprising four switches, one for each of said horizontal directions of displacement of said load.

10. In a system as claimed in claim **1,** said support means including a housing enclosing said first switch means, said first connecting means, said second switch means and said second connecting means; grip means below said housing; and third connecting means to connect said grip means with said housing, said third means being formed of a plurality of tie-rods;

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