Oct. 5, 1965 L. LAWTON 3,210,114

APPARATUS FOR ORIENTING A SUSPENDED LOAD

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FIG. 1.

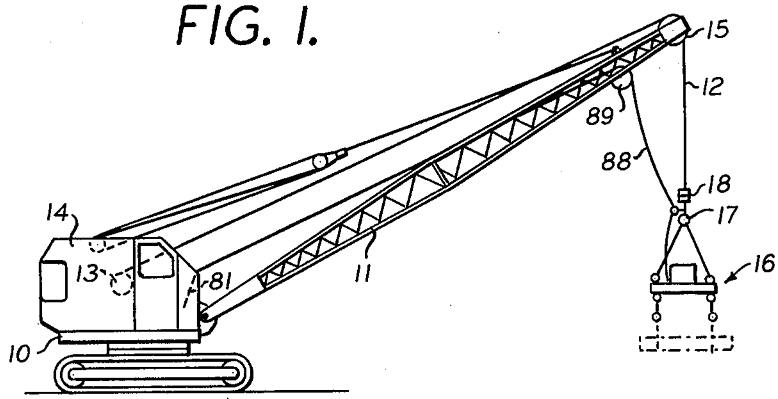


FIG. 2.

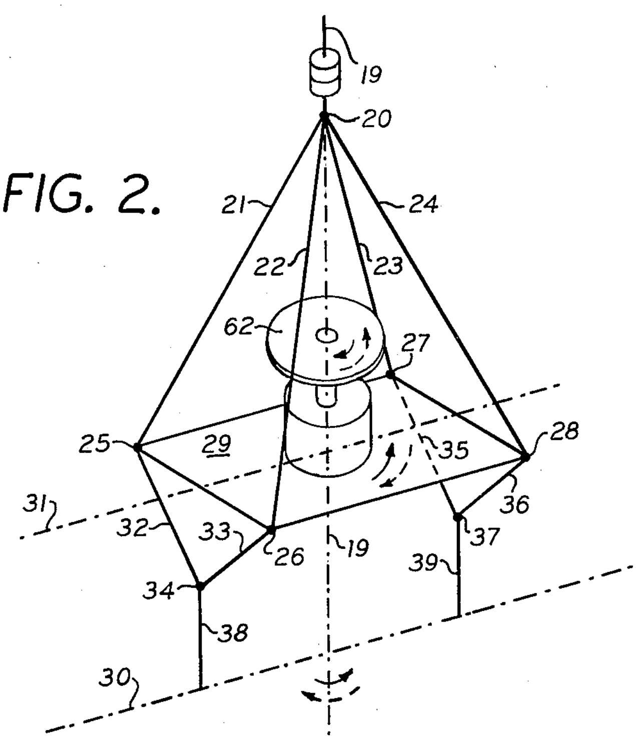


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FIG. 3.

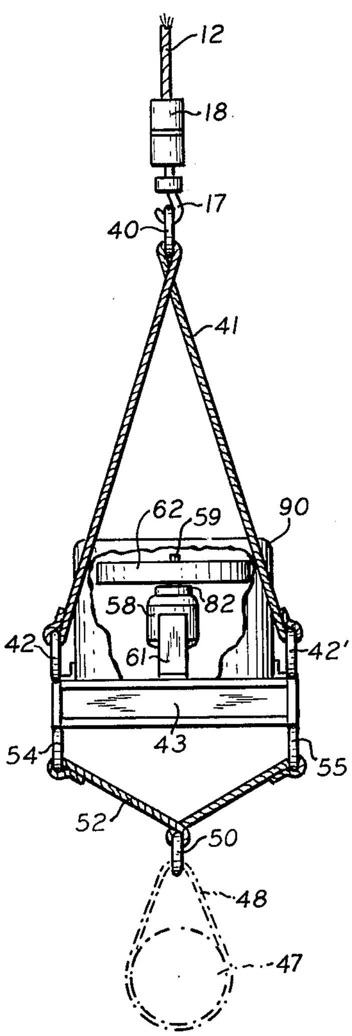



FIG. 4.

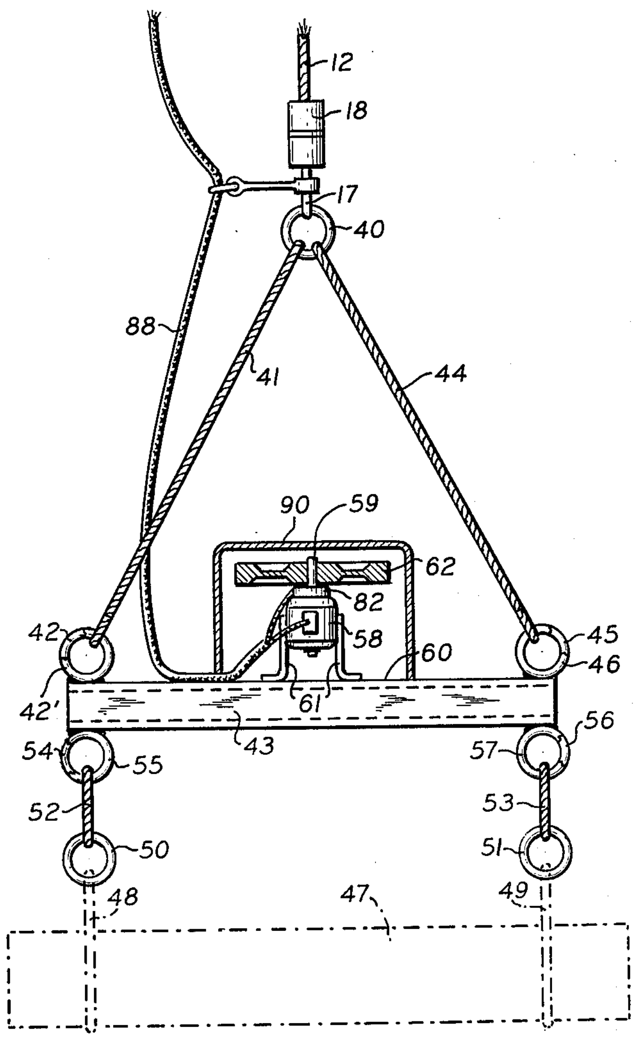



FIG. 5.

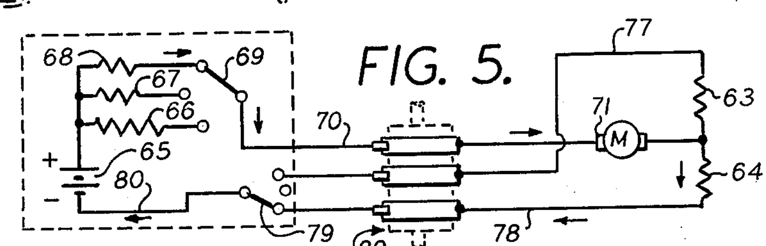
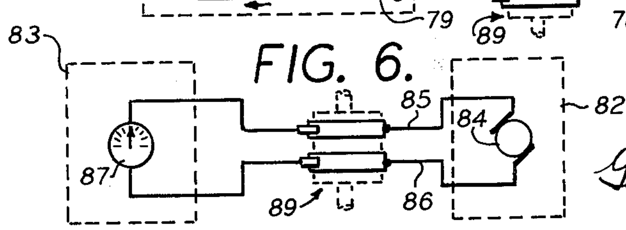



FIG. 6.

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# APPARATUS FOR ORIENTING A SUSPENDED LOAD

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8 Claims. (Cl. 294—81)

This invention relates to apparatus for orienting a suspended load with reference to the points of a compass and, more particularly, to means for changing the angular disposition of a suspended article for the purpose of placing the article in any desired relationship with reference to a stationary object such as parallel to the object or to a line of reference on the ground.

A characteristic of a body suspended by a cable is that it will more often than not veer from the vertical plane of its original position of rest on the ground unless it is restrained. It is common to employ lines attached to a suspended body for guiding the body in a particular vertical plane so that it may be moved in parallel relationship to a wall, or lowered to settle in a given position. For example, tag lines are used in the building construction industry for guiding a beam into its place of mounting and for turning a dangling load so that it may be brought into parallel relationship to objects on the ground such as when a crane is employed for stacking pipes or logs, for example, in an orderly arrangement.

Among the objects of the invention is to provide means to enable an operator to control the orientation of a suspended load from a point remote from the load, as in the cab of a travelling crane or at any position on the ground.

Another object is to dispense with the use of tag lines and to avoid conditions which are dangerous to and wearing on an individual responsible for guiding a hoist load.

According to the invention, the horizontal angular deviation of a suspended load from a desired position is modified or changed at will by applying sufficient torque to cause the load to turn towards the desired position and, if and as it becomes necessary, to apply a counter-torque of sufficient magnitude and duration to properly orient the load. A desired substantially static condition for a load may be attained as the result of only one application of torque of limited duration, or of several oppositely-acting applications applied alternately, depending upon the experience of an operator and on prevailing conditions. The weight of a load, its configuration, and the direction and force of a wind are factors which effect the ease by which the load may be placed in a desired relationship with respect to any given vertical plane.

In the apparatus of the present invention the torque for turning a load is derived from a reversible motor having an armature shaft journalled for rotation on a vertical axis and a flywheel which is coupled to the armature shaft for rotation in a horizontal plane. The motor is securely fixed to a frame which is suspended from a hoist cable in a manner to maintain the motor shaft vertical. The frame is connected to a hoisted article or objects constituting a load. In effect, the suspending system may be considered as being a part of the suspended load. The motor is operated by circuits including resistors and switches by which the speed of the armature shaft, and hence the angular momentum of the flywheel, may be varied, reversed or discontinued, at will. The torque developed by the motor to rotate the armature shaft and the flywheel reacts through the motor or motor casing to effect a counter-torque on the suspended load.

The effect of the counter-torque is to urge the load to turn about its point of suspension in a direction opposite to the direction of rotation of the flywheel. Information with regard to the quiescence of the load or of the rate and direction of turning of the load is transmitted to a control station by a telemetric system. By observing the functioning of an indicator it is possible to determine when the motor should be energized, or when the current to the motor should be varied, reversed or shut off.

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Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawing in which:

FIGURE 1 illustrates an application of the invention;

FIGURE 2 is a diagrammatic illustration of a suspension system for a load;

FIGURES 3 and 4 are, respectively, an end view and a side view of the suspension system illustrated in FIGURE 1;

FIGURE 5 is a wiring diagram of a controlling circuit; and

FIGURE 6 is a wiring diagram of a telemetric system for indicating the operating conditions of the operating motor.

The invention is useful with any form of hoisting apparatus and may be used for turning any kind of a load about the vertical axis of a hoist cable. The application of the invention is illustrated in FIG. 1 in assocition with a crane having a rotatable base **10** to which a boom **11** is pivotally attached. A cable **12** extends from a hoisting drum **13** in the cab **14** of the crane and passes over a sheave **15** on the boom and downwardly to the weighted end of the cable. A conventional crane is illustrated, but it is to be understood that it is intended to be representative of any form of hoisting mechanism. A load, generally designated **16**, is supported by a hook **17** which is attached to a swivel **18** at the end of the cable.

Insofar as the operation of the apparatus of the present invention is concerned, the suspending system by which a material object is to be positioned and the material object itself may be considered as the load on the end of a hoist cable. The structural stability desirable for a suitable suspending system may be made evident by considering the skeletonized structure of FIG. 2.

Referring to FIG. 2, the vertical axis of the hoist cable **12** is shown at **19**, and the point of suspension from the cable, as provided by the hook **17**, is indicated at **20**. The four ties **21**, **22**, **23** and **24** are of equal length and are respectively attached at points **25**, **26**, **27** and **28** to the four corners of a rectangle **29**, thus, the ties and the rectangle provide a pyramid-like system of forces. The rectangle **29** is representative of a rigid frame supported in a horizontal plane.

A reference line **30** is representative of a major axis of a suspended body passing through the center of mass of the body. The line **30** (and the suspended body) is maintained substantially parallel to a line **31** which is located mid-way between lines **25–27** and **26–28**. This is accomplished by means of a pair of ties **32** and **33** of equal length, and respectively extending from the points **25** and **26** and meeting at a common point **34**, and another pair of ties **35** and **36** of equal length and respectively extending from the points **27** and **28** and meeting at a common point **37**.

A hoisted object, as represented by the line **30**, is carried by lines **38** and **39** which are connected to the suspending system at the points **34** and **37**. The lines **38** and **39** represent ropes or cables adapted to be looped about a hoisted object or attached to the object in any appropriate manner for freely suspending the object from the ties **32**, **33**, **35** and **36**. The stresses in the ties and the force of gravity on the object stabilizes the object with respect to the central axis **31**.

In the arangement described, the existing stresses are in equilibrium. A frame, as represented by the rectangle **29**, is always disposed in a horizontal plane and a suspended object bears a definite relationship to the frame. Any turning of the frame about the vertical axis **19** produces a corresponding turning movement of a suspended object. The apparatus illustrated in FIGS. 3 and 4 possesses physical and functional characteristics similar to those described with reference to FIG. 2.

Referring to FIGS. 3 and 4, the supporting point for the suspending system is provided by the hook **17** and a ring **40** to which is attached a cable **41** having equal reaches corresponding to the ties **21** and **22**, respectively, of FIG. 2. The reaches are attached to rings **42** and **42'** at one end of a frame or platform **43**. Also attached to the ring **40** is another cable **44** having equal reaches corresponding to the ties **23** and **24**, respectively, of FIG. 2. The reaches of cable **44** are attached to a pair of rings **45** and **46** at the other end of the frame. The frame **43** consists of a plurality of steel plates which are welded together to provide a rigid box-like structure, but any form of structure suitable for supporting a flywheel and a motor for driving the flywheel may be employed.

A load **47**, such as a pipe, for example, is supported in equilibrium with respect to the frame **43** by means of lines **48** and **49** which respectively hang from rings **50** and **51** to which cables **52** and **53**, supported by the frame, are respectively attached. The upper ends of the cable **52** are respectively attached to rings **54** and **55**, which are welded to the underside of the frame **43**. The upper ends of the cable **53** are likewise respectively attached to rings **56** and **57** at the other end of the frame **43**. The downwardly pitching reaches of the cable **52** are of equal length and correspond to the ties **32** and **33** of FIG. 2. The downwardly pitching reaches of the cable **53** are also of equal length and correspond to the ties **35** and **36** of FIG. 2. As a consequence, the object **47** is supported in a state of equilibrium with respect to the frame **43**.

A motor **58** having an armature shaft **59** journalled for rotation on a vertical axis is mounted on the frame **43** with its axis of rotation disposed normal to a horizontal surface **60** of the frame **43**. The motor casing is securely fastened to the frame by a plurality of brackets **61**. Any suitable reversible motor having an armature shaft journalled for rotation on a vertical shaft may be employed. The motor is preferably located on the axis of the hoist cable **12**. A flywheel **62** is keyed or otherwise coupled to the armature shaft of the motor for rotation in a horizontal plane.

The relationship of the motor **58** to the frame **43** is such that a force acting to accelerate the flywheel **62** in one direction of rotation reacts on the frame to cause turning of the frame in the opposite direction as indicated by the solid line arrows in FIG. 2. When the motor is driven in the reverse direction the effect of angular acceleration of the flywheel produces a corresponding opposite angular acceleration as indicated by the dotted line arrows in FIG. 2.

The wiring diagram illustrated in FIG. 5 is for a direct-current, series wound motor having interchangeable oppositely wound field windings **63** and **64**, one for energizing the field for rotating the armature shaft in one direction and the other for energizing the field for rotating the armature shaft in the opposite direction. Current is supplied to the motor from the positive side of a supply source **65**, through any one of a number of resistors of different resistances **66**, **67**, **68**, switch **69**, wire **70**, the motor armature **71**, either the field winding **63** and wire **77** or the field winding **64** and wire **78**, switch **79** and wire **80** to complete the circuit to the negative side of the source of supply **65**. The flow of current in the field winding **63** or in the field winding **64** is determined by positioning the switch **79** for closing the circuit through either the wire **77** or the wire **78**. Current to the motor is discontinued when the switch **79** is in a neutral position.



The magnitude of the torque developed by the motor may be varied at will by manipulating the switch **69** to change the resistance in the motor circuit, as is well understood. The resistors and switches may be mounted on a control panel at any location convenient to an operator, as in the cab of a crane at **81**.

A telemetric system including a transmitter **82** and a receiver **83** is used for transmitting and receiving intelligence from the suspended frame. The transmitter may comprise a reversible direct-current generator **84** connected in a circuit with the receiver by a pair of lines **85**, **86**. The generator is mounted in fixed relationship to the motor **58** and its armature is keyed or otherwise coupled to the armature shaft of the motor. The receiver includes an indicating instrument **87**, such as a voltmeter, capable of indicating the direction of current flow and the speed of the armature shaft of the motor **58**. A voltmeter calibrated in revolutions per minute of the flywheel is admirably adapted to provide desired information on the operational condition of the flywheel.

The load is rotated, in the first instance, by the reaction to the energy expended in the acceleration of the flywheel. The energy expended in the deceleration of the flywheel, to substantially the same extent, will stop the rotation of the load. If the flywheel was at rest before the load rotating operation commenced, the flywheel will be substantially at rest at the termination of the operation. The cessation of load rotation is indicated in the crane cab by a zero reading of the indicating instrument which monitors the flywheel. Such a means of remote indication is helpful in those instances when the crane operator cannot see the load.

The various controlling and indicating instruments may be mounted on the control panel. All of the wires constituting the lines running between the control panel and the suspended frame are contained in a flexible cable **88**. Whenever the apparatus is used for hoisting loads through a great distance, a conventional take-up reel, such as diagrammatically illustrated at **89** may be interposed between the operator and the frame to take up or let off the cable as a load is being raised or lowered.

A housing **90**, FIG. 4, is provided on the frame for protecting the motor and the flywheeel.

The operation of the apparatus will be apparent to those skilled in the art in view of the foregoing disclosure. In accordance with the provisions of the patent statutes, I have herein described the principle and the mode of operation of my invention and an apparatus which is now considered to represent the best means for practicing the invention, but it is desired to have it understood that the invention can be practiced by other means. Also, while it is desired to use the various features and elements in the combinations and relations described, some of these may be altered and others omitted without interfering with the general results attained by the invention, within the scope of the appended claims.

What is claimed is:

**1.** In an apparatus for orienting a structure suspended by a hoist cable, means for attaching said structure to said hoist cable for supporting said structure against the pull of gravity, a reversible motor having an armature shaft journalled for rotation on a vertical axis, means for fixedly securing the casing of said motor to said structure with the armature shaft of the motor disposed vertically, a flywheel coupled to said armature shaft, circuit means for energizing said motor, and means for controlling the operation of said motor for rotating said flywheel in either of opposite directions of rotation whereby a torque reacting counter to the direction of rotation of said flywheel is applied to the casing of the motor and said structure for affecting rotation of said structure in the direction opposite from the direction of rotation of the flywheel.

**2.** The apparatus set forth in claim **1** in which said means for controlling the operation of said motor includes means for varying the speed of the motor.

**3.** The apparatus set forth in claim **1** in which said means for controlling the operation of said motor includes variable resistor means located remote from said structure.

**4.** The apparatus set forth in claim **1** including telemetric means for indicating the speed and direction of rotation of said flywheel.

**5.** The apparatus set forth in claim **4** in which said telemetric means comprises a generator driven from the armature shaft and a voltmeter.

**6.** In an apparatus for orienting a load suspended by a hoist cable, a frame, means for suspending said frame from a hoist cable, means connected to said frame for carrying a load in substantially non-rotatable relationship with respect to said frame, means for orienting said frame and load carried thereby rotatively about a vertical axis passing through the point of suspension of said frame from the hoist cable, said orienting means comprising a reversible motor having an armature shaft mounted for rotation on a vertical axis, means immovably attaching the casing of said motor to said frame with the armature shaft of the motor disposed vertically, a flywheel driven by said armature shaft for rotation in a horizontal plane, circuit means for controlling the operation of said motor for rotation in either of opposite directions of rotation of the armature shaft whereby a torque acting counter to the direction of rotation of said flywheel reacts on said frame to rotate the frame and load carried thereby in a direction opposite to the operational direction of rotation of the armature shaft.

**7.** The apparatus set forth in claim **4** wherein said means attached to said frame for carrying a load includes at least two lines attached to said frame for suspending a load from said frame against the force of gravity acting on the load.

**8.** In apparatus for orienting a load suspended by a hoist cable, means for supporting a load from a hoist cable in a manner to allow rotation of the load about a generally vertical axis, said means comprising a frame, a plurality of guys respectively attached to said hoist cable and to said frame, said guys attached to said hoist cable at a common point and to said frame at a plurality of points spaced apart from each other so as to support said frame substantially horizontally, means connected to said frame for carrying a load subject to the force of gravity, said load-carrying means constructed and arranged for transmitting rotary movement of the frame about a vertical axis to a load carried thereby, means for applying torque to said frame for effecting rotation of the frame in a horizontal plane, said last-named means including a reversible motor having an armature shaft journalled for rotation on a vertical axis, means immovably attaching said motor to said frame with its armature shaft disposed vertically, a flywheel coupled to said shaft, and means to selectively control the operation of said motor to cause rotation of said flywheel in either of opposite directions of rotation for causing counter rotational effects on said frame depending on the direction of rotation of the flywheel whereby the angular disposition of a suspended load may be changed, at will.

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SAMUEL F. COLEMAN, *Primary Examiner.*