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 axis if it is in a 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 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 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 in prevailing conditions. The weight of a load, its configuration, and the direction and force of a wind are factors which affect 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 journaled 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 telematic 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.

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 drawings 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 telematic 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 association 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 arrangement 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 suspension 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 operating 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 journaled 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 journaled 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 through any one of a number of resistors 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 photoelectric or current input instrument 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 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 flywheel.

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 a hoist cable for supporting said structure against the pull of gravity, a reversible motor having an armature shaft journaled for rotation on a vertical axis, means for fixing 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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