

[54] **HELICOPTER TAIL ROTOR DEVICE**

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Related U.S. Application Data

[60] Continuation of Ser. No. 55,223, July 15, 1970, abandoned, which is a division of Ser. No. 756,981, Sept. 3, 1968.

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[51] Int. Cl. **B66c 23/06, B66c 1/00**

[58] Field of Search **212/58 R, 59 R, 71; 294/67 R, 81 R**

[56] **References Cited**

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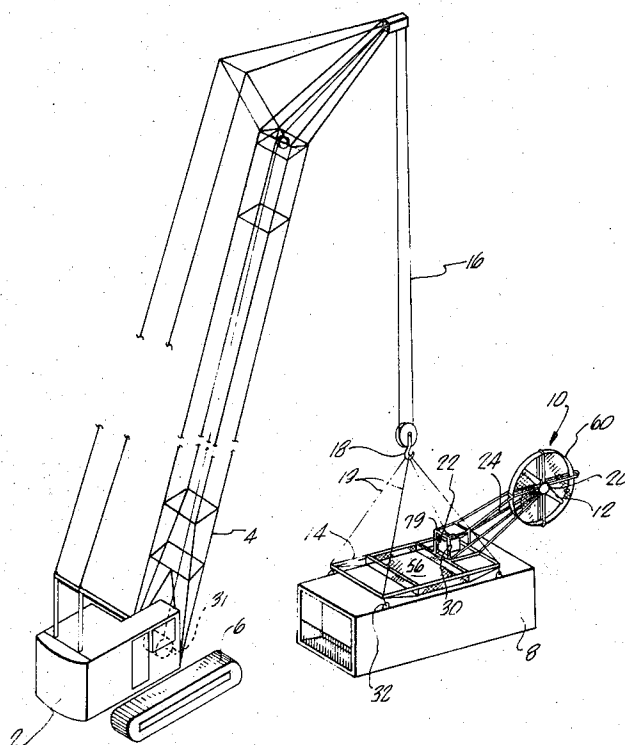
Primary Examiner—Robert S. Ward, Jr.

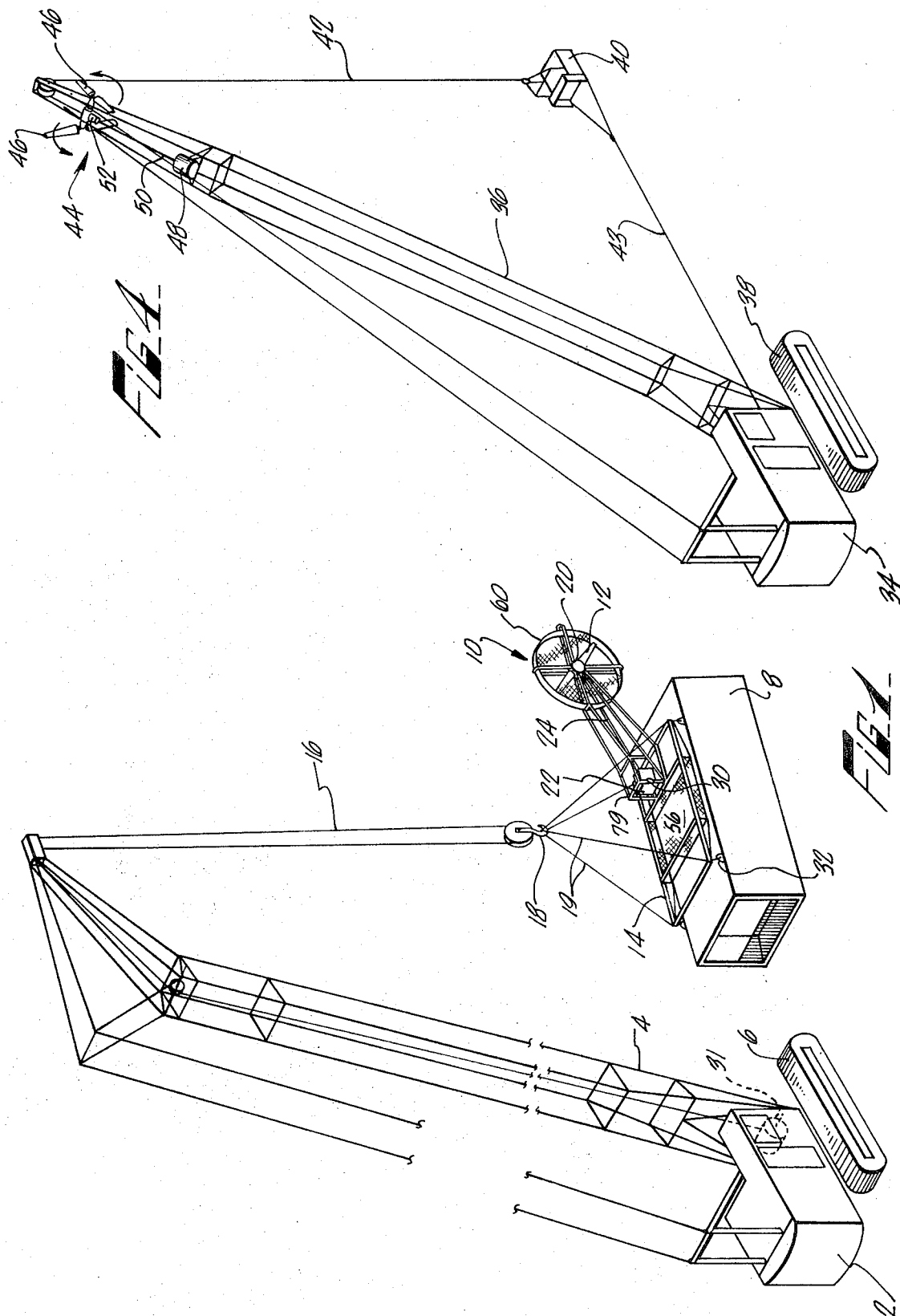
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[57] **ABSTRACT**

A helicopter tail rotor disposed on a crane for stabilizing a load suspended from the crane boom during a hoisting operation. The tail rotor is secured to a hoisting platform suspended from the upper end of the boom, the rotor blades being manually or automatically adjusted for turning the load horizontally in either direction such that the load is both stabilized during hoisting and easily directed to its assigned location. Alternately, the tail rotor is directly secured to the upper end of the boom such that the boom and crane body can be easily rotated about a fixed base, thereby avoiding the need for ring and pinion gears at the base of the crane, or reducing the load on such gears if they are used.

14 Claims, 4 Drawing Figures





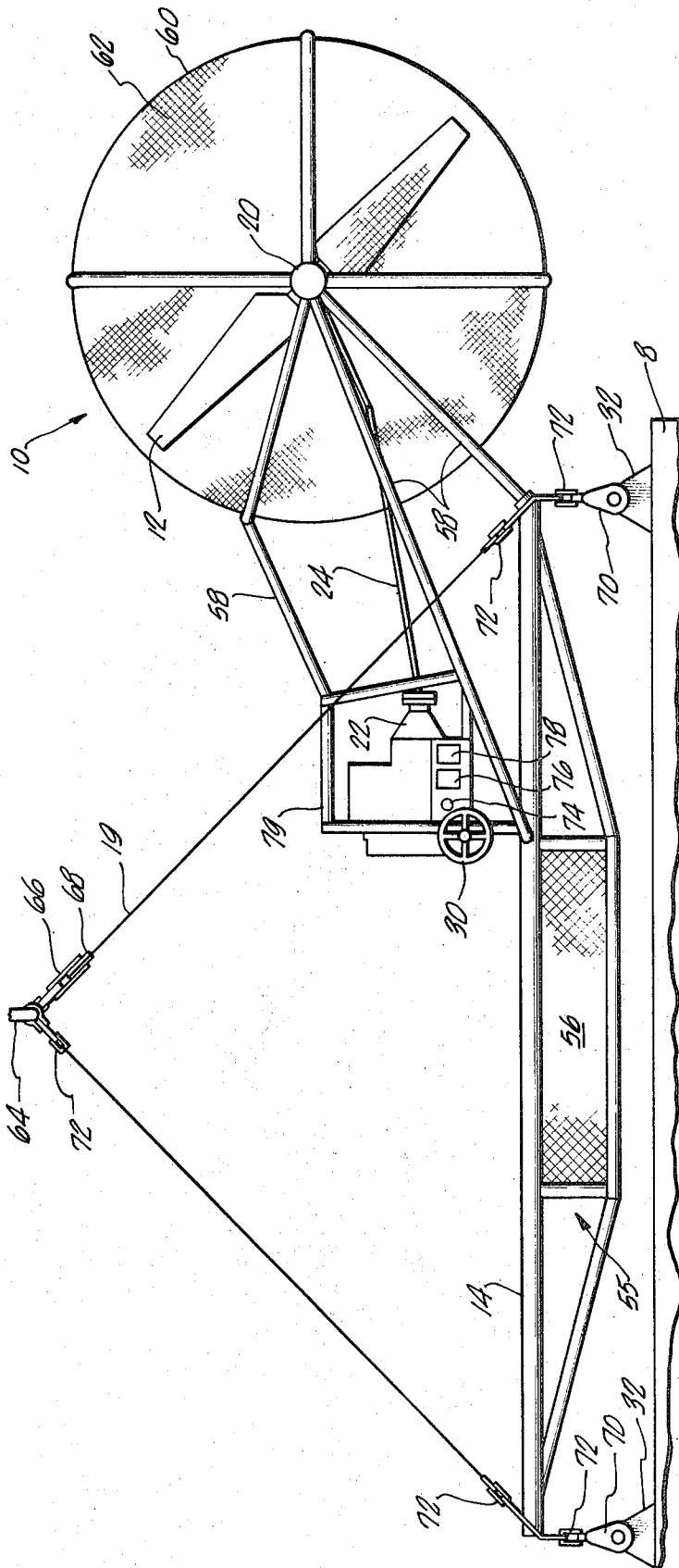


FIG. 2

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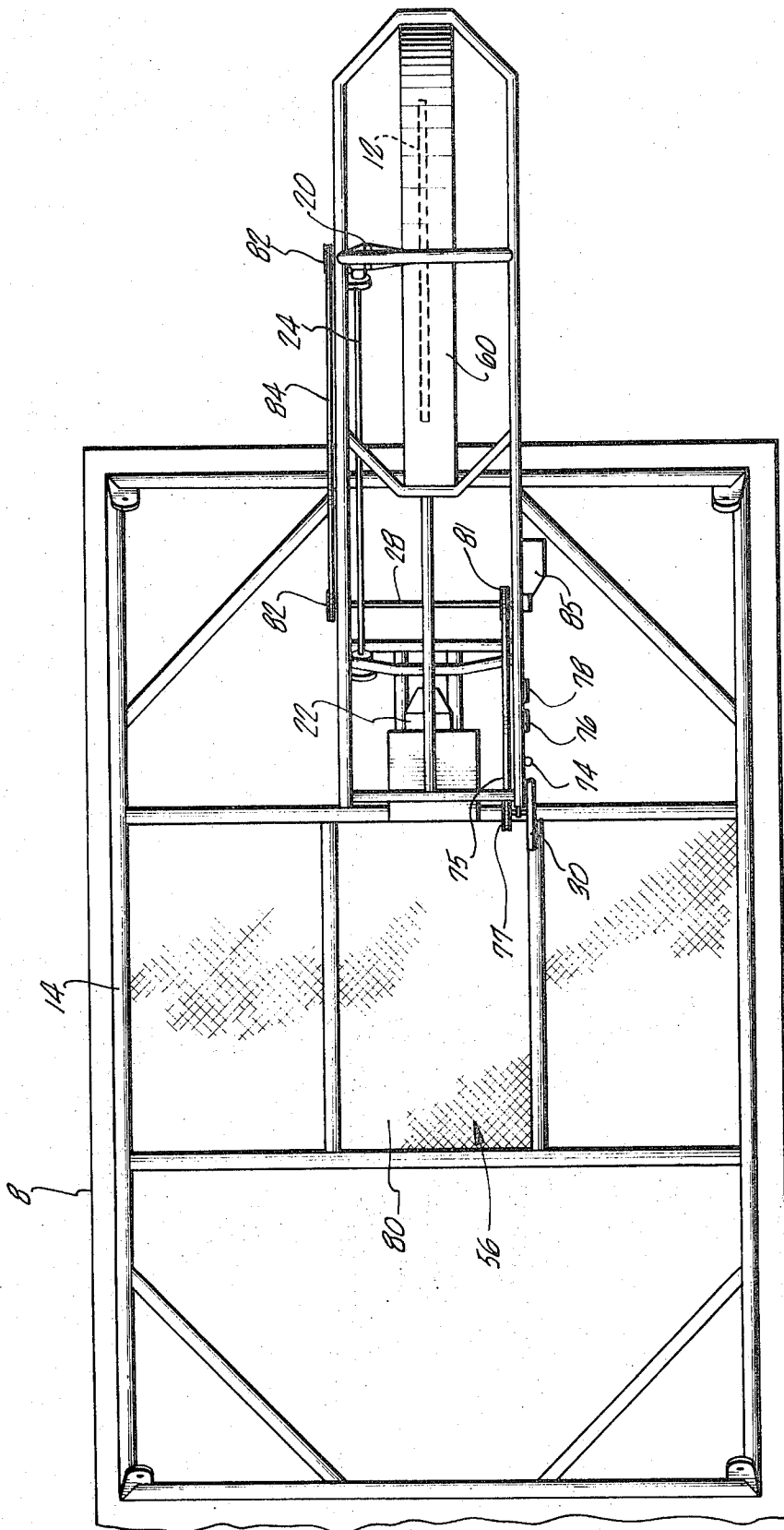


FIG. 3

HELICOPTER TAIL ROTOR DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of application Ser. No. 55,223, filed July 15, 1970, now abandoned, which is a division of application Ser. No. 756,981, filed Sept. 3, 1968.

BACKGROUND OF THE INVENTION

This invention relates to a hoisting machine having a boom, and more particularly concerns a helicopter tail rotor device utilized in combination with a crane boom for positioning the boom or for positioning a load carried by the boom.

Cranes, derricks, and related machinery, are widely used in industry for a variety of applications. Large cranes, consisting of a rotating body secured to a movable base and having an upwardly extending boom with support and lifting cables, are of considerable importance in the building industry for the hoisting of materials to various heights above ground level. Similarly, cranes having drag-line buckets, clam-shells, or the like, are valuable for use in excavation work.

More recently, prefabricated methods for the construction of buildings have generated increased demand for cranes capable of lifting and positioning extremely large loads. Precast concrete modules, each of which may comprise a separate living or office unit, are transported from a prefabrication area to the construction site, where the modules are placed on top of one another to form the building. The modules ordinarily are constructed of pre-stressed concrete and have weights in excess of 40 tons. Hotels, apartment buildings, office buildings, and the like can be constructed using a number of stacks of prefabricated modules of this type, the height of the stacks often being in excess of 20 stories.

Conventional hoisting machinery, such as cranes employed in the construction industry for the simple hoisting and lowering of construction materials, have not been satisfactory for the hoisting and positioning of heavier and bulkier loads, such as precast modules. Although cranes of adequate lifting capacity are available, it has been found that serious problems of load stabilization and positioning have occurred. For example, in the lifting of a precast module with a conventional crane, the module will tend to turn about the hoisting cable suspended from the upper end of the boom, thereby causing abnormal forces to be exerted on the crane. Moreover, the prefabricated building system requires accurate positioning of a module when it is placed on top of another module or between two stacks of modules. This positioning requirement cannot be met with standard hoisting machinery, which is primarily adapted only for simple hoisting and lowering operations.

Excavating cranes, such as large drag-line cranes, have also been found to be extremely disadvantageous in that positioning of the boom itself cannot be readily accomplished. The boom is ordinarily secured to a rotating body disposed on a fixed base, which may be movable on tractor treads or the like. Ring and pinion gears are disposed on the rotating body and fixed base for allowing rotation of the boom. The location of the ring and pinion gear at the center of rotation of the

boom gives rise to excessive torque loads and strain on the machinery. As a result, costly and troublesome components, such as clutches, gears, shafts, rings, and pinions are essential for cranes presently designed for such work.

STATEMENT OF THE INVENTION

In accordance with this invention, positioning of the boom, or a load suspended from the boom, can be readily effected by means of a positioning device comprising rotor blades and drive means for turning the rotor blades about a substantially horizontal axis. Positioning of a load, such as module being stacked in a system building method, is accomplished by utilization of a hoisting platform suspended from the upper end of the boom, the rotor assembly being secured to the hoisting platform such that the load carried can be horizontally moved in either direction. Alternately, the rotor assembly can be directly secured to the upper end of the boom and operated so as to swing the boom and machine body about the fixed base of the crane.

A helicopter tail rotor assembly, or similar apparatus, can be employed in combination with the boom of conventional hoisting machinery. Variable pitch and reversible rotor blades are utilized to enable movement in either horizontal direction. A drive motor and drive shaft, together with standard gear drive and pitch control mechanisms, can be disposed on the boom or on the hoisting platform of the crane. Although any practical number of rotors can be employed, a pair of rotors are preferably utilized for moving the boom itself, whereas a single rotor can be disposed on the hoisting platform.

The hoisting platform typically comprises a rectangular frame having cables running upwardly from each corner thereof to a cable extending from the upper end of the boom. The rotor blades are mounted to rotate about a substantially horizontal axis and are on the far end of a support which projects outwardly from the rectangular frame, the blades being enclosed in a guard cage or the like. Manual controls are disposed on the hoisting frame for allowing a workman to ride the hoisting frame and guide the load into proper position. An auto-pilot mechanism, such as that used in airplanes, can also be employed for setting and controlling the movement of the load from ground to a final position. This type of control is especially valuable during bad weather construction or when safety rules do not allow riding of the hoisting platform by a workman. Additionally, remote control equipment can be utilized for controlling the tail rotor.

The helicopter tail rotor device secured to the hoisting platform allows positive directional control of a load as it is hoisted. The load is given a predetermined heading, such as by using a magnetic compass and automatic controls secured to the hoisting platform, and directed to the desired location by varying the pitch of the vertical propeller. The crane operator ordinarily in radio contact, by means of headphones, with construction crewmen, receiving instructions for maneuvering the load into position by means of gears and pulleys. The combined action of the tail rotor assembly and the standard lifting mechanism of the crane afford an extremely efficient hoisting operation.

Rotors mounted on the upper end of the boom to rotate about a horizontal axis are operated by the crane operator to move and position the boom. An electric or

hydraulic motor is disposed at the upper end of the boom for turning the rotors in either direction to effect the positioning movement. A holding brake can also be disposed on the crane for terminating rotation of the boom at any normal angle of operation.

A crane having the boom and helicopter tail rotor assembly of this invention is particularly valuable for use in a system building technique wherein bulky and heavy modules are lifted from ground level to considerably height and positioned on top of a stack of modules or between stacks of modules. Each module can be "flown" into place manually, using an operator riding the hoisting platform on which the tail rotor is disposed, or automatically, by remote control. Loads lifted in this manner are easily stabilized and accurately positioned at the desired location in minimum time.

A helicopter tail rotor combined with the boom of a crane has been found to be surprisingly effective in the stabilization of loads to be lifted and for the positioning of such loads. When a rotor assembly is used with a lifting platform, as in the prefabricated building technique, a load can be quickly and safely lifted and positioned without the need for tag lines or other restraining means. The boom and crane body can also be readily positioned, employing a rotor assembly directly secured to the upper end of the boom, such that the need for ring and pinion gears is completely avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a crane having a boom and helicopter tail rotor assembly for the hoisting and positioning of a module;

FIG. 2 is a side view of the hoisting platform and tail rotor assembly employed in the crane of FIG. 1;

FIG. 3 is a plan view of the hoisting platform and tail rotor assembly shown in FIG. 2; and

FIG. 4 is a perspective view of a crane having a helicopter tail rotor assembly directly secured to the upper end of a boom, for rotating the boom and crane body about a fixed base thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a large crane, having a base 2 and boom 4 and being movable on caterpillar treads 6, for hoisting and positioning a precast concrete module 8. A helicopter tail rotor assembly 10, having a variable pitch and reversible propeller 12, is secured to the forward end of a hoisting platform 14. A hoisting cable 16 and swivel hook 18, together with bridle cables 19, suspend the hoisting platform from the upper end of the boom. The hook is raised and lowered with the hoisting cable, which is connected to conventional draw works 31. The module is suspended from the hoisting platform at the four corners thereof by suspension cables 32. The propeller 12 has a gear drive and reversible pitch control mechanism 20, which is connected to a drive motor 22 by a drive shaft 24. A gyroscopic auto-pilot mechanism (not shown) is disposed adjacent the drive motor for maintaining a desired boom heading during the lifting operation. A control wheel 30 is on the hoisting platform for permitting a load to be flown into position by a workman riding on the hoisting platform, the manual control being used in addition to or as a substitute for the auto-pilot mechanism.

The module, or any similar load, is stabilized and accurately directed to a desired location by the combined

operation of the crane and the helicopter tail rotor assembly. The crane operator, in radio contact with workmen stationed about the construction site, controls the conventional movements of the crane; i.e., for the simple raising and lowering of loads, as well as for swinging the boom to any angle. Stabilization and precise directional control is afforded either by the gyroscopic auto-pilot or by manual control of the tail rotor. Propeller pitch control of the rotor moves the module in a horizontal plane. A workman can ride the hoisting platform and operate the manual control wheel to provide optimum directional precision of the crane, although the auto-pilot mechanism alone can be utilized in bad weather or in other situations where it is inadvisable or impossible for a workman to ride the platform. Twin rotors can also be utilized so as to provide increased maneuverability.

FIG. 2 shows a side view of the tail rotor assembly and hoisting platform of FIG. 1. The hoisting platform 14 consists of a tubular frame 55 defining at its center a wire mesh box 56 capable of supporting a workman during the hoisting and lowering operations. The tail rotor 10 is disposed outwardly from the hoisting platform by tubular support members 58. An outer guard member 60 and screen 62 enclose the rotor blades to prevent accidents and protect the blades from damage. Cables 19 are secured at each corner of the hoisting platform, extending upwardly and being secured to a pear link 64. An equalizer block 66, having a sheave 68, is secured to the pear link 64 for connection with cables 19 to equalize the load when it is suspended from the swivel hook 18, as shown in FIG. 1. Cables 32 extend from swivel blocks 70 at each corner of the hoisting platform for attachment of the load to the hoisting platform. Screw pin shackles 72 secure the blocks 70 and cables 19 to the corners of the hoisting platform and to the pear link 64. A drive motor 22, an auto-control mechanism 74, a directional gyro 76, and a horizontal alignment control device 78, are secured by tubular members 79 between the rotor assembly 10 and the supporting box 56 of the hoisting platform. The drive motor typically can be one producing 60 HP at 3200 RPM, so the propeller can be turned at up to 1200 RPM.

FIG. 3 is a plan view of the tail rotor assembly and hoisting platform shown in FIG. 2. The supporting box 56 of the hoisting platform has a metal screen floor 80 capable of supporting one or more workmen during the hoisting operation. The drive motor 22 is connected to the rotor by drive shaft 24. The gear drive and pitch control mechanism 20 has sprockets 82 and a chain 84, driven by servo motor 85. A chain 75 and gears 77, 81 connect the manual steering wheel 30 and control mechanisms 74, 76 and 78 to the control shaft 28. The propeller pitch can be varied to provide excellent stabilization and directional control by a workman manipulating the manual control wheel 30. Alternately, when manual operation of the tail rotor is not feasible, the auto-pilot control can be preset to vary the propeller pitch to provide the required control. Additionally, remote control equipment can be employed for operating the tail rotor.

A load, such as a module, is secured at each corner of the hoisting platform by cable loops, as shown in FIGS. 2 and 3. The crane operator actuates the lifting cables of the crane to initiate hoisting. A workman, riding in the supporting box of the hoisting platform, oper-

ates the manual control wheel so as to stabilize the load during hoisting. As shown in FIG. 3, the manual control wheel 30 is connected with the reversible pitch control mechanism 20 by chain 75 and control shaft 28. Turning of the control wheel, with the auto-control mechanism 74 in its off position, causes lateral movement of the end of the load. If the load tends to rotate to the right, for example, the control wheel can be turned to effect rotation of the propeller to prevent such motion.

Alternately, the auto-control mechanism 74 can be actuated prior to hoisting so as to automatically adjust the reversible pitch control mechanism 20. The direction gyro 76 and horizontal indicator 78 are preset to the desired heading. The servo motor 85, in response to the control mechanisms 76 and 78, then operates the propeller to turn the load in the required direction.

FIG. 4 shows a large drag-line crane having a rotatable body 34 and a boom 36. The body is movably supported on caterpillar treads 38. A drag-line bucket 40 is suspended from the upper end of the boom by a hoisting cable 42. A drag cable 43 is also secured to the bucket, running to the crane body. A helicopter tail rotor assembly 44 is secured to the upper end of the boom to rotate about a horizontal axis. The boom and body 34 are rotatable about a vertical axis by the tail rotor to position the drag-line bucket 40. The tail rotor assembly comprises two propellers 46 connected to a drive motor 48, through a gear drive an reversible pitch control mechanism 52, by a drive shaft 50. Use of the helicopter tail rotor eliminates the need for ring and pinion gears on the crane body and reduces the bearing load at the lower end of the boom. A holding brake or similar mechanism (not shown) can be disposed on the rotating body for terminating swinging movement of the boom at any normal angle of operation. The drive motor 48 can be an electric or hydraulic motor and ordinarily is controlled by the crane operator. The pitch of propellers 46 preferably is reversible and variable, so as to permit smooth movement of the boom in either direction.

The helicopter tail rotor assembly, when utilized with a hoisting platform as in accordance with this invention, is invaluable in system building construction, which requires precise lifting and positioning of modules at considerably heights and under varying weather conditions. For example, precast concrete modules having dimensions of approximately 40 x 20 x 10 feet, and weighing over 40 tons, can be easily hoisted and positioned in stacks involving in excess of 500 modules. The modules can be fabricated at a casting plant either adjacent the construction site or at a distance therefrom. Modules comprising four-room executive suites, two-room suites, studio rooms, and double rooms, as well as office units and the like, can be prefabricated and hoisted to heights in excess of 20 stories in rapid succession.

Although the tail rotor assembly of this invention has been described in combination with the boom of a crane, it should be noted that such device can be used with any hoisting machine, such as a derrick, to provide improved control of any load hoisted by means of cables or the like. For example, a hoisting platform can be suspended from a hoisting apparatus having an upright support and conventional hoisting cables.

I claim:

1. Apparatus for adjusting the position of a load comprising a crane having an elongated boom, a hoisting cable suspended from the boom, a rigid propeller support structure connected to the hoisting cable and releasably secured to the load and extending to a point remote from the load and displaced laterally from the axis of the hoisting cable, a propeller mounted on the displaced portion of the support structure to be rotatable about a substantially horizontal axis spaced laterally from the axis of the cable, and means for rotating the propeller to exert a torque on the cable through the structure and the load to provide directional control for the load.

2. Apparatus according to claim 1 in which the support structure includes a platform releasably secured to the exterior surface of the load, and a rigid propeller support arm extending from the platform to said point remote from the load and displaced from the axis of the cable.

3. Apparatus according to claim 1 in which the propeller is rotatable in a substantially vertical plane.

4. Apparatus according to claim 1 in which the support structure is releasably secured to the exterior surface of the load and extends to a point remote from the load for positioning the propeller.

5. Apparatus according to claim 1 including means for varying the pitch of the propeller relative to said vertical plane.

6. Apparatus according to claim 5 including means for adjusting the direction of rotation of the propeller.

7. Apparatus according to claim 1 including manually operative steering means coupled to the propeller and positioned on the load to permit manual operation of the propeller by a workman on the load.

8. Apparatus according to claim 1 including remote-controlled steering means for automatically adjusting the rotation of the propeller to control directional movement of the load.

9. Apparatus according to claim 1 in which the load comprises a modular dwelling unit.

10. A method of adjusting the position of a load, the method comprising suspending the load from a hoisting cable connected to the boom of a crane, releasably securing a support structure to the load so at least a portion of the structure is remote from the load and displaced laterally from the axis of the cable, mounting a propeller on the support structure to be rotatable about a substantially horizontal axis spaced laterally from the axis of the cable, rotating the propeller to exert a torque on the cable through the structure and the load to provide directional control for positioning the load, and removing the propeller support structure from the load after the load is in position.

11. The method according to claim 10 including securing the propeller to an arm on a platform, and releasably securing the platform to the load such that the arm supports the propeller at a point displaced from the axis of the cable.

12. The method according to claim 10 including adjusting the pitch of the propeller to adjust the position of the load.

13. The method according to claim 10 including connecting manually operative steering means to the propeller to permit the pitch of the propeller to be adjusted, and manually operating the steering means from a position on the load to control the directional movement of the load.

14. The method according to claim 10 in which the load is a modular dwelling unit.

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