Oct. 22, 1963 B. H. MICHAEL 3,107,791

LOAD HANDLING APPARATUS

Filed Nov. 26, 1962 2 Sheets-Sheet 1

FIG. 1

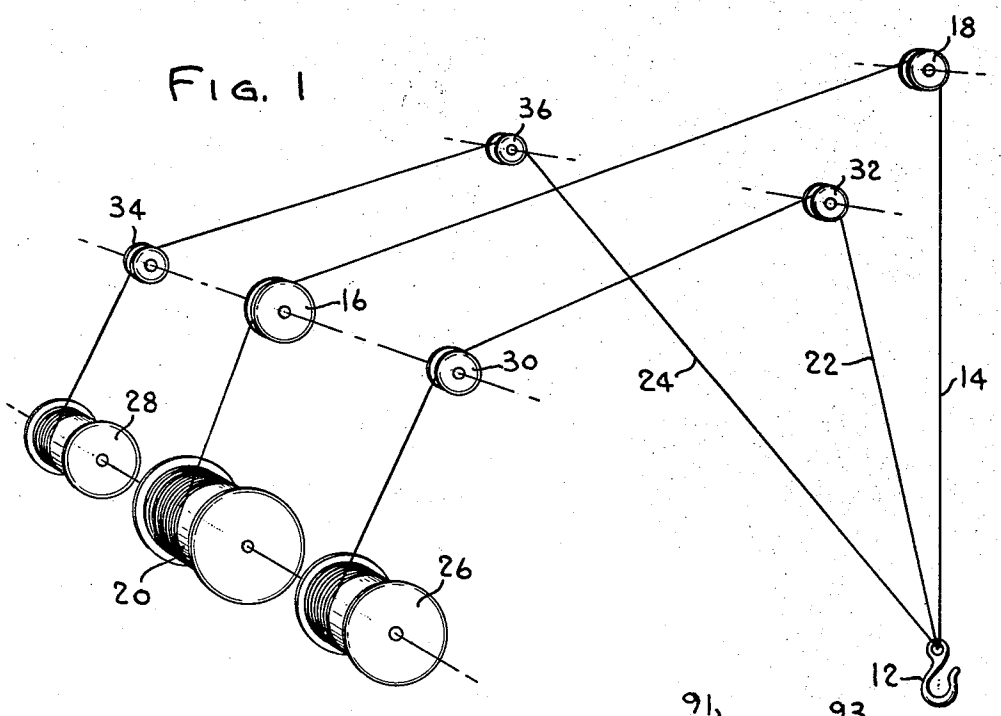
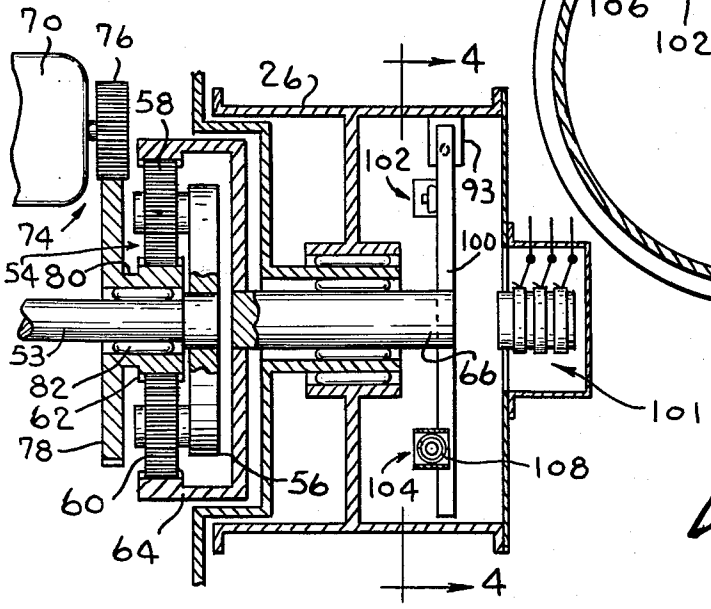


FIG. 3



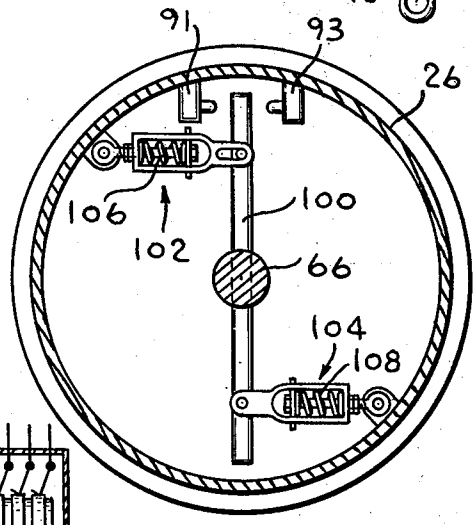


FIG. 4

INVENTOR.

Bayard H. Michael

Oct. 22, 1963 B. H. MICHAEL 3,107,791

LOAD HANDLING APPARATUS

Filed Nov. 26, 1962 2 Sheets-Sheet 2

FIG. 2

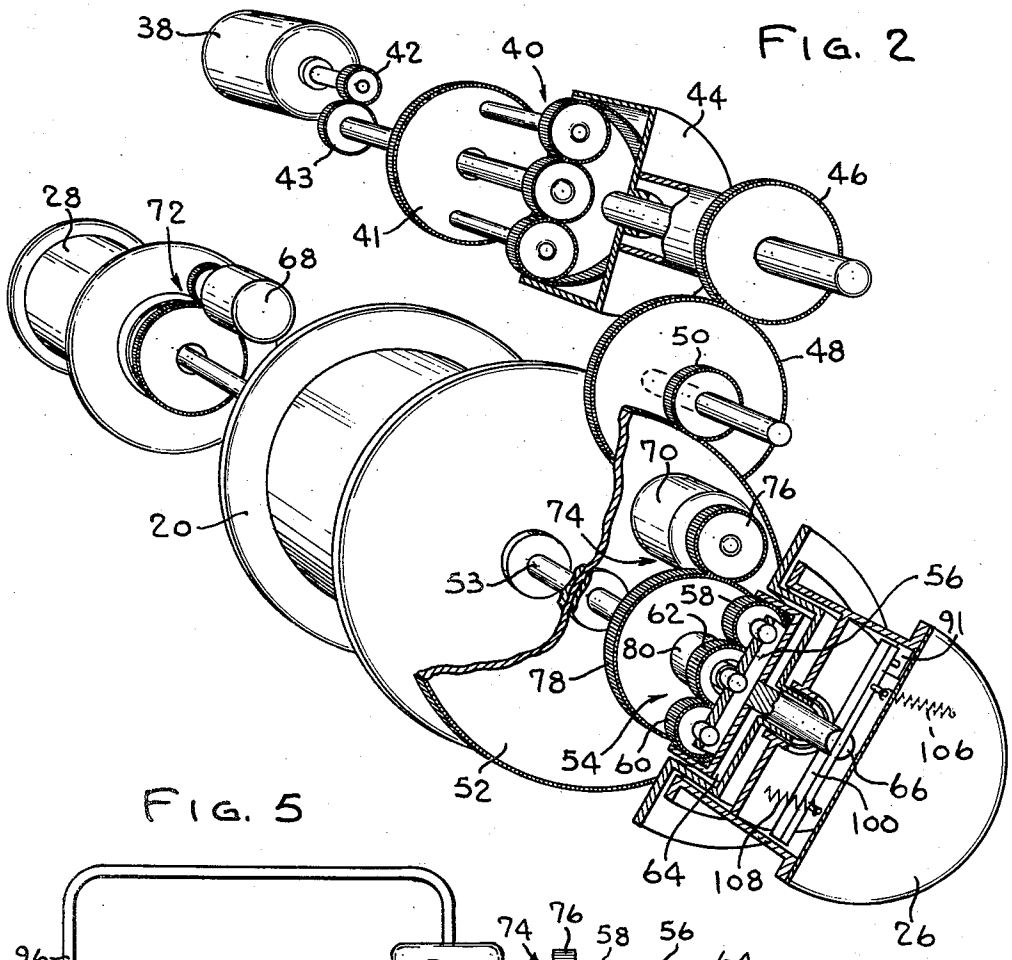
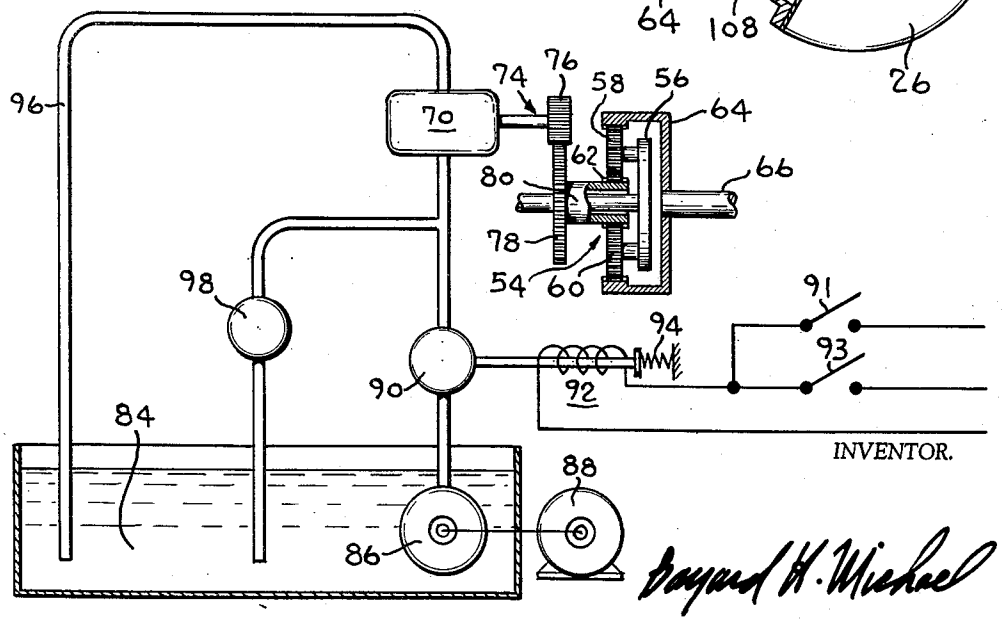


FIG. 5



INVENTOR.

Bayard H. Michael

United States Patent Office 3,107,791 Patented Oct. 22, 1963

3,107,791

LOAD HANDLING APPARATUS

Bayard H. Michael, Milwaukee, Wis., assignor to Lake Shore, Inc., Iron Mountain, Mich., a corporation of Michigan

Filed Nov. 26, 1962, Ser. No. 240,083
13 Claims. (Cl. 212—58)

This invention relates to load handling apparatus such as ship mounted cranes and, more particularly, to an anti-pendulation arrangement for use with such apparatus.

An object of this invention is to provide an improved, highly effective, and relatively simplified anti-pendulation system for use with such load handling apparatus.

Another object of this invention is to provide a sensitive and highly responsive anti-pendulation system for use with load handling apparatus such as ship mounted cranes.

A further object of this invention is to provide improved load handling apparatus of the ship mounted crane type.

For the achievement of these and other objects of this invention, it is proposed to provide load handling apparatus having a pair of tag lines connected to the load hook, or other suitable load engaging mechanism. The load hook is also suspended from a flexible hoist line and, under normal operating conditions, i.e. where the hoist line and hook assume a vertical, non-swinging position, the tag line drums are positively driven by the main hoist drive so that the hoist line and tag lines are heaved and payed out at the same speed. The tag line drums are also supported for movement in response to swinging movement of the hook, being movable in one direction in response to slack line and in an opposite direction when line tension increases. Secondary, or stabilizing, drives are provided for each of the tag line drums and are effective to provide differential movement between the tag lines and the hoist line as required to either heave slack tag line or oppose tag line payout. The secondary drives are controlled in accordance with the movement of the tag line drums due to either slack line or increased line tension so that the tag lines are continuously sensed and a swinging load hook will be effectively damped by retarding tag line payout and heaving slack line as required.

Other objects and advantages will be pointed out in, or be apparent from, the specification and claims, as will obvious modifications of the embodiment shown in the drawings, in which:

FIG. 1 is a schematic illustration of a crane arrangement in which this invention may be embodied;

FIG. 2 is a perspective view of the hoist and tag line drive mechanism;

FIG. 3 is an axial section of a tag line drum and a portion of its drive looking toward the hook end of the boom;

FIG. 4 is a section along lines 4—4 of FIG. 3; and

FIG. 5 is a schematic illustration of a hydraulic system and control for use in this invention.

With particular reference to the drawings, hoist apparatus of the type in which this invention may be embodied includes a load engaging hook 12 and hoist line 14 extending from hoist drum 20 over sheaves 16 and 18 which are normally supported on a crane boom (not shown). Tag lines 22 and 24 extend from tag line drums 26 and 28, over sheaves 30, 32, 34 and 36, also supported from the crane boom, to hook 12.

With reference to FIG. 2, the hoist drive includes a hoist motor 38 connected to planetary gear system 40 through spur gear combination 42 and shaft 43. Through this arrangement, motor 38 rotates sleeve 44 and a spur gear 46 which is carried on the sleeve and connected to

hoist drum drive gear 52 by spur gears 48 and 50. Hoist drum shaft 53 connects drive gear 52 to drum 20 so that the hoist drum is rotatable upon energization of motor 38, the motor being reversible so that hoist drum 20 can be rotated in either a heave or a payout direction to raise or lower the hook as desired. Spur gear 41, which is also connected to and driven from planetary gear system 40, is provided to establish a driving connection to a topping mechanism (not shown).

Shaft 53 extends from both ends of drum 20 and is connected to and drives tag line drums 26 and 28. Each of tag line drum drives are identical and for convenience only one drum drive has been illustrated in detail and will be described. Shaft 53 is connected to a planetary gear system 54 which includes a disk 56 connected to and rotatable with the shaft. Planet gears 58 and 60 are carried by and rotatable with disk 56 and are engaged between gear 62 and an internally toothed sleeve 64. Stub shaft 66 is connected to and rotatable with sleeve 64 and, as will be discussed more fully hereinafter, is connected to and imparts rotary motion to drum 26. Through arrangements such as that just described motor 38 is effective to drive the tag line drums as well as the hoist drum and through suitable design of the gear drive the tag line and hoist drum can be driven at the same speed so as to heave and payout tag line and hoist line at the same speed. Preferably, when motor 38 is de-energized both the tag lines and hoist line are held in position and the load hook can be raised or lowered only by energizing motor 38.

Secondary or stabilizing drives are provided for each tag line drum and include hydraulic motors 68 and 70 connected to planetary gear systems, such as planetary gear system 54, by gear drives 72 and 74. More particularly and with reference to gear drive 74, spur gear 76 is driven by motor 70 and engages spur gear 78. Spur gears 78 and 62 are provided on a common hub 80 which is supported by bearing 82 for rotation relative to shaft 53. When the hydraulic motors are de-activated, spur gear 62 is held against rotation and planet gears 58 and 60 are driven around sun gear 62 to drive sleeve 64 and the tag line drum to payout or heave tag line at the same speed as the hoist line. When the hydraulic motors are activated they are operative to produce differential movement between the hoist drum and tag line drums in order to damp swinging movement of the hook as will be described hereinafter.

A hydraulic system for one of the hydraulic motors is illustrated in FIG. 5. Hydraulic fluid from a reservoir 84 is delivered to motor 70 by pump 86 which is driven by electric motor 88. The flow of fluid to motor 70 is controlled by valve 90 which is in turn controlled by solenoid 92. Solenoid 92 is biased toward a valve closing position by spring 94 and when energized by closure of either switch 91 or 93, which will be discussed more fully hereinafter, operates to open the valve to permit flow to the motor. Hydraulic motors 68 and 70 are so arranged that when activated by the flow of hydraulic fluid the tag line drums are driven in a heave direction. Line 96 returns hydraulic fluid to the reservoir and relief valve 98 is adjustable to control the speed of and/or torque delivered by motor 70. If desired an electrically operated brake can be used with the hydraulic motor to hold it against rotation when the hydraulic motor is de-activated with the brake being released upon activation of the hydraulic pump.

Hydraulic motors 68 and 70 are activated in accordance with swinging movement of the load hook. More particularly, the drive connection to each of the tag line drums is completed by an elongated rod 100 which is carried by stub shaft 66 and connected to tag line drum 26 through spring mechanisms 102 and 104. It will be

appreciated that an identical drive connection is provided for drum **28**. As was stated above, when the hook is in its normal position, i.e. where it is not swinging and assumes a vertical position below sheave **18**, hydraulic motors **68** and **70** are de-activated and the tag line drums are driven only by the hoist drive and the tag lines are heaved and payed out at the same speed as the hoist line. Swinging movement of the hook will increase or decrease the tension on the tag lines to either exert a force in a heave direction or create slack line. In the preferred embodiment of this invention spring mechanisms **102** and **104** establish a direct driving connection between the tag line drums and the hoist motor and also provide for movement of the tag line drums due to swinging movement of the hook so that this movement of the tag line drums can be utilized to control actuation of hydraulic motors **68** and **70**.

More particularly and with reference to FIGS. 3–5, spring mechanism **102** includes spring **106** having a spring force less than the weight of the load hook, preferably less than ½ of the hook weight. Spring mechanism **104** includes spring **108** having a spring force greater than the weight of the load hook. Both springs are tension springs and, when the hook is in its normal position, spring **106** is ineffective and spring **108** establishes a direct driving connection between member **100** and drum **26**. Also as a result of this spring action member **100** is held in a null position, that is intermediate and spaced from switches **91** and **93** which are carried on the drum. A swinging hook will either produce slack line at or tend to heave line from a tag line drum. Assuming a slack tag line condition, the weight of the hook is removed from the line and spring **106** will rotate the drum clockwise engaging switch **91** with member **100**. Switches **91** and **93** are electrically connected (not shown) to collector ring assembly **101** and through that assembly to solenoid **92** so that when switch **91** is closed, solenoid **92** is energized to activate hydraulic motor **70** and increase the speed of rotation of the tag line drum with respect to the hoist drum and heave the slack line. Assuming a condition tending to heave line from the drum, a force will be exerted on the drum tending to rotate it counterclockwise. Spring **108** will resist counterclockwise rotation of the drum thereby imparting a partial damping force to the drum and, when the force on the tag line exceeds that of the spring, the drum will rotate counterclockwise engaging switch **93** with member **100** to activate hydraulic motor **70**. Hydraulic motor **70**, which runs in a heave direction, opposes pay out of the tag line and exerts a damping force on the tag line. Pendulation of the hook will alternately activate the secondary tag line drives to heave slack line and retard tag line pay out as required to effectively damp swinging movement of the load hook. When the load hook has returned to its normal position, member **100** is returned to its null position and the hydraulic motors are de-activated.

It will be appreciated that modifications of the preferred embodiment are possible, however, the arrangement illustrated and described is especially advantageous in that it is extremely sensitive to tag line tension, is simple in construction and is practically immediately responsive to variations in tag line tension. Accordingly, although only one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

What I claim is:

1. Load handling apparatus comprising, in combination, load engaging means, hoist means for raising and lowering said load engaging means, a pair of stabilizing members connected to said load engaging means, means for connecting said stabilizing members to and for driving said stabilizing members from said hoist means simultaneously with said load engaging means, secondary drive means connected to and operative to drive said stabilizing members independently of said hoist means, and means sensing the movement of said stabilizing members and operative to actuate said secondary drive means in accordance with movement of said load engaging means to provide differential movement between said hoist means and said stabilizing members to damp swinging movement of said load engaging means.

2. Load handling apparatus comprising, in combination, load engaging means, hoist means for raising and lowering said load engaging means along a normal vertical path, and means for damping swinging movement of said load engaging means from said normal path, said damping means comprising at least a pair of stabilizing members connected to said load engaging means, means for connecting said stabilizing members to and for driving said stabilizing members from said hoist means, first means operative independently of said hoist means to provide differential movement between said stabilizing means and said hoist means, and second means sensitive to the tension on said stabilizing members and operative to activate said first means to provide said differential movement and damp swinging movement of said load engaging means from said normal position.

3. Load handling apparatus comprising, in combination, load engaging means, hoist means for raising and lowering said load engaging means along a normal vertical path, at least a pair of flexible stabilizing members connected to said load engaging means, and means connected to said stabilizing members normally inoperative when said load engaging means is moving along said normal path and operative to sense swinging movement of said load engaging means from said normal path and in accordance with said swinging movement to exert a force on said stabilizing members in a heave direction to damp swinging movement of said load engaging means from said normal path.

4. Load handling apparatus comprising, in combination, load engaging means, hoist means for raising and lowering said load engaging means along a normal vertical path, at least a pair of flexible stabilizing members connected to said load engaging means, means for driving said stabilizing members independently of said hoist means and normally inoperative when said load engaging means moves along said normal path so that said stabilizing members are driven by said hoist means and movable with said load engaging means, and means sensitive to movement of said stabilizing members and operative when said load engaging means is displaced from said normal path to activate said stabilizing drive means to provide differential movement between said stabilizing members and said hoist means to damp swinging movement of said load engaging means from said normal path.

5. Load handling apparatus comprising, in combination, load engaging means, hoist means for positively driving said load engaging means along a normal vertical path to raise and lower said load engaging means, at least a pair of tag lines connected to said load engaging means and to said hoist means, first means operative when activated to exert a force on each of said tag lines in a heave direction independently of said hoist means, and means sensitive to movement of said tag lines controlling said first means and operative when said load engaging means is displaced from said normal path to activate said first means to provide differential movement between said drive means and said hoist means to damp swinging movement of said load engaging means from said normal path.

6. Load handling apparatus comprising, in combination, load engaging means, hoist means for driving said load engaging means along a normal vertical path, a pair of tag lines connected to said load engaging means, means connecting said tag lines to said hoist means so that said tag lines and said load engaging means are driven simultaneously from said hoist means, damping means operable independently of said hoist means to exert a force on said

tag lines in a heave direction to provide differential movement between said tag lines and said hoist means, said damping means normally inoperative when said load engaging means is in said normal path and sensitive to the movement of said tag lines for actuation in accordance with movement of said tag lines so that upon swinging movement of said load engaging means from said normal path said damping means is activated to oppose tag line payout and heave slack tag line to damp said swinging movement.

7. Load handling apparatus comprising, in combination, load engaging means, a hoist line normally supporting said load engaging means for movement along a normal vertical path, a hoist drive for raising and lowering said load engaging means along said path, a pair of tag lines, a drum for each tag line, means for establishing a driving connection between the tag line drums and the hoist drive and also providing for relative movement therebetween in accordance with an increase or decrease in tag line tension, stabilizing means for each of said drums operative when activated to apply a rotating force to said drums in a heave direction, and means sensitive to and actuated by movement of said tag line drums in accordance with said tag line tension for actuating said stabilizing means to provide differential movement between said hoist line and said tag lines to heave slack tag line and oppose tag line payout.

8. Load handling apparatus comprising, in combination, load engaging means, a hoist line normally supporting said load engaging means for movement along a normal vertical path, a hoist drive for raising and lowering said load engaging means along said path, a pair of tag lines, a drum for each tag line, means for establishing a driving connection between the tag line drums and the hoist drive and also providing for relative movement therebetween in accordance with an increase or decrease in tag line tension, and hydraulic drive means connected to said tag line drums and sensitive to movement of said tag line drums in accordance with variations in tag line tension, said hydraulic means normally inoperative when said load engaging means is moving along said normal path and operative when said load engaging means swings from said normal path to rotate said tag line drums in a heave direction to damp said swinging movement.

9. Load handling apparatus comprising, in combination, load engaging means, hoist means for raising and lowering said load engaging means along a normal vertical path, at least a pair of tag lines connected to said load engaging means, tag line drums for each of said tag lines, stabilizing drive means, means connecting said tag line drums to said hoist means and said stabilizing drive means so that said tag line drums are connected for movement with said hoist means and for movement with respect to said hoist means in response to swinging movement of said load engaging means for said path, said stabilizing drive means normally inoperative when said load engaging means is in said normal path and operative when activated to drive said tag line drums in a heave direction independently of said hoist drive, and means sensing the movement of said tag line drums and operative upon occurrence of movement of said tag line drums in response to swinging movement of said load engaging means to activate said stabilizing drive means to provide differential movement between said tag line drums and said hoist means to heave slack tag line and oppose tag line payout.

10. Load handling apparatus comprising, in combination, load engaging means, hoist means for raising and lowering said load engaging means along a normal vertical path, at least a pair of tag lines connected to said load engaging means, a drum for each of said tag lines, stabilizing drive means for each of said tag line drums and operative when energized to drive said tag line drums in a heave direction, means connecting said tag line drums to said hoist means and said stabilizing drive means so that said tag lines are connected for simultaneous movement with and differential movement with respect to said hoist means, said connecting means including means for establishing a direct driving connection to said tag line drums when said load engaging means is moving along said normal path and providing for movement of said tag line drums in accordance with said swinging movement of said load engaging means, and means sensitive to the movement of said tag line drums and operative to activate said stabilizing drive means in accordance with movement of said tag line drums due to said swinging movement to provide said differential movement for heaving slack tag line and opposing payout of tag line to damp said swinging movement.

11. Load handling apparatus comprising, in combination, load engaging means, a hoist line normally supporting said load engaging means for movement along a normal vertical path, a hoist drive connected to said hoist line for raising and lowering said load engaging means along said path, a pair of tag lines connected to said load engaging means, a drum for each tag line, stabilizing drive means for each of said drums operative when activated to drive said drums in a heave direction, motion transmitting means connecting said tag line drums to said hoist drive and said stabilizing drive means and operative to establish a direct driving connection between said tag line drums and hoist drive when said load engaging means is moving along said normal path and connecting each of said tag line drums for movement in response to slack tag line and increased tag line tension, and control means associated with each of said tag line drums to sense movement thereof due to said swinging movement and operative in accordance with said swinging movement to activate said stabilizing drive means to provide differential movement between said hoist line and said tag lines to heave slack tag line and oppose tag line payout.

12. Load handling apparatus comprising, in combination, load engaging means, a hoist line normally supporting said load engaging means for movement along a normal vertical path, a hoist drive connected to said load engaging means for raising and lowering said load engaging means along said normal path, a pair of tag lines connected to said load engaging means, a drum for each of said tag lines, stabilizing drive means for each of said tag line drums and operative when energized to drive said drums in a heave direction, means connecting said hoist drive and stabilizing drive means to said tag line drums and including a pair of spring means connected to each of said tag line drums, the strength of one of said springs of each pair being less than one-half the weight of said load engaging means and arranged to bias its respective tag line drum in one direction and the strength of the other of said springs of each pair being greater than the weight of said load engaging means and arranged to oppose motion of its respective tag line drum in an opposite direction so that said tag line drums are movable with said hoist drive and are movable with respect to said hoist drive in response to swinging movement of said load engaging means, a pair of switch means connected to and controlling actuation of each of said stabilizing drive means, and means normally spaced from and mounted for relative movement with said switch means in accordance with movement of said tag line drums in response to said swinging movement to activate said stabilizing drive means and provide differential movement between said hoist line and tag lines to heave slack tag line and oppose tag line payout to damp swinging movement of said load engaging means.

13. The combination of claim 11 wherein said stabilizing drive means comprise hydraulic motors.

References Cited in the file of this patent

UNITED STATES PATENTS

3,065,862 Patterson ---------- Nov. 27, 1962