A ton mileage recorder for integrating work to which the wire rope and related apparatus of the draw works of a drilling rig is subjected. A travel sensor in the form of a hydraulic pump which is actuated by the traveling wire rope provides power fluid which drives a hydraulic motor. A weight sensor actuates a cam which is in turn controls fluid flow from the motor. The motor drives a gear box which in turn is connected to an odometer having indicia thereon in the usual manner. Hence the weight sensor cooperates with the travel sensor by means of the cam which is associated with the pump to thereby integrate the distance which the wire rope travels while being subjected to a finite weight.

BACKGROUND OF THE INVENTION

In the material handling field, wire rope is generally rove between pulleys, blocks, and the like, so as to enable work to be performed such as in the hoisting of elevators, and especially in the oil industry for lifting string of drill pipe and the like within an oil well derrick or rig. When any flexible elongated member is utilized for hoisting, it is usually desirable to be able to predict the loss of tensile strength of the rope as it performs work so as to enable the replacement of the rope prior to its tensile strength being exceeded by the potential load to which it is subjected. This especially is so in the art of drilling bore holes where the wire rope is utilized for hoisting expensive drill strings and the like into and out of the bore hole. Parting of wire rope in an oil field derrick is a catastrophe and often results in the loss of thousands of feet of valuable tubular products and the like.

SUMMARY OF THE INVENTION

A ton mileage recorder determines the work performed by a wire rope and includes a travel sensor associated with the fast line of a wire rope and a weight sensor associated with the dead line of the same wire rope. The travel sensor actuates a hydraulic pump having a cam means associated therewith for governing or throttling the volume of fluid flow therefrom. The weight sensor actuates the cam means which in turn adjusts the means for throttling the fluid flow from the pump. Fluid flow from the pump therefore represents an integrated signal which is proportional to both the travel of the wire rope as well as the weight which the rope supports while traveling. The flow of the hydraulic fluid from the pump is utilized to drive a hydraulic motor-driven gear box which in turn positively actuates the recorder. The recorder may be in the form of a simple odometer.

Accordingly, a primary object of the present invention is the provision of a means for measuring the ton mileage to which a wire rope is subjected over an interval of time.

Another object of the present invention is to enable the simple determination of the work history of a wire rope.

Another object of the present invention is to provide a hydraulic pressure source which is proportional to both the distance traveled and the weight which a wire rope undergoes.

A still further object of the present invention is to provide a cam actuated throttle associated with a hydraulic pump which provides a hydraulic flow of fluid to a hydraulic motor actuated recorder wherein the recorder stores data indicative of the work history of the wire rope.

The above objects are attained in accordance with the present invention by the provision of a combination of elements which are fabricated essentially as outlined in the above abstract.

These and other objects of the present invention will become evident to those skilled in the art upon digesting the remainder of the instant disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematical representation of a wire line as it may be associated with the derrick of a drilling rig; FIG. 2 is an enlarged fragmentary representation of a portion of the apparatus seen in FIG. 1, with some parts being shown in cross-section;

FIG. 3 is an enlarged view of a modification of part of the device seen in FIG. 1;

FIG. 3A is a top plan view of the device seen in FIG. 3;

FIG. 4 is still another modification of part of the apparatus seen in the foregoing figures; and

FIG. 5 is still another modification of part of the device seen in FIG. 1.

DETAILED DESCRIPTION OF THE DRAWINGS

Looking to the details of FIG. 1, there is seen schematically illustrated an apparatus such as the draw works which may be associated with a drilling rig. Numeral 10 indicates a dead line having a weight sensor 12 attached thereto and a fast line 14 at the other extremity thereof. The arrow at numeral 16 indicates a hydraulic motor driven apparatus for actuating a recorder 18. The fast line has a travel sensor associated therewith which is disposed in close proximity to the draw works drum 22.

A wire rope 24 is rove between pulleys 26 which are supported from the upper extremity of the derrick in the usual manner as seen at 28. A traveling block 30 is supported from the wire rope with one extremity of the wire rope representing a dead line since it is anchored to the derrick floor at 32 with the other extremity of the wire rope being wound about the draw wor's drum, with the drum being rotated by means of power input shaft 34.

The travel sensor 36 is suitably attached to a portion of the derrick 38 and includes spaced apart pulleys 40, 42, 44 which maintain the rope bearing thereagainst in a manner to slightly bow the rope as seen at 48, so as to enable drive shaft 50, 50' to be actuated by pulley 40, which in turn rotatably actuates shaft 52 of hydraulic pump 54. Hydraulic pump 54 is a variable volume non-directional design which includes inlet and outlet 56, 58, respectively, and reservoir 60. Outlet 56 of the pump is fluid connected to a hydraulic motor 62 which in turn includes coupling 64 which drives gear box 66 to thereby rotate shaft 68. The last named shaft is rotatably connected to shaft 70 of an ordinary odometer 72. The odometer is suitably mounted to any convenient plate-like structure such as seen at 74. Recorders other than an odometer can be used while remaining within the scope of the present invention.

The weight sensor 12 is conventional in design and is connected to cylinder 88 having piston 89 reciprocatingly received therein. Trunnion 90 receives cam 91 in journaled relationship therewith and piston rod 92 actuates the cam in accordance with the position of the piston. The position of the piston is a measure of the tension of the wire rope. Throttling means in the form of pivotal plate member 93 and fluid control means 94 provides
a means for controlling the amount of fluid moved by the pump. The weight sensor 12 is of conventional design and includes a body member 76 having diaphragm member 78 at one face thereof which carries rope contacting member 80 thereon. The sensor is affixed to brackets 82 and is provided with fitting 84 which accommodates fluid conduit 86 to thereby flow connect cylinder 88 with the weight sensor. Long now to the details of the modification of FIG. 3, wherein there is disclosed a plate member 136 which is fabricated from a resilient metallic member and suitably contoured as seen at 135, 137 and is provided with cut-outs defined by edge portions 147, 148, 149 to form the illustrated depending leg members 135, 137 which sustain the illustrated strain gauge. A wire rope 124 engages the pulleys as illustrated. Pulley 140 is journaled in any suitable manner as indicated at 141; pulley 142 is journaled at 143; and pulley 144 is journaled at 145. The illustrated strain gauge includes a means for measuring the distance between each depending leg and may be attached to each leg member in a manner as shown at 112 and 182. Edge portions 147, 148 are free to move apart from one another in accordance with the tension exerted upon wire rope 124. It will be understood by those skilled in the art that the device of FIGS. 3 and 3A may be substituted for FIGS. 11 and 12 of FIG. 1. Referring now to FIG. 4 it will be observed that a wire rope travel sensor 20 receives wire rope 24 thereon, with the wire rope engaging pulleys 40, 42, 44 in a manner similar to that seen in FIG. 1. Centralized pulley 44 has shaft 150 which drives engaging hydraulic pump 154 to thereby produce a fluid pressure for actuating the mechanism illustrated by the arrow at numeral 16 of FIG. 1. Pressure from the weight sensor is received by conduit 186 to thereby position the piston within cylinder 188 in proportion to the weight imposed upon the wire line. Cam 191 is journaled to the piston by means of rod 192 with the face of the cam operatively engaging a spring loaded throttling member 194.

FIG. 5 illustrates a simplified modification of the foregoing integrator wherein the weight sensor piston rod 292 actuates the cam which is journaled within trunnion 290 with the end 291 of the cam bearing against linkage 290 to thereby position bypass valve 294 which is flow connected between the inlet and outlet conduits of hydraulic pump 254. Shaft 40' rotatably drives the hydraulic motor 254 in proportion to the rate of travel of the fast line.

OPERATION

In operation, the wire rope 24 is attached to the draw works drum and rope between the three pulleys of the travel sensor 36, between the crown block and the traveling block, to which the depending end which forms the dead line is fastened to anchor means at 32. In actual practice, the depending end, or dead line, is not cut where it is fastened at 32, but instead continues on to a spool or roll of wire line whereupon a predetermined amount of unused line can periodically be added to the dead line with the excess being taken up on the draw works drum. The amount of line which is added to the system as well as the time interval between addition of new line to the hoisting mechanism is determined by both the configuration of the hoisting system as well as the work which the line has performed.

The work to which the wire line 24 has been subjected is determined by the recorder 18 which integrates the distance which the wire rope has traveled as well as the weight or tension to which the line has been subjected during this travel. The weight to which the line has been subjected is determined by the weight sensor 12 which hydraulically actuates a throttling device associated with hydraulic pump 54. The amount of travel which the wire line undergoes is measured by the travel sensor 36 which operates hydraulic pump 54 in direct proportion to the rate of travel of the wire line. Fluid flow from the hydraulic pump is therefore an integration of the weight as well as the distance traveled by the wire line while subject to the weight. The fluid flow is utilized by the hydraulic motor to rotate the gear box which in turn actuates the recorder means.

The pump may be of any design so long as it is non-directional and provides a controllable variable volume with the fluid flow from the pump being in the same direction regardless of the direction of rotation of the shaft. This action enables the odometer to be actuated in the proper direction regardless of the direction of rotation of the pump. One known type pump of this design 52 engages rotary cylinders having a piston therein which is actuated by a wobble plate with the wobble plate being positioned against control member 94.

The weight sensor 12 can be fabricated as illustrated above or may be obtained from several different sources, such as the fluid diaphragm weight sensor marketed by the Martin Decker Corporation.

Looking more specifically to the operation of the embodiment of FIGS. 1 and 2, it will now be understood by those skilled in the art that rotation of drawworks shaft 34 winds and unwinds wire rope 24 therein so as to thereby cause traveling block 30 to travel in a vertical direction. Since the travel sensor is attached to the derrick with the wire rope engaging journalled pulleys 40, 42, 44, and with pulley 40 driving the hydraulic pump 54, the maximum output of the motor is directly proportional to the speed with which the wire rope travels across pulley drum 40. Hydraulic fluid flows from the pump through conduit 56 into hydraulic motor 62 whereupon hydraulic fluid is returned to reservoir 60. The hydraulic fluid which is returned to reservoir ultimately flows back to the pump by means of inlet conduit 58. Fluid flow is determined by the throttling mechanism comprised of pivotal plate member 93 and control member 94. Movement of control member 94 in one direction increases the output of the motor while movement in the opposite direction decreases the output of the motor to thereby throttle or control the total output of the motor in accordance with the position of cam 91 against plate 93. The configuration or curvature of the cam determines the effect of weight at 30 upon the system.

Cam 91 is actuated in accordance with the pressure imposed upon weight sensor 12. The magnitude with which the movable member of the nonlinear hydraulic diaphragm is imposed against the dead line determines the fluid pressure within conduit 86 which is proportional to the tension on the dead line. Piston 89 is therefore positioned within cylinder 88 in accordance with the pressure before mentioned conduit 86. The piston is reciprocatingly received within the cylinder and connected to the cam by means of piston rod 92. Accordingly, increase in pressure moves piston 89 in a direction which causes an increase in the fluid flow through the variable volume pump.

Since the recorder main drive is comprised of a motor driven gear box having a shaft associated therewith connected to the recorder 72, it follows that the total number or revolutions of shaft 68, 70 can be recorded as stored data with the indica of the odrometer being a measure of the tons miles to which the wire rope has been subjected.

In the modification of FIGS. 3 and 3A a bifurcated plate member 136 includes means forming a cut-out which is defined by numerals 147, 148, 149 to thereby provide the resilient plate member with depending leg members 135 and 137. The leg members are forced further apart from another one in accordance with the tension imposed upon fast line 124. Journalled pulleys 142, 144 are driven by a shaft member, while pulley 140 is journaled to pin 141 which in turn is attached to 139 to the plate member in a manner to permit vertical movement thereof to thereby
allow for movement between legs 135, 137. A sensor is suitably attached at 112, 182 in a manner to measure the distance between the fast line sides 147, 148 of the depending legs of the plate member. The sensor includes any means for moving the cam in proportion to the distance which the legs are sprung apart. Accordingly, the last named member functions in a manner to replace weight sensor 12 of FIG. 1. Where the plate member 136 is located on the fast line side, it is in proximity of the travel sensor of FIG. 1, pulley 140 will rotate in proportion to the rate of travel of fast line 124 to thereby enable the device illustrated in FIGS. 3 and 3A to replace both the weight sensor and the traveling sensor of FIG. 1.

FIG. 4 illustrates one embodiment of the invention wherein the hydraulic pump 154 is directly journaled to the fast line pulley. Where deemed desirable, the bifurcated plate can form one or both of the vertically disposed walls to which the pulleys 40, 42, 44 are journalled. FIG. 5 is a simplified embodiment of the foregoing figures which illustrates the manner in which the cam can be used to directly actuate a bypass valve 294. This configuration permits a conventional hydraulic pump to be utilized in driving the pump motor of reduction gear box.

While we have illustrated and described a preferred embodiment of our invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. We therefore do not wish to be limited to the precise details set forth but desire to avail ourselves of such changes as fall within the purview of our invention.

What we claim is:

1. Apparatus for measuring the ton mileage which a wire rope or the like is subjected to, comprising, in combination:
   a. A ton mileage recorder means, a reduction gear assembly, a hydraulic motor, a non-directional pump means for producing fluid flow and having means for controlling the flow therefrom, means for measuring the tension of the rope, and rotatable means for measuring the travel of the rope;
   b. Means for measuring the tension including means by which said pump means is actuated in proportion to the rate of travel of the rope;
   c. Means for measuring the tension of the rope; and
   d. Said ton mileage recorder means being connected to and actuated by said reduction gear assembly to thereby accumulate the work history of the rope.

2. The combination of claim 1 wherein said ton mileage recorder is an odometer:
   a. Said means for measuring the tension includes a hydraulic diaphragm adapted to bear against the rope, said diaphragm having a fluid therein, said diaphragm being a pressure acting upon the fluid contained therein which is proportional to the tension in the rope;
   b. A cam means being actuated by said fluid pressure associated with said diaphragm;
   c. Said cam being operatively positioned with respect to said means for controlling the flow; whereby:
   d. Movement in the cam in one direction permits a large flow while movement in another direction permits a small flow from said pump means.

3. The combination of claim 1 wherein said means for measuring tension includes two spaced apart pulleys and a bifurcated plate; said bifurcated plate having depending leg members; each said pulley being mounted on each said leg; a strain gauge for measuring the strain placed upon each leg of said bifurcated plate; with said strain gauge having means for actuating the means for controlling the flow.

4. The combination of claim 1 wherein said means for measuring tension includes a plate member; a pulley for driving said pump means mounted upon said plate member;
   a. Said means for measuring travel including said pulley which is rotatably placed adjacent the rope whereby movement of the rope causes said pulley to rotate to thereby enable the recited function of actuating said pump means.

5. The combination of claim 1 wherein said means for controlling the flow includes a shaft which is movable from a flow permitting to a flow preventing position;
   a. A cam means for positioning said shaft;
   b. Said means for measuring the tension including means for moving said cam.

6. The combination of claim 5 wherein said means for measuring the tension actuates a piston, said piston having a shaft connected to said cam whereby reciprocation of said piston positions said cam in accordance with the fluid pressure imposed upon said piston.

7. The combination of claim 1 wherein said means for measuring tension is a bifurcated plate having spaced apart leg members; a strain gauge for measuring the strain placed between the leg members of said bifurcated plate; and said strain gauge actuating the means for controlling the flow;
   a. Said means for measuring tension being mounted upon a portion of said plate;
   b. Said means for measuring travel including a pulley rotatably attached to said plate and placed adjacent the rope whereby movement of the rope causes said pulley to rotate to thereby enable the recited function of actuating said pump means.

8. The combination of claim 1 wherein said means for measuring tension is mounted upon a single plate member;
   a. Said means for measuring travel including a pulley rotatably attached to said plate member and placed adjacent the rope whereby movement of the rope causes said pulley to rotate to thereby enable the recited function of actuating said pump means;
   b. Said means for controlling the flow includes a shaft which is movable from a flow permitting to a flow preventing position;
   c. A cam means for positioning said shaft;
   d. Said means for measuring the tension including spaced apart legs formed in said plate and a strain gauge for measuring the relative position of said legs with respect to each other, said strain gauge forming a means for moving said cam.

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