

PATENT SPECIFICATION

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(54) ULLAGE MEASURING DEVICE

(71) We, MARINE MOISTURE CONTROL COMPANY, INC., a corporation of the State of New York, having its principal place of business at 449 Sheridan Blvd., Inwood, New York 11696, one of the United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to an ullage measuring device.

The term "ullage" is used to specify the measurement between the top of a cargo tank and the surface of a liquid in the tank. Specifically, the term "ullage" designates the amount of liquid which is missing from a tank in order to fill the tank completely.

More specifically, the invention is concerned with a device for measuring the ullage of tanks, which contain petroleum or other hazardous fluid substances in the liquid state, e.g., storage tanks of oil cargo ships or other fluid transporting vessels. The ullage device may be portable and hand carried and/or motorized.

Heretofore, in order to measure ullage, a coated tape measure with a bob at the end was lowered to the surface of the liquid and the distance between the top of the tank and the surface of the liquid was read on the tape. If volume is desired, tables were provided to convert the vertical measurement to its volumetric measurement using a specific calibration table for a specific tank. Ullage measurement is a necessity in the handling of liquid products, both aboard a tank ship and shoreside. The large size of today's tanks, plus the expensive costs of the liquids, demand accuracy never before required for custody transfer and inventory purposes. A 1/8" error in a large tank can cost thousands of dollars. Remote and automatic tank gauging systems cannot be used as they all have errors. In fact, they are brought into "best" calibration using the portable ullage device and tape according to the invention. The accuracy of this process depends on establishing with accuracy the positions of the top of the tank and the surface of the liquid below the top of the tank. The top of the tank is not difficult to locate, but the surface of the liquid is.

A few unsatisfactory methods have been used heretofore to ascertain the surface of the liquid. One such method is the visual sighting through a small opening in the tank hatch. In general, it is quite difficult to see the bob at the end of the tape since the bob could be 80 feet below the opening and be in the dark in the tank. Moreover, the user or operator of the tape (called herein the "gauger") is exposed to vapors or noxious fumes in the tank. Another method which has been used is to coat the end of the tape with chalk over a six-foot length, the tape is then lowered into the tank below the liquid surface and then the tape is withdrawn; after the tape is withdrawn, the wet length on the tape is subtracted from the tape length noted at the top of the opening. This process measures one tank. As is well-known, an oil tanker has a minimum of twenty tanks, and one can readily appreciate that this is a dirty, time-consuming and error-prone problem particularly on a crude oil tanker. Another method is the use of a conductivity cell attached to the end of a tape; this method cannot be used with liquids that are non-conductive.

At present, there is a new trend on ships to operate the vessel with all the cargo tanks filled with inert gas as a protection against explosion. This means that all the tanks are sealed tight and pressurized to one-half pound per square inch. The gauging of a tank in this condition is impossible with the existing gauging tapes. The instant an ullage hatch is opened, the flow of inert gas from the inside of the tank to the atmosphere at a very high velocity can endanger the individual or gauger taking the measurement. This high flow rate

9

can continue for fifteen minutes and perhaps indefinitely, if the inert gas system furnishing gas to the tanks is in operation. Accordingly, for the transfer of cargo from one owner to another, the only accepted method useful for determining exact quantities is to hand-gauge the tanks.

5 The opening of the ullage hatch is usually about six inches in diameter, and if the gauger uses the prior art gauging devices, he must stand over the ullage hatch. This is fraught with danger due to the possibility of the gaseous fumes hitting his face, thereby causing a loss of oxygen and asphyxia. 5

10 In accordance with the invention, a portable ullage measuring device is provided for the measurement of a liquid medium while affording protection to the gauger and avoiding the deleterious effects of the noxious fumes emanating from the ullage hatch, and includes a liquid responsive device for producing an output signal when it is placed in contact with the liquid medium, a tape reel mechanism adapted to support a tape reel assembly which includes measuring indicia to measure the ullage of a tank above and away from the ullage hatch while supporting the liquid responsive device inside the tank to take the ullage measurement, an alarm indication mechanism associated with the tape reel mechanism to produce an alarm indication in response to an output signal from the fluid response device, and means coupled with the tape reel mechanism to control the amount of payout of the tape assembly for stopping the payout thereof when the liquid responsive device is activated by contact with the liquid medium. 10 15 20

20 Preferably the device includes a tape assembly of the type claimed in our co-pending Patent Application No. 7929362 (Serial No. 1578608) which includes a pair of electrically conductive wires and a metallic tape which is used as an internal ground for the device and which is provided with marking for measuring indicia thereon, all enclosed within a jacket of a clear inert liquid-impervious material. Preferably, the tape reel mechanism is adapted to be hand-held and includes a battery to energise the liquid-responsive device; the alarm, which is preferably audible (but which may be any other type of indicating mechanism) is also housed within the tape reel mechanism, together with a switch which is provided to shut off the alarm after the liquid responsive device in a bob makes contact with the liquid. 25 30 A visual reading may be made of tape after the payout of tape is stopped. 30

30 With the present invention, it is not necessary for the gauger to look directly into the ullage hatch opening, and he can thereby avoid any injury as a result of gas spewing up into his face or being asphyxiated as a result of the noxious fumes from a product such as an oil or petroleum product. Hence, an important aspect of this invention is the ability to ascertain and to determine where the surface of a liquid is without visual sighting or inspection. 35

35 An ultrasonic probe of the type which may be used as part of the liquid responsive device in the invention and may form part of the bob disclosed in U.S. Patent No. 3,520,186. This patent discloses the use of pair of piezo-electric transducer crystals adapted to be fixed to the opposite sides of a container. Liquid gas passes through the air space between the two piezo-electric crystals, one of which is the transmitting transducer and is adapted to transmit ultrasonic energy, the signal being picked upon by the other (receiving) transducer. This patent also discloses that the spaced transducers can be suspended in the liquid or gas within the container, but there is no indication that the probe can be used for the measurement of ullage, or that a tape mechanism can be used in conjunction with the same to transmit electrical energy to the transducers and to return a signal from the transducers. 40 45

45 The tape assembly preferably includes a plastic coated measuring metallic tape which together with a pair of conductors is enclosed within a transparent plastic jacket such as of polytetrafluoroethylene (such as is sold under the Registered Trade Mark "Teflon"). In addition, a pair of electrically conductive wires may also be enclosed within the jacket but insulated from the metallic tape, which serves as an internal ground, so as to provide the suitable connection between the electronic components in the bob and the energization means and the alarm indication device on the tape reel mechanism. 50

50 The tape assembly may alternatively have an outer protective covering of electrically insulating material which is knurled or dimpled so as to provide for a metallic tape an irregular surface cover, which is especially useful in situations where there is a large build up-of static charge, because the charge leaks through and is dissipated by the metallic tape inside the dimpled insulating cover. 55

55 In order that the invention may be more clearly understood and readily carried into effect it will be described more fully with reference to the accompanying drawings, in which: 60

60 *Figure 1* illustrates one embodiment of portable hand-held ullage measuring device with the bob thereof in the fluid of a tank in which the ullage thereof is to be measured;

Figure 2 is a plan view looking down from the top of *Figure 1*;

Figure 3 is a section taken on line 3-3 of *Figure 2*;

65 *Figure 4* is a view of one embodiment of a tape assembly for use with the portable 65

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hand-held ullage device;

Figure 5 is a section taken on line 5-5 of Figure 4;

Figure 6 is a sectional view similar to Figure 5, but showing a modification of the tape assembly of Figure 4;

5 Figure 7 is a view of another modification of the tape assembly according to the invention;

Figure 8 is a section taken along line 8-8 of Figure 7;

Figure 9 is a sectional view of another modification of the tape assembly of Figure 7;

10 Figure 10 is a schematic representation of the circuit elements and electrical components of the ullage device; and

Figure 11 is a schematic representation of a cargo tanker of the type with a double bottom and illustrating "sounding" pipes through which cargo content readings may be taken with the hand-held ullage device according to the invention.

15 Referring to Figure 1 of the drawings, a tank 10 having an ullage to be measured is shown with the top of the tank at A and a liquid level, to be measured, at point B. The ullage U is the difference between the levels A and B, and it is this difference which is to be measured in order to ascertain the quantity of liquid which is missing from the tank 10. The portable ullage measuring device 12, which may be hand-held as illustrated, includes a handle 14 connected with housing 16 for supporting a tape reel mechanism 18. The handle 14 is held in one hand 15 of the gauger to support the ullage device 12. The tape reel mechanism 18 carries the tape assembly 20, which supports and carries a liquid responsive device 22.

20 The tank 10 may be any type of tank containing a liquid whose quantity is to be measured. And, more specifically, tank 10 may also be the type which is part of a cargo tanker for the transport of oil or other fluid or liquid commodity. The tank 10 may also be of the type shown in Figure 11 and form part of a cargo tanker 24 provided with a double bottom tank having separate compartments 26, 28 and 30 at a lower level of the tanker. While only three compartments have been shown in Figure 11, the cargo tanker 24 may suitably contain many separate compartments such as 26, 28 and 30. In order to take a reading of the quantity of liquid material in each compartment a "sounding" pipe, such as 32 which goes to compartment 26, and 34 which goes to compartment 28 is shown. It is to be understood that each compartment is provided with its own individual "sounding" pipe through which an ullage reading is to be taken, even though no "sounding" pipe is shown for compartment 30.

35 As will be explained further hereinafter, the reading is taken by a "gauger" who stands on the deck 36 with the hand-held ullage device 12 (not shown in Figure 10) and takes the reading. The edge 38 at the opening of the "sounding" pipe provides the reference point at which the reading is taken.

Referring now more particularly to Figure 2, in order to control the amount of payout of the tape assembly 20, means are provided which include another handle 40 rotatably coupled at 42 to a slide crank 44 for rotating tape reel mechanism 18, which is carrying tape assembly 20. The slide crank 44 includes a stop pin 46 adapted to engage a reel indexing mechanism 48.

45 The liquid-responsive device 22 includes (see Figure 1) a sonic energy piezoelectric transmitting crystal 50 and a sonic energy receiving crystal 52 positioned within a casing 54 which is provided with an air gap 56. Coupled to the crystal casing 54 is a casing 58 to hold the electronic circuitry, shown in Figure 10, generally designated as 60, which includes the means to energize the transmitting crystal 50 with sonic energy which is adapted to be transmitted past the air gap 56 only through a liquid medium and to be received by the receiving crystal 52. The electronic circuitry 60 also includes detection means and amplification means to detect the signal received from the receiving crystal 52, as will be explained further in connection with Figure 10. The mechanism 18 includes a hub 62 which is carried on a shaft 64 and forms a housing having a cover 89 which includes compartments in order to contain (see Figure 2) provisions for batteries 66, a horn alarm 68, and the electrical components for an on-off switch 70 which includes its toggle or pushbutton outside the compartment and the electrical connection elements inside the compartment.

55 The slide crank 44 includes a transverse slot 72 (see Figure 3) so as to permit the slide crank 44 to slide along shaft 64 to engage the stop pin or lug 46 with one of the peripherally spaced slots 74 provided on the periphery of the toothed sprocket device 76 of the tape reel mechanism 18, to lock the tape reel mechanism 18 against rotation. The tape reel mechanism 18 includes a reel 78 onto which tape assembly 20 may be wound or unwound and locked against payout by means of stop pin 46 and one of the stop slots 74, so as to facilitate the taking of the reading.

60 The tape reel mechanism 18 includes the hub 62 which carries reel 78 and includes a grounding screw 82 to electrically ground tape assembly 20 to the housing, and if desired, an external ground clip 88 with an extension coil from grounding screw 82 may be provided to

(11)

ground the ullage device 12 to cargo tanker 24. A washer or guide 86 is provided to guide and to control the movement of slide crank 44 on shaft 64. The shaft 64 is shown as having a square cross-section to permit slide crank 44 to slide along the shaft 64 and together with the washer 86 to guide the movement of the crank 44.

5 The tape assembly 20 includes a plastic jacket 90 which is impervious to the liquid in the tank 10 or compartments 26, 28, 30 and which encloses conductors 92 and 94 as well as a metallic tape 96 having measuring indicia thereon as seen in Figures 4 and 7. The conductors 92 and 94 are shown as positioned on opposite sides of the tape 96 in Figure 5 and next to each other in Figure 6.

10 The plastic jacket 90 is made to be impervious to the liquid under measurement, and preferably is oil-impervious when the tape assembly is used to measure oil ullage. The metallic tape 96 has one end 98 connected with grounding screw 82, and the tape forms the ground connection for the electrical circuit connecting conductors 92, 94 with the electronic circuitry 60.

15 In the Figures 4 to 6 embodiments of the tape assembly 20 (which is claimed in our copending application No. 7929362) (Serial No. 1578608), outer surfaces 100, 102 are shown generally flat and smooth with a uniform cross-section transverse to the longitudinal direction or run of the metallic tape 96. This configuration is generally satisfactory for most contemplated uses of the ullage device.

20 In some instance, electrical charge may build up along the outer surfaces of the tape assembly 20, and in order to avoid such charge build-up and to remove the same, a modified tape assembly 20' (as shown in Figures 7 to 9) is provided in which the outer surfaces 100' and 102' are dimpled or knurled as at 104 to provide a narrower cross-section of the jacket 90'. The narrowed longitudinal cross-section as shown at 106 permits the charge to leak through the plastic jacket 90' to the metallic tape and is dissipated thereby. When the device 12 is connected to an external ground, such ground assists in the dissipation of the electrical charge.

30 The embodiments of the tape assembly 20' shown in Figures 7 and 8 are generally similar to the Figures 4 and 5 embodiment with conductors 92 and 94 positioned on opposite sides of metallic tape 96, and the Figure 9 embodiment is generally similar to the Figure 5 embodiment, except that the outer jacket 90' is periodically undercut to provide the dimpling or knurling effect. While not specifically shown, it will be evident that it is possible to achieve almost the same results of eliminating electrical charge build-up by dimpling or knurling only one surface 100 or 102 of the outer jacket 90.

35 The embodiments of Figures 4, 5 and 7, 8 with conductors 92, 94 positioned on opposite sides of the metallic tape 96 may be more advantageous where a capacitative effect occurs as a result of the placement of the conductors 92, 94 on the same side of the tape 96. In some instances, where conductors 92 and 94 are placed on opposite sides of the tape 96, the center portion of the jacket 90 between the conductors may also be made of reduced cross-section, but uniform throughout. This will also serve to assist in the prevention of charge build-up by leaking the charge through the jacket to the tape for dissipation thereby. Moreover, the positioning of the conductors 92, 94 on opposite sides of the tape 96 aids in the maintenance of the tape assembly by imparting some rigidity thereto while maintaining the necessary flexibility to allow the tape assembly to be coiled onto the reel 78. The conductors 92, 94 and the tape 96 form a composite unit.

45 The tape 96 could alternatively be made of non-conductive material such as fibreglass or a fabric (instead of metal) in which case it will be necessary to provide a third wire within the tape as a grounding wire.

50 The circuitry 60 associated with the piezoelectric transmitting and receiving crystals 50 and 52 is depicted in its preferred form in Figure 10, wherein the transmitting amplifier section 110, which includes transistor amplifier 112 and its associated circuitry, is connected by means of one of the conductive wires 92 to switch 70 and battery 66, the common ground being supplied by tape 96, which is connected to ground at 98. The battery 66, which consists of preferably two "AA" cells e.g. of zinc-carbon or alkaline type, to provide three volts D.C., is applied across transistor amplifier 112 to energize the piezo-electric transmitting crystal 50 for the transmission of sonic energy. The transmitting amplifier section is only rendered operative when the switch 70 is closed to energize the crystal 50 to cause it to oscillate and to transmit sonic energy.

60 The piezo-electric crystal 52 is connected in circuit with a detector section 114 which includes transistor 116. The detector section 114 is only rendered operative to receive a signal from crystal 52 when the switch 70 is closed to connect the transistor 116 also with a minus three volts D.C. The crystal 52 is rendered operative to cause the detector section 114 to transmit a signal when the air gap 56 between the crystals 50 and 52 is filled with a liquid through which sonic energy is transmitted. The amplifier section 118 includes a transistor amplifier 120 which is coupled to the output of detector section 114 for amplifying

(12)

the signal detected by the transistor 116 and applying it to the horn 68 through conductor 94. The horn 68 is connected across conductors 92 and 94 and is rendered operative solely when there is a signal transmitted through the conductor 94 when the conductor 94 has a voltage which is positive with respect to the three volts D.C. on conductor 92. The horn 68 suitably transmits a 3500 Hz signal. The transistors used in the circuit 60 are preferably high voltage transistors for safety purposes, with the resistors used being 1/4 watt $\pm 5\%$ and designed to withstand 500 VAC insulation test.

While a preferred circuit has been shown, other circuits may also be used provided that conductors 92 and 94 electrically connect the transmit and the receive sections so as to energize the circuits to provide the energy for the transmit crystal 50 to transmit sonic energy to the receive crystal 52 and in turn for the electronic circuitry 60 to detect the sonic signal received by the receive crystal 52 and to amplify the same for transmission to the horn alarm 68 to activate the same. The tape 96 and conductors 92 and 94 are electrically connected to the appropriate elements inside the housing or hub 62.

In operation, the reel slide crank 44 is utilized by the operator to raise or lower the probe 22 which is attached to the tape. The teeth 74 on sprocket 76 cooperate with the stop pin 46 to prevent the reel 78 from rotating, and the crank 44 effectively locks the reel 78 to prevent payout of the tape assembly; the shaft 64, which is square instead of being round, permits the crank 44 to be guided by slot 72.

When the switch 70 is closed, e.g. manually by the operator, energy is fed from the batteries 66 to the electronic circuit 60, which causes the transmit crystal 50 to vibrate at its natural frequency, thereby sending a sonic signal through the air gap 56. Only when the air gap 56 is immersed in liquid to an extent that the lower face of the crystal 50 is wetted does this sonic transmission cause the horn alarm 68 to sound. When the gap 56 between the crystals is filled with air, there is very poor sonic transmission, as a result of which the horn alarm 68 does not operate or sound. The liquid-responsive device 22 is thus lowered into a tank until the horn alarm 68 is sounded, at which time, to confirm the measurement, it is lifted slightly until the horn is silent. As a result of this motion, the surface level of the liquid is established, and this is at point B (as shown in Figure 1).

Now, it remains for the operator to read the indicia on the tape which provides a direct indication of the amount of liquid missing between level B and level A. The tape may be directly calibrated in accordance with the tank capacity of the vessel so that direct readings may be obtained at point C with the gauger not standing directly over the opening 122 (as shown in Figure 1) or at the edge of the opening 38 (as shown in Figure 11). When the tape is not directly calibrated, the appropriate volume may be obtained by using the tank's calibration table.

It is not necessary for the gauger to move the tape aside so that he can look into the opening 122 to ascertain the position of a bob on the end of the tape, as was previously necessary and is indicated by the tape 20' shown in broken lines in Figure 1.

The tape 20 may be provided with indicia to measure lengths in feet or in meters. It is also possible to use a tape having indicia thereon which are related to the volume of oil, e.g. in liters or barrels, of the tank under measurement, so that direct readings of ullage can be obtained from the tape.

It has been found that the device will operate successfully with the following liquids:

Fresh Water	Butyl acetate	Methyl acetate (6-C-A)
Salt Water	Ethyl acetate	Methyl acetate (1-6-F)
Lubricating Oil	Vinyl acetate	Santicizor 711
Kerosene	Styrene	Santicizor 160 (butyl benzyl phthalate)
Crude Oil	Pentane	Methyl Ethyl Ketone
Gasoline	Jet A Oil	Heavy Paraffin (4-P-SP+41-5S)
Diesel Oil	Tallow Oil	
Xylene	No. 6 API 25 Oil	

The advantages of the portable ullage measuring device are that it requires no external

power source and weighs only five or six pounds and can be hand-held. It is driven by two "AA" penlight batteries with a minimum battery drain and will operate for a minimum of 500 hours (6 months normal usage). Accuracy can be obtained to 1/32 of an inch or better or 0.7 millimeters or better, and no correction for temperature or specific gravity of the fluid being measured is needed. Moreover, no knowledge of the approximate level in the vessel beforehand is needed. The signals which is used to energize the transmitting piezo-electric crystal transducer is preferably a one MHz signal.

The high intensity audible signal overcomes background noise and allows operation in bright sunlight as well as night-time and permits accurate gauging in wet weather.

Moreover, it is possible to measure tanks under inert gas pressure without exposing operators to fumes. In this respect, the ullage can be taken through a 1½ inch gate valve to reduce the escape of vapors to the atmosphere.

While the ullage device is shown as including a handle 14, such handle 14 may be omitted and the ullage device may be carried by a support or supported on the deck of a cargo tanker in proximity to the tank 10 and be non-portable. It is also possible to make the ullage device with heavier components so that it is not readily portable. However, the fact that the ullage device is either portable or non-portable does not change its characteristics or mode of operation. Because of the unique association of the various elements, it is possible to have the added feature of a portable ullage device without in any way detracting from the unique results obtained with its use as an ullage measuring device.

While the ullage device has been shown in its preferred form as portable and not motorized, it is possible to motorize the ullage device. Such motorization of the ullage device in its preferred form is best applied to the ullage device in its non-portable form so as not to add weight to the portable ullage device and detract from its portability. Nevertheless, it is possible to motorize the portable ullage device and thereby eliminate the handle 40 and slide crank 44. Moreover, while it is possible to eliminate the handle 40 and the slide crank 44, some manual means to control the amount of payout of the tape assembly 20 should be provided so that the manual means can act as an over-ride on the motorized means, should this be desired.

While there has been shown what is considered to be the preferred embodiments of the invention, it is obvious that various changes and modifications may be made therein without departing from the scope of the invention.

WHAT WE CLAIM IS:-

1. An ullage measuring device for the measurement of liquid in a storage tank without visual sighting comprising a tape reel mechanism comprising a tape assembly having measuring indicia thereon, the tape assembly having one end coupled to a liquid-responsive device for producing an output signal when in contact with a liquid medium and its other end coupled with the tape reel mechanism, an alarm indication mechanism responsive to the output signal for producing an alarm indication, and means coupled with the tape reel mechanism to control the amount of payout of the tape assembly for stopping the payout thereof when the liquid-responsive device is activated by contact with the liquid medium.

2. An ullage device according to Claim 1, comprising energization means carried by the tape reel mechanism, and switch means carried by the tape reel mechanism coupling the energization means with the alarm indication mechanism to render the alarm indication mechanism operative in response to the output signal from the liquid-responsive device and to decouple the energization means from the alarm indication mechanism after being rendered operative in response to the output signal, thereby to render said alarm indication mechanism inoperative.

3. An ullage device according to Claim 1 or 2, wherein the tape reel mechanism comprises a tape reel including a tape assembly receiving and attachment means therefor, a shaft fixed to the reel, a slide crank slidably coupled with the shaft for rotating said reel to wind or unwind the tape assembly, and the control means comprises a reel locking mechanism coupled to the shaft, the locking mechanism including a toothed sprocket mechanism, the crank including an elongated slot for coupling thereof to the shaft but permitting slidable transverse movement axially of the shaft, a lug carried by the crank engageable with the toothed mechanism to lock the reel against rotation, the crank being movable to move the lug out of engagement with the sprocket, the movement of the crank being guided by the slot, the crank being effective to rotate the shaft when the lug is disengaged from the toothed mechanism and being effective to cause the lug to engage the sprocket whereby to lock the reel against rotation, thereby preventing payout of the tape assembly.

4. An ullage device according to Claims 1 or 2, wherein the tape reel mechanism comprises a housing for supporting the tape assembly, a carrying handle connected with the housing for hand-carrying and holding thereof, a drive shaft and a hub fixed for rotation therewith rotatably coupled with the carrying handle, the hub including a plurality of

power source and weighs only five or six pounds and can be hand-held. It is driven by two "AA" penlight batteries with a minimum battery drain and will operate for a minimum of 500 hours (6 months normal usage). Accuracy can be obtained to 1/32 of an inch or better or 0.7 millimeters or better, and no correction for temperature or specific gravity of the fluid being measured is needed. Moreover, no knowledge of the approximate level in the vessel beforehand is needed. The signals which is used to energize the transmitting piezo-electric crystal transducer is preferably a one MHz signal.

The high intensity audible signal overcomes background noise and allows operation in bright sunlight as well as night-time and permits accurate gauging in wet weather.

Moreover, it is possible to measure tanks under inert gas pressure without exposing operators to fumes. In this respect, the ullage can be taken through a 1½ inch gate valve to reduce the escape of vapors to the atmosphere.

While the ullage device is shown as including a handle 14, such handle 14 may be omitted and the ullage device may be carried by a support or supported on the deck of a cargo tanker in proximity to the tank 10 and be non-portable. It is also possible to make the ullage device with heavier components so that it is not readily portable. However, the fact that the ullage device is either portable or non-portable does not change its characteristics or mode of operation. Because of the unique association of the various elements, it is possible to have the added feature of a portable ullage device without in any way detracting from the unique results obtained with its use as an ullage measuring device.

While the ullage device has been shown in its preferred form as portable and not motorized, it is possible to motorize the ullage device. Such motorization of the ullage device in its preferred form is best applied to the ullage device in its non-portable form so as not to add weight to the portable ullage device and detract from its portability. Nevertheless, it is possible to motorize the portable ullage device and thereby eliminate the handle 40 and slide crank 44. Moreover, while it is possible to eliminate the handle 40 and the slide crank 44, some manual means to control the amount of payout of the tape assembly 20 should be provided so that the manual means can act as an over-ride on the motorized means, should this be desired.

While there has been shown what is considered to be the preferred embodiments of the invention, it is obvious that various changes and modifications may be made therein without departing from the scope of the invention.

WHAT WE CLAIM IS:-

1. An ullage measuring device for the measurement of liquid in a storage tank without visual sighting comprising a tape reel mechanism comprising a tape assembly having measuring indicia thereon, the tape assembly having one end coupled to a liquid-responsive device for producing an output signal when in contact with a liquid medium and its other end coupled with the tape reel mechanism, an alarm indication mechanism responsive to the output signal for producing an alarm indication, and means coupled with the tape reel mechanism to control the amount of payout of the tape assembly for stopping the payout thereof when the liquid-responsive device is activated by contact with the liquid medium.

2. An ullage device according to Claim 1, comprising energization means carried by the tape reel mechanism, and switch means carried by the tape reel mechanism coupling the energization means with the alarm indication mechanism to render the alarm indication mechanism operative in response to the output signal from the liquid-responsive device and to decouple the energization means from the alarm indication mechanism after being rendered operative in response to the output signal, thereby to render said alarm indication mechanism inoperative.

3. An ullage device according to Claim 1 or 2, wherein the tape reel mechanism comprises a tape reel including a tape assembly receiving and attachment means therefor, a shaft fixed to the reel, a slide crank slidably coupled with the shaft for rotating said reel to wind or unwind the tape assembly, and the control means comprises a reel locking mechanism coupled to the shaft, the locking mechanism including a toothed sprocket mechanism, the crank including an elongated slot for coupling thereof to the shaft but permitting slidable transverse movement axially of the shaft, a lug carried by the crank engageable with the toothed mechanism to lock the reel against rotation, the crank being movable to move the lug out of engagement with the sprocket, the movement of the crank being guided by the slot, the crank being effective to rotate the shaft when the lug is disengaged from the toothed mechanism and being effective to cause the lug to engage the sprocket whereby to lock the reel against rotation, thereby preventing payout of the tape assembly.

4. An ullage device according to Claims 1 or 2, wherein the tape reel mechanism comprises a housing for supporting the tape assembly, a carrying handle connected with the housing for hand-carrying and holding thereof, a drive shaft and a hub fixed for rotation therewith rotatably coupled with the carrying handle, the hub including a plurality of





(14)

- compartments and a hub cover enclosing the compartments, the tape assembly being fixed to the hub for rotation therewith, the alarm indication mechanism including a horn alarm contained within one of the compartments, an energization means including batteries contained in another of the compartments, a power switch operable externally of the cover including parts contained in another of the compartments, and a pair of electrical wires coupled with the liquid responsive device electrically connected with the batteries and the horn alarm internally of said hub, and a tape assembly connection internally of the hub for connecting and holding the tape onto the reel, the coupling means including a reel index mechanism fixed to said housing and having a plurality of peripherally spaced stop openings, and a slide crank including a stop pin engageable with one of the stop openings to lock the crank with the housing, the slide crank including a longitudinal slot for coupling the crank with the shaft for rotation thereof and being movable transversely of the shaft but prevented from disengagement therewith from a first position in which the stop pin engages one of the stop openings to a second position in which the stop pin is disengaged from the stop openings whereby to permit rotation of the shaft.
5. An ullage device according to Claim 4, wherein the tape assembly includes a pair of electrical conductors coupling the liquid-responsive device with the alarm indication mechanism, a metallic tape having said measuring indicia thereon, and a clear plastic electrically insulating jacket enclosing the pair of electrical conductors and the metallic tape, the insulating jacket being impervious to the liquid being measured and preventing static charge build-up, the pair of electrical wires forming a composite unit with the metallic tape, but insulated therefrom.
6. An ullage device according to Claim 5, wherein the liquid-responsive device includes a housing enclosing sonic energy transmitting and receiving devices spaced apart from each other to provide a free space therebetween for the liquid to be measured by transmission of sonic energy through the liquid, and electrical circuitry and signal detection and amplification means connected with the devices, one of the conductors being connected with said energization means for energization of the electrical circuitry and the sonic transmitting device, the other of the electrical conductors being connected with the sonic energy receiving device through the signal detection and amplification means for transmitting a signal detected from the receiving device to energize the horn alarm, when a sonic signal transmitted from the transmitting device is received by the receiving device while the liquid under measurement fills the free space.
7. An ullage device according to any one of claims 1 to 3, wherein the tape assembly comprises a pair of electrical conductors coupling said liquid responsive device with the alarm indication mechanism, and a clear inert liquid-impervious material enclosing the electrical conductors and a tape provided with indicia thereon.
8. An ullage device according to any one of claims 5 to 7, wherein the electrical conductors are positioned on opposite sides of the tape in the jacket.
9. An ullage device according to Claim 6 or 8, wherein the tape forms an electrical ground for the device and the electrical circuitry.
10. An ullage device according to any of Claims 6 to 9, wherein one of the conductors is connected with the inputs to the transmitting and to the receiving devices and with the batteries through the power switch, whereby closing of the power switch renders the transmitting device operative to transmit a sonic signal and the receiving device operative to receive the transmitted sonic signal.
11. An ullage device according to any one of Claims 1 to 3 and Claim 7, including switch means and energization means, one of the conductors being connected in circuit with the switch means and the energization means to render the liquid-responsive device operative, the switch means being coupled with the tape reel mechanism and including an externally operative switch, the other of the conductors being coupled in circuit with the alarm indication device and the liquid responsive device to render the indication device operative to produce an audible sound in response to the liquid responsive device making contact with the liquid medium, the tape being in circuit with the conductors and forming a common ground for the device.
12. An ullage device according to any one of Claims 5 to 11, including an external grounding clip electrically connected with the tape for grounding the device.
13. An ullage device according to any one of the preceding claims, including electronic circuitry coupled with the liquid-responsive device and the alarm indication mechanism through the tape assembly, the electronic circuitry comprising an amplifier section having its output coupled to the fluid responsive device for energization thereof, a detector-amplifier section having its input coupled to the fluid responsive device and its output coupled to the alarm indication mechanism, electrical energization means carried by the tape reel mechanism including a battery and switch means for coupling the battery in circuit with the input of the amplifier section of the electronic circuitry, the tape assembly

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including a tape indicia means and a pair of electrically conductive wires; the tape forming a common ground, the switch means being coupled in circuit with the electronic circuitry through the tape and one of the conductors for energization of the liquid-responsive device to transmit sonic energy, the alarm indication device being coupled in circuit with the detector-amplifier section through the other of the conductors and the common ground, the liquid-responsive device including a sonic energy transmitting crystal and a sonic energy receiving crystal, the transmitting crystal being coupled in circuit with the amplifier section for energization and the receiving crystal being coupled in circuit with the detector-amplifier section for energization thereof in response to the receiving crystal receiving the transmitted sonic energy, the receiving crystal energizing the detector-amplifier section when the faces of the crystals are wetted by the liquid in the storage tank whereby the sonic energy transmitted from the transmitting crystal is received by the receiving crystal without attenuation.

14. An ullage device according to any one of the preceding claims, wherein the storage tank is in the lower portion of a cargo tanker having a sounding pipe to provide access to the storage tank, the tape assembly having a length sufficient to lower the liquid responsive device into the lower portion whereby to obtain a reading without visual sighting, and the tape assembly including a tape having indicia markings thereon to give a reading directly to provide an ullage indication in a volumetric measurement.

15. A portable hand-held ullage measuring device for the measurement of liquid in a storage tank without visual sighting while affording protection from gas fumes or other noxious substances, including:

a liquid responsive device for producing an output signal when in contact with a liquid medium;

a tape reel mechanism comprising a tape assembly having measuring indicia thereon, said tape assembly having one end coupled with said liquid-responsive device and another end coupled with said tape reel mechanism;

a tape reel including a tape assembly receiving and attachment means therefor, a shaft fixed to said reel;

a slide crank slidably coupled with said shaft; and a handle connected with said slide crank for rotating said reel to wind or unwind said tape assembly;

an alarm indication mechanism associated with said tape reel mechanism responsive to said output signal for producing an alarm indication;

and means coupled with said tape reel mechanism to control the amount of payout of said tape assembly for stopping the payout thereof when said liquid-responsive device makes contact with said liquid medium including:

a reel locking mechanism coupled to said shaft, said locking mechanism including a toothed ratchet mechanism, said crank including an elongated slot for coupling thereof to said shaft but permitting slidable movement transverse to said shaft, a lug carried by said crank engageable with said toothed mechanism to lock said reel against rotation, said crank being movable to move said lug out of engagement with said ratchet, the movement of said crank being guided by said slot, said crank being effective to rotate said shaft when said lug is disengaged from said toothed mechanism and being effective to cause said lug to engage said ratchet whereby to lock said reel against rotation, thereby preventing payout of said tape assembly.

16. A portable ullage device according to Claim 15, said tape reel mechanism comprising:

a housing for supporting said tape assembly;

a carrying handle connected with said housing for hand-carrying and holding thereof said drive shaft being rotatably coupled with said carrying handle;

a hub mounted rotatably on said shaft, said hub including a plurality of compartments, a hub cover enclosing said compartments, said tape assembly being fixed to said hub for rotation therewith;

said alarm indication mechanism including a horn alarm contained within one of said compartments;

energization means including batteries contained in another of said compartments, a power switch operable externally of said cover including parts contained in another of said compartments, and a pair of electrical wires coupled with said liquid-responsive device electrically connected with said batteries and said horn alarm internally of said hub; and

a tape assembly connection internally of said hub for connecting and holding said tape assembly onto said reel, said connection including a grounding for said tape assembly;

said reel locking mechanism including a reel index mechanism fixed to said housing provided with a plurality of peripherally spaced stop openings formed by said toothed ratchet, said lug forming a stop pin engageable with one of said stop openings to lock said crank with said housing, said slide crank including a longitudinal slot for coupling said crank

16

with said shaft for rotation thereof, said crank being movable transversely of said shaft but prevented from disengagement therewith from a first position in which said stop pin engages one of said stop openings to a second position in which said stop pin is disengaged from said stop openings whereby to permit rotation of said shaft; and, said tape assembly including:

5 a pair of electrical conductors coupling said liquid-responsive device with said alarm indication mechanism,

10 a metallic tape having said measuring indicia thereon, said electrical conductors being positioned on opposite sides of said tape, said tape forming a ground for said device and said electronic circuitry, and a clear plastic insulating jacket enclosing said pair of electrical conductors and said metallic tape, said insulating material being impervious to oil and adapted for the prevention of static charge build-up, said pair of electrical wires forming a composite unit with said metallic tape, but insulated therefrom.

15 17. An ullage device according to Claim 15 or 16, said liquid responsive device being as claimed in claim 6 said tape assembly having a length sufficient to lower said liquid responsive device into the lower portion of a cargo tanker whereby to obtain a reading without visual sighting, said tape assembly including a tape having indicia markings thereon to take a reading directly to provide an ullage indication in a volumetric measurement.

20 18. An ullage measuring device, for the measurement of liquid in a storage tank without visual sighting while affording protection from gas fumes or other noxious substances, having its parts constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

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