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LUBRICATION SYSTEM FOR SUBMERGED DRIVING MECHANISM

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Fig. 1

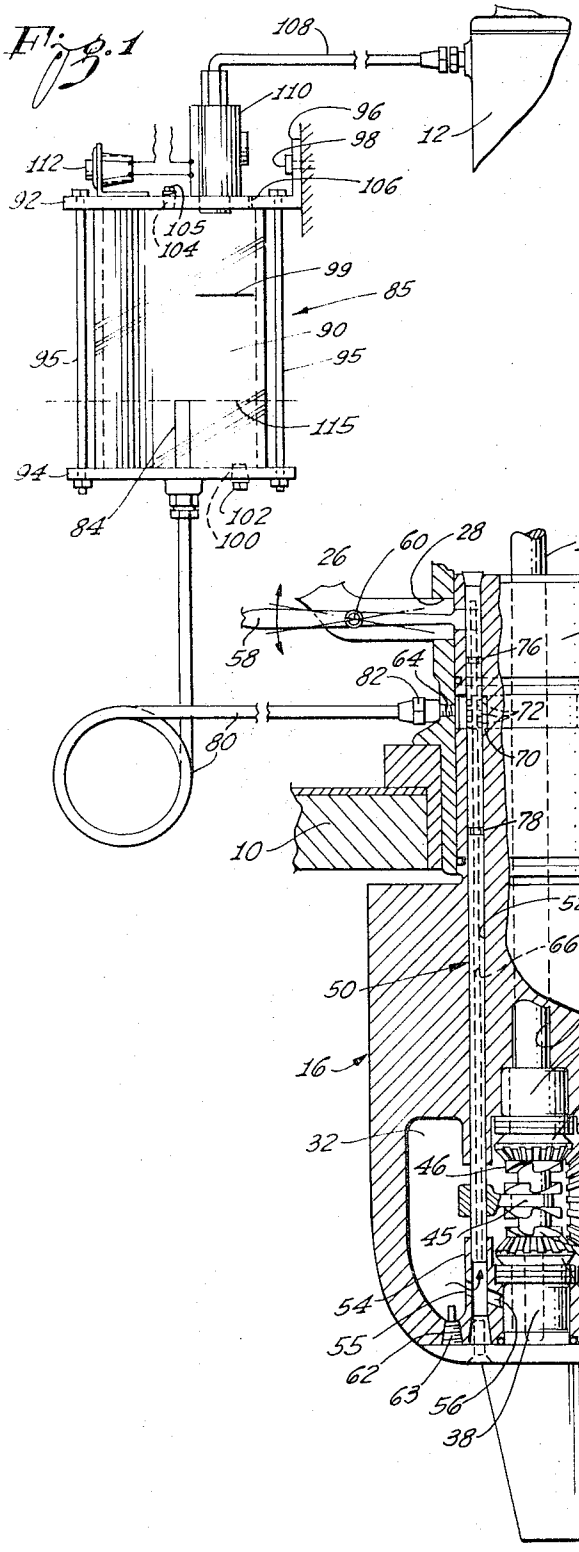
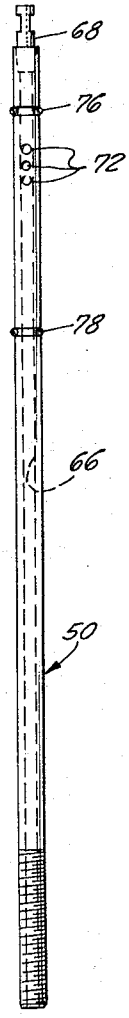


Fig. 2



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LUBRICATION SYSTEM FOR SUBMERGED DRIVING MECHANISM

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ABSTRACT OF THE DISCLOSURE

A housing encloses a body of lubricant together with a mechanism driven by an internal combustion engine. A separate elevated inspection chamber having a restricted vent aperture, an upper fill port and a bottom drain port is in communication with the housing through a first passage and is in communication with the intake of the engine through a second passage controlled by a normally closed valve. Opening the valve causes a vacuum to draw the lubricant from the housing into the inspection chamber for partial discard and replenishment as required. Closing the valve permits venting of the inspection chamber for gravitational return of the lubricant to the housing.

This invention relates to a method of checking the lubrication of mechanism, with special reference to concealed or remote mechanism, and further relates to the structure of a check system that may be provided for carrying out the method.

While the invention is widely applicable for its purpose, it has been initially embodied in a system on a boat for checking the lubrication of propulsion mechanism in an outboard housing that is below the water level. The description herein of this particular embodiment of the invention will afford adequate guidance for those skilled in the art who may have occasion to use the underlying concept for devising other lubrication check systems.

A conventional drive unit of a small boat comprises a housing for submersion in the water, a propeller carried by the housing and a lubricated mechanism in the housing operating in suitable bearings to actuate the propeller. The present embodiment of the invention pertains particularly to a boat having an inboard internal combustion engine with a drive mechanism in a permanently mounted rotatable outboard housing extending downward from the engine through the bottom of the boat. The moving parts of the drive mechanism include: an upright drive shaft extending downward from the engine; a laterally extending driven shaft carrying the propeller, and a clutch arrangement incorporating bevelled gears and operated by an upright push-pull rod for reversably connecting the drive shaft to the driven shaft.

The outboard housing is journaled in an upper bearing for rotation as a whole to steer the boat and the lower portion of the housing encloses bearing for the drive shaft, the driven shaft and the clutch mechanism. Since the parts in the submerged housing rotate at high speed under high load, any serious difficulty that occurs is likely to progress to complete failure. For this reason, frequent inspections of the bearings are highly desirable. Unfortunately, however, inspection of the various bearings in the submerged housing may be carried out only by taking the boat out of the water, elevating the boat and draining the lubricant from the housing. Such an inspection procedure entails so much time and trouble that it is only too easy to postpone an inspection on the unwarranted assumption that no insipient trouble exists.

The present invention corrects this situation by providing a lubrication system that makes it possible to carry

out a quick and reliable check on the operating conditions in the submerged drive mechanism without the necessity of taking the boat out of the water and without need for direct access to the drive mechanism. The underlying concept of the invention is to provide an easily accessible lubricant inspection chamber inside the boat above the level of the outboard housing with the inspection chamber in flow communication with the lower interior of the outboard housing and to provide temporary transfer of the lubricant from the outboard housing to the inspection chamber whenever inspection of the lubricant is desired.

If the transferred lubricant is found to be in good order it is promptly returned to the outboard housing. If the transferred lubricant is found to be contaminated by foreign particles or by intrusion, it is either partially or completely discarded and new lubricant is introduced into the inspection chamber for transfer to the outboard housing. If water leakage into the outboard housing has developed as indicated by water in the transferred lubricant, appropriately frequent change of the lubricant in the outboard housing makes it possible to continue to operate the boat without damage to the working parts. Thus if a check made in the course of a cruise reveals that a serious leak has developed, prompt changing of the lubricant may make it possible to get safely back to port without a complete breakdown. If a routine check reveals that only a minor leak has developed, changing the lubricant at appropriate intervals may make it possible to continue to operate the boat for a prolonged period without taking the boat out of the water.

One problem encountered in carrying out this basic concept is to provide a suitable flow passage for communication between the inspection chamber and the lower interior of the outboard housing, this problem arising because the outboard housing and the drive mechanism therein are compactly constructed with no spare space. In this regard a feature of the invention is the substitution of a tubular push-pull clutch rod for the usual solid rod, thus providing an upright passage to the lower interior of the outboard housing. The lower end of the tubular push-pull rod communicates with the lower interior of the drive unit and the upper portion of the tubular rod is ported for communication with an upper bearing in which the drive unit is journaled.

The invention further teaches that the upper bearing may be sealed off to form an upper annular chamber in communication with the tubular push-pull rod. Thus the upper annular chamber becomes part of the flow passage from the lower interior of the outboard housing to the inspection chamber, the rest of the passage being provided by an exterior conduit which connects the upper annular chamber with the inspection chamber. This arrangement simplifies the lubrication of the drive unit since a low viscosity lubricant for the lower bearings in the housing also serves as lubricant for the upper bearing in which the drive unit is journaled. In addition, the arrangement brings the upper bearing for the housing within the scope of the checking system.

In addition to the problem of providing a flow passage for the transfer of the lubricant to the inspection chamber there is the further problem of carrying out the transfer. The invention solves this further problem by connecting the inspection chamber to the intake of the engine under the control of a suitable valve. To transfer the lubricant from the submerged housing to the inspection chamber, it is necessary merely to open the valve while the engine is running thereby to create a vacuum in the inspection chamber. To return the lubricant to the drive unit it is necessary merely to close the valve to terminate the vacuum in the inspection chamber

thereby to permit the lubricant to gravitate back through the flow passage.

The features and advantages of the invention may be understood from the following description together with the accompanying drawing.

In the drawing which is to be regarded as merely illustrative:

FIG. 1 is a partly diagrammatic view of the presently preferred embodiment of the check system with the outboard housing shown in section; and

FIG. 2 is a side elevation on a larger scale of a tubular push-pull clutch control rod that is substituted for the usual solid rod.

In the drawing illustrating the initial embodiment of the invention, a boat having a bottom wall **10** is powered by an inboard engine having an intake manifold **12**. The engine actuates a drive shaft **14** that extends downward through the bottom wall **10** of the boat into an outboard housing, generally designated **16**, to actuate a propeller **18** that is carried by the housing. The outboard housing **16** is rotatable about its axis for steering the boat and for this purpose the upper end of the outboard housing is in the form of a journal **20** that is rotatable in a fixed bearing sleeve **22**. In the construction shown, the fixed bearing sleeve is telescoped into a fixed bushing **24** in the bottom wall **10**, the bearing sleeve having a circumferential flange **25** in abutment with the bushing. For the purpose of rotating the outboard housing **16** to steer the boat, a radial control arm **26** extends rigidly from the journal portion **20** of the outboard housing through a slot **28** in the fixed bearing sleeve **22**, which slot is of sufficient circumferential extent to provide the desired angular range of steering rotation.

The outboard housing **16** is in the form of a casting having an axial bore **30** to receive the drive shaft **14**, the lower portion of the casting being hollow to form what may be termed a lubricant chamber **32** which confines a body of suitable liquid of suitable viscosity for lubricating the moving parts in the outboard housing. The moving parts include the components of a clutch for controlling the rotation of the propeller **18**.

The clutch includes an upper bevelled gear **34** that is rotatably mounted on the drive shaft **14** adjacent a bearing **35**, a lower bevelled gear **36** that is journaled in a lower bearing **38** and a third bevelled gear **40** which is journaled in a bearing **42** and is fixedly united with a short shaft **44** that carries the propeller **18**. A conventional threaded ratchet collar **45** that is slidingly keyed to the drive shaft **14** is movable from a neutral position shown in FIG. 1 into engagement selectively with the two bevelled gears **34** and **36**, the two bevelled gears having integral ratchet teeth **46** for releasable engagement by the ratchet collar.

In a well known manner the threaded ratchet collar **45** is attached to and controlled by a push-pull rod **50** that is slidingly mounted in an upright bore **52** of the outboard housing **16**. The lower end of the push-pull rod **50** is slidingly embraced by a guide sleeve **54** in the lubricant chamber **32**, the guide sleeve having a port **55** in communication with the lubricant chamber and a second port **56** in communication with the lower bearing **38**. The push-pull rod is controlled in a conventional manner by a clutch lever **58** which is mounted on the steering arm **26** by pivot means **60**, the lever extending through the previously mentioned slot **28** in the fixed bearing sleeve **22** and being operatively connected to the upper end of the push-pull rod.

Usually two different lubricants are used, one lubricant being introduced into the lubricant chamber **32** through a fill port **62** that is normally closed by a plug **63**, the other lubricant which is more viscous than the first lubricant being introduced through a port **64** in the bearing sleeve **22**. The port **64** which is normally closed by a plug (not shown) communicates with a wide circumferential groove **65** in the journal portion **20** of the outboard housing.

All the structure described to this point is conventional and well known in the prior art. The additional structure and the modifications of the conventional structure for the purpose of the present invention will now be described.

A feature of the present invention is that the push-pull rod **50** is tubular instead of solid, the push-pull rod having an axial bore **66** as best shown in FIG. 2. The upper end of the axial bore **66** is closed by a fixedly mounted plug **68** which is operatively engaged by the previously mentioned lever **58**. In the region of the groove **65** in the journal portion **20** of the outboard housing, the journal portion is cut away around the push-pull rod to provide a recess **70** in communication with the circumferential groove. The portion of the push-pull rod **50** that lies within the recess **70**, i.e. within the region of the circumferential groove **65** is provided with a plurality of radial bores **72** that place the interior of the tubular push-pull rod in communication with the circumferential groove. An annular sealing means in the form of an O-ring **74** embraces the journal portion **20** of the outboard housing above the circumferential groove **65** and a second O-ring **75** embraces the journal portion below the circumferential groove. In like manner, an upper annular sealing means in the form of an O-ring **76** embraces the push-pull rod **50** above the region of the circumferential groove **65** and a second O-ring **78** embraces the push-pull rod below the circumferential groove.

In accord with the underlying concept of the invention the plug that usually closes the lubricant fill port **64** in the bearing sleeve **22** is omitted and instead a tube **80** is connected at its lower end to the fill port by a suitable fitting **82** and is connected at its upper end to the lower end of a standpipe **84** in an inspection chamber that is generally designated by numeral **85**.

In the construction shown, the inspection chamber comprises a cylinder **90** of transparent glass or plastic which is clamped between an upper end wall **92** and a lower end wall **94** by circumferentially spaced tie rods **95**. The upper end wall **92** is formed with an integral flange or ear **96** by means of which the inspection chamber may be anchored to fixed structure by a suitable screw **98**. In the preferred practice of the invention the transparent cylinder **90** is provided with a horizontal index mark **99** to indicate the level to which the inspection chamber must be filled to contain precisely the volume of lubricant required for the outboard housing **16**.

The lower end wall **94** of the inspection chamber is provided with a drain port **100** which is normally closed by a plug **102** and the upper end wall **92** has a supply or fill port **104** which is normally closed by a plug **105**. In addition the upper end wall **92** is provided with a vent aperture **106** which normally equalizes the pressure in the inspection chamber with the ambient atmospheric pressure.

It is to be understood that the inspection chamber **85** may be connected to any suitable vacuum source. In the present embodiment of the invention, a port in the upper end wall **92** of the inspection chamber is connected by a tube **108** with the engine intake **12** and this tube is normally closed by a suitable valve. Preferably the intake **12** is normally cut off from the inspection chamber **85** by a normally closed solenoid valve **110** which may be opened when desired by a push button switch **112**.

It is apparent that the described structure provides a first passage from the lubricant chamber **32** to the inspection chamber **85** and that the upper tube **108** provides a second passage from the inspection chamber to the intake **12**. The first passage for communication between the lubricant chamber **32** and the inspection chamber **85** includes the following: the port **55** in the guide sleeve **54**; the interior of the guide sleeve **54**; the axial bore **66** of the tubular push-pull rod **50**; the upper radial ports **72**

in the tubular push-pull rod; the recess **70** in the journal portion **20** of the inboard housing; the circumferential groove **65** around the journal portion **20**; the port **64**; the tube **80**; and the standpipe **84**.

The manner in which the invention serves its purpose may be readily understood from the foregoing description. Normally a residual amount of lubricant is trapped in the inspection chamber **85** at the level indicated by numeral **115** at the upper end of the standpipe **84**. The lower lubricant chamber **32** and the previously described, first passage from the lubricant chamber to the inspection chamber **85** are initially filled with a lubricant of suitable viscosity, the viscosity being low enough for the lubricant to flow by gravity through the first passage. Immediately after the system is filled with the lubricant the tube **80** is full but with the passage of time the lubricant level may drop in the tube **80**.

When it is desired to check the lubrication of the working parts in the outboard housing **16**, the push button **112** is manually depressed to open the solenoid valve **110** while the engine is operating, for example while the engine is idling. Air is exhausted from the inspection chamber **85** to the engine intake at a faster rate than the air in the inspection chamber can be replenished through the vent aperture **106**. Consequently a vacuum is quickly created in the inspection chamber to cause lubricant to be drawn upward through the first passage from the lubricant chamber **32** to the inspection chamber **85**. Unless there is a deficiency in the amount of lubricant, the transferred lubricant rises to the level **99** in the inspection chamber. If visual inspection reveals that the lubricant in the inspection chamber is in good order, depression of the push button **112** is terminated to cut off the inspection chamber from the engine intake and thus permit the vacuum to be destroyed by air entering the inspection chamber through the vent aperture **106**. When the pressure inside the inspection chamber rises to atmospheric pressure, lubricant in the inspection chamber above the level of the standpipe **84** gravitates back to the outboard housing **16** and the lubricant chamber **32** therein.

This cycle of operation permits any contaminates in the lubricant to gravitate to the bottom of the inspection chamber to be trapped in the residual lubricant below the level of the top of the standpipe **84**. In many instances it is desirable to carry out this cycle repeatedly for repeatedly transferring the lubricant from the lubricant chamber **32** to the inspection chamber **85**, each operation isolating contaminates in the residual body of lubricant below the level of the standpipe **84**.

After the inspection chamber has been emptied down to the liquid level **115**, the drain plug **102** may be removed to permit the contaminated lubricant to be discarded. If the contamination by rust or water is especially heavy, lubricant may again be transferred to the inspection chamber from the housing **16** to provide a new residual body to trap contaminants and the new residual body may be subsequently drained away.

The index line **99** on the transparent wall of the inspection chamber **85** serves as means to ascertain whether or not the inspection chamber contains enough lubricant to fill both the lubricant chamber **32** and the first passage from the lubricant chamber to the inspection chamber. If the lubricant is not up to the level of the index line **99** when the lubricant chamber and the first passage are emptied, fresh lubricant is introduced through the fill port **104** to bring the lubricant up to the index line. In practice, the lubricant gravitates slowly back to the outboard housing from the inspection chamber when the solenoid valve **110** is closed after an inspection of lubricant. Consequently there is ample time to introduce new lubricant into the inspection chamber up to the level of the index line **115** before any significant quantity of the lubricant drains out of the inspection chamber.

It is a simple matter to idle the engine and inspect the lubricant before beginning a cruise. The inspection procedure is quickly carried out and it is not necessary to delay operation of the propeller until the lubricant gravitates back to the outboard housing because residual lubricant within the housing is adequate for temporary lubrication of the parts. An important advantage of the invention is that the lubricant may be inspected as often as desired in the course of a cruise without interrupting the cruise. A further important advantage of the invention is that inspecting the lubricant at appropriately frequent intervals in the course of the cruise will reveal any serious condition as soon as the serious condition occurs. Thus if there is a serious intrusion of water into the lubricant chamber **32** the discovery of the intrusion will make it possible to replenish the lubricant often enough to avoid damage to the working parts within the time required to get back to port.

My description in specific detail of the initial embodiment of the invention will suggest various changes, substitutions and other departures from my disclosure within the spirit and scope of the appended claims.

I claim:

1. In a system for lubricating moving parts actuated by an engine having a vacuum-creating intake, the combination of:

a lubricant chamber to contain a body of fluid lubricant in contact with the moving parts;

an inspection chamber above the level of the lubricant chamber, said chamber having a port spaced substantially below the top thereof;

means forming a first passage from the lubricant chamber to said port of the inspection chamber;

means forming a second passage from the inspection chamber at a point above the level of said port to the intake of the engine; and

a valve normally closing the second passage,

whereby the valve may be opened to create a vacuum in the inspection chamber to transfer the body of lubricant from the lubricant chamber through said first passage to the inspection chamber for inspection and replacement as necessary and then the inspection chamber may be vented to permit gravitational return of the body of lubricant through said first passage to the lubricant chamber.

2. A combination as set forth in claim **1** in which the inspection chamber has a continuously open vent port of substantially less flow capacity than said second passage to bleed air into the inspection chamber whereby closing the valve results in restoration of atmospheric pressure in the inspection chamber to permit the gravitational return of the body of lubricant.

3. A combination as set forth in claim **2** in which the valve is a solenoid valve controlled by a manually operable switch.

4. In a boat having a housing extending below the water level and forming a lubricant chamber to confine a body of lubricant, a propeller carried by the housing, gearing in the housing in contact with the body of lubricant to drive the propeller, a clutch in the housing cooperative with the gearing, a push-pull rod extending downward through the housing into the lubricant chamber to control the clutch, and a cylindrical structure supporting the housing and journaling the upper portion of the housing to permit rotation of the housing about an upright axis for steering the boat, the improvement to permit lubricant to be withdrawn from the housing periodically for inspection, comprising:

two axially spaced annular seals interposed between the cylindrical structure and the upper portion of the housing and cooperating therewith to form an annular space with the push-pull rod extending through the annular space;

said push-pull rod being tubular and having at least one radial port in the annular space to form a pas-

sage for transfer of the body of lubricant from the lubricant chamber to the annular space; and

said cylindrical structure having a port in communication with the annular space to permit the body of lubricant to be withdrawn from the annular space through said part of the cylindrical structure for inspection.

5. An improvement as set forth in claim 4 which includes two spaced annular seals surrounding the tubular push-pull rod on opposite sides of the radial port of the rod.

6. In a boat having mechanism together with a body of liquid lubricant enclosed in a housing below the water level, a lubricant check system, comprising:

an inspection chamber above the level of the housing, said chamber having a port spaced substantially below the top thereof;

means forming a passage from the interior of the housing to said part of the inspection chamber;

means to create a vacuum in the inspection chamber to transfer lubricant from the housing to the inspection chamber temporarily for inspection of the lubricant and for replacement of the lubricant as necessary; and means to vent the inspection chamber to cause gravitational return flow of lubricant from the inspection chamber to the housing.

7. A combination as set forth in claim 6 in which said part is above the bottom of the inspection chamber to trap a portion of the lubricant in the bottom of the inspection chamber,

said chamber having a normally closed bottom outlet to permit the trapped lubricant to be discarded.

8. A combination as set forth in claim 7 which includes means to indicate the level to which the inspection chamber may be filled with lubricant to provide a volume above the port substantially equal to the desired volume of lubricant in the housing.

9. In a system for lubricating moving parts, for example in a region that is difficult of access, the combination of:

a lubricant chamber in the region to contain a body of lubricant in contact with the moving parts;

an inspection chamber above the level of said region at an accessible station away from the region, said inspection chamber having a first port spaced above the bottom thereof;

a passage from the lubricant chamber to said first port; and

means to create a temporary vacuum in said inspection port to cause lubricant to be transferred from the lubricant chamber to the inspection chamber through said passage with gravitational return of the lubricant to the lubricant chamber upon termination of the vacuum;

the inspection chamber having a lower drainage port and an upper supply port,

whereby the body of lubricant in the lubricant chamber may be transferred to the inspection chamber, the contaminates in the body of lubricant may be permitted to settle to the bottom of the inspection chamber, the contaminated lubricant may be discarded from the inspection chamber through said drainage port, the discarded lubricant may be replaced by new lubricant through said supply port, and the lubricant may be returned from the inspection chamber to the lubricant chamber.

10. A combination as set forth in claim 9 in which said passage terminates in a stand pipe in the inspection chamber extending upward through the bottom portion of the inspection chamber,

said drainage port being below the level of the upper end of the stand pipe,

said supply port being above the level of the upper end of the stand pipe.

11. In a boat having a propeller, an internal combustion engine with an intake, gearing for driving the propeller, clutch means cooperative with the gearing to connect the engine to the gearing, a housing enclosing the gearing and clutch means to confine a body of fluid lubricant, and a push-pull rod in the housing to control the clutch means, the improvement for maintaining adequate lubrication of the gearing and clutch means, comprising:

an inspection chamber above the level of the housing, said chamber having a port spaced substantially from the top thereof;

a first passage from the interior of the housing to said port of the inspection chamber,

the push-pull rod being tubular to form a portion of the first passage;

a second passage from the inspection chamber at a point thereof above the level of the first port to the intake of the engine;

a normally closed valve controlling the second passage; and

means to vent said chamber,

whereby said valve may be open to create a vacuum in the inspection chamber to draw the body of lubricant temporarily from the housing through said first passage to the inspection chamber and then the valve may be closed and the inspection chamber may be vented to cause gravitational return of the lubricant to the housing through said first passage.

12. In a boat having an internal combustion engine and having a mechanism together with a body of liquid lubricant enclosed in a housing below the water level, a lubricant check system, comprising:

an inspection chamber above the level of the housing, said inspection chamber having a first port spaced above the bottom thereof, said chamber further having an upper fill port and a lower drainage port;

a first passage from the interior of the housing to said first mentioned port of the inspection chamber;

a second passage from the inspection chamber at a point thereof above the first mentioned port to the intake of the engine,

said inspection chamber having an upper vent aperture of less flow capacity than said second passage; and

a normally closed valve controlling the second passage,

whereby said valve may be opened to create a vacuum in the inspection chamber to draw the body of lubricant from the housing through said first passage to the inspection chamber and subsequently the valve may be closed to terminate the vacuum and cause gravitational return of the lubricant to the housing through said first passage.

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