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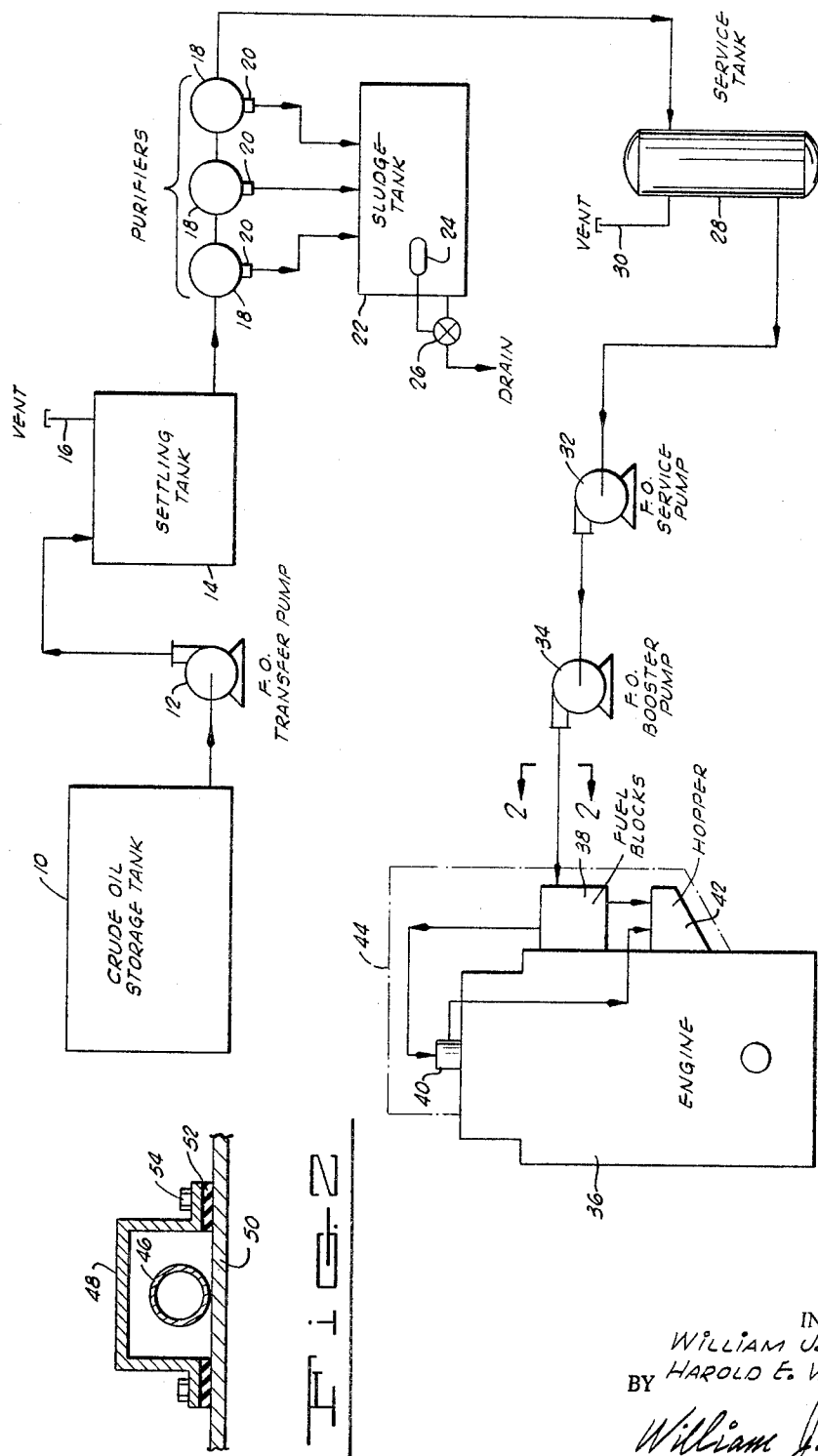
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3,272,168

MARINE DRIVE SYSTEM

Filed June 19, 1964

3 Sheets-Sheet 1



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5 Sheets-Sheet 2

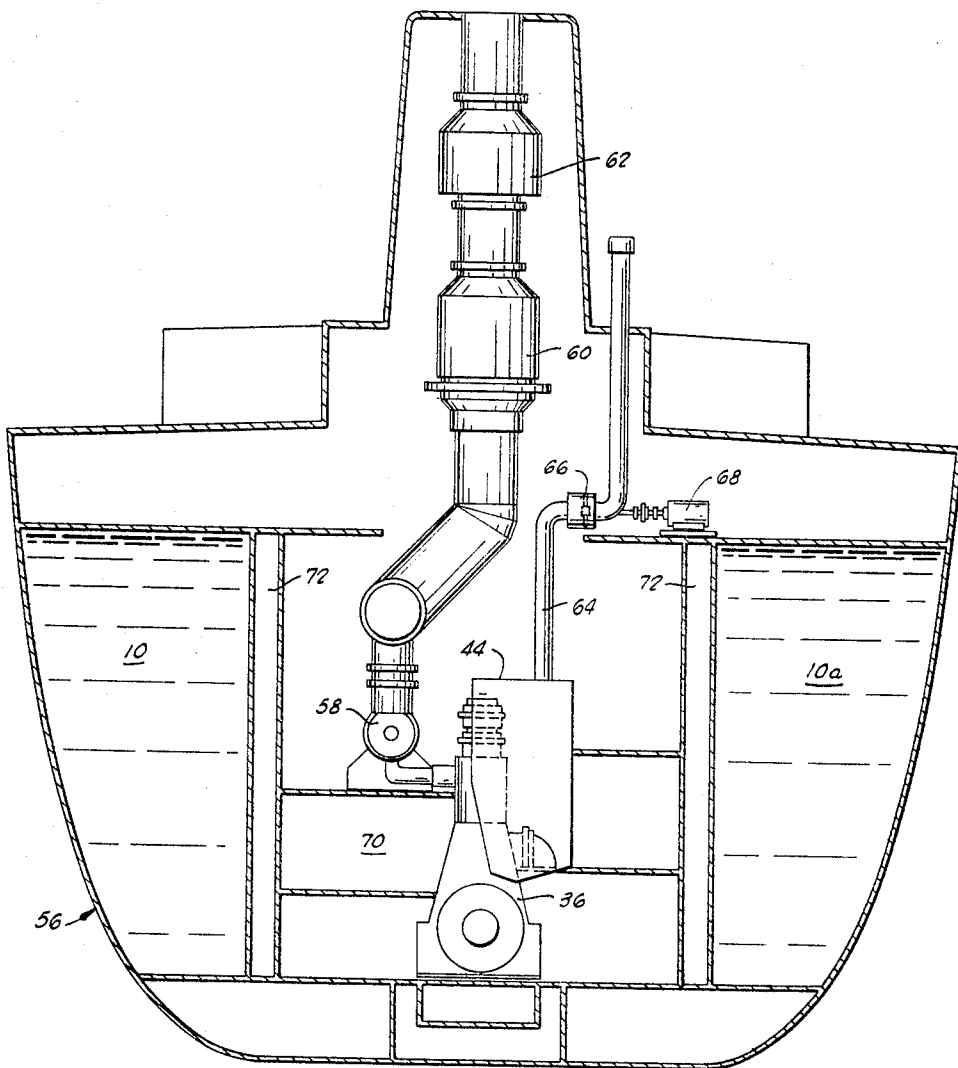


FIG 3

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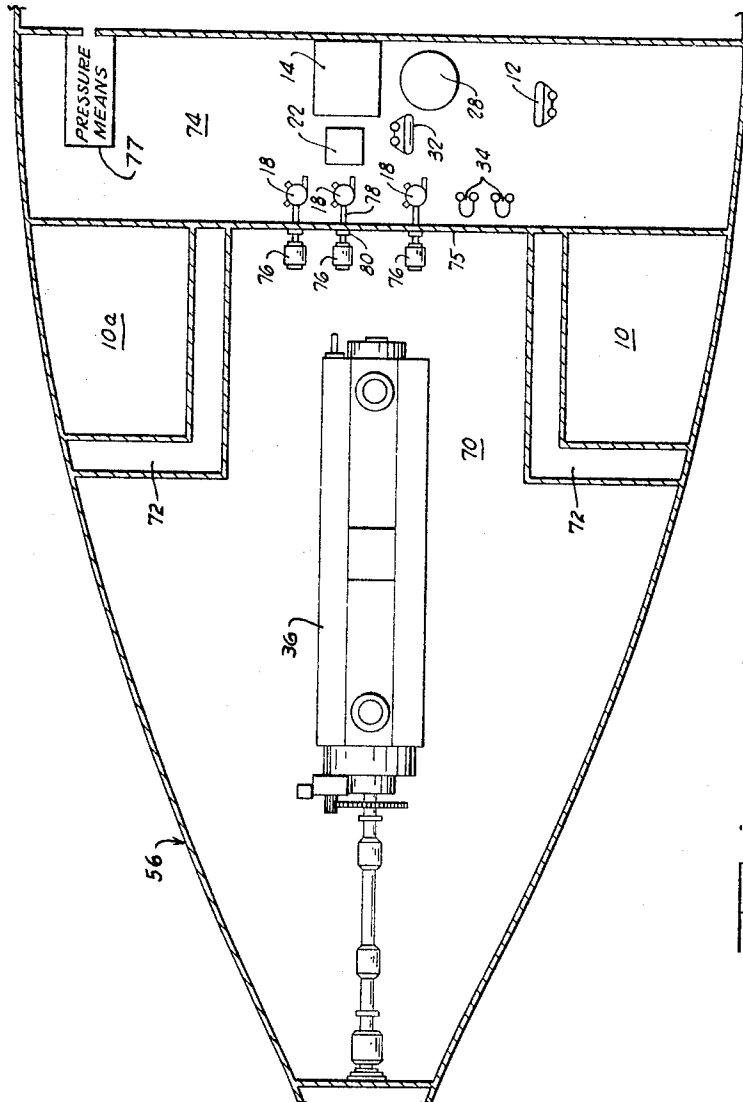
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MARINE DRIVE SYSTEM

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This invention relates generally to improvements in drive systems for ocean-going vessels, and more particularly, but not by way of limitation, to a drive system for a crude oil tanker and a method of operation thereof wherein crude oil being transported by the tanker may be used as fuel for the main propulsion engine of the vessel.

As it is well known in the shipping and ship building arts, compression-ignition internal combustion engines (commonly known as diesel engines) have been used aboard ships for many years, both as direct drive systems and in combination with electric generators and motors to provide what are commonly known as diesel-electric drive systems. Such drive systems have reached a relatively high state of development and have been proven to be reliable in operation. Heretofore, however, the compression-ignition internal combustion engines used on ocean-going vessels have required the use of a refined product, usually diesel oil, which is relatively expensive and requires separate storage facilities aboard the vessel, whether the vessel be a crude oil tanker or a dry cargo ship.

We have found that a conventional marine, compression-ignition internal combustion engine can be operated on crude petroleum oil (i.e., unrefined crude), if certain precautions are taken with respect to handling the fuel to prevent the creation of hazardous conditions. We have further found that such crude petroleum oil can be handled by conventional transfer and booster pumps and other fuel oil handling facilities normally used with diesel oils and refined products.

Probably the primary consideration is using crude petroleum oil as the fuel for a compression-ignition internal combustion engine is to prevent the escape of gases from such oil in the vicinity of the engine. We have found that this can be done by providing a sealed hood over the fuel pumping means attached to the engine; venting the gases evolved in the hood to a point remote from the engine, and by sealing the fuel overflow system of the engine from the atmosphere surrounding the engine. In an ocean-going vessel it is also highly desirable to place fuel handling equipment (such as the pumps and the centrifuges) and the main propulsion engine in different compartments sealed from one another to prevent any possible flow of gases escaping from the crude petroleum oil from one compartment to another. In many installations it is also desirable to operate the pumps and the centrifuges under a slight pressure above atmospheric to minimize the gasification of the crude oil being handled by this equipment. If desired, the storage tank being used for the crude petroleum oil fuel can also be maintained under pressure to minimize gasification and prevent the escape of evolved gas into the atmosphere around the storage tank.

Use of crude petroleum oil as the fuel on a marine, compression-ignition internal combustion engine has shown reduced wear and maintenance on the engine; such fuel has a greater energy content than conventional diesel oil, and when the engine is being used in a crude oil tanker, substantially greater flexibility of operation is obtained, since all of the storage tanks on the tanker can be filled with crude oil and one or more of such tanks be used as a fuel supply for the main propulsion engine of the vessel.

An object of this invention is to increase the flexibility of operation of ocean-going vessels, and particularly crude oil tankers.

Another object of this invention is to provide greater economy in the operation of ocean-going vessels utilizing compression-ignition internal combustion main propulsion engines.

Another object of this invention is to eliminate the necessity of vessels bunkering in remote locations for the purpose of taking on refined fuels.

Another object of this invention is to reduce the wear and maintenance of compression-ignition internal combustion engines used on ocean-going vessels.

A further object of this invention is to increase the cargo-carrying capacity of ocean-going vessels, and particularly crude oil tankers.

Other objects and advantages of the invention will be evident from the following detailed description, when read in conjunction with the accompanying drawings which illustrate the invention.

In the drawings:

FIG. 1 is a schematic flow diagram of a drive system constructed in accordance with this invention.

FIG. 2 is a cross-sectional view taken along lines 2-2 of FIG. 1, but showing the structure required at this point in the system.

FIG. 3 is a partially schematic cross-sectional view of a ship to illustrate a portion of the physical arrangement of the drive system aboard the ship.

FIG. 4 is a layout of an engine room and a pump room aboard a ship to further illustrate the physical arrangement of the equipment incorporated in the drive system.

Referring to the drawings in detail and particularly FIG. 1, reference character 10 designates a crude oil storage tank which will, of course, be installed aboard the ship on which the drive system is used. As previously indicated, the storage tank 10 may be one of the normal crude oil storage tanks in a ship when the ship is a crude oil tanker, and need not be a tank of special construction. Further details of the preferred location and construction of the tank 10 will be given with reference to FIGS. 3 and 4. The crude oil stored in the tank 10 and to be used as a fuel may be substantially any unrefined, crude petroleum oil, but preferably a crude having an appreciable paraffin content, such as 9% by weight.

The crude oil is withdrawn from the crude oil storage tank 10 by a positive displacement pump 12, normally referred to as a fuel oil transfer pump, and the crude is pumped by the pump 12 into a settling tank 14. The transfer pump 12 may be any suitable positive displacement pump and may be driven in any suitable manner, but is preferably driven by steam, rather than by an electric motor, in view of the hazardous service when handling crude, and as will be more fully set forth below. The settling tank 14 is normally of smaller capacity than the storage tank 10, such as having a capacity of about eight hours of fuel in order that the settling tank will be filled during each watch aboard the ship on which the system is used. The settling tank 14 is provided with a suitable vent 16 leading above the upper deck of the ship on which the system is used and the vent is provided with the usual flame arrestor (not shown).

The crude oil from the settling tank 14 is directed through a series of purifiers 18 utilized for the purpose of removing foreign matter from the crude oil fuel. The purifiers 18 may be standard centrifuges such as of the De Laval type. The usual water drain connection 20 of each purifier 18 is connected to a sludge tank 22 for providing a temporary storage of liquids and semi-liquids separated from the crude oil fuel. As is well known in the art, the water drain 20 of a purifier 18 is normally

merely directed overboard, since only water normally flows from such drain. When using crude oil, however, a percentage of the crude oil will be in a form of a sludge which also will collect at the water drain 20 of the purifier, and such sludge can be discharged overboard only when the ship is at sea. We, therefore, provide the sludge tank 22 to collect this sludge and water removed by the purifiers 18, and the sludge tank has a suitable control system (such as a float 24 controlling the discharge valve 26 of the tank, or some other suitable controlling device) to prevent the sludge from being dumped inside of harbors and the like. It will also be understood by those skilled in the art that one or more of the drains 20 may be connected to discharge directly overboard, since the water will normally be separated from the fuel oil before the sludge, and the specific number of purifiers connected to the sludge tank will depend upon the ratio of water and sludge being removed from the particular crude oil being used as the fuel.

The purified crude oil discharging from the last purifier 18 is directed into a service tank 28 to provide an intermediate storage of fuel, such as about a three hour capacity. In the present system the service tank is in the form of a pressure vessel with a suitable controlled vent 30 in order to withstand any possible build up of pressure in the tank. It will be understood that the crude oil entering the service tank 28 will contain an appreciable amount of gas, and at least a portion of this gas is removed from the service tank through the vent 30 to prevent extreme pressures arising within the tank. The vent 30 will also have the usual flame arrestor (not shown) on the discharge end thereof.

Crude oil is withdrawn from the service tank 28 by a fuel oil service pump 32 which may be any suitable positive displacement pump driven by any desired power system. However, it is preferred that the fuel oil service pump 32 be steam driven in view of the hazardous fluid being handled by the pump.

The fuel oil discharging from the service pump 32 is increased in pressure by a booster pump 34 which is also any suitable positive displacement pump, preferably steam driven. The booster pump 34 increases the pressure of the crude oil fuel in accordance with the design characteristics of the fuel system of the compression-ignition internal combustion engine 36 being employed in a particular drive system. The crude oil is directed from the booster pump 34 into the fuel blocks 38 of the engine 36 in the usual fashion in order that the crude oil fuel will be properly directed to the injectors 40 employed on the particular engine. The engine 36 may be any conventional marine compression-ignition engine such as a Sulzer RD engine, and it is not necessary to change the fuel system, such as the fuel pumping devices and valves (not shown) in the fuel blocks 38 or the injectors 40 in order to utilize crude oil as the fuel for the engine.

As also schematically illustrated in FIG. 1, a hopper 42 is provided along one side of the engine 36 in the usual fashion to receive fuel oil leaking from the fuel blocks 38 and fuel oil overflowing from the injectors 40. In accordance with the present invention, a hood or shield 44 is sealed to the engine 36 in enclosing relation around the fuel blocks 38, the injectors 40 and the hopper 42 in order that any gas being evolved from the crude oil fuel in any of these portions of the fuel system will be collected and will not be discharged into the engine room.

The hood 44 may be formed of any suitable material, such as plastic or sheet metal, and it is merely necessary to seal the hood to the outer surface of the engine 36 in order to prevent the escape of gas into the engine room. The hood 44 is vented as will be illustrated and described in connection with FIG. 3.

To further assure the engine room being free of gas evolved from the crude fuel oil, the conduit or line 46 leading to the engine 36 for conveying the crude fuel oil to the engine (see FIG. 2) is enclosed by a trunk 48.

The trunk 48 may be of any suitable construction, such as sheet metal, and is suitably shaped to enclose the conduit 46 and be sealed to the deck 50 of the engine room by seals 52 and bolt fasteners 54. The trunk 48 is provided to collect any gas evolving from fuel oil which may possibly leak from the conduit 46, and the trunk 48 is suitably vented to a point outside the engine room, such as through the same vent system used for the hood 44 over the engine 36, as will be described below.

As shown in FIG. 3 the engine 36 is mounted along the center line of a ship 56 in the usual fashion. The exhaust 58 of the engine 36 extends upwardly and includes the usual gas heater 60 and spark arrestor 62 to utilize the heat of the exhaust and prevent the discharge of sparks from the engine, respectively, through the exhaust system.

The hood 44 enclosing the portion of the fuel system on the engine 36 as previously described is provided with a vent line 64 extending vertically through the upper decks of the ship. A vent fan 66 is interposed in the line 64 and is driven by a suitable motor 68 positioned out of the engine room 70 in order to draw all gases from the hood 44 out of the engine room and direct such gases vertically upward to above the upper deck of the ship where they can be discharged safely into the atmosphere.

The crude oil storage tank 10 is shown in FIG. 3 at one side of the engine room 70 of the ship. When located in this position, the crude oil storage tank 10 should be separated from the engine room by a cofferdam 72 to assure that any crude oil leaking from the tank 10 will not enter the engine room and cause a hazardous condition. A second crude oil storage tank 10a may be located on the opposite side of the ship 10, and on the opposite side of the engine room 70, to provide additional fuel storage for the engine 36. This latter crude oil storage tank is also separated from the engine room by a cofferdam 72. It will be further understood by those skilled in the ship-building art that the storage tanks 10 and 10a may be located at any other point in the ship 56, and particularly when the ship 56 is a crude oil tanker.

As shown in FIG. 4, the pump room 74 is separated from and sealed from the engine room 70 by a bulkhead 75. In the present system it is preferred that no access ports be provided directly between the engine room 70 and the pump room 74 in order to assure that any gases evolving in the pump room will not enter the engine room 70 and create a hazardous condition. The fuel oil transfer pump 12, the crude oil settling tank 14, all of the purifiers 18, the crude oil sludge tank 22, the crude oil service tank 28, the fuel oil service pump 32 and the fuel oil booster pumps 34 are all positioned in the pump room 74 in order that any gases leaking or escaping from this equipment will not enter the engine room 70. As previously indicated, the pumps 12, 32 and 34 are preferably steam driven to prevent the creation of hazardous conditions in the pump room 74. The purifiers 18 are driven by electric motors 76 in the usual fashion, but the motors 76 are positioned in the engine room 70 and are connected to the purifiers by drive shafts 78 extending through the bulkhead 75. Also, suitable seals 80 are provided around each of the drive shafts 78 at the bulkhead 75 to prevent the escape of gas from the pump room 74 into the engine room.

This invention also contemplates the maintenance of the pump room 74 under a pressure above atmospheric by means 77, which may comprise a forced air fan or any other suitable means which is well known in the art to discourage gas evolving from crude oil at any of the equipment in the pump room. In this latter instance the pump room may be located in a position remote from the engine room, rather than in the position illustrated in FIG. 4.

The various piping between the equipment has been eliminated from the structural drawing in FIG. 4 to more clearly illustrate the locations of the equipment. It

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will be understood, however, that the various pieces of equipment are connected by piping as schematically illustrated in FIG. 1, and as previously described.

As an example of the use of the present invention, a series of tests were made using a standard Sulzer 6RD68 marine diesel engine with six cylinders and having an output of 6,600 B.H.P. at 135 rev./min. The standard fuel pumps, fuel valves, timing gear, etc., were unchanged on this engine, and the engine was run on straight mineral oil as the cylinder lubricant. The engine was provided with a hood over the fuel blocks, and the fuel overflow system of the engine was sealed as set forth above. The crude oil fuel was centrifuged in a standard De Laval marine centrifuge with the crude oil fuel being delivered to the fuel pumps in an unheated condition at about 18–22° C. In these tests the fuel tank was run under a pressure of 2.5 kg./cm.², then at 1.0 kg./cm.², and, finally, without pressure being applied to the fuel tank, with no difference in the results obtained on the engine. The pressure at the after fuel filter was about 6.0 kg./cm.² at the inlet and 5.5 kg./cm.² at the outlet, with the pressure in the six fuel pumps being 595–635 kg./cm.² at 100 percent load. The engine started on the initial attempt while operating on unheated crude, and the exhaust was without coloration, except for a barely perceptible haze. The engine was observed to operate during the tests at less noise than when operated on conventional diesel fuel, and with an increase in efficiency of fuel consumption at 100 percent load using the crude oil as the fuel. The exhaust temperature on the engine was also observed to be lower when using crude oil as the fuel, rather than conventional diesel oil. A minimum running speed of 36 rev./min. was recorded; and in the course of starting tests from an air reservoir of 13 m.³ capacity, 37 ahead-astern starts were obtained in turn from 16.4 to 4.2 kg./cm.² starting air pressure giving a starting air consumption figure of 0.67 litre/B.H.P.-maneuver. The particular crude oil used in this series of tests had a paraffin content of 9.2 percent by weight; a viscosity of 4.03 centistokes at 20° C. (compared with 3.4 centistokes for conventional marine diesel oil); a calorific value of 10.232 cal./kg. (compared with a calorific value of 10.177 for conventional marine diesel oil), and a specific gravity of 0.814 at 20° C. (compared with a specific gravity of 0.822 at 20° C. for conventional marine diesel oil). Upon being torn down following the tests, the engine disclosed no deposits about the fuel nozzles and no chocking of the purifier nozzles or filters was found.

The paraffin content of crude petroleum oil is an excellent lubricant for diesel engines; and it is believed that the increased liner wear and general engine maintenance reductions on using crude oil is attributable to a large degree to such paraffin content.

It will be apparent to those skilled in the art that the use of crude petroleum oil as the fuel for the main propulsion system of a ship will avoid the now frequent necessity of bunkering in remote locations to take on specially refined fuels. It will also be apparent that crude petroleum oil is cheaper than conventional diesel oil, and yet provides a greater energy per volume. The present invention will provide a greater flexibility in the operations of ocean-going vessels, including increased cargo-carrying capacity, and will be particularly useful on crude oil cargo ships.

Changes may be made in the combination and arrangement of parts or elements as well as in steps and procedures as heretofore set forth in this specification, and as shown in the drawings, without departing from the spirit and scope of the invention as defined in the following claims.

We claim:

1. In combination with a crude oil tanker having a

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plurality of compartments therein sealed from one another and having a storage tank therein containing crude petroleum oil;

a compression-ignition internal combustion engine having fuel pumping means and fuel overflow means thereon and being located in one of said compartments;

a hood for collecting gases evolving adjacent the engine and preventing the escape of said gases into the compartment containing the engine;

a transfer pumping means connected to the storage tank and the fuel pumping means on the engine for transferring said crude to the engine, said transfer pumping means being located in a second of said compartments;

a centrifuge interposed in the connection of the transfer pumping means to the engine fuel pumping means for removing foreign matter from said crude, said centrifuge being located in a second of said compartments;

a sludge tank communicating with said centrifuge; and means for maintaining said second of said compartments above atmospheric pressure.

2. The combination defined in claim 1 characterized further to include trunks enclosing the crude carrying conduit leading from the transfer pumping means to the engine within said one compartment.

3. A drive system for an ocean going vessel, comprising:

a compression-ignition internal combustion engine; fuel pumping means communicating with said engine; fuel overflow means adjacent said engine to receive fuel overflowing therefrom;

a supply tank for containing crude petroleum oil;

a transfer pumping means connected to the supply tank and the fuel pumping means for transferring said crude to the engine;

a centrifuge interposed in the connection of the transfer pumping means to the engine fuel pumping means for removing foreign matter from said crude;

a sludge tank communicating with said centrifuge for receiving and holding said foreign matter from said centrifuge;

a pressurized compartment containing said centrifuge and said transfer pumping means to minimize gasification of said crude,

a hood sealed around the fuel inlet side of said engine; and,

a vapor extraction fan connected to said hood for moving said gases from the vicinity of said engine.

4. The system defined in claim 3 further characterized by a fuel line between said engine and said supply tank, said line having a trunk formed therearound for collecting any gas evolved from the fuel line.

5. The system defined in claim 3 further characterized by a settling tank interposed between said transfer pumping means and said centrifuge.

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