Sept. 29, 1970 A. F. ENEMARK 3,531,220

OIL-FEED EQUIPMENT OPERABLE AS A SINGLE-LINE OR DOUBLE-LINE SYSTEM

Filed Aug. 15, 1968 2 Sheets-Sheet 1

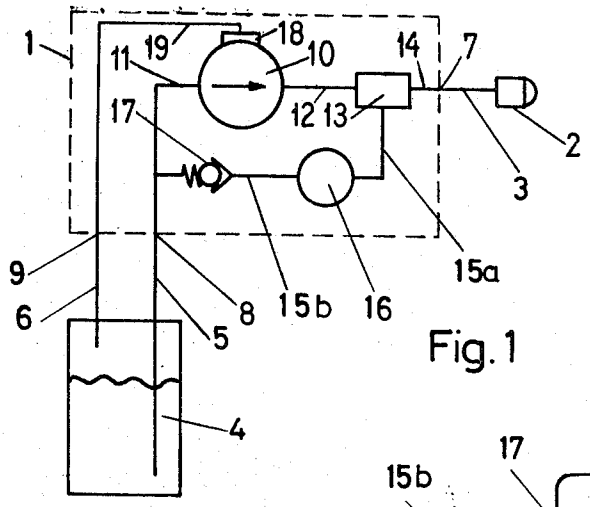


Fig. 1

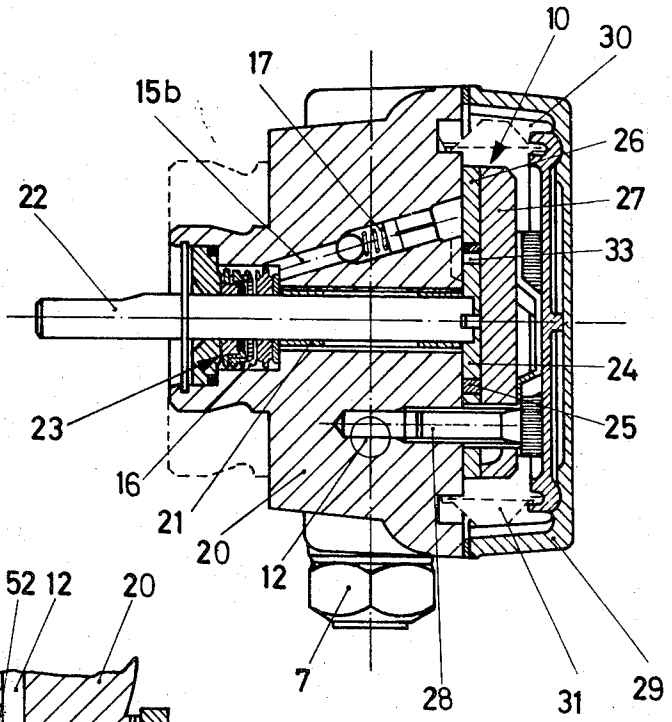


Fig. 2

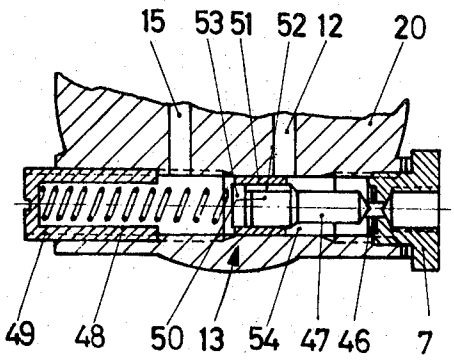


Fig. 6

OIL-FEED EQUIPMENT OPERABLE AS A SINGLE-LINE OR DOUBLE-LINE SYSTEM

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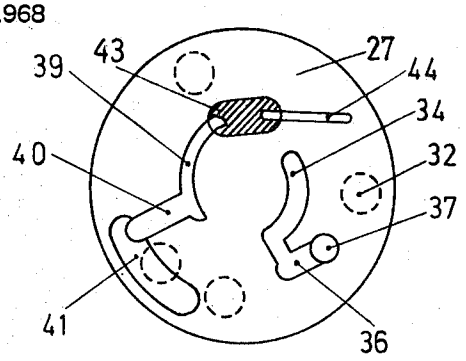


Fig. 3

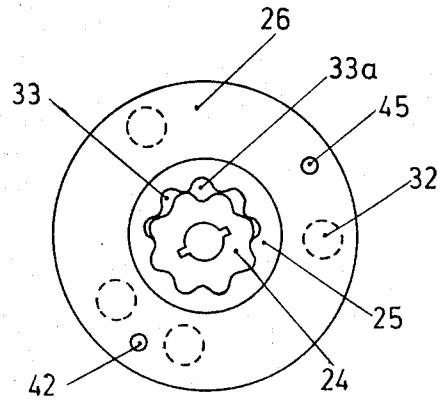


Fig. 4

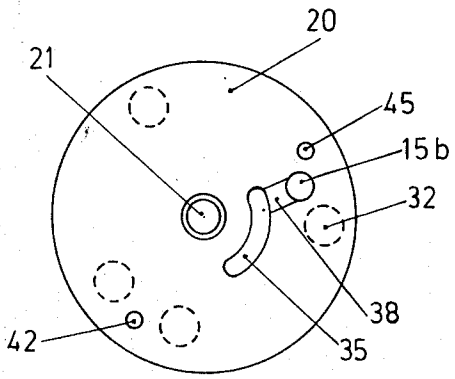


Fig. 5

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OIL-FEED EQUIPMENT OPERABLE AS A SINGLE-LINE OR DOUBLE-LINE SYSTEM

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ABSTRACT OF THE DISCLOSURE

The invention relates to oil pumping apparatus of the type used for oil burning equipment. The pumping apparatus includes air separating means on the pressure side of the pumping apparatus having a conduit associated therewith for venting the separated air. Means are provided for making the air separating means operative, at the option of the user, for particular installations such as where the tank is located below the pump or, if not needed, the air separating means may be made inoperative. The pumping apparatus also includes a pressure regulator valve which, in connection with its pressure regulating function, returns excess oil to the suction side of the pumping apparatus through a return line which has no functional connection with the air separating means. The operation of the pressure regulator valve is the same, and the same return line is used, regardless of whether or not the pumping apparatus is set to utilize the function of the air separating means.

This invention relates to an oil-feed system, optionally operable as a single-line or double-line system, and comprising a pump and a pressure-regulating valve, arranged in series therewith, the excess oil from which valve flowing via a return passage to the suction side of the pump during single-line operation.

In the known single-line systems, wherein only the pump suction pipe connects the tank with the rest of the equipment, the excess oil is passed to the suction side of the pump by way of the return passage. In the known double-line systems, wherein, in addition to the pump suction pipe, a return pipe is provided between the tank and the rest of the equipment, the excess oil is carried back into the tank through the return pipe. The double-line system is used if a vacuum can occur in the suction pipe, i.e. if the tank is arranged below the pump. In this mode of operation, it is known to employ measures for returning, to the tank, by way of the return pipe, any air that may find its way into the feed equipment.

Oil-feed equipment which is optionally operable as a single-line or double-line system is known wherein the pipe carrying the excess oil from the pressure control valve is connected to the shaft stuffing box chamber of the pump, which chamber serves as an air-separating chamber during double-line operation. On the one hand there branches from this chamber, at an upper point, a return pipe for connecting the second line through which excess oil, together with air, can be carried away, and on the other hand the return passage branches therefrom to the suction side. The last-named passage is provided with a check valve which keeps the passage closed when the second line is connected. The return pipe to the tank can be closed by means of a blocking screw, so that, during single-line operation, the check valve in the return passage to the suction side of the pump opens.

The air separation in the excess oil pipe renders it necessary for the pressure-regulating valve, at least each time the pump starts up and independently of the pump-pressure, to be kept open until the required air has been

carried away by way of the stuffing box chamber. If, as a result of slight contamination, the check valve does not close quite tightly, a by-pass occurs when the pump starts up and this has an adverse effect upon the suction power of the pump and causes uncertainty as to whether the required operating condition has been reached. Whilst, in a similar system, it is known to replace the check valve by a hand-operated stop-valve, this sacrifices the advantage whereby change-over to single-line operation only occurs by cutting off the second line. Also, in equipment of this kind, the drive motor must be designed for the power necessary in two-line operation, which power is considerably greater than in the case of single-line operation, since the entire quantity of oil to be fed must be sucked from the tank, whereas in single-line operation only the quantity exceeding the excess oil is drawn out of the tank.

An oil-feed system is also known wherein an air-separation device is arranged between the pump and the pressure-regulating valve. Here, the excess oil and the air-laden oil are returned from the separating device into the tank. If the same system is also to be used for single-line operation, then in this mode of operation the oil leaking from the air-separating device must be continuously circulated to the suction side of the pump by way of the return pipe.

The object of the present invention is to provide oil-feed equipment for optional operation as a single-line or double-line system which, for both modes of operation, ensures reliable high-speed running, provides the possibility of being changed over from one mode of operation to the other by means of only one actuating member, and has the lowest possible power consumption for both modes of operation.

According to the invention, this object is achieved by passing the excess oil likewise through the return passage during two-line operation and by connecting the second line to an air-separating device contained in the main path of the oil on the pressure side.

In this arrangement, the excess oil takes the same path in both modes of operation. A change-over from one path to another therefore does not arise. The same steps for both types of operation can be taken in the common return passage, e.g. the pressure in the shaft stuffing box chamber can be influenced in a particular manner. Also, in the case of double-line operation, the pump needs to suck up only that quantity of oil which is surplus to the excess oil, i.e. that amount of oil actually delivered to the nozzle. Consequently, the power requirement is small and roughly equal for both modes of operation. The function of the second line is limited to the removal of air and to dealing with the quantity of oil required for this, which quantity is substantially smaller than the excess oil. Since this outlet communicates only with the second line, it can be rendered completely non-operative as regards single-line operation. Since the equipment also has the same circuit for single- and double-line operation, the rendering inoperative of the outlet of the air-separating device suffices to "change-over" from one mode of operation to the other.

A particularly simple possible way of rendering said outlet non-operative consists in providing for a port for the second line and connected to the air-separating device to be closable by means of a plug during single-line operation. This corresponds to the routine practice of a fitter whereby he closes an unrequired connection by means of a plug. This, however, completes the change-over from double-line operation to single-line operation.

In a preferred embodiment, use is made of a gear pump, the chambers of which are formed by the gaps between the teeth of an externally castellated wheel and an internally castellated ring. Here, in the region of the

pump chambers of greatest volume, the pressure passage has, towards the suction passage, an extension of very small cross-section extending over approximately the distance of one pitch, the end of which extension is connected to the second line by way of a passage. This provides a very effective air-separating device having a throttle action whereby the quantity of oil carried away with the air is relatively small. Furthermore, a gradual rise in pressure is achieved from the suction side to the pressure side, so that the pump runs very much more smoothly.

In a further form of the invention, the pressure-regulating valve can remain tightly closed until the pump pressure has reached the value at which the pressure-regulating valve is set. Since the air is separated in the main path of the oil, the return passage to the suction side of the pump can be kept tightly closed during start-up with the help of the pressure-regulating valve already present, so that there can be no by-passing through the return passage that would adversely affect the suction conditions.

It is also possible to provide, in the return passage, a spring-loaded check valve which only opens at a predetermined minimum pressure. This check valve is operative both in single-line operation and in double-line operation and can therefore take over the required functions in both cases. Contamination of this valve does not lead to by-passing of the pump, since the interposed pressure-regulating valve is tightly closed during start-up.

In particular, and in known manner, the excess oil can be passed through the shaft stuffing box chamber of the pump, the check valve being fitted beyond this chamber. In both modes of operation, this chamber is then under a higher pressure than is otherwise usual. Consequently, the loss of oil by leakage from the pressure side of the pump through the pump bearing to the stuffing box chamber is smaller. In addition, the oil pressure can be utilized for pressing the running ring of the seal against its seat.

Hitherto, the return passage led into the pump suction chamber which usually also contains a filter or has a filter fitted in front of it. A further reduction of the work done by the pump is achieved, however, if the return passage opens directly into the suction passage of the pump, that is, between the suction chamber of the pump and the actual pump chambers.

In particular, the pump can here be provided on both sides with a suction passage, that one facing the shaft stuffing box being connected to the return passage and the other to the suction chamber of the pump. In this way, the gear of the pump is loaded by the suction pressure on both sides and therefore uniformly. Furthermore, the return passage can be extremely short and its resistance therefore kept down.

The invention will now be described in more detail by reference to an embodiment illustrated in the drawing, wherein:

FIG. 1 shows the circuit of the oil-feed equipment according to the invention,

FIG. 2 is a longitudinal section through the pump-valve unit,

FIG. 3 is a plan view of the end face of the pump cover-plate facing the pump,

FIG. 4 is a plan view of the end face of the pump gears facing the housing and of the ring surrounding them,

FIG. 5 is a mirror-image plan view of the housing end-face facing the pump gears, and

FIG. 6 shows the construction of a combined pressure-regulating and cut-off valve which may be used in conjunction with the invention.

In the circuit shown in FIG. 1, the oil-feed equipment is illustrated for two-line operation. The equipment consists of a pump-valve unit **1**, a nozzle **2** plus nozzle-pipe **3** and an oil tank **4** with the first line **5** for supplying the oil, and a second line **6** for the return path. As far as the present invention is concerned, the unit **1** has three connecting ports, namely port **7** for the pipe running to the nozzle, port **8** for the first line and port **9** for the second line. Forming part of the unit **11** is a gear pump **10** which sucks oil from the port **8** by way of a suction passage **11** and feeds it via a suction passage **12** to a combined pressure-regulating and cut-off valve **13** and via a further passage **14** to the port **7**. A return pipe **15** running to the suction side of the pump **10** branches from the pressure-regulating valve **13**. The first portion **15***a* of this pipe opens into the shaft stuffing box chamber **16** of the pump **10**. In the second portion **15***b* of the return pipe **15** there is provided a check valve **17** which, during operation, maintains the pressure in the chamber **16** at a predetermined value.

Connected to the pump **10** is an air-separating device **18** which leads to the port **9** by way of a passage **19**. During double-line operation, oil mixed with air is passed back into the tank **4** through this passage **19**. During single-line operation the connection **9** is closed by a plug, so that this part of the equipment is inoperative. The remaining part of the unit **1**, however, is operative in like manner for both modes of operation.

Some parts of the unit **1** can be seen in the longitudinal section shown in FIG. 2. A housing **20** contains the bearing **21** for the pump shaft **22** and the chamber **16** for the shaft stuffing box, here taking the form of a rotary seal **23**. The housing also contains the valves **13** and **17**, as well as numerous passages in the form of bores. The connecting ports are also formed on the housing. In the longitudinal section, the check valve **17**, the passages **12** and **15***b*, as well as the port **7** can be seen. Located at the end face of the housing **20** is the pump **10** which comprises a gearwheel **24** driven by the shaft **22** and a toothed ring **25**. The latter is mounted to rotate in a housing ring **26**. A cover plate **27**, which also contains distributing passages, covers the gear wheels **24** and **25** and is secured to the housing by means of screw bolts **28**. The pump **10** is surrounded by a cover **29**, which encloses the suction chamber **30** of the pump, in which chamber a filter **31** is fitted.

In FIGS. 3–5, which, in superimposed manner, illustrate the way in which the pump functions, the drilled holes **32** for accommodating the screw bolts **28** are just shown in broken lines. Between the gearwheel **24** and the toothed ring **25** are formed pump chambers **33**, the largest of which **33***a* will occupy the position shown in the drawing. On the cover-plate **27** as well as on the end wall of the housing **20** are located arcuate suction passages **34** and **35**. The passage **34** communicates with the suction chamber **30**, within the filter **32**, by way of a connecting passage **36** and a bore **37**. The suction passage **35** communicates, via a connecting passage **38**, with the return passage portion **15***b* behind the check valve **17**. On the suction side, the pump chambers **33** can therefore be fed from both sides. The cover-plate **27** also has an arcuate pressure passage **39** which communicates with the passage **12** in the housing by way of passage portions **40** and **41** and bores **32** in the ring **26** and in the housing **22**. A similar pressure passage **39** could be additionally provided at the end-face of the housing **20**.

Contiguous with the pressure passage **39** and extending in the direction of the suction passage **34** is an extension **43** having a very small cross-section and therefore very considerable resistance. The depth of the extension may be only $\frac{1}{10}$ mm., for instance. A passage **44** and bores **45** in the ring **26** and in the housing **20** lead from the end of this extension **43** to the pipe **19**. This arrangement forms the air-separating device. The extension extends over approximately the distance of one tooth pitch. When the pump supplies air, the air tends to escape through the extension **43** and the passage **44** to a greater extent than does the oil. Since the extension **43** covers the entire tooth width, the included air can be almost completely removed. On the other hand, the amount of any

air that might escape during operation is limited on account of the pronounced throttle action of the extension **43**. The extension also effects compensation when the pump chamber **33** again becomes smaller in the direction of the suction side. Consequently, a gradual increase in pressure from the suction side to the pressure side takes place. Apart from separating the air, this arrangement therefore also ensures smoother running of the pump.

A pressure-regulating and cut-off valve **13** is shown in FIG. 6. The port **7** for the nozzle pipe **3** carries the seat **46** of the cut-off valve, the body **47** of which is loaded by a spring **48** which can be pre-tensioned by means of a screwed member **49**. As soon as the pressure in the pipe **12** has reached a certain value, the cut-off valve **46, 47** opens. Joined to the body **47** of the cut-off valve is the body **50** of the regulating valve, which latter body co-operates with an insert **51**. The body **50** has a passage **52** and a flange **53** which, together with the insert **51**, forms a slide valve. This pressure-regulating valve **51, 53** remains closed, even when the cut-off valve **46, 47** has already opened, for as long as a certain pressure is not exceeded in the chamber **54**. When this value is reached, this pressure-regulating valve **51, 53** opens each time to an extent permitting just enough oil to flow back through the passage **15** for the pressure in the nozzle pipe **3** to remain constant.

Instead of the air-separating device described, other air-separating devices can be inserted in the main path of the oil, provided that the amount of oil flowing away through them during operation can be kept small, for example by means of appropriate throttle devices or by means of a suitable construction of the cut-off device. A pressure-regulating valve and a cut-off valve separate from each other can also be used and they may be of any appropriate construction. Nor is it necessary for the pressure-regulating valve to keep the return path blocked during the start-up phase; a further valve controlled by the start-up conditions can also be used for this blocking function.

I claim:

1. Oil pumping apparatus comprising a casing, suction inlet means and pressure outlet means in said casing, air separating means having fluid communication with said pressure outlet means, vent means for said air separating means, a pressure regulating valve connected to said pressure outlet means on the downstream side thereof from said air separating means, and return passage means between said regulating valve and said suction inlet means for returning excess oil to said suction inlet means.

2. Oil pumping apparatus according to claim **1** including means for closing the downstream side of said venting conduit to incapacitate said air separating means.

3. Oil pumping apparatus according to claim **1** having gear elements operative to form expansible and contractible chambers, each of said chambers when fully expanded being adjacent said air separating means, said air separating means including a recess of small cross section having fluid communication with said pressure outlet means and said venting conduit and with fully expanded ones of said chambers, said recess extending circumferentially a distance approximating one tooth pitch of said gear elements.

4. Oil pumping apparatus according to claim **1** wherein said pressure regulating valve remains fully closed until the pressure developed by said pumping means reaches a predetermined value.

5. Oil pumping apparatus according to claim **1** wherein check valve means are provided in said return passage means, and resilient means maintaining said check valve means closed below a predetermined pressure.

6. Oil pumping apparatus according to claim **5** including a shaft stuffing box chamber, said stuffing box chamber forming a portion of said return passage means and being disposed between said pressure regulating valve and said check valve means.

7. Oil pumping apparatus according to claim **6** wherein said return passage means is entirely within the confines of said casing.

8. Oil pumping apparatus according to claim **2** wherein said suction inlet means has a portion thereof on each side of said gear elements, one of said portions of said suction inlet means having fluid communication with said return passage means and the other of said portions having fluid communication with said external port.

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