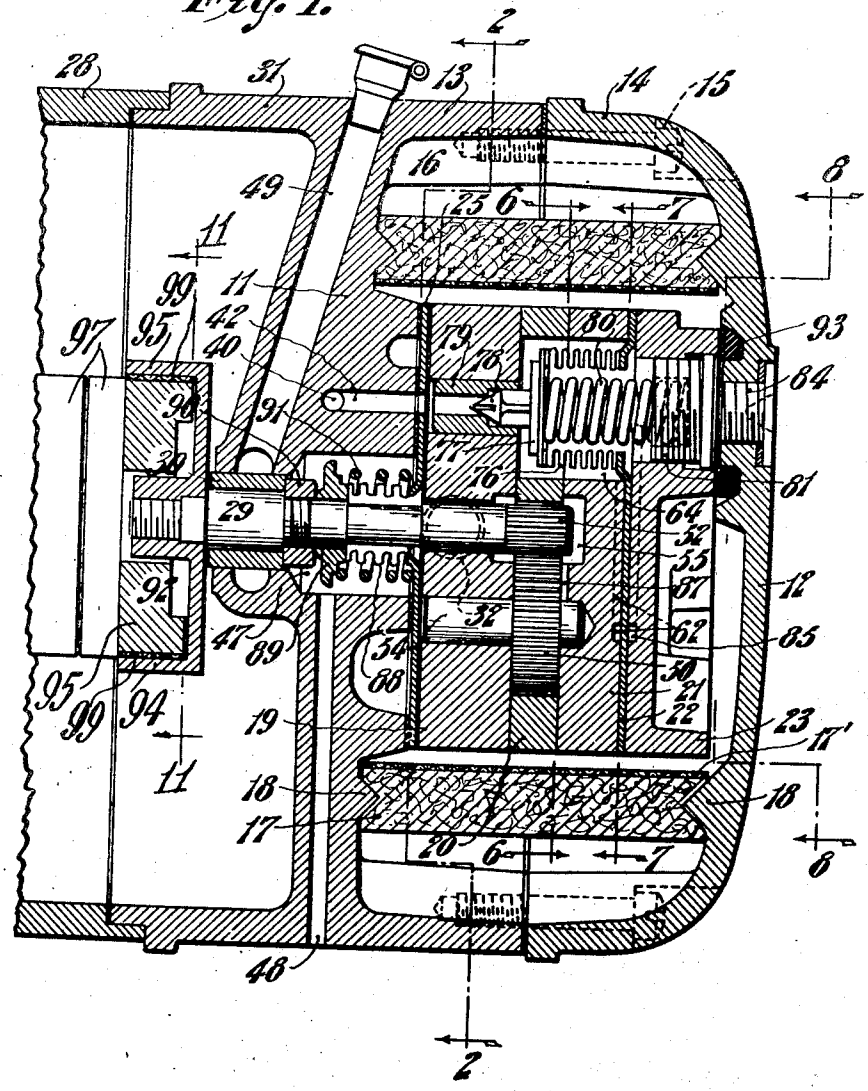
Dec. 24, 1946. D. C. ELLIOT 2,413,040

FUEL PUMPING UNIT

Filed May 18, 1944 4 Sheets-Sheet 1

Fig. 1.



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Filed May 18, 1944 4 Sheets-Sheet 2

Fig. 3.

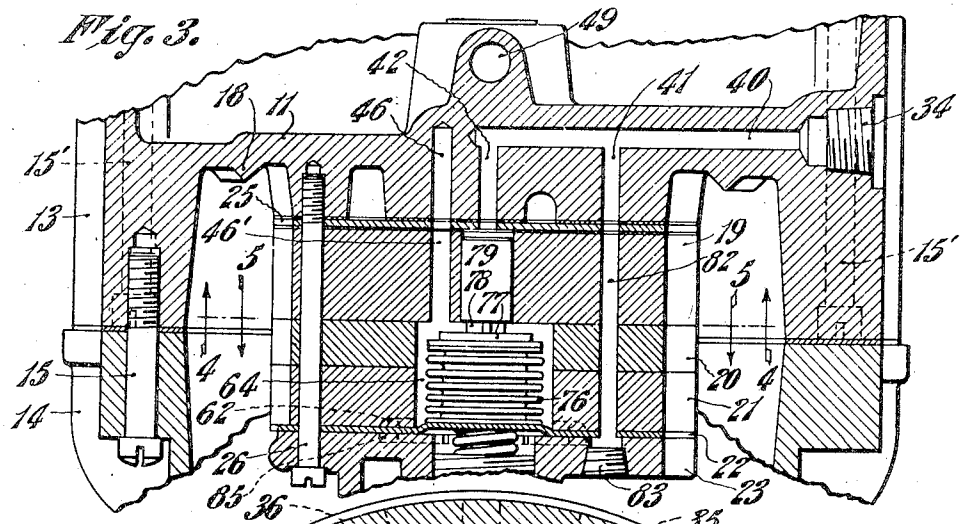
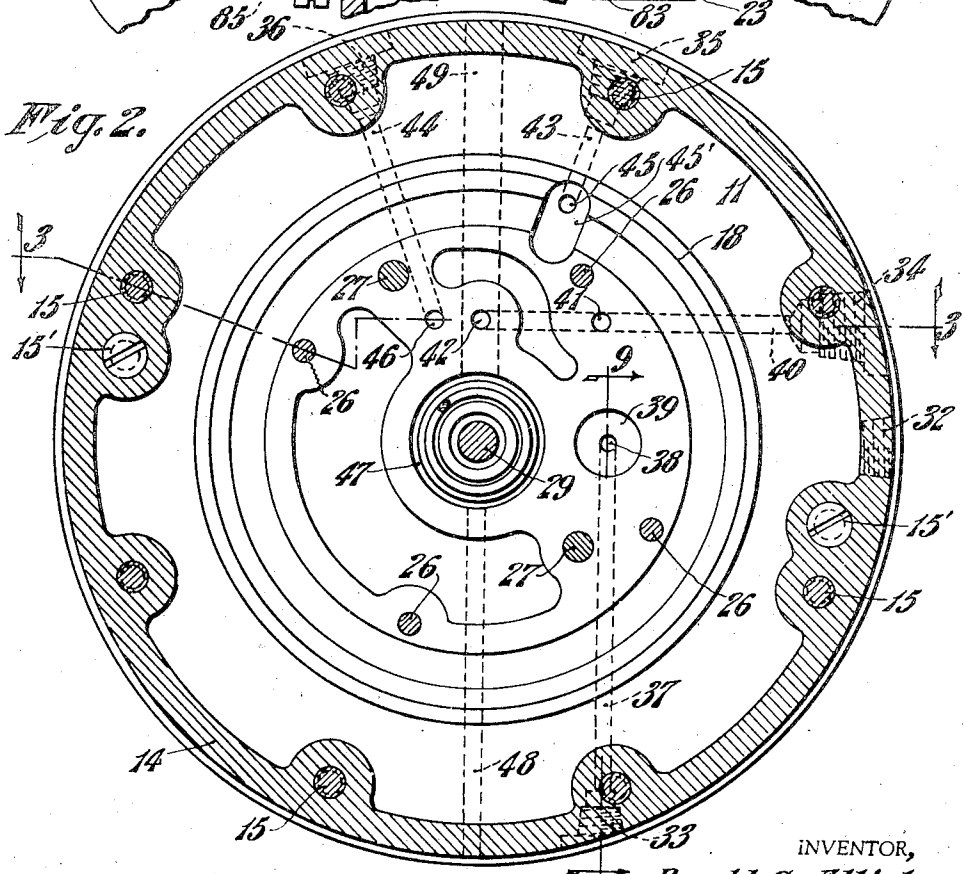


Fig. 2.



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Filed May 18, 1944 4 Sheets-Sheet 3

Fig. 4.

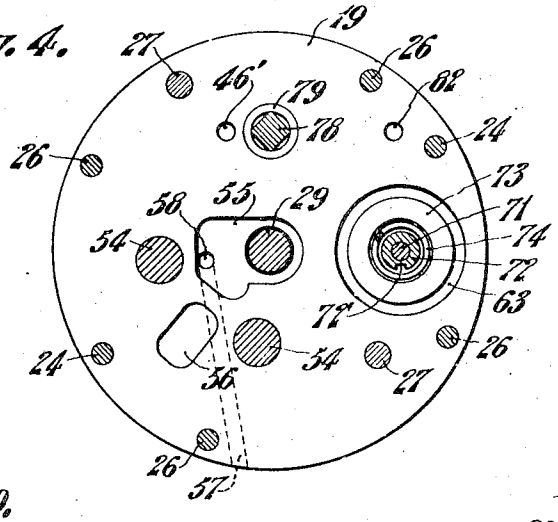


Fig. 10.

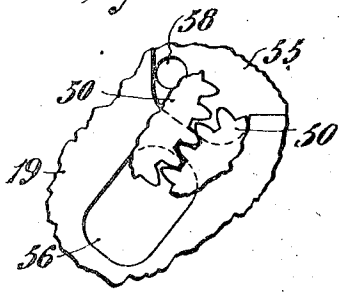


Fig. 5.

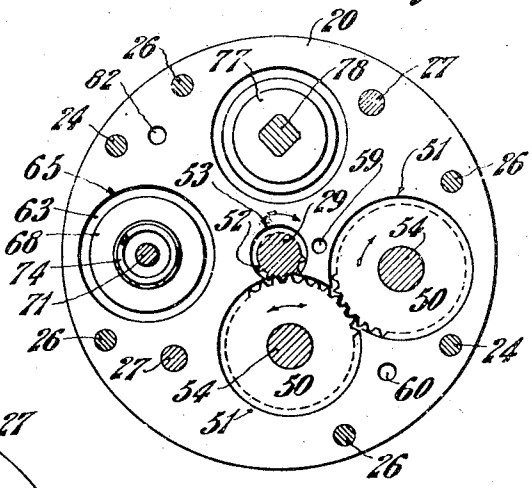
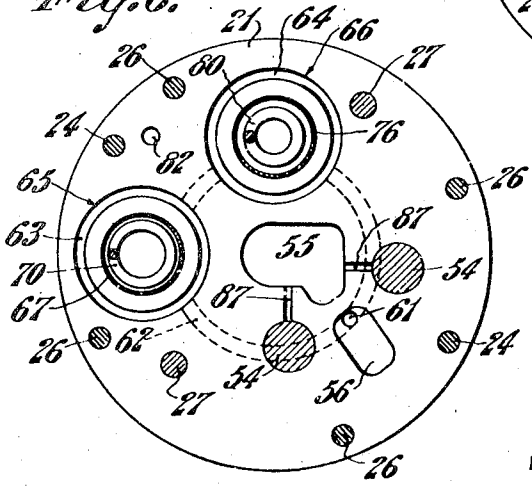


Fig. 6.



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FUEL PUMPING UNIT

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Fig. 7.

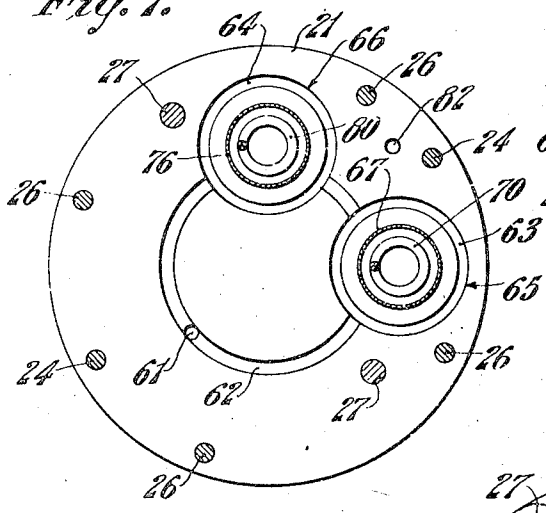


Fig. 12.

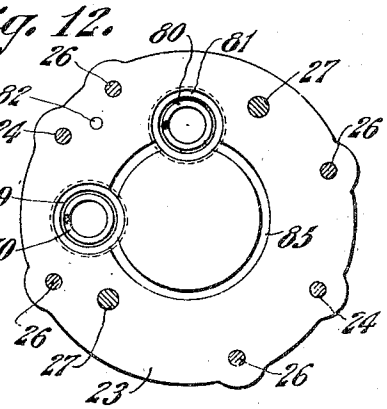


Fig. 8.

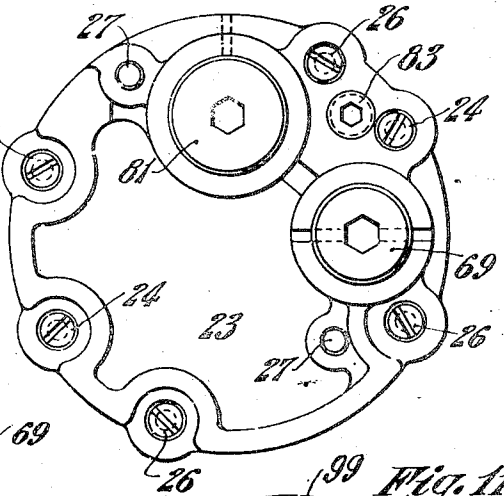


Fig. 9.

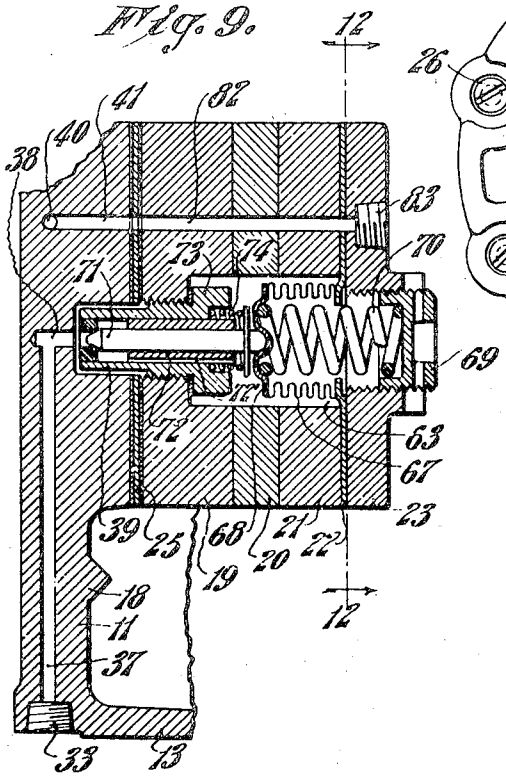
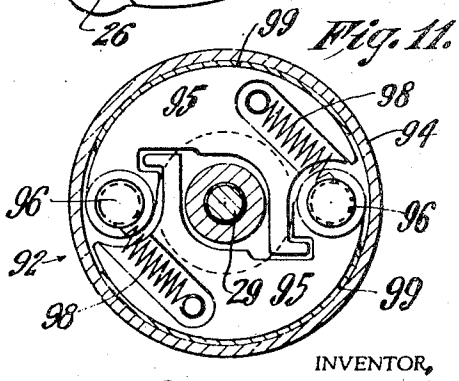


Fig. 11.



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Patented Dec. 24, 1946 2,413,040

UNITED STATES PATENT OFFICE

2,413,040

FUEL PUMPING UNIT

Donald C. Elliot, West Springfield, Mass., assignor to Gilbert & Barker Manufacturing Company, West Springfield, Mass., a corporation of Massachusetts

Application May 18, 1944, Serial No. 536,224

4 Claims. (Cl. 103—42)

1

This invention relates to improvements in fuel pumping units for oil burners.

These pumping units usually include a positively-acting displacement pump for the oil, a driving motor for the pump and a pressure regulating valve. There is also included in many cases, a burner cut-off valve which closes the outlet from the pump to the burner nozzle until a predetermined minimum oil pressure has been built up by the pump. The pressure regulating valve opens, after a predetermined maximum oil pressure has been built up by the pump, and allows excess oil to be by-passed either back to the supply tank or to the suction side of the pump. The pressure regulating valve is a safety valve which definitely limits the pressure that can be built up by the pump and holds it within a safe limit.

The pressure regulating valve usually includes a diaphragm, bellows or other form of movable wall in a chamber. One side of this wall is exposed to the pressure of the liquid pumped into the chamber. A spring acts on the other side of such wall with a tendency to close the valve. When the force due to liquid pressure overcomes that due to the spring, the valve opens and allows oil to flow from the chamber into a by-pass. The difficulty with this arrangement is that in the event of a leak in the movable wall, such as a crack in the diaphragm if one is used, or a fracture of the bellows when this form of movable wall is used, liquid pressure will then act equally on both sides of the movable wall and the valve will be closed by its spring. There will then be no outlet adequate to pass enough liquid to keep the pump pressure within safe limits. There is usually a small by-pass, such as a nick in the pressure regulating valve or its seat, which is open at all times but this is too small to serve the purpose. If a burner cut-off valve is used, that valve would open and afford an outlet. However, this outlet shouldn't be used for this purpose because oil at much higher pressures than were intended would be emitted from the nozzle and cause an unsafe condition. Hence, if a burner cut-off valve is used in the pump unit, it should be made to close on failure of the pressure regulating valve. Of course any failure of the bellows or other movable wall of the cut-off valve would cause that valve to close but the pressure regulating valve would act as a safety valve and prevent dangerous pressures from being built up. But if the movable wall of the pressure regulating valve fails, then the safety means

2

fails and dangerous pressures can build up in the pump.

This invention has for an object to provide in a fuel pump, having a pressure regulating valve, a clutch in the drive between the pump and its motor for the purpose of limiting the pressure that can be built up in the pump in the event of failure of the pressure-regulating valve to function, the clutch slipping under the increased load caused by pressures higher than the usual limits and thereby preventing dangerous pressures from being established.

Another object of the invention is to provide in apparatus of the class just described, a burner cut-off valve and a passage at all times interconnecting the spring side of the movable wall of the cut-off valve and the spring side of the movable wall of the pressure regulating valve, whereby on failure of the wall of the latter, liquid pressure on opposite sides of the movable wall of cut-off valve will be equalized so that the cut-off valve will be closed by its spring.

These and other objects will best be understood as the detailed description proceeds and they will be particularly pointed out in the appended claims.

The invention will be disclosed with reference to the accompanying drawings, in which,

Fig. 1 is a sectional elevational view of a fuel feeding unit embodying the invention;

Fig. 2 is a cross sectional view taken on the line 2—2 of Fig. 1 and showing the body or supporting member of the unit;

Fig. 3 is a fragmentary sectional plan view taken on the line 3—3 of Fig. 2;

Figs. 4 and 5 are cross sectional views taken on the lines 4—4 and 5—5, respectively, of Fig. 3 and showing one face of one of the end plates for the pump and the pump plate, respectively;

Figs. 6, 7 and 8 are cross sectional views taken on the lines 6—6, 7—7, and 8—8, respectively of Fig. 1 and showing the inner face of the other end plate for the pump; the outer face of the last-named end plate; and the cover plate for the pumping unit;

Fig. 9 is a fragmentary sectional view taken on the line 9—9 of Fig. 2;

Fig. 10 is an enlarged fragmentary cross sectional view showing the relationship of the intermeshed gear teeth with the inlet and outlet ports;

Fig. 11 is a fragmentary cross sectional view taken on the line 11—11 of Fig. 1; and

Fig. 12 is a cross sectional view taken on the line 12—12 of Fig. 9.

Referring to these drawings, the pumping unit

(Fig. 1) includes a housing having a body member 11 and a cover member 12. These members 11 and 12 have mating and confronting circular flanges 13 and 14, respectively, which are suitably held together, as by cap screws 15 (see also Figs. 2 and 3). These two housing members afford between them an inlet chamber 16 for the pump. They also support between them a suitable filter 17 of annular form, as by means of the annular rings 18 (Figs. 1, 2, and 3) of triangular section which engage one in each end face of the filter. This filter is preferably made of absorbent material for a purpose which will later be explained. It may, for example, consist of cotton thread wound upon a coarse mesh wire screen 17'.

Within the inner chamber, which is formed within the filter 17, is located the pumping unit proper. This unit (Fig. 1) comprises an inner end plate 19, a pump plate 20, an outer end plate 21, a thin bellows-bearing disc 22 and a cover plate 23. These several plates and disc 22 are held together by a pair of cap screws 24, which are indicated in Figs. 4 to 8 and which pass loosely through plates 23, disc 22 and plates 21 and 20 and thread into plate 19. These screws 24 serve to hold the component parts of the unit in proper assembled relation while it is being mounted in place on the body or supporting member 11. The assembled unit is held to one finished face of member 11, with a seal-ring bearing disc 25 and suitable gaskets clamped therebetween, by a plurality of cap screws 26, which are best shown in Fig. 2 and also indicated in Figs. 3 to 8 inclusive. These screws 26 pass loosely through all the plates and both discs and are threaded into member 11. A pair of dowels 27, fixed in member 11, extend through and closely fit registering holes in the several plates and both discs and gaskets and serve accurately to hold all these plates and discs in proper angular relation with each other and with member 11.

The housing member 11 may be, and desirably is as shown, an end plate for a pump driving member, such as an electric motor. This motor has a smooth, cylindrical exterior, indicated in part at 28 and of the same diameter as the smooth cylindrical exterior of the parts 13 and 14. The motor serves to drive the shaft 29, which has a bearing 30 in the member 11. The latter has a circumferential flange 31 to fit the motor casing and is suitably held thereto, as by screws 15'. Flange 31 is of smooth cylindrical form and of the same diameter as parts 28, 13 and 14. An outer casing of smooth, unbroken, streamlined form is thus provided.

All pipe connections are made to the body member 11, whereby the cover 12, filter 17 and the pump unit may be removed without disturbing any pipe connections. Referring to Fig. 2, there are ports 32, 33 and 34 for connection, respectively, to a suction pipe leading from the fuel oil supply tank; to a pipe leading to the burner nozzle; and to a return pipe leading back to said tank. There are also ports 35 and 36 for connection to vacuum and pressure gauges, respectively. The inlet port 32 opens directly into chamber 16 through the peripheral wall 13 thereof. The burner port 33 is connected by a passage 37 (see also Fig. 9) which leads upwardly to and connects with a short passage 38, leading outwardly to and opening into a well 39 formed in the outer face of the member 11. The by-pass port 34 (Figs. 2 and 3) is connected by a horizontal passage 40 to each of two short passages

41 and 42 which open outwardly to said face of member 11. The ports 35 and 36 are connected by passages 43 and 44 to short passages 45 and 46, respectively, which lead outwardly to said face of member 11. The passages 38, 41, 42 and 46 open in said face at points within the area covered by the end plate 19 of the pumping unit, while the passage 45 opens into a recess 45' which lies outside said area and inside the filter 17.

The body member 11 also contains a central recess 47 coaxial with shaft 29 and a passage 48 for venting and draining said recess. Another passage 49 serves to conduct lubricant to bearing 30.

Referring now to the pumping unit proper, this includes a pair of intermeshing gears 50 (Fig. 5) housed one in each of a pair of cylindrical holes 51 formed in, and passing entirely through, the pump plate 20. One of these gears is driven by a small pinion 52 formed on the outer end of shaft 29 (Fig. 1). The pinion is housed in a cylindrical hole 53 (Fig. 5) formed in and passing entirely through plate 20. The outer extremities of the teeth of gears 50 and those of pinion 52 closely fit the peripheral wall of their respective holes 51 and 53. The teeth of the gears and those of the pinion are preferably relatively pointed as shown. The gears 50, as shown, are of equal size. The pinion 52 is much smaller so as to effect a reduction of the speed of the gears to approximately one third of the speed of shaft 29. Each gear 50 is rotatably mounted on a stud 54. Each such stud is fixed at one end by being pressed into plate 19 (Fig. 1) and has its other end extending into a hole in plate 21. The faces of the gears 50 closely fit the adjacent faces of said end plates, as shown in Fig. 1.

The inlet and outlet ports for the gear pump are shown at 55 and 56, respectively. They are formed in those faces of plates 19 and 21 which engage the pump plate 20. One set of these ports is shown in Fig. 4 and the other in Fig. 6. Both inlet ports are alike and both outlet ports are alike. Fuel oil is drawn from the chamber 16 through a passage 57 (Fig. 4) leading from substantially the lowest point in the periphery of plate 19 upwardly to about the level of the shaft 29 but at a point laterally offset therefrom where it communicates with a hole 58 which opens into the inlet port 55 in plate 19. The two inlet ports 55 are interconnected by a through passage 59 in pump plate 20 (Fig. 5). The two outlet ports 56 are similarly interconnected by a through passage 60 in plate 20. The outlet port 56 in plate 21 is connected by a passage 61 (Fig. 6) to a circular groove 62 in the outer face of the plate (see also Fig. 7). This groove serves to conduct the pumped oil into two cylindrical chambers 63 and 64. The chamber 63 is formed by registering holes 65 in plates 21, 20 and 19. These holes extend entirely through plates 21 and 20 but only partly through plate 19. The chamber 64 is formed by registering holes 66 formed in and extending entirely through the plates 21 and 20. These chambers 63 and 64 respectively receive part of the cut-off valve mechanism (controlling the flow of oil to the burner) and part of the by-pass valve (controlling the flow of oil back to the suction side of the pump or to the supply tank, whichever is desired).

The disc 22, above referred to, carries a bellows 67 which extends into the chamber 63 and forms a movable partition therefor. Within the bellows and acting between the closed end wall 68

thereof and an adjustable seat 69 on cover plate 23 is a spring 70. The cut-off valve is shown at 71. It is slidably mounted in a sleeve 72 which fits within a bushing 73 and has a longitudinal groove 72' (Figs. 4 and 9) in its exterior enabling oil to flow from chamber 63 to the valve. The bushing 73 carries the seat for valve 71. This bushing is threaded into plate 19 and has an end extending into the well 39, above described. The outer end of the stem of valve 71 rests against the wall 68 of the bellows. A small spring 74 tends to open valve 71, when permitted by an outward movement of wall 68 under the pressure of oil in chamber 63. Oil will then flow into hole 38 and thence by passage 37 to the burner port 33. The valve 71 will open when the oil attains the desired pressure for atomization, say for example 85 pounds per square inch.

The disc 22 also carries a second bellows 76 (Fig. 1) which extends into chamber 64 and forms a movable partition therefor. Its inner and closed end 77 bears the pressure-regulating valve 78 which engages with a seat formed in a bushing 79 fixed in plate 19. The stem of this valve is of modified square section (Fig. 4) and slidably fits in the round hole of bushing 79 (Fig. 1) to guide the valve, spaces being left for oil to flow from chamber 64 past the guide to reach the valve. A spring 80 acts between wall 77 and an adjustable seat 81 in cover plate 23 to hold valve 78 closed. When, however, the pressure of the pumped oil reaches a predetermined figure, the wall 77 will be moved outwardly (to the right as viewed in Fig. 1) and open the valve 78, allowing oil to escape into passage 42 and thence into passage 40. The valve 78 is intended to open at a somewhat higher pressure than the cut-off valve, say from 90 to 125 pounds per square inch.

The cut-off valve 71 is preferably made of very hard and non-corrosive material. An example of one suitable material, having these characteristics, is "Nitroloy." The seat for this valve is a small insert, preferably made from softer material, which is an also non-corrosive, such for example, as stainless steel. The valve 78 may have the usual nick or scratch in its needle-pointed end to maintain a small by-pass even when valve 78 is on its seat.

The oil escaping into passage 40 may be returned to the fuel supply tank by means of a pipe connected to the port 34 or it may be returned directly to the inlet chamber 16 by means of a passage 82 (Fig. 9) made up of a series of registering holes formed in plates 19, 20, 21 and 23, in disc 22 and in disc 25 and the gaskets therefor, which holes are coaxial and communicate with the hole 41 above described. When a separate return pipe connected to port 34 is used, then the outer end of passage 82 will be closed, as by a plug 83, threaded into cover 23. When an internal by-pass is used, the port 34 is closed by a plug and the plug 83 is removed.

Access to plug 83 may be had by removing cover 14. Access may also be had in the same manner for adjusting the tension of the cut-off valve spring 70 by turning the threaded spring seat 69. The adjustment of spring 80 of the pressure-regulating valve may be varied without removing cover 14. A plug 84 is provided in cover 14 and by removing this plug, access may be had for turning the adjustable nut 81 which varies the tension of spring 80. It is seldom necessary to adjust the tension of the spring of the cut-off valve. Hence, the adjustment therefor need not be accessible from outside cover 14.

In the end plate 19 (Fig. 3) and in the disc 25 are registering holes 46' which align with the passage 46 leading to the pressure gauge. The hole 46' in plate 19 opens into the pressure chamber 64 which houses the bellows for the pressure-regulating valve and thus to the pressure side of the pump.

The bearings and faces of the gears 50 may be lubricated by the pumped oil, as by means of a pair of passages 87 (Fig. 6) in plate 21. Each passage 87 leads from an inlet port 55 radially to the stud receiving recess in plate 21 of the gear it is intended to lubricate. One such passage 87 is shown in section in Fig. 1.

The disc 25 (Fig. 1) carries a bellows 88 located coaxially thereof and extending into the recess 47 in housing member 11. This bellows carries a seal ring element 89 which engages a rotary seal ring element 90 threaded and sealed on shaft 29. A spring 91 acts between disc 25 and element 89 to urge the latter against element 90. The element 90 and the motor driven member 92 engage opposite ends of bearing 30 and serve to hold the pump drive shaft 29 against undue axial displacement.

A rubber gasket 93 (Fig. 1) is clamped between the inner cover 23 and the outer cover 12 and forms a tubular passage between the openings in which plug 84 and spring seat 81 are mounted. This passage is sealed off from the rest of the inlet chamber so that no fluid can enter or leave the chamber when plug 84 is removed to adjust the spring seat 81. In the case of a gravity feed (one-pipe) system, oil would flow out from chamber 16 on removal of plug 84, except for seal 93. In the case of a suction feed from a low-level tank in a two-pipe system, the removal of plug 84 would break the vacuum and cause the pump to lose its prime, if the seal 93 were not provided.

The pumping unit is shown as adapted for connection to a low-level supply tank by a suction pipe, connected to port 32, and a return pipe connected to port 34. Operation of the motor will rotate the gears 50 and create a vacuum to draw oil up through the suction pipe and into chamber 16, where the oil will rise to a level above the intake end of suction passage 57. Oil entering this passage will eventually reach the gears 50 and be carried around in the tooth spaces of these gears to outlet ports 56, whence the oil will flow through hole 61 to groove 62 and thence to chambers 63 and 64. When sufficient pressure has been built up in chamber 63, the cut-off valve 71 will open and allow oil to flow through passages 38 and 37 and port 33 to the nozzle of the oil burner. When the oil in chamber 64 reaches a somewhat higher pressure, valve 78 will open and allow excess oil to pass by passages 42 and 40 to port 34 and thence by the return pipe to the low-level tank.

To adapt the unit for a gravity-feed, one-pipe system, the port 34 is plugged and the plug 83 is removed. Operation of the pump will draw in liquid from the supply chamber 16 and force it to the burner port 33, as before, but on opening of the pressure-regulating valve 78, the excess oil will be carried through passages 42, 40, 41 and 82 back to the inlet chamber 16, these passages forming an internal by-pass for the pump.

The interior of the two bellows 67 and 76 are interconnected by a circular groove 85 provided in the inner face of cover plate 23 (Fig. 12). This groove intersects the holes 69' and 81' in

which the spring seats **69** and **81**, respectively, are threaded. The purpose of this groove is to insure that the cut-off valve **78** will close in the event of a leak in or rupture of the bellows **76**. In such an event, the pressure on opposite sides of each bellows will become equalized and the springs **70** and **80** will close the valves **71** and **78**, respectively, except that a small but constant by-pass due to the nick in valve **78** will be provided. Any leak or fracture of either bellows will result in a closing of the burner cut-off valve so that no oil can be emitted from the burner nozzle.

With the standard controls usually employed with domestic oil burners, the burner motor will be stopped shortly after the flow from the nozzle ceases. The fire is extinguished and the firebox and stack cools, so that the burner thermostat, which in some cases responds to the temperature in the firebox and in other cases to the temperature in the stack, will cause the burner to be "placed on safety," so that it will be stopped by the opening of the safety switch in a predetermined time, say for example, 30 seconds.

Meanwhile, during the time interval necessary to effect stopping of the motor, the pump continues to be driven by the latter and it could, unless means were provided to prevent it, build up pressures high enough to damage the pump. The constant by-pass provided by the nick in valve **78** is not large enough to prevent the rapid building up of dangerously high pressures in the pump. To prevent trouble from this source, I provide in the drive between the motor and pump a clutch which will slip when an abnormal load is imposed thereon, such as that of the pump after its valves **71** and **78** close. The result of this arrangement will be to limit the pressure that can be built up in the pump. After the pressure builds up to a predetermined amount, the clutch will slip and the pump will continue to operate but at a slower speed sufficient to maintain the pressure limit. The predetermined pressure at which the clutch will slip can be varied by suitable adjustments of the clutch.

Any suitable clutch may be used for this purpose. As shown herein, the clutch is of the centrifugal type because it is desired to start the pump after the fan has built up speed and to stop the pump before the fan loses much speed. Having the centrifugal clutch for that purpose, it may also be used as a slip clutch to limit the pump pressure. It will be clear that any other form of clutch which will perform the same function may equally well be used.

Referring to Fig. 11, the clutch includes a drum **94** fixed to the inner end of the pump shaft **29** and two weight segments **95** pivoted at diametrically opposite points on studs **96**, fixed in an end face of the rotor **97** of the motor. A spring **98** connects each segment to its pivot stud **96** and tends to draw the segments **95** inwardly and hold them away from the drum **94**. These segments have suitable clutch facings **99** to engage the drum. When the rotor **97** reaches a predetermined speed, the centrifugal force acting on segments **95** will overpower the force of springs **98** acting on segments **95** and cause the segments to move outwardly to force the facings **99** against the internal periphery of drum **94**. Insofar as the present invention is concerned, if the clutch is engaged, when either of the bellows becomes leaky or is fractured, then the drum **94** will slip on the clutch facings **99**, allowing the pump to

turn at a reduced speed until the burner motor is stopped by the automatic controls, above described. If the leak or fracture occurs while the burner is stopped, then shortly after the centrifugal clutch picks up the pump, the drum **94** will slip on the clutch facings as before.

The invention thus provides a safety means for fuel pumping units for oil burners, whereby to guard against dangers from abnormal pressures in the oil pump in the event of failure of the pressure regulating valve to function in the normal way.

I claim:

1. In a fuel supply unit for oil burners, a pump, a motor for driving the same; a pressure-regulating valve including a chamber with an inlet connected to the discharge side of the pump and an outlet, a valve controlling said outlet, a wall partitioning said chamber so that the inlet and outlet lie on one side of said wall, said wall being movable by the pumped oil when the latter attains a predetermined pressure to open said valve, a spring acting on the other side of the movable wall to close the valve when the pressure of the oil is less than the predetermined pressure, leakage through said wall causing oil pressure to act equally on opposite sides of the movable wall whereby the valve will close by its spring, and a safety device in the drive between the motor and pump for limiting the pressure that can be built up by the pump in the event of leakage through said wall.

2. In a fuel supply unit for oil burners, a pump, a motor for driving the same; a pressure-regulating valve including a chamber with an inlet connected to the discharge side of the pump and an outlet, a valve controlling said outlet, a wall partitioning said chamber so that the inlet and outlet lie on one side of said wall, said wall being movable by the pumped oil when the latter attains a predetermined pressure to open said valve, a spring acting on the other side of the movable wall to close the valve when the pressure of the oil is less than the predetermined pressure, leakage through said wall causing oil pressure to act equally on opposite sides of the movable wall whereby the valve will close by its spring, and a clutch in the drive between the motor and pump adapted to slip in the event of leakage through said wall and limit the pressure that can be built up by the pump.

3. In a fuel supply unit for oil burners, a pump, a burner cut-off valve and a pressure-regulating valve respectively adapted to open when the pumped oil attains predetermined minimum and maximum pressures; each valve including a chamber having an inlet connected to the discharge side of said pump and an outlet, a valve for controlling the outlet, a wall movable in one direction by the pressure of the pumped oil to open the valve, said wall partitioning said chamber so that the inlet and outlet thereof lie on one side of the wall, and a spring acting on the other side of the movable wall tending to close the valve; a conduit inter-connecting said chambers on the last-named side of its movable wall, whereby in the event of a leak through the movable wall of the pressure-regulating valve the oil pressure will be caused to act equally on opposite sides of the movable wall of the cut-off valve and cause the latter to be closed by its spring.

4. In a fuel supply unit for oil burners, a pump, a motor for driving the pump, a burner cut-off valve and a pressure-regulating valve respectively adapted to open when the pumped oil at-

tains predetermined minimum and maximum pressures; each valve including a chamber having an inlet connected to the discharge side of said pump and an outlet, a valve for controlling the outlet, a wall movable in one direction by the pressure of the pumped oil to open the valve, said wall partitioning said chamber so that the inlet and outlet thereof lie on one side of the wall, and a spring acting on the other side of the movable wall tending to close the valve; a conduit inter-connecting said chambers on the last-named side of its movable wall, whereby in the event of a leak through the movable wall of the pressure-regulating valve the oil pressure will be caused to act equally on opposite sides of the movable wall of the cut-off valve and cause the latter to be closed by its spring, and a clutch in the drive between the motor and pump adapted in said event to slip and limit the pressure that can be built up by the pump.

DONALD C. ELLIOT.