Dec. 8, 1959 A. F. ENEMARK 2,915,974

DOUBLE-ACTING ROTARY PISTON PUMP

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Fig. 1

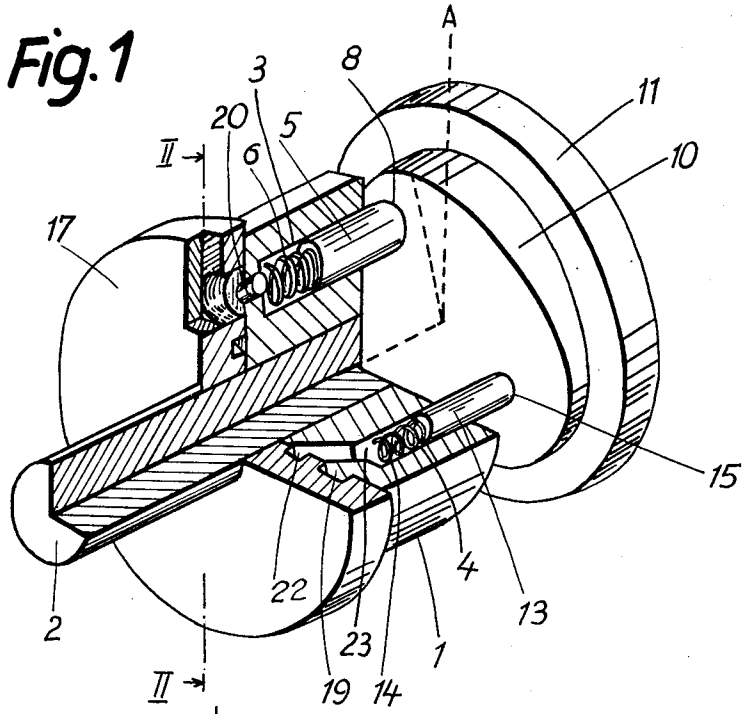
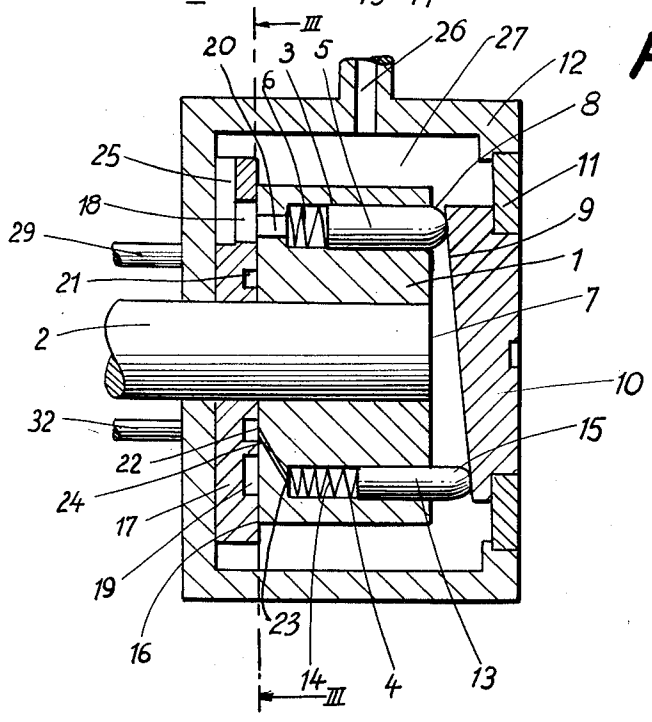



Fig. 2



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DOUBLE-ACTING ROTARY PISTON PUMP

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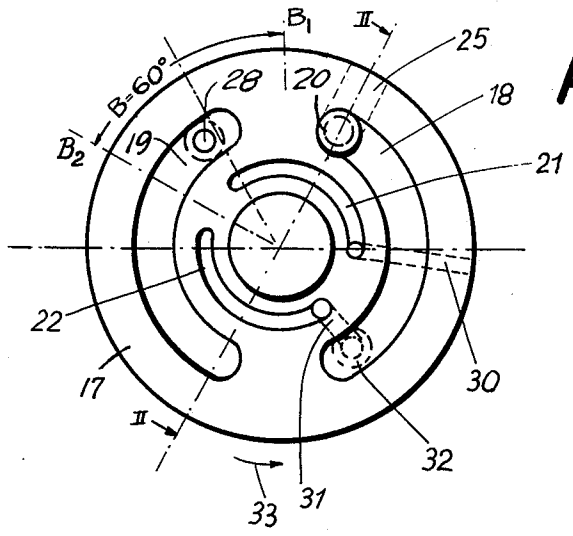



Fig. 3

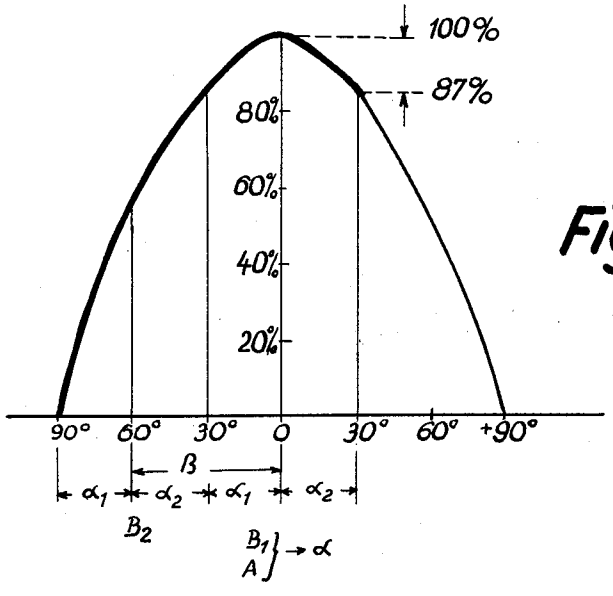



Fig. 4

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2,915,974

# DOUBLE-ACTING ROTARY PISTON PUMP

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Claims priority, application Denmark July 28, 1956

4 Claims. (Cl. 103—5)

The invention relates to a double-acting rotary piston pump, preferably for feeding fuel to oil burners and of the kind in which a rotatable, cylindrical body with a plurality of pump cylinders disposed with their axes parallel to the axis of rotation of the pump has pistons to which a reciprocating movement is imparted thereby that their end parts, located outside one end surface of the cylindrical body, under the action of springs rest in contact with a flat guiding surface. The said guiding surface is obliquely disposed in relation to the axis of rotation and is formed in a guiding disc which constitutes the end bottom of the pump casing, sliding members being furthermore provided to cooperate with the cylindrical body for controlling the flow of fuel fed to and discharged from the pump cylinders.

Double-acting piston pumps of the aforesaid kind are known and preferably used in connection with low pressure oil burners in which apportionment of a regulable quantity of fuel fed to the oil burner is required. However, the quantity apportioned will be somewhat dependent on the pressure at which the oil is fed to the pump, and it is therefore common practice to insert a suction pump between the measuring pump proper and the oil storage tank of the burner installation. The said suction pump is capable of counteracting the pressure drops involved by the different levels of the measuring pump and the tank and by the resistance to the flow in their connecting pipings. These pressure drops vary from one installation to another and with the operating conditions of the burner and the different quantities available in the tank. The said suction pump is adapted to feed the measuring pump with excessive amounts of oil and an overflow valve inserted in the pipe connecting the suction pump and the measuring pump is adapted to control that the measuring pump is fed with oil at a constant pressure determined by the adjustment of the overflow valve. The suction pump may be a pump of any kind whatever and be mechanically coupled in various manner to the motor shaft of the oil burner which shaft as a rule also drives the fan of the oil burner.

It is the object of the invention to devise the construction of a double-acting rotary piston pump of the aforesaid kind, in which the suction pump and the measuring pump are built together to form a very simple unit that is suitable for mass production and particularly owing to its comparatively simple composition is both durable and reliable in operation, in addition to being adjustable in a very convenient manner.

An essential feature of a double-acting rotary piston pump according to the invention is that a plurality of the pump cylinders are adapted to cooperate as a suction pump, whereas another set of cylinders is adapted to operate as a measuring pump, inserted in parallel or in series with the suction pump. The sliding members, furthermore, consist of a slide disc, fitting tightly to the other end surface of the cylindrical body and rotatable in relation to the guiding disc about the rotational axis



of the pump, the said sliding disc being provided with at least two sets of arc-shaped sliding grooves recessed in such surface of the slide disc as faces the body, each of the said grooves extending over to an angular arc adapted to the number of cylinders and being adapted to cooperate with the inlet and discharge openings of the pump cylinders and with the feed and discharge pipings of the two pumps.

As a result, a simple and compact pump construction is obtained in which the pumping effect of the suction pump and the measuring pump alike may be regulated by turning the guiding disc and the sliding disc in relation to each other and in which the sealing between the sliding members and the cylindrical body is obtained solely by axial attachment of the sliding disc in relation to the cylindrical body. Any wear on the surfaces sliding against each other will thereby be automatically equalized, and waste of oil and intake of air owing to such wear, which may be injurious to the pump operation, may be avoided.

In one embodiment of the piston pump according to the invention one set of pump cylinders is designed with a relatively large diameter and the other set of pump cylinders with a relatively small diameter.

As a result, the suction pump pumps for each revolution a larger amount of fuel than the measuring pump, and by coupling the suction pump to the measuring pump in a manner known per se by means of a piping which is provided with an overflow valve it will always be possible to feed the fuel to the measuring pump at a pressure predetermined by the adjustment of the overflow valve.

In a preferred embodiment of the piston pump according to the invention an axial plane of symmetry of the sliding grooves of the suction pump lying between the ends of the two grooves is staggered by an angle of 60° in relation to the corresponding plane of symmetry of the sliding grooves of the measuring pump.

As a result, the pumping effect of the measuring pump can be varied almost linearly from nil to a relative high value by turning the plane of symmetry of the guiding disc in relation to a plane of symmetry of the sliding disc simultaneously with the pumping effect of the suction pump only varying comparatively little. This quality in the piston pump according to the invention may advantageously be used for regulating the fuel supply in oil burners or similar installations where regulable quantities of liquid or gaseous substances are to be apportioned.

The invention will now be further described with reference to the drawing, in which—

Figure 1 is a perspective view, partially in section, of essential parts in an embodiment of a double-acting rotary piston pump according to the invention,

Figure 2 is a section of same on the line II—II of Figure 1,

Figure 3 is a section of same on the line III—III of Figure 2, and

Figure 4 is a curve showing the variation of the pumping effect of same when essential parts of the pump are turned in relation to each other.

In the drawing 1 denotes a rotatable cylindrical body which is coupled to the driving shaft 2 of an oil burner and is provided with a plurality of pump cylinders 3, 4 mounted with their axes parallel to the rotational axis of the pump so that the axes are angularly staggered, for example in one and the same cylindrical surface coaxial with the rotational axis. A set of the pump cylinders 3 is adapted to cooperate as a suction pump, being provided with cylindrical pistons 5 which under the action of springs 6 rest with their end parts 8 that are lying outside the one end surface 7 of the cylindrical body 1 against

a flat guiding surface 9 which is obliquely disposed in relation to the axis of rotation, the said guiding surface 9 being formed on a guiding disc 10 which in combination with a ring 11 constitutes an end plate of the pump casing 12. Another set of pump cylinders 4 is adapted to cooperate as a measuring pump of preferably less pumping effect than the suction pump which is constituted by the pump cylinders 3, and each of the cylinders 4 are provided with pistons 13 which under the action of springs 14 rest with their end sections 15 against the guiding surface 9. At the other end surface 16 of the cylindrical body and in close contact with the said end surface is provided a sliding disc 17, positioned about the driving shaft 2 of the pump and permanently secured in the pump casing 12. The said sliding disc has a set of arc-shaped sliding grooves 18, 19 recessed in the end surface of the sliding disc 17 which faces the body 1, concentrically with the rotational shaft of the pump. The sliding grooves 18, 19 cooperate with the inlet and outlet openings 20 of the pump cylinders 3. The sliding disc 17 is furthermore provided with another set of arc-shaped sliding grooves 21, 22 which are likewise arranged concentrically with the rotational shaft of the pump and cooperate with the inlet and outlet openings 23 of the measuring pump cylinders 4. The sliding grooves 18, 19, corresponding to the inlet and outlet openings 20 of the suction pump cylinders 3, are in the embodiment according to the invention shown in the drawing located at greater distance of the rotational axis than the sliding grooves 21, 22 corresponding to the inlet and outlet openings 23 of the measuring pump cylinders 4, the last mentioned openings communicating with the sliding grooves 21, 22 by radial passages 24 from the bottom of the measuring pump cylinders 4 to the end surface 16. In the sliding disc 17 there is recessed a radial feeding passage 25, emanating from the sliding groove 18, which passage is in direct communication with a suction chamber 27 which is in series with the feed piping 26 for the pump as shown in Figure 2, and correspondingly a discharge passage 28, extending in the pump casing 12 from the sliding groove 19 may lead to the return piping 29 of the oil burner or to a return chamber (not shown), which communicates with the return piping.

The suction chamber 27 of the pump or the return chamber (not shown) is connected to a feeding passage 30 which opens into the sliding groove 21 for the measuring pump cylinders 4, and similarly a radial discharge passage 31 leads from the sliding groove 22 and opens into the surface of the sliding disc 17 facing the opposite direction of the cylindrical body 1, the said discharge passage 31 communicating with the discharge piping 32 of the measuring pump cylinders. The said piping 32 which is indicated by broken lines in Figure 3 leads to the burner nozzle (not shown) of the oil burner.

It will be appreciated from the above that during the rotation of the pump the suction pump will draw oil from the pump feed piping 26 or from the suction chamber 27 through the feeding passage 25 when the cylindrical body 1 rotates, for example in the direction indicated by an arrow 33 in Figure 3, in relation to the stationary sliding disc 17 in the pump casing 12 and the guiding disc 10, i.e. from the position indicated by the dotted circle 20 in Figure 3 to the diametrically opposed position. During the same interval the piston 5 will under the action of the spring 6 move from its innermost position in the cylinder 3 as shown in the drawing to its outermost position, the end part 8 of the piston 5, remaining in contact with the guiding surface 9. During the remaining part of its movement the piston 5 will force the oil in the cylinder 3 through the discharge opening 20 and the sliding groove 19 and the discharge passage 28 to the return piping 29 or to the return chamber, which may communicate with the feeding passage 30 of the sliding groove 21. Any excessive amount of oil will via the return piping 29 be returned to the oil storage tank. From the feeding passage 30 of the measuring pump the oil will by means of suction be passed from the sliding groove 21 to the sliding groove 22 and further to the discharge passage 31 of the measuring pump and hence through the discharge piping 32 to the burner of the oil firing installation.

It is known that a piston pump of the aforesaid kind yields its maximum pumping effect when the plane A of symmetry of the guiding surface 9 is coinciding with the plane of symmetry extending between the two sliding grooves, that is, for the suction pump incorporated in the pump a slide symmetry plane $B_1$ and for the measuring pump incorporated in the pump a slide symmetry plane $B_2$ as indicated in Figure 3. The pumping effect will decrease in accordance with a cosine curve when the two planes of symmetry, A and $B_1$ or A and $B_2$, respectively, form an angle $\alpha$, and the pumping effect will be equal to nil when the angle $\alpha$ is equal to $\pm 90°$ as shown in Figure 4.

In a preferred embodiment of the piston pump according to the invention an axial plane of symmetry $B_1$ lying midways between the sliding grooves 18, 19 of the suction pump are staggered by an angle $\beta=60°$ in relation to the corresponding plane of symmetry $B_2$ of the sliding grooves 21, 22 of the measuring pump. The pumping effect of the suction pump can be regulated as its maximum value, located at the maximum of the cosine curve, by turning the plane of symmetry A of the guiding disc in relation to the plane of symmetry $B_1$; for the sliding grooves of the suction pump, for example up to an angle $\alpha_1=30°$ or $\alpha_2=+30°$, from the position in which the pumping effect is optimum and where the plane A coincides with the plane $B_1$, whereby the pumping effect of the suction pump will vary between 87%, corresponding to $\alpha=\pm 30°$ and cos $\alpha=0.866$ to 100%, corresponding to $\alpha=0$ and cos $\alpha=1.000$. At the same time the pumping effect of the measuring pump will, owing to the angular staggering applied, i.e. $\beta=60\%$, at a corresponding turning of the plane A vary from 0% corresponding to $\alpha=90°$ and cos $\alpha=0$, to 87%, corresponding to $\alpha=30°$ and cos $\alpha=0.866$, as will be seen from Figure 4. The pumping effect of the measuring pump will thus vary approximated linearly from 0% to 87% when the plane of symmetry 8 of the guiding disc is turned $\pm 30°$ in relation to the plane of symmetry $B_1$ of the sliding grooves 18, 19, while the pumping effect of the suction pump simultaneously with approximation will keep constant, varying only between 87% and 100%.

Although the invention is described in the foregoing in an embodiment using four cylinders, it will be appreciated that by modifications that will be obvious to one skilled in the art the invention may be used both for other numbers of cylinders and for an irregular number of cylinders in the two sets.

What I claim and desire to secure by Letters Patent is:

1. A double-acting rotary piston fluid feed pump having fluid inlet means and fluid outlet means and comprising, in combination, a rotatable cylindrical body formed with a plurality of cylinders disposed with their axes parallel to the axis of rotation of said body including a first pair of cylinders and a second pair of cylinders, said body having a forward end face and a rearward end face and said cylinders communicating with said end faces, resiliently urged pistons disposed in said cylinders, said pistons having their forward ends projecting beyond said forward end face of said body, means defining a flat guiding surface disposed opposite said forward end face of said body and engaged by said forward ends of said pistons, said guiding surface being obliquely disposed with respect to the axis of rotation of said body, a sliding member disposed opposite said rearward end face of said rotatable cylindrical body, said sliding member having the form of a disc having a first face applied tightly to said rearward end surface of the cylindrical body but non-rotatable therewith, said disc being provided with at least two pairs of arc-shaped sliding

grooves recessed in such first face of the disc, one of said pairs of grooves being positioned to communicate with said first pair of cylinders and the other pair of grooves being positioned to communicate with said second pair of cylinders, and said inlet means and said outlet means communicating respectively with one member of each pair of grooves, one pair of grooves being staggered by an angle of 60° in relation to the second pair of grooves.

2. A double-acting rotary piston fluid feed pump having fluid inlet means and fluid outlet means and comprising, in combination, a rotatable cylindrical body formed with a plurality of cylinders disposed with their axes parallel to the axis of rotation of said body including a first pair of cylinders and a second pair of cylinders, said first pair having a greater diameter than said second pair and said cylinders being disposed along a circle coaxial with the axis of rotation in such manner that cylinders of different diameters alternate along circumference of said circle, said body having a forward end face and a rearward end face and said cylinders communicating with said end faces, resiliently urged pistons disposed in said cylinders, said pistons having their forward ends projecting beyond said forward end face of said body, means defining a flat guiding surface disposed opposite said forward end face of said body and engaged by said forward ends of said pistons, said guiding surface being obliquely disposed with respect to the axis of rotation of said body, a sliding member disposed opposite said rearward end face of said rotatable cylindrical body, said sliding member having the form of a disc having a first face applied tightly to said rearward end surface of the cylindrical body but non-rotatable therewith, said disc being provided with at least two pairs of arc-shaped sliding grooves recessed in such first face of the disc, one of said pairs of grooves being positioned to communicate with said first pair of cylinders and the other pair of grooves being positioned to communicate with said second pair of cylinders, and said inlet means and said outlet means communicating respectively with one member of each pair of grooves, one pair of grooves being staggered by an angle of 60° in relation to the second pair of grooves.

3. A double-acting rotary piston fluid feed pump having fluid inlet means and fluid outlet means and comprising, in combination, a rotatable cylindrical body formed with a plurality of cylinders disposed with their axes parallel to the axis of rotation of said body including a first pair of cylinders and a second pair of cylinders, said body having a forward end face and a rearward end face and said cylinders communicating with said end faces, resiliently urged pistons disposed in said cylinders, said pistons having their forward ends projecting beyond said forward end face of said body, means defining a flat guiding surface disposed opposite said forward end face of said body and engaged by said forwards ends of said pistons, said guiding surface being obliquely disposed with respect



to the axis of rotation of said body, a sliding member disposed opposite said rearward end face of said rotatable cylindrical body, said sliding member having the form of a disc having a first face applied tightly to said rearward end surface of the cylindrical body but non-rotatable therewith, said disc being provided with at least two pairs of arc-shaped sliding grooves recessed in such first face of the disc, one of said pairs of grooves being positioned to communicate with said first pair of cylinders and being radially outwardly spaced in relation to the other pair of grooves, and the other pair of grooves being positioned to communicate with said second pair of cylinders, and said inlet means and said outlet means communicating respectively with one member of each pair of grooves, one pair of grooves being staggered by an angle of 60° in relation to the second pair of grooves.

4. A double-acting rotary piston fluid feed pump having fluid inlet means and fluid outlet means and comprising, in combination, a rotatable cylindrical body formed with a plurality of cylinders disposed with their axes parallel to the axis of rotation of said body including a first pair of cylinders and a second pair of cylinders, said first pair having a greater diameter than said second pair and said cylinders being disposed along a circle coaxial with the axis of rotation in such manner that cylinders of different diameters alternate along circumference of said circle, said body having a forward end face and a rearward end face and said cylinders communicating with said end faces, resiliently urged pistons disposed in said cylinders, said pistons having their forward ends projecting beyond said forward end face of said body, means defining a flat guiding surface disposed opposite said forward end face of said body and engaged by said forward ends of said pistons, said guiding surface being obliquely disposed with respect to the axis of rotation of said body, a sliding member disposed opposite said rearward end face of said rotatable cylindrical body, said sliding member having the form of a disc having a first face applied tightly to said rearward end surface of the cylindrical body but non-rotatable therewith, said disc being provided with at least two pairs of arc-shaped sliding grooves recessed in such first face of the disc, one of said pairs of grooves being positioned to communicate with said first pair of cylinders and being radially outwardly spaced in relation to the other pair of grooves, and the other pair of grooves being positioned to communicate with said second pair of cylinders, and said inlet means and said outlet means communicating respectively with one member of each pair of grooves, one pair of grooves being staggered by an angle of 60° in relation to the second pair of grooves.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,506,892 | Egersdorfer | Sept. 2, 1924 |
| 1,714,148 | Weldy | May 21, 1929 |
| 2,445,281 | Rystrom | July 13, 1948 |