Sept. 29, 1953 N. B. TVEDEN 2,653,756

PLUNGER PUMP

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Fig. 1.

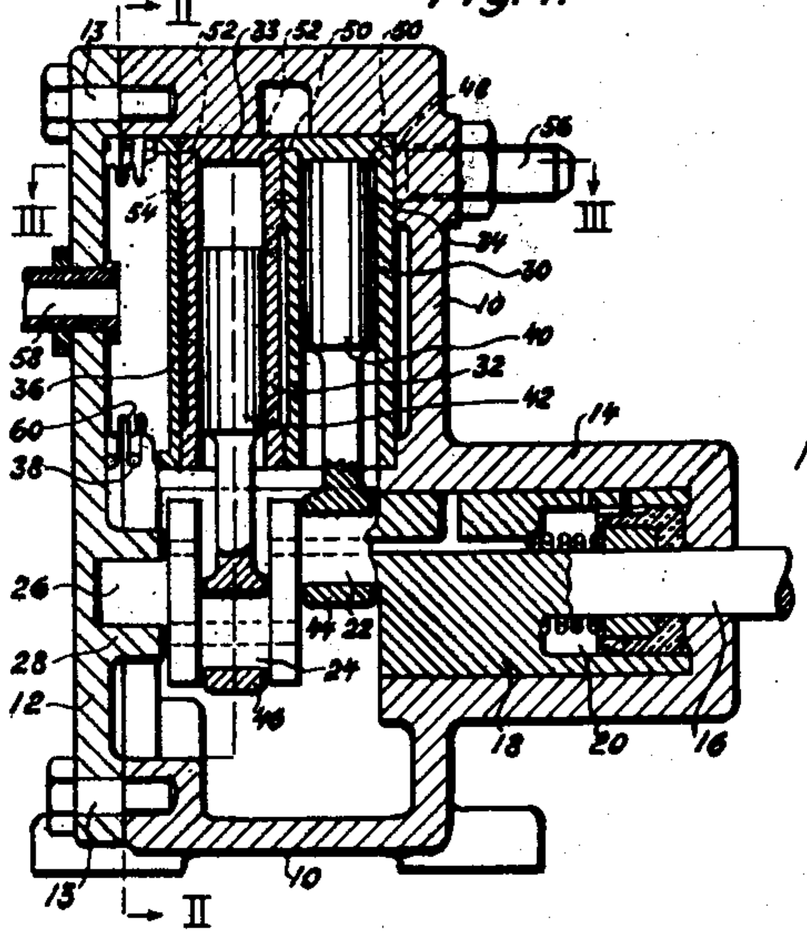


Fig. 4.

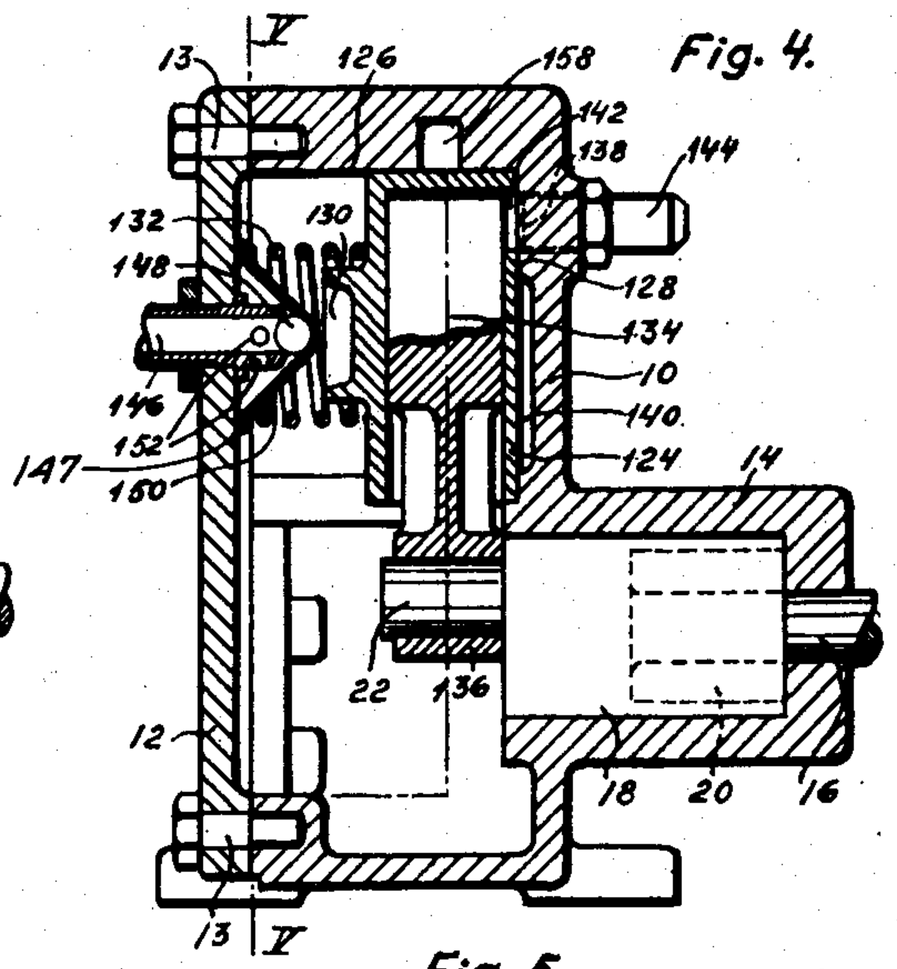


Fig. 2.

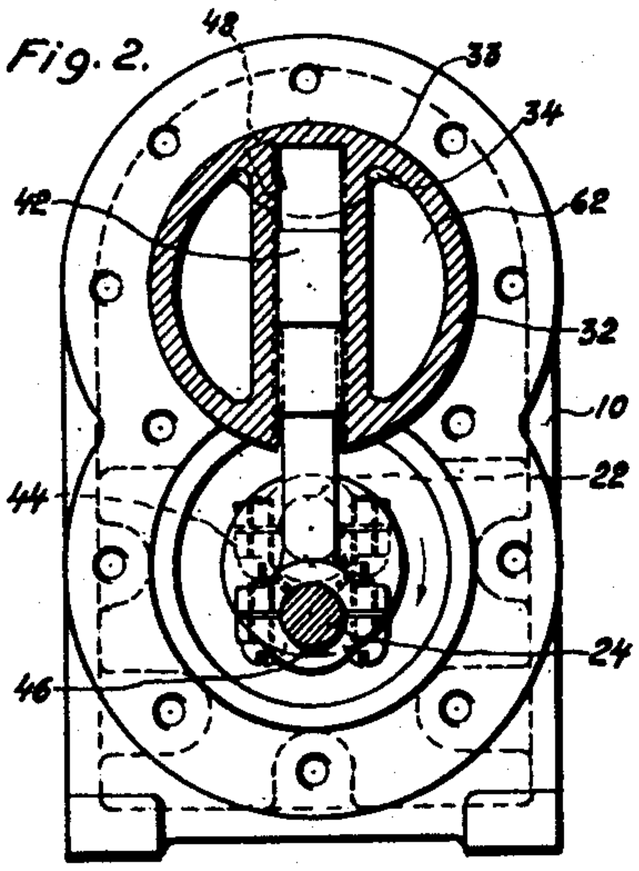


Fig. 5.

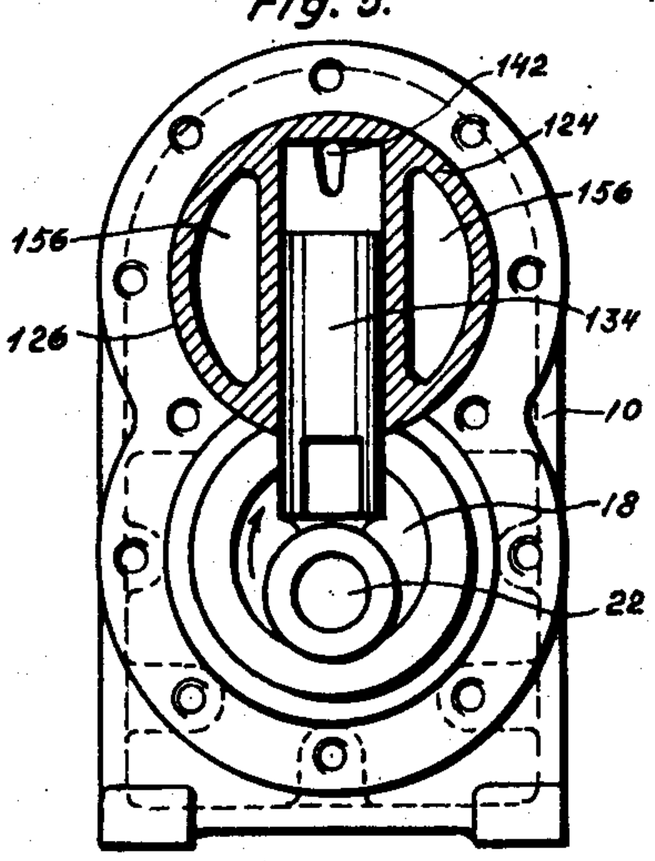


Fig. 3.

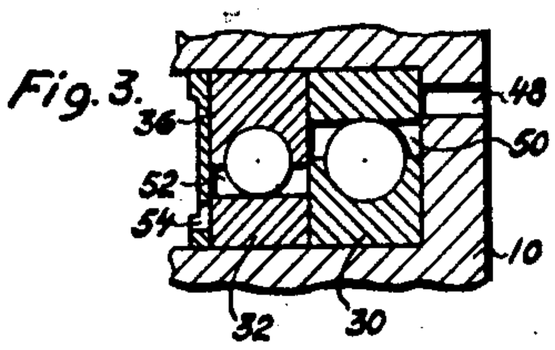
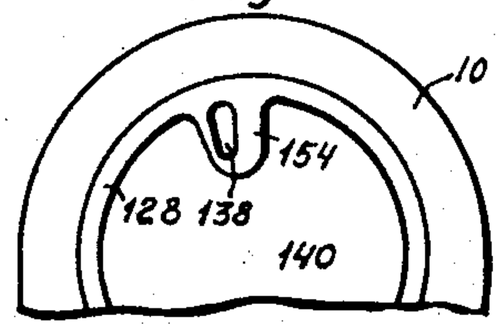


Fig. 6.



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PLUNGER PUMP

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Fig. 7

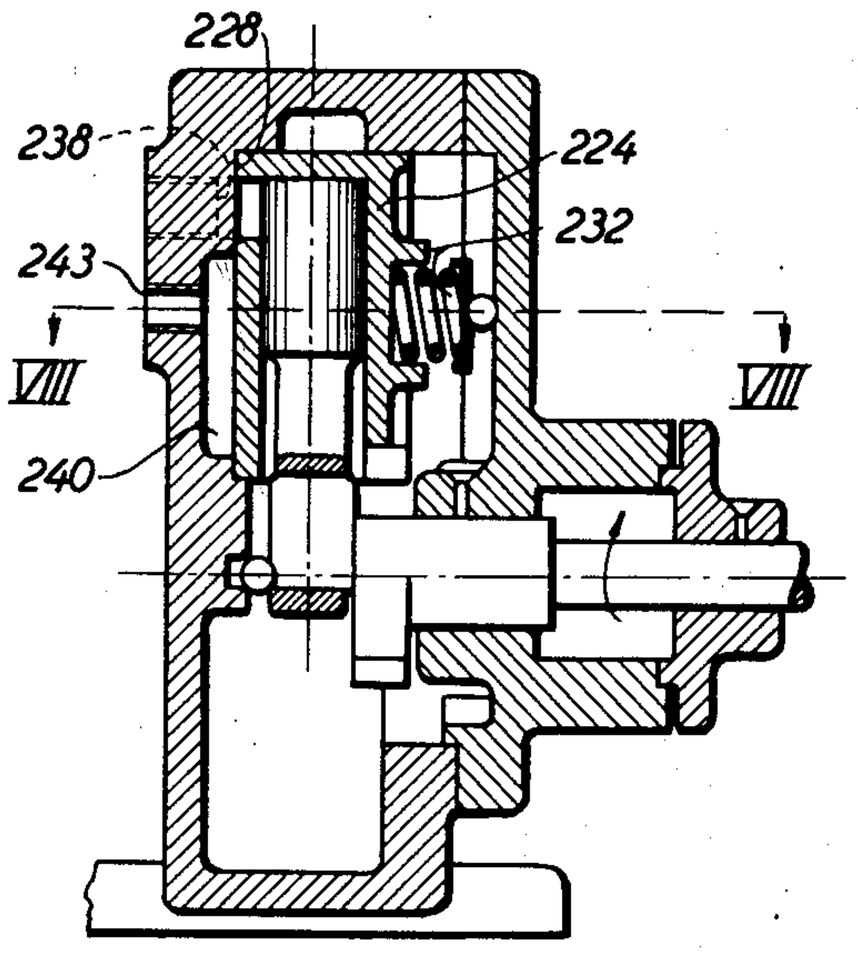


Fig. 8

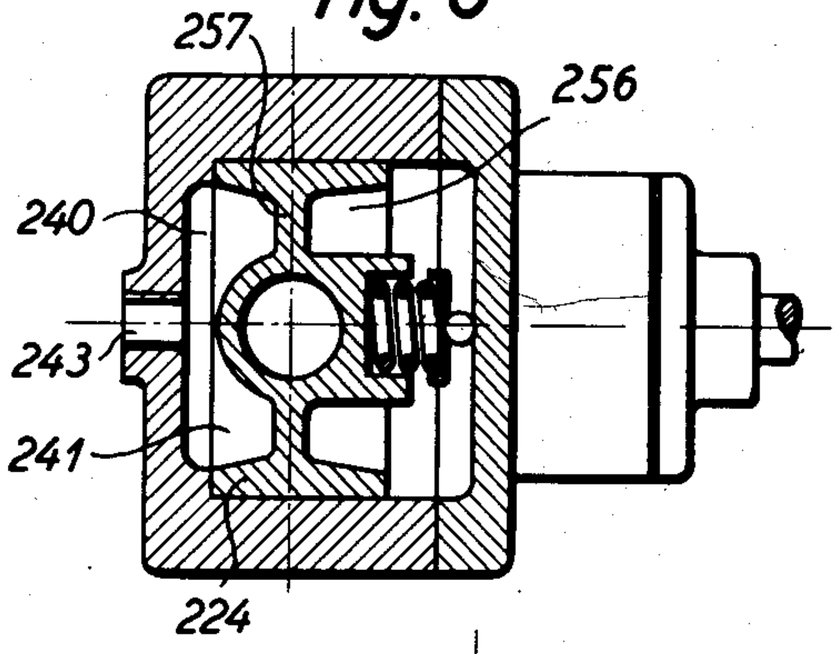


Fig. 9

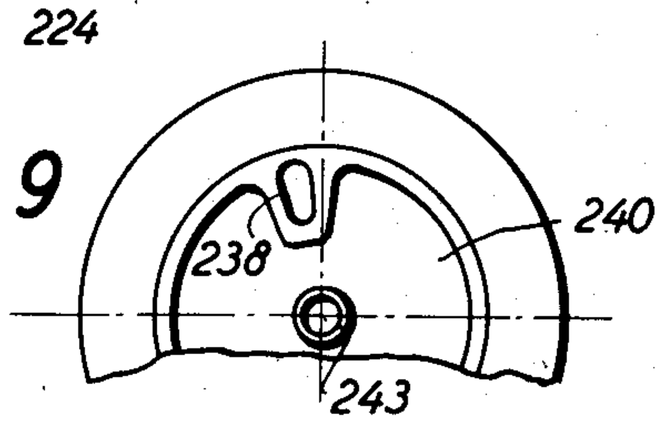


Fig. 10

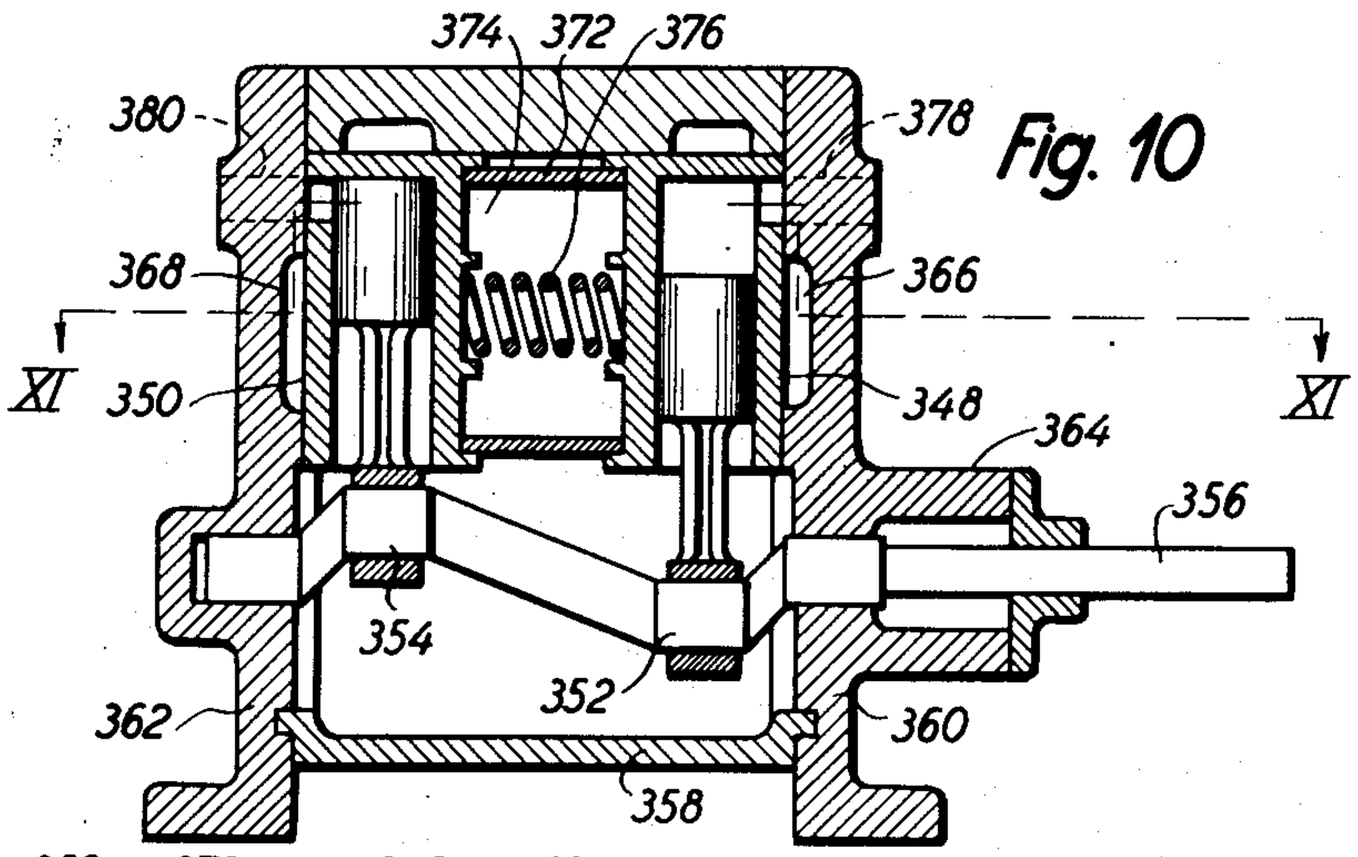
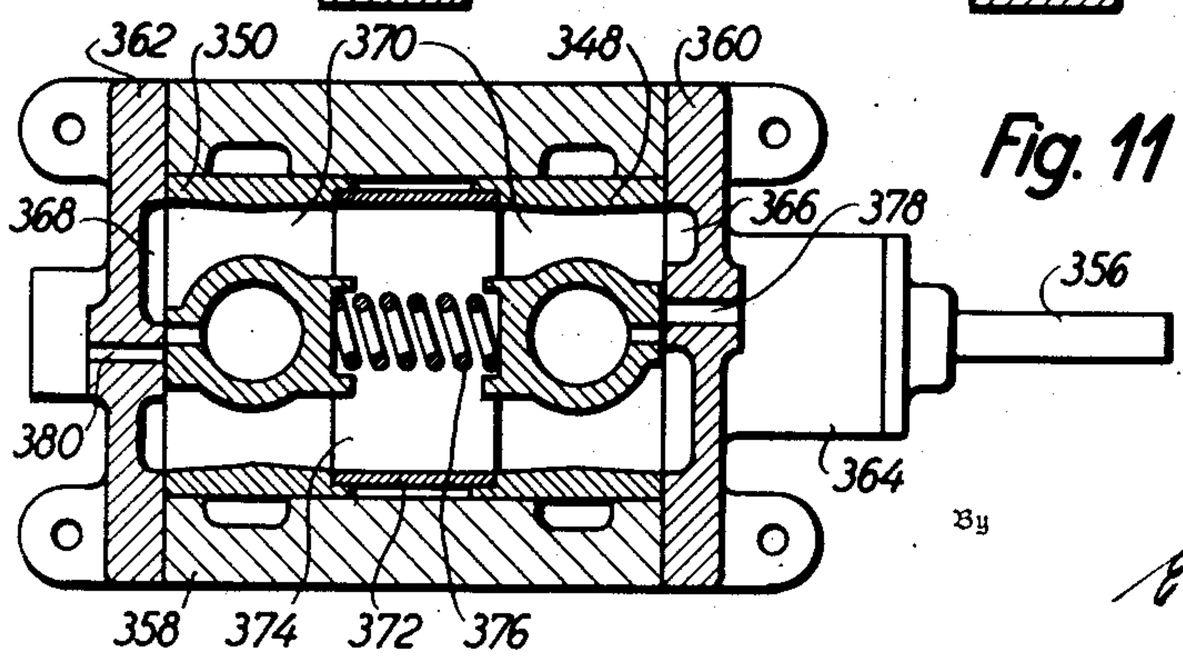


Fig. 11



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UNITED STATES PATENT OFFICE

2,653,756

PLUNGER PUMP

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In Denmark July 27, 1946

4 Claims. (Cl. 230—175)

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This invention relates to high-speed, single or multi-cylinder plunger pumps of the kind in which the crank imparts to each cylinder an oscillating movement which is utilized for compulsory control of the admission and discharge of the working medium by co-operation between orifices in a lateral surface of the cylinder and in a countersurface, against which the first-mentioned surface is held in abutment.

The main object of the invention is to provide a pump of this kind, capable of producing a comparatively high pressure, and which can be operated at very high speeds. Another object of the invention is to adapt the pump in such a manner that the higher the pressure produced by the pump, the greater the tightness of the valve gear. A further object of the invention is to adapt the pump in such a manner as to avoid that the working medium in the latter pump design flows through that part of the pump casing in which the shaft of the pump and the crank or cranks are located. Finally, the invention has for its object to provide a pump of the kind in question which is simple in construction, easily assembled and disassembled and moreover very reliable in operation. Still further objects of the invention will be disclosed by the following description with reference to the drawings, in which

Figure 1 is a vertical axial section of an embodiment for a twin-cylinder two-stage pump for use as a compressor in a refrigerating plant.

Figure 2 is an end view of same, the cover of the pump casing being removed, certain parts being shown in section on the line II—II in Figure 1.

Figure 3 is a partial section on the line III—III of Figure 1.

Figure 4 is another embodiment with a single cylinder, in vertical axial section.

Figure 5 is an end view of same, the cover of the casing being removed and certain parts shown in section on the line V—V in Figure 4.

Figure 6 is the top part of the casing for this pump as seen from the interior, with the cover removed.

Figure 7 is a third embodiment, likewise with a single cylinder, in vertical axial section.

Figure 8 is a section on the line VIII—VIII in Figure 7.

Figure 9 is the top part of the casing of this pump as seen from the interior, with the cover removed.

Figure 10 is a fourth embodiment with two cylinders, for use as a two-stage compressor, in vertical axial section.

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Figure 11 is a section on the line XI—XI in Figure 10.

The pump shown in Figures 1–3 consists of a casing **10**, one end of which is closed by a cover **12** secured by means of screws **13**. The opposite end of the casing is provided with a bored neck **14** forming a bearing for a crankshaft **16** with an enlargement **18** constituting the journal of the shaft **16** in the bearing and accommodating a stuffing box, of which no further description is given, since it is outside the scope of the invention. The shaft **16** is passed through the neck **14** and may outside the latter be coupled directly to a driving motor. The shaft is provided with two cranks **22** and **24** and a gudgeon **26** co-axial with the enlargement **18** and resting in a stud **28** on the inner side of the cover **12**.

The pump has two cylinders, worked out diametrically in substantially disc-shaped bodies **30** and **32** which are placed in a bore **33** at the top of the casing **10** parallel to the crankshaft **16**. The said bore **33** is moreover provided with a machined plane surface **34** forming a support for one lateral surface of the body **30**. The body **32** is supported against the opposite side of the body **30**, and in the bore **33** on the other side of the body **32** is inserted a disc **36** which is secured against turning and held in abutment against the said body by means of a coil spring **38**. The cylinder bores of the bodies **30** and **32** accommodate plungers **40** and **42**, respectively, having two-piece bearings **44** and **46** co-operating with the cranks **22** and **24**, respectively. The plunger **40**, which acts as a low pressure piston, is of a larger cross-sectional area than the plunger **42**, which acts as a high pressure piston, and the cranks **22** and **24** are offset by 180° in relation to each other, the two plungers thus working in push-pull.

The face **34** of the casing **10** against which the body **30** abuts, is provided with an opening **48**, see Figure 3, which forms the inlet opening of the pump. The top end of the cylinder in the body **30** is provided with a cross-passage **50** constituting both the inlet and the discharge channel for this cylinder. Similarly, the body **32** has a passage **52** constituting the inlet and discharge channel of the cylinder in that body. Finally, an opening **54** in the disc **36** constitutes the discharge opening of the pump.

In the opening **48** is screwed a pipe branch **56**, to which the supply pipe of the pump can be connected, and in the cover **12** is inserted a nipple **58** for connection to the discharge pipe. A cup-shaped diaphragm **60**, which, for example, may be of copper, is soldered along its edge to the disc **36**, whereas the nipple **58** is passed through

the diaphragm bottom, keeping the diaphragm in position between a collar on the nipple and the cover 12.

When the compressor is turned clockwise from the position shown in Figure 2, the upper part of the body 30 will by its oscillation be moved upwards as in Figure 3, and the upper part of the body 32 will be moved downwards. After a slight movement the cylinder of the body 30 will register with the inlet opening 48, and the cylinder in the body 32 similarly register with the discharge opening 54. The working medium will be drawn into the first-mentioned cylinder, and the pre-compressed medium in the last-mentioned cylinder will be forced out. During these operations there will be no inter-communication between the two cylinders. When the crank 22 has passed its lower dead centre and the crank 24 has passed its upper dead centre, inter-communication will be established between the passages 50 and 52 owing to the oscillating movement of the cylinders, whereas the said passages will be cut off from the openings 48 and 54, respectively. Thus, the charge in the cylinder of the body 30 will be transferred to the cylinder of the body 32 which involves a pre-compression of the medium, since the first-mentioned cylinder is bigger than the last-mentioned one.

The medium leaving the compressor will flow to the space formed between the disc 36 and the diaphragm 60 and consequently exert a pressure against the said disc, which, again, because of the diaphragm being slightly resilient, will exert a pressure on the body 32, forcing it against the body 30 and further pressing the latter against the surface 34 of the casing 10. The pressure between the abutting surfaces of the said parts will therefore be substantially proportional to the pressure produced by the pump on the working medium, which is very purportable with a view to maintaining constant tightness between the co-operating sliding surfaces of the said parts. The spring 38 may be comparatively light or may, for example, be dispensed with altogether, the diaphragm 60 being capable of exerting the slight pressure necessary on the disc 36 until a pressure on the working medium has been established.

As plainly indicated in Figure 1, the bodies 30 and 32 are only contacting the corresponding counter surfaces at the edge of their lateral surfaces. This will ensure an even wear of the sliding surfaces, so that the tightness between same at the inlet and outlet openings, which are compulsorily controlled by means of the oscillating movement of the bodies 30 and 32, is maintained even after operation over a long period. The said bodies may be provided with recesses 62, as in Figure 2, in order to reduce weight.

Owing to the bodies 30 and 32 being placed in direct contact with each other, the dead space existing between the stages of the compressor may be materially reduced.

Referring to Figures 4–6, the reference numbers 10, 12 13, 14, etc., and 22 denote the same parts as the corresponding reference numbers in Figures 1–3. The pump shown here has a single cylinder provided diametrically in a substantially disc-shaped body 124 which, as in the former case, is journalled in a bore 126. The body 124 rests with one of its lateral surfaces against a machined surface 128. At the opposite lateral surface of the said body is provided an annular projection 130 enclosed by a coil spring 132

forcing the body 124 against the surface 128. The cylinder bore of the said body accommodates a plunger 134 with a bearing 136 co-operating with the crank 22.

The surface 128 is provided with an opening 138, see Figure 6, constituting the inlet opening of the pump. The discharge opening consists in the case of this embodiment of a recess 140 surrounded by the surface 128, as will appear from the following. At the top the cylinder body 124 has an opening 142 forming the inlet and outlet passage for the cylinder.

The supply pipe of the pump can be connected to a pipe branch 144 screwed into the opening 138. In the cover 12 there is inserted a nipple 146 for connection to the discharge pipe, the said nipple being co-axial with the axis of oscillation of the cylinder body 124. The opening of this nipple is closed inwardly by means of a ball 148 forming a support for a cone disc 150, the edge of which serves as a support for the spring 132. At its inner end the nipple 146 is provided with three radial bores 152 opening downwards and laterally, whereas there is no corresponding bore facing upwards. The said bores form communication between the space of the casing 10 and the nipple 146, moreover, there is a slot 147 between the edge of the disc 150 and the interior side surface of the cover 12.

When the shaft 16 is turned, the cylinder body 124 will perform an oscillating movement. With the plunger 134 in its top position as indicated in Figure 4, the opening 142 will be covered by that part 154 of the surface 128 which is immediately to the right of the opening 138, see Figure 6. When the shaft 16 is turned in the direction of the arrow shown in Figure 5, the opening 142 will register with the opening 138 during the downward stroke of the plunger. This communication will again be cut off at the lower dead centre of the crank 22, and during the further movement the opening 142 will get into communication with the recess 140. In operation of the pump a suction from the branch pipe 144 will thus alternate with an exhaust to the recess 140. From the lastmentioned recess the working medium can flow through passages 156 in the body 124 to the space of the casing 10 proper, from which it may escape through the slot 147, previously referred to, at the edge of the disc 150, and through the bores 152 to the discharge nipple 146.

When the pump is in operation, the pressure on the working medium will be present in the casing 10, and as the cylinder body 124 has a larger free area on its left side, see Figure 4, than on its right side, this pressure will contribute towards maintaining abutment between the cylinder body and the surface 128. The spring 132 need only exert a comparatively light pressure against the body 124, as its object only is to produce the necessary contact pressure in case of insufficient pressure on the working medium.

The lubrication oil is fed to the bottom of the casing 10, being thrown about by the movement of the crank 22 and supplied to all surfaces requiring lubrication, an annular passage 158 being provided so as also to secure lubrication of the circumferential surface of the body 124. The space in the pump casing serves as an oil separator, because the rate of flow of the working medium through this space is very slow. The disc 150 protects the nipple 146 from oil splashes.

The embodiment shown in Figures 7–9 is

mainly distinguished from that referred to in Figures 4–6 thereby that the working medium does not pass the entire space of the pump casing, but only part of it, serving as an oil separator, the working medium thus being not admitted to that part of the pump casing accommodating the crank.

Referring to Figures 7–9, the cylinder body is denoted by **224**. In the passages **256** of the said body there are partitions **257**, so that the recess **240** in the pump casing will have an opposite recess **241** in the cylinder body **224**. The inlet opening **238** of the pump is located as in the former case, whereas the discharge opening **243** is located in the side wall of the pump casing at the recess **240**. The exhaust from the pump on leaving the space **240**, **241** will therefore pass directly to the discharge opening **243**. A further description of the construction of this embodiment seems superfluous.

When the compressor is put into operation, the pressure established on the working medium will initially be present in the space **240**, **241**. The spring **232** acting on the cylinder body **224** is, however, so powerful that the abutment pressure between the said body and the opposite surface **228** will not be relieved. The pressure in the said space will gradually be diffused to the entire space of the pump casing, and in case of equivalent pressures in both spaces, the pressure of the working medium will, as in the former case, contribute towards keeping the cylinder body in abutment. This effect, however, is not required in the embodiment described, the spring **232** alone being capable of providing the necessary abutment pressure.

It is immaterial that the opening **238** serves as inlet and the opening **243** as discharge, it being also possible to design the machine in such a way that the working medium flows in the opposite direction.

The two-stage compressor shown in Figures 10 and 11 has two cylinder bodies **348** and **350** actuated by separate cranks **352** and **354** on the crank shaft **356**. The pump casing **358** is provided with two covers **360** and **362**, both with bearings for the crankshaft **356** and each constituting an endwall of the casing, and one of which has a neck **364** for a stuffing box.

Each of the cylinder bodies **348** and **350** abuts against its own cover **360** and **362**, and the spaces thus formed, **366** and **368** respectively, are interconnected through passages **370** in the cylinder bodies, see Figure 11. The cylinder bodies are disposed at a certain distance from each other in axial direction, and between the said bodies there is provided a space **374**, limited by an annular element **372**, through which space the said communication passes, being separated from that part of the pump casing accommodating the cranks **352** and **354**. Between the cylinder bodies is provided a spring **376** forcing the said bodies away from each other towards their respective counter surfaces.

When the pump is in operation, the working medium is drawn in through an opening **378** in the cover **360** and conveyed to the space **366** by the reciprocating movement of the plunger in the cylinder body **348**. The spaces **366** and **368** and the passages **370** in the cylinder bodies, which latter passages provide communication between the said spaces, form, together with the space **374** in the element **372**, a receiver for admission of the pre-compressed working medium. The secondary compression is effected by means

of the plunger working in the cylinder body **350**, the said plunger taking off the pre-compressed medium from the receiver and forcing it to the outlet opening **380** of the pump provided in the cover **362**.

A further description of the mode of operation of this pump is considered unnecessary in view of the detailed description given of the embodiments previously mentioned.

The invention is more particularly intended for use in compressors of small refrigerating plants, for example, for household purposes. In such plants the compressor has hitherto been driven through a speed reducer, the spring-loaded valves used for ordinary compressors not being capable of working at the speed corresponding to that of the motor in the case of direct coupling with the motor. A compressor according to the present invention, however, can be coupled directly to a high-speed motor, because the inlet and the outlet openings of the compressor are subject to compulsory control.

If it is preferred not to use any stuffing box in the compressor at all, the compressor casing may be designed so as to enclose the driving motor too, for example an electromotor, thus practically eliminating any possibility of leakage.

Having thus fully described my invention I claim as new and desire to secure by Letters Patent:

1. A plunger pump having at least two cylinders, of the type in which an oscillatory movement is imparted to the cylinders, consisting of a pump casing having a bore, two disc shaped cylinder bodies, each with a circumferential surface of rotation surrounding the corresponding cylinder and journalled oscillatory in said bore, each of the said cylinder bodies having one end surface in abutment against a surface at the inner side of the pump casing at one of the ends of said bore, each of said last named surfaces being provided with a recess which together with the corresponding cylinder body forms a space, said spaces being interconnected by passages in the cylinder bodies and forming together with said passages a part of a receiver, arranged inside the pump casing, for the working medium of the pump.

2. A plunger pump as claimed in claim 1, in which the two cylinder bodies are disposed at a distance from each other in the direction of their axes, an annular element restricting the space between the two bodies and constituting another part of the receiver, a spring being mounted in said annular element to force the bodies away from each other against the surfaces at the inner side of the pump casing.

3. A plunger pump, comprising a pump casing having a bore, and inlet and outlet openings and at least one cylinder body having a cylinder therein and a surface of rotation surrounding said cylinder, said body being journalled oscillatory in said bore in said pump casing, a plane substantially annular counter surface inside said pump casing, said body abutting with a lateral surface against said plane substantially annular counter surface inside the pump casing, said lateral surface being provided with a passage leading to the cylinder, said counter surface being provided with an orifice connected to one of said openings in the pump casing, a recess, facing towards the cylinder body, in the pump casing and being encircled by the counter surface, oscillatory movement of the cylinder body alternately connecting said passage to said ori-

fice and said recess, so that the working medium of the pump will flow through said recess on its way from the inlet to the outlet in the pump casing.

4. A plunger pump as claimed in claim 3, in which communication is established between said recess and the space of the pump casing at the other side of said cylinder body, said inlet and outlet openings in the pump casing being arranged on opposite sides of the cylinder body.

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