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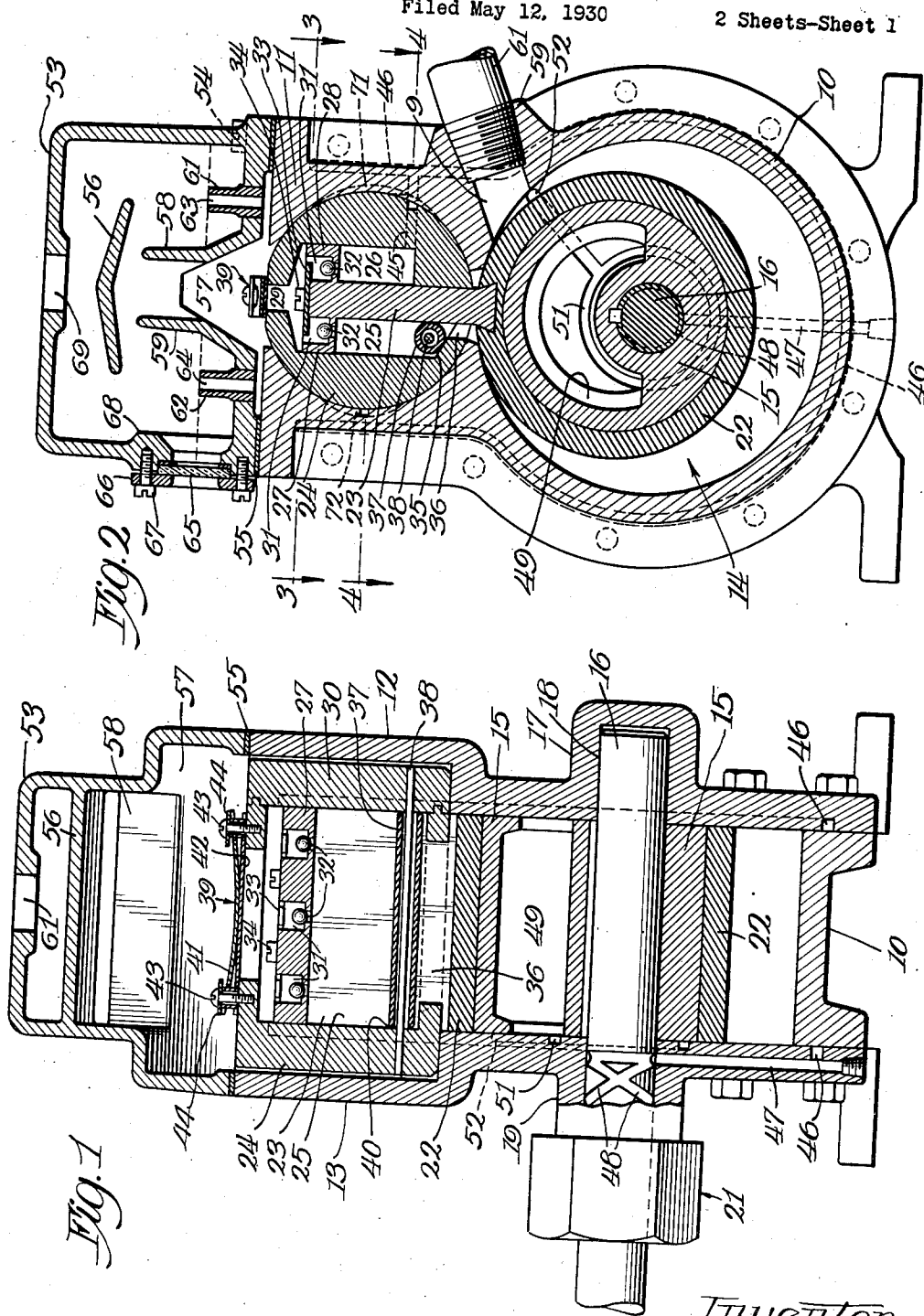
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1,890,574

VACUUM PUMP

Filed May 12, 1930

2 Sheets-Sheet 1



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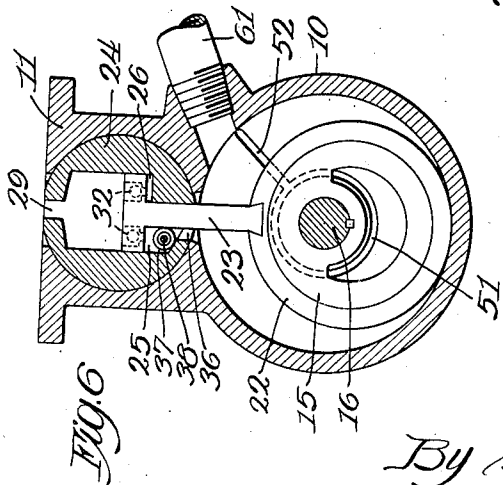
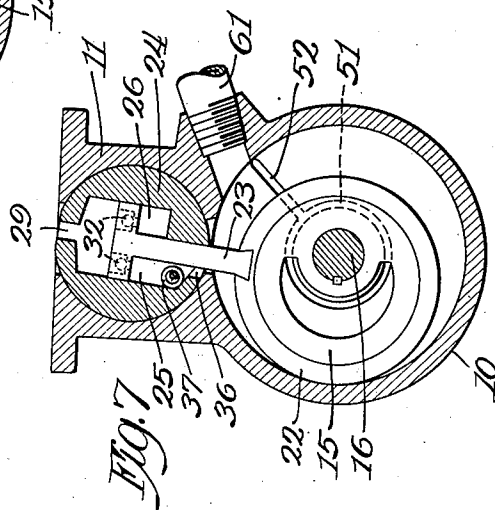
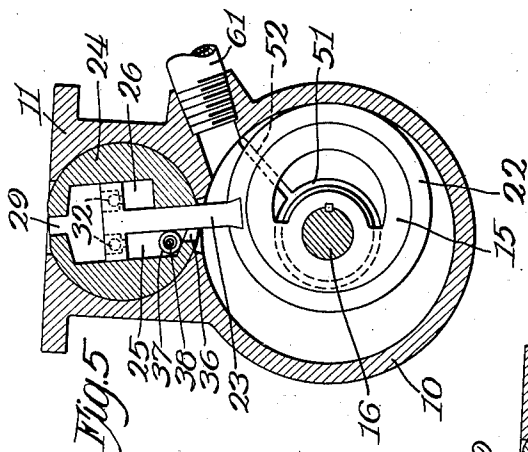
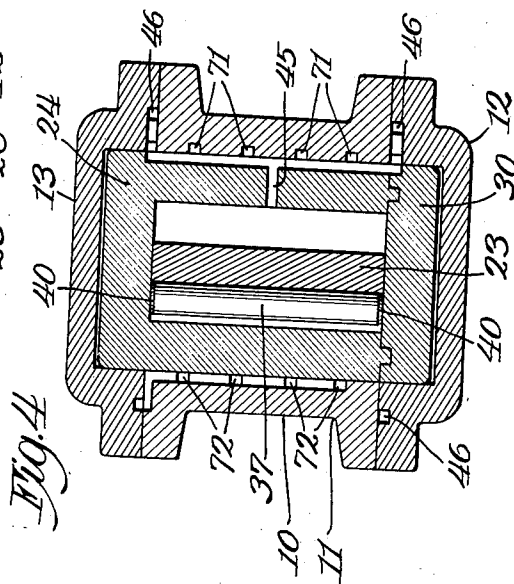
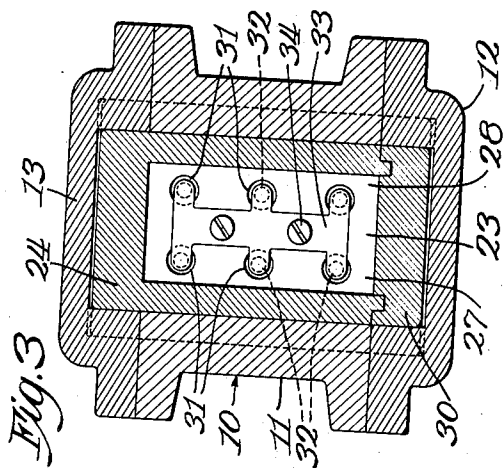
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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VACUUM PUMP

Application filed May 12, 1930. Serial No. 451,567.

This invention relates to improvements in vacuum pumps.

It is an object of the present invention to provide a simple and effective backing pump in combination with a high vacuum stage and to combine the two so that the backing pump becomes in effect a fore-stage for the high vacuum cylinder, and to do this without substantially increasing the number of parts required or changing in any material degree the bulk of the pump.

It is an object of the invention to allow better cooling than has heretofore proved possible and to avoid difficulties with the sealing fluid; to secure the rapid outgassing of the oil so that the highest vacuum may be quickly attained; to reduce as far as may be practicable the volume of oil necessary for sealing the pump; and to subject this oil continuously to an outgassing process.

By "sealing" the pump by means of oil channels instead of running it immersed in a tank of oil, I not only materially reduce the volume of oil to be outgassed, but I also expose the outer surfaces of the pump directly to the air and, as a direct result, achieve much lower operating temperatures and a greater capacity for my device. The principles and details of construction will become apparent from the specification and the annexed figures in which

Fig. 1 is a vertical, longitudinal section through my device;

Fig. 2 is a sectional elevation of the same;

Fig. 3 is a section through the pump taken on the line 3—3 of Fig. 2;

Fig. 4 is a section through the pump taken on the line 4—4 of Fig. 2;

Figs. 5, 6, and 7 are diagrammatic representations of the position of the parts in my improved pump in three positions of its operating cycle.

With reference to Fig. 1, the pump is composed of a ring section 10, provided with a neck like extension 11 and the end closure plates 12 and 13. Both the ring and the plates are ground upon their mating surface and the joint thus formed is made as tight as possible. The ring is provided with a cy-

lindrical pump chamber 14 in which the eccentric 15 affixed to the shaft 16 rotates.

An intake passage is provided by the bore hole 9, as shown in Fig. 2. Connecting with the bore 9 is the intake pipe 61 which is threaded and sealed into the boss 59 on the ring 10. The configuration of the plate 12 provides a housing 17 for the bearing 18. The plate 13 is provided with a hollow stud 19 which provides a bearing for the shaft. The stud is counterbored to receive a gland (not shown) which is held in place by the packing nut 21 threaded on the stud.

An eccentric strap 22 surrounds the entire face of the eccentric and bears a blade 23 operatively connected to the strap in some fluid tight manner such as the tongue and groove lock shown. The strap may itself contact with the cylinder wall, as shown on Fig. 2, or the eccentric member may be made to do the actual contacting necessary and the strap occupy merely a narrow zone thereon.

A gland 24 adapted to oscillate as the movement of the blade demands, is journaled in a bearing provided in the extension 11 of the ring member 10. The gland is hollowed out to form a substantially rectangular chamber extending longitudinally across the gland. For machining reasons only, the gland is sectional and is closed by the cap 30. The chamber is divided by the blade into two pump cylinders 25 and 26 in which the pistons 27 and 28, which are here shown as integral extensions of the blade, operate. The two pumps exhaust into the space 29 which forms the common exhaust passage for both pumps.

The pistons carry the ball exhaust valves 32, 32, the balls being seated in the passages 31, 31. A light retainer 33, held in place by screws 34, prevents the balls from being displaced.

By reference to Fig. 2, it will be seen that the floor 35 of the cylinder 25 forms a sharp angle with the blade and that a portion of it is cut away, as shown at 36, Fig. 1, to form the exhaust passage from the rotary stage of the pump.

The angular floor urges a cylindrical valve

37 against the blade 23. The movement of the valve is limited by the retainer pin 38. The ends of the cylindrical valve 37 are slightly chamfered, as at 40, to provide a by-pass through which the oil may pass into the exhaust passage and into the rotary pump stage.

The oscillating gland 24 bears an exhaust valve 39 on its upper exposed area, composed of an upper arcuate spring 41 and a lower leaf spring 42. These are maintained in position by the screws 43 and stops 44.

As indicated on Fig. 2, the intake passage 45 to the pump cylinder 26 leads to a groove 46 which may be in either the mating surface of the ring 10 or of the plates 12 and 13. An extension of the groove formed by a drilled passage 47 leads up to the shaft 16 and is connected with the grooves 48, 48 cut on the shaft.

In order to counterbalance the device, it is usually preferable to hollow out the rotor 15, as is shown at 49. The plate 12 accordingly bears an annular groove 51 cut in its inner face surrounding, but spaced from the shaft 16. The groove 51 is connected by a groove 52 to the suction space of the pump.

An oil trap member 53 held in position by the screws 54 forms the cover of the device. A gasket 55 is interposed between the trap and pump casing to prevent leaks. The bottom of the trap is broken by a channel 57 extending transversely across it, and rising from the edge of the channel are two oil retaining and baffle members 58 and 59 which also extend across the trap. Two oil level regulating nipples 61, 62 with longitudinal passages therethrough 63, 64, are forced into the bottom wall of the trap. A V-shaped baffle 56 covers the channel 57 and forms a spray hood. A sight glass 65 is provided in one wall of the trap. The bezel 66 drawn up by the screw 67 presses the glass up against the flexible gasket 68. The outlet from the pump is provided by the orifice 69.

The Figs. 2, 5, 6 and 7 illustrate the position of the operative parts at 90° intervals in one cycle of the pump.

The operation of the pump is as follows: Starting with the position of the device as shown in Fig. 2, as the shaft rotates in a clockwise direction, the eccentric causes different portions of the eccentric strap to come progressively in contact with the cylinder wall. Momentarily, there is but one space within the cylinder (Fig. 2) equalizing the gas pressure therein, and then the space is cut in two (Fig. 5). Thereafter, (Figs. 6 and 7), the space to the right (ahead of the piston) aspirates the gas. The space to the left, (behind the piston) compresses it.

Since the eccentric carries the eccentric strap first to one side, then to the other, the blade which is a rigid extension of the strap must swing from side to side. Accordingly,

the gland which forms a stuffing box preventing the gas on the compression side from mixing with the gas on the intake side must oscillate and the blade ride up and down in the gland. The upstroke of the blade which bears the pistons on its upper end creates a suction in the pump chambers 25 and 26. The gas being exhausted through the passage 36 is under compression and rushes in to fill the space 25.

When the article to be exhausted is nearly at atmospheric pressure, the amount of gas handled by the eccentric stage is greater than the reciprocating stage can actually pump. Both valves in the reciprocating stage are accordingly displaced and a constant flow of gas maintained through the passage and piston. However, when vacua of any substantial degree requiring a fore-pump are approached, the amount of gas delivered through the port 36 is not sufficient to overload the chamber and the efficacy of the fore-pump then begins to be felt and increases as increasing vacua are obtained.

Because of the great range of both volume and pressure which a vacuum pump commonly encounters, considerable difficulty has been experienced with valves. The use of a ball valve in the reciprocating piston is, however, particularly helpful since the valve is operated not by the pressure against the seat, but by its own inertia and will respond although very small quantities of gas are expelled as the higher vacua are approached. The piston may thus act as a scavenger without unduly compressing the gas in the cylinders 25 and 26.

On standing, oil seeps into the cylinder. When the pump is started, slugs of oil and gulps of air practically at atmospheric pressure pass through the device. A relief valve is thus a necessity. The valve 39 is both a relief valve and a differentially responsive exhaust valve.

When the pressure in the space is high, as when trapped oil or atmospheric air is passing, the bowed spring is forced up and the leaf valve rises on its guide studs exposing a wide slot. As the pressure drops, the leaf valve remains seated, but since it is very thin and flexible (it may even be taper ground to aid in this effect), it is deflected over smaller and smaller areas. Thus the effective opening of the valve is secured at pressures so low that operation of a gravity inertia or fixed tension spring valve becomes uncertain.

In order to balance the eccentric to allow high speed operation of the pump, a hollow space in the body of the eccentric is provided. Upon standing, this space will build up to atmospheric pressure and since pumps which are capable of producing very high vacua are nice mechanical jobs, the fit between the rotor and the plates 12 and 13 is necessarily close and practically sealed by

the oil film therebetween. An evil known as "slipping" then may occur, since the gas contained in the hollow slowly leaks into the high vacuum area. This is prevented in the present pump by the provision of the annular passage 51 (which may be in either of the end plates) and the connecting passage 52. The effect of this is to add the space within the body of the eccentric to the space to be evacuated and, since the gas within the space is pulled down to the pressure of the high vacuum chamber, no "slipping" can occur.

To prevent leaks, it is desirable to reduce the pressure differential existing between the outer and the inner edges of the mating faces and in fact at any joint in the pump where leaks could occur. The channel 46 is accordingly cut into the face of the plates 12 and 13 or into the ring 10, as may be desired. The channel is connected by the passage 45 to the second reciprocating pump 26 contained in the gland. The extension of the channel 47 connecting with grooves 48 allows this vacuum seal to be applied to the joint between the shaft and packing.

The vacuum in the chamber 26 and the sealing channels 46 is in the order of millimeters. Consequently, the pressure tending to make the pump casing leak exists as a gradient between the outer surface and the sealing channel. Whatever air leaks into the pump along the joints in the casing is consequently trapped in the sealing channel and swept out. The residual gradient between the sealing channel and the high vacuum chamber is small. It will cause no trouble if the joints are well machined and usual sealing precautions are taken.

Upon first glance, it would seem as if no passages were provided through which sealing and lubricating oil could be led to the moving parts. In this pump, however, all free fits are open oil passages, for it must be remembered that the oil is under a pressure of more than 14 lbs. to the sq. inch, as referred to any space below the pistons, that it meets no obstruction of trapped gas, and that it spreads and creeps over every surface.

Oil will adsorb gas in considerable quantities whenever it is exposed to a gaseous atmosphere. If such oil then were admitted into the high vacuum chamber, the gas would be delivered up and consequently the degree of vacuum obtainable would depend upon the freedom from adsorbed gases which the sealing medium enjoyed. In order to prevent such polluted oil from working into the high vacuum stage, it is necessary to expose it to a degree of vacuum sufficient to cause it to deliver up the major portion of the gas before it can reach the chamber.

Whatever oil comes in under the valve 39 and passes down the walls of the reciprocating pumps into the high vacuum pump cham-

ber will have been very thoroughly vacuum treated by the reciprocating stage. However, there is another path by which the oil can get into the high vacuum chamber and that is along the joint between the gland and the casing. It is advantageous, therefore, to provide one or more longitudinal channels in the bearing face between the casing and gland and connect these channels to the entrainment channel system 46. It may even prove advantageous to make arcuate transverse extensions to this channel as shown at 71, 72, Fig. 2, so that more oil may be trapped and subjected to vacuum. Whatever oil, therefore, reaches the high vacuum stage has been robbed of the adsorbed gas by this precaution.

Upon starting a new pump, it is necessary to pour in through the opening 69 a quantity of oil sufficient to rise up to the top of the nipples 61, 62, and in addition an amount which will fill the sealing channels and sufficiently seal and lubricate all of the working parts. It will be the tendency of the working parts to squeeze and force out some of this oil which will be blown against the baffle as a spray, but whatever oil drops off the baffle will cause an overflow of the reservoir and the excess will pass through the channels 63, 64 back into the moving system.

I have described my improved design as applied to a vacuum pump capable of producing vacua of very high degree. Such a pump will produce vacua of the order of 1/10,000 of a millimeter without difficulty. It is, of course, obvious that the pump will be decidedly useful in other work.

Where high vacua are not desired or a pump for liquids needed, the channels 51, 52, 45 and 46 are not necessary, and a passage may be drilled through the blade just below the piston so as to cause the two sides of the piston to operate in parallel upon the fluids discharged by the rotary stage.

I do not limit myself to a precise arrangement, for it is obvious that modifications and rearrangements may be made in which the action is in full accord with the principles herein set forth.

I claim as my invention:—

1. A vacuum pump of the rotary plunger type comprising a casing and a pump cylinder having inlet and exhaust passages, in combination, an eccentric in the cylinder, an eccentric strap, a blade separating the inlet and exhaust chambers of the cylinder, operatively connected to the strap, an oscillating gland within the casing forming an oscillating pump cylinder in which the blade reciprocates, a piston carried by the blade, the inlet passage to the reciprocating stage forming the exhaust passage of the first named stage, and a valve closing the passage.

2. A vacuum pump of the rotary plunger type comprising, in combination, a plunger

member provided with a radial blade, an oscillating gland cooperating with the blade and having a pump cylinder therein, a piston in the pump cylinder, a connection between the piston and the radial blade causing the piston to reciprocate, and an inlet passage to the pump cylinder receiving material discharged by the rotary plunger stage of the pump.

3. A vacuum pump comprising, in combination, a casing having a cylindrical chamber, an inlet thereto, an eccentric rotor in the chamber, an annular piston surrounding the rotor and provided with a radial blade rigidly affixed thereto, a gland adapted to oscillate and in which the blade reciprocates, a cylinder in the oscillating gland, a piston in the oscillating cylinder operated by the blade, an outlet passage from the cylindrical chamber communicating with the inlet to the oscillating cylinder, and a valve in the passage.

4. In a pump of the rotary plunger type, including a casing and a pump cylinder having inlet and exhaust passages, in combination, an eccentric in the cylinder, an eccentric strap, a blade operatively connected to the strap separating the inlet and exhaust chambers of the cylinder, an oscillating gland within the casing forming an oscillating pump cylinder in which the blade reciprocates, a piston carried by the blade, the inlet passage to the reciprocating stage being the exhaust passage of the first named stage, a valve closing the passage, and a bypass around the valve through which sealing fluid may be admitted to the pump chamber.

5. In a pump of the rotary plunger type including a casing and a pump cylinder having inlet and exhaust passages, in combination, an eccentric in the cylinder, an eccentric strap, a blade separating the inlet and exhaust chambers of the cylinder operatively connected to the strap, an oscillating gland within the casing forming an oscillating pump cylinder in which the blade reciprocates, a piston carried by the blade, the inlet passage to the reciprocating stage forming the exhaust passage of the first named stage, a valve closing the passage, inertia valves carried by the piston, and a leaf spring exhaust valve closing the oscillating cylinder.

6. A vacuum pump of the rotary plunger type, comprising, in combination, a casing, a cylinder therein provided with intake and exhaust passages, a hollow eccentric within the cylinder, and an annular eccentric strap surrounding the eccentric, a blade operatively integral with the strap, and a channel in the casing extending from the suction space and intercepting the path swept by the hollow of the rotor whereby the space within the rotor may be reduced to, and maintained substantially at, the same pressure as that existing in the suction passage of the pump.

7. A vacuum pump of the rotary plunger

type, comprising a casing made of joined parts containing a pump cylinder wherein a blade attached to an eccentric strap is caused to operate a reciprocating pump, channels formed in the components of the casing and interposed in the mating face between the joined parts, a sealing fluid within the casing and the channels, a cylinder in the reciprocating stage adapted to outgas the sealing medium, and a connection between the channels and the outgassing pump.

8. In a vacuum pump of the rotary plunger type comprising a casing made of joined parts containing a pump cylinder wherein a blade attached to an eccentric strap is caused to operate a reciprocating pump, means for preventing leakage along joints in the casing and packing members which consists of channels formed in the components of the casing and interposed in the bearings and in the mating faces of the joined parts, a sealing liquid in the channels and a connection between the reciprocating pump and the channels for producing a vacuum therein, whereby the pressure gradient tending to cause leaks into the high vacuum space is materially reduced and the sealing liquid is outgassed.

9. A multi-stage vacuum pump of the rotary plunger type comprising a casing sealed against leaks by a liquid, a high vacuum pump cylinder formed in the casing, an eccentric in the cylinder, an oscillating gland journaled in the casing and a pump cylinder formed in the oscillating gland, means to apply a preliminary vacuum between the gland and casing and to outgas the sealing liquid before its entrance into the high vacuum cylinder, which consists of channels in the bearing surface between the casing and gland, and a connection to the intake of the oscillating pump cylinder.

10. In a multi-stage vacuum pump of the rotary plunger type, sealed against leaks by a liquid, a casing, a cylindrical oscillating member journaled in the casing, a pump cylinder formed in the oscillating member, a blade connected to the rotary plunger and caused to reciprocate in the oscillating member, two pistons carried by the blade, which blade together with the walls of the oscillating member forms two pump chambers therein, one chamber being the exhaust passage of the rotary plunger pump, the other serving to outgas the sealing medium of the pump.

11. In a vacuum pump including a casing wherein the amount of fluid and the pressure at its discharge vary through wide limits, having a fixed rotary pump cylinder and an oscillating reciprocating pump cylinder within the casing, the combination of valves in the reciprocating member operated by inertia and an exhaust valve for the oscillating cylinder adapted to open a different amount

with differing pressures and volumes of the exhausted fluid.

12. In a vacuum pump provided with a piston chamber, a piston for said chamber, an intake and a discharge port for said chamber, a valve for said discharge port, an oil receptacle over said discharge port, oil retaining members extending upwardly about said discharge port for forming an oil chamber for retaining oil over said valve for sealing the same, said chamber having an opening for conducting oil from said oil receptacle to said chamber and a baffle above said oil retaining members for deflecting oil splashed from said oil chamber by air discharged through said outlet port into said receptacle. In testimony whereof I affix my signature.

JOHN DUBROVIN.

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