

Sept. 17, 1940.

H. I. STOLTZ

2,215,256

HIGH VACUUM PUMP APPARATUS

6 Sheets-Sheet 1

Filed May 6, 1938

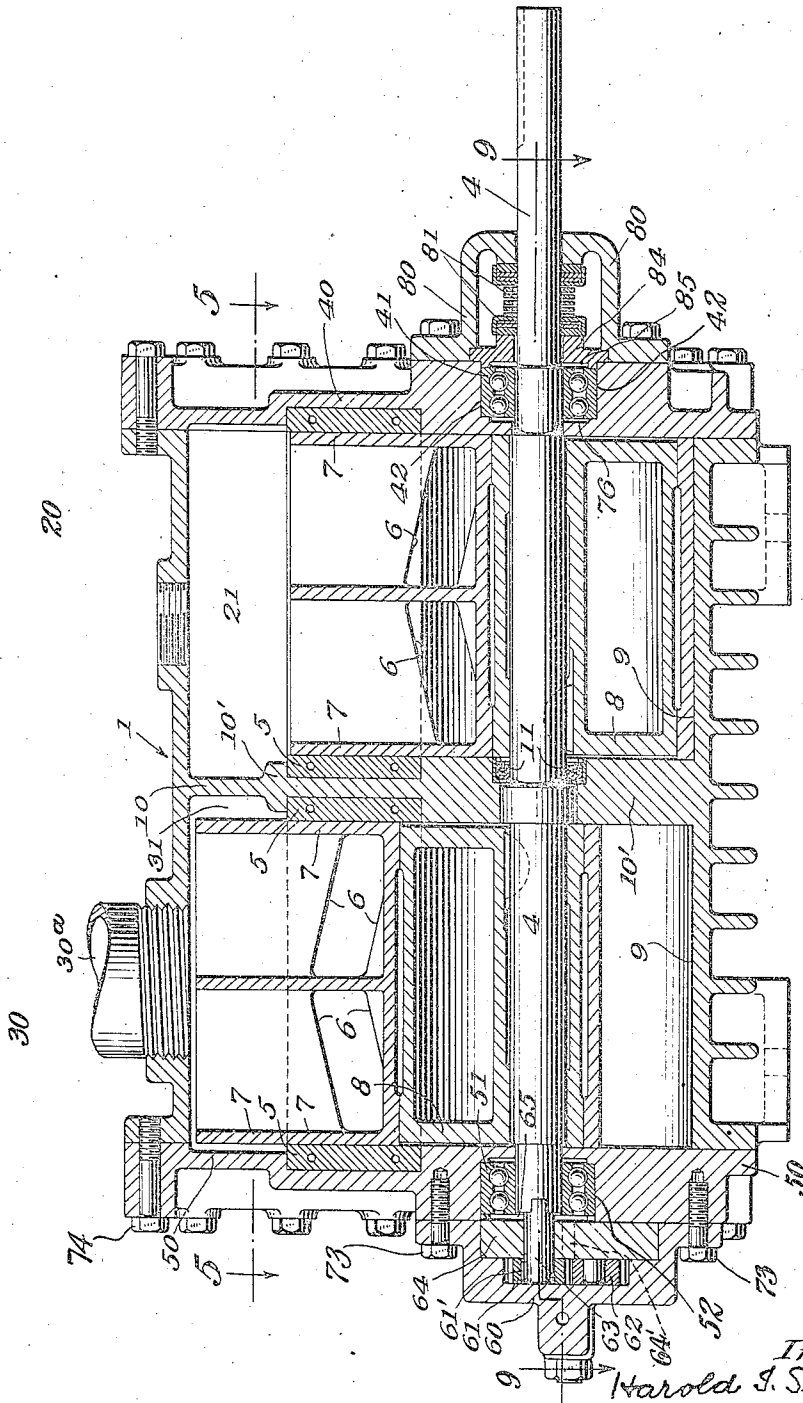


Fig. 1

Inventor:
Harold I. Stoltz
By Spear, Rawlings & Spear.
Attorneys.

Sept. 17, 1940.

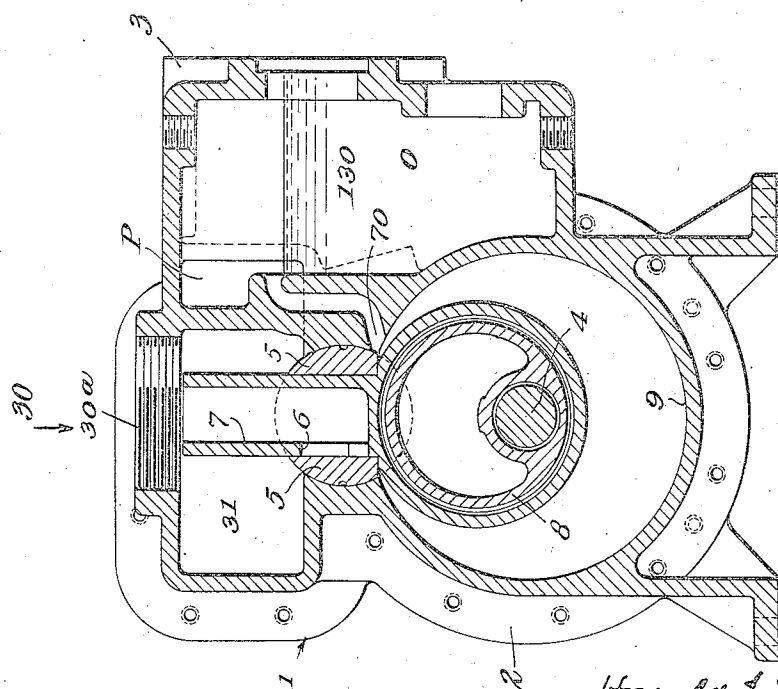
H. I. STOLTZ

2,215,256

HIGH VACUUM PUMP APPARATUS

6 Sheets-Sheet 2

Filed May 6, 1938



2017

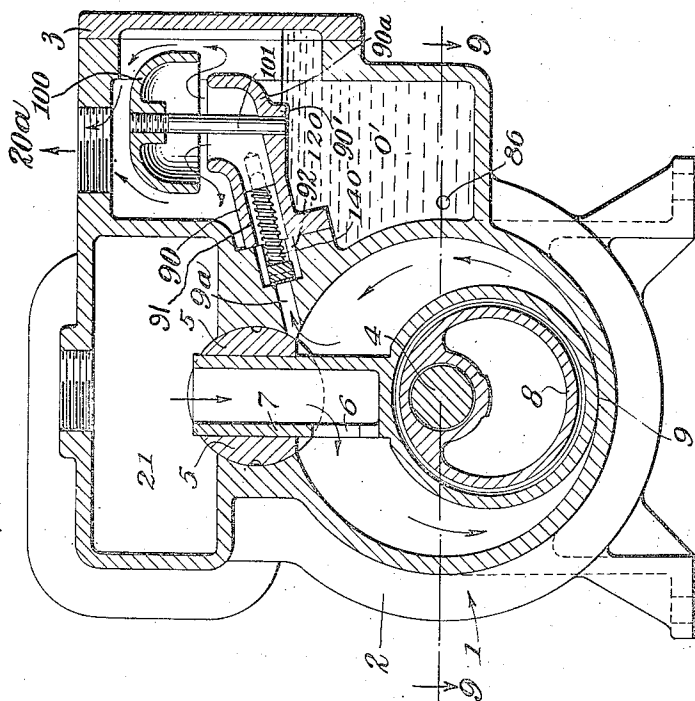


Fig. 3

Inventor:
Harold I. Stoltz
By Spear Rawlings & Spear.
Attorneys.

Sept. 17, 1940.

H. I. STOLTZ

2,215,256

HIGH VACUUM PUMP APPARATUS

6 Sheets-Sheet 3

Filed May 6, 1938

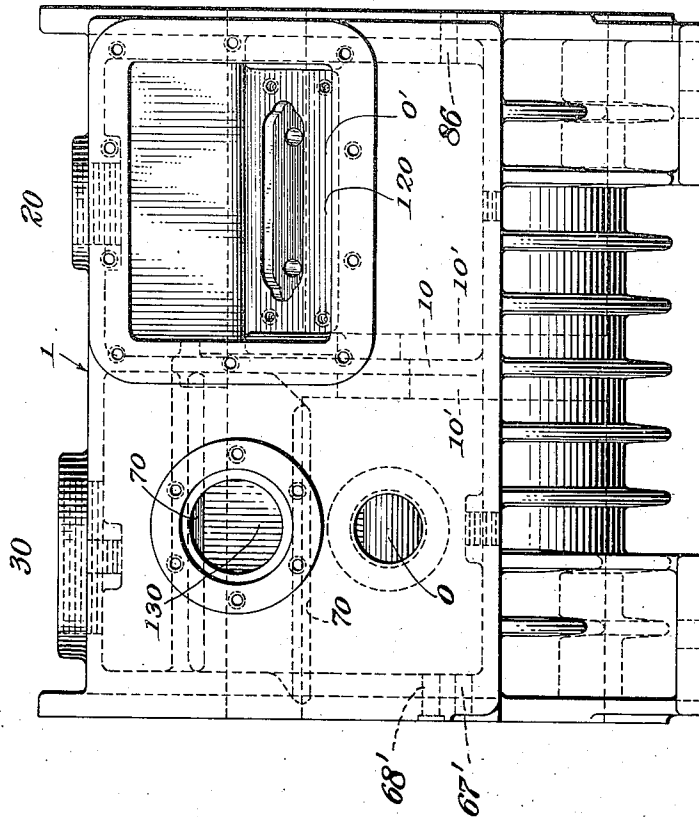


Fig. 4

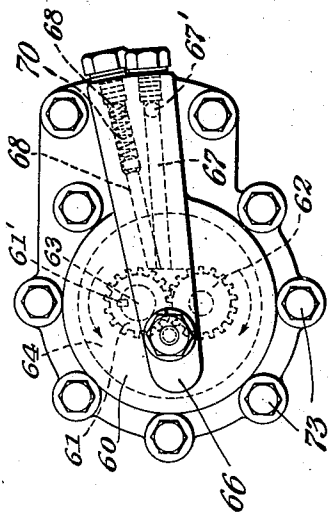


Fig. 6

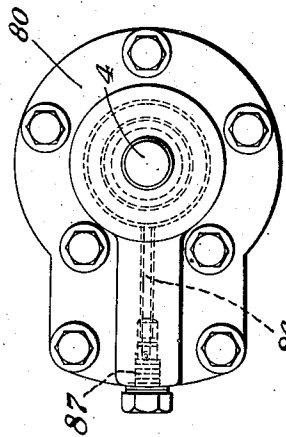


Fig. 7

Inventor:
Harold I. Stoltz
By Spear, Rawlings & Spear.
Attorneys.

Sept. 17, 1940.

H. I. STOLTZ

2,215,256

HIGH VACUUM PUMP APPARATUS

6 Sheets-Sheet 4

Filed May 6, 1938

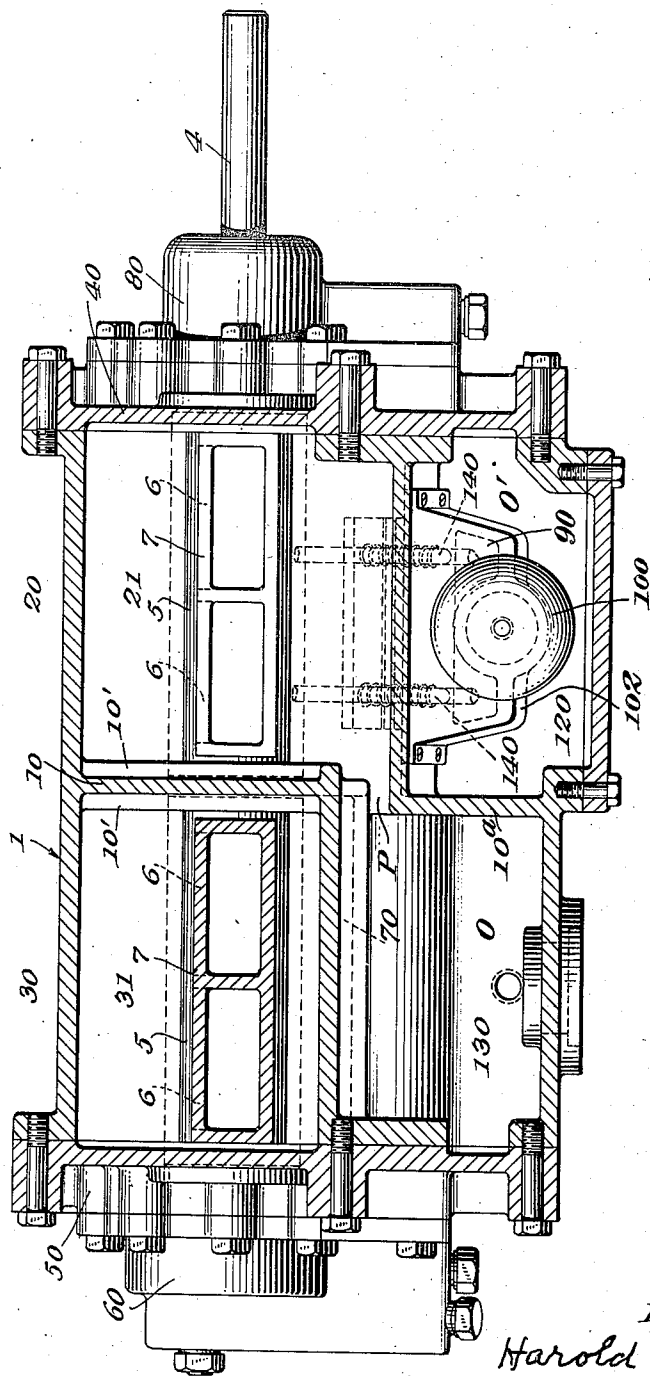


Fig. 5

Inventor:
Harold I. Stoltz
By Spear Rawlings & Spear.
Attorneys.

Sept. 17, 1940.

H. I. STOLTZ

2,215,256

HIGH VACUUM PUMP APPARATUS

6 Sheets-Sheet 5

Filed May 6, 1938

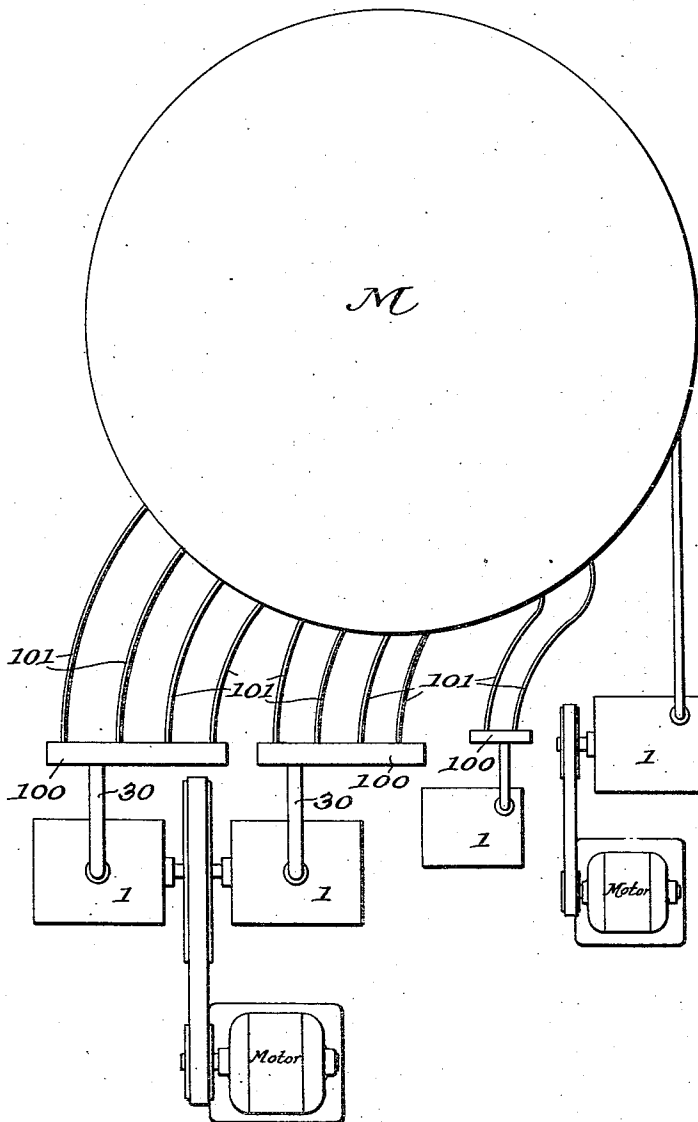


Fig. 8

Inventor:
Harold J. Stoltz
By Spear, Rawlings & Spear.
Attorneys.

Sept. 17, 1940.

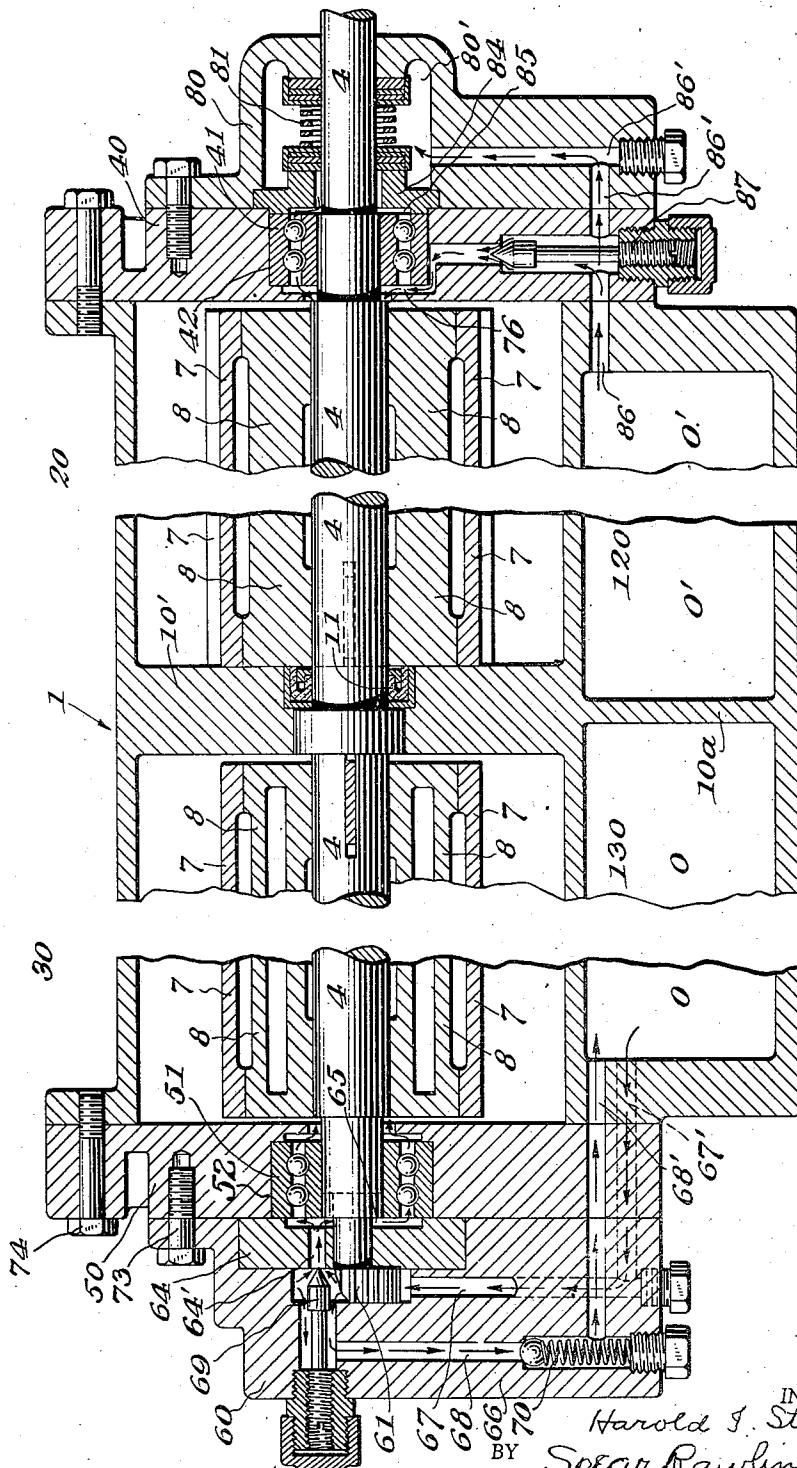
H. I. STOLTZ

2,215,256

HIGH VACUUM PUMP APPARATUS

Filed May 6, 1938

6 Sheets-Sheet 6



INVENTOR.

Harold I. Stoltz
Spear Rawlings & Spear
ATTORNEYS.

Spear Rawlings & Spear

ATTORNEYS.

UNITED STATES PATENT OFFICE

2,215,256

HIGH VACUUM PUMP APPARATUS

Harold I. Stoltz, Hyde Park, Mass., assignor to
Kinney Manufacturing Company, Jamaica
Plain, Mass., a corporation of Massachusetts

Application May 6, 1938, Serial No. 206,423

11 Claims. (Cl. 230—147)

5 In the commercial development of high vacua in the manufacture of radio tubes, light bulbs and like envelopes or vessels, increasing demands have grown as the manufacturers of such articles have seen new possibilities could their equipment be raised to super efficiencies.

10 Originally a high vacuum by means of an oil sealed vacuum pump was thought of as anything over 29 inches of mercury, as read on one of the old gages. Researches at that time had developed vacua only readable on supersensitive instruments like the so-called McLeod gages which provided readings in microns. These were supposed, with some refinements given them during my earlier researches, to represent the limit of measurement of degrees of exhaustion then known outside of laboratory rarefactions.

15 That such rarefactions could be developed and held in operative subservience to manufacturing manipulations, steps and production processes, was considered not humanly possible in any engineering sense. According to my present concept I have improved my systems and secured an embodiment that shows on my adapted McLeod gages a rarefaction beyond what it was devised to indicate. In checking my system on the basis of laboratory gages, using an emanation extension on a radio active source, I found that I was attaining practical vacua readings in hundredths of a micron. This, it will be understood by those familiar with laboratory experiments, represents measurement so delicate as to create new standards in the field of production of such practical importance as hardly at once to be fully appreciated.

20 During the past few years it has been evident that the radio tube industry desired pumping equipment capable of producing a lower absolute pressure with speed and reliability consistent with that obtained with available high vacuum pumps now in general use throughout the industry. Various types of equipment are being used, but with only partial success. During this period many experiments have been made with the pump of patent to Kinney, No. 1,623,315 which ultimately led to the present invention.

25 In studying the performance of my experimental units, it was apparent that there were too many threaded and other connections to expect to produce commercially units which would approach anywhere near the actual capacities required. Further, when I studied the natural entrainment of air in oil it became an apparent fact that the oil supply entering the high vacuum stage must be completely deaerated. By my research

I definitely proved that if a supply of deaerated oil between the high and low vacuum stages were to be maintained, the pressure differential was insufficient to provide a consistent flow of sealing oil to the high vacuum stage. It will be understood that the problem is to maintain at all times a sufficient amount of sealing oil about all the joints and parts of the pump so that there will be no loss of the high vacuum resulting from the evacuating action of the pump.

5 In general, my concept contemplated oil sealed mechanical pumps in which I would stage two pumps in one casing and provide the stages with a positive seal, one from the other, except through the ported connections provided for communication one to the other. Also, I would provide sealing oil free from air or vapor for the high vacuum stage which would be independent of the oil seal of the backing-up stage, and which oil would be located intermediate the two stages and continuously deaerated by the suction of the backing up stage to which the body of oil would be subjected through the ported connections between the two stages. I would also provide a positive means of supplying this deaerated sealing oil to the high vacuum stage in proper regulated quantity as a definite seal to the working vacua. By staging in one casing, I would reduce the number of joints which must be sealed off to prevent air leakage into the pump to a minimum, this being particularly important on the high vacuum stage.

10 For the purposes of illustration of a subject matter so subtle I am compelled to disclose my own practical structural basis of operation. Because my structure is capable of a wide range of modification, its tolerances being so fine and so difficult accurately to keep checked, I make such detailed disclosure relying on securing adequate patent coverage to protect me against close competition.

15 In the drawings I have shown a unit of obvious adaptability, and to those skilled in the art, of great efficiency. Apart from my method which it operatively epitomizes, it represents a novel pumping device of mechanical merit which embodies various features of advantage.

20 Throughout the specification and drawings like reference numerals are employed to indicate corresponding parts, and in the drawings:

Fig. 1 indicates a central vertical section through a unit according to my invention.

Fig. 2 illustrates a transverse section through the left or high vacuum side of the unit of Fig. 1.

Fig. 3 is a similar section through the backing-up section to the right of Fig. 1.

Fig. 4 is a partial side elevation of the unit of Fig. 1, with valve cover removed.

Fig. 5 shows substantially a section on the plane 5-5, of Fig. 1.

Fig. 6 is a detail of the oil pump cap showing its indicated dual or twin controls as viewed from the left of Fig. 1.

Fig. 7 is a similar treatment of the open head cap as viewed from the right of Fig. 1.

Fig. 8 is a schematic view of an evacuating system according to my invention operating in conjunction with a tube machine arbitrarily indicated as of a rotary table type, and

Fig. 9 is a section on the lines 9-9 of Figs. 1 and 3.

In the illustrative embodiment shown in the drawings, I have indicated at 1 a unit casing having its high vacuum side indicated at 30 and its backing-up stage indicated at 20. The casing 1 is partially divided midway of its length by a partition or central wall 10 isolating atmospherically two independent but cooperative sections indicated as 21 and 31. On each side of the wall 1 is one of my oil seal pump units 2 (see Figs. 2 and 3).

The casing 1 also includes a compartment 3 forwardly or rearwardly of the pump units 2, which compartment may be of the overhanging construction shown in Figs. 2 and 3 or of other design. This compartment also is divided substantially midway as by the wall 10a which is connected to the wall 10 except adjacent the top of the casing as at the point marked P in Figs. 2 and 5.

On the left hand side of this partition 10a as shown in Figs. 5 and 9, I provide an oil chamber 130 intermediate of the two pump sections 30 and 20 into which is delivered the exhaust from the port 70 of the high vacuum side of the compound pump. From this chamber 130 leads the corridor P (Fig. 5) through which the exhaust oil and gases are drawn by suction to the intake chamber 21 of the backing up pump section 20. As this chamber 130 is open to the intake or suction side 21 of the pump section 20, the oil O therein continuously is being deaerated, a vacuum in the vicinity of a few microns being maintained.

A supply of such deaerated oil O is maintained in this intermediate oil chamber 130 at a level just below the mouth of the exhaust 70 (Fig. 2). Thus the two pumping stages are completely sealed one from the other except through the corridor P. The deaerated oil O is positively fed to the oil sealing system of the pump 30 as hereinafter described.

The chamber 120 on the opposite side of the wall 10a adjacent the second stage pump 20 serves as a reservoir for the oil under atmospheric pressure which supplies the oil seal for the second stage pump 20.

The central wall 10 has in its thicker portion 10' recesses for the cylindrical sides of the slide pins 5 in which the hollow stems 7 of the rotary piston 8 are guided. (Fig. 1). The piston 8 sweeps the cylindric interior 9 of the lower part of the casing 1 on each side of its central wall 10. The hollow stems 7 have ports 6 which are uncovered when the piston is at the bottom of its stroke. (Figs. 2 and 3).

The casing 1 is closed at the ends of the stages by heads 40 and 50. Through these and the center wall 10 passes the main drive shaft 4. This is tightly packed in the wall 10 as at 11 to prevent any leakage between the sections 21 and

31. The shaft 4 is supported in oil sealed bearings 41 and 51 mounted within pockets 42 and 52 in the heads 40 and 50 respectively, the sealing control of which will be discussed later.

On the head 50 is mounted a gear pump 60 in which are sealed a pair of continuously driven intermeshing gear pump rotors 61 and 62. The rotor gear 61 is fast as at 61' to a short shaft 63 which has a key and kerf driving connection with the outer end of the main drive shaft 4 (Fig. 1).

This short gear shaft 63 is mounted in a plate 64 having a recessed face 65 disposed next to the bearing 51 so as to close the shallow annular oil chamber 52 containing the bearing 51.

The oil pump 60 communicates with the de-aerated oil reservoir 130. It comprises the casing 66 (Figs. 6 and 9), suitably bored longitudinally to provide the passageway 67 for the deaerated oil to the pump rotors 61, 62, this passage 67 communicating with a passage 67' through the wall of the main casing 1 leading from the reservoir 130 (Fig. 5). Spaced laterally and angularly from the inlet passage 67 is the by-pass or return passage 68 leading from the discharge side of the oil pump 60 and which communicates with a passage 68' through the casing wall communicating with the reservoir 130. In this by-pass is positioned an adjustable needle valve 69 for regulating the flow of sealing oil to the high vacuum pump 30 through the passage 64' in the plate 64. A spring loaded ball valve 70 (Figs. 6 and 9) which permits the return of surplus oil to the reservoir only when the desired pressure within the pump 60 is exceeded is also positioned in the by-pass 68.

The deaerated oil is forced by the pump 60 to the bearing chamber 52 as indicated above by way of the transverse passage 64' through the plate 64 (Figs. 1 and 9), from which chamber the sealing oil passes to the usual oil sealing system of the high vacuum pump 30 along the shaft 4 which communicates with the various sealing oil ducts and grooves about the parts 5, 6, 7, 8 and 9, for example as shown in the patent to Kinney 1,623,315. The pressure maintained in the chamber 52 is sufficient to keep the oil sealing system full of sealing oil at all times and to promptly replace any withdrawn with the exhaust.

The pump casing 66 is suitably fastened to the head 50 as by bolts 73, the head 50 being secured to the main casing 1 as by bolts 74.

Opposite the gear pump 60 on the other end of the casing 1 is mounted what may be called the open head cap 80, in which the shaft 4 is sealed against oil leakage as at 81. This head cap backs up an inner open head cap 84, having a concaved face 85 disposed next to the bearing 41 opposite the concavity 76 so as to form the annular oil sealing chamber 42.

Through the head 40 is guided the oil O' from the reservoir 120 to the oil sealing system of the backing up pump section 20, the oil being fed to the sealing system of this pump only under atmospheric pressure regulated by the adjustable needle valve 87 in the passage 86. Such pressure causes the sealing oil to flow to an extent adequate to protect the vacuum in this open head pump, the function of which is to back up the more complete rarification secured with the pump 30. The oil passage 86' through the head 40 and cap 80 (Figs. 7 and 9) communicates with the passage 86 through the casing 1 to the reservoir 120 (Figs. 5 and 9). The passages 86-86' de-

liver oil under atmospheric pressure to the chamber 42 in which a supply of oil builds up for the oil sealing system of the backing-up pump 20, which oil passes from the chamber 42 along the shaft 4 to the usual oil sealing grooves of the pump parts. The passages 86—86' also supply oil for sealing and lubrication to the rotary seal in the chamber 80' of the cap 80.

As the chamber 42 is emptied by oil passing therefrom to the oil sealing system as required, the valve 87 is adjusted to permit oil from the reservoir 120 to enter the chamber 42 in proper quantity. The oil seal of the unit is along the general lines heretofore established, but under my novel control it becomes a new system.

In the first place, it must be explained that in my research I have discovered what I believe is the missing linkage between the surprisingly high vacuums as already demonstrated, and the supposedly impossible super-vacua for which commercial science has been waiting. This it will be seen results from the continuous supply of deaerated sealing oil, to replace that withdrawn in the exhaust, from an independent continuously deaerated oil source, wherever located, connected intermediate the auxiliary systems, identified as the oil reserve O in Fig. 2. This source is independent of and to be distinguished from the secondary oil reserve O' on what I have termed the open or backing-up side of the unit on the opposite side of the partitions 10 and 10a.

In my oil seal system as developed by me I have introduced this novel concept of a final oil barrier of deaerated oil protective of the high vacua developed. As shown, this is accomplished simply and effectively by the positive needle valve control 69 which, with its companion check valve 70, ensures the definite feed of deaerated oil to seal the parts in predetermined feed (Fig. 6).

As first suggested, the demands of industry kept close on the heels of such improvements as pump manufacturers had been able to make. The production of radio tubes is a striking instance of the demand or challenge and the mechanical difficulties entailed by its established machinery and practice.

As illustrative of a hookup in which a plurality of my units I as herein described services a radio tube machine M, I have shown in Fig. 8 a schematic view arbitrarily indicated as of rotary table type, as such is characteristic and has its own peculiar difficulties.

The high vacuum suction 30 of the units I may be connected with the vacuum system of the machine M as by manifolds 100 and suitable pipes 101 made as short and tight as the installation permits.

The present invention is the result in part of the above study and theorizing and has shown readings in the neighborhood of .01 micron, whereas in previous attempts at compounding, readings of .5 micron were considered good, but could not be maintained consistently.

Following briefly the functioning of my present invention in an installation such as is schematically suggested in Fig. 8, the rarefied gases exhausted from the machine M through the connection 100 enter the high vacuum stage through the suction connection 30a shown at the top of Fig. 2. This high vacuum stage is also shown on the left hand side of Fig. 1. From the intake chamber 31 of the high vacuum phase, the gases pass through the piston slide 7 being drawn into and forced out of the pump cylinder

9 by the piston 8 at the discharge port 70 on the right hand side of the cylinder bore. The gases and excess oil pass over the intermediate oil chamber 130, through the corridor P connecting to the suction side 21 of the backing stage 20 (see Fig. 5). The pump 20 exhausts through the port 30, the exhaust matter passing about the condensing baffle 100 which tends to separate the oil and gases, the oil dropping into the reservoir 120 and the gases exhausting to atmosphere through the port 20a. The oil chamber 120 is completely separated from the intermediate chamber 130 by the transverse wall 10a.

It will be noted that the discharge member 90 of this backing stage is fitted with a spring loaded valve 140 (see Fig. 3) to prevent the re-entrance of air and oil under atmospheric pressure. The discharge member 90 is shown in assembly with the mushroom-shaped baffle 100 in Figs. 3 and 5. This member 90 is secured by suitable means to the pump wall above the cylinder 9 with its throat 91 communicating with a pocket 92 in the pump wall into which leads the exhaust port 9a from the pump cylinder 9 and in which is positioned the valve 140.

At its outlet end the discharge member 90 flares outwardly and upwardly as at 90a, but its bottom portion is thickened and flattened as at 90' to provide a base for the vertical support 101 on which the baffle 100 is mounted. (Fig. 3). The baffle is also supported by brackets 102 suitably secured to the discharge member adjacent either end thereof (Fig. 5).

As shown, the baffle 100 is of greater diameter than the width of the discharge member 90 so that the exhaust is substantially all delivered beneath its concaved lower face, the oil impinging thereon falling back into the reservoir 120 and the gases passing down and around the baffle and up and out through the outlet 20a.

As indicated above the clearances and parts in the high vacuum stage 31 are sealed and lubricated by the deaerated oil in the chamber 130 shown at the right of Fig. 2 through the small gear pump 61, 62 shown at extreme left of Fig. 1 as controlled by the valve 69 the excess oil being by-passed back to this same chamber as at 68—68' shown in Fig. 6. The oil O in this chamber 130 is open to the suction intake of the backing up pump 20 through the corridor P and thus is continuously being deaerated.

The pump clearances and parts of backing stage 21 are similarly sealed and lubricated by atmospheric pressure on the oil O' instead of by a separate pump (see Fig. 7). The amount of oil delivered to the chamber 42 is controlled by the valve 87 in the passage 86 leading through the head 40 and communicating with the reservoir 120. (Figs. 7 and 9.) Oil is also fed through the cap 80 shown in Fig. 7 to the stuffing box seal 81 shown in Fig. 1. This seal when properly lubricated without further adjustment effectively eliminates any leakage of air along the shaft and into the backing stage.

The above construction eliminates every possibility of leakage and allows the full pump capacity to be utilized in pumping down the system to which it is attached, to those new degrees of super vacua above indicated. It does this consistently in spite of machine fluctuations. In case of breakage of a tube under exhaustion in the machine, the positively fed oil seal of the high vacuum phase will hold against total loss of vacuum which in the operating machine ne-

cessitated a long delay to rebuild before proper evacuation could continue.

My invention is applicable through such units to all current types of machines. The units are
5 subject to modification within my invention by those skilled in this art.

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

1. A high vacuum pumping unit comprising a
10 pair of separate rotary pumps, one of said pumps constituting a primary pump and the other of said pumps constituting a backing-up pump,
each of said pumps including an intake port and a discharge port, said primary pump having a
15 reservoir for sealing oil adjacent and connected to its discharge port and the discharge port of said primary pump opening into said reservoir above the level of the oil therein, the intake port
20 of said backing-up pump being operatively connected to said reservoir to continuously deaerate the sealing oil therein, and said connection being at a point below the discharge port of the primary pump so as to maintain the deaerated
25 oil at a selected level, and positive pumping means to continuously deliver a controlled flow of deaerated sealing oil to said primary pump from said reservoir against the influence of the intake of said backing-up pump.

2. The unit of claim 1, there being a chamber intermediate of the discharge port of said
30 primary pump and the intake port of said backing-up pump, said chamber including said reservoir for deaerated oil, and said backing-up pump having a capacity relative to that of the primary pump and to the space above the oil in the reservoir such as to substantially immediately
35 deaerate the oil in said reservoir.

3. A high vacuum pumping unit comprising a primary pump and a separate backing-up pump,
40 each of said pumps including an intake port and a discharge port, said primary pump having a reservoir for sealing oil adjacent and connected to its discharge port and the discharge port of said primary pump opening into said reservoir
45 above the level of the oil therein, the intake port of said backing-up pump being operatively connected to said reservoir to continuously deaerate the sealing oil therein and said connection being at a point below the discharge port of said
50 primary pump so as to maintain the deaerated oil at a selected level, and means to continuously deliver a controlled flow of deaerated sealing oil to said primary pump from said reservoir against the influence of the intake of said backing-
55 up pump, said means comprising a valve-controlled delivery port in communication with said primary pump, a pump to supply deaerated oil from said reservoir to said delivery port, and a pressure responsive by-pass connecting said
60 delivery port and reservoir for returning excess deaerated oil from said delivery port to said reservoir.

4. A high vacuum pumping unit comprising a
65 pair of separate rotary pumps, one of said pumps constituting a primary pump and the other of said pumps constituting a backing-up pump, each of said pumps including an intake port, a discharge port, and a reservoir for sealing oil adjacent and connected to its discharge port, the
70 discharge port of said primary pump opening into its reservoir above the level of the oil therein, the intake port of said backing-up pump being operatively connected to the reservoir of said primary pump to continuously deaerate the seal-

ing oil therein, and said connection being at a point below the discharge port of the primary pump so as to maintain the deaerated oil at a selected level, means to deliver sealing oil to said
5 backing-up pump from its reservoir, and positive pumping means to continuously deliver a controlled flow of deaerated sealing oil to said primary pump from its reservoir against the influence of the intake of said backing-up pump.

5. The unit of claim 4, said last-named means
10 including a valve controlled conduit from the deaerated oil reservoir to said primary pump, an oil pump in said conduit, a by-pass from said oil pump to said deaerated oil reservoir to return excess deaerated oil to said reservoir, and a
15 pressure operable valve in said by-pass.

6. A high vacuum pumping unit comprising a casing and end walls, a pair of separate rotary
20 pumps enclosed within said casing, one of said pumps constituting a primary pump and the other of said pumps constituting a backing-up pump, each of said pumps including an intake port, a discharge port and a reservoir for sealing oil adjacent and connected to its discharge port, the discharge port of said primary pump opening
25 into its reservoir above the level of the oil therein, the intake port of said backing-up pump being operatively connected to the reservoir of said primary pump to continuously deaerate the sealing oil therein, said connection being at a point
30 below the discharge port of the primary pump so as to maintain the deaerated oil at a selected level, means to deliver a controlled flow of sealing oil to said backing-up pump from its reservoir through said casing and one end wall, and positive
35 pumping means to continuously deliver a controlled flow of deaerated sealing oil through said casing and the other end wall to said primary pump from its reservoir against the influence of the intake of said backing-up pump.

7. A high vacuum pumping unit comprising a casing and end walls, a pair of separate pumps enclosed within said casing, one of said pumps
40 constituting a primary pump and the other of said pumps constituting a backing-up pump, each of said pumps including an intake port and a discharge port, said primary pump having a reservoir for sealing oil adjacent and connected to its discharge port, the discharge port of said
45 primary pump opening into its reservoir above the level of the oil therein, the intake port of said backing-up pump being operatively connected to said reservoir to continuously deaerate the sealing oil therein, said connection being at a point
50 below the discharge port of the primary pump so as to maintain the deaerated oil at a selected level, and positive pumping means to continuously deliver a controlled flow of deaerated sealing oil through said casing and one end wall to said primary pump from said reservoir against the influence of the intake of said backing-up pump.

8. The unit of claim 7, said means including a
55 valve controlled conduit from the deaerated oil reservoir to said primary pump, an oil pump in said conduit, and a by-pass through said end wall and casing from said oil pump to said deaerated oil reservoir to return excess deaerated
60 oil to said reservoir, and a pressure operable valve in said by-pass.

9. A high vacuum pumping unit comprising a casing and end walls, a pair of separate rotary
65 pumps in said casing, a partition separating said

pumps from each other, one of said pumps constituting a primary pump and the other of said pumps constituting a backing-up pump, each of said pumps including an intake port, a discharge port, and a reservoir for sealing oil adjacent and connected to its discharge port, said partition having a passage therethrough to connect the intake port of said backing-up pump to the space above the level of the oil in the said primary pump reservoir so that said backing-up pump continuously deaerates sealing oil in said reservoir, a common shaft for said pumps extending through said partition and end walls sealing means for said shaft located in the end wall adjacent said backing-up pump, a bearing carried in each of said end walls to support said shaft, means to deliver sealing oil from said reservoir of said backing-up pump through said casing and the end wall adjacent said backing-up pump to one bearing and along said shaft to said backing-up pump and to said shaft sealing means, and positive pumping means to continuously deliver a regulated flow of deaerated sealing oil from said reservoir for said primary pump through said casing and the other end wall to the other bearing and along said shaft to said primary pump against the influence of said backing-up pump.

10. A high vacuum pumping unit comprising a casing and end walls, a pair of separate rotary pumps in said casing, a partition separating said pumps from each other, one of said pumps constituting a primary pump and the other of said pumps constituting a backing-up pump, each of said pumps including an intake port, a discharge port, and a reservoir for sealing oil adjacent and connected to its discharge port, the intake port of said backing-up pump being operatively connected to the space above the level of the oil in the reservoir of said primary pump so that said backing-up pump continuously deaerates the sealing oil therein, a common shaft for said pumps extending through said partition and end walls, a bearing carried in each of said end walls to support said shaft, a head secured to each end wall, the head secured to the end wall adjacent said backing-up pump including a chamber having an aperture to receive said shaft, sealing means for said shaft in said chamber compressibly interposed between said head and said end wall, means to deliver sealing oil from said reservoir for said backing-up pump through said casing and the end wall adjacent said backing-up pump to one bearing and along said shaft to said backing-up pump and through said

head to said compressible sealing means, and positive pumping means to continuously deliver a regulated flow of deaerated sealing oil from said reservoir for said primary pump through said casing, the other end wall and head to the other bearing and along said shaft to said primary pump against the influence of the backing-up pump.

11. A high vacuum pumping unit comprising a casing and first and second end walls including first and second end plates and heads, a pair of separate rotary pumps in said casing, a partition separating said pumps from each other, one of said pumps constituting a primary pump and the other of said pumps constituting a backing-up pump, each of said pumps including an intake port, a discharge port, and a reservoir for sealing oil adjacent and connected to its discharge port, the intake port of said backing-up pump being operatively connected to the space above the level of the oil in the reservoir of said primary pump so that said backing-up pump continuously deaerates the sealing oil therein, a common shaft for said pumps, said end plates, said partition and said second head being apertured to receive said shaft, bearings carried by said end plates to support said shaft, resilient shaft sealing means between said second head and second end plate, a conduit from said reservoir for said backing-up pump extending through said casing, said second end plate and said second head in communication with said shaft sealing means, a branch conduit through said second end plate in communication with said first-named conduit and the bearing in said second end plate and a valve in said second conduit to regulate the flow of oil to said second end plate bearing, an oil pump having an intake port and a discharge port, means intermediate the first end plate and the first head carrying said oil pump and connecting it to said shaft, a conduit from said reservoir for deaerated oil through said casing, said first end plate, and said first head in communication with said intake port of said oil pump, a conduit from said discharge port of said oil pump in communication with the bearing in said first end plate, a valve in control of said last-named conduit, a by-pass for deaerated oil in communication with said last-named conduit extending through said first head, said first end plate and said casing to return excess deaerated oil to its reservoir, and a pressure operable valve in said by-pass.

HAROLD I. STOLTZ.