

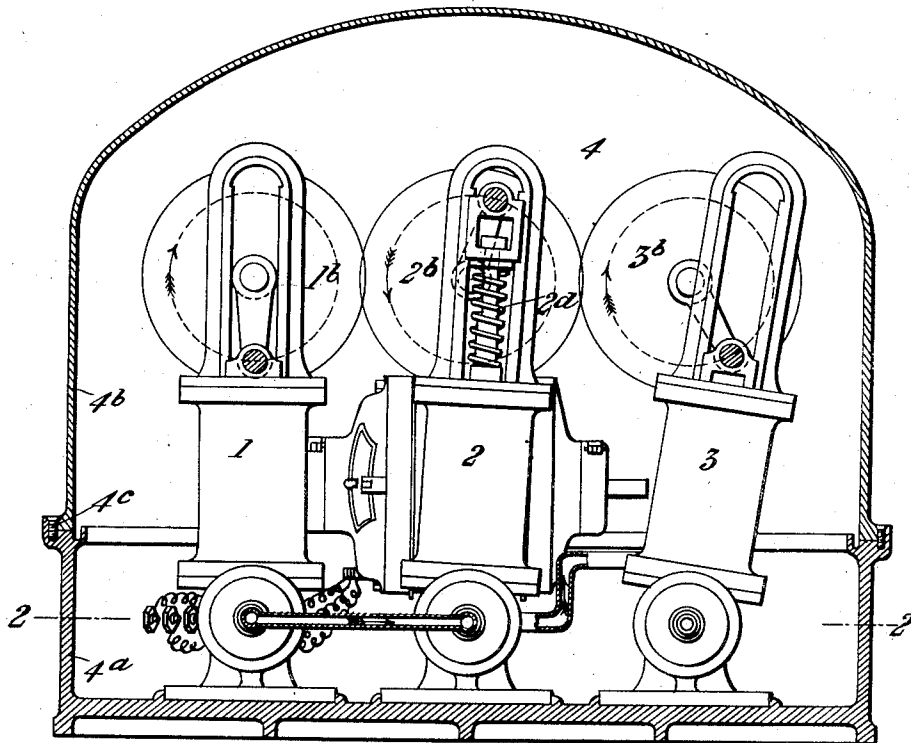
J. ZEITLIN.
MECHANICAL PRODUCTION OF HIGH VACUUMS.
APPLICATION FILED JUNE 18, 1907.

905,973.

Patented Dec. 8, 1908.

4 SHEETS—SHEET 1.

Fig. 1.



WITNESSES

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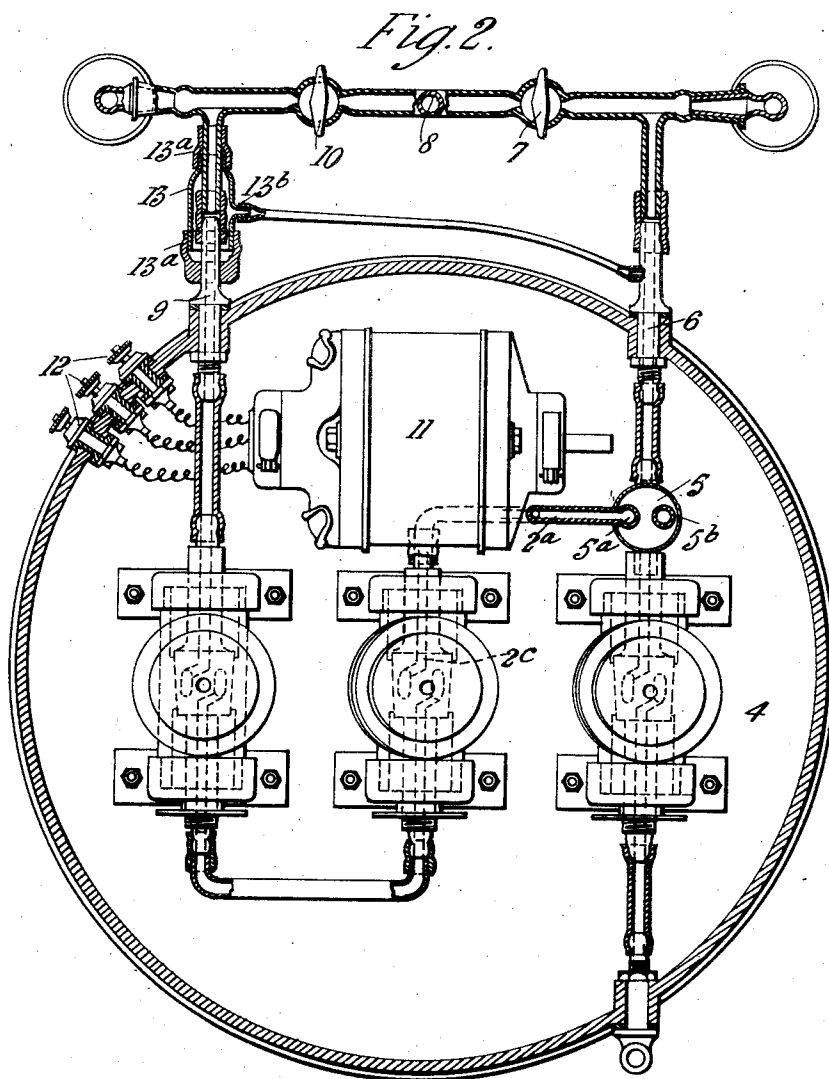
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4 SHEETS—SHEET 2.



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4 SHEETS—SHEET 4.

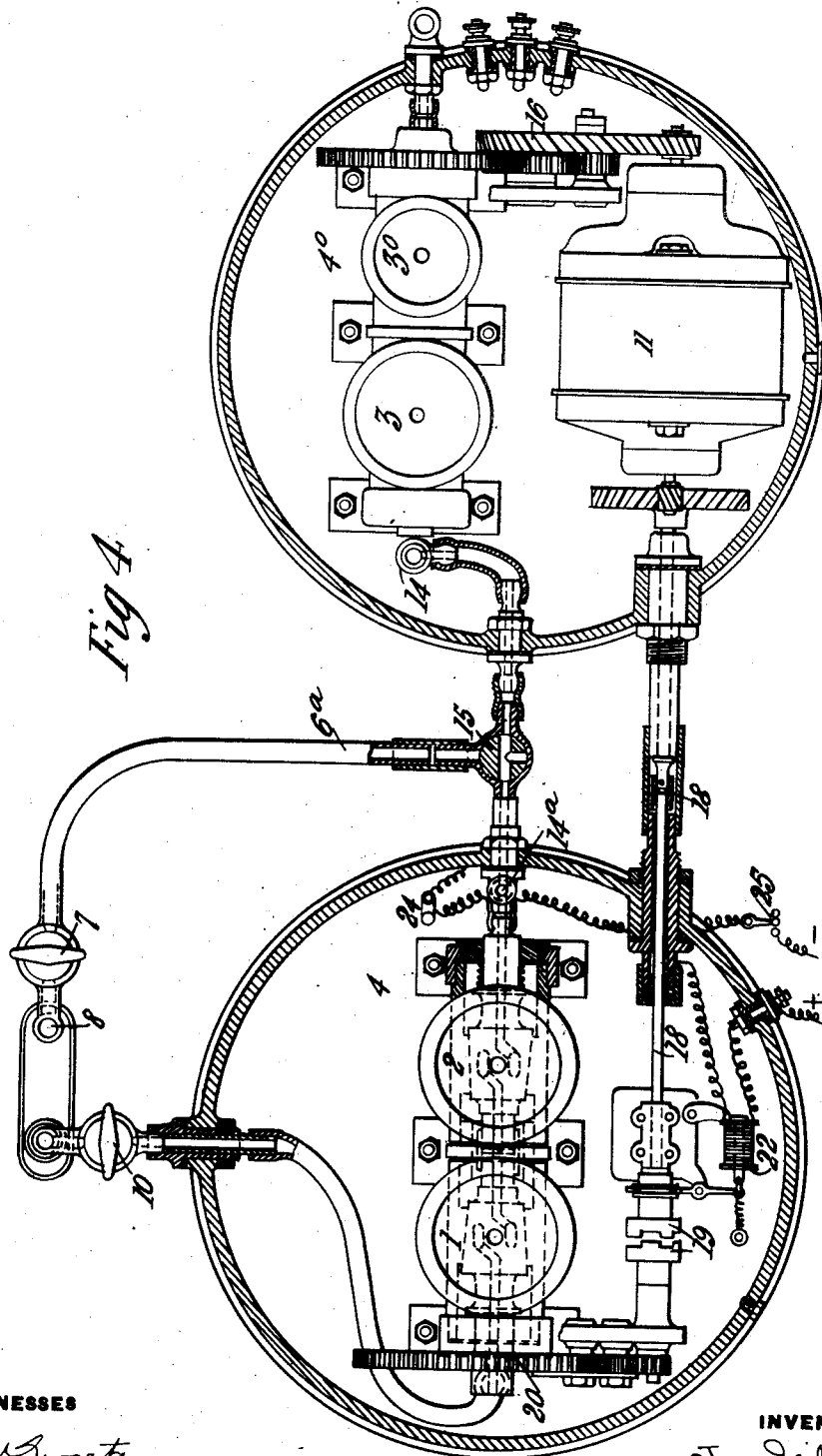


Fig 4

WITNESSES

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UNITED STATES PATENT OFFICE.

JOSEPH ZEITLIN, OF SOUTH KENSINGTON, ENGLAND.

MECHANICAL PRODUCTION OF HIGH VACUUMS.

No. 905,973.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, JOSEPH ZEITLIN, a citizen of Russia, residing at 5 Gilston road, South Kensington, in the county of London, England, student, have invented certain new and useful Improvements in the Mechanical Production of High Vacua, of which the following is a specification.

When two or more vacuum pumps are connected in series with each other for the purpose of obtaining a higher degree of exhaustion than is possible with a single pump it may be that the exhausting action of those pumps of the series which are connected on the suction side with a vessel having a comparatively high degree of exhaustion may be more or less annulled, even when delivering to a space or vessel at a low absolute pressure, by backward leakage of air over the working surfaces of the pump or valves or through the material of the leather or other packing of the pump cylinder or piston, owing to the fact that the pump and valve casings are open to the air, and that consequently there is such a large absolute difference of pressure operating to produce such leakage that the rate of leakage may approximate or equal the rate of exhaustion.

According to the present invention, such multi-stage vacuum pumps together with their driving motor are entirely inclosed in a hermetically sealed chamber from which the air is exhausted either by the action of the inclosed multi-stage pump itself or by means of an auxiliary pump external to the chamber. By this means the difference of pressure available for the production of leakage towards the suction end of the pump is so reduced as to be practically ineffective, thereby facilitating the rapid production of high degrees of exhaustion. Such an inclosed pump may be conveniently driven by an electric motor placed within the inclosed chamber or shell, and in this case the walls of the chamber need only be pierced for the passage of the suction pipe of the first pump of the series, the delivery pipe of the last pump, and for the electric supply leads or lead of the motor (an earth return could be used if the casing were wholly or partly of metal).

The inclosing chamber might conveniently be constructed in two parts of which the lower is fixed and cup-shaped and has its wall fitted for the establishment of the pump and motor connections, while the upper part

is removable and may be dome-shaped, the abutting edges of the two parts being ground or otherwise shaped to a truly plane surface so that an air-tight joint may be conveniently made either with the assistance of an indiarubber ring or of resin cerate or other suitable sealing agent. The chamber would also be provided with a relief valve or cock for the purpose of breaking the vacuum to permit the removal of the upper part of the shell.

When an auxiliary pump is provided for exhausting the inclosing vessel, the various unit pumps of the inclosed multi-stage pump would be connected in series in the usual manner, but if no auxiliary pump is provided, the exhaustion of the inclosing vessel may be effected by arranging the delivery pipe of the pneumatic pump, and the suction pipe of the last pump of the series to open within the inclosing vessel.

In the accompanying drawings, Figure 1 is an elevation partly in section and Fig. 2 a sectional plan showing three oscillating cylinder vacuum pumps with their driving motor inclosed in a vacuum chamber; and Figs. 3 and 4 are similar views showing four pumps arranged in pairs in two vacuum chambers with a common driving motor inclosed within one of the chambers.

The vacuum pump shown in these drawings is of the kind described in my pending application, Serial No. 264,463, filed April 8th, 1905 but it will be understood that the practice of this invention does not depend on the use of this particular kind of pump, and that any suitable mechanical pump may be substituted therefor.

Referring first to Figs. 1 and 2, the suction side of pump 1 is connected with the vessel to be exhausted and the delivery side to the suction of pump 2 which in turn delivers to the vacuum chamber, while the third pump 3 is open on the suction side to the vacuum chamber 4, either directly or through the valve box 5 and delivers to the atmosphere. The suction side of pump 3 is also arranged so that it can be connected directly to the vessel to be exhausted for the purpose of effecting the preliminary exhaustion of the vessel. This connection is established through the pipe 6 which passes air-tight through the wall of the chamber 4, a stop cock 7 being interposed between the pipe 6 and the tube 8 leading to the vessel to be exhausted. The suction side of pump

1 is similarly connected with the tube 8 through pipe 9 and stop cock 10. The check valves 5^a 5^b are normally open to the vacuum chamber, the valve 5^a only closing when the pressure in the delivery pipe 2^a of pump 2 is less than that of the valve box 5 or of chamber 4 if delivering directly thereto, and valve 5^b only closing when the pressure inside the valve box 5 is greater than the pressure in the chamber 4.

The driving motor 11 which is preferably a shunt or a compound wound motor is connected through suitable reducing gear not shown in the drawings, with the crank disk of one of the pumps, say to the crank 2^b of pump 2 which oscillates the pump cylinder to open and close the suction and delivery ports of the distributing valve 2^c and reciprocates the elastically coupled piston rod 2^d by the means and in the manner described in my application, Serial No. 254,463, already referred to.

The crank disks 1^b, 3^b of pumps 1, 3 are respectively geared with that of pump 2 one on either side, and pumps 1, 3 are arranged to be practically opposed in phase to pump 2. As a matter of practice, pump 2 is arranged to lag slightly behind its theoretical phase relation so as to insure that the suction stroke of pump 2 will not be completed before the completion of the delivery stroke of pump 1, and similarly pump 3 is arranged to lag slightly behind its theoretical phase relation with respect to pump 2 for the same reason.

The electrical connections between the motor and a suitable source of electric current are established through the binding posts 12 which are fixed air-tight in the wall of the vacuum chamber and insulated therefrom by any suitable means, such as by a collet of vulcanized fiber or ebonite with an internal or external washer of dermatine or other suitable material.

The vacuum chamber 4 is made in two parts, the lower part 4^a being preferably a casting on which the pumps and motor are bedded, and the upper part 4^b preferably a dome-shaped glass cover as shown for purposes of inspection during working. The abutting edges of the two parts are ground to truly plane surfaces to form an air tight joint with the assistance of resin cerate or the like with or without the interposition of an indiarubber washer. Or the upper edge of the casting 4^a may be formed with a circumferential groove for the reception of a ring of india-rubber or dermatine or other suitable material on which the cover 4^b would rest. The joint between the abutting edges may be supplemented by a liquid seal of castor oil or the like contained in an annular channel 4^c formed around the edge of the casting 4^a as shown in Fig. 1. A relief valve or tap, not shown in the drawings, is

fitted to the casting 4^a for the purpose of admitting air to the chamber 4 so as to enable the cover 4^b to be removed.

To reduce the liability to leakage at the india-rubber connection between the metal pipe 9 and the glass or other tube to which it leads, this joint is preferably inclosed in a tube 13 the ends of which are closed by india-rubber caps or sleeves 13^a and a branch 13^b from which is connected by rubber tubing with the pipe 6 or other tube connected with the suction side of pump 3. By this means the difference of pressure between the inside and outside of the india rubber joint is reduced to a very small amount and the tendency to leakage at the joint thereby practically annulled.

In the operation of the apparatus the cocks 7 and 10 are first closed, and the motor started. When the vacuum chamber has been exhausted by pump 3 the apparatus is ready for producing a high vacuum in any vessel to which it may be connected and for this purpose the cock 7 is opened and the preliminary exhaustion of the vessel effected, also by pump 3. Valve 7 is then closed and valve 10 opened and the exhaustion continued by pumps 1 and 2 working in series and delivering to the valve box 5 or chamber 4, the vacuum in which is maintained by pump 3 delivering to the atmosphere outside the chamber 4.

In the modification shown in Figs. 3, 4, the vacuum chamber pumps 3, 3^o which may also serve for preliminary exhaustion of the vessel, are separated from the final exhaustion pumps 1, 2 and together with the motor are housed in a separate vacuum chamber 4^o. A check valve 14 is interposed in the pipe connecting the delivery pipe of pump 2 with the suction of pump 3 to prevent access of any gas or vapor from the chamber 4^o to the chamber 4 and a three way cock 15 is also inserted in this connection at the point of junction with the pipe 6^a through which communication is established between the pumps 3, 3^o and the vessel to be exhausted. By means of this three way cock the pumps 3, 3^o may be connected up as explained for preliminary exhaustion or they may be connected in series with the pumps 1, 2 for the final stages of the exhaustion. The motor 11 is connected through reducing gear 16 with a driving shaft 17 which has a double throw crank the two crank pins 17^a, 17^b, of which are set at about 180° apart and are connected with the crossheads of the respective pumps 3, 3^o. The armature is also geared with a shaft 18 which passes through sleeves 18^a secured airtight in the walls of the two vacuum chambers 4^o 4 and a stuffing box 18^b within the latter chamber preventing access of gases or vapors thereto between the shaft and the sleeve, and is coupled through an electrically

actuated clutch 19, and reducing gear 20 with the driving shaft 21 which works the pumps 1, 2 through the cranks 21^a 21^b in the manner already described with reference
 5 to pumps 3, 3^o. The various gears are arranged so that the pumps are all driven at the same speed successive pumps of the series being opposed in phase to the preceding pump or lagging slightly behind such phase
 10 relation as already explained.

By separating the high vacuum pumps from the preliminary exhaustion pumps as above explained, the whole of the apparatus in the chamber 4 may be lubricated without
 15 the use of liquid lubricants, and consequently the chamber will be free from the vapor of such lubricants which may for example be used in the motor 11, and which, if present, might find its way into the pumps and so
 20 increase the difficulty of obtaining a pure and vaporless vacuum. The clutch 19 is actuated by an electromagnet 22 in the energizing circuit of which is included a break or gap 23 constituted by the space between
 25 the mercury of the pressure gage 24 and a contact 24^a in one of the limbs of the gage. The energizing circuit of the magnet remains open until the pressure within chamber 4 is reduced to a very small amount say
 30 a few millimeters, and consequently the pumps 1, 2 are not operative until that condition holds. An additional switch 25 outside the chamber 4 may be provided to control the clutch independently of the auto-
 35 matic pressure switch 23.

In operation the three way cock is first turned to the position shown in Fig. 4 and the cocks 7, 10 are closed. Exhaustion of the chambers then proceeds when the motor
 40 is started to drive the pumps 3, 3^o the air being drawn in through the check valves 14, 14^a. Of these valves 14^a is perfectly free but 14 is arranged to have a slight resistance as by means of a spring so that it will close
 45 and remain closed when the pressure in chamber 4^o has been reduced to say half an inch, and the exhaustion of chamber 4 is continued to the point at which the magnet 22 becomes energized by the closing of the
 50 circuit at 23, and is then further exhausted until a higher vacuum is attained which must not exceed two millimeters. The cock 15 is then turned to connect the pumps 3, 3^o
 55 with the vessel to be exhausted and the cock 7 opened. After preliminary exhaustion is effected the cock 7 is closed, the cock 15 turned to its first position as shown in Fig. 4, and the cock 10 opened and the final stage of exhaustion proceeds by means of
 60 the whole series of pumps.

It will be evident that the vacuum chambers 4, 4^o as also the vessel to be exhausted may be arranged to be first partially exhausted by an independent pump of large
 65 capacity, before the apparatus above de-

scribed is brought into operation, and for this purpose suitable connections would be provided with the interior of the chambers 4, 4^o. Also it will be understood that the electrical part of the driving mechanism and
 70 also the reducing gear may be arranged outside the chambers 4, 4^o and only the actual driving shaft or shafts or a countershaft carried into the chambers 4, 4^o; and also that other modifications may be made in the
 75 arrangement and design of the apparatus as above described without exceeding the scope of the present invention.

Having thus described the nature of my said invention and the best means I know of
 80 carrying the same into practical effect, I claim:—

1. For the production of high vacua, a mechanically operated pump entirely surrounded by a vacuum, inclosed in a chamber
 85 containing the vacuum and connected with the vessel to be exhausted, substantially as described.

2. In apparatus for the production of high vacua, a multiple unit mechanical
 90 pump, and inclosing means therefor, said pump being entirely surrounded by a vacuum while operating to produce the high vacua and having connections for exhausting the air within the inclosing means and
 95 also for exhausting an external vessel; substantially as described.

3. In apparatus for the production of high vacua, a multiple unit mechanical pump, and a closed chamber therefor, said pump
 100 having connections for exhausting the air within the closed chamber and for effecting a preliminary exhaustion of an external vessel by one or more of its units and for effecting the final stages of exhaustion of the said
 105 vessel by the simultaneous operation of the whole series of units, substantially as described.

4. In apparatus for the production of high vacua, a mechanical pump contained in
 110 a vacuum chamber or chambers, a part of said pump having connections for producing and maintaining the vacuum in said chamber or chambers and also for effecting a preliminary exhaustion of an external vessel; substantially as described.
 115

5. In apparatus for the production of high vacua, a multiple unit mechanical pump having at least one of its elements arranged in a vacuum chamber with connections for effecting a preliminary exhaustion of an external vessel, and its other element or elements arranged in a separate vacuum chamber, and means for connecting all the pump elements in series to effect a final ex-
 120 haustion of the external vessel; substantially as described.
 125

6. In apparatus of the character described, a multiple unit mechanical pump having some of its elements contained in one vacu-
 130

um chamber, and the remainder in another vacuum chamber, the elements in one chamber having connections for effecting a preliminary exhaustion of an external vessel
5 and also for maintaining the vacua in said chambers, and means whereby all the elements may be connected in series to effect a final exhaustion of the external vessel; substantially as described.
10 7. Apparatus for the production of high vacua, comprising a mechanical multiple unit pump, and means for maintaining a vacuum surrounding the pump and in which the pump units are entirely located and op-
15 erate; substantially as described.

8. In apparatus for the production of high vacua, a mechanically operated pump, a closed chamber or vessel surrounding the pump and its operating mechanism, and means for exhausting the closed chamber or vessel and for producing a vacuum surrounding the pump; substantially as described.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

JOSEPH ZEITLIN.

Witnesses:

JOSEPH MILLARD,
WALTER J. MERTIN.