June 10, 1941. R. S. MORSE 2,245,215

HIGH VACUUM

Filed Sept. 29, 1939

Fig. 1.

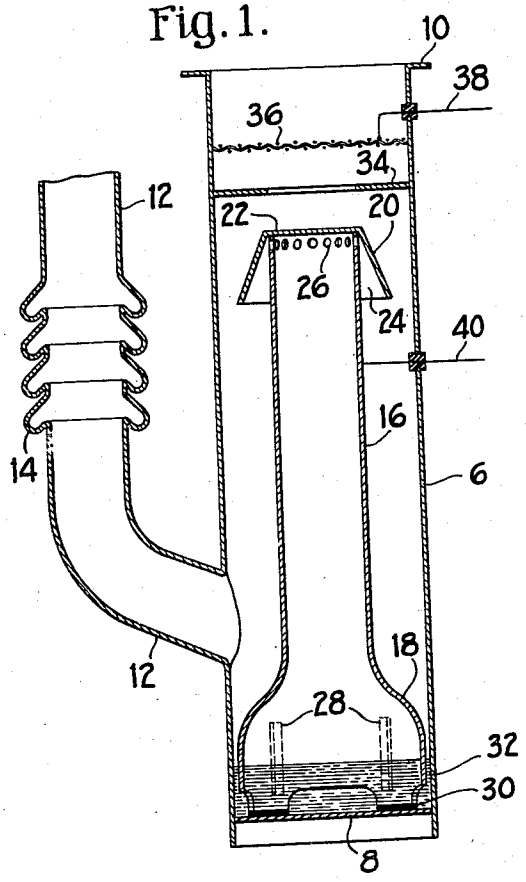


Fig. 2.

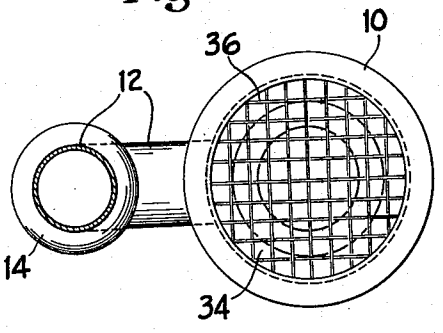


Fig. 3.

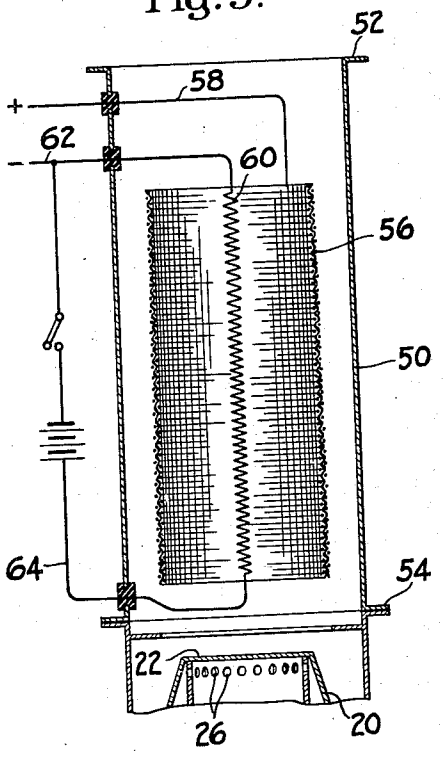
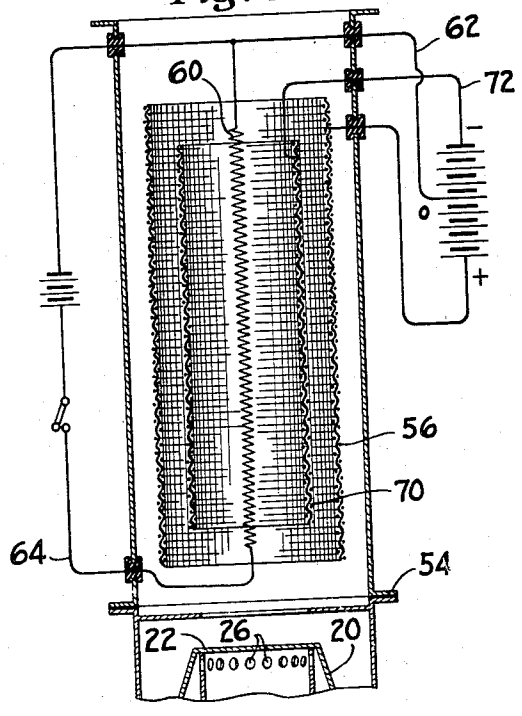


Fig. 4.



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Patented June 10, 1941

2,245,215

UNITED STATES PATENT OFFICE

2,245,215

HIGH VACUUM

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Application September 29, 1939, Serial No. 297,146

5 Claims. (Cl. 230—101)

This invention relates to improvements in high vacuum production and particularly improved means for removing vapors from condensation pump jets which tend to pass in a reverse direction to that in which the gases being pumped are flowing.

A difficulty with condensation pumps which has never been completely overcome is the tendency of vapors issuing from the jet of the pump to partially pass backwards in a reverse direction. The vapors eventually reach the receptacle being evacuated and consequently prevent the production of the highest vacua therein. It has been proposed that these vapors be removed by traps cooled with liquid air or other similar cooling means. However, such traps are expensive to operate because of the cost of the cooling material and also have a rather high impedance to the passage of gases being pumped.

This invention has for its object to provide a simple, efficient and economical method of removing such reverse flowing vapors. Another object is to provide a condensation pump provided with electrical means for removing reverse flowing vapors. A further object is to provide a trap for reverse flowing vapors which has low impedance for gases being pumped. Other objects will be apparent from the following description and claims.

These objects are accomplished in accordance with my invention which comprises means for applying an electrical charge to reverse flowing vapors and means located at the high vacuum end of the pump or between the high vacuum jet of the pump and receptacle being evacuated for presenting an oppositely charged surface to that of the vapor molecules so that they are attracted to the surface and condensed thereon.

In the following description I have described several of the preferred embodiments of my invention, but it will be understood that these are given for the purpose of illustration and not in limitation thereof.

In the accompanying drawing wherein like numbers refer to like parts:

Fig. 1 illustrates in vertical section a condensation pump provided with electrical means for removing reverse flowing vapors in accordance with my invention;

Fig. 2 is a top plan view of Fig. 1; and

Figs. 3 and 4 illustrate in vertical section modifications of the apparatus shown in Fig. 1.

Referring to Figs. 1 and 2, numeral 6 designates a cylindrical pump casing closed at the base by plate 8 and provided with a flange 10 at the top thereof. Numeral 12 designates a side conduit integral with the lower portion of the wall of casing 6 which conduit is L-shaped and the vertical portion of which is provided with re-entrant rings 14. Numeral 16 designates a cylindrical conduit, the lower portion of which is expanded as illustrated at 18 so that its external diameter is only slightly smaller than the internal diameter of casing 6. Numeral 20 designates a truncated cone, the top of which is closed by plate 22 and which is integral with conduit 16 so as to form an expansion annular jet 24. Numeral 26 designates a plurality of holes through which working vapors flow into jet 24. Numeral 28 designates a plurality of spacers constructed of material which will not conduct electricity and which function to center the base portion 18 so that it is concentric with the lower portion of cylinder 6, but not in actual contact therewith. Numeral 30 designates insulating material which forms the base of legs 32 and is attached thereto in such a manner as to electrically insulate cylinder 16 from base plate 8. Numeral 34 designates a baffle integral with the walls of casing 6 and provided with a central opening as illustrated. Numeral 36 designates a screen integral with the inside walls of casing 6 to which is connected electrical lead wire 38. Numeral 40 designates an electrical lead wire connected to conduit 16.

Referring to Fig. 3, numeral 50 designates a cylindrical casing of approximately the same diameter as pump casing 6 which is provided with flanges 52 and 54 at the top and bottom ends thereof. Flange 54 cooperates with flange 10 of the condensation pump to securely fasten the two units together in a gas-tight manner. Numeral 56 designates a cylinder constructed of metal gauze which is of somewhat smaller diameter than casing 50 and is mounted therein so that it is substantially concentric with the walls thereof. Numeral 58 designates an electrical lead wire which connects to gauze 56. Numeral 60 designates a filament constructed of tungsten or other material adapted to be heated without destruction in a vacuum to which is connected electrical lead wires 62 and 64.

Referring to Fig. 4, numeral 70 designates a cylinder constructed of metal gauze which is of smaller diameter than gauze cylinder 56 and which is located inside and approximately concentric with gauze cylinder 56. Numeral 72 designates an electrical lead wire connected to gauze cylinder 70.

During operation of the apparatus illustrated in Fig. 1, pump fluid is introduced into the base

thereof to the approximate level indicated. The base of the pump is then heated by heating means (not shown) so that the pump fluid is vaporized and the vapors pass upwardly through openings **26** and downward through jet **24**. Conduit **12**, of course, connected to a backing pump and flange **10** is connected to the system to be evacuated. Gases diffusing from the system pass through the opening in baffle **34** and are entrained in the jet of vapors issuing from jet nozzle **24**. Vapors issuing from jet nozzle **24** do not all have the same direction of motion or the same velocity so that many of them pass or burst sideways when they reach the lip of the jet and stream backwards in a reverse direction through the opening in baffle **34** and pass into contact with metal screen **36**. A positive or negative electrical charge is applied to these vapors since the pump is constructed of metal and is charged to a relatively high potential by lead wire **40** connected to a suitable source of direct current. An opposite charge is applied to metal screen **36** by lead wire **38**. Therefore, the charged reverse flowing vapors are attracted to the metal screen **36** and become condensed thereon. The pump fluid is thus prevented from continuing backwards into the receptacle to be evacuated where it would otherwise exert a harmful effect upon the vacuum produced therein.

The potential difference between lead **40** and **38** may be varied considerably. A difference of between 500 to 5,000 volts will be satisfactory under ordinary pumping conditions, but it will be understood that lower or higher potential differences may be employed with satisfaction.

In operating the apparatus of Fig. 3, flange **52** is connected to the system to be evacuated and the condensation pump is put into operation as described in connection with Fig. 1. However, it should be pointed out that the jet assembly of the pump is not charged by a lead wire such as **40** as described in connection with Fig. 1. Filament **60** is heated to a temperature at which electrons are emitted by passage of current through lead wires **62** and **64**. A potential of high voltage either negative or positive is also applied to filament **60** by means of lead wire **62**. An opposite charge to that applied to filament **60** is applied to gauze cylinder **56** by lead wire **58**. In the preferred embodiment the filament is negatively charged and the metal gauze is positively charged. Electrons emitted from filament **60** collide with vapors passing in reverse direction through the system. These pump fluid vapors, therefore, become charged and are attracted to oppositely charged screen **56** where they are condensed and thus removed from the system. The potential difference between filament **60** and metal gauze **56** can likewise vary considerably, but potential differences of between 200 and aout 5,000 volts are preferred. A voltage of —500 applied to filament **60** and +500 applied to gauze cylinder **56** has been found to operate satisfactorily.

During operation of the apparatus illustrated in Fig. 4, an electrical charge is applied to screen **70** and an opposite charge is applied to screen **56**. Filament **60** is heated and is maintained at a zero potential with respect to screens **56** and **70**. Electrons given off by the heated filament charge and/or ionize the pump fluid molecules which are then attracted to the screens **56** or **70**, depending upon whether they become positively or negatively charged. They thus become condensed thereon and are prevented from exerting harmful action. The voltage differences in the apparatus of Fig. 4 may be the same as that described in connection with Figs. 1 and 3.

In some cases it is recommended that voltages be employed which are sufficiently high to produce visible ionization. However, even with low voltages, the pump fluid will acquire a slight charge sufficient for it to be attracted to or repelled by suitably charged screens or electrodes as described.

If desired, the surfaces upon which the vapors are condensed may be cooled by providing suitable means for circulating cooling fluid into contact therewith. This precaution is usually unnecessary, however, since the reverse flowing vapors are of relatively low volume as compared with the volume of the vapors issuing from the pump jet. Provision may also be made for collecting condensate from the charged surfaces and returning it to the boiler. Since the volume is small, it is usually satisfactory to merely allow the condensate to accumulate and if accumulated in sufficiently large amounts to form drops, it will drop or flow through the opening in baffle **34** down the inside walls of casing **6** and be returned to the boiler of the pump.

Although I have illustrated my invention in connection with a simple condensation pump of conventional construction, it can be applied to the removal of reverse flowing vapors derived from any type of condensation pump. It is of value in connection with pumping by means of fractionating condensation pumps which are described in Hickman Patent 2,080,421, May 18, 1937.

Baffle **34** serves to condense and remove a substantial proportion of back-streaming vapors. Therefore, its use is desirable. Baffle systems have been devised for removing to a substantial extent such back-streaming vapors without too greatly hindering flow of gases being pumped. All such baffle systems may be used. If desired, the baffle may be eliminated entirely, although I do not recommend such construction. It should be understood that the baffle does not remove all of the back streaming or reverse flowing vapors and that a baffle system which would effectively do so would present such impedance to the pump gases that it would be unsatisfactory.

The invention can be operated in connection with any type of condensation pump and will effectively remove vapors whether of the organic type such as diamyl or di-octyl phthalate or sebacate or inorganic such as mercury.

What I claim is:

1. In a high vacuum vapor jet or condensation pump the improvement which comprises means for applying an electrical charge to pump fluid vapors which pass in a direction opposite to that in which gases are pumped, and means positioned in the high vacuum or intake end of the pump adapted to receive an electrical charge opposite to that of the pump fluid vapors whereby during operation, reverse flowing, charged vapors are attracted to said last named oppositely charged means and condensed.

2. In a high vacuum vapor jet or condensation pump the improvement which comprises means for applying an electrical charge to the pump fluid vapors which pass in a direction opposite to that in which gases are being pumped, and means positioned in the high vacuum or intake end of the pump adapted to receive an electrical charge opposite to that of the pump fluid vapors, which means has a low impedance to the flow

of vapors therethrough, whereby during operation, reverse flowing, charged vapors are attracted to said last named oppositely charged means and condensed while gases being pumped flow substantially unhindered into the condensation pump.

3. The apparatus described in claim 2 in which the low impedance means is a metal screen.

4. In a high vacuum vapor jet or condensation pump the improvement which comprises a filament located intermediate the highest vacuum jet and the high vacuum or intake end of the pump, means for heating the filament, means for applying an electrical charge to the filament, an electrode positioned near the filament and intermediate the highest vacuum jet and the intake end of the pump which electrode has low impedance to the flow of gases therethrough and means for applying to the electrode a charge opposite to that applied to the filament whereby during operation vapors which pass in a reverse direction from the high vacuum jet are electrically charged and then are attracted to the oppositely charge electrode and condensed thereon.

5. The combination which comprises a high vacuum vapor jet or condensation pump, means for applying an electrical charge to pump fluid vapors which during operation pass in a reverse direction from the high vacuum jet and into the intake end of the pump and means positioned between the high vacuum jet and the intake end of the pump adopted to receive an electrical charge opposite to that applied to the pump fluid vapors whereby during operation, reverse flowing, charged vapors are attracted to said oppositely charged means and condensed.

RICHARD S. MORSE.