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J. W. TILLS ET AL
PRODUCTION OF HIGH VACUA

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3 Sheets-Sheet 1

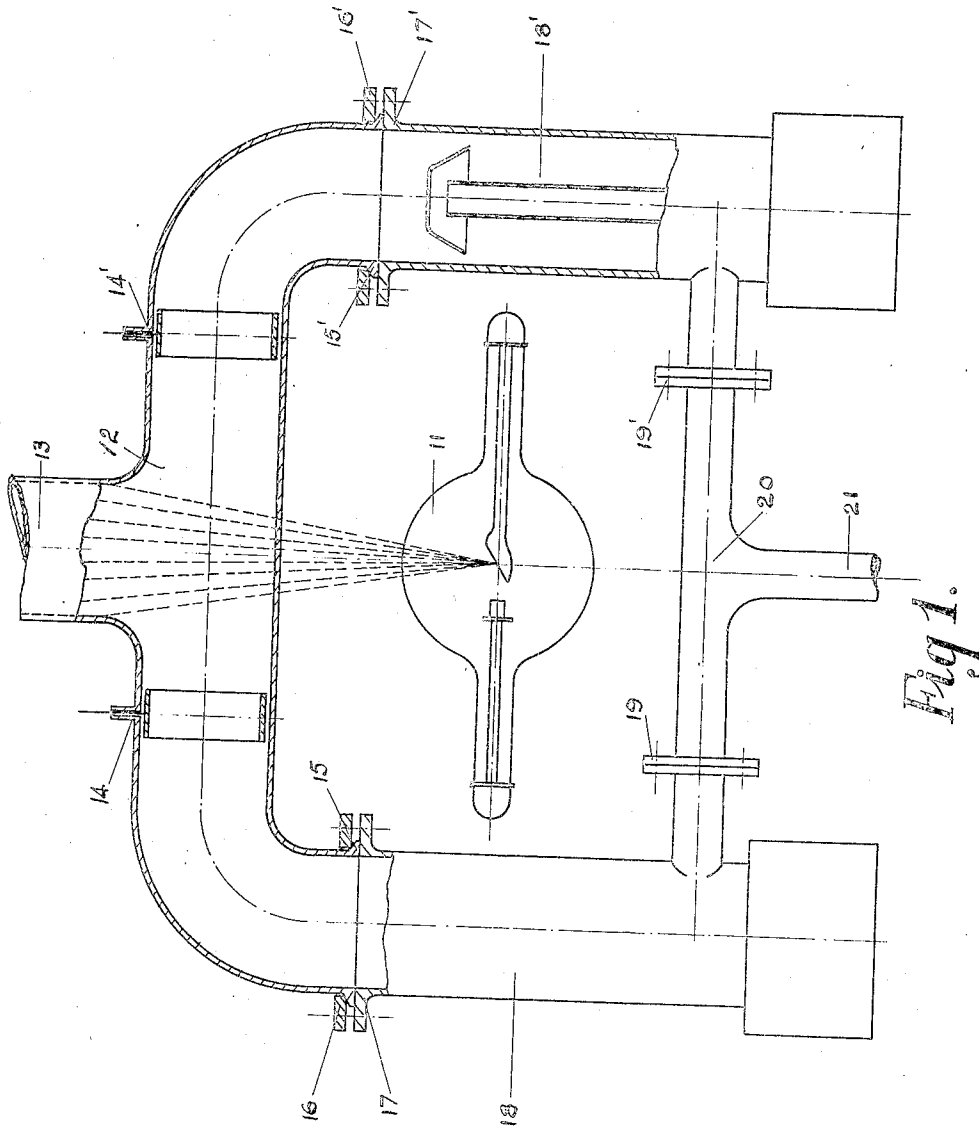


Fig. 1.

J. W. Tills
John B. Kovacs
F. C. Potts

INVENTORS.

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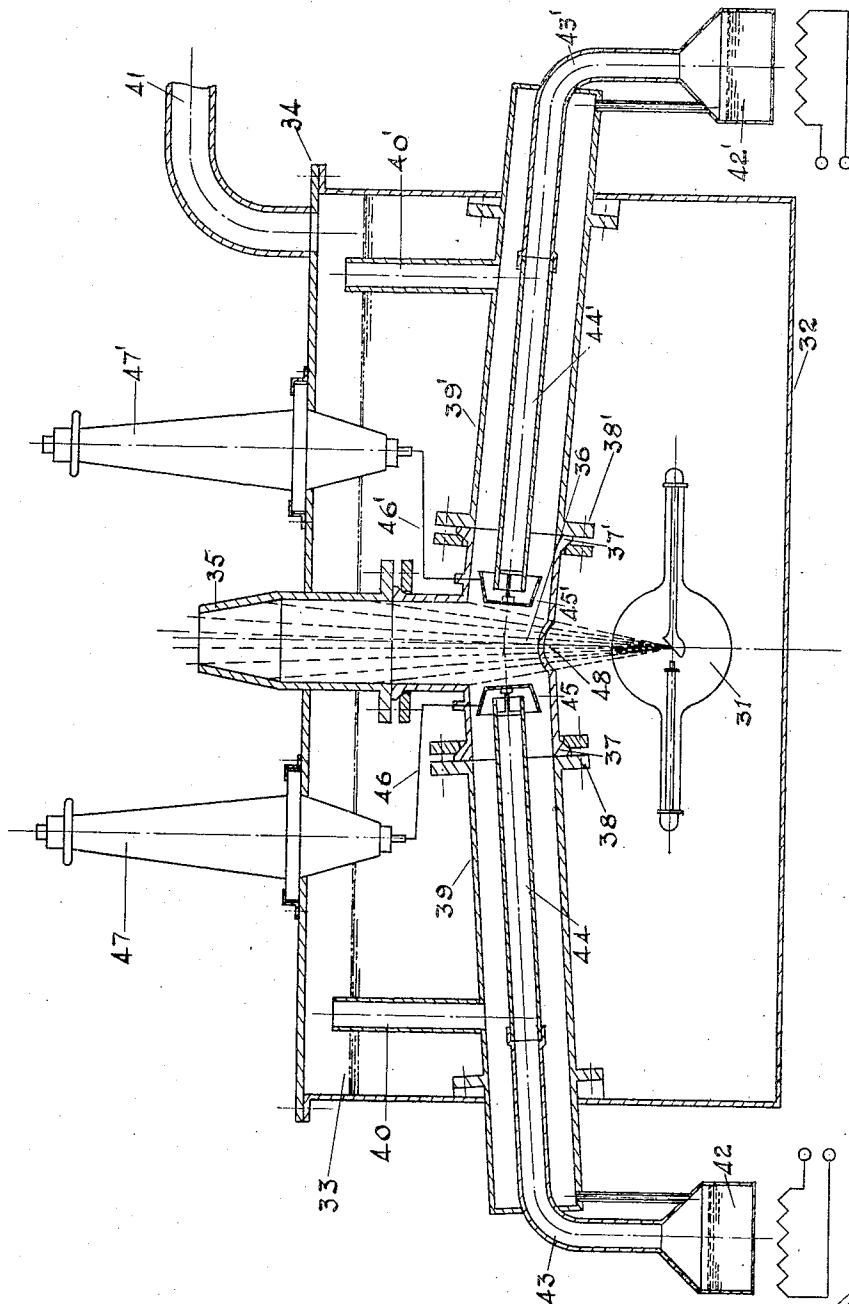


Fig 2.

John B. Tills
F.C. Potts

INVENTORS.

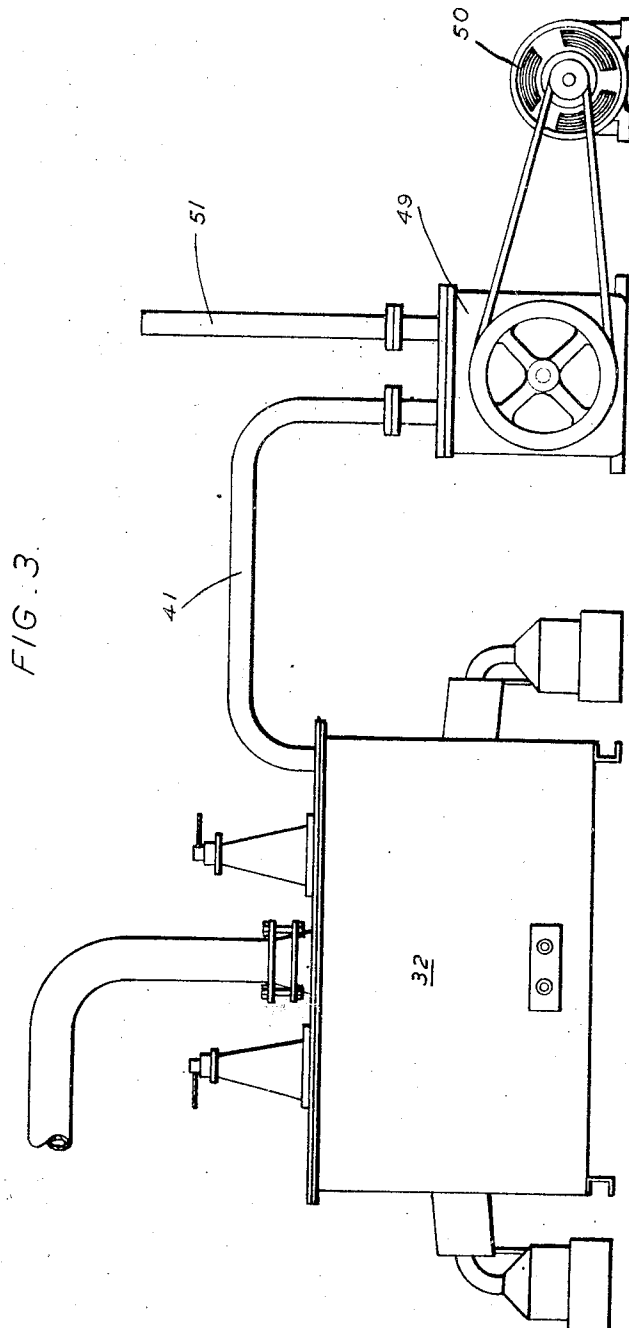
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John W. Tills
John B. Lovatt
F. C. Potts
Inventors

UNITED STATES PATENT OFFICE

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PRODUCTION OF HIGH VACUA

John William Tills, Upton, Wirral, John B. Lovatt,
Hoylake, Wirral, and Frank C. Potts, Upton,
Wirral, England

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12 Claims. (Cl. 230—45)

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This invention relates to the production of high vacua, and has for one object the attainment of very low pressures which are substantially independent of the vapour pressure of any working fluid associated with the pumping system.

Another object is to provide positive pumping action of gases at reduced pressures by ionising said gases and submitting the ionised gases to the action of electrostatic and/or electromagnetic fields.

A further object of the invention is to provide X-ray means for irradiating the gases to produce ionisation.

A still further object is to provide a self-contained pumping unit embodying X-ray means for ionisation of gas and including electrodes maintained at high electrostatic potential suitably protected and enclosed for the convenience and safety of the operator.

These and other objects will be apparent after perusal of the appended description with reference to the annexed drawings in which:

Fig. 1 illustrates diagrammatically a side view of one form of migration pump.

Fig. 2 shows an alternative form.

Fig. 3 is a side elevation of an apparatus including a backing pump and the migration pump of Fig. 2.

An X-ray tube 11 (Fig. 1) is arranged to irradiate gas in a tubular glass migration chamber 12 having a high vacuum connexion 13 and electrodes 14, 14' between which an electrostatic field of high potential gradient is provided by connecting the electrodes to opposite poles of a high voltage source of direct current.

The moulded flanged ends 15, 15' of the tube are secured respectively by split conical joint rings 17, 17' to the inlet conduit flanges of diffusion pumps 18, 18' whose outlet conduits are similarly jointed at 19, 19' to the ends of a glass T-piece 20 having a backing pump connexion 21.

The diffusion pumps or parts thereof may also serve as electrodes, in which case, pump 17 for example would be connected either to electrode 14 or to a pole of a higher voltage supply of the same polarity as that connected to 14. The arms of the X-ray tube actually extend in a plane disposed at right angles to that of the drawing and thus are clear of the diffusion pumps.

In operation of this form of migration pump a backing pump (not shown, but connected at 21) is first run and then the diffusion pumps are started when the pressure of the system is sufficiently low for initiation of pumping action.

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The electrodes are then energised and power supplied to the X-ray tube.

The residual gas will become ionised and will move from 13 towards 14 or 14' according to the sign of the ionic charge. Since the electrodes are of cylindrical form the ions will on account of their kinetic energy move on into the diffusion pumps where they may be neutralised if the pump itself comprises an electrode or may be discharged as ions into 20. If the diffusion pumps are of metal they should of course be insulated from earth potential.

In an alternative arrangement (Fig. 2) an X-ray tube 31 is mounted in a steel vessel 32 containing transformer oil 33, and fitted with a gas tight lid 34. A metal extension of high vacuum connexion 35 of a glass or porcelain migration chamber 36 extends through lid 34. Jointed to flanged ends 37, 37' of the chamber 36 are respectively flanged ends 38, 38' of inlet conduits of diffusion pump casings 39, 39' which have outlet conduits 40, 40' discharging into the gaseous space above the oil surface. This space forms a common fore-vacuum and is maintained at the requisite low pressure by a mechanical backing pump 49 driven by an electric motor 50 and connected to outlet 41. Pump 49 discharges through pipe 51 to atmosphere. External metal boilers 42, 42' are connected by metal stand pipes 43, 43' to glass pipe sections 44, 44' terminating in metal jet covers 45, 45' which form the electrodes of the migration chamber and are externally connected with the high voltage supply by leads 46, 46' through vacuum-tight insulators 47, 47'.

The transformer oil in which the X-ray tube, migration chamber and diffusion pump casings are immersed serves not only as an insulator for the electrical leads but also to cool the condensing surfaces of the diffusion pumps and helps to seal the glass to metal joints, and prevents rise of temperature of the envelope of the X-ray tube.

In order to assist return of condensate of the diffusion pump working fluid, which fluid is preferably an organic substance, to the boiler 42, 42' the pump casings and the arms of the migration chamber may be slightly inclined as shown, whilst additionally or alternately a pip or indent 48 may be formed in the bottom wall of the chamber to prevent collection of condensate in that part of the chamber.

The X-ray tube may if desired be exterior to the main vessel and adapted to project rays into said vessel by way of a window or aperture formed

of any non-ray absorbing material in the vessel. To ensure that the rays are directed in the manner desired lead or lead-glass applicators may be used. In addition certain parts of the vessel may be lead lined in order to afford protection to the operator from any rays which may otherwise emerge from the vessel.

In other forms of construction the apparatus may include a migration chamber of arcuate shape the ends of which discharge to a common chamber which may be exhausted by one diffusion pump or in some cases by other types of pump. Also magnetic fields may be used additionally or in place of the electrostatic fields for the purposes set forth.

There may be other electrodes provided in order to give an electrostatic focussing or accelerating effect or to improve the gas flow past diffusion pump jets or other restrictions. As an example the potential applied to an insulated jet cap may be nearer earth potential than the potential of an adjacent electrode.

One of the migration chamber electrodes may be heated to provide an electronic stream which may be used for initiating or augmenting ionisation of residual gas. If a gas which ionises to form ions of only one sign of charge is to be pumped it is obvious that the migration chamber will require merely one means for eduction.

The X-ray tube or insert may be formed integrally with the migration chamber, the X-ray anode and cathode being contained in a side bulb of said chamber.

The cooling of the diffusion pump may be effected by an insulated water system or by use of an insulating fluid such as transformer oil. Grid or other control of the X-ray tube may be effected by using a circuit responsive to current flowing through a lead to one of the migration chamber electrodes, whilst an indicator responsive to this current may in some instances be used to afford a visual measure of the ionic concentration.

We claim:

1. An apparatus for producing a high vacuum, comprising means for irradiating gas to be pumped with X-rays to ionize said gas, and means for applying electrostatic forces to effect pumping action on the ionized gas.

2. An apparatus for producing a high vacuum comprising a chamber connected to a space to be evacuated, pumping means connected to said chamber, means for producing X-rays for ionising gas in said space by irradiation and means for providing an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said pumping means.

3. An apparatus for producing a high vacuum comprising a chamber having a high vacuum conduit adapted for connection to a space to be evacuated, two diffusion pumps disposed respectively on opposite sides of said conduit, a forevacuum chamber into which said diffusion pumps discharge, a backing pump connected between said forevacuum chamber and atmosphere, means for producing X-rays for ionising gas in said space by irradiation and means for providing an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said diffusion pumps.

4. An apparatus for producing a high vacuum comprising a chamber having a high vacuum conduit adapted for connection to a space to be evacuated, two diffusion pumps disposed respectively on opposite sides of said conduit, a forevacuum chamber into which said diffusion pumps

discharge, a backing pump connected between said forevacuum chamber and atmosphere, means for producing X-rays for ionising gas in said space by irradiation and electrodes of cylindrical form disposed in said chamber and maintained at different electrostatic potentials as to provide an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said diffusion pumps.

5. An apparatus for producing a high vacuum comprising a chamber having a high vacuum conduit adapted for connection to a space to be evacuated, two diffusion pumps disposed respectively on opposite sides of said conduit, a forevacuum chamber into which said diffusion pumps discharge, a backing pump connected between said forevacuum chamber and atmosphere, an X-ray generator disposed in said chamber for ionising gas in said space by irradiation, and electrodes of cylindrical form disposed in said chamber and maintained at different electrostatic potentials so as to provide an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said diffusion pumps.

6. An apparatus for producing a high vacuum, comprising a chamber having a high vacuum conduit adapted for connection to a space to be evacuated, two diffusion pumps having inlets connected to said chamber respectively on opposite sides of said conduit, a forevacuum enclosure into which said diffusion pumps discharge, a backing pump connected between said forevacuum enclosure and atmosphere, means for irradiating gas in said space with X-rays to ionise said gas, and means for providing an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said diffusion pumps.

7. An apparatus for producing a high vacuum, comprising a chamber having a high vacuum conduit adapted for connection to a space to be evacuated, two diffusion pumps having inlets connected to said chamber respectively on opposite sides of said conduit, a forevacuum enclosure into which said diffusion pumps discharge, a backing pump connected between said forevacuum enclosure and atmosphere, means for irradiating gas in said space with X-rays to ionise said gas, and electrodes of cylindrical form disposed in said chamber and maintained at different electrostatic potentials for providing an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said diffusion pumps.

8. An apparatus for producing a high vacuum, comprising a chamber having a high vacuum conduit adapted for connection to a space to be evacuated, two diffusion pumps having inlets connected to said chamber respectively on opposite sides of said conduit, a forevacuum enclosure into which said diffusion pumps discharge, a backing pump connected between said forevacuum enclosure and atmosphere, an X-ray generator for ionising gas in said space by irradiation, and electrodes of cylindrical form disposed in said chamber and maintained at different electrostatic potentials for providing an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said diffusion pumps.

9. An apparatus for producing a high vacuum, comprising a chamber having a high vacuum conduit adapted for connection to a space to be evacuated, two diffusion pumps having inlets connected to said chamber respectively on

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opposite sides of said conduit and jet assemblies projecting through said inlets into said chamber, an enclosed vessel containing said chamber and a part of each of said diffusion pumps together with an insulating fluid such as transformer oil surrounding said parts of the diffusion pumps for cooling the same, the gaseous space above the fluid in said vessel constituting a forevacuum enclosure into which said diffusion pumps discharge, a backing pump connected between said forevacuum enclosure and atmosphere, an X-ray generator disposed in said chamber for ionising gas in said space by irradiation, and electrodes constituted by part of each jet assembly in said chamber and maintained at different electrostatic potentials so as to provide an electrostatic field in said chamber to effect migratory movement of said ionised gas towards said diffusion pumps.

10. An apparatus according to claim 9 in which there is provided an upwardly extending indent in the bottom wall of the chamber to prevent collection of working fluid condensate in the chamber.

11. An apparatus for the production of high vacua comprising an enclosed vessel, an insulating liquid such as transformer oil partly filling said vessel, a generally cylindrical chamber disposed in said liquid and having end portions emerging through the walls of said vessel, a bottom wall sloping downwardly towards said end portions, diffusion pumps formed integral with said chamber one near each end portion thereof and adapted to discharge gas into said vessel above the liquid level therein, a backing pump connected to the vessel to exhaust gas collecting above said liquid level, a conduit of diameter

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substantially equal to that of said chamber extending from the centre of said chamber and emerging outside said vessel and adapted to be connected to a space to be evacuated, electrodes on opposite sides of said conduit in said chamber adapted to be charged to different electrostatic potentials, and an X-ray generator arranged below the liquid level in the vessel to irradiate gas in said chamber, conduit and space to be evacuated.

12. An apparatus for the production of high vacua comprising an enclosed vessel, an insulating liquid such as transformer oil partly filling said vessel, a generally cylindrical chamber disposed in said liquid and having end portions emerging through the walls of said vessel, a bottom wall sloping downwardly towards said end portions, diffusion pumps formed integral with said chamber one near each end portion thereof and adapted to discharge gas into said vessel above the liquid level therein, an umbrella jet deflector of metal forming part of each diffusion pump, a backing pump connected to the vessel to exhaust gas collecting above said liquid level, a conduit extending from the centre of said chamber and emerging outside said vessel and adapted to be connected to a space to be evacuated, electrodes constituted by said deflectors on opposite sides of said conduit in said chamber adapted to be charged to different electrostatic potentials, and an X-ray generator arranged below the liquid level in the vessel to irradiate gas in said chamber, conduit and space to be evacuated.

JOHN WM. TILLS.
JOHN B. LOVATT.
F. C. POTTS.