July 15, 1924. 1,501,071

H. C. SNOOK

VACUUM PUMP

Filed Oct. 5. 1921

Fig. 1.

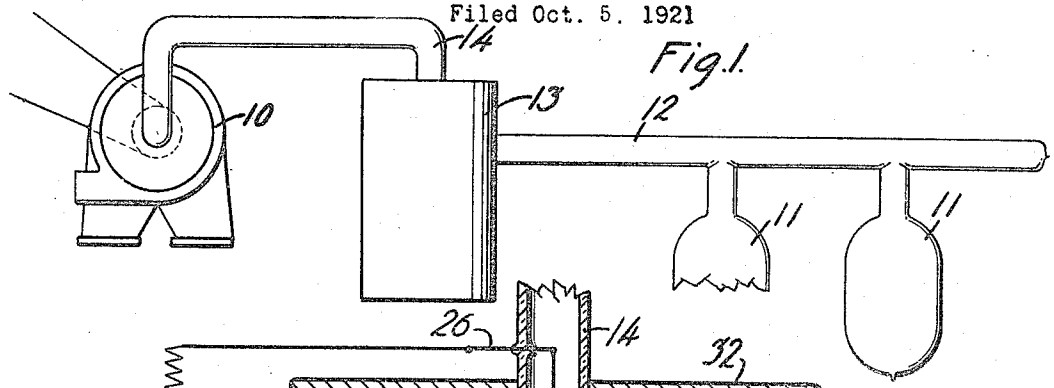
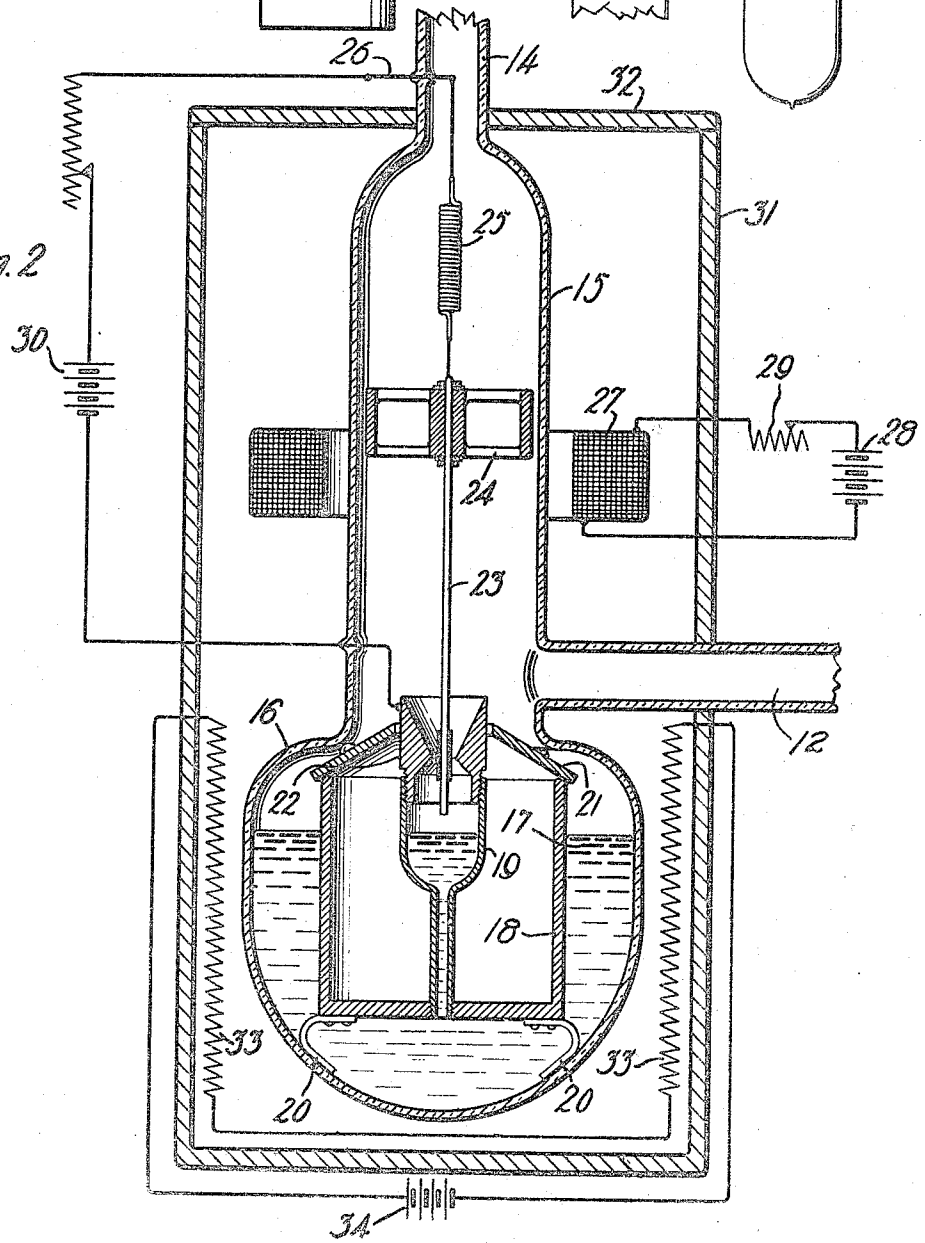


Fig. 2



Inventor:
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by C. C. Sprague. Atty.

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UNITED STATES PATENT OFFICE.

HOMER CLYDE SNOOK, OF SOUTH ORANGE, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

VACUUM PUMP.

Application filed October 5, 1921. Serial No. 505,576.

To all whom it may concern:

Be it known that I, HOMER CLYDE SNOOK, a citizen of the United States, residing at South Orange, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Vacuum Pumps, of which the following is a full, clear, concise, and exact description.

This invention relates to vacuum pumps and more especially to an auxiliary pump of the metal vapor type.

In my copending application Serial No. 477,916, filed June 16, 1921, there is disclosed an auxiliary pump in which a portion of a puddle of molten pumping material, having at or near its melting temperature a vapor pressure less than the pressure to be obtained within the vessel to be exhausted, for example, a vacuum tube of the pure electron discharge type, or another puddle of said material fed from said first puddle, is heated by means external of the puddle container to a sufficiently high temperature to cause the emanation from said portion or puddle of a vapor stream to be used as the pumping medium.

This invention has for its object the generation of heat within the container for vaporizing the pumping material to produce a vapor stream and the use of the pumping material itself as an element of the heating means.

This object is accomplished by providing an oven for heating the pumping material to a molten condition and by arranging an electrode adjacent the molten material between which and the electrode is established an electric arc. The electrode is movable toward and away from the pumping material by means controlled exterior of the pump whereby the arc may be started and regulated.

This invention will be better understood by having reference to the following specification and accompanying drawing wherein Fig. 1 discloses the relation of the roughing pump, auxiliary pump and the vessel to be exhausted, and Fig. 2 is a vertical section through the pump.

In Fig. 1, 10 is a roughing pump capable of reducing the pressure as low as 10^{-3} mm. of mercury and 11 are the vessels to be evacuated. The glass tubing 12 leads from the vessels 11 to the auxiliary pump 13 which is connected with the roughing pump 10 by means of the tubing 14.

The high vacuum pump comprises a substantially cylindrical pumping chamber 15 having at its lower end an enlarged portion 16 within which is contained the pumping material 17, preferably a metal such as lead, tin, bismuth, or the like, which is solid at room temperature and has at its melting temperature a vapor pressure less than the gas pressure desired in the vessel to be exhausted, for example, that employed in vacuum tubes of the pure electron discharge type. Arranged within the enlarged portion 16 is the cup 18 having in its bottom wall a tapped aperture in which is threaded the tubular member 19, the lower portion of which is a small diameter tube and the upper portion of which is of somewhat greater diameter. This arrangement divides the puddle into a central and an annular portion. On the bottom of the cup are legs 20 which contact with the bottom of the portion 16 and on the upper portion is provided a conical shield 21 having knobs which contact with the everlying annular shoulder of the portion 16. The cup 18 is thus held rigidly in the position shown.

Threaded into the upper portion of the member 19 is the expanding nozzle 22 which extends through and is slightly spaced from the shield 21. An electrode 23 extends through the nozzle 22 to a point near the pumping material contained within the member 19 and is provided with insulation along that portion of its length adjacent the restricted portion of the nozzle. The electrode 23 is carried by the core 24 of magnetic material which is in turn supported by the spring 25 attached to the inner end of the rod 26 sealed in the wall of the tube 14. Surrounding the pumping chamber 15 and in operative relation to the core 24 is a solenoid 27 which is supplied with current from the battery 28, the flow of the current being controlled by the variable resistance 29. This solenoid is operative, when energized, to advance the electrode 23 toward the puddle of pumping material in the member 19 against the opposition of the spring 25. A battery 30 has one of its terminals connected to the rod 26 and the other to the nozzle 22.

Surrounding the pump is an oven 31, hav-

ing a cap 32, which is heated by means of the resistance units 33, which may extend the full height of the oven, to a sufficiently high temperature to maintain the pumping chamber and the pumping material at or only slightly above the melting point of the material used. The battery 34 supplies the resistance units with heating current.

The operation of this device is as follows: The pumping chamber and its contents are heated until the pumping material has become molten. The solenoid 27 is then energized to bring the electrode 23 into contact with the molten material, thus completing a circuit through the battery 30. The resistance 29 is then regulated to decrease the pull of the solenoid 27. The spring 25 thereupon lifts the electrode 23 sufficiently to cause the establishment of an arc between it and the pumping material. The length of the arc is regulated by balancing the pull of the solenoid against the tension of the spring 25.

The heat generated by the arc in the puddle of pumping material causes the emanation therefrom of a vapor jet of the pumping medium which is directed by the nozzle 22 past the entrance point of the tube 12 into the pumping chamber 15, the molecules of the pumping material being directed in approximately parallel lines by the nozzle 22. The vapor acts mechanically upon the gas emitted from the vessels 11 and drives it toward the upper portion of the pumping passage from which it is removed by the roughing pump 10. The vapor is condensed on the inner wall of the chamber 15 in a molten condition and flows back into the low temperature portion of the supply over the shield 21 through the space between it and the annular shoulder of the bulb 16.

Only the small amount of pumping material contained within the member 19 is heated to a temperature sufficiently high to cause the emanation therefrom of a vapor jet and as the material is evaporated, it is replenished from the low temperative portion of the puddle through the lower end of the member 19. The heat generated in the inner puddle is largely prevented from being transferred to the outer puddle because of the poor thermal conductivity of the metal in 19 due to its small diameter and the vacuum interposed between the inner and outer puddles by virtue of the cup 18.

What is claimed is:

1. In a pump, a pumping chamber having an inlet and an outlet, a pumping material, means for maintaining said material in molten condition and means for producing an arc having as one of its electrodes a small portion of said molten material, said arc being so positioned as to produce a vapor jet in said chamber traversing the mouth of said inlet.

2. In a pump, a pumping chamber having an inlet and an outlet, a pumping material, and means for producing an arc having as one of its electrodes a small portion of said material, said arc being so positioned as to produce a vapor jet in said chamber traversing the mouth of said inlet.

3. In a pump, a pumping chamber having an inlet and an outlet, a pumping material having at approximately its melting temperature a vapor pressure less than the pressure desired within the vessel to be exhausted, means for maintaining a supply of said material in molten condition, and means for producing an arc having as one of its electrodes a portion of said molten material to establish a vapor stream in said chamber traversing the mouth of said inlet.

4. In a pump, a pumping chamber having an inlet and an outlet, a pumping material, means dividing said material into connected puddles, means for producing an arc having as one of its electrodes one of said puddles to establish a vapor jet in said chamber traversing the mouth of said inlet.

5. In a pump, a pumping chamber having an inlet and an outlet, a pumping material having at approximately its melting temperature a vapor pressure less than the pressure desired within the vessel to be exhausted, means for maintaining a supply of said material in molten condition, means dividing said material into connected puddles, and means for producing an arc having one of said puddles as an electrode to establish a vapor jet in said chamber traversing the mouth of said inlet.

6. In a pump, a pumping chamber having an inlet and an outlet, two interconnected puddles of pumping material, means for melting said pumping material, and means for producing an arc having one of said puddles as an electrode to establish a vapor jet in said chamber traversing the mouth of said inlet.

7. In a pump, a pumping chamber having an inlet and an outlet, two interconnected puddles of pumping material having at approximately its melting temperature a vapor pressure less than the pressure in pure electron discharge devices, means for melting said material, and means for producing an arc having one of said puddles as an electrode to establish a vapor jet in said chamber traversing the mouth of said inlet.

8. In a pump, a pumping chamber having an inlet and an outlet, a supply of pumping material, a movable electrode adjacent a portion of said material, and means for producing an arc between said electrode and said pumping material to establish a vapor jet in said chamber traversing the mouth of said inlet.

9. In a pump, a pumping chamber having an inlet and an outlet, two interconnected puddles of pumping material, an electrode

adjacent one of said puddles, and means for producing an arc between said electrode and said puddle to establish a vapor stream in said chamber traversing the mouth of said inlet.

10. In a pump, a pumping chamber having an inlet and an outlet, a pumping material having at approximately its melting temperature a vapor pressure less than the pressure employed in a pure electron discharge device, means for melting said material, an electrode, and means for producing an arc between said electrode and a portion of said pumping material to establish a vapor jet in said chamber traversing the mouth of said inlet.

11. In a pump, a pumping chamber having an inlet and an outlet, a supply of pumping material, an electrode, a source of electrical energy connected to said electrode and said pumping material, means to move said electrode into contact with and away from said material for producing an arc between said electrode and pumping material to establish a vapor jet in said chamber traversing the mouth of said inlet.

12. In a pump, a pumping chamber having an inlet and an outlet, a supply of pumping material, an electrode, a source of electrical energy connected to said electrode and said pumping material, electromagnetic means to move said electrode into contact with said material, and means to move said electrode out of contact with said material for producing an arc between said electrode and pumping material to establish a vapor jet in said chamber traversing the mouth of said inlet.

13. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, means in said puddle dividing it into two portions, and means for heating one of said portions to establish a vapor jet in said chamber traversing the mouth of said inlet.

14. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a tubular member in said puddle separating said puddle into two portions, and means for heating the pumping material within said tubular member to produce a vapor jet in said chamber traversing the mouth of said inlet.

15. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a tubular member in said puddle dividing said puddle into two portions, and means for producing an arc for heating the material within said tubular member to establish a vapor jet in said chamber traversing the mouth of said inlet, said material within the tubular member constituting an electrode of said arc.

16. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a tubular member in said puddle separating said puddle into two portions, an electrode adjacent the material within said tubular member, and means to produce an arc between said electrode and said material to establish a vapor jet in said chamber traversing the mouth of said inlet.

17. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a tubular member in said puddle dividing said puddle into two portions, an electrode, means to establish contact between said electrode and the material within said tubular member, and means to break said contact to produce an arc for heating said pumping material to establish a vapor jet in said chamber traversing the mouth of said inlet.

18. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a tubular member in said puddle dividing said puddle into two portions, an electrode, a source of electrical energy connected to said electrode and said pumping material, and means to move said electrode toward and away from said puddle to establish an arc between said electrode and puddle for producing a vapor stream in said chamber traversing the mouth of said inlet.

19. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a tubular member in said puddle dividing said puddle into two portions, an electrode adjacent one of said portions, a source of electrical energy connected to said electrode and said pumping material, electromagnetic means for moving said electrode into contact with said pumping material, and means to move said electrode out of contact therewith to establish an arc between said electrode and pumping material for producing a vapor stream in said pumping chamber traversing the mouth of said inlet.

20. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a tubular member in said puddle separating said puddle into two portions, an expanding nozzle carried by said tubular member, and means to heat the pumping material within said tubular member to produce a vapor stream in said pumping chamber traversing the mouth of said inlet.

21. In a pump, a pumping chamber having an inlet and an outlet, a puddle of pumping material, a heat insulating tubular member in said puddle dividing it into two portions, and means to heat the portion of said puddle within said member to produce a vapor stream in said pumping chamber traversing the mouth of said inlet.

22. In a pump, a pumping chamber, a puddle of pumping material in said cham-

ber, a heat insulating tubular member within said puddle dividing it into two portions, and means for generating heat within said chamber for causing the emanation of a vapor stream from the material within said tubular member.

23. In a pump, a puddle of pumping material, a cup in said puddle, said cup having an aperture in the bottom thereof, a tubular member arranged in said aperture, a nozzle carried by said tubular member, and a shield carried by said cup, said shield having an aperture through which said nozzle extends.

24. The method of operating a vapor pump which comprises dividing the pumping material into two puddles, producing a vapor stream from one of said puddles by means of an arc established between it and an electrode within said pump, and directing said jet across the mouth of a conduit leading from a vessel to be exhausted.

25. The method of operating a vapor pump which comprises dividing the pumping material into a central and an annular puddle, generating heat within the pumping chamber, applying the heat thus generated to said central puddle to cause the emanation therefrom of a vapor stream, and directing said vapor stream across the mouth of a conduit leading to a vessel to be exhausted.

26. In a vacuum pump, a pumping chamber, a supply of pumping material therein, an electrode, a resilient member supporting said electrode out of contact with said material, a solenoid surrounding said pumping chamber and adapted, when energized, to move said electrode into contact with said pumping material, and a source of electrical energy connected to said electrode and to said pumping material.

27. In a vacuum pump, a pumping chamber, a supply of pumping material divided into a central and an annular portion, and means for generating heat within said chamber to cause the emanation from said central portion of pumping material of a vapor-stream in said pumping chamber.

In witness whereof, I hereunto subscribe my name this 3rd day of October A. D. 1921.

HOMER CLYDE SNOOK.