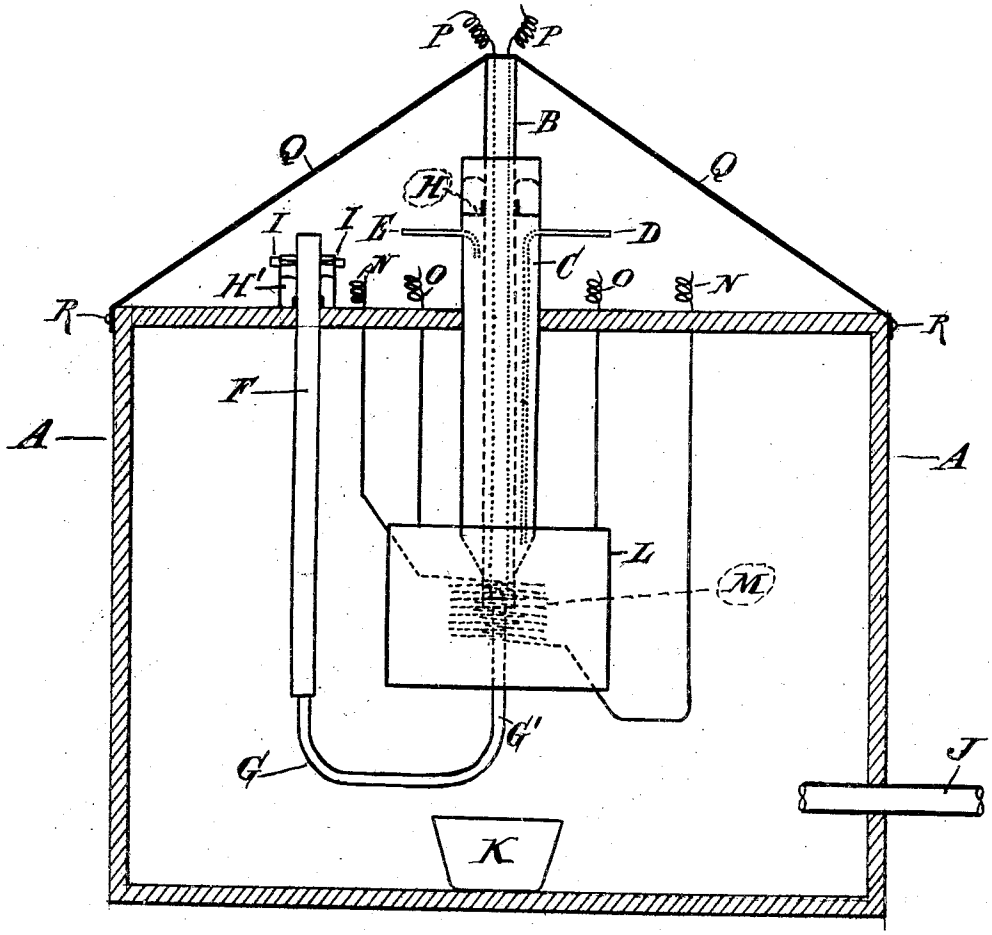
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THERMIONIC VALVE

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THERMIONIC VALVE.

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This invention relates to improvements in thermionic-valves, and it has for one of its objects the substitution of more efficient generators of thermions or electrons for the filaments than have hitherto been used for this purpose in said class of valves.

The current capacity of a thermionic-valve has heretofore been small and the limited emission of the customary filaments in the valve has been the retarding factor in the desired development of large-sized valves of high capacity.

Another important object of the invention herein is the substitution, for the filament, of a so-called "candle" of burning metal, such candle, herein, consisting of a thin metal tube whose interior is packed with a granular or powdered metal mixture, such as aluminum, which is the metal to be burnt, and a metallic oxide, such as iron oxide, the purpose of which is to supply the required oxygen for the combustion of said metal. It is not intended herein, however, to limit the invention to the above exact combination of metal and metal oxides, nor to having the metals in a powdered condition, or even inclosed in a tube, and the combustion may also be supported by some other element than oxygen with the metal, provided, of course, that incandescence is accomplished with due emissions of thermions or electrons.

Therefore, by means of the combustion of a metal, there is produced a mixture of incandescent metal and metallic oxides, which, it is well known, is a prolific source of electrons emitted into space.

As it is very important that a high vacuum be maintained inside the thermionic-valve, when the said valve is used as a "hard" valve, that is, a very high vacuum valve, in contradistinction to a "soft" valve, one containing some gas, the following precautions should be observed to insure this condition:—

(1) A vacuum-pump is operated continuously to exhaust the valve.

(2) The materials used for supporting combustion are duly freed from occluded gases and carbon before use. If the materials are packed into a so-called "candle" this may be exhausted of air and hermetically sealed. If the materials are used in loose powder form, the powder may be passed through a preliminary vestibule vacuum-chamber in order to free them of occluded gas.

(3) The grid and plate of the valve may be made of such metal as will absorb or occlude gases.

In order to dispel or carry away the great amount of heat generated by the combustion of the metal, the candle may be surrounded by a cooling-jacket through which water or other cool liquid may be circulated.

In order to initiate the combustion of the candle it is provided with two enamel-insulated wires leading to its tip, where such wires are connected with a bridge composed of high-resistance wire. This bridge is made to glow by passing an electric current through it, and ignition of the material then follows. If the metal mixture is to be used in powdered form it may be ignited by allowing it to fall to the bottom of the thermionic-valve box which has already been heated to a degree of redness.

In order to preserve the proper spatial relation between the burning portion of the candle and the valve grid and plate a suitable stop may be provided, and against which the burning end of the candle may be driven. This stop may carry a shoe or the like made from tungsten or other high-melting metal, or metal oxide. Instead of said stop, however, a clock-work mechanism may be used to feed the candle, in which event no stop is necessary. As a substitute or an alternative to the said clock-work it is obvious that a rubber-band or a spring may be used in connection with a stop.

An obvious method of maintaining the operation of the valve and that without breaking the vacuum inside the valve, is to place a fresh candle on top of the one that is nearing complete consumption. The rubber band is lifted to the top of the fresh candle so as to drive it. Since placing the stub of an old candle on the top of a new one, or vice versa, is as old as the use of candles, this method is considered obvious and is not claimed as a part of the invention.

A modified form of the apparatus herein will be found in the following structure:

A thermit-candle of small diameter and great length is prepared by drawing down such a candle of larger diameter. The

smaller diameter candle is flexible so that, therefore, it is used, wound on a drum, the latter and the candle being contained or housed in their entirety, with the feeding mechanism, which may be clock-work, a solenoid, or an electric motor within the valve case. The candle is fed, in this form, from the drum by such mechanism into the central area of the grid-coil.

A bowl or catch-all may be conveniently placed under the candle in the valve-casing for the express purpose of catching the hot metal drippings therefrom.

The accompanying drawing is a diagrammatic view, showing the valve-casing in block-section and all the parts of the device comprising my invention within said valve-casing, some of them being in dotted lines and some being extended from the casing in assembled relation as well as in initial position ready for operation and use.

In said view—

A indicates the casing or inclosing body-portion of the device, which is composed of iron, brass, glass, or other suitable material and it must be absolutely air-tight.

B indicates the thermit candle, and C, a surrounding, concentric, water-cooling jacket for the candle, the latter extending a little above the jacket. The jacket is provided with a water inlet-pipe D and an outlet-pipe E for the candle.

A mechanically-strong rod or strip F serves as a stop for the candle and it must be of insulating material for at least a portion of its length. The candle and stop-rod extend parallel to each other a short distance above the top of the casing and the lower end of the said stop-rod is connected by means of a U-shape lateral extension G with the lower end of the candle. The stop-rod and its lower lateral extension are made of a high-melting metal, or a refractory metal oxide such as magnesium oxide.

Suitable mercury-seals H and H′ are provided near the top of the water-jacket C and that of the said stop-rod F, respectively, to prevent air leaking into the valve.

Set-screws I, I, are provided on the mercury-seal H′ to adjust the stop-rod F for the candle.

A pipe J leads from the lower part of the casing to a vacuum-pump (not shown), the latter being operated continuously while the valve herein is in action.

A bowl K, made of a refractory material, is provided beneath the lower end of the candle to catch any molten metal drippings from the candle in use.

L indicates the plate, which is in the form of a cylindrical metallic section made from high-melting metal, and M indicates the grid, both located at the lower end of the candle, said grid and the greater portion of the candle being shown in dotted lines which is deemed quite sufficient to indicate their position and structure.

N, N, indicate a pair of wire-connections leading to the grid, and O, O, a similar pair of wire-connections leading to the plate, both pairs of wires being insulated from the valve casing.

P, P, indicate a pair of wire-connections leading to the tip of the candle, where is located a resistance-wire that is arranged to cross or span said wire-connections P, P. The candle is ignited by means of an electric current sent across said resistance-wire.

Q represents a rubber-band or rubber-strip stretched from the opposite sides of the casing across the top of the candle to act as a driving means to force or keep the lower end of the candle into contact with the longer upturned end G′ of the stop-rod extension G. Suitable lugs R, R, extend laterally from the upper part of the valve casing for the engagement of the opposite ends of the said rubber-strip Q in fastening the latter in strained or stretched relation with the top of the candle.

In summing up the advantages of my improvements herein I call particular attention to the following:—

The basic idea or principle of producing electrons in unlimited or large quantities by the chemical combustion of metals, instead of, as heretofore, by heating a filament; the great advantage of having electrons produced in said large quantities upon which the increased capacity of any thermionic-valve largely depends; the basic idea or principle of having metal oxides produced in a state of incandescence, metal oxides being so much better as emitters of electrons than the metals themselves the effect is well known as the "Wehnelt" effect and the invention herein offers means of getting the desired benefit of said effect without recourse to an oxide-coated filament such as in general use; the decided advantage of eliminating the gas from the thermionic-valve although it is to be understood that it will function for most purposes in the presence of gas or vapor, such operation being probably ionic instead of electronic; the further advantage of providing means for producing electrons or thermions at a place where they may be utilized in the customary way by arrangements well known in this particular art; the further advantage that the materials used for combustion do not necessarily have to be confined in a tube, but that they may be otherwise utilized in the form of a powder that is introduced through the wall of the thermionic-valve from an auxiliary vacuum-chamber, or fed through the said tube by means of a screw-conveyor; the ready substitution or replacing of a candle when required, after consumption or otherwise; and, furthermore, that the composi-

tion of the burning-mixture is so regulated that a temperature is produced that is sufficiently high to produce electrons.

It will be understood that I do not confine or bind myself to any particular materials in the production of the effects or results sought by me herein, but looking always to the basic principles as applied to the thermionic-valve.

It is obvious that chemically pure materials should be used for the substances undergoing combustion, or that at least certain of the ordinarily occurring impurities must be eliminated. Otherwise, quantities of gas objectionable under certain conditions and uses of the valve would be produced by the combustion, which, under ideal conditions, does not produce gas.

It is to be understood that the invention herein is not confined to any single theoretical way in which a thermionic valve may operate. All the ways in which such valves may operate is at present a matter of considerable obscurity and the theory of operation of even the well known forms cannot yet be said to have been positively proven. It is not really known how far ions are responsible for what takes place or whether the phenomena are produced only by electrons. Therefore I cannot and will not state at this time that only electrons or only ions are produced, or that a mixture of them is produced. There is even confusion among scientists as to where the identity of an electron stops and the identity of an ion begins.

I claim:—

1. In a thermionic valve, the method of operating said valve by producing carriers of electric charges in said valve by conducting a chemical reaction therein.

2. In a thermionic valve, the method of operating said valve by producing thermions in said valve by conducting a chemical reaction therein.

3. In a thermionic valve, a candle which is a generator of electric charges, means for positively feeding said candle into a position wherein the ignited end of said candle may generate carriers of electric charges so that they may be efficiently acted upon by an electrical field surrounding said candle and means for stopping and regulating said candle in such correct position.

4. In a thermionic valve, a "thermit" candle, cooling means surrounding said "thermit" candle, feeding means and stopping means for said "thermit" candle whereby said candle is fed into the zone of greatest electrical intensity of said valve and maintained in such position.

5. A thermionic-valve having means for generating carriers of electric charges by chemical combustion.

6. In a thermionic-valve, a tubular thermit-candle, a tubular water cooling-jacket surrounding said candle, means for supplying and draining said water cooling-jacket, means for positively feeding said candle into action, stop means for controlling the feed of said candle, means for maintaining a vacuum in the valve casing, means for supplying electric current to the valve, sealing means to prevent air leaking into the valve, a grid and a cylindrical plate, said grid and plate being arranged in operative relation with the lower end of said candle.

7. The process of producing carriers of electric charges in a thermionic-valve by combusting a metal therein.

8. The method of producing thermions in a thermionic-valve to operate the valve, which consists of combusting a metal therein.

9. The method of generating carriers of electrical charges in a thermionic-valve by bringing into electrical influence with the plate and grid members of said valve and their associated structure, a mass of incandescent, molten material, said material being a known generator of electrical charges when so molten.

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