June 11, 1929. R. B. PRINDLE 1,716,930

TERMINAL FOR SPACE CURRENT DEVICES

Filed Dec. 5, 1924

Fig. 1

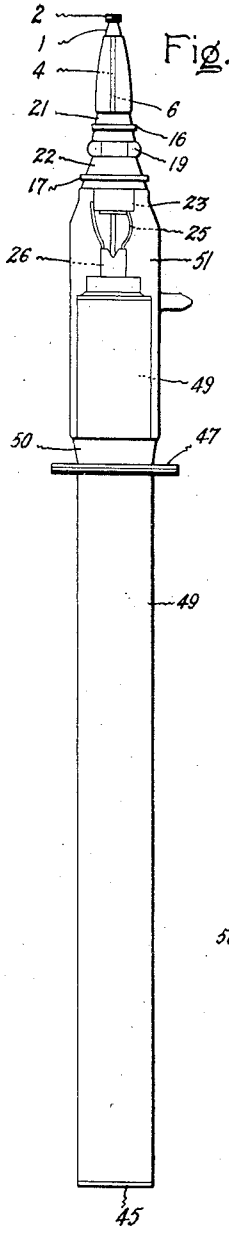
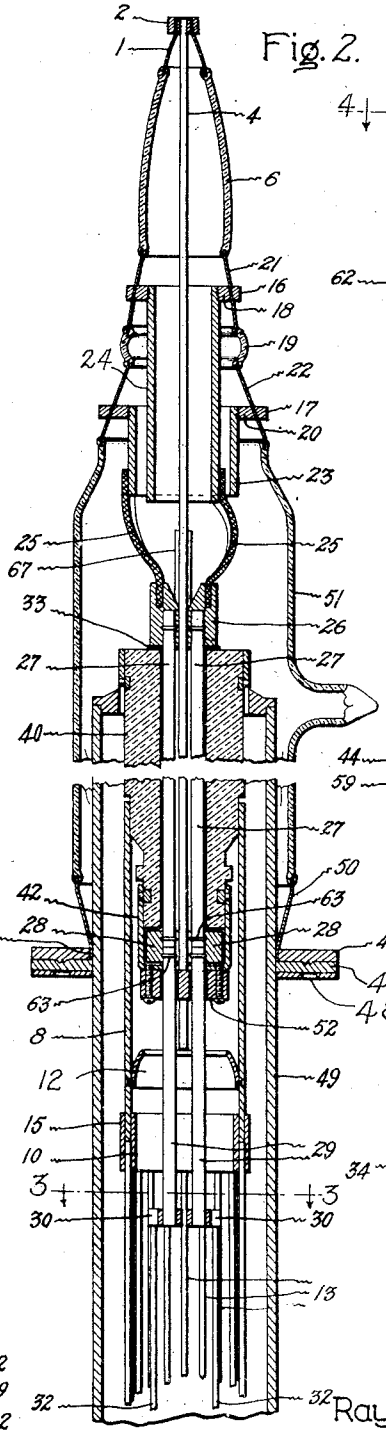
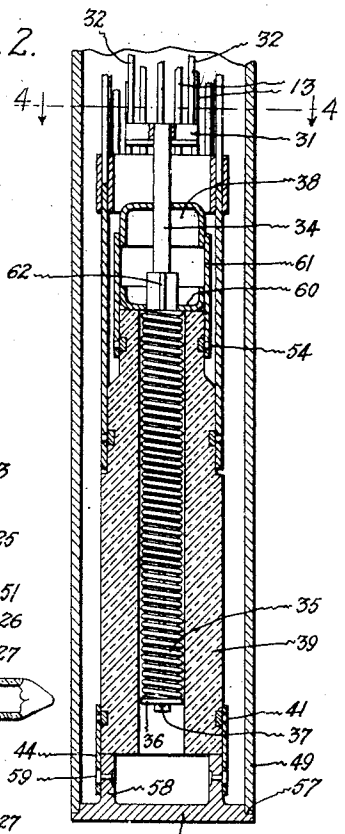


Fig. 2.





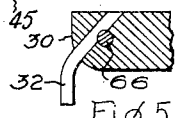


Fig. 5

Fig. 3.

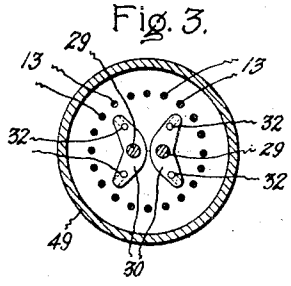
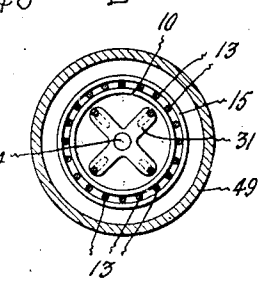


Fig. 4.



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UNITED STATES PATENT OFFICE.

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TERMINAL FOR SPACE CURRENT DEVICES.

Application filed December 5, 1924. Serial No. 754,224.

My invention relates to improvements in space current devices and more particularly to devices adapted for the control of large amounts of power.

Space current devices of this type are usually referred to as "power tubes" and consist of an evacuated container within which is disposed a system of cooperating electrodes comprising generally a cathode, an anode, and a control electrode, although for particular purposes a plurality of each or any of such electrodes may be used. In some cases the container of the space current device is composed of two portions joined together, one of which may be made of metal and serve as the anode while the other may be of glass and serve to hold the cathode and grid terminals as well as to insulate them from each other and from the anode.

One of the objects of my invention is to provide a rugged concentric terminal structure which may be mounted upon the glass portion of a device of the character described and to which terminal structure the leads of the respective electrodes of the device may be attached.

Another object of my invention is to construct the terminals and their cooperating seals in such a manner that they may readily be attached to the glass portion of the device with the aid of machinery in order to obviate the use of hand labor and to insure the accurate concentric positioning of the terminals with respect to each other and the body of the device.

It is another object of my invention to dispose the electrode terminals of the device in the normal sequence of their potential gradation so as to avoid unduly increasing the separation of the terminals in order to prevent dangerous arc-overs and short circuits.

A still further object of my invention is to provide an improved cathode tensioning means consisting of a resilient supporting structure disposed within the metal anode.

The invention itself, both as to its organization and method of operation together with further objects and advantages will best be understood by reference to the following description taken in connection with the accompanying drawing in which

Figure 1 shows in outline form one type of power space current device embodying the features of my invention.

Figure 2 illustrates in detail the elements of the device depicted in Figure 1. In order to avoid too great reduction of detail the device is shown in three sections.

Figure 3 shows a cross section of the anode structure taken on the line 3—3 of Figure 2.

Figure 4 illustrates a cross section of the anode grid filament structure taken on the line 4—4 of Figure 2.

Fig. 5 is a detail view, on an enlarged scale, of a portion of the filament connector.

The drawing shows a space current device embodying the improvements of my invention as an operative device comprising a container or evacuated envelope composed of a hollow copper anode body portion 49 to which is sealed a glass superstructure 51. The superstructure carries the coaxial terminal system which forms one of the main features of the invention.

The entire grid and cathode structure is carried by a supporting system comprising the upper quartz insulator 40 and the lower quartz insulator 39.

Disposed within the lower portion of the hollow anode and cooperating with the cathode, grid, and upper terminal structure is a spring actuated cathode tensioning system which constitutes part of the present invention. Referring in greater detail to Figure 2 the cathode in the present case consists of four tungsten rods 32 arranged in two groups of two rods each, the rods of each group being connected in parallel by means of connectors 30, and the two groups in series with each other.

The method of fastening the ends of the cathode to the connectors 30 is indicated in Figs. 3 and 5. The lower edge of the connector is beveled and two holes are drilled through the edge so produced and extending obliquely into the body of the connector as indicated in Fig. 5. The bent ends of the cathode are inserted into these holes and pins 66 are then driven through holes drilled at right angles to the cathode 32 and adjacent thereto. A similar method of fastening is used to retain the lower end of the cathode in the metal member 31.

The cathode is tensioned and its lower end retained in place by means of a resilient system comprising a coiled spring 35 whose lower end bears against a retaining washer 36 held in place upon a fin-equipped guide

rod 34 by means of cotter pin 37. At its upper end the spring 35 bears against a shoulder 60 which together with a cup shaped and centrally perforated member 38 constitutes a guiding system for the rod 34. This guiding system is retained in place upon the upper end of the quartz insulating member 39 by means of a molybdenum sleeve 61 and bayonet fastening 54, the molybdenum sleeve 61 being riveted with molybdenum rivets to both guide member 38 and shoulder 60. The spring 35 of the resilient system may be made of tungsten or other heat resisting metal while the fin-equipped spring guide 34 and its cooperating retaining washer and cotter pin are preferably made of molybdenum.

The spring guide 34 comprises a rod whose lower portion is provided with a plurality of fins 62 which bear against the inside wall of the coiled spring to prevent lateral displacement and consequent dragging of the exterior of the spring against the quartz insulating member. I have found that a small rod equipped with outwardly extending fins which bear against the spring at a plurality of places is preferable to a cylindrical guide rod in that the latter is apt to bind unless turned down to provide sufficient clearance in which case, however, there is a tendency for too much lateral displacement of the spring. The upper end of the rod 34 may be left round so as to permit ready passage through the guide piece 38. The tungsten spring 35 and guide rod 34 cooperating with it move longitudinally inside of an insulating member 39 which is made of fused quartz and which consists of a cylinder whose walls have sufficient thickness to constitute a rigid, non-vibrating structure, and whose internal diameter is sufficient to accommodate and guide the coiled spring 35 without binding or undue lost motion and yet maintaining a voltage spacing clearance. The exterior of the cylinder 39 is provided with peripherally disposed channels adapted to accommodate the retaining rings of a bayonet type of fastening which is used to secure the various metallic mountings and assembly sleeves in place. The quartz member 39 owing to its low thermal expansion co-efficient is capable of withstanding abrupt changes of temperature. The end 45 of the anode is provided with a peripheral shoulder 57 by means of which it is fitted to the body portion 49, the two elements being united by silver solder. An internal and upwardly extending flange 58 which is integral with the end 45 serves to hold a molybdenum sleeve 44 through the intermediary of bayonets 59. The molybdenum sleeve 44 in turn supports the quartz insulating member 39 by means of a bayonet ring fastening 41.

Considering now the upper end of the cathode, it will be observed that the rods 32 constituting the cathode are united in parallel by means of connectors 30, as hereinbefore set forth. The cathode therefore consists of two halves and these are attached to short leads 29 which extend through a clamping system 52 composed of three parts insulated from each other by means of mica.

The short cathode leads 29 are connected to the upwardly extending long filament leads 27 by pins 63 located in a cathode lead connector system 28 consisting of two triangular members which are insulated from the grid lead 4. The filament lead connector system 28 is held in place upon the quartz insulator 40 by means of a cap 42 secured by a bayonet fastening.

The long filament leads 27 terminate in connecting members 26 which are insulated and spaced from each other by means of mica separators 33. From members 26 connection is made to the outside terminals of the space current device by means of flexible cathode leads 25 which may be made of heavy wire braid or the like.

Referring in detail to the exterior cathode and grid terminals it will be observed that they are disposed coaxially with respect to each other and with the anode terminals. The lower cathode terminal to which one of the cathode leads 27 is attached by means of the flexible conductor 25 consists of a hollow lead 23, which may be a copper tube, to the upper end of which is screwed the large inner filament or cathode terminal 20 whose chamfered periphery is copper soldered to the large cone-shaped filament or cathode seal 22. On the outside of the cathode seal 22 there is copper soldered or silver soldered the large exterior cathode terminal 17 which is placed in direct juxtaposition to the inner terminal so that the sealing cone 22 is in effect sandwiched between the two terminal elements. The upper cathode terminal is analogous in construction to the lower one. The hollow lead 24, which may be a copper tube, to which one of the flexible cathode leads 25 is attached terminates at its upper portion in the small inner filament terminal 18 which is attached to the tube by a screw joint. The inner terminal 18 is copper soldered at its periphery to the upper cone-shaped cathode seal 21 to whose outside and in exact juxtaposition to the inner terminal 18 is copper soldered or silver soldered the ring-shaped outer filament terminal 16.

The lower end of the cathode seal 22 is sealed to the glass superstructure 51 of the device, otherwise known as the high tension bushing. At its upper end the seal 22 is sealed in a similar manner to a glass member 19 which serves to insulate the two low potential terminals. The lower end of the upper or small cathode seal 18 is sealed to the glass member 19 in the same way while its upper end is sealed to the relatively large glass member 6 which functions as an insu-

lator between the grid and cathode terminals. The glass member 6 is joined at its upper portion to the grid seal 1 to which in turn is attached the outside grid terminal 2. A rod 4 constitutes the grid lead and this passes through a quartz bushing (not shown but located in the insulated lead clamp 52) to a connector (also not shown) thence through the quartz tube 67, the upper exposed portion of which alone is visible in the drawing, through quartz insulating member 40, mica spacer 33 and flexible lead connectors 25, which assume a triangular position with respect to the lead 4. At its upper extremity the lead 4 is screwed into an iron plug which is copper soldered to the grid seal member 1, the latter being in turn joined to the external grid terminal 2. At its lower end the grid lead 4 is attached to the upper grid shield 12 which in turn is riveted to the upper grid sleeve 8. The grid sleeve 8 is sandwiched between the upper outside grid band 15 and the upper inside grid band 10, while the grid wires 13 are sandwiched between similar bands at their lower portion.

The glass superstructure 51 or high tension bushing as it is more properly called is attached to the anode body by means of an anode seal 50. At its lower end the anode seal is attached to the upper anode flange 47 by means of a chamfered joint and silver solder shown at 56. Intimately connected with the flange 47 is the copper lower anode flange 46.

The anode 49 is of the exposed type and may be cooled by being placed in a suitable receptacle containing water or other cooling liquid which may be admitted for the purpose of cooling the soldered flanges 46 and 47 by means of a channel or trench 48 located in the gasket of the lower flange 46 which in turn is soldered to the upper end flange 47.

It will be apparent that one of the chief advantages accruing from the coaxial disposition of the terminals resides in the ease with which they and their cooperating seals may be joined to their respective glass insulating members by means of machinery. Thus, the metal flange 47 is readily mounted in the chuck of a lathe and owing to the large diameter of the anode seal 50 the tubular glass high tension bushing or superstructure 51 is readily sealed thereto and accurately centered.

Of course in the case of some tubes it may be desirable to mount the anode itself in the chuck of the lathe, particularly if the weight and dimensions of the anode are such as to make it undesirable to support it by its flange alone. The large filament seal 22 may be similarly handled and the glass cathode seal insulator 19 attached by machinery while the same applies to the small filament seal 21 to which the glass grid cathode insulator 6 is attached whose upper end in turn carries the metal grid seal 1. Lumping and bunching of the plastic glass during the sealing process are obviated and the result is a symmetrical and perfectly balanced structure.

It will be appreciated that the electrode terminals are arranged in the natural order of their potential gradation starting at the top of the device and following down along the exterior. Thus, the grid terminal 2 may have a negative voltage of −3000 the filament terminals 16, 17, immediately below will ordinarily be at about ground or zero potential while the anode terminal 46 which is located a considerable distance below and insulated by the high tension glass bushing 51 may have a voltage of plus 30,000. It is obvious that the danger of short circuiting or external arcing which causes the glass to crack is greatly decreased if the potential gradient is kept as low as possible, the best results being secured when the polarity of the terminals is arranged so as to be in the order of plus to zero to minus.

The cathode seals in addition to being removed from the heated area are readily inspected owing to their large size, and although the danger of the occurrence of pin-holes is remote, a coating of enamel may be applied after the tube is finished to guard against any suspected porosity.

During the exhaustion process the elements of the device are preferably subjected to a heat treatment usually referred to as "vacuum firing" for the purpose of expelling occluded gases. If high frequency heating is used it is necessary that the axes of the electrical fields produced be concentric with the elements of the device otherwise local overheating may occur. The coaxial terminal structure described and the symmetrical construction of the entire device however fulfill this desideratum and preclude the danger of overheating.

It will be appreciated that the coaxial terminal structure of my invention is not limited in its application to space current devices but that the same may be applied to any similar or analogous electrical device in which a plurality of electrodes are disposed within a container and where it is necessary to lead off such electrodes to the exterior of the device. The structure is therefore suitable for use on vapor-electric translating devices such as mercury arc rectifiers and even incandescent lamps. The container or receptacle need not necessarily consist of glass or analogous insulating material so that metal containers may be used, provided, of course, that the terminals are disposed thereon in suitably insulated spaced relation and if necessary in any desired order of potential gradation. In the case of an incandescent lamp the filament and its ends are to be regarded as electrodes within the meaning of the present invention.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A space current device comprising a container, electrodes disposed within the container, a plurality of metal seals mounted in insulated spaced relation with one another adjacent one end of said container, ring terminals secured to the seals, and connections from said terminals to said electrodes.

2. An electrical device comprising an evacuated receptacle of cylindrical configuration, a plurality of cooperating electrodes disposed therein, a lead for each of said electrodes, a ring-shaped terminal and a cooperating cylindrical seal for each of said leads, at least one of said seals of substantially the same circumference as said evacuated receptacle and mounted thereon and the other seals being disposed in coaxial insulating spaced relation with respect to said first seal, the said ring-shaped terminals being electrically connected to their cooperating cylindrical seals and coaxial with each other.

3. An electrical device comprising an insulating receptacle, a plurality of electrodes disposed therein, a tubular terminal-bearing metallic seal for each of said electrodes, said seals being disposed on said insulating receptacle in spaced relation to each other, an annular internal terminal flange member metallically connected to at least one of said seals and a similar concentric external flange member metallically connected to said seal in juxtaposition to said internal member.

4. An electrical device comprising an insulating receptacle, a plurality of electrodes disposed therein, a tubular terminal-bearing metallic seal for each of said electrodes, said seals being disposed on said insulating receptacle in insulating spaced and coaxial relation to each other, an annular internal terminal flange member metallically connected to at least one of said seals and a similar external flange member metallically connected to said seal in juxtaposition to said internal member.

5. In a space current device the combination of a metal receptacle adapted to serve as an anode, a flange upon said anode adapted to serve as the terminal therefor, a control electrode and cathode disposed within said anode and in electron responsive relation thereto an insulating receptacle mounted upon said anode, a plurality of metallic conical seals disposed coaxially and in insulating spaced relation from each other upon said insulating receptacle and remote from said anode.

6. In a space current device the combination of a metallic receptacle provided with a flange and adapted to be used as an anode of said device, said flange being adapted to serve as the terminal of said anode, a cathode and control electrode disposed within said anode and in electron responsive relation thereto, a cylindrical vitreous body member sealed to said anode and a plurality of ring-shaped terminals disposed upon said vitreous body member and connected with the cathode and control electrode, the said anode, cathode and control electrode terminals being disposed coaxial with each other upon said vitreous body member in the normal sequence of their potential gradation.

7. In a space current device the combination of an evacuated receptacle, a cathode disposed therein a lead for each end of said cathode and a terminal for each of said leads, said terminals each comprising a conical metallic seal, an annular member metallically joined to the inside of said conical seal, a complementary annular member similarly joined to the outside of said seal and in juxtaposition to said inside member, the leads of said cathode being attached to said inside annular members, the ensemble of each terminal structure being disposed upon an insulating portion of the evacuated receptacle in coaxial and spaced relation to the ensemble of the other terminal structure.

8. In a space current device the combination of an evacuated receptacle, a cathode disposed therein a hollow lead for each end of said cathode and a terminal for each of said leads, said leads being concentrically mounted with respect to one another, said terminals being disposed coaxially with respect to each other and in spaced relation upon an insulating portion of said evacuated receptacle.

9. An electrical device of symmetrical configuration comprising an evacuated receptacle composed of a cylindrical metal portion to which is sealed a substantially similar vitreous portion within the confines of which receptacle a plurality of cooperating electrodes are disposed, the leads of said electrodes being attached to terminals disposed upon the vitreous portion and which terminals are disposed upon the said vitreous portion in coaxial and spaced relation to each other.

10. In a space current device the combination of a metal receptacle adapted to serve as an anode, a flange upon said anode adapted to serve as the terminal therefor, a control electrode and cathode disposed within said anode and in electron responsive relation thereto, an insulating receptacle mounted upon said anode, a plurality of metallic conical seals disposed coaxially and in insulating spaced relation from each other upon said insulating receptacle and remote from said anode, annular members metallically joined to the inside of said conical seals, complementary annular members similarly joined to the outside of said seals and in juxtaposition to said inside members said inside annular members being conductively connected with said control electrode and cathode.

11. An electrical terminal comprising a conical metal seal to whose top and bottom edges vitreous members are joined, a tubular

terminal member provided with a flange whose periphery is metallically united to the inside of said conical seal and a ring-shaped member metallically united to the exterior of said conical seal and substantially in juxtaposition to the corresponding internal tubular member.

12. In an electrical device comprising an evacuated insulating receptacle provided with a plurality of electrodes and corresponding electrode leads, the combination of a plurality of terminals each comprising a conical metal seal to the exterior of which is metallically connected an annular member and to the interior of which and in juxtaposition to said exterior member is metallically connected a complementary annular member to which the electrode leads are attached, the said terminals being disposed coaxial with respect to each other upon the said evacuated insulating receptacle and in spaced relation thereon.

13. A resilient tensioning system for the cathode of a space current device comprising a hollow cylindrical insulating member, a coiled spring disposed therein, a shoulder at one end of said insulating member, a fin equipped rod extending through said spring and provided with spring retaining means at its extremity, the said spring cooperating with said shoulder and said retaining means to permit movement of said rod longitudinally of said insulating member.

14. A resilient tensioning system for the cathode of an electrical device comprising a coiled spring, a rod member disposed within said spring, attached to said cathode, and cooperating with said spring to exert traction upon said cathode, said rod member being provided at its spring embraced extremity with a plurality of radially disposed fins adapted to guide the said spring rod through said spring.

15. In combination, an electrical device comprising a receptacle, a filamentary electrode mounted therein, a pair of leads for said electrode, said leads comprising a pair of hollow conductors mounted in the receptacle concentrically with respect to one another.

In witness whereof, I have hereunto set my hand this 4th day of December 1924.

RAYMOND B. PRINDLE.