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CATHODE RAY ELECTRON DISCHARGE DEVICE

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Fig. 1 PRIOR ART

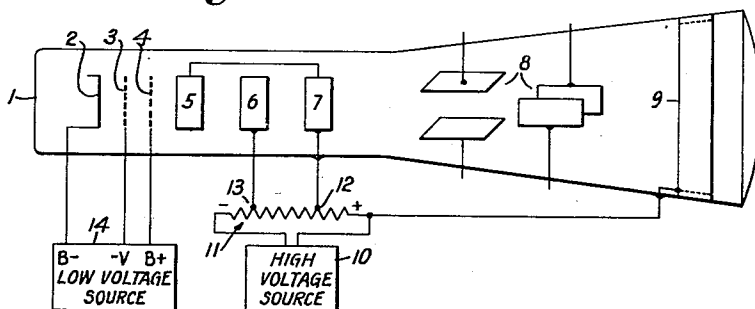


Fig. 2

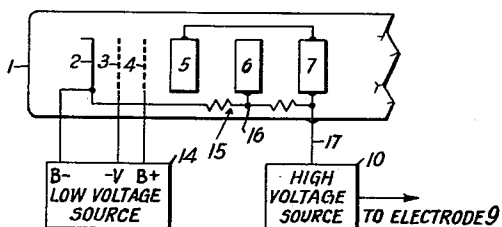


Fig. 3

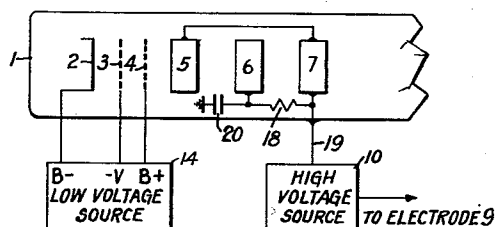
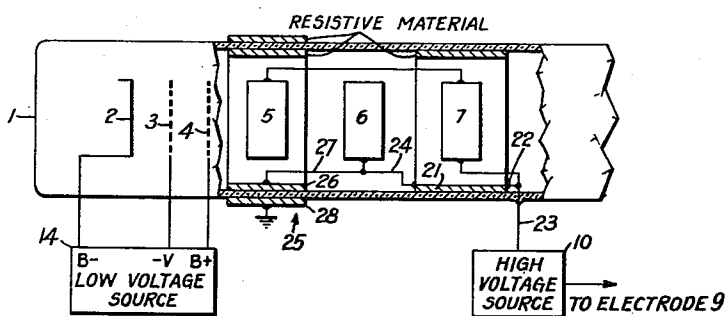


Fig. 4



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CATHODE RAY ELECTRON DISCHARGE DEVICE

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7 Claims. (Cl. 315—16)

This invention relates to electrostatic focus type cathode ray electron discharge devices and more particularly to means for maintaining automatically the optimum focus of the electron beam therein.

It is well known in the art that in electrostatic focus cathode ray electron discharge devices the focusing electrode potential for optimum electron beam focusing is a definite predetermined fractional value of the accelerating electrode potential. Therefore, if in such a cathode ray device, the focusing electrode potential is maintained at the optimum ratio for any one particular application of the cathode ray device, such as television, oscillographic uses, and the like, then maintenance of the optimum electron beam focus is assured.

Heretofore, maintenance of the optimum focusing electrode potential to accelerating electrode potential ratio has been attempted by judicious connection to predetermined points along the load impedance of a high voltage power supply. This arrangement provided a means external to the cathode ray tube for maintenance of the desired D.-C. operating potentials for the electrodes of the cathode ray device. A disadvantage of this external potential supplying arrangement is that it is very susceptible to line or high voltage power supply variations with no assurance that such a variation will still provide the desired potential ratio for optimum focusing since the potentials of the accelerating electrode and the focusing electrode would tend to change an unequal amount thereby upsetting the optimum focusing ratio and consequently the desired electron beam focusing.

Therefore, it is an object of this invention to provide a cathode ray device which by its internal construction permits the automatic maintenance of electron beam focus regardless of line voltage or high voltage supply variations.

Another object of this invention is the provision of a means incorporated internally of a cathode ray electron discharge device immune from humidity and other atmospheric hazards, for maintaining the desired predetermined ratio of focusing electrode to accelerating electrode potential with the external connection to the high voltage power supply being accomplished by only the accelerating electrode.

A feature of this invention is the provision of an internal voltage divider disposed between the accelerating electrode and a voltage reference, such as the cathode, having a predetermined value and tap location dependent upon the desired bleeder current, for connection of the focusing electrode to said tap whereby the optimum electron beam focusing ratio is automatically maintained regardless of the variations of the high voltage power supply or line voltage.

Another feature of this invention is the provision of an internal series resistor disposed between the accelerating electrode and the focusing electrode, the value of said resistor together with the nominal focusing electrode current automatically insuring the maintenance of the optimum electron beam focusing ratio regardless of power supply variations.

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Still another feature of this invention is the provision of a layer of resistive material coated on the inner surface of the vacuum envelope of a cathode ray device arranged in a predetermined manner to form a voltage divider of appropriate value disposed between the accelerating electrode and a reference potential, such as the cathode potential, having a tap position located thereon to automatically maintain the desired electron beam focusing ratio.

A further feature of this invention is the provision of a coating of resistive material on the inner surface of the vacuum envelope of a cathode ray device arranged in a predetermined manner to provide a series resistance of appropriate value between the accelerating electrode and focusing electrode to automatically maintain the desirable electron beam focusing ratio. As is known in electron discharge devices having screen grid electrode, the D.-C. potential for application to the screen grid electrode may be provided by having a dropping resistor between B+ and this electrode. In some circuitry employing such a discharge device it is desirable to provide a by-pass condenser between the screen grid electrode and ground potential. In a particular application of a cathode ray device, it may be desirable to provide a similar by-passing means for the focusing electrode. Thus, another feature of this invention is the provision of a by-pass condenser formed by coating the inner and outer surfaces of the vacuum envelope of a cathode ray device with a predetermined amount and configuration of resistive material sandwiching therebetween the ceramic envelope to form the desired condenser. The by-passing of the focusing electrode is then accomplished by coupling said focusing electrode to the interior resistive layer at an appropriate point and connecting the exterior resistive layer appropriately to ground potential.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagrammatic illustration of the prior art arrangement for applying desired operating potentials to the various electrodes of a cathode ray device;

Fig. 2 is a diagrammatic illustration of an embodiment of a cathode ray device employing internal electrode connections following the principles of this invention;

Fig. 3 is a diagrammatic illustration of another embodiment of this invention; and

Fig. 4 is a diagrammatic illustration of a further embodiment of this invention.

Referring to Fig. 1, a cathode ray electron discharge device is diagrammatically illustrated comprising an envelope 1 which encloses therein a cathode 2, a control electrode 3, a screen electrode 4, a pre-accelerating electrode 5, a focusing electrode 6, an accelerating electrode 7, electrostatic deflection plates 8, and an intensifier electrode 9, the structural arrangement of such a device and the function of each element therein being well known in the prior art.

The structural arrangement of this electron discharge device is such that means are provided for connection of the various electrodes therein to a source of D.-C. potential through cap connections located appropriately on the envelope or cathode end of said device for development thereon of a predetermined potential for establishment of the desired electrostatic fields for control of the electrons emitted from cathode 2, acceleration of the electron beam, and maintenance of the focusing of the electron beam. As diagrammatically illustrated in Fig. 1, the high voltage power supply 10 would be connected in a manner to be present across a load resistor 11 having the voltage with the relative polarity as indicated. From taps 12 and 13 disposed in a predetermined manner along

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resistor 11, as relatively indicated, the focusing and accelerating electrodes 6, 7, and 5, respectively, are connected externally to these taps for production of the desirable electrostatic fields between these internal electrodes. The electrodes 2, 3, and 4 are externally connected to appropriate points of low voltage power supply 14 for development of proper and known electrostatic fields between these respective electrodes. Structurally the above external connections would be made by means of caps or connections to the tube base through its associated tube socket. As was pointed out hereinabove any changes in the power supply 10 or line voltage would be reflected at load resistor 11 in such a manner that a change will occur in the desired optimum ratio between the potentials on the accelerating electrode and the focusing electrode, thereby resulting in an undesirable and possibly a fluctuating focusing of the electron beam.

I have discovered that incorporating a means associated internally with the accelerating and focusing electrodes of a cathode ray device, automatic maintenance of the optimum ratio between the accelerating electrode potential and the focusing electrode potential is possible regardless of the variations of the power supply 10 voltages. An embodiment of such a means is diagrammatically illustrated in Fig. 2 wherein the electrode elements and accompanying power supplies of the cathode ray device have associated therewith the same reference characters as employed in Fig. 1. In fabricating the structural elements of this device there is incorporated therein a voltage divider 15 connected structurally between accelerating electrode 7 and a predetermined reference potential, such as cathode 2. Focus electrode 6 is then structurally connected to a tap 16 disposed at a predetermined point along voltage divider 15 thereby establishing the desired optimum ratio between the potentials present on the accelerating and focusing electrodes. The desired value of potential for accelerating electrode 7 is coupled from high voltage source 10 by the single external connection 17. The bleeder current present in conductor 17 flows through voltage divider 15 in a manner to establish the focusing electrode 6 potential at tap 16 which is a predetermined fractional value of the potential at electrode 7. The other electrodes, cathode 2, screen electrode 4 and control electrode 3, receive their operating potential by appropriate connections to low voltage power supply 14.

It will be obvious to those skilled in the art that modification of the internal structure of a cathode ray device as proposed in this invention will maintain the desired potential ratio for optimum focusing of the electron beam regardless of voltage variations in the power supply or line voltage. With this internal structural arrangement a change of voltage on the single external lead 17 to electrode 7 and hence to electrode 6 via the voltage divider 15 will be reflected an equal amount at electrode 6 thereby maintaining the same potential ratio. Furthermore, this internal structural modification will provide a reduction of external components necessary in a power supply to maintain a well regulated voltage and will reduce to a great extent the shock hazard now present for operators and maintenance personnel. This internal structure also provides vacuum immunity from humidity and other atmospheric hazards for the components of this automatic focusing system, thereby, providing a substantially indefinite life for these components.

Fig. 3 diagrammatically illustrates a further embodiment of this invention wherein corresponding elements of the cathode ray device have the same reference characters as the preceding embodiment. The internal structure of the cathode ray device is modified to incorporate internally a resistor 18 disposed between electrodes 6 and 7 having a value which in cooperation with the nominal focus electrode current will provide the desirable potential ratio between electrodes 6 and 7. As before the potential for application to electrodes 6 and 7 is derived from a power supply 10 by means of the single external

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conductor 19. As will be noted the external lead to the focusing electrode 6 is again omitted with the desired potential being supplied thereto by the combination of the external lead 19 coupled directly to the accelerating electrode 7 and the internal resistor 18 establishing the potential thereon at a predetermined fractional value of the electrode 7 potential to provide the desired optimum potential ratio. As in the embodiment of Fig. 2, a variation of voltage coupled to electrode 7 will be reflected an equal amount at electrode 6 through resistor 18 thereby maintaining automatically the desired potential ratio that should exist between electrodes 6 and 7 for optimum focusing of the electron beam. This internal arrangement provides the same advantages of long life for the internal resistive element along with reduction of external components and shock hazards as mentioned above in connection with the embodiment of Fig. 2.

In some applications of the embodiment of this invention illustrated in Fig. 3, it may be desirable to provide an R-F. by-pass for electrode 6 similar to the practice in some applications of electron discharge devices having a screen grid. Such an arrangement for by-passing the focusing electrode 6 with respect to radio frequency may be accomplished by employing condenser 20 as diagrammatically illustrated.

The structural modifications, as shown by the embodiments of Figs. 2 and 3, may be accomplished by employing conventional resistive elements of small physical size. However, it has been discovered that practically the same results may be achieved by employing a coating or layer of resistive material disposed on the interior of the vacuum envelope of a cathode ray device in a predetermined manner to provide an appropriate resistive value whereby the desired electron beam focus ratio may be maintained automatically.

A representative embodiment of such an arrangement is diagrammatically illustrated in Fig. 4. Although the arrangement of resistive material coating is illustrated to provide an internal series resistance between electrodes 6 and 7, with an associated radio frequency by-pass condenser, it must be remembered that the same principle may be employed to provide an internal voltage divider as disclosed by the embodiment of Fig. 2.

The embodiment of Fig. 4 comprises a layer 21 of resistive material adhering to the inner surface of envelope 1 having an appropriate property and configured in a manner to provide a proper value of resistance which in cooperation with the nominal focusing current will maintain the desired electron beam ratio regardless of variations in the high voltage power supply 10. The high voltage potential to electrode 7 of appropriate value for a particular application of the device is coupled to layer 21 at one longitudinal edge thereof, such as point 22, by conductor 23 from source 10. At the remote longitudinal edge, electrode 6 will be connected thereto by an internal conductor 24, thereby, inserting an internal series resistance between focusing electrode 6 and accelerating electrode 7 of appropriate resistive value for desired electron beam focusing.

As hereinabove mentioned there is, for certain applications of the cathode ray device, a necessity for providing a radio frequency by-passing means for the focusing electrode 6 when incorporating therewith the internal series resistance of Figs. 3 and 4. Fig. 4 illustrates a practical means of obtaining such a by-passing means by forming a condenser 25 of proper value which incorporates envelope 1, consisting of ceramic material, as the dielectric therefore. One plate or foil for condenser 25 is provided by a layer 26 of resistive material coating the inner surface of envelope 1 having an appropriate configuration. Layer 26 is electrically coupled to electrode 6 by means of conductor 27. The other plate or foil is provided by a similar layer 28 of resistive material adhering to the outer surface of envelope 1. To accomplish the desired radio frequency by-passing, a multiple finger,

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spring type, contacting sleeve or yoke may be slipped over layer 28 in such a manner that the outer layer 28 is effectively grounded.

The embodiment of Fig. 4 may be easily adapted to conform to the embodiment of Fig. 2 by assuring that the resistive value of layers, similar to layers 22 and 26, are the proper value for forming a voltage divider similar to voltage divider 15. These resistive layers may be coupled together in any convenient manner to form a voltage divider between electrode 7 and a reference potential and the required connection to electrode 6 may be made from this voltage divider, at a predetermined point therealong.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. An automatic focus system for an electrostatic cathode ray electron discharge device having an envelope containing therein at least an electron emitter, a control electrode, a screen electrode, an accelerating electrode and a focusing electrode, comprising a low voltage power supply for supply of a predetermined D.-C. potential to certain ones of electron beam forming electrodes of said cathode ray device, a high voltage power supply for supply of a predetermined D.-C. potential to other ones of said electron beam forming electrodes, and a focusing unit located within the envelope of said cathode ray device, said focusing unit being coupled to said high voltage power supply and to said accelerating and said focusing electrodes for automatic maintenance of optimum electron beam focusing, said focusing unit including a series resistance coupled between said accelerating electrode and said focusing electrode to establish a D.-C. potential at said focusing electrode related to the D.-C. potential at said accelerating electrode by a predetermined fraction thereof, said series resistance comprising a layer of resistive material of predetermined configuration adhering to the inner surface of said envelope.

2. An automatic focus system for an electrostatic cathode ray electron discharge device having an envelope containing therein at least an electron emitter, a control electrode, a screen electrode, an accelerating electrode and a focusing electrode, comprising a low voltage power supply for supply of a predetermined D.-C. potential to certain ones of electron beam forming electrodes of said cathode ray device, a high voltage power supply for supply of a predetermined D.-C. potential to other ones of said electron beam forming electrodes, and a focusing unit located within the envelope of said cathode ray device, said focusing unit being coupled to said high voltage power supply and to said accelerating and said focusing electrodes for automatic maintenance of optimum electron beam focusing, said focusing unit comprising a voltage divider disposed in connecting relation between said accelerating electrode and said cathode electrode, said voltage divider comprising a layer of resistive material of predetermined configuration coating the inner surface of said envelope having disposed therealong a tap coupled to said focusing electrode for establishment of a D.-C. potential at said focusing electrode related to the D.-C. potential at said accelerating electrode by a predetermined fraction thereof, said accelerating electrode being externally connected to said high voltage supply.

3. In a cathode ray system; a cathode ray electron discharge device having an envelope containing therein certain low voltage electrodes including a cathode electrode, a control electrode and a screen electrode, and certain high voltage electrodes including an accelerating electrode and a focusing electrode, a low voltage power supply to apply a predetermined value of D.-C. potential

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to said low voltage electrodes, a high voltage power supply to apply a predetermined value of D.-C. potential to said high voltage electrodes, and a focusing unit situated within the envelope of said cathode ray discharge device interconnecting said accelerating electrode and said focusing electrode to provide from said high voltage power supply an automatic maintenance of optimum electron beam focusing, said focusing unit comprising an internal voltage divider disposed in connecting relation between said accelerating electrode and a predetermined D.-C. reference potential, said voltage divider comprising a coating of resistive material of predetermined ohmic value adhering to the inner surface of said envelope having disposed therealong a tap for connection to said focusing electrode for automatically maintaining the optimum ratio of accelerating electrode potential to focusing electrode potential.

4. In a cathode ray system; a cathode ray electron discharge device having an envelope containing therein certain low voltage electrodes including a cathode electrode, a control electrode and a screen electrode, and certain high voltage electrodes including an accelerating electrode and a focusing electrode, a low voltage power supply to apply a predetermined value of D.-C. potential to said low voltage electrodes, a high voltage power supply to apply a predetermined value of D.-C. potential to said high voltage electrodes, and a focusing unit situated within the envelope of said cathode ray discharge device interconnecting said accelerating electrode and said focusing electrode to provide from said high voltage power supply an automatic maintenance of optimum electron beam focusing, said focusing unit comprising an internal series resistance disposed in connecting relation between said accelerating electrode and said focusing electrode for automatically maintaining the optimum ratio of accelerating electrode potential to focusing electrode potential said series resistance comprising a coating of resistive material of predetermined ohmic value adhering to the interior of said envelope.

5. An automatic focus system for an electrostatic cathode ray electron discharge device having an envelope containing therein at least an electron emitter, a control electrode, a screen electrode, an accelerating electrode and a focusing electrode, comprising a low voltage power supply for supply of a predetermined D.-C. potential to certain ones of electron beam forming electrodes of said cathode ray device, a high voltage power supply for supply of a predetermined D.-C. potential to other ones of said electron beam forming electrodes, a focusing unit located within the envelope of said cathode ray device, said focusing unit being coupled to said high voltage power supply and to said accelerating and said focusing electrodes for automatic maintenance of optimum electron beam focusing, said focusing unit comprising a voltage divider disposed in connecting relation between said accelerating electrode and said cathode electrode, and a capacitive means in coupled relation to said focusing electrode to by-pass radio frequency from said focusing electrode, said voltage divider comprising a first layer of resistive material of predetermined configuration coating the inner surface of said envelope having disposed therealong a tap coupled to said focusing electrode for establishment of a D.-C. potential at said focusing electrode related to the D.-C. potential at said accelerating electrode by a predetermined fraction thereof, said accelerating electrode being externally connected to said high voltage supply, said capacitive means comprising a second predetermined layer of resistive material disposed on the outer surface of said envelope in relation to said first resistive layer to sandwich therebetween the dielectric material of said envelope, said second layer being in coupled relation with ground potential.

6. An automatic focus system for an electrostatic cathode ray electron discharge device having an envelope containing therein at least an electron emitter, a control

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electrode, a screen electrode, an accelerating electrode and a focusing electrode, comprising a low voltage power supply for supply of a predetermined D.-C. potential to certain ones of electron beam forming electrodes of said cathode ray device, a high voltage power supply for supply of a predetermined D.-C. potential to other ones of said electron beam forming electrodes, a focusing unit located within the envelope of said cathode ray device, said focusing unit being coupled to said high voltage power supply and to said accelerating and said focusing electrodes for automatic maintenance of optimum electron beam focusing, said focusing unit including a series resistance coupled between said accelerating electrode and said focusing electrode to establish a D.-C. potential at said focusing electrode related to the D.-C. potential at said accelerating electrode by a predetermined fraction thereof, said accelerating electrode being externally connected to said high voltage power supply, and a voltage divider disposed in connecting relation between said accelerating electrode and said cathode electrode, said series resistance comprising a first layer of resistive material of predetermined configuration adhering to the inner surface of said envelope and said voltage divider comprising a second layer of resistive material of predetermined configuration spaced from said first layer coating the inner surface of said envelope having disposed therealong a tap coupled to said focusing electrode.

7. An automatic focus system for an electrostatic cathode ray electron discharge device having an envelope containing therein at least an electron emitter, a control electrode, a screen electrode, an accelerating electrode and a focusing electrode, comprising a low voltage power supply for supply of a predetermined D.-C. potential to certain ones of electron beam forming electrodes of said cathode ray device, a high voltage power supply for supply of a predetermined D.-C. potential to other ones of said electron beam forming electrodes, a focusing unit located within the envelope of said cathode ray device, said focusing unit being coupled to said high voltage power supply and to said accelerating and said focusing

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electrodes for automatic maintenance of optimum electron beam focusing, said focusing unit including a series resistance coupled between said accelerating electrode and said focusing electrode to establish a D.-C. potential at said focusing electrode related to the D.-C. potential at said accelerating electrode by a predetermined fraction thereof, said accelerating electrode being externally connected to said high voltage power supply, a voltage divider disposed in connecting relation between said accelerating electrode and said cathode electrode, and a capacitive means in coupled relation to said focusing electrode to by-pass radio frequency from said focusing electrode, said series resistance comprising a first layer of resistive material of predetermined configuration adhering to the inner surface of said envelope, said voltage divider comprising a second layer of resistive material of predetermined configuration spaced from said first layer coating the inner surface of said envelope having disposed therealong a tap coupled to said focusing electrode and said capacitive means comprising a third predetermined layer of resistive material disposed on the outer surface of said envelope in relation to said second resistive layer to sandwich therebetween the dielectric material of said envelope, said third layer being in coupled relation with ground potential.

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