

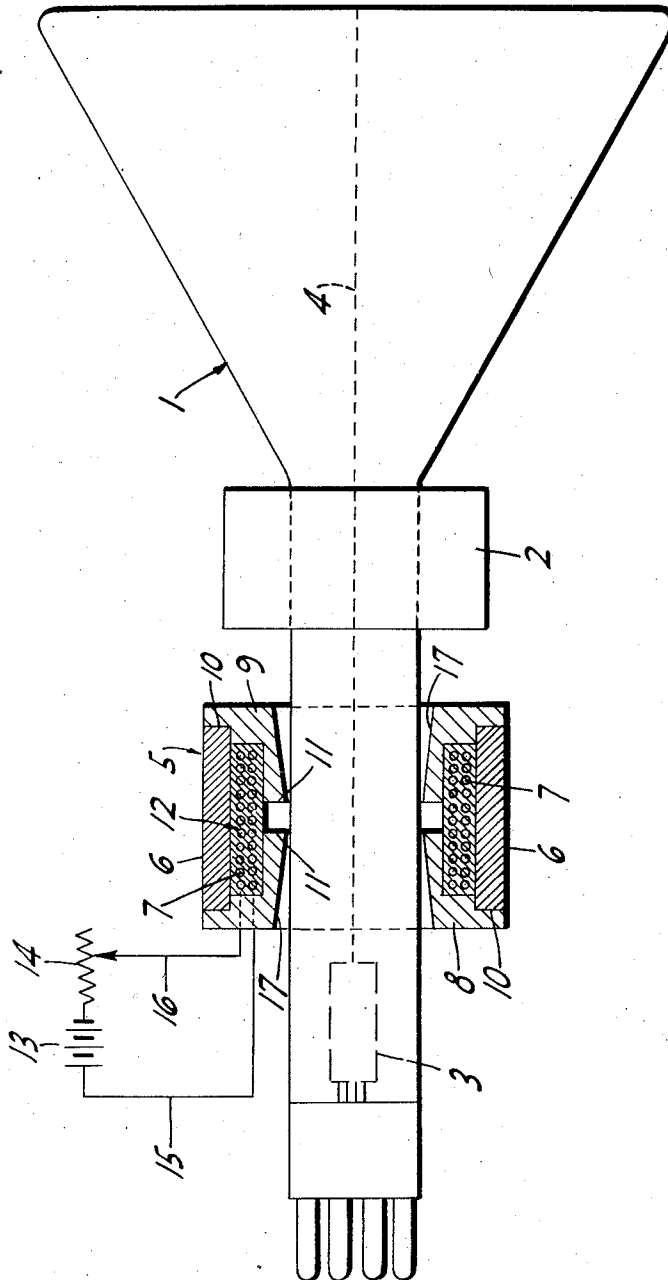
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ELECTRON FOCUSING APPARATUS

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ELECTRON FOCUSING APPARATUS

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This invention relates to electron tubes, and is especially concerned with apparatus for focusing the electron beams of cathode-ray tubes, and the like. More particularly, the invention has to do with that class of tubes which utilize magnetic focusing.

In tubes focused in this manner, there is encountered in practice a gradual defocusing, known as "drift" which, as will be readily appreciated, deleteriously affects the operation of the tube. Such defocusing arises from variations in the resistance of the focusing solenoid, or coil, resulting from the heat generated therein. Variations in the coil current and, consequently, variations in the intensity of magnetic field occur as a result of the above-mentioned instability of the coil resistance. It will be understood that the magnitude of the drift may become substantial, since the heat generated in the focusing coil is proportional to the second power of the current. It is, therefore, highly advantageous to keep the power delivered to the coil, and the consequent heating thereof, as small as possible.

Accordingly, it is the primary object of the present invention to provide a novel magnetic focusing arrangement in which the deleterious heating effects heretofore inherently existent in prior arrangements are substantially eliminated.

More particularly, the invention is concerned with the provision of tubes of this character having, in novel combination, a permanent magnet and an electromagnet cooperating to provide unusually stable focusing characteristics. To this end, the invention contemplates the provision of a magnetic focusing means, in which a substantial portion of the required magneto-motive force is supplied by a permanent magnet, the remainder being provided by an electromagnet which need be supplied with only a small fraction of the electrical energy previously required.

The invention further contemplates focusing means of the character above set forth, in which necessary adjustments in the focus are effected by varying the current supplied to said electromagnet.

The foregoing, and other objects and advantages of the invention, will be understood by reference to the following description, considered with the accompanying drawing, the single figure of which is an elevational view of a cathode-ray tube constructed in accordance with the present invention, the focusing apparatus being shown in section for the sake of clarity in illustration.

Referring more particularly to the drawing, the cathode-ray tube which is designated generally

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by the reference character 1, is provided with a deflecting coil 2 and an electron gun 3, the electron beam being indicated by the dotted line designated by the reference numeral 4. Both the deflecting coil and the electron gun may take any desired known form, and as the invention is not concerned with the cathode-ray tube, per se, detailed illustration and description thereof is not deemed necessary herein.

In particular accordance with the present invention, the focusing apparatus shown at 5 comprises a permanent magnet 6 and an auxiliary electromagnet including the winding 7, the magnets cooperating to provide the necessary focus of the electron beam 4. As the elements of the focusing apparatus are all rotationally symmetrical about the axis defined by the electron beam 4, the cross-sectional portion of the drawing clearly illustrates the configuration of the several elements.

The permanent magnet 6, of predetermined field strength, surrounds the neck portion of the tube 1, and cooperates with a pair of oppositely disposed circular pole pieces 8 and 9, which provide a common low-reluctance path for the flux of both the permanent magnet and the electromagnet. Each of the pole pieces is provided with a peripheral recess as shown at 10, by means of which the permanent magnet 6 may be supported and maintained in its proper position. As will be evident, the permanent magnet forms a portion of the magnetic circuit of the electromagnet. Oppositely disposed, annular extensions 11 define the pole faces, which are of a size to fit snugly over the neck of the tube, while the winding of the electromagnet 7 is disposed within the recess 12, defined by the inner annular surface of the permanent magnet and cooperating surfaces of the two pole pieces. It will be observed that each of the pole pieces is provided with a conical bore, indicated at 17, to permit initial adjustment of the position of the focusing apparatus 5, whereby to center the spot upon the fluorescent screen.

As indicated above, and in particular accordance with the present invention, a substantial portion of the magneto-motive force required to accomplish focusing, is supplied by the permanent magnet. The field strength of this magnet would, of course, be varied in accordance with requirements of tubes of different types. The arrangement is such that the magneto-motive force provided by the electromagnet need only be in an amount sufficient to permit focusing adjustment and, therefore, it is contemplated that this electromagnet be supplied with only a small fraction

of the electrical energy required with focusing arrangements previously employed. Preferably, of course, the magneto-motive force supplied by the electromagnet should aid, rather than oppose, that supplied by the permanent magnet. The windings of the electromagnet are connected in series with a suitable source of direct current 13 and a variable resistor 14, by means of leads indicated at 15 and 16. It will be understood that adjustment of the resistor 14 serves to provide the necessary variations in the current supplied to the electromagnet. Thus, in the system of the present invention, the electromagnet constitutes a vernier adjustment of the overall field intensity.

It will be understood that a substantial portion of the magnetic flux passing between the pole faces will fringe into the neck of the cathode-ray tube, thereby providing a magnetic lens which is employed to accomplish the focusing of the electron beam, as is well known in the art.

From the foregoing description, it will be evident that the invention provides an improved magnetic focusing apparatus having exceedingly stable focusing characteristics, while still including provision for any desired variations in the focus adjustment.

In addition, the apparatus is susceptible of unusually inexpensive manufacture, particularly since the assembled structure includes a winding which may conveniently be employed to effect magnetization of the permanent magnet. This may be done by passing through the coil a short pulse of unidirectional current of large magnitude.

I claim:

1. In combination with a cathode-ray tube or the like, electron beam focusing apparatus comprising, a permanent magnet, and an electromagnet, said permanent magnet supplying a substantial portion of the focusing magneto-motive force, said magnets being arranged in nested con-

centric relation and associated with a neck portion of the tube.

2. In combination with a cathode-ray tube or the like, electron beam focusing apparatus comprising, a permanent magnet, an electromagnet, said permanent magnet supplying a substantial portion of the focusing magneto-motive force, said magnets being arranged in nested concentric relation and associated with a neck portion of the tube, and pole structure providing a magnetic circuit common to both of said magnets.

3. An electron beam focusing apparatus comprising, in combination, a permanent magnet, and an electromagnet, said magnets together providing the total focusing magnetomotive force, the magnetomotive force provided by said electromagnet being only a small fraction of the total and being adjustable, whereby said electromagnet may be utilized to effect adjustments in focus of the electron beam.

4. In combination with a cathode-ray tube or the like, electron beam focusing apparatus comprising, a permanent magnet, and an electromagnet, said magnets together providing the total focusing magnetomotive force and said permanent magnet supplying the major portion thereof, said magnets being arranged in nested concentric relation and being associated with a neck portion of the tube.

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