313-414. XR 2,072,651 SR

6309
X 6295

March 2, 1937. F. SCHRÖTER ET AL 2,072,651

ELECTRON TUBE

Filed Aug. 8, 1932

TR 1423 ?
X 1421
X 1344

Fig. 1

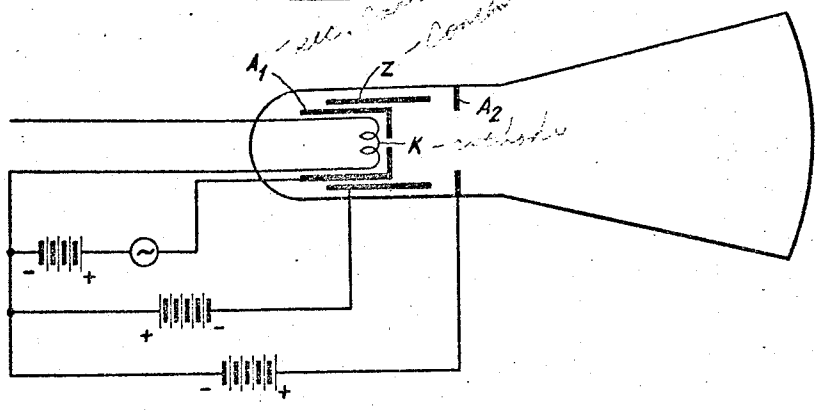


Fig. 2

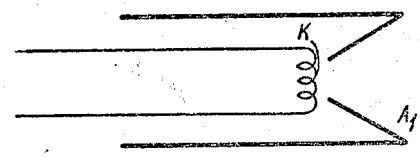
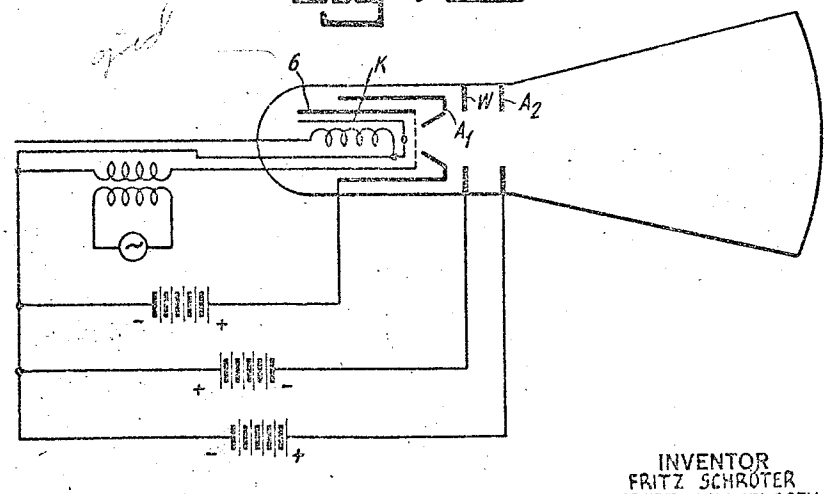


Fig. 3



INVENTOR
FRITZ SCHRÖTER
FRITZ MICHELSSEN
BY W. S. Grover
ATTORNEY

Patented Mar. 2, 1937

2,072,651

UNITED STATES PATENT OFFICE

2,072,651

ELECTRON TUBE

Fritz Schröter and Fritz Michelssen, Berlin, Germany, assignors to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application August 8, 1932, Serial No. 627,926
In Germany August 29, 1931

2 Claims. (Cl. 250—27.5)

The present invention relates to electron tubes of the cathode ray type and particularly to ways and means by which the electron pencil may be concentrated at the point on the fluorescent screen at which it impinges.

It is known that for the production of a sharply pencilled or focused electron ray bundle such as required, for instance, in Braun tubes, a rather large number of auxiliary means and ways have been suggested in the prior art. One of these schemes consists of the disposition of a so-called Wehnelt cylinder about the electron emitting body of the cathode. The Wehnelt cylinder serves the object, by virtue of its potential, of focusing the emission of the cathode upon a diaphragm portion of the accelerating anode. The concentration of the pencil issuing through the anode diaphragm, if desired, may be further promoted by the constrictive action of a low pressure gas atmosphere.

However, in the course of research work with the above and similar arrangements, it has been discovered that a prerequisite for permanent satisfactory focusing is to provide a fixed or sharply bounded source of electrons which results in the radiation or pencil. For instance, if the cathode member of the arrangements used in the prior art, after some prolonged period of operation, no longer gives uniform emission, this becomes causative of a shift in the origin of the pencil, which in turn means that the effect of the anode and cylinder potentials is no longer focusing so far as the new origin or source of the electrons is concerned. While it is occasionally feasible to adjust the same to the values required for a sharply focused pencil, it will in the majority of cases be found that subsequent improvement of conditions is not possible.

The present invention therefore has as its primary object that of disclosing ways and means adapted to overcome the difficulties of the prior art and thus to insure a sharply focused cathode ray pencil in a reliable manner for long periods of time. The invention also provides means whereby the intensity of the emitted electron pencil may be influenced in the desired manner and to modulate the same in a manner such as to insure reliable operation wherever this is desirable, as, e. g., in television work. According to the present invention these results are accomplished by shifting the origin of the pencil to be used in connection with the purposes of the tube to a secondary cathode disposed in the vicinity of the electron-emissive element instead of using the electron ray pencil from the electron emissive cathode, the latter being either of the directly or indirectly heated type.

The accompanying drawing serves to illustrate the principles of the invention and discloses by Fig. 1 a form of the invention which has been found satisfactory to carry out the aims and objects above set forth, and by Figs. 2 and 3 suitable modifications of the arrangement of Fig. 1.

Referring now to the embodiment of the invention shown by way of example in Fig. 1, the letter K represents the directly indirectly heated electrode (the possible heating means including also glow-discharge or equivalent means), from which electrodes the electrons enter into the free space. A_1 designates an electrode provided with a diaphragm aperture, this electrode being maintained at a positive potential in reference to the cathode K. The cylindrical electrode Z by the potential of which the electrons issuing from electrode A_1 in a diffuse manner are concentrated upon the anode diaphragm proper, as indicated at A_2, such focusing or concentrating action being optionally promoted by the constrictive effect of a gas filling is arranged to surround substantially the electrode A_1. Instead of the cylindrical formation of the concentrating electrode Z, also other forms may be chosen which, for instance, may be in the shape of a planar electrode having a diaphragm.

The scheme of modulating the intensity of the cathode ray pencil by the potentials of such a Wehnelt cylinder as is known in the earlier art in the present instance may be used in such a way that it is brought to act upon the ray pencil issuing from the secondary electrode (cathode). In some cases the concentrator electrode Z may be entirely dispensed with by pencilling or focusing the electron ray pencil merely by the constrictive action of slight gas traces.

What is essential for the invention is that the arrangements are so chosen that a secondary cathode designated at A_1 is used to act as the source or starting point of the electron ray pencil rather than the emissive cathode K proper. In such a scheme the dimensions of the primary cathode K and of the secondary cathode A_1 are suitably so chosen that the diaphragm aperture of A_1 is situated at close proximity to the cathode K, while the other parts of electrode A_1 are at a greater distance from the heated cathode than the edge constituting the diaphragm, in a way as roughly shown by Fig. 2. The result is that nearly the entire emission current issuing from cathode K, owing to the accelerative effect of the potential of electrode A_1 across the diaphragm in A_1 enters into the free space where it is subjected to the concentrating action of the other factors, e. g., the potentials of the concentrator electrode Z and anode A_2 as well as the constrictive action produced by gas ions.

In choosing the values of the potentials of electrodes Z and A_2 and the through action of the plate potential of electrode A_2 upon the origin of the ray pencil, as will be understood, these will be different from what they are in the case of

an electrode construction known in the prior art. If the origin of the ray pencil is not the heated cathode, but rather the secondary cathode, it will be seen that the anode potential and the cylinder potential will be called upon to produce a concentrative action upon substantially faster electrons than is true in the case of arrangements used in the prior art. However, as a new merit of this arrangement it is discovered that even after operation during long periods, when the electrons of the heated cathode K are emitted from another point than initially the origin of the cathode ray pencil on the diaphragm A_1 will be unaltered.

The invention offers further advantages as regards the modulability of the pencil intensity. According to the invention, as before pointed out, it is feasible to control and regulate the intensity of the secondary ray pencil, for instance, by the alternating current potentials of the concentrating electrode (Wehnelt cylinder or other form of electrode) or else by direct current magnetic fields. However, in some instances, this embodiment involves demerits. Since according to the invention the pencil originates from the secondary cathode it will be seen that it is possible to dispense with the co-action of such concentrator or focusing elements as the Wehnelt cylinder in the modulation of the pencil. The emission of the secondary electrode is not subject to the thermal inertia of emissive cathodes. By appropriate circuit means it is possible to modulate the very emission of the secondary cathode at the rhythm or rate of the frequencies to be impressed upon the ray pencil. The simplest scheme of this kind is shown by way of example in Fig. 1, where the alternating current potentials are impressed upon the electrode A_1 acting as the secondary cathode, for the purpose of regulating the electron emission issuing from the diaphragm, whereas the concentrating electrodes Z and A_2 carry only direct current potentials. It will be understood that it is also feasible according to this invention to apply only alternating current potentials to the secondary cathode, or to apply the modulating potential in series with a direct current potential.

Occasionally this troublesome action may arise in an arrangement as just described, namely, that, while the emission of the secondary cathode may be regulated by the alternating current potential of A_1, also the velocity of the electrons at the origin of the ray pencil may fluctuate at the rhythm of the modulator frequency inasmuch as this alternating current potential exercises an accelerative action upon the electrons issuing from the secondary cathode diaphragm. In many cases these slight fluctuations of energy of the electrons will not occasion any troublesome effects. But if, for instance, the cathode ray pencil is to be operated only with very low potentials at A_2 (say, 100 v.), the energy content (volume) of the electrons varying at the rhythm of the secondary cathode potential may make itself felt, e. g., by a decrease in sharpness of the ray pencil.

Also, these difficulties can be overcome according to this invention by regulating the emission of the secondary cathode by electric or magnetic circuit means, and then it will be the volume of the electrons issuing from the diaphragm A_1 rather than the velocity thereof that is controlled, whereas the electrode acting as the real secondary cathode is operated only with a constant direct current potential.

An embodiment of this sort is illustrated by way of example in Fig. 3. In this scheme a grid G is interposed between the indirectly heated primary cathode K and the electrode A_1 acting as a secondary cathode and having a positive potential, the potentials of the said grid G being capable of controlling the volume of the electrons flowing to A_1 and across the diaphragm of A_1. The concentrating electrode is supposed to consist of a flat diaphragm electrode W. By choosing suitable dimensions for the grid G, the secondary cathode emission may be shifted in the range of negative grid potentials so that grid current need not necessarily become a source of trouble, if in addition to the alternating current potential the right bias is imparted to the grid. It is to be noted that there are also other practicable ways and means with a view to influence the emission of the secondary cathode A_1, for instance, by means of magnetic fields or by the control action of plate potentials as used, for example, in connection with the "plation".

As regards the utilization of such cathode ray pencils originating at a secondary cathode there exist the same chances as in the embodiments heretofore known in the art. After having passed through the anode diaphragm A_2, they may be deflected in any desired direction, for instance, by means of electric deflector plates or by magnetic elements, and may be employed as a safe and dependable operating element in a Braun tube for widely varying purposes in connection with measuring or television work.

Having now described our invention, what we claim and desire to secure by Letters Patent is the following:

1. An electron tube comprising an envelope containing at one end a fluorescent screen and at the opposite end an electron emitting cathode, a secondary cathode substantially surrounding the electron emitting cathode and adapted to produce an effective concentrated electron source, a concentrator electrode adapted to produce jointly with the secondary cathode a conical electrostatic field adapted to focus the electron beam at a predetermined point, a control grid interposed between the primary cathode and the secondary cathode to control in accordance with the potential thereof the concentration and dispersion of the generated electron beam, and an accelerator electrode to control the velocity of impact of the concentrated electron beam upon the electron tube fluorescent screen structure.

2. A cathode ray tube comprising a source of cathode rays, a secondary cathode adapted to produce the effect of a concentrated electron source, said secondary cathode substantially surrounding the primary cathode, a tubular concentrator electrode extending beyond the secondary cathode in the path of the electron stream issuing therefrom and adapted to produce jointly with the secondary cathode a conical electrostatic field serving to focus the generated electron pencil to a sharply defined point at a predetermined distance from the source, and an accelerator electrode interposed between the concentrator electrode and the focus point for controlling the velocity of the cathode ray pencil within the envelope.

FRITZ SCHRÖTER.
FRITZ MICHELSSEN.