Nov. 17, 1953 O. STERNBECK 2,659,814

CONNECTING DEVICE FOR ELECTRON TUBES

Filed June 2, 1950 3 Sheets-Sheet 1

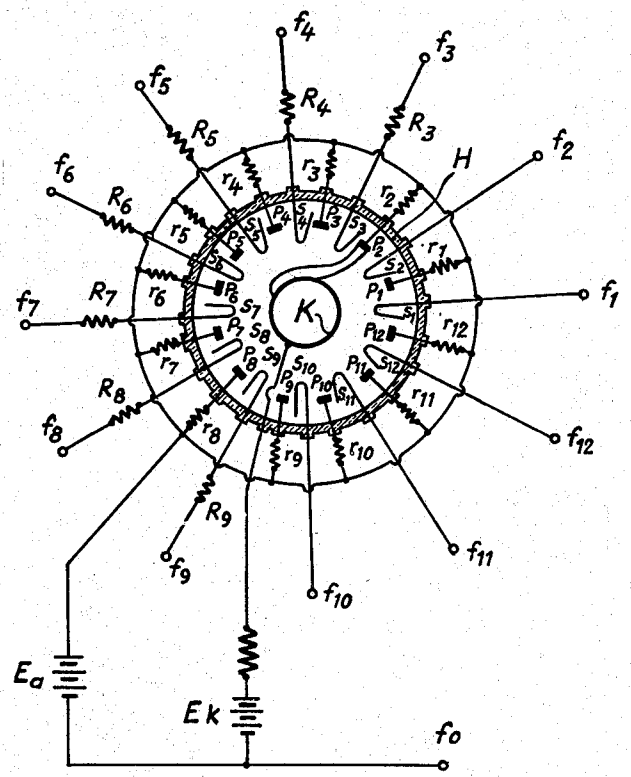


Fig. 1

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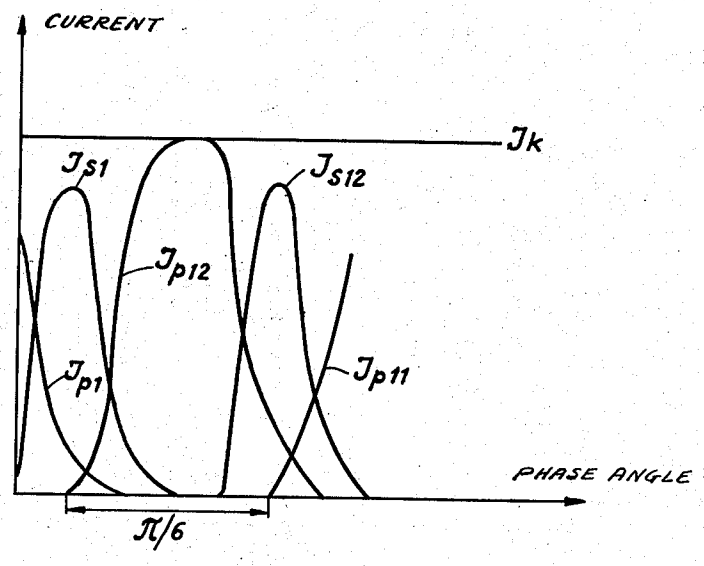


Fig. 2

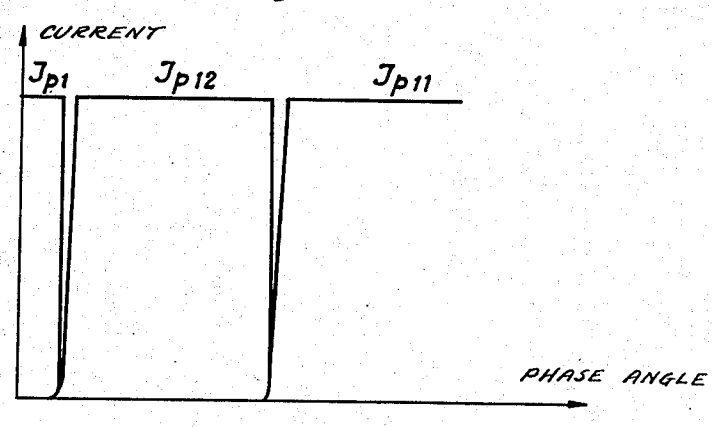


Fig. 3

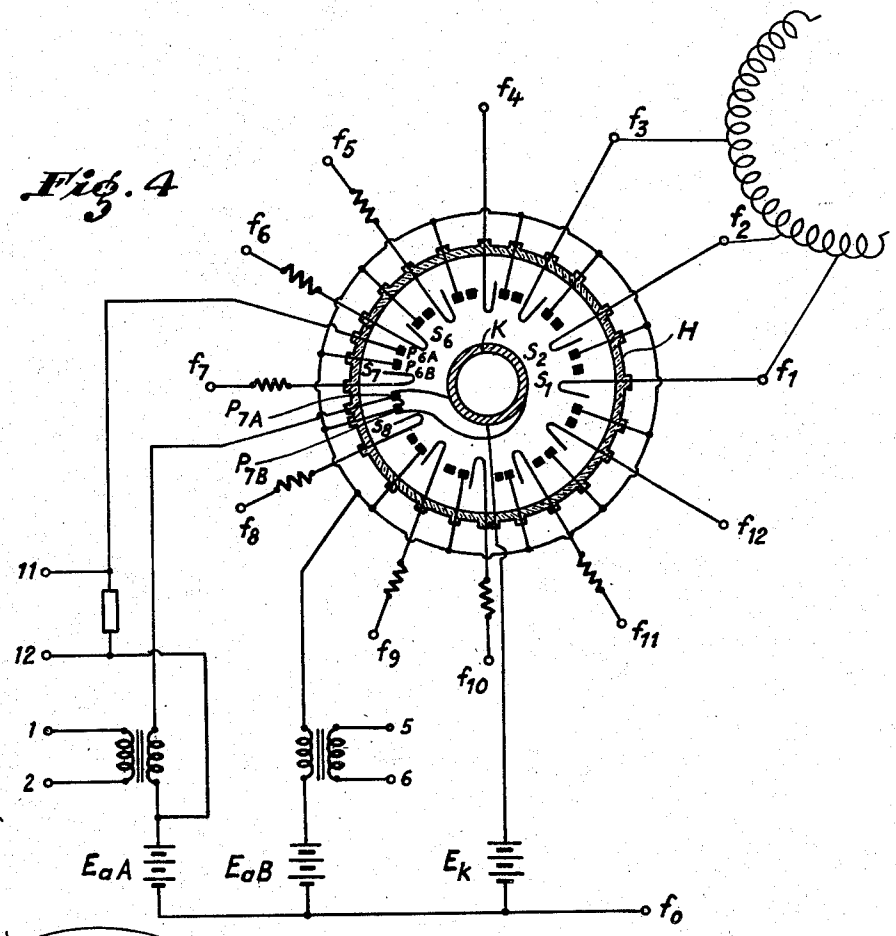
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Fig. 4



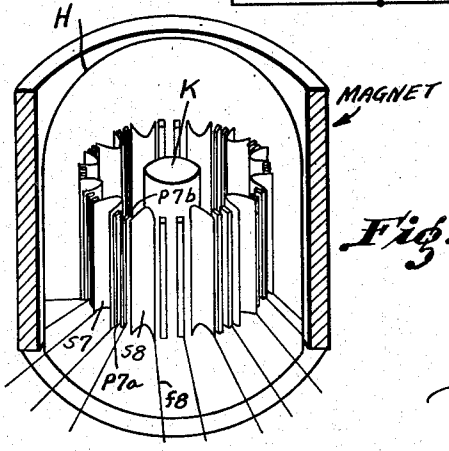


Fig. 5

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CONNECTING DEVICE FOR ELECTRON TUBES

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Application June 2, 1950, Serial No. 165,667

Claims priority, application Sweden June 21, 1949

1 Claim. (Cl. 250—27)

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This invention relates to connecting devices for electron tubes of the kind which is described in the copending application of N. E. G. Backmark, Serial No. 122,443, filed October 20, 1949, now Patent No. 2,591,997 dated April 8, 1952.

The electron tube utilized for the purpose of the invention includes, as appears from said patent, a discharge chamber penetrated by a magnetic field and containing a cathode arranged centrally among a plurality of electrodes situated in different directions around and out from the cathode, as seen in a plane perpendicular to the magnetic field. Said electrodes are by means of different connecting devices arranged to be given individual voltages different from those of the other electrodes.

If in such a tube the potential of one of the electrodes is reduced to zero, it turns out that current flow is initiated to the next preceding electrode, counting in the direction in which a tangential velocity is imparted to the electrons due to the magnetic field; Figs. 1 and 2 in said patent. It has been proved by practical experiments that this current substantially is derived from a limited part of the cathode which, counting in the above-mentioned direction, lies immediately behind that electrode which has zero potential. Electrons may thus not be emitted appreciably from the larger part of the cathode surface, due to influence from the space charge of the electron beam, but only from said limited part of this surface, and the size of the effective emitting surface will be dependent on the strength of the electric and magnetic fields.

After the electron beam has started from said limited cathode sector situated immediately behind that electrode which has been given a zero voltage, it passes then round the cathode and is deflected due to the curvature of the electric field in the vicinity of the zero voltage electrode and hits finally the next preceding positive electrode situated at an equal or a greater distance from the cathode; see Figs. 1 and 2 in the patent indicated above.

A disadvantage of electron tubes of this kind is the noise current arising which in many cases complicates an easily controllable function. This disturbing influence on the function of the tube arises from electrons which have received energies that differ from the sum of the potential energy corresponding to the electric field and the initial energy. These "disturbed" electrons, which have received or delivered energy to the surroundings, will also give rise to a dispersion of the electron beam, which in many cases is extremely unsuitable from a functional point of view.

Said noise increases with the path length which

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the electrons have to travel and is also dependent on the current density of the electron beam and limits the maximum current that may be allowed to flow in a tube of this kind.

This invention has for its object to remove these and other difficulties arising, in such electron tubes, said difficulties limiting the current which may be utilized in practice for different connecting functions. According to the invention an increase of the maximum current is obtained by shortening the path of the electrons from the cathode to the electrode to which the current is desired.

In a device according to the patent cited above one can thus let some of the radially arranged electrodes normally be at a negative potential or zero potential, whilst the remaining electrodes are given a positive potential in relation to the cathode. Thus the said emitting cathode sector will be closer to the active electrodes to which the current is desired, and a considerable shortening of the path of the electrons is obtained and also a considerable increase in the current which can be utilized in the tube.

In an embodiment of the device according to the invention the different electrodes surrounding the cathode are connected to alternating voltages of the same frequency, which are mutually phase-displaced between an electric angle corresponding to the geometric angle between electrodes of this kind arranged adjacent each other within the tube.

A similar application of phase voltage operation is already known, but the tube referred to in this connection differs as to its structure very much from the one utilized for the invention, and has also a considerably smaller focussing of the electron beam than what is obtained according to this invention.

The invention will be described in the following in connection with the embodiments of the same shown in the annexed drawing. Fig. 1 in the drawing shows a section of an electron tube according to the invention containing a number of control electrodes and receiving electrodes. Fig. 2 shows the current to certain spades and plates as a function of the phase position of a polyphase voltage connected to the spades. Fig. 3 shows current characteristics for a number of plates, whereby the current to these electrodes is by means of certain connecting elements held at a rather high and constant value during an interval of time which is considerably greater than in the case shown in Fig. 2. Fig. 4 finally shows another embodiment of the electron tube according to the invention, and Fig. 5 is a broken-away perspective view thereof.

In the embodiment according to Fig. 1 the elec-

tron tube, the envelope of which is indicated by H, contains a cathode K situated centrally in the tube and also a number of electrodes arranged round the same, including twelve plates P_1—P_{12} and spades S_1—S_{12} arranged between these plates and situated closer to the cathode. All these plates are, by means of leads through the envelope of the tube and through resistances r_1—r_{12} connected with the same voltage source E_a which is positive in relation to the cathode. To the spades S_1—S_{12} alternating voltages of the same frequency are supplied, but with a phase displacement of $\pi/6$ radians, each individually through resistances or impedances R_3 etc. or directly at the points f_1—f_{12}. The zero point f_0 for this polyphase system is connected to the cathode voltage source E_k. Under influence of this polphase voltage a continuously varying voltage distribution is obtained round the cathode, so that half the electrodes S_1—S_{12} get potentials $0-\!-V_0$ and the remaining ones the potentials $0-\!+V_0$, if V_0 indicates the maximum value of the supplied phase voltage. A comparison between Fig. 1 of the annexed drawing and the figures of said patent shows that a rather short electron path is obtained in the device according to this invention; in the figure this is indicated with dotted lines. The electron beam is accelerated by the electrodes of the positive sector in the tube, whilst the electrodes of the negative sector remain passive in this respect.

In Fig. 2 of the drawing the progress of the current to different electrodes during a part of a period of phase revolution is shown. As appears from the figure the current I_{P12} to the plate P_{12} equals the cathode current indicated by I_k during a part of the period comprising $\pi/6$ radians. In the figure the currents I_{S1} and I_{S12} to the spades S_1 and S_{12} surrounding this plate are also indicated.

By connecting for instance resistances R_3 etc. in Fig. 1 to the connections for the spades a form of positively acting stepping may be obtained. The electron beam may thereby give a maximum and comparatively constant current to the plates during a rather long period of time, whereafter an instantaneous stepping over to the next plate takes place as appears from Fig. 3, where curves of the current as a function of the phase position are shown. It appears from the figure that the currents I_{P12} etc. have their relatively constant maximum value during the greatest part of the period comprising $\pi/6$ radians, i. e. that practically the whole cathode current during this period flows to the intended electrode and that during the next period comprising $\pi/6$ radians it will be completely and instantaneously transferred to the next following plate.

In the embodiment of the invention shown in Figs. 4 and 5 each plate is divided into two completely separated parts, for instance the plates P_{6A}, P_{6B} and P_{7A}, P_{7B}. Of these the plates indicated with B are interconected by the battery E_{aB}. The plates with index A are each provided with their individual connections. The electron beam will when directed into a box, for instance the one situated between the spades S_7 and S_8, be branched into two parts one for each of the plates P_{7A} and P_{7B} situated in this box and the relation between the currents to these two electrodes is determined by the respective potentials of the same. The total current is hardly influenced by the voltages of the plates and a voltage increase of the plate P_{7B} will for instance result in an increase of the current to the same

plate and a corresponding decrease of the current to the plate P_{7A}. In this manner a signal may evidently be sent for instance from the terminals 1, 2 of the transformer pertaining to the plate P_{7A} to the terminals 5, 6 of the common transformer for all the plates indicated by B, or else in the opposite direction. This may however be performed only during the time when the electron beam touches the plates P_{7A} and P_{7B}. The transformers shown in the drawing may be replaced by other elements, for instance as is shown at the terminals 11, 12. The spades of the device according to Fig. 4 are as in Fig. 1 connected to a polyphase voltage at the points f_1—f_{12} with or without interconnection of resistance elements. The cathode voltage is obtained from the battery E_k, which like the other batteries E_{aA} and E_{aB} is connected to the zero point f_0 of the polyphase system.

An electron tube device according to the invention may advantageously be used for applications within the fields of multiplex telephony and multiplex telegraphy, for exploring connecting means and circuits and for producing multiple frequencies. The rotating electron beam may also be phase modulated by variation of the potential of the cathode or, if a control grid is used, be amplitude modulated. Modulation may also be produced by super-position of modulation voltages on the spades and the plates.

The invention is not limited to the embodiments described above as it is obvious that different modifications of the same will fall within the scope of the same. It is for instance evident that it may be directly applicable to tubes having only one kind of electrodes surrounding the cathode, as are shown in Fig. 1 of the above-mentioned application.

I claim:

Connecting device comprising an electron tube having an envelope within which are a number of radially mounted control electrodes, a cylindrical cathode for producing a ribbon shaped electron stream, said cathode being mounted centrally among said control electrodes, and a greater number of radially mounted receiving electrodes located in the compartments formed between adjacent control electrodes and mounted at a greater distance from the cathode surface than those parts of the control electrodes which lie nearest to said surface, means outside said envelope for producing a constant magnetic field penetrating the discharge space of said tube and the field lines of which are parallel to the axis of said cathode, means connecting one of the receiving electrodes in each of said compartments to a common positive voltage, means connecting the remaining receiving electrodes to positive voltages, and a polyphase alternating current source having each phase connected to one of said control electrodes for the purpose of directing said electron stream in sequence to said receiving electrodes.

OLAF STERNBECK.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,555,677	Leblanc	Sept. 29, 1925
1,585,173	Simpson	May 18, 1926
2,217,774	Skellett	Oct. 15, 1940
2,432,608	Besch et al.	Dec. 16, 1947
2,591,997	Backmark	Apr. 8, 1952