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ELECTRONIC SWITCHING DEVICE FOR CONTROLLING SIGNAL TRANSMISSION PATHS

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Fig.1

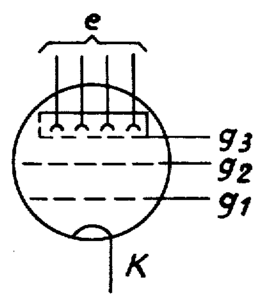

Fig.2

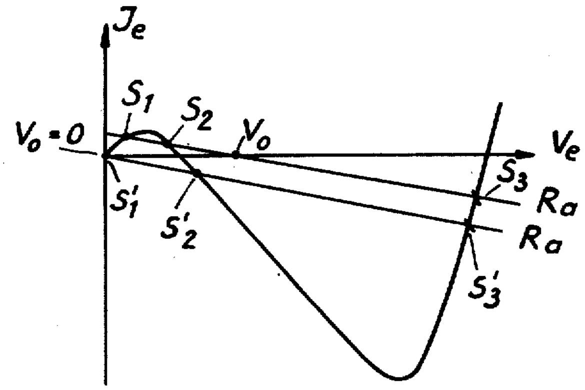

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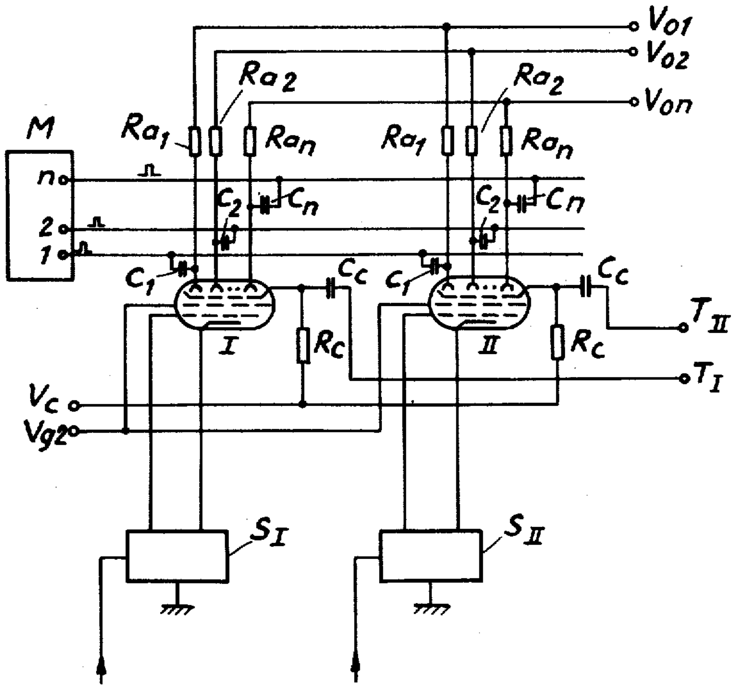
Fig. 3



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ELECTRONIC SWITCHING DEVICE FOR CONTROLLING SIGNAL TRANSMISSION PATHS

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3 Claims. (Cl. 250—27)

The following invention relates to a device for establishing and independently maintaining one or more signal transmission paths in a wholly electronic manner. These signal transmission paths may be arranged between a number (n) of inputs and a number (m) of outputs, and it is possible to connect each input to one or more outputs and respectively each output to one or more inputs. The electronic means used according to this invention are: a high vacuum tube comprising at least one electron emitting cathode, means for controlling the current emitted from the cathode, a number of dynodes functioning as storing elements which, connected in circuits with suitable external impedances, can have two different stable potentials owing to their negative current voltage characteristic within a certain voltage range, and one or more collector electrodes for collecting the primary current and the secondary electron currents. In such tubes all the storing dynodes are electrically accessible directly from outside the tube shell. According to the invention each output is formed by the collector circuit of a single tube, but each input is formed by one or more storing dynodes in all the tubes used in the connection, and there are means to shift the dynode pertaining to the input of the tube pertaining to an output by a D. C. manipulation to the highest of the two stable potentials, lying near the collector potential or, as the saying is, in "locked position," said dynode being kept at said potential owing to the secondary emission, the dynode being thereby electronically connected to the collector.

The invention will be more clearly described below in connection with the accompanying drawings, in which:

Fig. 1 schematically shows a storing tube of the kind to which the invention may be applied,

Fig. 2 shows the current voltage characteristic for a storing dynode in the tube shown in Fig. 1,

Fig. 3 shows a switching device according to the invention.

To begin with the operation of the tubes used in connection with the invention will be explained shortly in connection with Figs. 1 and 2. Such a storing tube comprises a filament cathode (k) as source of electrons, a control grid ($g1$) usually operating within the negative range, a positive acceleration grid ($g2$), a collector electrode ($g3$) and a number of storing dynodes (e). The electron current emitted by the cathode k and controlled by the control grid $g1$ is accelerated by the acceleration grid $g2$ and flows partly directly to the collector electrode $g3$ and partly to the storing dynodes e. So long as these dynodes are fed with cathode potential, the electrons cannot reach them, but as soon as a dynode is fed with positive potential an electron current flows to it, said electron current increasing, to begin with, with increasing potential. Owing to the starting secondary emission said current does not increase linearly with the voltage, but reaches a maximum and thereafter decreases. At a certain given voltage when the secondary emission factor of the dynode is 1, the current becomes 0 again and has negative values above said voltage. After having, at further increased voltage, passed a minimum, it rises again and passes through 0 at a voltage corresponding to the collector voltage.

Fig. 2 shows the current voltage characteristic for such a storing dynode, which has a negative slope within a certain range. If a positive voltage V_0 is fed to the storing dynode over a sufficiently great resistance Ra, said voltage being so high, that the line of resistance for Ra crosses the dynode characteristic at three points, i. e. S_1, S_2 nd S_3, it is obvious that, due to the known stability conditions, only the points S_1 and S_3 are stable, whereas point S_2 has an unstable state of equilibrium. In such an arrangement a dynode can thus only have two different determined stable potential values, either a high value corresponding to the cross point S_3 near the collector potential, or a low value corresponding to S_1 near the cathode potential.

The two stable points S_1 and S_3 differ from each other fundamentally. At point S_1 the internal resistance of the dynodes with respect to the collector is very high and the result is, that a modulation of the collector voltage cannot influence the dynodes. At point S_3, however, the internal resistance of the dynodes with respect to the collector is small and therefore the dynode can follow the modulation of the collector and emit an output voltage. On the other hand, A. C. signals can be fed to the dynodes, and said signals appear or do not appear at the output of the collector circuit, depending on whether the D. C. potential of the dynode in question is on collector potential (is "locked"), thus being electronically connected to the collector, or wherether the dynode has cathode potential (is "unlocked"), thus being electronically disconnected from the collector.

Thus the switching function consists in the respective dynode in the respective tube being shifted to one of the two stable potentials. Said switching function can take place in any of the known manners.

For the disconnecting process, at which the dynodes are shifted to the low stable potential or "unlocked," it is sufficient to choose the voltage V_0 applied to the dynode over the resistance Ra so that it lies below the given value S_2 of the unstable state of equilibrium, i. e. in this case below the value of the first 0-passage of the storing dynode characteristic, for example $V_0=0$, and simultaneously to cut off the current flow for a short while. The potential of the dynodes thereby also shifts to the value $V_0=0$ and is, after the current flow is reestablished, restored to a low stable value S_1', corresponding to S_1.

In a connecting process in which the respective dynodes are thus shifted to the high stable potential or "locked," it is in principle possible to proceed in the same manner. It should however be observed, that in this case the voltage V_0 externally applied to the dynodes over the resistance Ra is chosen greater in comparison with the voltage value of the first 0-passage of the dynode characteristic. Quite generally expressed, the chosen dynodes of all the tubes are applied either of two different voltages. It is then achieved by means of a local current manipulation in one of the used tubes, that the switching information gathered from the applied D. C. values are stored only in said tube.

A switching device according to the invention is shown in Fig. 3. In that example two tubes have been chosen and thereby two outputs designated by T_I and T_{II}, and a number n of inputs corresponding to the number of dynodes in each tube. Pulse trains are used as signal voltages, said trains being received from a multiplex system M and having the same shape but being displaced with regard to time. Said pulse trains are applied to the dynodes 1–n of both tubes over the condensers C_1–C_n. The D. C. supply to the dynodes is fed through the common sources of direct current V_{o1}, V_{o2} . . . V_{on} over the separate resistances Ra_1, Ra_2 . . . Ra_n. The storing and erasing of the switching information takes place with the help of a control means S pertaining to the respective tube, which means has been drawn schematically in the connection and in the present case exerts its influence on the control grid and the cathode. The collector output circuit in each tube consists of the external resistance Rc of the collector and the condenser Cc, over which the output voltage reaches the outputs T_I and T_{II}, respectively. At such an output a pulse train will appear in the shown connecting device, the phase position of said train corresponding to the number of the dynode, which is "locked" in the tube. If several of the dynodes in the tube are "locked," a pulse train appears at the output composed of the sum of the pulse trains appearing at the "locked" dynodes. Thus it is possible, with the help of such a circuit, to select one or more pulse positions in a time-separated multi-channel transmission system, whereby channel branching can easily be effected and controlled in such systems.

The circuit is however not limited to the use of pulses as input signals. Tone frequencies having the same or different frequencies and the same or different phase positions may also be used. The output signal is always a signal or the sum of several signals, depending on which dynode or dynodes in the corresponding tube are "locked" and thus electronically connected to the collector circuit (output circuit).

We claim:

1. An electronic switching device for establishing and maintaining several simultaneous transmission paths between a group of incoming lines and at least one outgoing line, said device comprising an electron tube including a thermionic cathode continuously emitting electrons during operation of the device, a control electrode for con-

trolling the electron current emitted by said cathode, an electron accelerating electrode, several secondary electrons emitting storage electrodes, each of said secondary electrons emitting electrodes having a high and a low stable potential state and each being directly and separately conductively accessible from the outside of the tube, a common collector electrode for collecting the electrons emitted by said cathode and said secondary electrons emitting electrodes, each incoming line being connected to a secondary electrons emitting electrode and the outgoing line being connected to the collector electrode, and circuit control means for selectively locking a selected combustion of said secondary electrons emitting electrodes simultaneously in the high stable potential state thereby electronically connecting each incoming line associated with a locked electrode in said selected combination to the outgoing line and locking the other secondary electrons emitting electrodes in the low stable potential state thereby electronically disconnecting the incoming lines connected to said latter electrodes from the outgoing line.

2. A device according to claim 1, wherein secondary electrons emitting electrodes are locked in said high stable potential state by applying thereto the same operational potential as to the collector electrode and are locked in said low stable potential state by applying thereto the same operational potential as the operational potential of the cathode.

3. A device according to claim 1, wherein said collector electrode is connected to an output circuit including resistance means and capacitance means.

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