

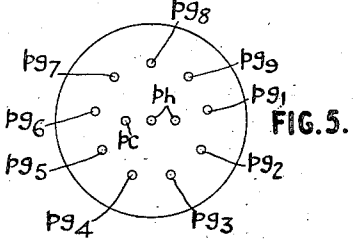
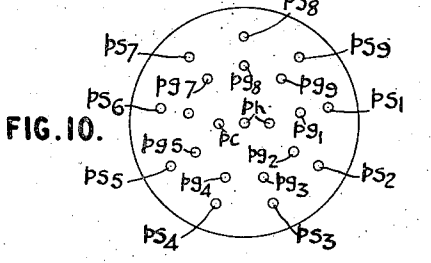
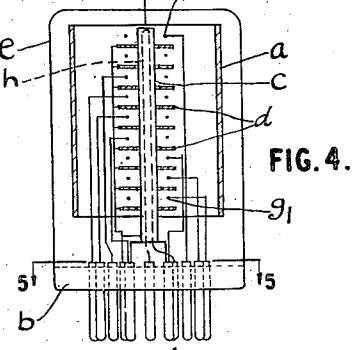
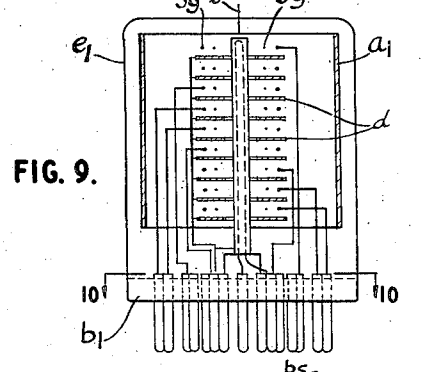
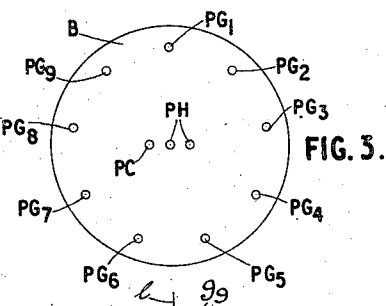
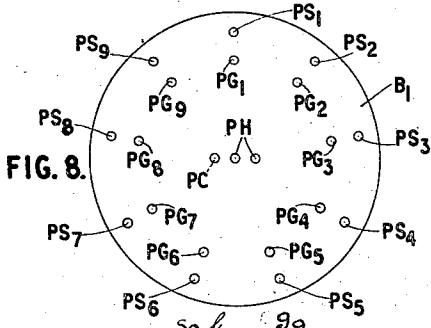
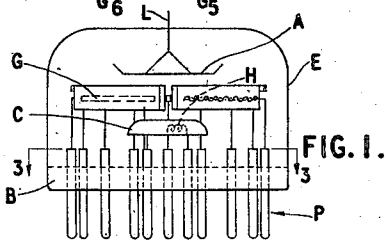
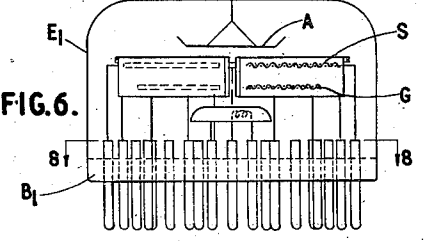
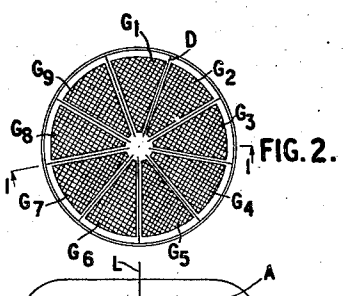
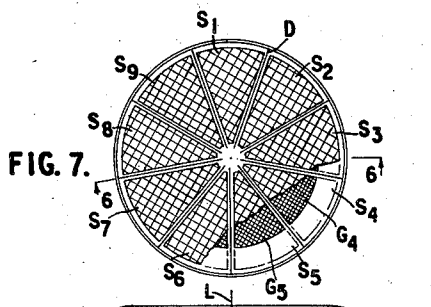
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2,399,429

ELECTRON DISCHARGE DEVICE

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2,399,429

ELECTRON DISCHARGE DEVICE

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12 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices, and more especially to such devices having multi-control electrodes by which the mixing of a number of waveforms can be effected, such as is necessary in multi-channel telephone systems. The invention has for its object to provide an improved device which is especially useful for mixing waveforms but which may also have other applications in the electric and communications arts.

An electron discharge device embodying the present invention has an electron source or cathode spaced from an output electrode or anode, the cathode and anode being common to a group of similar control electrodes or grids which are disposed in close proximity to the common anode in the space between the cathode and anode so that each grid is spaced the same distance as the others from the cathode and anode, and screening electrodes being disposed partition-wise between the grids so as to screen each grid from the others. These screens may be grounded or connected to a low potential when the device is in operation. In such a device when in operation, a fraction of the electron stream from the cathode is controlled by each grid, each of which may have one of the signals to be mixed applied thereto. The inter-grid screens are provided to reduce grid interaction (the so-called Miller effect) to negligible proportions. Control of the proportion appearing at the anode of each input signal may be effected by controlling the bias of each of the grids, or for this purpose further control electrodes may be included in the device.

Various constructional forms of the invention are possible, and by way of example in the accompanying diagrammatic drawing

Fig. 1 is a view in elevation of one form of electron discharge device constructed in accordance with the invention, with the multi-control electrode assembly depicted as a section taken on the line 1—1 of Fig. 2;

Fig. 2 is a plan view of the multi-control electrode assembly;

Fig. 3 is a plan view taken on line 3—3 of Fig. 1 showing the layout of the lead-in pins in the base of the device;

Fig. 4 is a view in elevation of another embodiment of the invention;

Fig. 5 is a plan view taken on line 5—5 of Fig. 4 showing the layout of the lead-in pins in the base of the device of Fig. 4;

Figs. 6, 7 and 8 are views corresponding respectively to Figs. 1, 2 and 3 showing the device

of Figs. 1 to 3 modified by the inclusion of additional control electrodes; and

Figs. 9 and 10 are views corresponding respectively to Figs. 4 and 5 showing a similar modification applied to the device of Figs. 4 and 5.

In the drawing like parts are denoted by the same reference characters in the different views and relationship between corresponding parts in the different embodiments is denoted by the use of capital and small letters of reference for corresponding parts.

Referring to Figs. 1 to 3, an electron discharge device according to the invention is depicted having a plane-parallel arrangement of electrodes, in which a substantially flat electron emitter or cathode C of the equipotential type provided with an internal heating element H is mounted horizontally in the evacuated glass envelope E of the device and parallel with the base B. Spaced above the cathode C and in parallel relation thereto is a group (designated by G in Fig. 1) of similar control electrodes or grids $G_1 \dots G_9$, disposed side by side in a circle of which the individual grids constitute sectors separated from one another by narrow gaps to as to be insulated from one another. In the radial gaps between adjacent sectorial grids are disposed partitioning screens D which may be imperforate and may be made of metal sheet or strip. The screens D are shown disposed in vertical planes perpendicular to the plane of the sectorial grid array and extending sufficiently above and below that plane to ensure effective screening of the grids from one another. In operation, the screens D may be grounded or connected to chassis or to a low potential and, therefore, may be conductively connected together within the device, for instance by an encircling metal band or ring secured to their outer extremities to form a wheel-like structure as shown, whereby the screens D may be all connected to the same potential by a single conductor leading from the screen structure. On the side remote from the cathode of the grid array G and in close proximity to the latter is mounted in parallelism therewith a substantially flat common anode A.

The device is shown constructed with a moulded glass base B having sealed through it stiff lead-in pins, generally indicated by P, upon which the cathode, grid and screen structures are supported by stiff wire leads welded to the electrodes and pins. The grids $G_1 \dots G_9$ are respectively connected to pins $PG_1 \dots PG_9$ in a circular array near the periphery of the base B, as shown

in Fig. 3. The cathode C and its heater H are respectively connected to pins PC and PH in the centre of the base B. The screen structure D may be connected to the cathode pin PC (as indicated in Fig. 1) or to one of the heater pins PH. After inserting the electrode assembly mounted on the base B into the envelope E, the latter is sealed to the glass base. The anode A is separately supported by a stiff lead L which is taken out through the top of the envelope E.

Instead of a plane-parallel electrode arrangement, a coaxial electrode arrangement as depicted in the embodiment of Figs. 4 and 5 may be employed. The electrode structure in this case includes a central cylindrical cathode *c* arranged vertically within the evacuated envelope *e* of the device, the cathode depicted being of the equipotential type provided with an internal heater *h*. Coaxially surrounding the cathode *c* is a group of similar control electrodes $g_1 \dots g_n$ constituted by separate rings or short spiral sections superposed in a column and equally spaced apart along the length of the cathode *c*. These control electrodes may be made of wire or formed from metal sheet or strip. Interposed between the electrodes $g_1 \dots g_n$ are annular or disc-like partitioning screens *d* which may be made from metal sheet or strip. Surrounding the column of electrodes $g_1 \dots g_n$ and coaxial therewith and with the cathode *c* is the common anode *a* in the form of a sheet metal cylinder.

As in the case of the embodiment of Fig. 1, the device of Fig. 4 is shown constructed with a moulded glass base *b* having a circular array of lead-in pins $pg_1 \dots pg_n$ sealed therethrough which are connected respectively to the electrodes $g_1 \dots g_n$. Also, the cathode *c* and its heater *h* are respectively connected to lead-in pins *pc* and *ph* sealed through in the centre of the base *b*, and likewise the screens *d* are connected together and to either the pin *pc* or one of the pins *ph*. The anode lead *l* is again taken out through the top of the envelope *e* of the device.

The described devices operate as waveform mixers by connecting each of the channels to be mixed between the cathode and individual mixing electrodes $G_1 \dots G_n$ or $g_1 \dots g_n$. The presence of a potential on any electrode of the group causes the electron stream between cathode and anode to be modulated in the vicinity of that mixing electrode. This control is limited, since only a fraction of the electron stream is affected by each mixer, but this is of no great significance in a device designed specially for mixing. The device according to this invention may be used in any apparatus where it is desired to mix two or more signals, and the proportion of each input signal appearing at the anode may be controlled by controlling the biasing potential of each of the mixing electrodes. Such control of the mixing may be effected in another way by means of further control electrodes included in the device especially for this purpose. For instance, Figs. 6 to 8 illustrate the application of this modification to the device of Figs. 1 to 3 by the introduction of a second group (indicated by S in Fig. 6) of similar control grids $S_1 \dots S_n$ which are associated respectively with the mixing grids $G_1 \dots G_n$. In order to accommodate the additional electrode group S and additional lead-in pins required, the envelope *E* and base *B*₁ are made somewhat larger than their counterparts in the device of Fig. 1. The further control grids $S_1 \dots S_n$ are, like grids

$G_1 \dots G_n$, of sectorial form and are disposed each immediately above and opposite the corresponding one of the mixing grids. The screens D screen not only the grids of the set G but also those of the set S from one another. The moulded base *B*₁ of the device is provided with an additional circular array of lead-in pins $PS_1 \dots PS_n$ connected respectively to the electrodes $S_1 \dots S_n$.

In a corresponding manner, as depicted in Figs. 9 and 10, the device of Figs. 4 and 5 may be provided with a second group of control electrodes $s_1 \dots s_n$ of similar construction to the mixing electrodes $g_1 \dots g_n$ and positioned between the latter and the cylindrical anode *a* so that they coaxially surround and lie opposite the mixing electrodes $g_1 \dots g_n$ respectively. The base *b*₁ of the device is provided with an additional circular array of lead-in pins $ps_1 \dots ps_n$ connected respectively to the electrodes $s_1 \dots s_n$.

The number of mixing electrodes which may be mounted in a single envelope is, of course, restricted by mechanical considerations, but up to ten mixing electrodes with separating screens and further control electrodes may be mounted in a single envelope without undue constructional difficulties arising.

Although specific embodiments have been described, various constructional modifications may be made therein and other constructional forms devised within the scope of the invention as defined by the appended claims. For instance, in a further modification of the specific embodiments described and illustrated in the drawings, the screens D or *d*, as the case may be, are not connected together within the device as has been described and shown, but are left insulated from one another and are respectively connected to a separate set of lead-in pins or conductors additionally provided for the purpose, so that the screens can be individually connected to suitable potentials and separately controlled. Thus, in the case of the devices of Figs. 1 and 6, this modification means that the encircling band connecting screens D together would be omitted and replaced by leads to the individual screens brought out of the envelope separately, through additional pins in the base or through the envelope elsewhere.

I claim:

1. In an electron discharge device, an electron emitting cathode, a group of similar control electrodes, a cooperating anode common to said group of control electrodes, said anode being spaced from said cathode and located to receive the electron stream emitted by said cathode, said group of control electrodes being disposed in the space between said cathode and anode and spaced from one another and similarly located with respect to said cathode for each, independently of the others, to modulate a fraction of the total electron stream received by said common anode from said cathode, and screening electrodes disposed partition-wise in the spaces between said control electrodes to form compartments in which said control electrodes are respectively situated, to screen each of said control electrodes from the others.

2. In an electron discharge device, a cathode and a cooperating anode spaced therefrom, a group of similar control electrodes, to which said cathode and anode are common, disposed in the space between said cathode and anode so that each of said control electrodes is spaced the same distance as the others from said cathode and

anode, screening electrodes disposed partition-wise between said control electrodes so as to screen each of them from the others, and a second group of control electrodes disposed in the space between said first group and said anode with the electrodes of said second group opposite those of said first group respectively.

3. In an electron discharge device, a substantially flat cathode spaced from a substantially flat cooperating anode parallel therewith, a group of similar sectorial control electrodes, to which said cathode and anode are common, disposed in a plane-parallel with said cathode and anode in the space between said cathode and anode, said control electrodes being positioned side by side in a circular array and separated by radial gaps, and screen electrodes disposed partition-wise in said gaps between said control electrodes so as to screen each of them from the others.

4. In an electron discharge device, a substantially flat cathode spaced from a substantially flat cooperating anode parallel therewith, a group of similar sectorial control electrodes, to which said cathode and anode are common, disposed in a plane-parallel with said cathode and anode in the space between said cathode and anode, said control electrodes being positioned side by side in circular array and separated by radial gaps, screen electrodes disposed partition-wise in said gaps between said control electrodes so as to screen each of them from the others, and a second group of similar sectorial control electrodes disposed in a plane parallel with the first group and in the space between said first group and said anode with the sectors of the two groups opposite each other respectively.

5. In an electron discharge device, a central elongated electron emitting cathode, a group of similar annular control electrodes coaxially surrounding said cathode and spaced apart along its length for each, independently of the others, to modulate a fraction of the electron stream emitted by said cathode, a cooperating anode common to said group of control electrodes surrounding said group and extending coaxially to said cathode to receive the electron stream therefrom, and annular screening electrodes coaxially surrounding said cathode and disposed partitionwise in the spaces between said control electrodes to form compartments in which said control electrodes are respectively situated, to screen each of said control electrodes from the others.

6. In an electron discharge device a central elongated cathode, a cooperating anode coaxially surrounding and spaced from said cathode, a group of similar annular control electrodes, to

which said cathode and anode are common, coaxially surrounding said cathode and spaced apart along the length thereof, annular screen electrodes coaxially surrounding said cathode and disposed in the spaces between said control electrodes so as to screen each of them from the others, and a second group of similar annular control electrodes disposed in the space between said first group and said anode with the electrodes of the second group coaxially surrounding and lying opposite the electrodes of the first group respectively.

7. An electron discharge device as defined in claim 1, in which said anode is supported by a conductor sealed through one end of the envelope of the device, the remaining specified electrodes of the device all being assembled on and supported by a member sealed to the other end of the envelope and constituting a closure therefor.

8. An electron discharge device as defined in claim 2, in which said anode is supported by a conductor sealed through one end of the envelope of the device, the remaining specified electrodes of the device all being assembled on and supported by a member sealed to the other end of the envelope and constituting a closure therefor.

9. An electron discharge device as defined in claim 3, in which said anode is supported by a conductor sealed through one end of the envelope of the device, the remaining specified electrodes of the device all being assembled on and supported by a member sealed to the other end of the envelope and constituting a closure therefor.

10. An electron discharge device as defined in claim 4, in which said anode is supported by a conductor sealed through one end of the envelope of the device, the remaining specified electrodes of the device all being assembled on and supported by a member sealed to the other end of the envelope and constituting a closure therefor.

11. An electron discharge device as defined in claim 5, in which said anode is supported by a conductor sealed through one end of the envelope of the device, the remaining specified electrodes of the device all being assembled on and supported by a member sealed to the other end of the envelope and constituting a closure therefor.

12. An electron discharge device as defined in claim 6, in which said anode is supported by a conductor sealed through one end of the envelope of the device, the remaining specified electrodes of the device all being assembled on and supported by a member sealed to the other end of the envelope and constituting a closure therefor.

BADEN J. EDWARDS.