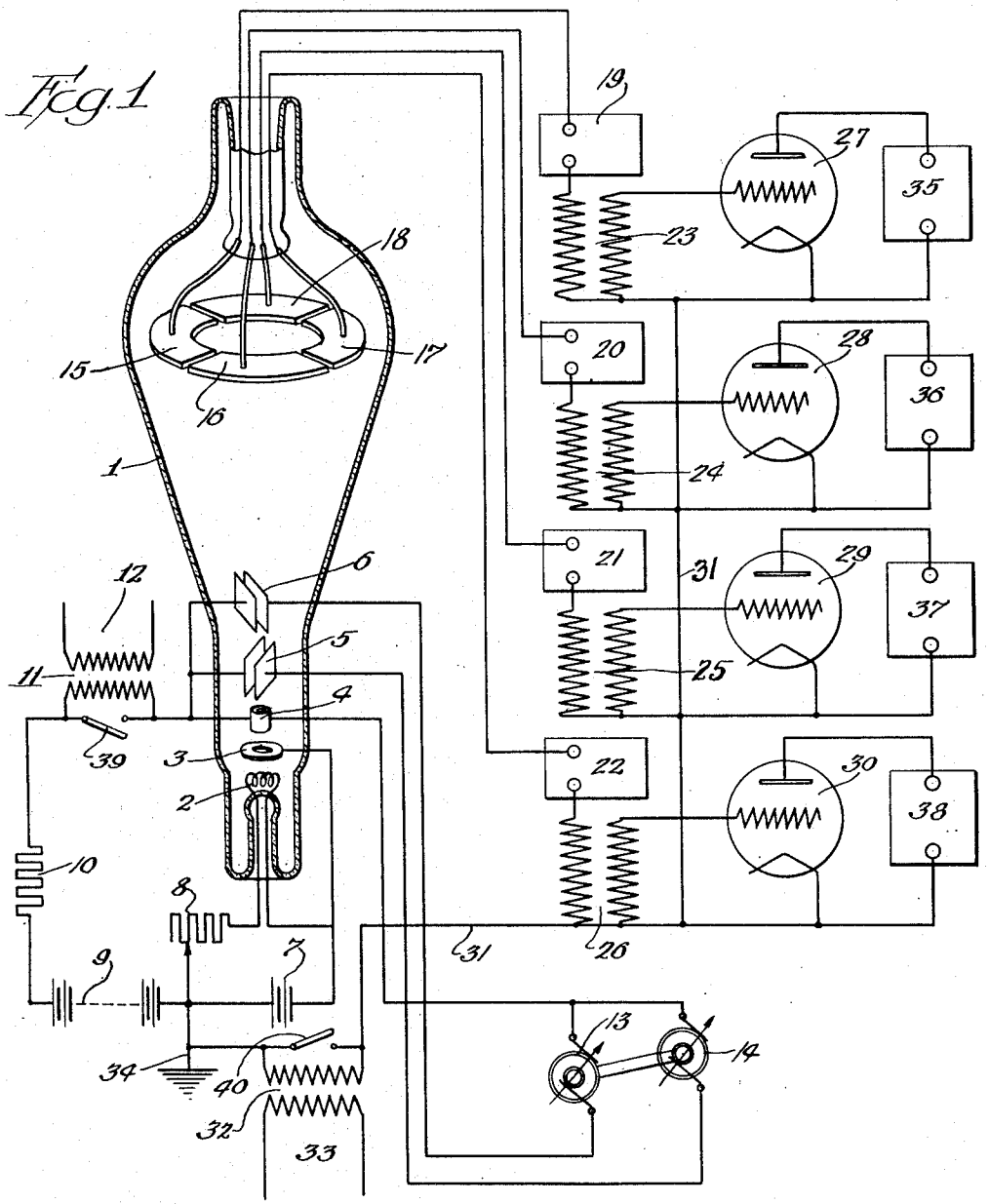
Oct. 16, 1934. M. MORRISON 1,977,398

HIGH FREQUENCY CIRCUIT SELECTOR

Filed May 31, 1930 3 Sheets-Sheet 1

Fig. 1



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HIGH FREQUENCY CIRCUIT SELECTOR

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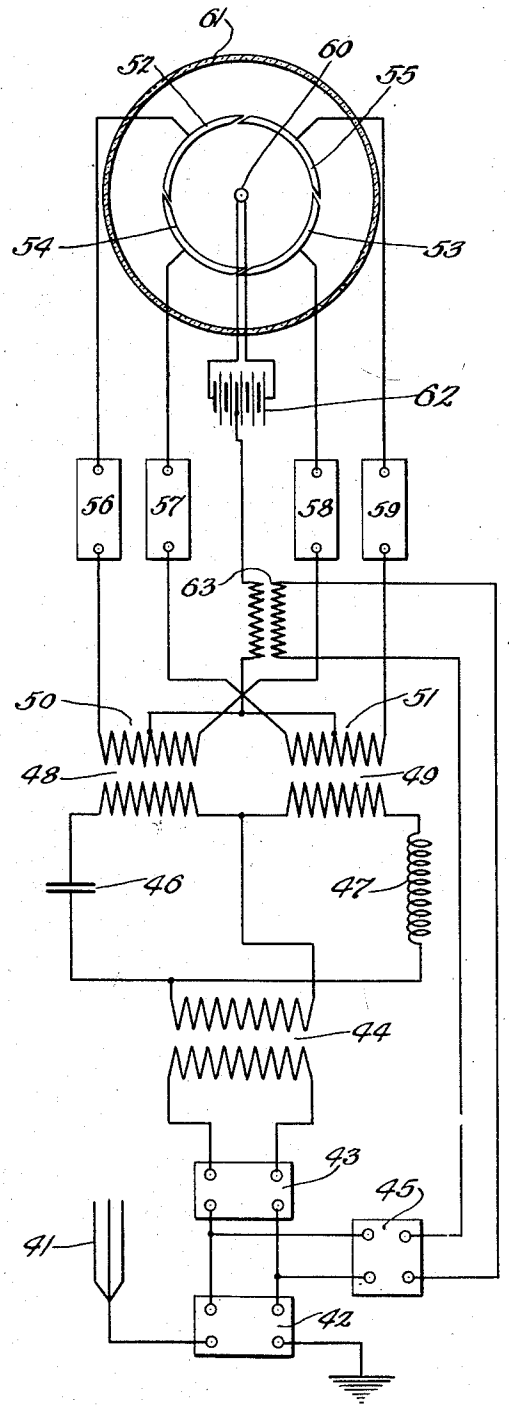


Fig. 2

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HIGH FREQUENCY CIRCUIT SELECTOR

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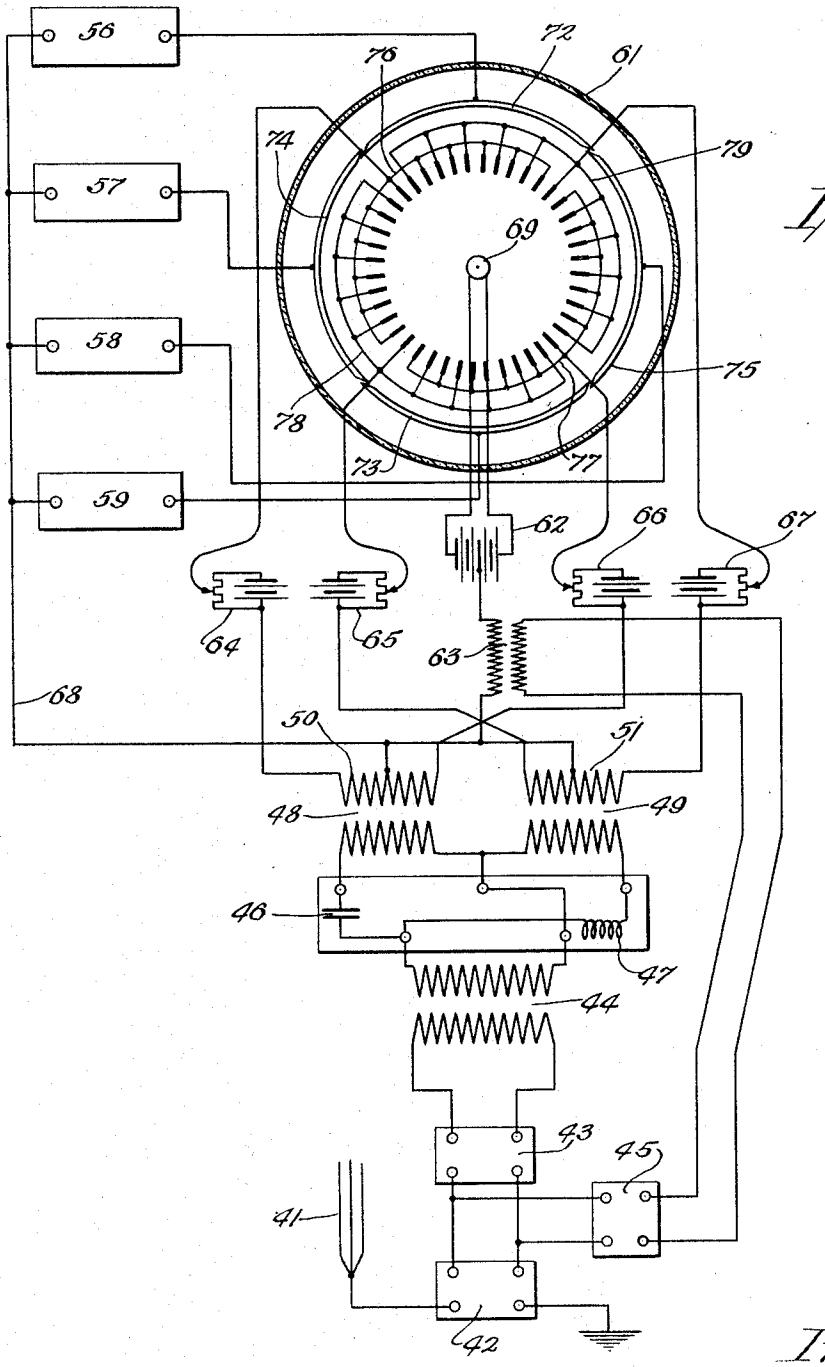


Fig. 3

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Patented Oct. 16, 1934 1,977,398

UNITED STATES PATENT OFFICE

1,977,398

HIGH FREQUENCY CIRCUIT SELECTOR

Montford Morrison, Chicago, Ill.

Application May 31, 1930, Serial No. 457,816

14 Claims. (Cl. 250—27.5)

This application is in part a part of, or related to, co-pending applications Serial Numbers 421,-790 filed January 18, 1930, 445,593 filed April 19, 1930, 445,980 filed April 21, 1930, 449,216 filed May 2, 1930, 449,515 filed May 3, 1930, and 453,-672 filed May 19, 1930.

This invention relates to a class of devices known as circuit selectors and circuit distributors, particularly to devices adapted to work in circuits employing frequencies too high for practical operation of mechanically moving parts; and has further application where quickness of response, independent of frequency, is important.

Among the objects of this invention are; to provide a device and circuits therefor adapted to function as a circuit selector having no mechanically moving parts and thereby eliminating the difficulties attendant thereto; to provide such a device with operating characteristics devoid of inertia, making it practically instantaneous in response to the control circuits; and to provide a selector device suitable for super-audio-frequency circuits and capable of providing circuit selectivity for communication systems operable at any practical frequency of selectivity.

The above objects are general and typical of specific cases; further and other objects will be obvious to those skilled in the art upon reading the specification and claims hereunder.

A distinguishing characteristic of this invention lies in the fact that the control field governing the periodicity of revolution of the electric field in the present invention bears a different relation to the number of anodes present than do the prior disclosures. Another distinguishing characteristic is the fact that certain embodiments of the present invention may have one number of effective control electrodes, and an entirely different and unrelated number of anodes.

A further distinguishing characteristic is the fact that the control circuit, and the source of the circuit to be controlled, may be arbitrarily related.

The structural characteristics of embodiments hereunder constituting electron discharge devices, have been so fully disclosed in some of the prior applications cited above, that certain obvious practical details will not be stressed herein and the present invention will deal particularly with the novelties of invention not already fully covered in the above cited applications.

Fig. 1 is a diagram illustrating an electron device embodying this invention with illustrative circuits employed therewith, being the electron discharge device employed in the systems disclosed in applications Serial Numbers 445,593 and 445,980 above referred to. Fig. 2 is a second embodiment of this invention having certain operative advantages, and employs electron discharge devices having structural characteristics related to application Serial Number 421,-790 above referred to. Fig. 3 is a third embodiment of this invention employing an electron discharge device having structural characteristics related to Serial Number 449,216 and Serial Number 453,672 above referred to.

In Fig. 1, 1 is an hermetically sealed envelope containing a filament 2, a screen 3, an anode 4, and two sets of parallel deflecting plates arranged at right angles 5 and 6 as is common practice in the art for use in connection with cathode ray oscillographs.

7 is a filament battery, 8 is a filament rheostat, 9 is an anode battery, 10 is a current limiting resistor for the anode circuit.

The circuits for the elements described are those common in the oscillographic art with the following exceptions and additions: the circuit for anode 4 is provided with a means 11, for introducing circuit variations in series with the anode battery 9; whereby the voltage of the anode 4 may be caused to respond to variations introduced from a circuit 12.

This circuit may be used if and when desired, and jointly with another circuit hereinafter described, or the two circuits may be used independently of each other, as will be more fully discussed further on in the specification.

Plates 5 and 6 are provided for purposes of illustration with two sources of alternating current 13 and 14, which may be varied with respect to voltage, frequency, wave-form and synchronous relation.

Within the envelope and along the same axis with the other electrodes already described, are located a plurality of electrodes 15, 16, 17 and 18, which may have any shape desirable, and a number subject to variation depending upon the net result desired, and upon the combination wave-forms from generators 13 and 14 as will be hereafter obvious. Electrodes 15, 16, 17 and 18 are provided with circuits including a source of electrode potential 19, 20, 21 and 22, which are connected through grid couplings 23, 24, 25, and 26 to a series of three electrode electron discharge tubes 27, 28, 29 and 30, to a common lead 31, which is in turn connected to a means 32, for introducing circuit variations from an

external circuit 33, into the described circuit, which is closed through connection 34.

The electron discharge devices 27, 28, 29 and 30 are provided with output circuits including anode sources of potential 35, 36, 37 and 38.

Circuit 12 may be eliminated from the operation of the device by closing switch 39, and circuit 33 may be eliminated from the operation thereof by closing switch 40.

In the operation of the embodiment in Fig. 1, the filament 2 is excited, and the anode 4 is provided with voltage, which causes an electron stream to emerge from filament 2, through screen 3, through anode 4, through plates 5 and 6, taking a path along the axis of the tube as is well known in oscillographic art.

By introducing circuit variations at 11, the change in anode potential thereby affects the electron stream passing through 4 to a sufficient extent, to make it possible to repeat some of this effect in the output circuits, the anode 4 acting somewhat in the role of a control electrode, though in the actual operation described hereunder, switch 39 is closed and switch 40 is open, introducing circuit variations at 32 hereafter more fully described.

By the creating of direct current potentials in 19, 20, 21 and 22, the electrodes 15, 16, 17 and 18 become the operating anodes for the device, and circuit variations introduced at 32 are in series with the main circuit of the electron stream.

By the excitation of generators 13 and 14, the deflection of the electron stream passing through parallel plates 5 and 6, is such as to cause the said electron stream to be deflected in such a circuitous manner, as will cause the said stream to traverse the electrodes in a certain predetermined order periodically. The order depending upon their shape, arrangement, and the end result desired.

Any circuitous path across all of the electrodes may be used as long as the frequency wave-form and phase relation of generators 13 and 14 are such as to make the said electron stream follow the desired path.

In the present embodiment, quarter-phase sine waves are assumed to be impressed upon the plates 5 and 6, of such a value as to cause the electron stream arising from filament 2 to take a circular path around the electrodes 15, 16, 17 and 18, in the order named.

In some cases it is desirable to maintain synchronous relation between circuit 33, and, circuit 12 and the generators 13 and 14. This may be accomplished by any of the various tie-in methods suitable to the particular embodiment used and some of which have been fully discussed in applications Serial Numbers 445,593 and 445,980 above cited.

In the embodiment under discussion, 33 is a circuit having a source of potential subject to variation the characteristics of which it is desired to distribute into output circuits 35, 36, 37 and 38.

Generators 13 and 14 constitute a source of potential for the control circuit operating upon the electron stream at 5 and 6.

The electron stream provides a conductivity between the filament 2 and the electrodes 15, 16, 17 and 18, and the said electron stream, making one complete circuit of the electrodes for each complete period of one of the generators 13 or 14, so that the electron stream from 2 under the control of generators 13 and 14 provides a continuity of circuit to the said electrodes during a time interval equal to one-fourth of the period of the said control generators, so that the characteristics of circuit variations introduced at 32 are directed ultimately to output circuit 35 for the first quarter period of the control generators; to 36 for the second quarter period; to 37 for the third quarter period; and to 38 for the last quarter period; and then this order is repeated.

It will be appreciated that with generators at 13 and 14, having super-audio-frequencies of extremely high values, the device remains operative, because of the absence of inertia in the selector.

Where the generators 13 and 14 are tied-in synchronously with circuit 33, synchronism between circuit 33 and the resultant output circuits 35, 36, 37 and 38 is also maintained—that is, the periodic repetitions in the output circuits are maintained in synchronism with the input circuit.

The embodiment shown in Fig. 1 is merely illustrative of the uses to which the present invention may be put. The set-up as shown in this figure may be looked upon as providing an inertialess selector represented by the tube 1 having all the controlled electrodes enclosed within the hermetically sealed envelope of the tube, and adapted to divide these variations up into a plurality of equally timed intervals and distribute these divided portions consecutively and periodically into a plurality of delivery circuits such as 35, 36, 37 and 38.

Such a general structure may be applied to telephony, telegraphy, to the transmission of likenesses of images and other similar applications. Specific applications of such a selector device to the above mentioned fields are more fully covered in some of the above mentioned co-pending applications.

In Fig. 2, 41 is the terminal of a communication receiving apparatus; 42 is the terminal apparatus thereof.

At the terminal 41 there is assumed to be received a super-audio-frequency wave, constituting a communication-modulated carrier-wave, and an unmodulated carrier wave of a different frequency. 43 is a unit for separating the unmodulated carrier wave from the received wave, and delivering it to a transformer device 44. 45 is a unit for separating the communication modulated carrier wave from the received wave, and delivering it through coupling 63 to an electron discharge device hereinafter described. The unmodulated wave received at 44 is divided into two unmodulated waves, having a phase difference of 90 electrical degrees, which is affected by a phase-splitter illustrated conventionally by a capacitor 46 and a reactor 47, which deliver to transformers 48 and 49 the said quarter-phase current. Transformers 48 and 49 have secondaries 50 and 51, which are connected to anodes 52 and 53, and to 54 and 55 respectively, through output circuit units 56, 57, 58 and 59.

The anodes 52, 53, 54 and 55 for conventionality are illustrated as ring segments, but which are formed in reality into segmental cylindrical surfaces, and through the axis of these said surfaces is located a rod filament 60 and all enclosed within an hermetically sealed envelope 61. all of which have structural details similar to the several electron discharge devices in the above mentioned patent applications. Filament 60 is provided with a filament battery 62, which

is connected through a means 63, for introducing the output of 45 into the filament circuit. The filament circuit is further connected to the centers of the transformers 50 and 51 as conventionally illustrated.

Units 56, 57, 58 and 59 may contain reception translating devices, and, sources of plate potential, if and when desired.

The unmodulated carrier wave received at 41 is applied to the anodes in the form of a quarter-phase revolving electric field and determines, in conjunction with the direction of the conductivity of the electron discharge, and the circuit variation introduced at 63 due to the communication modulation discussed, to which of the several anodes the said circuit variation is directed and duration of the said direction depending upon the periodicity and phase relation of the alternating current control field already described, as will be understood by those skilled in the art from the aforegoing disclosure.

The embodiment described in Fig. 1 utilizes a control field at right angles to the electron discharge stream; and the embodiment described in Fig. 2 employs a control field in the same plane with the electron discharge field.

Referring to Fig. 3, this relates to an embodiment similar to that illustrated in Fig. 2 with certain exceptions and additions, one of which is the introduction of a control grid into the electron discharge field, which provides means for more sensitive control than may be obtained in Fig. 2, and in addition to which, amplification may be simultaneously effected.

Equivalent elements of Fig. 3 have the same reference numerals used in Fig. 2 for conciseness and clearness.

Instead of the output circuits of transformers 48 and 49 being connected to the hollow cylindrical surface electrodes contained within the hermetically sealed envelope 61, the secondaries thereof are connected through potentiometer control grid batteries 64, 65, 66 and 67 to be used if and when desired, to adjust the potentials of the grids enclosed in the envelope, 61.

The grid structure utilized in 61 is of a form and character fully disclosed in applications Serial Numbers 449,216 and 453,672 above cited.

The output circuit units 56, 57, 58 and 59 in Fig. 3 are connected to a plurality of segmental cylindrical anodes similar to those of Fig. 2, and designated by 72, 73, 74 and 75, and have one terminal thereof each connected together, and to a common lead 68 tied in with the filament circuit at the center of the secondaries 50 and 51.

The secondaries 50 and 51 are connected to a plurality of inter-meshed grids 76, 77, 78 and 79 of the kind and character described in the first two preceding patent applications referred to. Filament 69 for Fig. 3 may be a form depending upon which type of inter-meshed grid structure is used; and for that of the figure, a straight rod similar to 60 provides an operative structure.

The embodiment illustrated in Fig. 3 bears somewhat the relation to that of Fig. 2, that a three electrode electron discharge device bears to a two electrode electron discharge device.

The grids 76, 77, 78 and 79 act as control electrodes for the anodes 72, 73, 74 and 75.

The quarter-phase unmodulated output of secondaries 50 and 51 produce a revolving control field, directing the electron stream against certain anode members 72, 73, 74 and 75, and depending upon the periodicity of the said unmodulated wave-forms, and thereby directing the modulated carrier current introduced at 63 into the output circuits 76, 77, 78 and 79 in a predetermined order in cyclic form, as is fully understood from comparison with Fig. 2.

The above described embodiments have been reduced to simplest form consistent with clearness of disclosure. It is obvious to those skilled in the art that the structure herein described is adaped to reversible operation—that is, the devices described may take current from a single circuit and deliver it selectively to several circuits, or vice versa, the device may take current from several circuits and deliver it to a single one.

With special reference to Fig. 1, it will be noted that such details as filament and grid batteries have been omitted as these are well understood and may be brought into use by those skilled in the art when desired. Particular attention is directed to the fact that although in Fig. 1 the electron discharge device contained in 1 actually directs the current through the said device to the several selective circuits, that this circuit is by no means a limitation of the invention hereunder and that the grid-control electron-discharge tubes 27, 28, 29 and 30 may receive their super-audio-frequency modulated carrier-currents from sources not including the electron discharge device contained in 1 as a part of the circuits thereof and the electron discharge device contained in 1 may merely act as a grid biasing device for the tubes 27, 28, 29 and 30, causing the said tubes to become operative in a predetermined and cyclic order by providing grid biasing for the said tubes in the desired order.

These modifications are given as illustrative examples of practical variations in embodiments, but the scope of this invention is best described in the claims hereunder.

1. A distributor comprising a sealed envelope containing a thermionic cathode, a plurality of anodes and a plurality of control electrodes located within the path of the cathode discharge and overlapped collectively presenting an electrically effectively continuous control electrode surface, whereby discontinuity in the electrostatic control field is eliminated under operation and said discharge is distributed to predetermined ones of said anodes.

2. A distributor comprising a sealed envelope, a thermionic cathode within said envelope, a plurality of anodes collectively presenting an electrically effectively continuous discharge surface for the electron stream, a plurality of control electrodes between said cathode and said substantially continuous discharge surface, and means including said control electrodes to direct the electron stream against said continuous discharge surface.

3. A distributor comprising a sealed envelope, a thermionic cathode within said envelope, a plurality of anodes collectively presenting an electrically effectively continuous discharge surface surrounding said cathode, a grid structure between said cathode and said anodes, and means including said grid structure to direct the electron stream against a predetermined anode.

4. A distributor comprising a sealed envelope, a cathode in said envelope, a plurality of anodes collectively presenting an electrically effectively continuous discharge surface in said envelope surrounding said cathode, a plurality of grids between said cathode and said anodes, means for causing said cathode to emit an electron stream,

and means, including said grid, to distribute said stream to said anodes in a predetermined and cyclic order.

5. A distributor, comprising a sealed envelope containing a thermionic cathode adapted to emit electrons radially within a plane at right angles to a geometric axis of said cathode, a plurality of segmental-cylindrical anodes disposed concentrically with aforesaid axis, and a plurality of control electrodes defining a substantially continuous figure and disposed between said cathode and said anodes, electrostatically operative within aforesaid plane.

6. A distributor comprising a sealed envelope containing a thermionic cathode adapted to emit electrons radially within a plane at right angles to a geometric axis of said cathode, a plurality of anodes disposed about said axis, a plurality of overlapping control electrodes electrostatically operative within aforesaid plane and adapted to polyphase excitation.

7. A distributor comprising a sealed envelope containing a thermionic cathode adapted to emit electrons radially within a plane at right angles to a geometric axis of said distributor, a plurality of anodes disposed about said axis and passing through said plane, and means including a plurality of control electrodes to cause the emitted electrons to flow in a quantitatively substantially uniform stream continuously radially from said axis and simultaneously to revolve about said axis and within said plane under excitation.

8. A distributor comprising a sealed envelope containing a thermionic cathode surrounded by a plurality of anodes and a plurality of overlapping grids disposed between said cathode and said anodes, said plurality of grids collectively presenting an electrically effectively continuous control electrode surface for the electron discharge.

9. A distributor comprising a sealed envelope containing a thermionic cathode, a plurality of anodes arranged in a complete circle and disposed about a thermionic cathode and an even number of control electrodes between said cathode and said anodes, the effective length of the electron discharge path from the aforesaid cathode being less than the diameter of the said anode circle.

10. A distributor adapted to multi-circuit operation comprising a cathode, a plurality of anodes and a plurality of control electrodes, said control electrodes collectively presenting an electrically effectively continuous control electrode surface to the said cathode.

11. A distributor adapted to multi-circuit operation comprising a cathode and a plurality of anodes, said plurality of anodes collectively presenting an electrically effectively continuous discharge surface to said cathode.

12. A distributor comprising a sealed envelope containing a thermionic cathode adapted to emit electrons radially within a plane at right angles to a geometric axis of said distributor, a plurality of anodes disposed about said axis and passing through said plane, and a plurality of control electrodes disposed between said cathode and said anodes and collectively presenting a surface offering a substantially uniform cathode-control-electrode impedance for any radial instantaneous position of the electron stream about the aforesaid axis under operation.

13. A distributor comprising a sealed envelope containing a thermionic cathode adapted to emit electrons radially within a plane at right angles to a geometric axis of said distributor, a plurality of control electrodes disposed about said cathode and passing through said plane, and a plurality of anodes disposed about said control electrodes and opposite the side thereof facing the aforesaid cathode and collectively presenting a surface offering a substantially uniform cathode-anode impedance for any radial instantaneous position of the electron stream about the aforesaid axis under operation.

14. A distributor comprising a sealed envelope containing a thermionic cathode adapted to emit electrons radially within a plane at right angles to a geometric axis of said distributor, a plurality of anodes disposed about said axis and passing through said plane, a plurality of control electrodes disposed between said cathode and said anodes, said anodes and said control electrodes collectively presenting surfaces offering substantially uniform distributor impedance for any radial instantaneous position of the electron stream about the aforesaid axis for a given excitation under operation.

MONTFORD MORRISON.