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F. GRAY

2,228,266

SIGNAL TRANSLATING APPARATUS

Filed July 1, 1939

FIG. 1

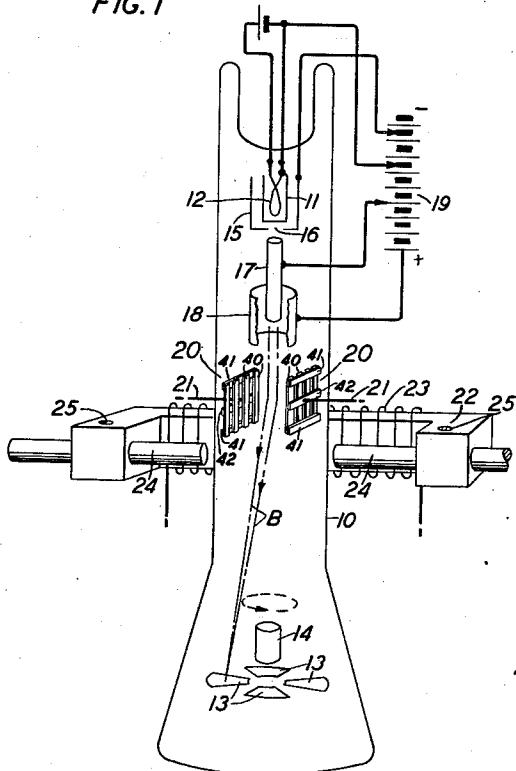


FIG. 2

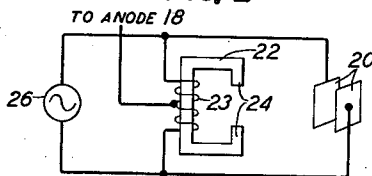


FIG. 3

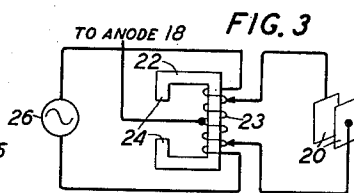


FIG. 4

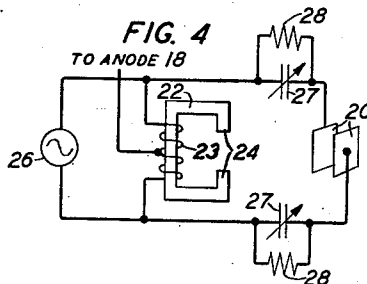


FIG. 5

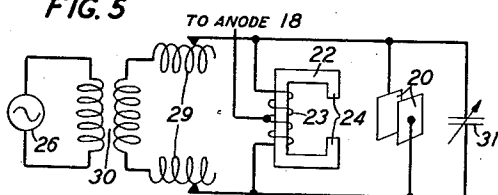


FIG. 6

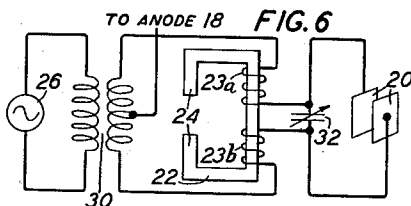


FIG. 7

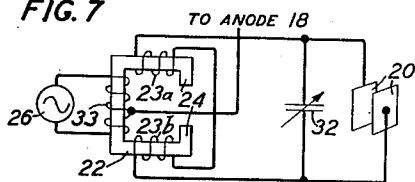


FIG. 8

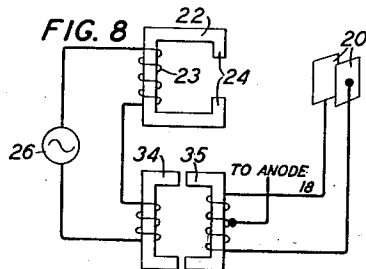
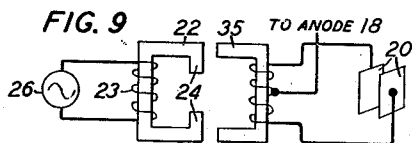


FIG. 9



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SIGNAL TRANSLATING APPARATUS

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Application July 1, 1939, Serial No. 282,385

4 Claims. (Cl. 250—27)

This invention relates to signal translating apparatus including electron discharge devices of the beam type and more particularly to apparatus and circuits for producing movement of the electron beam in cathode ray devices over a desired path.

In a number of systems including cathode ray devices, for example in multiplex telephone systems such as disclosed in my application Serial No. 255,897, filed February 11, 1939, it is desirable to produce circular rotation of the electron beam whereby the beam is caused to impinge repeatedly and in succession upon a number of targets. Such rotation may be produced, for example, as disclosed in the application above identified, through the agency of two pairs of deflector or sweep plates energized from separate alternating current sources, the two sources having their outputs 90 degrees out of phase.

In many installations, only a single phase alternating current supply, for example an electron discharge device, is available for energization of the deflector or sweep plates and phase shifting means are necessary to obtain the desired relationship between the potentials applied to the deflector or sweep plates. Such phase shifting means introduce large power losses and this, together with the limited power obtainable from the source, may necessitate the use of additional equipment, such as amplifiers, to produce the requisite power for rotating the electron beam. The use of such additional equipment greatly increases the installation and maintenance costs of electron beam discharge apparatus.

One object of this invention is to simplify and thereby to reduce the installation and maintenance costs of signal translating apparatus including electron discharge devices of the rotating beam type.

Another object of this invention is to enable attainment of rotation of the electron beam in cathode ray devices through the use of a single phase alternating current supply for energizing the deflector or sweep members.

A further object of this invention is to reduce the power necessary to effect rotation of the electron beam in cathode ray devices.

In one illustrative embodiment of this invention, signal translating apparatus comprises a cathode ray discharge device including a cathode, a plurality of targets spaced from the cathode, and one or more electrodes between the cathode and the targets for concentrating and accelerating the electron beam. The concentrated beam is caused to rotate by a pair of deflector or sweep

plates and an electromagnetic structure producing a field parallel to the electrostatic field extant between the deflector or sweep plates and transverse to the plates.

In accordance with one feature of this invention, the sweep or deflector plates and the coil of the electromagnetic structure are connected in a single phase circuit in such a manner that the current in the coil and the voltage across the deflector or sweep plates are 90 degrees out of phase.

In accordance with another feature of this invention, the coil mesh of the energizing circuit is tuned to the driving frequency whereby the desired circular motion of the electron beam is obtained with a small power expenditure.

In accordance with a further feature of this invention, means are provided for adjusting the relative effects of the magnetic and electrostatic fields so that the transverse components of motion resulting therefrom are equalized and exact circular rotation of the electron beam obtains.

The invention and the foregoing and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a perspective view, partly diagrammatic, of an electron beam discharge device and associated electromagnetic structure illustrative of one embodiment of this invention;

Fig. 2 is a circuit diagram illustrating one manner of energizing the deflector plates and electromagnetic structure in the apparatus shown in Fig. 1, in accordance with this invention;

Figs. 3, 4, and 5 are circuit diagrams illustrative of modifications of the circuit shown in Fig. 2 and including means for effecting adjustment between the magnetic and electrostatic fields;

Figs. 6 and 7 are circuit diagrams illustrating other embodiments of this invention wherein means are provided for tuning the coil mesh to the driving frequency; and

Figs. 8 and 9 are circuit diagrams illustrating still other embodiments of this invention including both the amplitude adjustment and tuning features.

Referring now to the drawing, the cathode ray discharge device, which may be, for example, of the construction described in my application above identified, comprises an evacuated enclosing vessel 10 having therein, adjacent one end, a cylindrical cathode 11, which may be of the indirectly heated type energized by a heater filament 12, and at the other end a plurality of

sectoral targets 13 mounted in circular formation coaxial with an output or collector electrode 14. The cathode 11 is encompassed by a cylindrical concentrating electrode 15 coaxial with the cathode and having a central restricted aperture 16 in alignment with the collector electrode 14. Opposite the aperture 16 and coaxial therewith are a pair of cylindrical anodes 17 and 18, the anode 17 preferably extending into the anode 18. Suitable potentials may be applied to the electrodes 15, 17 and 18 by a source such as a battery 19.

Mounted on opposite sides of the axis extending between the anodes 17 and 18 and the collector or output electrode 14 and equally spaced therefrom are a pair of parallel deflector or sweep plates 20 having leading-in conductors 21 sealed in the enclosing vessel 10. In order to reduce the induction of eddy currents in the deflector sweep plates 20 by the magnetic field, these plates may be slotted or sectionalized. For example, as shown in Fig. 1, each plate 20 may comprise a plurality of parallel metallic strips 40 secured at opposite ends to insulators 41, such as mica strips, and electrically connected by a metallic band 42 to which the corresponding leading-in conductor 21 is affixed. An electromagnetic structure for producing a magnetic field parallel to the electrostatic field between the deflector or sweep plates 20, is mounted externally of the vessel and adjacent the plates and comprises a U-shaped magnetic core 22 having a low resistance coil 23 thereon and having also a pair of aligned pole-pieces 24. The pole-pieces 24 may extend slidably through apertures in the arms of the core 22 to allow adjustment of the air-gap therebetween and may be locked in any desired position as by set screws 25 threaded into the arms of the core.

During operation of the device and with the sweep plates 20 and coil 23 energized as described hereinafter, the electrons emanating from the cathode 11 are concentrated by the cylindrical electrode 15 and accelerated and further concentrated into an electron beam, indicated by the broken lines B, by the anodes 17 and 18. The fields produced by the plates 20 and the electromagnetic structure cause the beam to rotate so that it impinges upon the targets 13 in sequence. The targets, when thus energized by the beam, emit secondary electrons which flow to the output or collector electrode 14. The beam or the secondary electron currents may be controlled or modulated as described in my application identified above.

Various ways of energizing the sweep or deflector plates 20 and the coil 23 to produce the desired rotation of the electron beam B in accordance with this invention are illustrated in Figs. 2 to 9, inclusive, in each of which the power is obtained from a single phase sinusoidal alternating current source 26, such as an electron discharge device oscillator, the frequency of which is that at which rotation of the beam is desired. It is advantageous for most applications to balance the sweep or deflector plates 20 with respect to the anode 18 and this is effected in each of the circuits shown by the connection labeled "To anode 18."

In the circuit shown in Fig. 2, the sweep or deflector plates 20 are connected directly in parallel with the low resistance coil 23 so that, as will be apparent, the current through the coil 23 is 90 degrees out of phase with the potential between the sweep or deflector plates 20 and the magnetic

field between the pole-pieces 24 is 90 degrees out of phase with the electrostatic field between the sweep or deflector plates 20. The two fields, therefore, will result in rotation of the electron beam B about the axis extending between the anodes 17 and 18 and the output or collector electrode 14.

In order that the beam may have a circular movement, it is necessary that the electrostatic and magnetic fields be of proper relative magnitudes. This may be effected by varying the gap between the pole-pieces 24 as described heretofore. Such adjustment may be effected also electrically as illustrated in Figs. 3, 4 and 5. In Fig. 3, the adjustment is made by moving the connections from the sweep plates 20 along the coil 23. In Fig. 4, variable condensers 27, each shunted by a high resistance 28, are connected between each sweep plate 20 and the corresponding end of the coil 23. In Fig. 5, the adjustment is effected by inductances 29 in series with the coil 23 and the secondary winding of the transformer 30, or by a variable condenser 31 connected across the plates 20, or by both the inductances 29 and condenser 31.

It will be understood, of course, that the desired beam motion may be obtained by electrical adjustment, as illustrated in Figs. 3, 4 and 5, and adjustment of the air-gap between the pole-pieces 24, in combination.

In the circuit illustrated in Fig. 6, the coil 23 is divided into two equal halves 23a and 23b in series with the sweep or deflector plates 20 and the adjustment of the magnetic and electrostatic fields may be accomplished by the variable condenser 32 in shunt with the plates 20. Further adjustment, if necessary, may be made by varying the gap between the pole-pieces 24. The coils 23a and 23b and condenser 32 preferably are designed so that the coil mesh is tuned to the frequency of the source 26. Consequently, the losses in this mesh will be a minimum so that but a small amount of power is required to rotate the electron beam B.

In the modification of the circuit of Fig. 6 illustrated in Fig. 7, the transformer 30 is omitted and the core 22 is provided with a primary winding 33 connected to the source 26.

In the circuit illustrated in Fig. 8, the sweep plates 20 are energized from a transformer 34, 35 having its primary winding in series with the coil 23 and the requisite adjustment of the magnetic and electrostatic fields is effected by varying the mutual inductance of the transformer 34, 35.

As illustrated in Fig. 9, the core 22 and the core 34 of the transformer of Fig. 8 may be combined and the adjustment obtained by varying the mutual inductance of the transformer.

In both Figs. 8 and 9, the constants of the transformer circuits may be made such that these circuits are tuned to the frequency of the source 26 so that but a small amount of power is required to produce the desired circular rotation of the electron beam.

Although specific embodiments of the invention have been shown and described, it will be understood, of course, that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. Electron beam discharge apparatus comprising a cathode, an electron receiving electrode, means for concentrating the electrons emanating from said cathode into a beam directed toward said electron receiving electrode, means for rotat-

ing said beam including a pair of opposed field plates on opposite sides of the electron beam path, means including a coil for producing a magnetic field parallel to the electrostatic field between said field plates and a single phase source connected to said coil and said plates for impressing an alternating potential between said field plates and supplying to said coil current 90 degrees out of phase with said potential, and means in circuit with said coil defining therewith a circuit tuned to the frequency of said source.

2. Electron beam discharge apparatus comprising a cathode, an electron receiving electrode spaced from said cathode, means for concentrating the electrons emanating from said cathode into a beam directed toward said electrode, and means for rotating the electron beam comprising a pair of opposed sweep plates, a pair of coils for producing a magnetic field parallel to the electrostatic field between said sweep plates, a series circuit including said plates and coils, said plates being connected between said coils, means for impressing an alternating current potential upon said circuit and a condenser bridged across said plates.

3. Electron beam discharge apparatus comprising a cathode, an electron receiving electrode spaced from said cathode, means for concentrating

ing the electrons emanating from said cathode into a beam directed toward said electrode, a pair of opposed sweep plates on opposite sides of the beam path, a magnet structure including a core, a pair of pole-pieces aligned parallel to the line of alignment of said sweep plates and a pair of coils on said core, a series circuit including a variable condenser and said coils, said condenser being connected between said coils, means for impressing a single phase alternating current potential upon said circuit, and means connecting said sweep plates to opposite terminals of said condenser.

4. Electron beam discharge apparatus comprising a cathode, an electron receiving electrode spaced from said cathode, means for concentrating the electrons emanating from said cathode into a beam directed toward said electrode, a pair of sweep plates on opposite sides of the beam path, a magnet structure having a coil and pole-pieces aligned transverse to said path, and means including a single phase source and a transformer of variable mutual inductance for impressing an alternating potential between said field plates and supplying to said coil a current 90 degrees out of phase with said potential.

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