

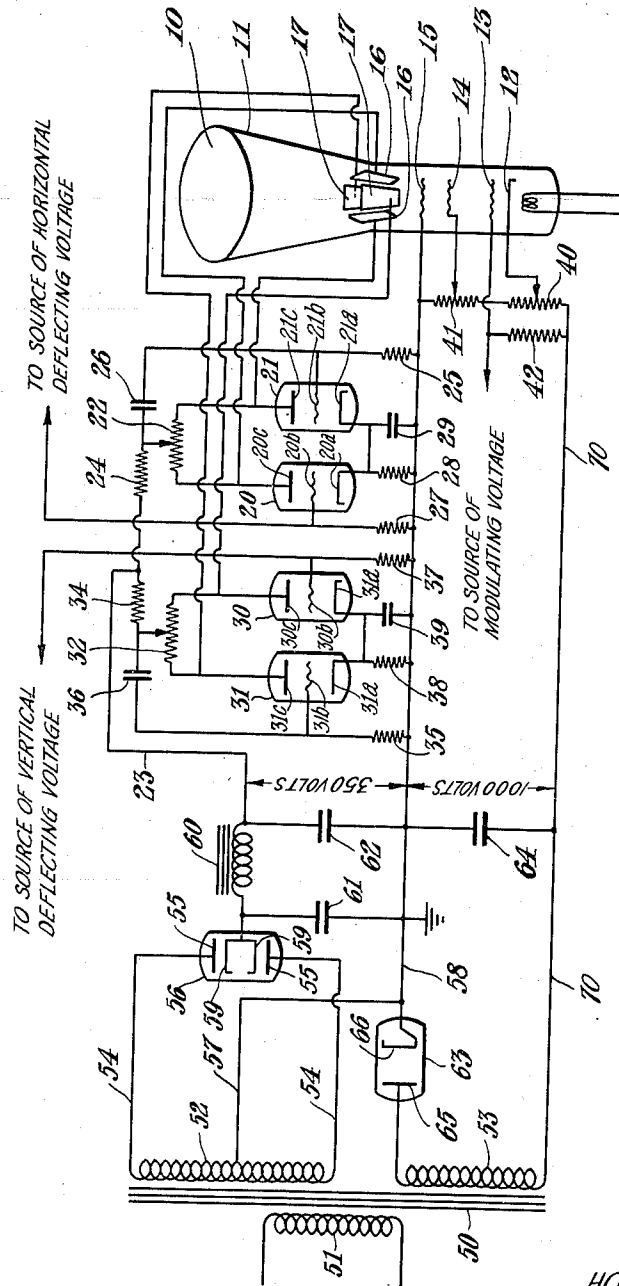
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ELECTRICAL CIRCUIT ARRANGEMENT

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ELECTRICAL CIRCUIT ARRANGEMENT

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The present invention relates to electrical circuit arrangements and more particularly to circuit arrangements for operating cathode-ray discharge tubes in which the position and/or displacement of an electron beam is controlled by applying varying voltages to one or more sets of electron-beam deflecting electrodes.

The circuit arrangements of the invention are particularly suitable for energizing the deflecting electrodes of cathode-ray tubes suitable for television purposes and in which the control or signalling voltages having generally a saw-tooth form, embody an extensive frequency range extending from the fundamental frequency of the saw-tooth wave to frequencies of the order of fifty megacycles or more.

It is an object of the invention to provide an improved circuit arrangement for energizing the deflecting electrodes of cathode-ray tubes.

Another object of the invention is to provide a coupling amplifier circuit for cathode-ray tubes which circuit is characterized by a high degree of stability, a uniform amplification over an extended frequency range and by a minimum of harmonic and phase distortion and which at the same time is simple and requires a minimum of components.

These and further objects of the invention will appear as the specification progresses.

The circuit arrangement in accordance with the invention comprises a push-pull voltage amplifier having output electrodes connected in symmetrical relationship to the deflecting electrodes of the cathode-ray tube and comprising a degenerative phase-inversion network which provides at the output of each branch of the amplifier signalling voltages for the deflecting electrodes which are mirror images of each other with respect to both amplitude and phase and which network simultaneously makes possible the control of the dynamic position of the electron beam pattern of the cathode-ray tube. In accordance with a preferred embodiment of the invention the output electrodes of the push-pull voltage amplifier are directly connected to the deflecting electrodes of the cathode-ray tube whereby a maximum voltage transfer efficiency between these elements is obtained.

A further feature of the invention is a novel circuit arrangement by which the operating potentials for the cathode-ray tube and its associated amplifier are supplied by low and high voltage sources in series and arranged in such manner that the low voltage components of the

amplifier are shielded from the high voltage source.

Referring to the drawing, there is shown a cathode-ray tube 10 comprising within an envelope 11 an electron-emitting cathode electrode 12, a control electrode 13, and focusing electrodes 14 and 15 for producing an electron beam. For deflecting the electron beam in a horizontal and vertical manner there are provided horizontal deflecting electrodes 16—16 and vertical deflecting electrodes 17—17. The construction and arrangement of electrodes 12 to 17 inclusive is well known to those skilled in the art and a further description of the same is believed to be unnecessary.

Connected across beam forming electrodes 12, 13, 14 and 15 is a resistor network comprising series connected potentiometer resistors 40 and 41. The free end of resistor 40 is connected to the grid electrode 13 through a grid leak resistor 42 and to the negative pole of the voltage supply later to be described, whereas the free end of resistor 41 is connected to the electrode 15 and to a ground conductor 52.

Cathode 12 is connected to the adjustable tap of resistor 40 and focusing electrode 14 is connected to the adjustable tap of resistor 41 whereby adjustment of the intensity of the electron beam respectively proper focusing of the electron beam is obtained by adjusting the positions of the respective tappings. In accordance with the known practice in the television art a modulating voltage may be applied to the control grid 13, for example, from an external source (not shown), said source also including automatic background control devices of the usual type.

Horizontal deflecting electrodes 16—16 are energized from a push-pull voltage amplifier comprising a valve 20 having cathode, grid and anode electrodes 20a, 20b and 20c respectively, and a valve 21 having cathode, grid and anode electrodes 21a, 21b and 21c respectively. As shown in the drawing and in accordance with the invention, the anodes 20c and 21c are directly connected to the deflecting electrodes 16—16.

Interconnecting the anodes 20c and 21c is a potentiometer resistor 22 the adjustable tapping of which is connected to a voltage supply conductor 23 through a resistor 24. Potentiometer 22 and resistor 24 in combination constitute the output resistors of the valves 20 and 21 whereby the output resistor of valve 20 comprises the resistor 24 in series with that portion of the potentiometer 22 contained between the tapping and the anode 20c. Similarly, the output re-

sistor of valve 21 comprises the resistor 24 in series with that portion of the potentiometer 22 contained between the tapping and the anode 21c. Since the resistor 24 is common to the anode circuits of both of the valves 20 and 21 and has one end effectively at ground potential with respect to the signalling currents, there is developed across resistor 24 in the operation of the push-pull amplifier a differential voltage which is degenerative in character with respect to the valve 21 and has a value substantially inversely proportional to the voltage amplification of valve 21.

Grid electrode 20b is energized by a suitable source of horizontal deflection signalling voltage for example, a saw tooth wave generator (not shown) to which the grid 20b is connected in conventional manner. Grid electrode 21b is energized by the differential voltage degeneratively developed across resistor 24 to which the grid electrode is connected through a blocking condenser 26. Grid leak resistors 25 and 27 provide a direct current path to the ground conductor 58 for the grid electrodes 20b and 21b respectively.

When the valves 20 and 21 have a substantially high amplification factor the cathodes 20a and 21 are interconnected and returned directly to the ground conductor 57 in which case sufficient bias voltage for operating the valves is obtained by grid rectification of the signalling voltage. However, when the valves 20—21 have a low amplification factor I prefer to provide other sources of bias voltage for example a cathode bias resistor 28 which is interposed between the cathodes 20a—21a and the ground conductor 58. A condenser 29 connected across the resistor 28 serves as a low impedance shunt for the signalling currents transmitted through the amplifier.

The voltages for energizing the vertical deflecting plates 17—17 are derived from a push-pull amplifier similar to that above described and comprising a valve 30 having cathode, grid and anode electrodes 30a, 30b and 30c respectively and a valve 31 having cathode, grid and anode electrodes 31a, 31b and 31c respectively. Anodes 30c and 31c are directly connected to their respective deflecting electrodes 17—17 and are interconnected by a potentiometer resistor 32 the movable tap of which is connected to the supply conductor 23 through a resistor 34.

Grid electrode 30b is energized from an external source of vertical deflection signalling voltage (not shown). In instances where the cathode-ray tube is to be used for television purposes, said source may be a saw-tooth wave generator whereas in the case where the cathode-ray tube is to be used as an oscilloscope or similar visual indicator the source comprises the generator of the voltage to be observed. Grid electrode 31b is energized by the differential voltage degeneratively developed across the resistor 34 to which the grid is connected through a blocking condenser 36. Grid leaks 35 and 37 provide direct current paths to the ground conductor 58 for the grid electrodes 30b and 31b respectively. Bias voltage for the valves 30—31 is provided by a cathode resistor 38 interposed between cathodes 30a—31a and the ground conductor 58. A condenser 39 connected across resistor 38 serves as a low impedance shunt for the signalling currents transmitted through the amplifier.

The operating potentials for the amplifiers

20—21 and 30—31 and for cathode-ray tube 10 are derived from a transformer 50 having a primary winding 51 and secondary windings 52 and 53. Winding 52 is connected in full-wave rectifying arrangement to produce a comparatively low direct voltage (i. e. 350 volts) and for this purpose the ends 54—54 of the winding are connected to anodes 55—55 of a rectifier valve 56. A center-tapping 57 of the winding connected to the ground conductor 58 serves as the direct current return and as the negative pole of the voltage supply. The positive pole of the voltage supply is taken from cathodes 59—59 of the valve 56 to which the supply conductor 23 is connected with the interposition of a low-pass filter comprising a choke inductance 60 and filter condensers 61 and 62.

Winding 53 is connected in half-wave rectifying arrangement to produce a comparatively high direct voltage (i. e. 1000 volts) said winding having one end connected to the free end of resistor 40 through a conductor 70 serving as the negative pole of the voltage supply. The other end of winding 53 is connected to the anode 65 of a rectifier valve 63 the cathode 66 of which is connected to the ground conductor 58 serving as the positive pole of the voltage supply. A condenser 64 connected across the conductors 58 and 70 serves for smoothing the rectified voltage derived from the rectifier valve 63.

It will be seen that by means of the circuit arrangement above described in which the anodes of the amplifier valves are directly connected to the deflecting electrodes, a maximum transfer efficiency between the amplifier and the deflecting electrodes is obtained at all frequencies at which the cathode-ray tube can be used and the full value of the voltages appearing at the anodes is impressed on the deflecting electrodes. Moreover, since the stray capacities of the output circuit of the amplifiers are greatly reduced, frequency discrimination, non-linearity and other forms of distortion likewise are reduced to a low value. Furthermore, because of the degenerative feed-back coupling to which each of the amplifiers is subjected by the phase-inversion networks for energizing the valves 21 and 31, the above distortions are further minimized.

An important advantage of the circuit above described is that the tappings of the degenerative feed-back networks being adjustable make it possible to obtain both phase and voltage balance of the amplifiers and to simultaneously neutralize or counterbalance substantially entirely the effects of unpredictable residual stray capacities introduced by the amplifier tubes, the cathode-ray tube and the interconnecting wiring.

A further advantage arises from the unique manner in which the low-voltage supply and the high-voltage supply are interconnected which permits the necessary high voltages to be applied to the elements of the cathode-ray tube 10 without subjecting the amplifier valves 20—21 and 30—31 to a voltage in excess of that obtained from the low voltage supply notwithstanding the direct interconnection between the cathode-ray tube and the anodes of the amplifier valves.

It should be well understood that while the invention has been illustrated with amplifier valves 20—21 and 30—31 of the triode type, the invention is equally applicable to amplifier valves of the tetrode, pentode or other multi-grid construction.

While I have described my invention in a specific embodiment and by means of a specific example, I do not wish to be limited thereto for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

What I claim is:

1. In a circuit arrangement in combination, a cathode-ray tube comprising electron-beam producing elements and a pair of deflecting electrodes for displacing said beam, and a voltage amplifier for applying signalling currents to said deflecting electrodes, said amplifier comprising two discharge valves having grid and anode electrodes connected in push-pull arrangement, an impedance element having its end portions interconnecting the anodes, a second impedance element common to both valves and interposed between an adjustable tapping of said first impedance element and a point of low-signalling current intensity, means to apply signalling currents to the grid electrode of one of said valves, and means comprising an interconnection between said tapping and the grid electrode of the other valve for applying signalling currents to said latter grid electrode in phase opposition to the signalling currents applied to the grid electrode of the first of said valves.

2. In a circuit arrangement in combination, a cathode-ray tube comprising electron-beam producing elements and a pair of deflecting electrodes for displacing said beam, a voltage amplifier for applying signalling currents to said deflecting electrodes and a voltage source for energizing said amplifier, said amplifier comprising two discharge valves having grid and anode electrodes connected in push-pull arrangement with the anode electrodes directly connected to said deflecting electrodes, a resistor element having its end portions interconnecting the anodes, a second resistor element common to both valves and interconnecting said voltage source and an adjustable tapping of said first resistor element, means to

apply signalling currents to the grid electrode of one of said valves and means comprising an interconnection between said tapping and the grid electrode of the other valve for applying signalling currents to said latter grid electrode in phase opposition to the signalling currents applied to the grid electrode of the first of said valves.

3. In a circuit arrangement in combination, a cathode-ray tube comprising electron beam producing elements including a cathode and an anode and a pair of deflecting electrodes for displacing said beam, a voltage amplifier for applying signalling currents to said deflecting electrodes, a voltage source for energizing said cathode-ray tube, a voltage source for energizing said amplifier, said amplifier comprising two discharge valves having grid and anode electrodes connected in push-pull arrangement with the anode electrodes directly connected to said deflecting electrodes, a resistor element having its end portions interconnecting the anodes, a second resistor element interconnecting the said amplifier energizing voltage source and an adjustable tapping of said first resistor element, means to apply signalling currents to the grid electrode of one of said valves, and means comprising an interconnection between said tapping and the grid electrode of the other valve for applying signalling currents to said latter grid electrode in phase opposition to the signalling currents applied to the grid electrode of the first of said valves, the voltage source for energizing the cathode-ray tube having its negative pole connected to the cathode of the cathode-ray tube and its positive pole connected to the anode of the cathode-ray tube and the voltage source for energizing the amplifier having its negative pole connected to the positive pole of said first voltage source and having its positive pole connected to the anodes of the said amplifier valves and the deflecting electrodes through said second resistor element.

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