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CATHODE-RAY TUBE SOUND RECORDER

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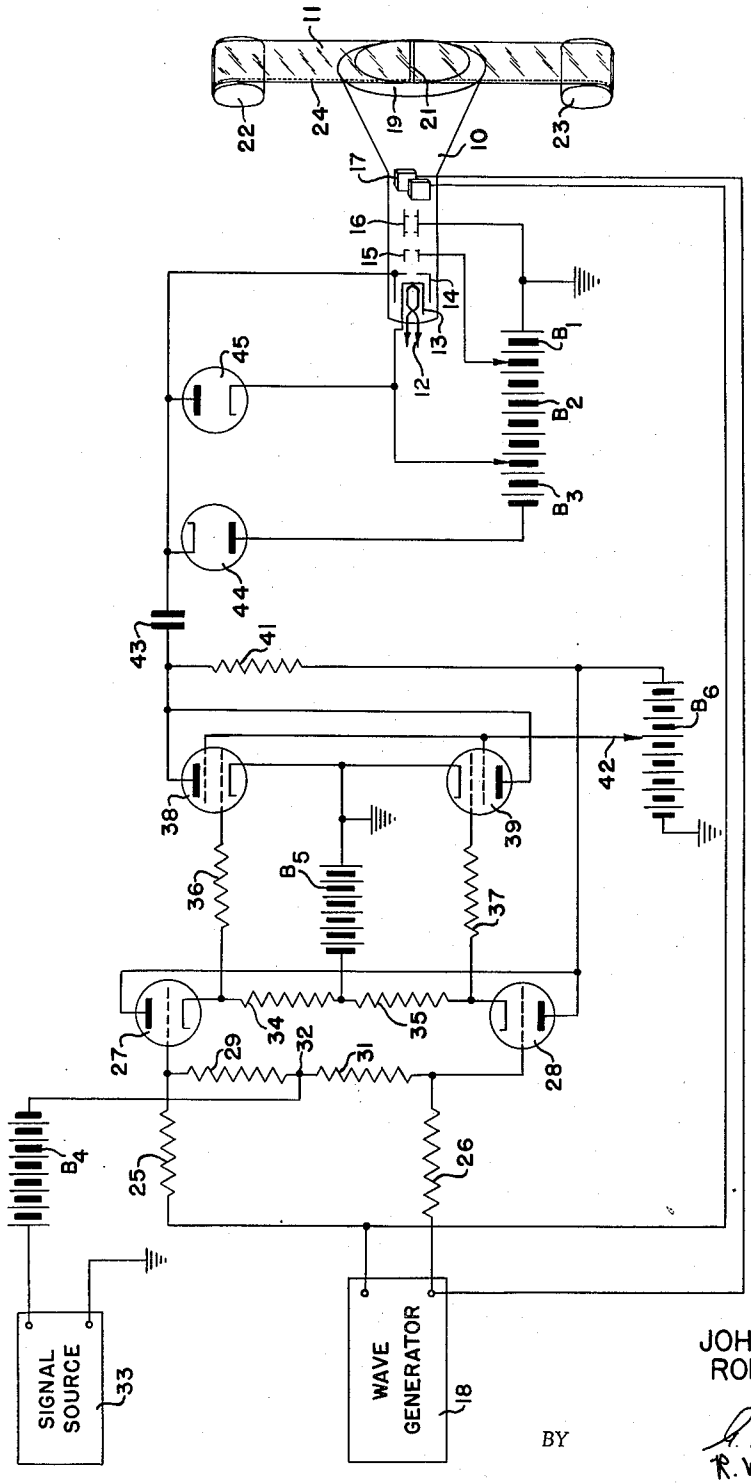

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CATHODE-RAY TUBE SOUND RECORDER

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5 Claims. (Cl. 179—100.3)

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This invention relates to signal recording and more particularly to a method and apparatus for photographic recording of sound signals by means of cathode ray tubes.

Heretofore, it has been known to produce a variable area type photographic recording of sound signals by means of a cathode ray tube. In the prior art devices, the length of a trace on the face of the cathode ray tube is varied in accordance with the instantaneous sound signals to be recorded. Variations in the length of the trace is effectuated by amplitude modulating the deflecting voltages applied to the deflecting elements of the cathode ray tube by the sound signals, whereby the amplitude of the deflecting voltages, and consequently the length of the trace on the cathode ray tube screen, is correlative with the sound signals. The trace is then recorded on a photosensitive film which is moved at a preferably constant rate of speed across the face of the cathode ray tube, in a direction transverse to the trace.

Since the intensity of the electron beam in the cathode ray tube is substantially constant, variations in the width of the trace, in the manner set forth above, varies the electron density on the screen, and consequently the trace varies in illumination. This decreases the density of the exposed portion of the film as the width of the exposed portion is increased, thereby reducing the sensitivity of the sound track.

The sound recording system of the present invention employs a cathode ray tube having a screen of short persistence and deflecting circuits for continuously deflecting the electron beam between predetermined limits, to provide a single illuminated line or trace on the cathode ray tube screen. A voltage is also applied to the cathode ray tube control grid to effectuate blanking of the electron beam during a portion of each sweep interval, in accordance with the instantaneous amplitude of the signal to be recorded. For this purpose, a signal correlative with the instantaneous position of the electron beam is utilized to blank the electron beam during a portion of each sweep interval, the signal to be recorded controlling the portion of the sweep interval during which the electron beam is blanked.

In order to provide a trace the length of which varies equiproportionately from the mid-point thereof and thereby provides a variable area recording which may be used in conventional sound-on-film reproducing systems, a pair of oppositely phased voltages having amplitudes correlative with the instantaneous deflection of the cathode ray beam are utilized. These voltages are such that one voltage is a minimum and the other a maximum at the beginning of the sweep of the electron beam, the voltages varying in amplitude inversely in accordance with the deflection of the electron beam and respectively approach a maximum and a minimum at the end of each sweep. The oppositely phased voltages are each applied to an electron discharge device so as to render the associated discharge device conducting when the voltage applied thereto exceeds a predetermined value. The levels of the oppositely phased voltages are varied in accordance with the instantaneous amplitude of the signal to be recorded, whereby the discharge devices are each rendered conducting for variable periods at relatively opposite end portions of each sweep interval, the duration of the periods being dependent upon the amplitude of the signal to be recorded. Conduction in either of the discharge devices reduces the potential on the control grid of the cathode ray tube, thereby blanking the electron beam during a variable portion of the sweep interval.

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An important object of this invention is to provide a sound track recording system which can record signals from 0 to 20 kilocycles with high fidelity and flat frequency response over the entire range of the sound signals.

Another object of this invention is to provide a cathode ray tube type sound track recorder for producing a variable area photographic record of the sound signals, the exposed portion of which photographic record is of uniform density.

A further object of this invention is to provide a cathode ray tube type sound track recorder in which the electron beam is continuously deflected between predetermined limits and in which the electron beam is extinguished during a portion of each sweep interval in accordance with the signal to be recorded, to thereby provide a trace on the cahode ray tube screen of uniform intensity which varies in length in accordance with the signals to be recorded.

Yet a further object of this invention is to provide a cathode ray tube type sound recorder in which width of the trace is varied equiproportionately from the midpoint thereof in accordance with the sound signals to be recorded.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing:

The drawing is a schematic diagram of a cathode ray tube type sound track recorder of the present invention. Reference is now made more particularly to the drawing wherein there is illustrated a cathode ray tube 10 for scanning a moving film 11. As is conventional, a cathode ray tube includes a thermionic source of electrons such as the heater 12, which is energized from a suitable source [not shown], a cathode 13, a control grid 14, first and second anodes 15 and

16 respectively and deflection plates 17. Although a cathode ray tube of the type which employs electrostatic focusing and deflection is illustrated, it is to be understood that a cathode ray tube of the type employing electromagnetic focusing and deflection may be utilized without departing from the scope of the invention.

The first anode 15 is maintained at a predetermined negative potential with respect to the second anode 16 by source B_1, and the cathode 13 is maintained at a negative potential with respect to the first anode by source B_2. The relative potentials between the first and second anodes 15 and 16 respectively and the cathode 13 are chosen such that the electrons from the cathode are focused to a fine spot on the screen 19 which has an electron sensitive coating thereon. The electron beam is cyclically deflected between predetermined limits by a deflecting voltage from the wave generator 18 which is applied to the deflecting electrodes 17. The deflecting voltage is preferably such as to cause the electron beam to be deflected linearly with respect to time across the screen 19, and in a cathode ray tube of the type illustrated employing electrostatic deflection, such voltage will be of the saw-tooth type. In the event a triangular shaped saw-tooth voltage is applied to the deflection plates 17, the electron beam will traverse the screen 19 at a uniform rate in one direction to a predetermined limit of deflection determined by the amplitude of the deflecting voltages and produce one sweep, and then traverse the screen in the opposite direction and produce a second sweep. Alternatively, a saw-tooth voltage of the type which rises linearly to a maximum and decays rapidly, may be utilized, in which event only one sweep will be produced during each cycle of deflecting voltage, the "retrace" line produced on the decay of saw-tooth voltage producing negligible excitation of the screen 19. The term "sweep" as used in the specification and claims refers to the continuous non-reversing deflection of the cathode ray beam from one position to a second position and which is of a nature such that an appreciable line or trace is formed on the face of the screen 19 as a result thereof. The term "sweep interval" connotes the time interval during which the sweep occurs. In the preferred form of the invention, the deflecting voltage from the wave generator 18 is applied in push-pull to the deflecting plates, the deflecting plates being maintained at proper potential with respect to the second anode to prevent defocusing of the electron beam. In the circuit illustrated, the second anode is at ground potential and hence the deflecting electrodes may be energized by the push-pull output of the wave generator 18 when the latter has the center-tap [not shown] of the output thereof at ground potential. A slitted mask 21 may be positioned in front of screen 19, to more sharply define the trace, and the image of the trace is projected, either directly or through the intermediary of a lens [not shown] on the photosensitive film 11 which is moved at a preferably constant rate of speed in a direction transverse to the trace. For this purpose, the film 11 which disposed on spools 22 and 23 may be advanced by a sprocket [not shown], which engages the track 24, as is conventional.

In order to effect blanking of the electron beam during a portion of each sweep, the output of the wave generator 18, which is preferably of the push-pull type, is applied through resistors 25 and 26 to the control grids of cathode-follower connected triodes 27 and 28 respectively. The output of the wave generator is also applied across a potential divider comprising resistors 29 and 31 having a center tap 32 therebetween. The signals to be recorded from the signal source 33, such as a microphone or the like, are applied to the tap 32, negative grid bias for tubes 27 and 28 being provided by battery B_4. The cathodes of tubes 27 and 28 are respectively connected through cathode resistors 34 and 35 to a negative bias supply source B_5, the positive side of which supply source is grounded. The output of tubes 27 and 28 which is taken across the cathode resistors 34 and 35 thereof, is applied through resistors 36 and 37 to the control grids of tubes 38 and 39. Plate potential for tubes 38 and 39 is provided by plate supply source B_6 and is applied through resistor 41 to the plates thereof, the screen grids of tubes 38 and 39 being maintained at the proper positive potential as by the tap 42 on plate supply source B_6. The potential of bias source B_5 is chosen such that in the absence of a signal of proper amplitude applied to the control grids of tubes 27 and 28, the tubes 38 and 39 are maintained non-conducting. In the non-conducting condition of tubes 38 and 39 the plate potential thereof is high, and a positive pulse is supplied through blocking condenser 43 to the control grid 14 of the cathode ray tube 10. When the instantaneous sum of the deflecting voltages from the wave generator 18 which are applied in push-pull to the grids of tubes 27 and 28, and the signal voltage which is applied to the mid-point 32 of the potentiometer comprising resistors 29 and 31, becomes sufficiently positive in either half of the dual circuit, either the tube 38 or the tube 39 becomes conducting, and the plate potential thereof is reduced by the current flow through load resistor 41, whereby a negative pulse is applied to the control grid of the cathode ray tube. Since the positive pulse on the control grid 14 turns on the cathode ray tube, while a negative pulse extinguishes the electron beam, it is apparent that the cathode ray tube screen is excited only when the deflecting voltage applied to either of the tubes 27 or 28 is near zero, and that the beam is extinguished at the extremes of its sweep. The point at which the transition occurs is controlled by the potential of the mid-point of the grid voltage of tubes 27 and 28.

A pair of diodes 44 and 45 are provided, and serve as voltage limiters to clip the pulses on the grid of the cathode ray tube to uniform height. For this purpose the cathode of tube 45 is maintained at the same potential as the cathode 13 of the cathode ray tube 10, by being connected thereto and the plate of diode 44 is maintained at a negative potential with respect to the cathode 13 of the cathode ray tube by source B_3.

In operation, the electron beam produced in the cathode ray tube 10 is continuously deflected between predetermined limits by the deflecting voltage from wave generator 18 which is applied to deflecting electrodes 17 in the cathode ray tube to thereby produce a linear trace on the screen 19. Tubes 27 and 28 are operated push-pull by the output of the wave generator, whereby the potential on the control grid of one of the tubes, such as 27, due to the deflecting voltage, will be decreasing from a maximum, while the voltage on the control grid of the other tube will be increasing towards a maximum during each sweep of the electron beam.

The potentials on the control grids in tubes 27 and 28 are thus a maximum at relatively opposite end portions of the sweep interval. The fre-

quency of the wave generator is high as compared to frequency of the signal source, whereby the signal to be recorded, which is applied at tap 32 effectively raises or lowers the level of the saw-tooth voltage applied to the control grids of tubes 27 and 28. Since the change in the signal voltage during each sweep cycle will be small, it will be appreciated that the grid bias on tubes 27 and 28 and consequently conduction through both tubes 27 and 28 will be increased or decreased by substantially the same amount, in response to a corresponding increase or decrease in the amplitude of the signal from source 33. Bias supply source B_5 normally maintains tubes 38 and 39 non-conducting, the negative grid bias on tubes 38 and 39 being decreased as the conduction through the associated tubes 27 and 28 increases. The grid voltages on tubes 38 and 39 are thus inversely related, and vary with time in accordance with the time variation of the deflecting voltage from the wave generator 18. Additionally, the grid voltages on tubes 38 and 39 are raised and lowered in accordance with the instantaneous amplitude of the signal from source 33, and by proper choice of the value of the bias from source B_5 with respect to the cut-off potential of tubes 38 and 39, it will be appreciated that the tubes 38 and 39 may be made to conduct only when instantaneous sum of the signals from the wave generator 18 and the signal source 33 exceeds a predetermined value whereby the time interval of conduction through either of these tubes will be either increased or decreased in accordance with the signal to be recorded. Since tubes 38 and 39 are operated in push-pull, it will be appreciated that each of these tubes conduct once during each sweep, at relatively opposite end portions thereof. Thus each of the tubes 38 and 39 are rendered conducting at opposite end portions of the sweep interval, for a period determined by the instantaneous amplitude of the signal from source 33, and apply a negative pulse through coupling condenser 43 to the control grid 14 of the cathode ray tube 10. The electron beam through the cathode ray tube is thus blanked at opposite end portions of the sweep, whereby there is provided a trace on the screen thereof, the length of which varies equiproportionately from the mid-point of the trace in accordance with the signal from source 33.

The diode 45 having the plate thereof coupled to the control grid 14 of the cathode ray tube and the cathode thereof maintained at virtually the same potential as the cathode 13 of the cathode ray tube 10, thus serves to maintain the control grid 14 of the cathode ray tube at very nearly cathode potential. Diode 44 which has a cathode thereof connected to the control grid 14 and the plate thereof maintained at a slightly more negative potential than the cathode 13, thus "clips" the peaks of the negative pulses which are applied to the control grid 14.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is desired to be secured by Letters Patent of the United States is:

1. A signal recording apparatus comprising a cathode ray tube including means for producing an electron beam, a control grid and a screen, means including a sweep voltage generator for causing said electron beam to sweep across said screen and produce a visible trace thereon, means including a pair of discharge devices having control electrodes for applying an electron beam blanking pulse to the control grid of said cathode ray tube in response to conduction through either of said devices, means for applying opposedly phased voltages correlative in amplitude with the sweep voltage in push-pull to said control electrodes, means responsive to the signal to be recorded for varying the amplitude of the voltages applied to said control electrodes to thereby vary the time intervals of conduction through said discharge devices, and means for producing a time record of the traces on said screen.

2. The combination of claim 1 including means for limiting the amplitude of the beam blanking pulses applied to said control grid of said cathode ray tube.

3. A signal recording apparatus comprising a cathode ray tube including means for producing an electron beam, a control grid and a screen, means including a sweep voltage generator for causing said electron beam to sweep across said screen and produce a trace thereon, circuit means including a pair of normally non-conducting grid-controlled electron discharge devices connected in parallel and including a load impedance therefor, means including a capacitor for applying the voltage across said load impedance to said control grid of said cathode ray tube, means including an asymmetrical conducting device for limiting the amplitude of the positive pulse applied to said control grid of said cathode ray tube, means for applying the sweep voltage from said generator in push-pull to the control grids of said discharge devices, means including a potential divider for varying the amplitudes of the voltages applied to the control grid of said discharge devices in accordance with the instantaneous amplitude of the signal to be recorded to thereby render said discharge devices conducting during variable portions of each sweep interval, and means for producing a time record of the traces on said screen.

4. The combination of claim 3 wherein said sweep voltage applying means includes a cathode follower stage for coupling each of said discharge devices to said sweep voltage producing means.

5. The combination of claim 3 including means for limiting the amplitude of the negative pulses applied to said control grid of said cathode ray tube in response to conduction in either of said discharge devices.

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