FIG. 1

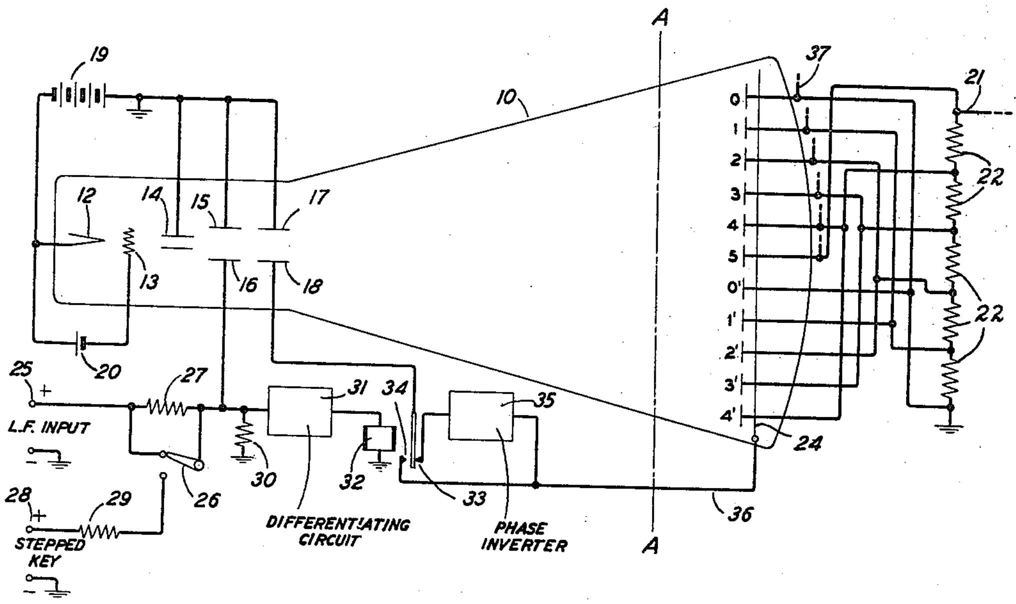
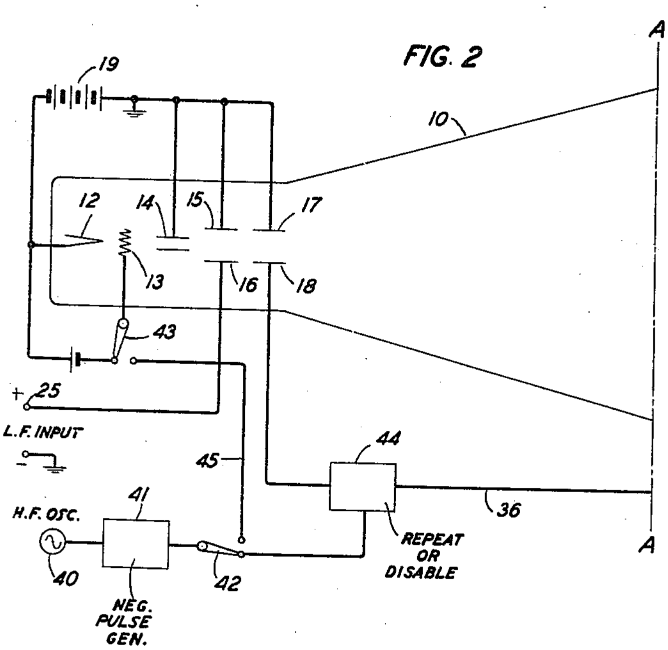


FIG. 2



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CATHODE BEAM TUBE CIRCUIT HAVING MEANS FOR CONVERTING CURRENT VARIATIONS TO STEPPED WAVEFORM

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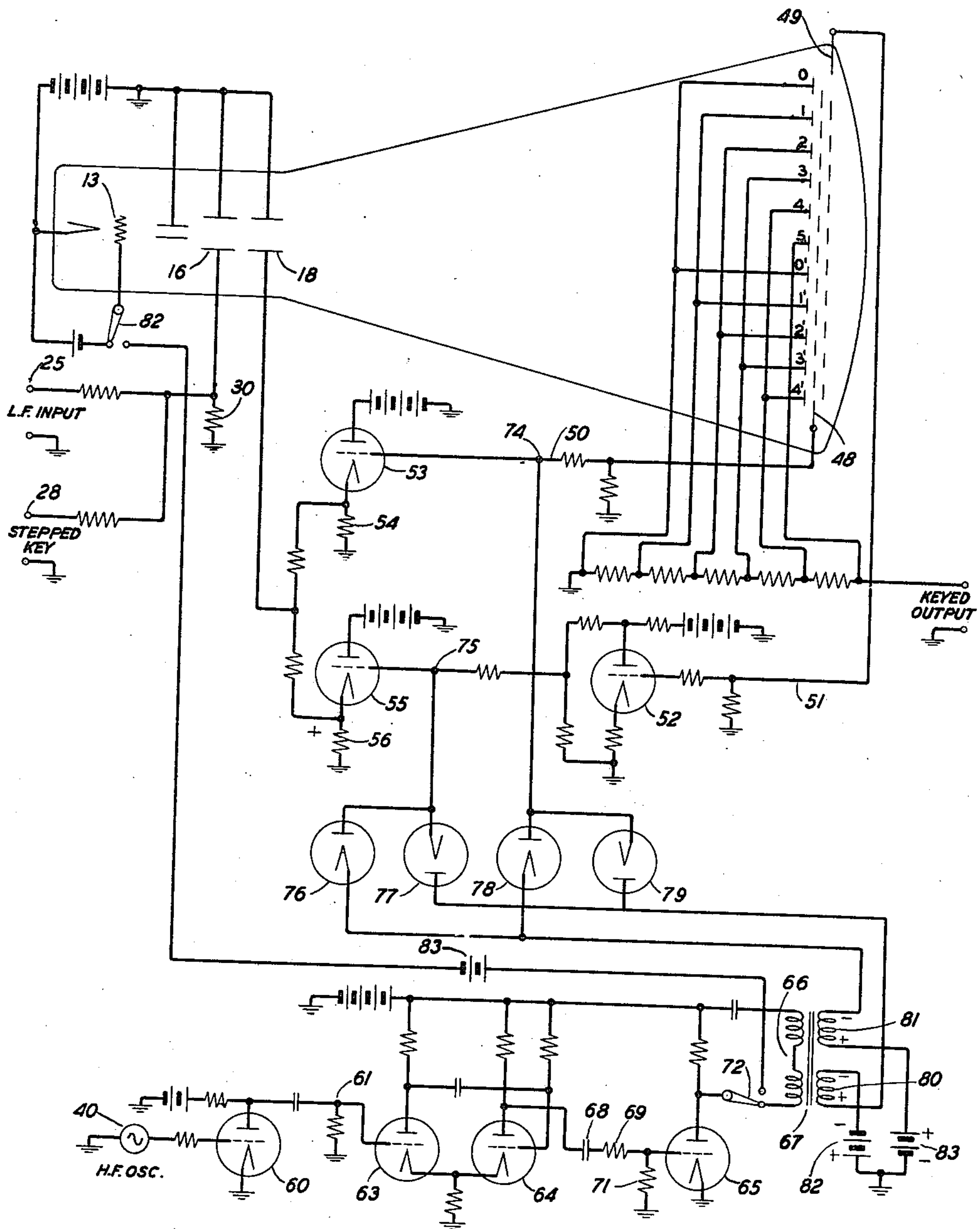
FIG. 3



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3,076,146
CATHODE BEAM TUBE CIRCUIT HAVING MEANS FOR CONVERTING CURRENT VARIATIONS TO STEPPED WAVEFORM

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10 Claims. (Cl. 328—186)

The present invention relates to electrical signaling and more particularly to means for converting current variations to stepped wave form.

In accordance with the present invention, a cathode beam tube having a plurality of targets is used as the means for producing an output wave varying in steps, and auxiliary electrode means is used together with auxiliary circuit means for preventing the beam from splitting between two adjacent targets.

Objects of the invention are greater accuracy and certainty of operation with improved fidelity of output relative to input variations.

The nature and objects of the invention will be more fully understood from the following detailed description in connection with the attached drawings in which:

FIG. 1 is a schematic representation of a cathode beam tube embodying the invention in one form;

FIG. 2 shows a modification of the portion of FIG. 1 to the left of the line A—A; and

FIG. 3 is a schematic representation of a beam tube and circuit therefor according to a further embodiment of the invention.

In FIG. 1 the glass envelope 10 encloses a cathode 12, grid 13, and accelerating and focusing electrode 14 for projecting a well defined thin beam toward the right in the figure between the pairs of deflecting plates 15, 16 and 17, 18. Polarizing batteries 19 and 20 are shown for the cathode and grid. At the right hand end of tube 10 is an array of targets, shown as eleven in number by way of illustration, and designated individually by the numbers 0 to 5 and 0′ to 4′ in succession. These numbers also designate the step value of the output current that is produced in output circuit 21 when the beam is impinging on a respective target. The step value of this output current is determined by the number of equal resistors 22 through which the target current flows in series to ground.

The targets are placed as close to one another as feasible and the beam is shaped to have a cross-section that is very narrow in the vertical direction although it may be spread out horizontally so as to be of sheet form. In order to produce well defined steps of output current it is desired that the beam should not split between targets but that it should always entirely fall on some one target. To help to insure this, a back electrode 24 extends across the tube behind the targets so that whenever the beam or any portion of it passes between two targets it strikes this back electrode and places a voltage on it which can be fed back to deflecting plate 18 to urge the beam toward an adjacent target.

The electrodes 15 and 17 are shown grounded while opposite electrodes 16 and 18 are arranged to have different voltages placed upon them to cause the beam to be deflected vertically in the plane of the paper.

It is assumed for illustration that the signal applied at 25 is a varying direct current, of positive polarity. When this is applied, it causes the electrode 16 to move the beam downwardly from its assumed normal position on target 0. If necessary a bias (not shown) can be used to cause the beam to strike the target 0 when no signal is being applied at 25. A switch 26 when in the position shown short-circuits resistance 27, and when in its alternate position it connects a source of stepped key waves at 28 in parallel with the signal current source so that the signal and key voltages are added and their summation voltage is applied to electrode 16. High series resistors 27 and 29 cooperate with resistor 30 in adding the signal and key voltages on electrode 16. These key currents can be obtained in any suitable manner and can for example be prepared in advance and recorded on a phonograph or other record in the manner disclosed, for instance, in Newby-Vaughan application Serial No. 456,356 filed August 27, 1942.

With the switch 26 in the position shown, only the low frequency direct current signals are effective on the tube. These consist of rising and falling portions and it will be assumed for illustration that their total range of variation is just sufficient to move the beam from target 0 to target 5 as a maximum. During a rising portion of the signal, relay 32 is assumed to be deenergized and a feedback circuit exists from electrode 24 through phase inverter 35 and relay contact 33 to deflecting plate 18. The polarity of this feedback is such as to tend to move the beam downward, that is in the same direction that the signal is tending to move the beam, since the signal is assumed to be rising in value. This feedback exists, as stated, only when the beam or part of it leaks past the edge of a target and strikes electrode 24. As a result, the beam is caused to shift quickly across to the next target as soon as it reaches the edge of the preceding target and starts to impinge on electrode 24. In this action the feedback is assumed to be relatively strong so that when a small amount of the beam reaches electrode 24 the feedback takes over control and shifts the beam to the next target.

If the signal changes from rising to falling, it is necessary under the assumptions made with respect to FIG. 1, to change the sign of the feedback since otherwise the signal would not be able to move the beam from one target to the next lower-numbered target in the figure if the feedback were such as to move the beam downward when the beam is between targets. Accordingly, a differentiating circuit 31 is provided for distinguishing between rising and falling signal current and for causng operation of the relay 32 only in response to falling values of signal. It may be of known type comprising a condenser and resistance in series with each other with a unidirectional connection from the resistance to the winding of the relay, such as a rectifier poled to furnish energizing current to the relay only in response to falling signals. By use of this relay and phase inverter 35 (which may be a grid-controlled vacuum tube stage, for example) the polarity of the feedback is changed in going from rising to falling signals or vice versa.

Instead of using the single output terminal 21 and the resistances 22, individual leads may be brought out through the envelope 10 from the targets, one of these leads being indicated at 37 as an alternative connection and other similar leads being shown for targets 1 to 5. When these six leads are thus brought out they may be connected to individual indicators such as relays or vacuum tubes and the device can be used as an analyzer since the leads are energized in accordance with the step values of the impressed signal. To indicate one use for such a circuit, the signal may be the varying direct current speech defining wave obtained from one channel of a Vocoder system, an example of which is shown in H. W. Dudley Patent 2,151,091 granted March 21, 1939. In accordance with that disclosure speech waves are analyzed into pitch defining and spectrum defining waves in the form of slowly varying direct currents in a plurality of parallel channels. In connection with speech privacy or other systems, it is sometimes desired to analyze each one of these speech defining waves in terms of the number of steps of amplitude which the wave comprises either from time to time or in continuous manner by energizing individual circuits representing respective step values. This may be done by the circuit of FIG. 1 as above described.

If it is desired to add a stepped key the switch 26 is thrown to its alternate position as already stated. Assuming that the signal (which may in this case also be the variable direct current signal in a Vocoder channel) as before has a total range of 0 to 5 steps of amplitude, and that the key also has a similar total range of amplitude, the summation of signal plus key will have a total range of 0 to 10 steps. The circuit of FIG. 1 will then convert the summation wave into a stepped output wave (using the resistors 22) in output circuit 21 varying from 0 to 5 steps, the reduction in range representing a reentry operation performed by virtue of the parallel connection within the tube of pairs of targets similarly numbered, one unprimed and one primed, e.g. targets 0 and 0′, 1 and 1′ etc. The circuit otherwise operates as already described.

The embodiment shown in FIG. 1 has a certain amount of hysteresis as may be seen from the fact that a given value of signal which corresponds to a beam position half way between two adjacent targets will in the case of a rising signal move the beam to the next higher value of target while the same value of signal in the case of a falling signal will move the beam to the next lower value of target. This effect is obviated in the other embodiments disclosed in FIGS. 2 and 3.

Referring to FIG. 2, provision is made for disabling the feedback intermittently at a rate that is high in comparison with the rate of signal variation. For this purpose an oscillator 40 is used, feeding into a pulse producer 41 which applies negative pulses via switch 42 either to the disabler 44 in the feedback connection 36 or to the grid 13 if switch 43 is in its alternate position. With the switches 42 and 43 in the positions shown the feedback connection is interrupted while with these switches in their alternate position the beam is interrupted. In either case the polarity of the feedback remains the same for both rising and falling signals, and it may be given either polarity. If the signal strength at a given instant is such as to place the beam between targets 3 and 4, for example, the beam will always be thrown to a particular one of these targets depending upon which polarity of feedback is used. The signal alone determines the beam position (actual or virtual) in the instants when the feedback action is absent due to interruption at either 44 or 13. The device 44 may comprise a grid-controlled vacuum tube with connections for applying the negative pulses from 41 to the grid to drive the grid potential beyond cut-off, by way of one example.

In FIG. 3 the tube is provided with a pair of back plates 48 and 49 in the form of grids having horizontal conducting slats, seen end-on in the figure, staggered so that the slats of grid 48 overlap the lower edges of the targets and extend part-way across the inter-target space while the slats of grid 49 overlap the upper edges of the targets and extend across the rest of the inter-target space not covered by the slats of grid 48. If the beam is pictured as drifting downward off the lower edge of a target it strikes one of the grid slats of electrode 48. If it drifts the opposite way it strikes one of the grid slats of electrode 49.

Grid 48 is connected to one feedback path 50 and grid 49 is connected to a second feedback path 51 which includes a phase inverter tube 52. When the beam strikes any one of the parts of grid 48, a negative potential is fed back to the grid of tube 53 and is repeated through this tube via cathode resistor 54 and impressed on deflector plate 18. This voltage tends to deflect the beam upwards in the figure, that is, to hold it in register with

a target against a tendency to drift in the downward direction. If the beam strikes any portion of grid 49, the negative potential produced is inverted in stage 52 to a positive potential which is repeated by tube 55 as a positive potential via cathode resistor 56 and is impressed on electrode 18 tending to deflect the beam in the downward direction in the figure. By means of these two back electrodes 48 and 49, therefore, the beam is entrapped on a particular target until an interruption occurs in the beam or in the feedback path. The beam is then free to be positioned on any target under control of the signal.

For interrupting the beam or feedback path, oscillator 40 is provided followed by limiter tube 60 which produces square-topped waves. These generate positive pips of voltage at point 61 which are applied to the grid of the first tube 63 of the single trip multivibrator 63, 64. Tube 64 is normally transmitting saturation current and the space current of tube 63 is cut off. The application of the positive pulse to the grid of tube 63 operates in the well understood manner to cut off tube 64, which then applies a positive pulse of definite duration, determined by the time constant of the circuit, to the grid of tube 65. This is a power tube for producing pulses in the primary winding 66 of balanced transformer 67. Tube 65 is self-biased by the charge on condenser 68 caused by the flow of grid current from the plate of tube 64 when this tube is cut off and its plate is at its highest positive potential, through condenser 68 and resistor 69 in series to the grid of tube 65. When tube 64 conducts, condenser 68 discharges through resistors 69 and 71 in series. The time constant of this circuit is proportioned to cause definitely timed pulses of definite duration to flow through the primary winding 66, via closed switch 72.

Diodes 76, 77, 78 and 79 normally receive cut-off bias from batteries 82 and 83 so that they then have no effect on the feedback paths 50 and 51. Pulses in secondary windings 80 and 81, however, oppose the bias voltages from batteries 82 and 83. Due to circuit balance, a ground potential is established at points 74 and 75 preventing transmission of feedback voltage to the grids of tubes 53 and 55. In this way the feedback paths are disabled.

Instead of disabling the feedback paths, the beam can be suppressed by application of negative pulses to grid 13. These can be derived from the plate of tube 65 when switches 72 and 82 are thrown to their alternate positions from those shown. Battery 83 is for bias purposes.

What is claimed is:

1. In combination, a cathode beam tube having beam forming means, an array of targets on which the beam may impinge one at a time when the beam is deflected by different amounts, beam deflecting means to cause the beam to impinge on selected targets, a source of signal current variations connected to said beam deflecting means to cause variable deflection of the beam, an auxiliary electrode adjacent said array of targets, on which the beam impinges when between two adjacent targets, a circuit leading from said auxiliary electrode for impressing a voltage on said deflecting means to cause the beam when impinging on said auxiliary electrode to be influenced away from said auxiliary electrode and toward an adjacent target, and means for making the impression of such voltage upon said deflecting means intermittent.

2. In a signaling system, a source of signal currents having rising and falling portions, a cathode beam tube having beam forming means and beam deflecting means, a plurality of targets to which the beam can be deflected, indicator means connected to said targets, means to impress said signal currents on said deflecting means to cause said beam to strike one or another of said targets, auxiliary electrode means in said tube on which said beam may strike when not completely incident on one of said targets, circuit connections from said auxiliary electrode means to said deflecting means to feed back a voltage to said deflecting means in response to interception of

said beam by said auxiliary electrode means, means for distinguishing rising from falling portions of said signal currents, and means operated by said last means for introducing a phase reversal in said fed back voltage.

3. In a signaling system, a source of signal current variations, a cathode beam tube having beam-producing means, target means for intercepting the beam and beam deflecting means, connections for impressing the signal variations on said deflecting means to deflect the beam relative to said target means, a feedback path from said target means to said deflecting means for feeding back voltages thereto, and means for periodically interrupting the feeding back of said voltages at a rate that is high in comparison with said signal variations.

4. In a signaling system, a source of signal current variations, a cathode beam tube having beam-producing means, beam-deflecting means and target means on which the beam may strike when deflected by said deflecting means, an output circuit connected to said target means, auxiliary target means on which the beam may strike when not completely incident upon said target means, a feedback circuit for feeding back a voltage from said auxiliary target means to said deflecting means in response to the beam striking the former, and means for interrupting periodically the feeding back of said voltage at a rate that is high in comparison with said signal variation.

5. The invention claimed in claim 4 in which said interrupting means comprises an interrupting device in the feedback circuit, and a source of recurrent pulses for periodically actuating said device.

6. In a signaling system, a cathode beam tube having beam forming and beam deflecting means, target means on which said beam may strike when deflected, auxiliary target means on which the beam strikes when not in full register with said target means, two feedback paths connected between said auxiliary target means and said deflecting means, said feedback paths operative one only at a time, means in one of said feedback paths for causing the feedback voltage applied to said deflecting means by one of said paths to be opposite in phase to the voltage applied thereto by said other path, and means for rendering each of said paths intermittently operative during signaling.

7. In combination, a cathode beam tube having beam forming means and beam deflecting means, target means on which the beam impinges, two back electrodes on alternate sides of said target means, on one or the other of which said beam impinges when not fully in register

with said target means, two feedback paths leading from alternate back electrodes to said deflecting means, means in said paths for applying voltage of respectively opposite phase to said deflecting means from said respective paths, and means for rendering said paths operative one at a time to apply said voltages to said deflecting means.

8. In combination, a cathode beam tube having beam forming means and beam deflecting means, a plurality of targets on which the beam may be caused to impinge one at a time when deflected to various extents by said beam deflecting means, a first back electrode having portions adjacent analogous edges of said targets, a second back electrode having portions adjacent the other edges of said targets, said back electrodes being positioned to intercept the beam when it passes off one target toward the next, one feedback path from said first back electrode to said deflecting means and a second feedback path from said second back electrode to said deflecting means, means in said paths to cause said paths to apply respectively opposite voltage to said deflecting means, and means rendering said feedback paths inoperative in rapid succession.

9. The combination claimed in claim 8 in which said last means comprises a source of pulses, and disabling means in each path connected to said source of pulses and rendering said paths inoperative in response to said pulses.

10. The combination claimed in claim 8 in which said last means comprises a pair of rectifiers in parallel, oppositely poled with respect to each other, shunted across each path in series with batteries biasing said rectifiers against transmission, a source of pulses and means to use said pulses to counteract momentarily the bias voltages applied to said rectifiers and to cause said rectifiers thus to present low shunting impedances across said paths.

References Cited in the file of this patent

UNITED STATES PATENTS

2,159,818	Plaistowe et al.	May 23, 1939
2,224,677	Hanscom	Dec. 10, 1940
2,265,216	Wolf	Dec. 9, 1941
2,287,296	Dallos	June 23, 1942
2,305,646	Thomas	Dec. 22, 1942
2,313,209	Valensi	Mar. 9, 1943
2,358,902	Ziebolz	Sept. 26, 1944
2,390,250	Hansell	Dec. 4, 1945
2,417,450	Sears	Mar. 18, 1947