

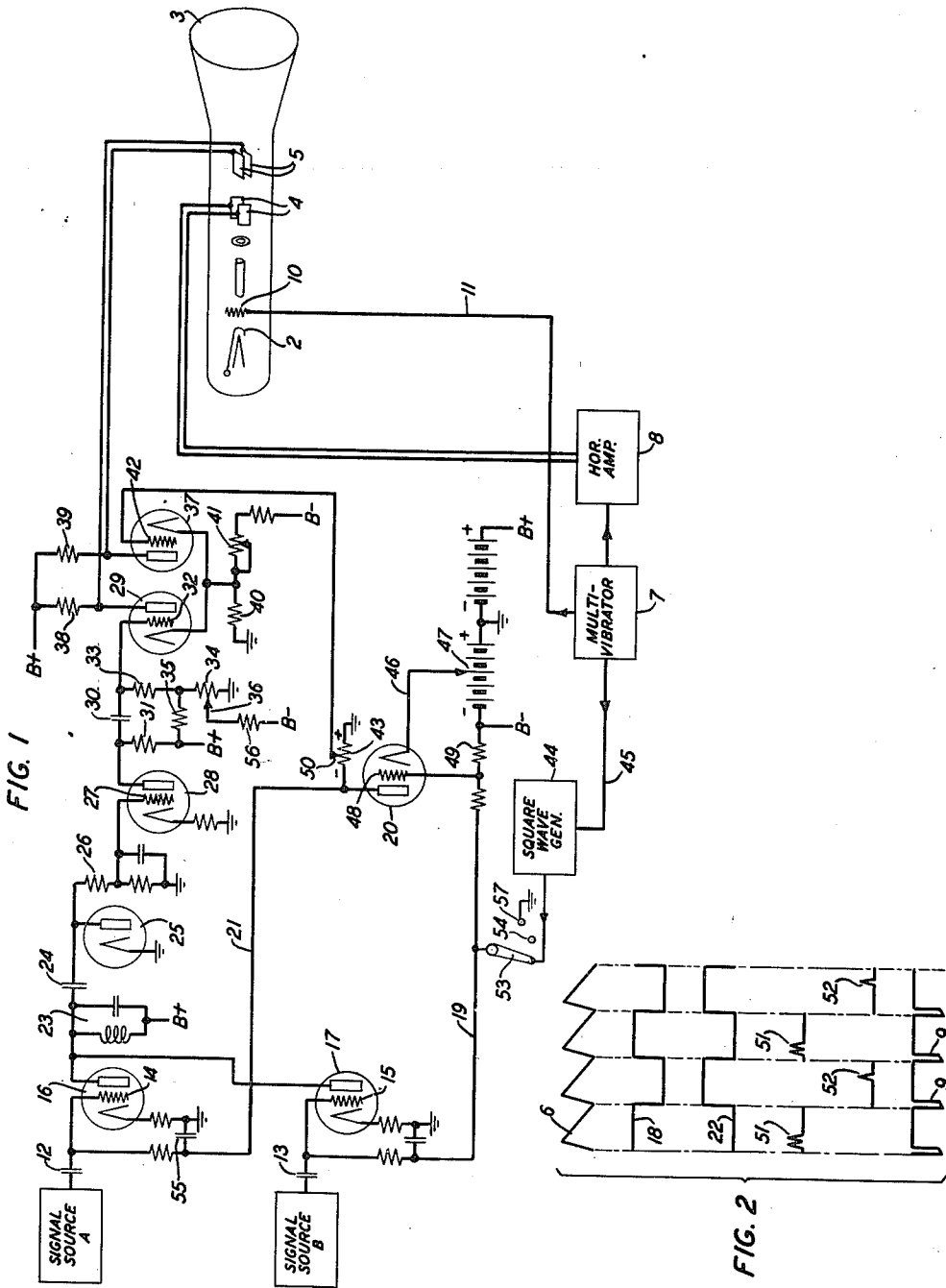
June 29, 1948.

T. L. DIMOND

OSCILLOSCOPE CIRCUIT

Filed June 4, 1945

2,444,338



BY *T. L. DIMOND*
G. H. Heydt.
ATTORNEY

UNITED STATES PATENT OFFICE

2,444,338

OSCILLOSCOPE CIRCUIT

Thomas L. Dimond, Rutherford, N. J., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application June 4, 1945, Serial No. 597,458

4 Claims. (Cl. 315-26)

1

This invention relates to cathode ray oscilloscopes of the type in which two signals are viewed substantially simultaneously in displaced relation on the same screen.

The object of the invention is an oscilloscope of this type which is capable of operating satisfactorily on very high frequency signals.

It is common practice in the oscilloscope art to use a single cathode ray tube for viewing two different signals simultaneously by connecting the vertical deflecting plates of the tube to the two signal sources alternately in cyclic succession, as for example by means of an electron switch. In these prior systems the patterns are separated in various ways some of which involve the use of extra tubes which increase the cost and complexity of the circuit. In other cases the operation of the beam shifting means produces transient effects which retard the motion of the beam and make the system unsuitable for high frequency applications.

According to this invention the beam is shifted from one position to the other, in synchronism with the switching between the two signal sources, by changing the grid bias on one of the tubes associated with the deflection plates of the oscilloscope. This change in bias is made in a portion of the circuit where there are no capacities large enough to introduce a time constant which would appreciably retard the changes in static grid potential produced by the switching operation.

It is well understood in the art that the deflecting plates are preferably excited from a balanced circuit which may be of any suitable type such as the cathode phase inverter described on page 118 of "Time Bases" by Puckle, published 1943 by Chapman and Hall, Limited, of London. The present invention is readily applicable to a system of that type since the different biases required may be applied to the grid of the inverter tube which is normally conductively connected to ground.

A further advantage of shifting the beam in this particular manner is that when the oscilloscope is energized continuously from either one of the signal sources, the signal pattern produced by that source appears and remains in the same position as it occupies when both signals are being observed.

In the drawing, Fig. 1 shows an oscilloscope according to the invention and Fig. 2 is a series of wave forms showing the voltage variations in different parts of the circuit.

In Fig. 1 the conventional cathode ray tube

2

1 projects a beam from the cathode 2 to the screen 3 between the horizontal deflecting plates 4, 4 and the vertical deflecting plates 5, 5. A sweep voltage wave 6 (Fig. 2) from the multivibrator 7 is applied to the horizontal plates through the usual amplifier 8 and the retrace is blanked out by blanking pulses 9, 9 (Fig. 2) applied from the multivibrator to the grid 10 of the tube at appropriate times over the conductor 11, all in the well-known manner.

The signals to be observed are transmitted from the sources A and B through condensers 12 and 13 to the grids 14 and 15 of the tubes 16 and 17, respectively. These tubes function as an electron switch for transmitting signal pulses alternately from the sources A and B in cyclic sequence in the usual manner. For this purpose a conventional square wave generator 44 controlled by the multivibrator 7 over the conductor 45 generates an output wave 18 which varies at the sweep frequency as indicated in Fig. 2. This square wave is applied directly to the grid 15 over conductor 19 and through a phase reversing tube 20 and conductor 21 to the grid 14 which is then subjected to potential variations according to the wave 22. It is then clear that with the waves 18 and 22 of suitable amplitudes the tubes 16 and 17 will conduct on alternate pulses of the wave 18 and will be biased to cut-off by the other alternate negative pulses of the respective waves.

In this system it is assumed that the outputs of the sources A and B are modulated carrier waves of some high frequency such as 455 kilocycles per second and that the plate circuits of tubes 16 and 17 are energized from the power supply through a network 23 which is sharply anti-resonant at the carrier frequency so as to transmit the modulated signals at high efficiency and at the same time attenuate other extraneous frequencies.

The output circuits of the tubes 16 and 17 are coupled through a condenser 24 to a diode detector 25 and associated voltage dividing resistor 26 so that the demodulated signals are applied at suitable level to the grid 27 of an amplifying tube 28. Since the application of the square wave pulses to the tubes 16 and 17 produces transient disturbances which would otherwise obscure the signal patterns to be observed on the screen 3, the circuit constants must be such that these transients have effectively disappeared during the retrace of the beam under the control of the blanking pulses 9, 9. The output circuit of the tube 28 is coupled to the input

circuit of tube 29 by a condenser 30 and the plate of the tube 29 is connected through the plate resistor 31 to a point of suitable positive potential in the power supply as indicated. The grid 32 of the tube 29 is connected to ground through resistor 33 and the potentiometer 34. Positive potential is applied to the grid 23 through resistor 35 and the arm 36 of the potentiometer is connected through a resistor 56 to a source of potential negative with respect to ground. With resistors 35 and 56 of the proper values the static potential of grid 32 of the tube 29 can be made either positive or negative with respect to ground to position the beam on the screen 3 of the tube 1.

The tubes 29 and 37 are connected as a cathode phase inverter in which the signal potentials are applied to grid 32 as stated above and the normally balanced output across the plate resistors 38 and 39 is applied to the deflection plates 5, 5 as shown. The cathodes of the tubes 29 and 37 are connected to ground through the common resistor 40 and to the source of negative potential through a variable resistor 41 for adjusting the plate to cathode voltage of the tubes to the proper value.

In order to separate the signal traces from each other on the screen the grid 42 of the inverter tube 37 is connected to an adjustable point on the resistor 43 which forms a conductive path from the plate of tube 20 to ground as shown. Plate voltage for the tube 20 is supplied by connecting the cathode 46 to a point 47 in the power supply which is at a suitable negative potential with respect to the grounded plate. When the potential from the square wave generator 44 is negative, the grid 48, which is connected through resistor 49 to the negative terminal of the power supply, biases the tube to cut-off and the grid 42 of tube 37 is therefore at ground potential.

In operation, the zero potential pulses of the output wave 18 of the square wave generator 44 will unblock the tubes 17 and 20 thereby connecting signal source B to the cathode ray tube and driving the plate of tube 20 negative with respect to ground due to the potential drop produced by the plate current in the resistor 43. This drop in plate potential biases the tube 16 to cut-off thereby effectively disconnecting the signal source A from the cathode ray tube and at the same time driving the grid 42 of the inverter tube 37 to a suitable negative potential with respect to ground, as determined by the setting of contact 50.

This change in bias on the follower tube grid reduces the plate current of tube 37 with the result that there is a corresponding increase in the plate current of tube 29 due to the cathode follower action of the circuit. The potential of the plate of tube 37 is therefore increased and the potential of the plate of tube 29 is decreased with the result that the cathode beam is shifted toward the deflection plate connected to the tube 37.

Upon the negative pulses of the wave 18 from the generator 44 the tubes 17 and 20 are biased to cut-off, the signal source B is therefore effectively disconnected from the circuit and the corresponding positive pulses at the grid 14 of tube 16 due to the return of the plate of tube 20 to ground potential, will unblock the tube 16 and connect signal source A to the circuit.

The signals 51, 51 from the source B will therefore appear on the screen 3 during the positive pulses of the wave 18 and the signals 52, 52 from

the source A will appear during the positive pulses of the wave 22 as shown in Fig. 2. These two sets of pulses will be in vertically displaced relation, as indicated, by a distance proportional to the change in bias produced on the grid 42 by the action of the tube 20. It will be noted that since the changes in bias on the grid 42 are obtained from the circuit of the tube 20, which is required in any case for phase reversing purposes, no additional circuit elements are required. While the grid by-pass condenser 55 of tube 16 is in shunt to the resistor 43 of the phase reversing tube, this capacity is so small that it introduces no appreciable delay in the change of bias on the grid 42 from one value to the other and these changes occur almost instantaneously.

If it is desired to view only the signals from one of the sources, the switch 53 is operated to disconnect conductor 19 from the square wave generator 44 thereby stopping the cyclic operation of the electron switch. To view only signals from source A the switch is moved to an intermediate open position, such as on the contact 54, in which case conductor 19 and the grids 15 and 48 are biased negatively to B— potential and the tubes 17 and 20 are cut off. The grid 14 of the tube 16 and grid 42 of the tube 37 are then at ground potential and signals from the source A will be displayed in the normal manner with the beam in its down position as indicated by the pulses 52 of Fig. 2. When the switch 53 is moved to the grounded contact 57, the tubes 20 and 17 are then continuously in the same condition as when under the control of the positive pulses of the wave 18 from generator 44. That is to say, the blocking bias on tube 20 is reduced by the drop in potential in resistor 49 sufficiently to produce current in resistor 43. This potential negatively biases grid 42 with respect to ground to shift the cathode beam to its upper position and blocks the tube 16 to cut off the signals from source A. At the same time grid 15 of tube 17 is raised to ground potential thereby unblocking this tube and permitting the signals 51 to appear on the screen in their usual position so that there is no possibility of confusion as to the source from which the observed signal is derived.

The invention has been described in connection with a cathode phase inverter type of circuit which is preferred because of the simplicity with which the beam may be shifted in such a circuit, but the same fast action can be obtained also in systems using output stages having both the input and output circuits connected in push-pull. If, for example, the push-pull connected tubes are of a type having two control grids, the signals may be applied in push-pull to one control grid of each tube and the static biases on the other control grids may be switched in the same general manner as in the circuit shown. It will be noted, however, that in such a circuit the two biases must be changed in opposite senses but this can be effected very easily by deriving the second bias voltage from a voltage divider connected to ground from the output lead 19 of the square wave generator 44.

What is claimed is:

1. In an oscilloscope the combination with a cathode ray tube, two signal sources, an amplifier having an input circuit and two vacuum tubes having output circuits connected in push-pull to the cathode ray tube, and switching means for successively connecting the signal sources to the amplifier input circuit in cyclic sequence, of a grid in each of the vacuum tubes, circuits for biasing

5

the grids to position the beam of the cathode ray tube, at least one of the biasing circuits including stray capacities only and means in at least said one circuit for changing the bias on the grid in synchronism with the operation of the switching means to separate the patterns of the signals from the two sources.

2. In an oscilloscope the combination with a cathode ray tube, two signal sources, an amplifier including two vacuum tubes having plate, grid and cathode electrodes connected to form a cathode phase inverter with an input circuit and a balanced output circuit connected to one pair of deflecting plates in the cathode ray tube, and switching means for alternately connecting the signal sources to the input circuit, of means for determining the static bias between the grid and cathode of the inverter tube and means for adjusting the bias between two values in synchronism with the operation of the switching means to separate the reproductions by the cathode ray tube of the signals from the two sources.

3. In an oscilloscope a cathode ray tube, two signal sources, an amplifier having an input circuit, and output circuit terminals connected to the cathode ray tube, electronic switching means for successively connecting the signal sources to the input circuit in cyclic sequence, means for generating sweep voltage for the cathode ray tube, square wave generating means controlled by the sweep voltage generator for operating the switching means, and a circuit including stray

6

capacities only between the square wave generating means and the amplifier for cyclically changing the average relative potentials of the output terminals in synchronism with the operation of the electronic switching means to separate the patterns produced by the signals from the two sources.

4. In an oscilloscope, a cathode ray tube, two signal sources, an amplifier including two tubes each having grid, cathode and plate electrodes cathode-coupled to form a phase inverter with the plate electrodes connected to the cathode ray tube, electronic switching means for connecting the two sources to one of the grids in cyclic sequence, a source of control waves for operating the switching means and a path including stray capacities only, extending from the control wave source to the other grid for cyclically changing its potential to separate the signal patterns produced on the cathode ray tube by the signals from the two sources.

THOMAS L. DIMOND.

REFERENCES CITED

25 The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
30 Re. 22,672	Shumard	Aug. 28, 1945
2,208,254	Geohegan	July 16, 1940
2,221,115	Shepard, Jr.	Nov. 12, 1940
2,300,999	Williams	Nov. 3, 1942