

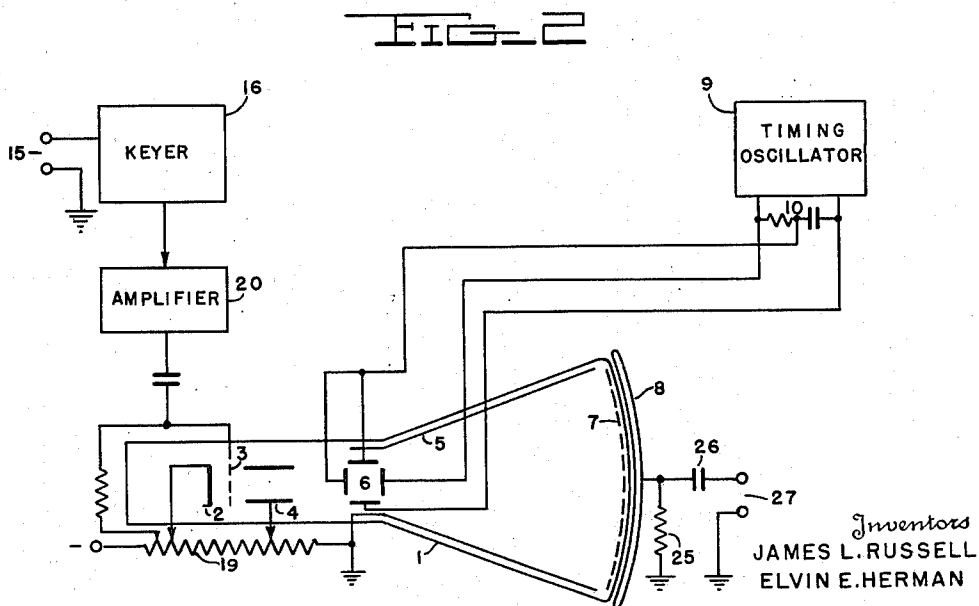
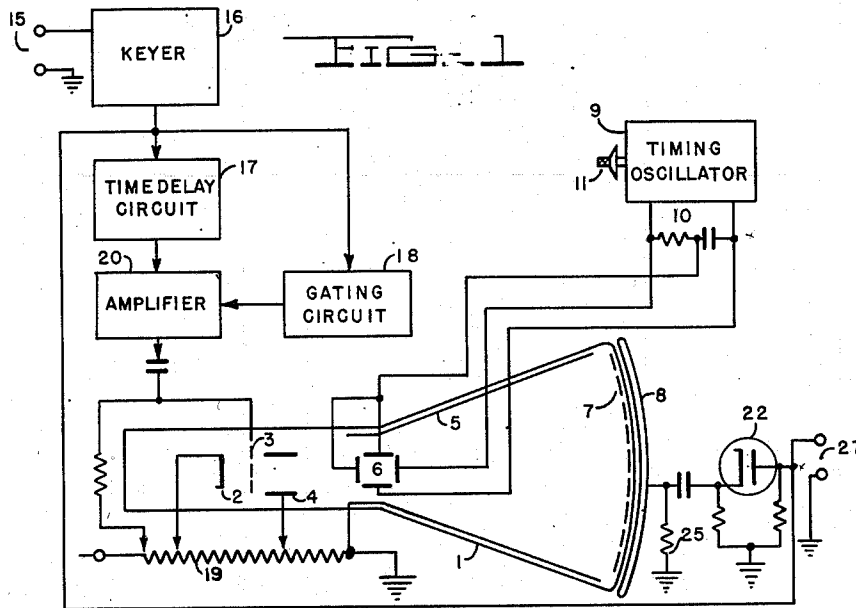
May 19, 1953

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FOR RADAR SYSTEMS AND THE LIKE

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Filed Dec. 16, 1943

2 Sheets-Sheet 1



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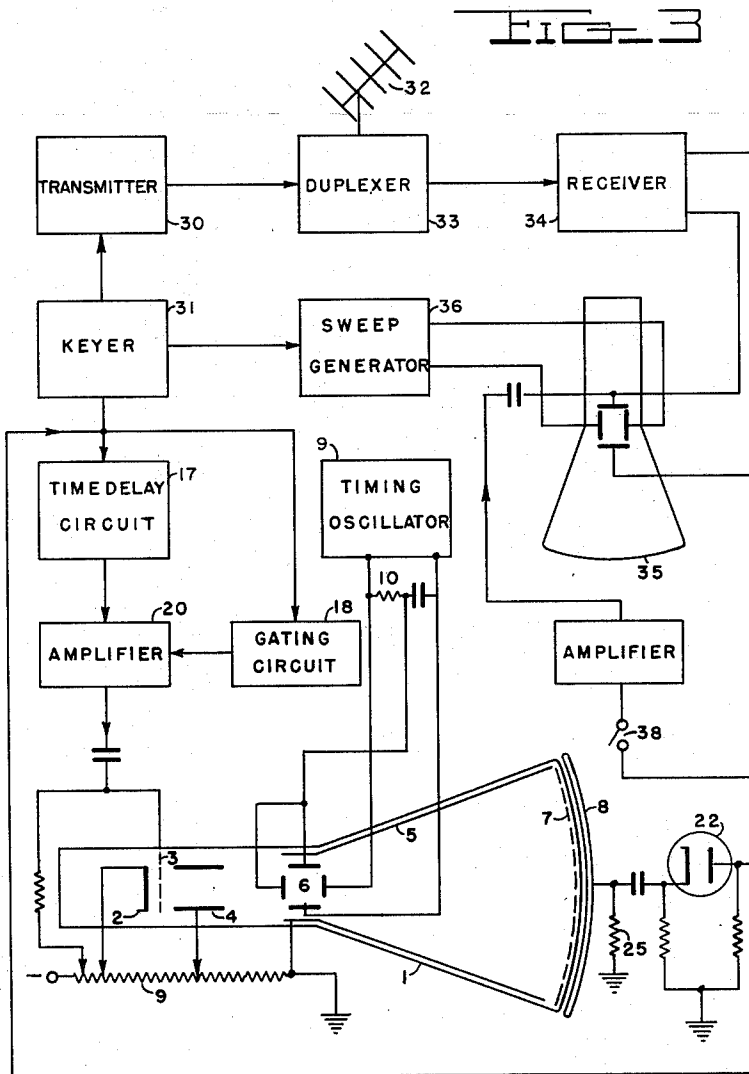
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CATHODE-RAY TUBE TIMING PULSE GENERATOR FOR RADAR SYSTEMS AND THE LIKE

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This invention relates to the generation of timing impulses and is particularly directed to the determination of the time interval separating two events.

Accordingly, it is an object of the invention to provide a timing impulse generator for generating a series of impulses inaugurated in definite time relation with an event.

It is a further object of the invention to provide a series of timing impulses of high accuracy.

Another object of the invention is to provide means for generating impulses spaced at a desired interval selected by adjustable control means.

A specific object of the invention is to provide means for calibrating the time base of an echo ranging system.

The invention provides for generation of timing impulses by scanning a charge pattern sustaining surface. The target surface is recurrently swept with an electron beam to establish a voltage distribution along the sweep path. The charge sustaining surface is provided with a conductive backing plate to enable a signal output to be taken off.

The charge sustaining surface may, for instance, be of the iconoscope mosaic type, although photoemission is of no advantage. A convenient arrangement employs a conventional cathode ray tube provided with a backing sheath consisting of a metallic foil or conductive coating. Such coating may be obtained by applying a carbon suspension such as "Aquadag" over the tube envelope at the end carrying the fluorescent screen. The phosphor itself is not necessary and the inner face of the tube need not be coated, although it is convenient to view the sweep locus on the inner face to the end wall to ascertain that the tube is operating properly.

The scanning beam establishes a potential under the spot which is in part a function of the beam current. Normally the current level is fixed, and therefore a uniform potential obtains along the sweep locus.

The beam, which is continuously swept, is modulated or deflected from the sweep locus by an impulse at the start of the timing period. This action establishes a departure at the scanning point from the distribution pattern potential of the locus, and on the subsequent sweep over the point generates an impulse in the target output circuit as the voltage at the scanning point is shifted toward that of the normal potential along the sweep. The target output circuit may be capacitatively coupled to the

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target as is the signal plate backing an iconoscope mosaic, or it may be fed from the attendant current variations in the collector or second anode circuit.

In order that the period between imposition of the voltage departure on the target and the output impulse may accord with the sweep period, manifestly the sweep path must not retrace any common point during a sweep cycle, as a voltage discontinuity established on such a point will be retraced to supply an output impulse before the full cycle is completed. Suitable sweeps will therefore trace around a portion of the target area, and will be referred to as defining a closed sweep locus. For simplicity in the sweep generating circuits a circular pattern supplied by a sine wave oscillator and phase splitting circuit is desirable.

Under the system so far described the operation will supply a single impulse following the inaugurating impulse by a single oscillator period where the normal scanning beam wholly restores the voltage departure to the pattern value at the point. However, operating conditions in the tube may be obtained to shift the potential incrementally on each succeeding sweep until the pattern potential is reached, and thereby generate a plurality of output signals each following another by the sweep period.

The latter operation produces output impulses of limited amplitude and requires more stringent storage characteristic of the target. The invention contemplates alternatively the generation of a series of timing impulses through re-establishing a voltage departure on the sweep locus under control of the target output signal. This is accomplished by feeding the output signal through a time delay circuit and back to the beam control means. In this embodiment the interval between impulses is the sweep period plus the delay time. By suitably controlling transmission through the feedback circuit re-establishing the voltage departure in response to the inaugurating impulse, the system may be caused to terminate operation after a selected number of pulses, and is ready for a subsequent timing operation.

The principles of the present invention are manifestly adaptable to the continuous generation of timing impulses through a constantly operative feedback network, and it is further apparent that the inaugurating impulse in such case need not be generated in response to the signal whose time relations are to be determined.

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The system of the present invention will be further described in connection with reference to the exemplary specific embodiments shown in the drawings, in which

Fig. 1 is the circuit diagram of a timing impulse generator,

Fig. 2 is the circuit diagram of another embodiment of the invention, and

Fig. 3 is the circuit diagram of an echo range finding system incorporating the present invention.

As shown in Fig. 1, the system includes storage tube 1 provided with the conventional gun elements 2, 3, 4, and 5, deflection electrodes 6, and fluorescent screen 7. The tube envelope is externally coated with a conductive sheath 8. The gun elements are energized across divider 19. The electron beam is constantly swept over a circular, or approximately circular, pattern by timing oscillator 9 and phase splitting network 10. Oscillator 9 may be a conventional type of sine wave generator tunable by control knob 11 to provide timing impulses at selected intervals, or a crystal controlled high frequency precision oscillator.

Under the constant gun potentials in the system shown, the electron beam establishes a uniform potential on target surface 7 along the sweep locus. The initiating signal is supplied at terminals 15 and operates a keyer 16 to generate a standard impulse. Keyer 16 may supply an impulse substantially at the beginning of an extended wave train which is to be examined, or it may respond to an impulse signal of some other type. In case an initiating signal similar to the signal generated by the keyer is available, manifestly the latter will not necessarily be incorporated in the circuit. Keyer 16 may be of the Kipp relay unbalanced multivibrator type.

The keyer impulse, which may be a square wave of short duration, is fed to a time delay circuit 17, for instance an artificial line. Simultaneously the keying impulse is supplied to gating circuit 18. Gating circuit 18 controls operation of amplifier 20 feeding the impulse to the storage tube by maintaining its operation during the limited relay output period. The keyer impulse is fed through its time delay circuit to amplifier 20, which is already in an operative condition by operation of gating circuit 18.

Gating circuit 18 is operative to supply a control voltage of a duration limited by the time constant of its circuit components. In the system shown a positive impulse is generated which may be applied to a control grid of the amplifier 20. The gating circuit 18 may be of the unbalanced multivibrator type which is normally inactive, but may be keyed into another condition to hold the amplifier 20 in operation. The circuit is further characterized in that for a period after reverting to the original condition, it is insensitive to keying impulses and thereafter is again sensitive to an inaugurating impulse from keyer 16.

Amplifier 20 supplies the keyer impulse to grid 3 of the cathode ray tube to modulate the beam current and establish a departure from the normal voltage on the target at the sweep point. Preferably the polarity of the control grid signal will be such as to decrease the beam current.

The operation of the system requires that the voltage departure thereby recorded on the sweep locus be taken off on the next cycle and then re-establish on the locus again. The output signal

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is generated across resistor 25. There is present in the output circuit, however, in addition to the signals generated on the wiping sweeps which remove the voltage departure, signals which occur at the moment of recording when the beam is modulated. This latter series of signals performs no useful function, and being of opposite sign from the desired series of timing impulses, may be rejected by suitable rectifier means.

It is also preferred that the feedback circuit re-record the timing impulse series of signals through negative modulation of the beam current in the same manner as the inaugurating signal was recorded.

Where operating conditions in the storage tube are such that electron storage occurs, the timing impulse on the succeeding cycle is of the same polarity as the recorded grid signal. Under these conditions, therefore, the feedback system will be non-inverting, and the unilateral network will reject the unwanted series of impulses. In Fig. 1, rectifier 22 conducts the negative timing impulses on the wiping sweeps and components 17 and 20 supply these as negative impulses to grid 3. The positive signal accompanying the recording is blocked by rectifier 22.

Where excess secondary emission exists during recording, the timing impulses are of opposite polarity from the recording impulses applied to the grid, and consequently the unilateral impedance will be arranged to pass these impulses, and the feedback circuit including components 17 and 20 will invert the same at grid 3.

The process is repetitive until the end of the gating period which renders amplifier 20 inoperative to disable the feedback circuit and terminate generation of the timing impulses at terminals 27. The final timing impulse generated on the sweep succeeding the gating period does not key the gating circuit 18 due to the insensitivity thereof immediately following the gating period.

A simplified circuit is shown in Fig. 2 wherein the impulse signal supplied to the grid 3 of cathode ray tube 1, and a subsequent timing impulse generated at output terminals 27 after one cycle of timing oscillator 9. As mentioned above, the operating conditions of tube 1 may be such as to generate a single timing impulse on the next trace of the beam over the point of voltage discontinuity on the sweep locus by immediate restoration of the pattern potential, or a plurality of timing impulses separated by the oscillator period through incremental restoration of the pattern potential.

Application of the timing impulse generator in a radio echo system is shown in Fig. 3. The radar is a conventional circuit including an impulse transmitter 30 tripped by keyer 31 and feeding a directional antenna 32 through duplexing network 33. Receiver 34 feeds the echo signals to viewing tube 35 which is supplied with a timing sweep from generator 36 synchronized with the transmitter repetition cycle.

Timing impulses are applied to the viewing tube from the output of cathode ray tube 1. The timing system is directly fed by the transmitter keyer 31 and functions to establish a voltage departure on target surface 7 of tube 1 which results, on the succeeding trace thereafter, in a timing output signal indicated as a deflection perpendicular to the time base on viewing tube 35. Such impulses are repeated until amplifier 20 is disabled by gating circuit 18, and furnish calibration points on the viewing tube. Mani-

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festly the gating period will be shorter than the interval between the radar transmitter pulses. When such system is employed only for verifying the radar range indicator, the application of the timing impulses may be terminated by switch 38.

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.

We claim:

1. Means for time delaying a momentary input signal comprising a cathode ray tube including a charge pattern sustaining target and a single electron beam generating means, means for periodically tracing the electron beam generated by said single electron beam generating means over a closed locus on said target to establish a voltage distribution along said locus, means modulating said electron beam responsive to the input signal to establish a potential departure from said voltage distribution on said locus on receipt of said signal, and a target output circuit operative to furnish an output signal on the next subsequent trace of said beam over said departure.

2. Means for time delaying a momentary input signal, comprising a cathode ray tube including a charge pattern sustaining target and a single electron beam generating means, oscillator means operative to sweep the electron beam generated by said single electron beam generating means over a closed locus on said target to establish a voltage distribution along said locus, means modulating said electron beam responsive to the input signal to establish a potential departure from said distribution on said locus on receipt of said signal, and a target output circuit operative to furnish an output signal on the next subsequent trace of said beam over said departure.

3. Means for generating recurrent signals at spaced intervals including a charge pattern sustaining target, means for sweeping said target with an electron beam recurrently over a closed locus to establish a voltage distribution along said locus, means for controlling said beam operative to establish a potential departure from said distribution on said locus, target output circuit means operative to supply an output signal on the next succeeding sweep over said potential departure and means operative in dependency on the output signal to establish another potential departure on the sweep locus.

4. Means for generating recurrent signals at spaced intervals including a charge pattern sustaining target, means for sweeping said target with an electron beam recurrently over a closed locus to establish a voltage distribution along said locus, means for controlling said beam operative to establish a potential departure from said distribution on said locus, target output circuit means operative to supply an output signal on the next succeeding sweep over said potential departure, and means including a time delay circuit fed by the output circuit operative to establish another potential departure on the sweep locus.

5. Means for generating a series of output signals at equally spaced intervals after an input signal including a charge pattern sustaining target, means for sweeping said target with an electron beam recurrently over a closed locus to establish a voltage distribution along said locus, means responsive to the input signal operative to establish a potential departure from said dis-

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tribution on said locus on receipt of said signal, target output circuit means operative to supply an output signal on the next succeeding sweep over said voltage variation, and means operative in dependency on the output signal to establish another potential departure on the sweep locus.

6. Means for generating a limited series of output signals at equally spaced intervals after an input signal including a charge pattern sustaining target, means for sweeping said target with an electron beam recurrently over a closed locus to establish a voltage distribution along said locus, means responsive to the input signal operative to establish a potential departure from said distribution on said locus on receipt of said signal, target output circuit means operative to supply an output signal on the next succeeding sweep over said voltage variation, means operative in dependency on the output signal to establish another potential departure on the sweep locus and means operative after a plurality of signal generation cycles to terminate operation of said last mentioned means.

7. Means for repeating a signal including a charge pattern sustaining target, means for recurrently sweeping said target along a locus to establish a voltage distribution thereon, means for establishing the signal as a potential departure from said distribution along said locus, a target output circuit operative to supply said signal as an output signal on the succeeding sweep over said part of the locus, and means including time delay transmission circuit means fed by the output circuit operative to re-establish the signal as a potential departure from said distribution on said locus.

8. In a radar system, an impulse transmitter, and echo receiver, cathode ray tube indicator means including a beam controlling electrode fed by the receiver, means for supplying a timing signal to the indicator including a charge pattern sustaining target, means for recurrently sweeping an electron beam along a closed locus on said target to establish a voltage distribution along said locus, beam control means for establishing a potential departure from said distribution on said locus in definite time relation to the period of transmitter operation, a target output circuit operative to supply a signal on the succeeding sweep over said potential departure, and means coupling an output signal from said target output circuit to the beam controlling electrode of said indicator to establish a timing marker on said indicator.

9. A timing impulse generator including a charge pattern sustaining target, means for recurrently sweeping an electron beam over a closed locus on said target to effect a voltage distribution pattern along said path, beam control means for effecting a departure from said voltage distribution, a target output circuit, input circuit means for the beam control means including a time delay circuit feeding an amplifier, amplifier control means operative to terminate operation of the amplifier after a timing period, means for simultaneously feeding an input impulse to the amplifier control means and to the time delay circuit to establish a potential departure from the voltage distribution, and means for feeding the output signal generated in the target output circuit on the next succeeding sweep over the potential departure to the time delay circuit to re-establish the signal at another point on the locus, whereby target output circuit pulses are repeated at fixed intervals until termination of the amplifier operation by the amplifier control means.

10. A timing impulse generator including a charge pattern sustaining target, means for re-currently sweeping an electron beam over a closed locus on said target to effect a voltage distribution pattern along said path, beam control means for effecting a departure from said voltage distribution, a target output circuit, input circuit means for the beam control means including a time delay circuit feeding an amplifier, amplifier control means operative to terminate operation of the amplifier after a timing period, a keyer circuit operative to supply an impulse signal simultaneously to the amplifier control means and to the time delay circuit to establish a potential departure from the voltage distribution, and means for feeding the output signal generated in the target output circuit on the next succeeding sweep over the potential departure to the time delay circuit to re-establish the signal at another point on the locus, whereby target output circuit pulses are repeated at fixed intervals until termination of the amplifier operation by the amplifier control means.

11. Means for time delaying a momentary input signal comprising a cathode ray tube including a charge pattern sustaining target and a single electron beam generating means, means for periodically tracing the electron beam generated by said single electron beam generating means over a closed locus on said target at a saturation level to establish a uniform voltage distribution along said locus, means modulating said electron beam responsive to the input signal to decrease the beam current to effect a decrease in potential at a point on said locus, and a target output circuit operative to furnish an output signal on the next subsequent trace of said beam over said point.

12. Means for time delaying a momentary

input signal, comprising a cathode ray tube including a charge pattern sustaining target and a single electron beam generating means, oscillator means operative to sweep the electron beam generated by said single electron beam generating means over a closed locus on said target to establish a voltage distribution along said locus, means modulating said electron beam responsive to the input signal to establish a potential departure from said distribution on said locus on receipt of said signal, a target output circuit operative to furnish an output signal on the next subsequent trace of said beam over said departure, and means for varying the oscillator frequency.

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