The Use of the Conventional Saw-Tooth Oscillator to Generate Steep Wave Front Impulses

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Description of apparatus.—The conventional saw-tooth oscillator used to produce a linear time base or sweep voltage for the cathode ray oscilloscope is shown with slight modifications in figure 1. The type 34 tube provides a constant rate of charging the condenser C, and at a critical condenser potential type 885 discharge tube breaks down so that the discharge current from the condenser flows through the plate-cathode circuit of the tube. The

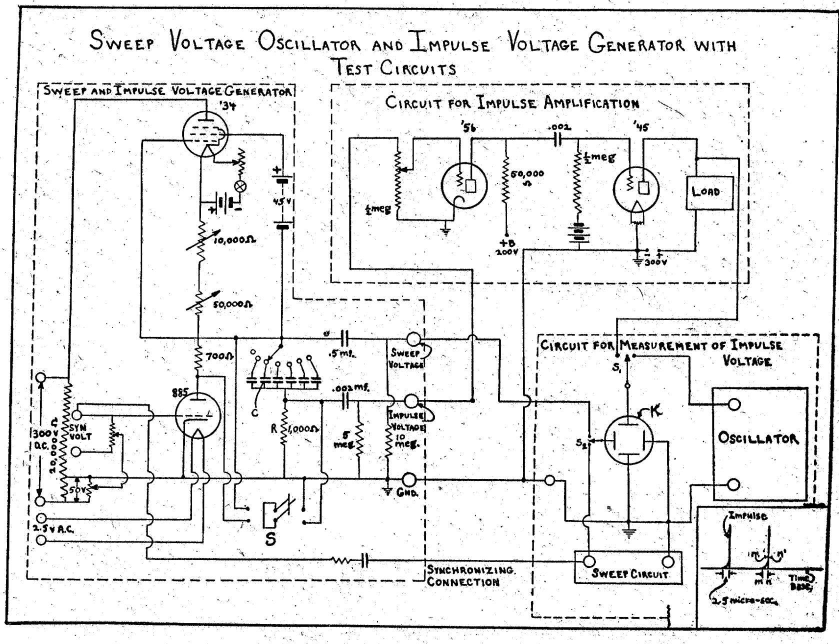

Fig. 1—Conventional saw-tooth oscillator used to produce a linear time base or sweep voltage for the cathode ray oscilloscope, with slight modifications.

switch S is closed to the right when the ordinary sweep voltage output is desired, allowing the 700 ohm limiting resistor in the discharge circuit as shown. When switch S is closed to the left this resistor is short circuited and a 1,000 ohm resistor R is introduced, and the condenser discharge produces an impulse voltage drop across this resistor. There is also a voltage drop across the resistor while the condensers are charging, but this is so small compared to the amplitude of the impulse upon condenser discharge that the former is negligible in comparison. The 0.002 mf. condenser and 5 megohm resistor are connected across the impulse voltage output terminals for convenient coupling to output circuits such as vacuum tube amplifier grids and so forth. From the impulse voltage terminal connection is made through a potentiometer to an impulse voltage amplifier illustrated in the figure. This impulse amplifier has low value coupling resistors and capacitor, that in the plate circuit of the type 45 power tube being of the order of 1,000 ohms or less. Impulse voltage amplitudes of 150 to 200 volts are thus easily obtained. A cathode-ray tube K is shown in the figure with its vertical deflection plates connected to the amplifier output by means of switch S_1. By means of switch S_2 the horizontal deflection plates can be connected to another sweep circuit shown in the figure so that a pattern of the impulse voltages can be observed on the cathode-ray tube screen.

Impulse voltage pattern.—When the cathode ray tube is used as explained, impulse voltage waves which appear to be simply spaced parallel lines perpendicular to the time base trace are observed. These are illustrated in the small diagram in the lower right-hand corner of the figure. With the impulse voltage generator operating with a saw-tooth wave frequency of 25,000 sweeps per second, the impulses are of course 1/25,000 second apart. The portion mn on the tracing where the beam leaves and returns to the base line was measured and it was found that it could be made as small as approximately 2.5 microseconds. This portion of the impulse can be conveniently eliminated by biasing the type 45 amplifier tube below cutoff, leaving only the vertical line impulse indicated by m'n' and the peak value 0 of the impulse.

In order to determine the space between the impulses switch S_1 is closed to the right, introducing a 1,000 to 10,000 cycle oscillator, and after observing the horizontal distance between the crests of the comparison oscillator voltage wave, and distance between the impulse voltage traces, and hence the time interval, can be very easily estimated. In order to determine the time interval between the start, m', and the finish, n', of the unidirectional steep wave-front impulse, a radio frequency oscillator is substituted for the sweep circuit shown diagrammatically in the lower part of the figure. This oscillator is adjusted until a stationary Lissajoux figure is obtained, after which the time interval is determined from the form of the figure and the measured frequency of the oscillator. This was found to be as low as 1 microsecond.

Application of regularly timed steep wave front impulses.—The useful applications of repeating regularly timed impulse voltages of short duration are many. One of its possibilities is in the study of polarization of a dielectric or in studying the depolarization phenomena. The impulse may be used to shift the grid bias of an amplifier or gaseous discharge tube for a sufficiently short interval to remove the geometric charge on the test electrode plates embracing the dielectric under study, after which the rate at which the charge coming from the dielectric under test may be observed by the resulting pattern on the cathode-ray tube screen. Another possibility is in the study of break-down of air or gases under the influence of impulse voltage, such as are produced by switching, lightening, or other disturbances. This impulse voltage is entirely sufficient to excite a circuit into damped oscillations, and, while the device is not intended to be a transient visualizer, the decaying portion of a transient may be readily observed on the oscilloscope screen by closing S_2 on its upper position, and the sweep voltage will then immediately follow the impulse voltage, giving the transient phenomena pattern upon the screen. This does not show the starting of the transient as does the transient visualizer.[1] Such characteristics as the logarithmic decrement of the damped oscillation and hence of the circuit can be very readily determined by measuring the amplitudes N cycles apart and taking 1/Nth of the natural logarithm of the two amplitudes so measured. In obtaining these decaying transients the circuit being studied is merely connected in the plate circuit of the amplifier tube of either the type 56 or type 45 stages indicated in the diagram.

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[1] H. J. Reich. "Electronic Transient Visualizers"; Electrical Engineering, Volume 55, No. 12, December, 1936.