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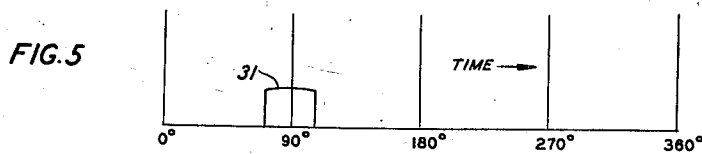
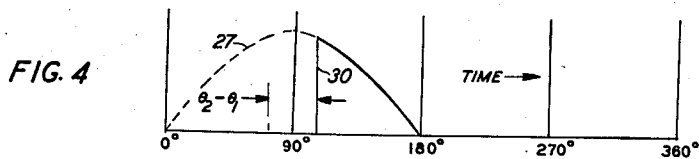
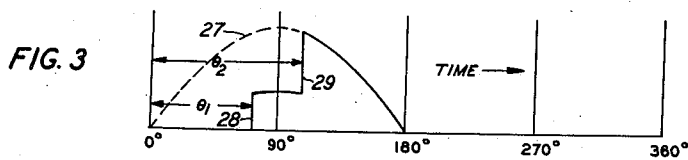
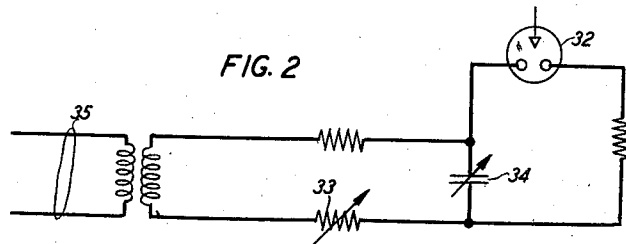
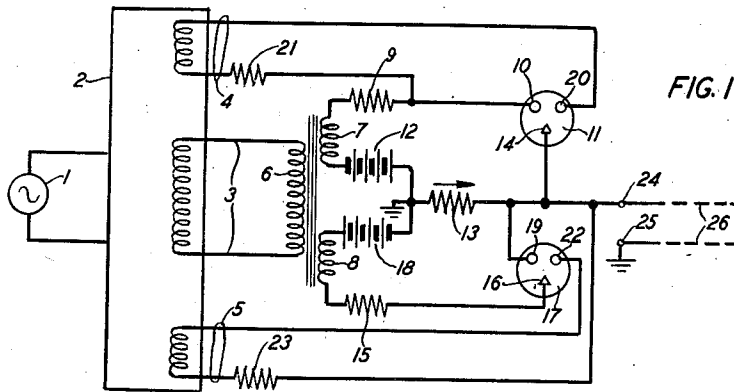
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2,309,525

ELECTRIC SIGNALING

Filed Jan. 21, 1941

2 Sheets-Sheet 1



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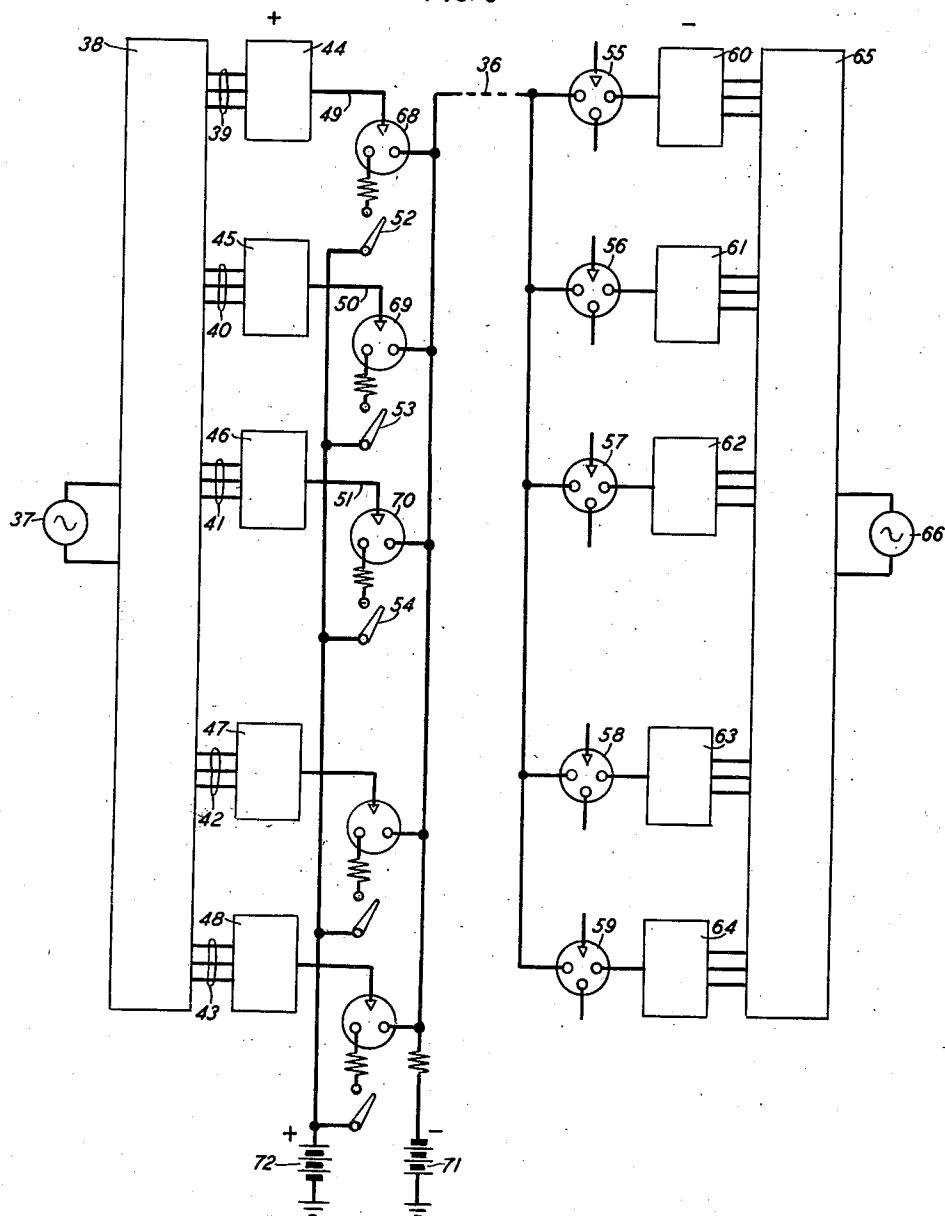
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FIG. 6



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ELECTRIC SIGNALING

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Application January 21, 1941, Serial No. 375,201

7 Claims. (Cl. 250—27)

This invention relates to signaling and particularly to the generation and transmission of electric signals and impulses.

An object of the invention is to obtain signaling impulses which are accurately fixed in time. Another object is to obtain impulses which have amplitudes that are substantially uniform throughout their duration. Another object of the invention is to control with a high degree of accuracy the phase or the position in time in which these impulses occur.

These objects are realized in accordance with the present invention by means of an impulse generating system comprising two discharge tubes and means for applying alternating voltages to the control and main gaps of these tubes in such phases that one tube ionizes first to cause the flow of current in a common resistance element and the other tube ionizes a predetermined interval thereafter to neutralize the current flow in said resistance element. The desired impulse results from the flow of current in the resistance element, and its position and duration may be accurately controlled by controlling the phases of the voltages applied to said tubes.

A feature of the invention is an impulse generating system in which the polarity of the impulses may be controlled by controlling the phases of the voltages applied to the tubes such that either tube ionizes first and the other tube ionizes a predetermined interval thereafter.

These and other features of the invention will be described more fully in the following detailed specification.

In the drawings accompanying the specification:

Fig. 1 discloses an impulse generating system incorporating the features of this invention;

Fig. 2 shows a phase shifting network for controlling the impulses produced by the generator;

Figs. 3, 4 and 5 are graphs showing the shape, duration and other characteristics of the impulses; and

Fig. 6 is a diagram of a signaling system incorporating the impulse generator.

The generating system disclosed in Fig. 1 comprises a supply source of alternating current 1 having any desired voltage and frequency. The supply source 1 is connected to a phase producing mechanism 2 which may be of any suitable and well-known character. The phase mechanism 2 has three supply circuits 3, 4 and 5, which supply voltage of the desired phases and of the same frequency as the source 1. The supply circuit 3 is connected to the primary winding 6 of a trans-

former which has two secondary windings 7 and 8. The upper terminal of winding 7 is connected through a resistance element 9 to the cathode 10 of a space discharge tube 11. The lower terminal of winding 7 is connected to the negative pole of battery 12, and the grounded positive pole of this battery is connected through a common resistance element 13 to the anode 14 of the tube 11. The lower terminal of the winding 8 is connected through a resistance element 15 to the anode 16 of discharge tube 17, and the upper terminal of winding 8 is connected to the positive pole of battery 18. The grounded negative pole of this battery is connected through the common resistance element 13 to the cathode 19 of the tube 17.

The discharge tubes 11 and 17 may be of any suitable type, but the well-known gas filled tube is preferred. Also these tubes may have either hot or cold cathodes. The ionizing or control gaps of these tubes are supplied with voltages from the supply circuits 4 and 5. More specifically, the supply circuit 4 is connected across the gap formed by the cathode 10 and the control electrode 20 of the tube 11, a resistance element 21 being included in series with this circuit. Likewise, the supply circuit 5 is connected across the gap formed by the cathode 19 and control electrode 22 of tube 17, a resistance 23 being included in this circuit.

The output terminals 24 and 25 of the generating system are connected to impulse circuit 26, and the impulses are produced by discharging one of the tubes to set up a voltage across the common resistance element 13 and by discharging the other tube a predetermined time thereafter to neutralize this voltage and thereby terminate the impulse. The supply circuit 3 supplies voltage through the transformer windings 7 and 8 to the main or anode gap circuits of the tubes 11 and 17, respectively, and the supply circuits 4 and 5 supply the control gap voltages to cause the ionization of these tubes at the proper times.

For some purposes it is desirable to have impulses of substantially uniform amplitude throughout their duration. This may be achieved by producing impulses in that region of the voltage wave appearing in the supply circuit 3 where the rate of change is smallest, namely in the region of the maximum instantaneous value. If, therefore, one of the tubes is discharged at the time the wave of the supply source 3 is approaching its maximum value and the other tube is discharged as the wave of the supply source

begins to recede from its maximum value an impulse is produced having a substantially uniform amplitude throughout its duration.

Considering the operation of the impulse system, it may be assumed that the sine curve 27 shown in Figs. 3 and 4, including the broken and solid portions, represents the current that would flow in the anode circuits of the tubes 11 and 17 during a half cycle of the supply source 3 if common resistance 13 were omitted and the tubes 11 and 17 conducted during the respective half cycles of the source. The phases of the sources 3 and 4 are so selected that the voltage across the gap 10—20 reaches the ionizing value of the tube 11 at the instant the voltage of the source 3 reaches the value represented by the angle θ_1 illustrated in Figs. 3 and 4. Assuming the source 3 to be in the half cycle aiding the direct current sources 12 and 18, current now flows in the anode circuit of the tube 11. This circuit may be traced from the positive pole of battery 12 through the resistance 13, in the direction indicated by the arrow, anode 14, cathode 10, resistance 9 to the upper terminal of the winding 7. Therefore, the current in the resistance element 13 rises abruptly from zero value to the ordinate value 28 (Fig. 3) and continues at approximately this value while the wave of the source 3 is passing through its maximum ordinate. During this period of current flow in the resistance 13 the wave of the supply source 5 is approaching the ionizing value of the tube 17. The phase of the source 5 is so selected that the tube 17 ionizes at the desired predetermined interval following the ionization of the tube 11, which may be at the angle θ_2 . Current now flows in the anode circuit of tube 17, traceable from the positive pole of battery 18 through the winding 8, resistance 15, anode 16, cathode 19, resistance element 13 to the negative pole of battery 18.

It will be noted that the voltage across the resistance 13 resulting from the ionization of tube 17 opposes the current flowing in said resistance as a result of the ionization of tube 11. Assuming the opposing voltage is just sufficient to completely neutralize the current flow in resistance 13, the resultant cancellation of the voltage across this resistance causes the current in the remaining part of the anode circuit of tube 11 to rise abruptly to the ordinate value 29 in Fig. 3. Also since no voltage appears across the resistance element 13 the current in the anode circuit of tube 17 rises abruptly to the ordinate 30 of Fig. 4. Since in the common resistance 13 the anode current of tube 17 represented by the ordinate 30 is in opposition to the anode current of the tube 11, represented by the ordinate 29, the subtraction of these ordinates gives the graph of Fig. 5, representing the completed impulse. Stated in other words, the discharge of the tube 17 sets up a voltage across the resistance 13 equal and opposite to the voltage set up across this resistance by the tube 11, whereby the current ceases to flow, and the impulse is terminated. The left-hand terminal of the common resistance element 13 is grounded, and the right-hand terminal is connected to the output terminal 24 of the generating system. Therefore, during the interval between angles θ_1 and θ_2 , when current is flowing from left to right in the resistance element 13, an impulse of negative potential is produced on the terminal, and an impulse of corresponding polarity flows in the impulse circuit 26.

By properly selecting the phases of circuits 4 and 5 with respect to the phase of circuit 3 the position and duration of the impulse may be controlled at will. That is to say, the impulse may be produced at any point in the half cycle of the supply source 3, and the duration of the impulse may be varied at will.

It is also possible by selecting the phases of circuits 4 and 5 to cause tube 17 to discharge first to commence the impulse and to cause the subsequent discharge of tube 11 to end the impulse. When the tubes are discharged in this order the impulses produced are of positive polarity.

If the phases of circuits 3, 4 and 5 are fixed by the phase producing mechanism 2 and it is desired to vary the length of the impulses from time to time, this may be accomplished by inserting a variable phase shifting network in the control gap circuit of one of the tubes, such as the tube 17 in Fig. 1. Such a phase shifting network is illustrated in Fig. 2. The control gap circuit of the tube 32 of Fig. 2 is substantially the same as that of the tube shown in Fig. 1, except that a variable resistance 33 and a variable condenser 34 have been added. By varying the resistance 33 and the condenser 34 the phase angle of the voltage wave supplied by the circuit 35 may be varied to control the length of the impulse.

Fig. 6 illustrates one of the many useful applications of the impulse generating system shown in Fig. 1. Assume, for example, that it is desired to transmit a plurality of different signals over the single transmitting conductor 36. At the transmitting end of the line a source of alternating current 37 is provided together with a suitable phase generator 38 whereby a plurality of different phases are derived from the source 37. These phases, of which there may be ten different sets of three phases, appear in the ten groups of phase supply circuits 39, 40, 41, 42, 43. Each group of three phase supply circuits serves an impulse generator, such as the generators 44, 45, 46, 47, 48, each of these generators being similar to the one disclosed in Fig. 1. In this manner generators 44, 45, 46, etc., produce impulses of ten different phases in their output circuits 49, 50, 51, etc. These output circuits are connected to the anodes of the respective tubes 68, 69, 70, etc., which serve to isolate the impulse generators from each other. The cathodes of the tubes are connected to the signal conductor 36 and to source 71. The control electrodes of the tubes are connected through resistances to the contacts of switches 52, 53, 54, etc., and the movable elements of these switches are connected to battery 72.

When it is desired to transmit a signal over the conductor 36, one or more of the impulse generators at the transmitting end are connected to the line 36 by means of the switches 52, 53, 54, etc. The operated switches close ionizing circuits for the associated tubes, and impulses of the corresponding phases are sent through these tubes and over the line 36. At the receiving end of the system these incoming impulses are all applied to the electrodes of ten register tubes 55, 56, 57, 58, 59. Also at the receiving station ten impulse generators 60, 61, 62, 63, 64 are provided, one for each of the register tubes 55, 56, 57, etc. These generators are supplied with voltages of different phases by the phase producing device 65, which in turn is supplied with energy from a source 66 having the same fre-

quency as the source 37. Each of the generators 10, 61, 62, etc., generates impulses of one of the different phases and applies these impulses to the electrodes of the corresponding register tubes 55, 56, 57, etc. If the generators 44, 45, 56, etc., produce impulses of positive polarity and the generators 60, 61, 62, etc., of negative polarity, it is possible to select and ionize any one or more of the register tubes by applying to the single conductor 36 from the transmitting end 10 impulses of the corresponding phases.

Register tubes suitable for use in a system of this kind are disclosed in the patent to W. H. T. Holden, No. 2,285,815 of June 9, 1942. The Holden patent also discloses impulse generators 15 for generating impulses of opposite polarities.

Many other useful applications will appear for the impulse generator disclosed herein. For example, the square shaped impulses produced by this generator may be employed in the generation of harmonic voltages.

What is claimed is:

1. The combination in an impulse system of a discharge tube having a control gap and a main gap, a second discharge tube having a control gap and a main gap, a discharge circuit for the main gap of the first tube, a discharge circuit for the main gap of the second tube, an impedance element included in common in both of said discharge circuits, an impulse conductor including said impedance element, means for ionizing the control gap of the first tube, means effective a predetermined interval thereafter for ionizing the control gap of said second tube, means responsive to the ionization of said first tube for causing current to flow in the discharge circuit thereof, the voltage across said impedance element resulting from said current flow serving to produce an impulse in said conductor, and means responsive to the ionization of said second tube for causing current to flow in the discharge circuit thereof, the voltage across said impedance element resulting from the current flow in said second discharge circuit serving to oppose the first voltage across said element to terminate said impulse.

2. The combination in an impulse system of a discharge tube having a control electrode and an anode, a second discharge tube having a control electrode and an anode, discharge circuits for said tubes, a resistance element included in each of said discharge circuits, a supply source for producing alternating voltage waves, means for applying said waves to said anodes, an impulse circuit including said resistance element, means for applying an alternating voltage of a given phase to the control electrode of said first tube for ionizing the same when the voltage of the anode is near its maximum value, said anode voltage causing current to flow in the discharge circuit of said first tube to produce a voltage across said resistance element, the voltage across said element serving to produce an impulse in said impulse circuit, and means for applying an alternating voltage of a different phase to the control electrode of said second tube for ionizing the same a definite interval following ionization of the first tube, the anode voltage of said second tube causing current to flow in the discharge circuit thereof to produce a voltage opposing and neutralizing the first-mentioned voltage across said resistance element to terminate said impulse.

3. The combination in an impulse system of two discharge tubes having control gaps and

main discharge gaps, means for applying voltages of different phases to said control gaps to cause either one of said tubes to ionize first and the other tube to ionize a definite time thereafter, an impulse circuit having a resistance element therein, means responsive to the ionization of the first tube for causing current to flow in the main gap thereof and through said resistance element in a given direction, the flow of current in said element producing an impulse in said impulse circuit, and means responsive to the ionization of the second tube for causing current to flow in the main gap thereof, the current flow in said second tube opposing the current in said resistance element to cause the cessation of said impulse.

4. The combination in an impulse system of two discharge tubes having control gaps and main discharge gaps, means for applying voltages of different phases to said control gaps to cause either one of said tubes to ionize first and the other tube to ionize a definite time thereafter, an impulse circuit having a resistance element therein, means responsive to the ionization of the first tube for causing current to flow in the main gap thereof and through said resistance element in either direction according to which of the tubes is ionized first, the flow of current in said element producing an impulse in said impulse circuit, the polarity of said impulse depending on the direction of current in said element, and means responsive to the ionization of the second tube for causing current to flow in the main gap thereof, the current flow in said second tube opposing the current in said resistance element to cause the cessation of said impulse.

5. The combination in an impulse system of two discharge tubes having control gaps and main discharge gaps, means for applying voltages of a given frequency and of different phases to said control gaps to cause one of said tubes to ionize first and the other tube to ionize a definite time thereafter, an impulse circuit having a resistance element therein, a supply source of alternating voltage of said given frequency, means including said supply source effective upon the ionization of the first tube for causing current to flow in the main gap thereof and through said resistance element in a given direction, the flow of current in said resistance element producing an impulse in said impulse circuit, and means including said supply source effective upon the ionization of the second tube for causing current to flow in the main gap thereof, the current flow in said second tube neutralizing the current in said resistance element to cause the cessation of said impulse.

6. The combination in an impulse system of two discharge tubes having control gaps and main discharge gaps, means for supplying voltages of a given frequency and of different phases to said control gaps to cause one of said tubes to ionize first and the other tube to ionize a predetermined time thereafter, an impulse circuit having a resistance element therein, means responsive to the ionization of the first tube for causing current to flow in the main gap thereof and through said resistance element to produce an impulse in said impulse circuit, means responsive to the ionization of the second tube for causing current to flow in the main gap thereof, the current flow in said second tube opposing the current flow in said resistance element to cause the cessation of said impulse, and means for varying the phase of the voltage ap-

plied to the control gap of one of said tubes for varying the length of said predetermined interval.

7. The combination in an impulse system of two discharge tubes having control gaps and main discharge gaps, sources of alternating voltage of different phases, means for applying the voltage of one of said phases to the control gap of one of said tubes to cause said tube to ionize successively in each of the successive cycles of the applied source, means for applying voltage of the other of said phases to the control gap of said other tube to cause successive ionizations thereof in each of the successive cycles of the applied source, each ionization of either one of said tubes occurring first followed

after a definite time interval by the ionization of the other tube depending on the relative phases of the applied sources, an impulse circuit having a resistance element therein, means responsive to each ionization of the first tube to ionize for causing current to flow in the main gap thereof and through said resistance element, each flow of current in said element producing an impulse in said impulse circuit, and means responsive to each ionization of the second tube to ionize for causing current to flow in the main gap thereof, the current flow in said second tube opposing the current in said resistance element to cause the cessation of the impulse.

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