April 2, 1940. C. J. FITCH 2,195,853

SIGNAL GENERATOR

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FIG. 1.

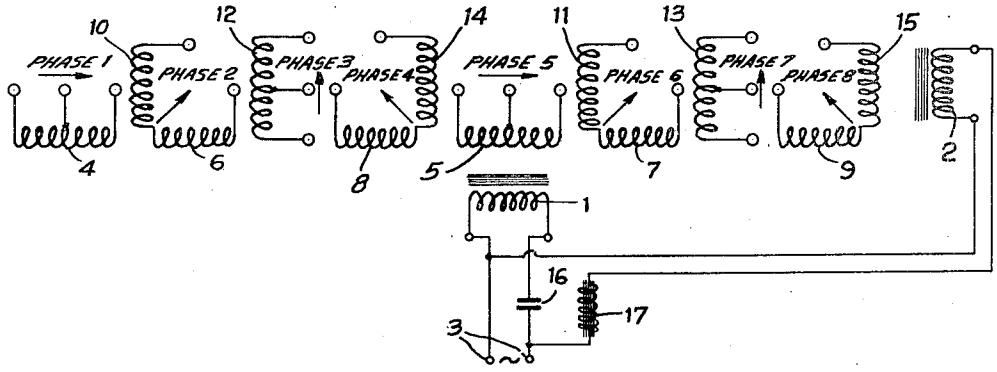


FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

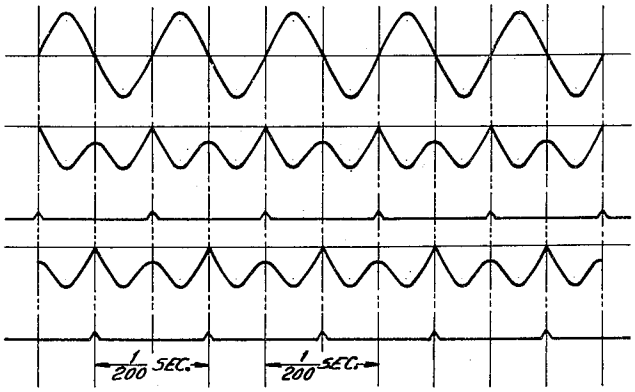
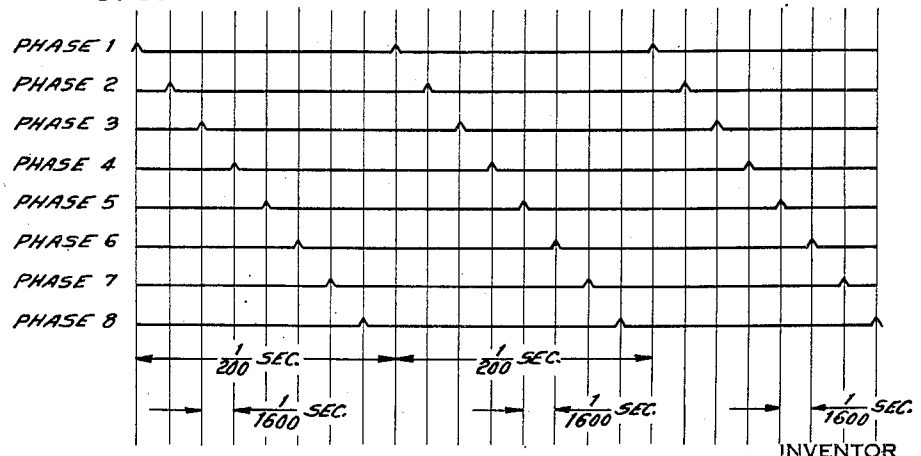


FIG. 9.



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FIG. 10.

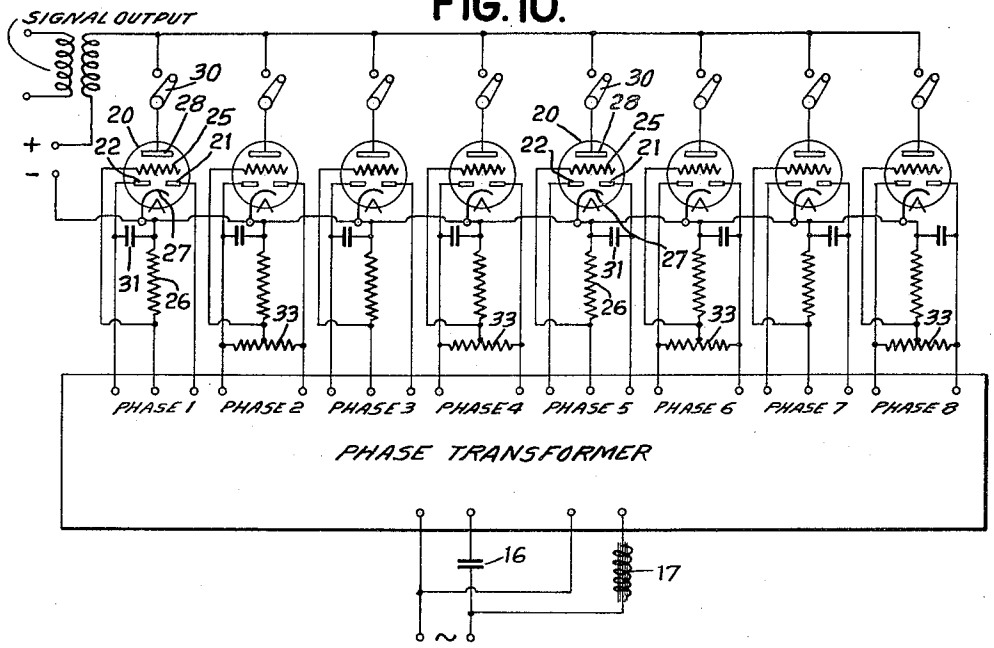


FIG. 2.

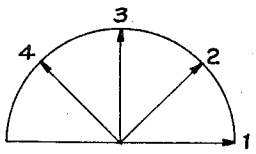


FIG. 2A.

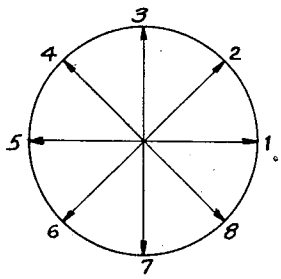
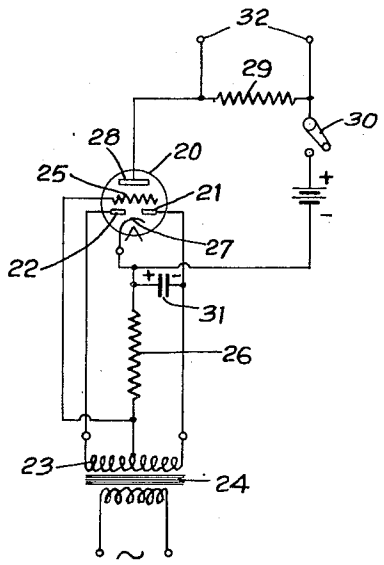


FIG. 3.



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SIGNAL GENERATOR

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Application December 1, 1936, Serial No. 113,591

3 Claims. (Cl. 250—27)

This invention relates to signal generating circuits and more particularly to the type of signal generating circuits capable of initiating a series of timed signals or impulses which automatically are equally spaced electrically upon transmission thereof.

The features of the present invention comprise chiefly the provision of means whereby a source of alternating current is applied to a novel type of phase splitter generating a plurality of out-of-phase voltages and applying the different voltages to separate circuits, each including electric discharge devices which are adapted to emit a series of short signal impulses equally spaced with respect to each other. A plurality of the said signal generating circuits may be applied simultaneously to a line or radio network and a plurality or combinations of the signal impulses may be transmitted over the network.

Various other objects and advantages of the invention will be obvious from the following particular description of one form of mechanism embodying the invention or from an inspection of the accompanying drawings; and the invention also constitutes certain new and useful features of construction and combination of parts hereinafter set forth and claimed.

In the drawings:

Fig. 1 shows diagrammatically the phase splitting transformer.

Fig. 2 and Fig. 2A show vectorially the relationship of the generated phases.

Fig. 3 shows an individual electric discharge circuit embodying the present invention.

Figs. 4 to 9 show the wave shape forms in different sections of the circuits.

Fig. 10 shows one type of assembly of the signal generator circuit.

The applications of the present invention are innumerable; however, for exemplary purposes, reference will be made to a copending application Serial No. 756,443, filed December 7, 1934, which application has matured and issued as U. S. Patent No. 2,153,178, dated April 4, 1939, and illustrates a system in which this invention may be used.

Referring now to Fig. 1, one type of phase splitter or transformer will be explained. The primary windings 1 and 2 are connected in parallel to a source of single phase alternating current supply 3. Six secondary windings are associated with each of the primary windings, namely, the secondary windings 4 to 9 are associated with the primary winding 1 and windings 10 to 15 are associated with the primary winding 2. The purpose of the said arrangement is to transform the single phase supply into four phases, equally spaced, and with the double or twin secondary windings, such as 4 and 5 or 12 and 13, eight secondary circuits are available, the purpose of which will be understood as the description progresses.

In the circuit including primary winding 1 a condenser 16 is included and in the circuit including primary winding 2 an induction coil 17 is inserted, and the values of C and L are chosen so that the currents in the said primary windings are ninety degrees out of phase. The voltage across each primary winding is the same. It is to be noted that the turns ratio of some of the individual secondary windings vary so that the voltages across the said windings vary accordingly, for example, the secondary windings associated with the primary winding 1 comprise two windings 4 and 5 of voltages E and four windings 6 to 9 of voltages equal to $\frac{1}{2}\sqrt{2}$ E. The secondaries 10 to 15 associated with the primary winding 2 are similarly rated, and therefore the output voltages of the secondary windings are, of course, all the same values. It is evident from the description thus far that four different phases equally spaced electrically, namely, 45° apart, are developed, the phase directions vectorially are shown by the arrows for each of the phases and set forth in a vector diagram in Fig. 2; and as mentioned hereinbefore, the output circuits of the secondary windings are arranged in pairs; that is, two circuits of which develop the same phases such as phases 1 and 5 or phases 2 and 6. It will be seen later herein that the amount of power required from the A. C. source is reduced to a minimum if the secondary windings 4, 5, 12 and 13 are provided with center taps as shown, thus avoiding the use of center tapped resistors across these circuits.

Referring now to Fig. 3, one type of electric discharge circuit, which may be associated with the secondary outputs of the phase transformer, will now be described. However, it is not intended to limit the application of the circuit particularly to phase transformers of the type described; the circuit may be used singly instead of being used in combination with a number of similar circuits, and therefore is shown in the figure to be connected to any source of A. C. supply.

The electric discharge device 20 is shown comprising the combination of a full wave rectifier

and triode in one envelope and is a type well known in the art, commonly referred to as a duplex diode triode type. The diode plates 21 and 22 are joined to the terminals of the secondary winding 23 of transformer 24, the center tap of which is connected to the grid 25 of the tube. A resistance 26 is inserted between the said center tap and the cathode 27. The triode plate 28 is connected to positive battery through the resistor 29 and switch 30. A condenser 31 is shown inserted between the cathode 27 and one of the diode plates 21.

It is evident from the description of the circuit connections, thus far, that normally the grid 25 of the tube is at zero bias due to the fact that no current is passing through resistor 26, therefore, upon closure of the switch 30 current flow will be established in the triode plate circuit as follows: from positive battery through switch 30, resistor 29, and the connected anode and cathode of the tube to the negative side of the battery; however, the condition just described exists in the circuit for only a comparatively short time because the bias on the grid 25 is not a constant factor but varies in a timed relationship with the frequency of the A. C. supply source. The said supply is impressed upon the full wave rectifier and therefore the rectified current passing through the resistor 26 immediately drives the grid bias negative with respect to the cathode which is of sufficient value to prevent further flow of plate current in the triode output circuit; but as mentioned before the grid bias becomes effective to reduce the plate current to substantially zero value, a pulse is impressed upon the output of the triode in which the resistor 29 is included so that a signal is impressed on the desired output circuit connected to terminals 32.

It was mentioned that condenser 31 is inserted between the cathode and one of the diode plates, as shown. The curve in Fig. 4 shows the sinusoidal wave form impressed across the diode plates of the tube. When the polarity is such that current passes from one diode plate 22 to cathode, this current passes through the resistor 26 and also charges the condenser 31 to the polarity as shown. At the end of this particular half cycle as the current passes through zero, the charge in the condenser maintains the grid of the tube negative with respect to the cathode and of such value as to be sufficient to permit no plate current to flow. The charge in the condenser leaks off through the resistor 26, the values of the capacitor and resistor being such that the time constant of the circuit is adjusted so as to maintain the tube biased below cut-off during the timed interval that the said half cycle of the A. C. wave passes through zero. The following half cycle passing from diode plate 21 to cathode and through resistor 26 has reached sufficient amplitude to maintain the tube biased below cut-off. At the end of the second half cycle, the charge in condenser 31 has completely leaked off, and as the second half cycle passes through zero, the grid bias is zero and plate current again is permitted to flow through the tube impressing an impulse upon the resistor 29 and the connected output circuit to terminals 32. The curve in Fig. 5 shows the wave shape of the rectified voltage across the resistor 26. The effect of the condenser 31 is evident, suppressing the alternate peaks of the rectified wave as shown and, as just explained, the suppressed waves are reduced in amplitude so as to be ineffective to send out signal pulses in the plate circuit whereas the unsuppressed waves are effective to impress signals upon the output circuit. Thus it is seen that but one impulse is transmitted for a complete cycle of the input oscillations, whereas without the condenser two impulses would be transmitted for a complete cycle. Fig. 6 shows the short signal impulses in the output circuit of the tube and impressed upon the resistor 29 at equally spaced timed intervals. In the Figs. 4, 5, and 6, it is assumed that the fundamental frequency of the supply source impressed upon the rectifier is 200 cycles per second and therefore the short signal pulses impressed upon the output circuit are at the rate of 200 per second.

It will now be understood that by connecting the condenser 31 between the cathode 27 and diode plate 22 instead of cathode and diode plate 21, the opposite peaks in the rectified wave are reduced in amplitude as shown in Fig. 7 so that the suppressed portions thereof are ineffective to trigger the tube so as to pass plate current and generate a signal pulse. Now, it is evident if two of the secondary circuits of the phase transformer are connected to individual tube circuits of the type described and in the one tube circuit the condenser is inserted between cathode 27 and diode plate 21 and in the other tube circuit the condenser is inserted between cathode 27 and diode plate 22, two different and separate signal generating circuits are obtained, thereby initiating two series of equally spaced impulses but separated 180° electrically, that is, each series of impulses generated by the individual circuits is spaced 360° and for the two circuits generating the two series of impulses these impulses of each series are electrically separated by 180°. Now referring to Fig. 1, it was mentioned that pairs of similar or like phases are developed; for example, phases 1 and 5 are shown vectorially in the same direction and are as described of equal voltage. Therefore, by connecting the individual electric discharge circuits described hereinbefore and shown in Fig. 3 to the individual secondary outputs of phases 1 and 5, and in one of the discharge circuits have condenser 31 connected between cathode 27 and diode plate 21 (assume this connection for phase 5) and in the other discharge circuit have condenser 31 connected between cathode 27 and diode plate 22 (assume this connection for phase 1), see Fig. 10, it will be obvious that the short signal pulses generated thereby will be diametrically opposite in phase, that is, separated by 180 electrical degrees as shown in the vector circle diagram in Fig. 2A. Thus, by referring to Fig. 10, it will be understood, without further detailed description, that with the four different phases developed by the phase transformer and a twin or double set of secondary circuits, and by connecting the electric discharge circuits thereto, and connecting the condensers 31 inversely in the twin secondary circuits, how eight separate signal generating circuits are obtained to generate eight different signal pulses (in the example, spaced 45° electrically) for control purposes (Fig. 10). In the event that all the eight switches 30 are closed at the same time to generate the signal pulses, the arrangement of the pulses as viewed by an oscillograph, for example, would be substantially as shown in Fig. 9; of course, all the signal pulses would be seen on the same axis or plane, whereas in the figure,

for the sake of clarity, each of the signal pulses is shown in separate plane.

In connecting the electric discharge circuits to the transformer secondary circuits, it is seen for phases 1, 3, 5, and 7 (see Figs. 1 and 10), center taps on the secondary windings may be employed to be directly connected to the resistors 26, whereas in phases 2, 4, 6, and 8 it is necessary to connect the terminals of the secondary windings to the resistors 33, the center taps of which are connected to resistors 26. The center tapped resistors 33 are not necessary in the phases mentioned and the center taps of the secondary windings may be used thus reducing the amount of power required from the A. C. source to a minimum. In the combined secondary windings, such as for phases 2, 4, 6, and 8, direct center taps cannot be made and therefore the center tapped resistors 33 are used in these circuits.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is as follows:

1. A signal generator of the character described comprising an electron discharge device having input and output circuits and a control grid included in the input circuit, an alternating current supply, means for rectifying the supply to produce a fluctuating unidirectional current supply, means for impressing the unidirectional current supply upon the said input circuit, a regulating device having resistance included in the input circuit, the resistance of said device automatically controlling the bias condition on the control grid in accordance with the flow of current therethrough, thereby controlling the conductivity of the discharge device and said resistance being of such value with relation to current flow therethrough and the characteristic of the electron discharge device as to render it non-conductive upon flow of appreciable current therethrough and to render it conductive only as the current supply impressed thereupon approaches zero value and control means included in the said input circuit for limiting further the conductivity of the discharge device whereby single impulses are initiated in the output circuit for each complete cycle of the alternating current supply.

2. The invention set forth in the preceding claim wherein the said control means comprises a condenser.

3. The combination of an electron discharge device having a common cathode, a plurality of diode plates, a control grid and triode plate, of means for applying a positive potential to the triode plate with respect to the cathode, a source of alternating current and means for impressing said current upon the diode plates, a regulating device having resistance and having one terminal connected to the said cathode element and the other terminal connected to the control grid and an intermediate point on said source of alternating current, the resistance of said device automatically controlling the bias condition on the grid in accordance with the flow of current therethrough thereby controlling the conductivity of the discharge device and said resistance being of such value with relation to current flow therethrough and the characteristic of the electron discharge device as to render the triode section non-conductive upon flow of appreciable current therethrough and to render the said triode section conductive only as the current supply impressed thereupon approaches zero value, and a capacity element connected between the cathode element and one of the diode plates for further limiting the conductivity of the discharge device.

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