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M. E. MOHR

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IMPULSE PRODUCING CIRCUIT

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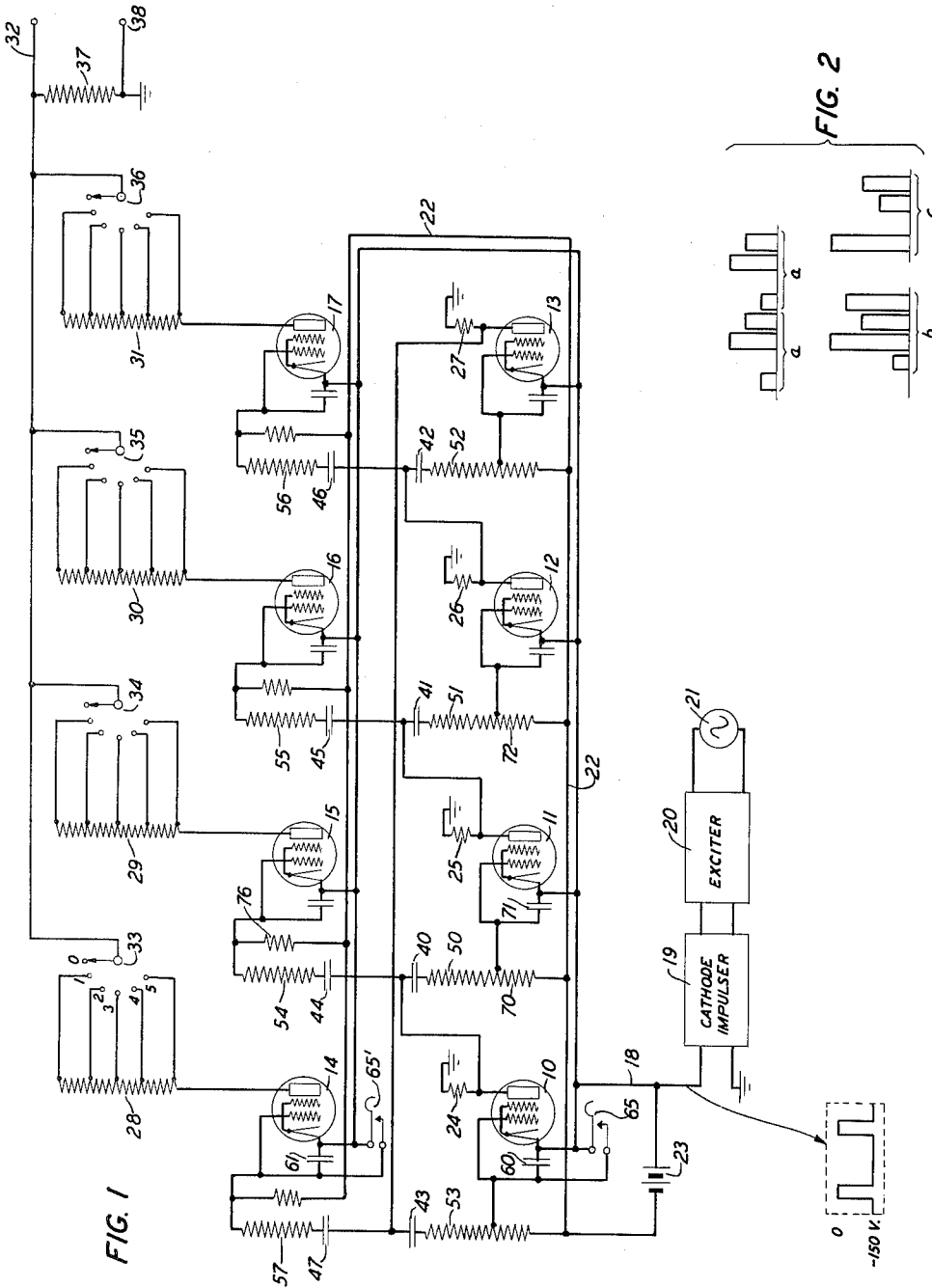


FIG. 1

FIG. 2

INVENTOR
M. E. MOHR
BY *H. A. Burgess*
ATTORNEY

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IMPULSE PRODUCING CIRCUIT

Milton E. Mohr, Summit, N.J., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

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3 Claims. (Cl. 328—154)

The present invention relates to the production of electrical current or voltage of stepped wave form for signaling, testing or other purposes.

The general object of the invention is to produce an output electrical wave varying in steps of different amplitude in any one of several different orders as desired and to repeat the wave over and over as desired.

In certain types of signaling or testing it is desired to have available a wave which has different amplitudes definitely related to time but in an order which may not necessarily be ascending or descending but may be irregular. As one example, the wave may have four, five or any number of definite amplitudes related in arithmetic or geometric proportions or in any other manner and occurring in time in the order 1, 2, 3, 4 or 2, 4, 1, 3 or in any other order as desired and repeating in the same order indefinitely. The invention provides for generating such waves and for varying their form or type at will, so that the same circuit is capable of producing a wide range of wave forms.

The application of such a circuit to the testing of relays, vacuum tubes, gas-filled tubes or any circuit having threshold or marginal operating characteristics will be obvious to those skilled in the art. Other uses might be to generate pulses for signaling and kindred purposes.

In its more specific aspects, the embodiment to be disclosed herein for illustration employs a plurality of trigger tubes operating one at a time in a cycle which is repeated over and over and a secondary series of trigger tubes operating one at a time in unison with and under control of the first plurality of tubes and having a common output circuit to which the secondary tubes are coupled through individual couplings that permit a given fractional output of each to be applied to the common output.

The nature of the invention and its various features and objects will be more fully understood from the following detailed description together with the accompanying drawing in which FIG. 1 is a schematic circuit diagram of one illustrative embodiment of the invention and FIG. 2 shows sample types of wave forms readily obtainable with the circuit of FIG. 1.

Referring to FIG. 1, the first plurality of trigger tubes mentioned above comprises in this case the four tubes 10 to 13 although any plural number greater or less than four such tubes could be used as desired. The secondary series of tubes comprises the four tubes 14 to 17. All of these tubes are of the type in which a control grid, or equivalent, controls initiation of the discharge which thereafter persists until the plate circuit is interrupted or the plate voltage otherwise reduced below the sustaining value. One example of such trigger tube is a gas-filled tube in which the discharge is carried by ionization. In this case heated cathodes are assumed although no heating circuit is shown.

All of the cathodes are connected together and to lead 18 which applies between the cathodes and ground a pulsing voltage derived from the impulser 19, which is in turn controlled by exciter 20 and constant frequency driving oscillator 21. The impulser circuit puts out a voltage of the form indicated in the diagram adjacent lead 18, comprising negative pulses of -150 volts peak value and some convenient length, such as 18 milliseconds for

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example, separated by spaces of zero voltage lasting 2 milliseconds on the basis of a 50-cycle wave from source 21. The exciter 20 and impulser 19 of themselves form no part of the present invention and may be of any known suitable type, one example being given in Lundstrom-Schimpf application Serial No. 456,322, filed August 27, 1942. Briefly, the exciter has a pair of vacuum tubes which are biased too far negative to transmit current during the negative half cycle of the control wave from 21 but which both transmit current for a part of the positive half cycle, the arrangement being such that one of the tubes is caused by a phase delay in its grid circuit to begin to transmit slightly in advance of the other (2 milliseconds in advance, in this case). When the second tube begins to transmit, its plate current cuts off the first tube by swinging the grid bias beyond cut-off. The plate current of the first tube which flows for a duration of 2 milliseconds interrupts the normal passage of current through the cathode impulser by applying a high negative bias to the grid of a tube in the cathode impulser 19. This impulser supplies a regulated voltage of -150 volts to the cathode lead 18 at all times except for the 2-millisecond periods of interruption.

All of the grids of the tubes 10 to 17 are connected through individual leak resistances (such as 70 and 72) to lead 22 which connects through negative bias battery 23 to the cathode lead 18.

The anodes of tubes 10 to 13 are individually connected to ground through resistors 24 to 27 and the plates of the tubes 14 to 17 may be individually connected to resistors 28 to 31, each of which is provided with a series of tapping points connectable to the output lead 32 when the corresponding selector switch 33 to 36 has been moved off its first or open circuit position and on to one of the contacts connected to a tapping point of the resistor 28, 29, etc. The load terminals for taking off the generated impulses are at 32 and 38 connected to the ends of coupling resistor 37.

A condenser-resistance timing circuit is connected between the anode circuit of each tube in each row of tubes and the grid circuit of the next. This comprises a condenser 40 to 43 for the lower row in the figure and condenser 44 to 47 for the upper row together with the resistors 50 to 53 and 54 to 57, the associated plate resistors 24 to 27 for the lower row of tubes and the grid leak resistors in each case. The purpose of these timing circuits is to condition the next succeeding tube in the series for firing when the cathode impulser again applies -150 volts to all of the cathodes after an interruption period has restored the previously operated tube, as will be more fully described. Small condensers 60 and 61, one per tube, also assist in establishing the firing conditions for the next tube as well as in suppressing transients and preventing false operation. These small condensers are each in shunt across the leak resistor and bias battery 23. One way in which these condensers prevent false firing is by off-setting the effect of grid-to-ground capacity which might produce a positive grid pulse sufficient to fire the tube in case the cathode potential is dropped very abruptly.

A start key 65 consists of two halves, 65 and 65', which when closed shunt out the small condensers 60 and 61 associated with the grids of tubes 10 and 14, respectively, and connect the control grids directly to the cathodes.

When the energizing circuit is first turned on and with key 65, 65' open it is possible that no tubes will be fired or that certain of the tubes may fire irregularly. The purpose of the key 65 is to control the start of the sequence by causing tube 10 to fire repeatedly each time the cathodes are driven negative while the key is closed. Then, upon release of the key, the tubes will fire in the fixed sequence 10, 11, 12, 13, 10, etc. Such tubes of the

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secondary series 14 to 17 as have their plate circuits closed at the switches 33 to 36 will fire in unison with the corresponding tubes of the primary series.

In explaining the voltage and time relations, only the primary series of tubes 10 to 13 will be taken into account, since it is clear from what is said above that the tubes 14 to 17 are individually controlled in their firing by the firing of the primary series.

Before the circuit is started by pressing key 65, each condenser 40 to 43 becomes practically fully charged during each firing period of 18 milliseconds since the time constant of its circuit is about 11 milliseconds. The 2-millisecond restoring period is too short to allow very much of the charge to leak off. The voltage at the terminals of these condensers nearest the grids (lower plates in the drawing) therefore varies between limits of about -159 volts and -120 volts with respect to ground so that the grid-to-cathode voltage is in every part of the cycle too far negative to allow the tubes to fire.

When key 65 is closed the grid of tube 10 is connected directly to its cathode so that tube 10 fires each time its cathode is driven negative and is restored in the intervening periods. The drop of potential across plate resistor 24 when tube 10 is conducting is about 135 volts, the drop across the tube being only about 15 volts. Condenser 40 does not, therefore, charge to more than a few volts since the drop across the circuit 40, 50, 70 is only the difference between the voltage across tube 10 and the voltage of battery 23. However, as long as key 65 is held closed tube 10 alone will continue to fire and its firing will result in such a large potential drop across resistor 24 that tube 11 cannot fire. As soon as the key 65 is opened, however, the existence of only the very small charge on condenser 40 and the absence of any potential drop in resistor 24 will permit the tube 11 to fire because the distribution of potentials along the potentiometer 24, 40, 50, 70 due to charging current into condenser 40 allows the grid to go sufficiently positive with respect to the cathode. Tube 11 will, therefore, fire once and establish the necessary conditions in the circuit 25, 41, 51, 72 to cause the next tube 12 to fire in the next succeeding firing period, and the tubes in this manner fire in a closed cycle.

Considering tube 15 in the upper row, by way of example, the same voltage conditions exist on its control grid and cathode as exist in the case of tube 11 since the capacities and resistances in the interstage circuit are the same in both cases. This is true of each of the stages. The upper tubes are, therefore, caused to fire in the same sequence as the lower row of tubes.

The switches 33 to 36 can be set to any position at any time either during the operation of the circuit or before starting it. In order to generate current of the type indicated at *a* in FIG. 2, having impulses of amplitudes 1, 0, 3, 2 in rotation, switches 33 to 36 are set on terminals 1, 0, 3 and 2. Other types of waves are indicated at *b* and *c* by way of example, these being of the form 1, 5, 3, 4 and 5, 0, 2, 3, respectively. Other types of waves will be obvious from the examples given.

What is claimed is:

1. In a circuit for producing a wave of repetitive

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stepped form, a plurality of trigger tubes operating one after another in a closed cycle with each tube initiating operation of the next, a secondary series of tubes operating one at a time in unison with and under control of said plurality of trigger tubes, a common output circuit for all of the tubes of said secondary series, and connections from said common output circuit to the outputs of individual tubes of said secondary series including adjustable individual coupling means to apply a different fractional part of the individual tube output current to said common output circuit.

2. In an impulse producing circuit, a plurality of trigger tubes operating in sequence in a closed cycle, a source of periodically interrupted space current supply voltage for said tubes, coupling circuitss between successive tubes for determining the order in which said tubes fire, a second plurality of trigger tubes each tube of which is paired with and is operated by a tube of the first-mentioned plurality, a common output circuit for all of the tubes of said second plurality and variable coupling impedances between each of said last-mentioned tubes and said common output for enabling different fractional portions of the output current of each of said latter tubes to be applied to said common output circuit.

3. In an impulse producing circuit, a primary series and a secondary series of trigger tubes, means for firing one tube in each series in unison as pairs, a timing circuit connecting the anode of each primary tube to the control electrode of both tubes of the next pair to determine the firing order, a source of periodically interrupted voltage for driving the cathodes of all tubes in common to a negative potential with respect to ground to enable said tubes to fire and restore at periodic times, resistors connecting the anodes of each tube to ground, a common output circuit for the tubes of the secondary series, and selective switches for varying in steps the point of connection between the respective anode resistor of each tube in the secondary series and said common output circuit.

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ARTHUR GAUSS, *Primary Examiner*.

ARTHUR W. CROCKER, CLARE M. WHITMAN,
JAMES L. BREWINK, *Examiners*.