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METHOD AND APPARATUS FOR GENERATING IMPULSES

Filed April 21, 1944

2 Sheets-Sheet 1

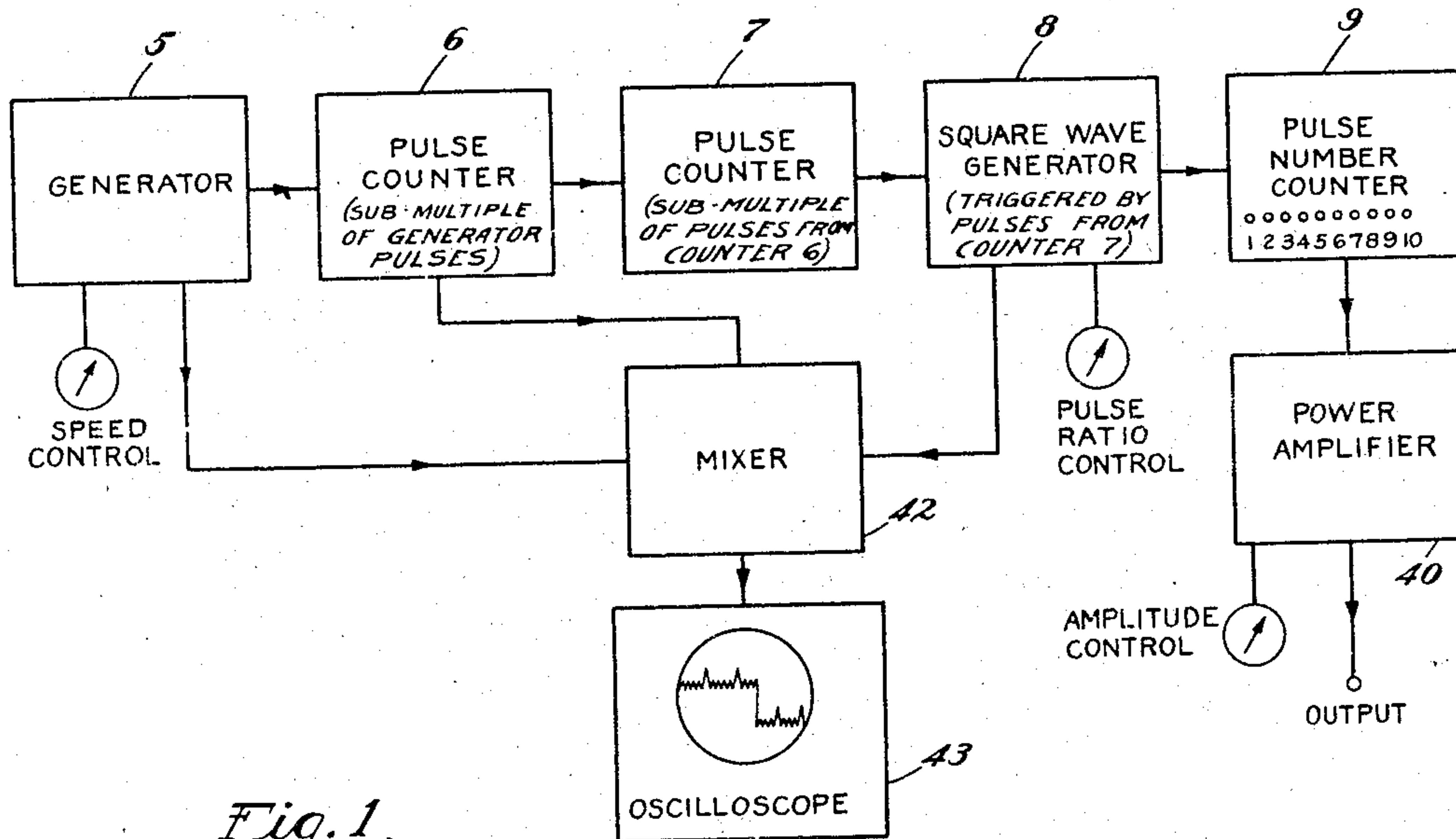


Fig. 1

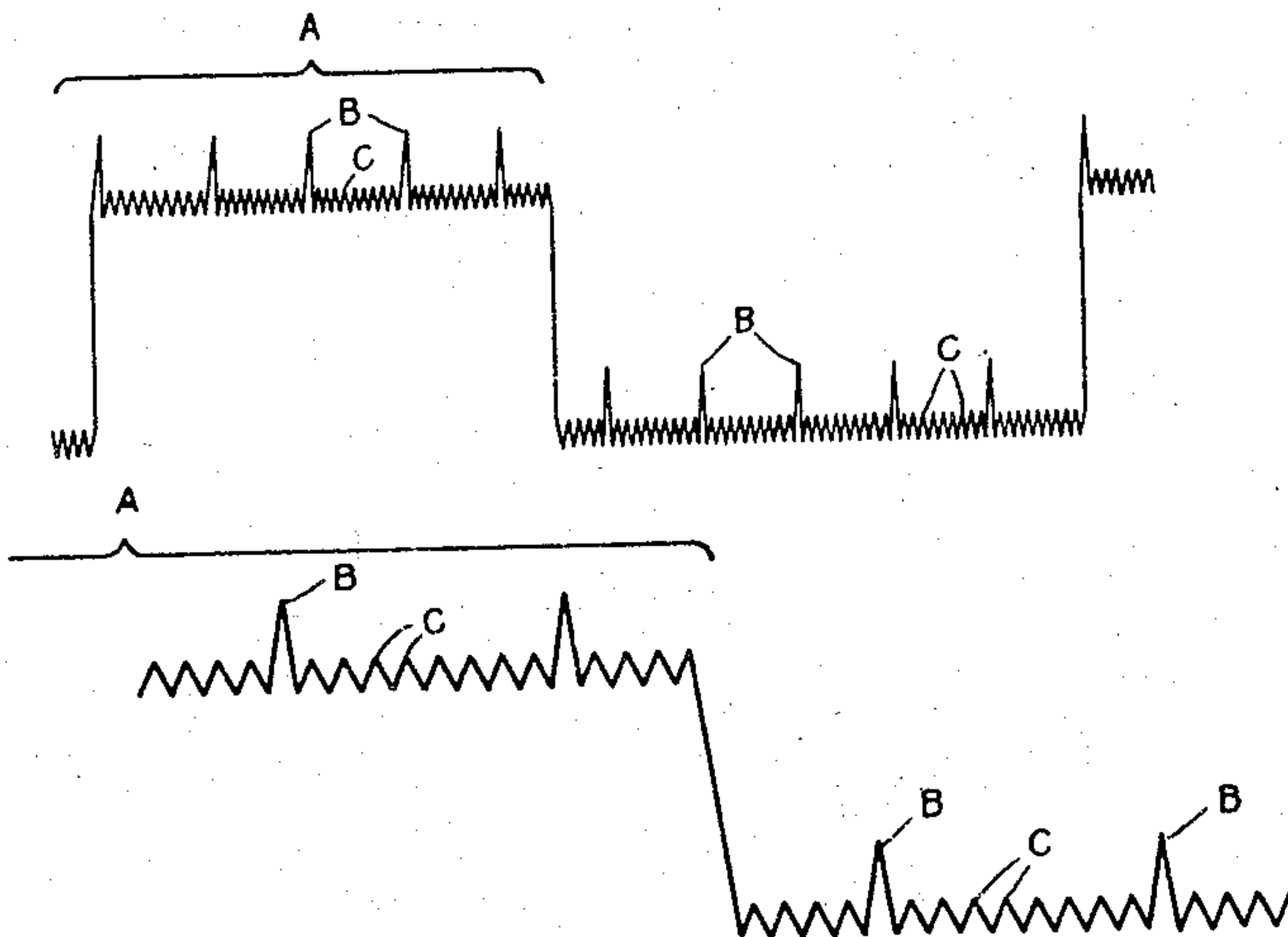


Fig. 2

Fig. 2a

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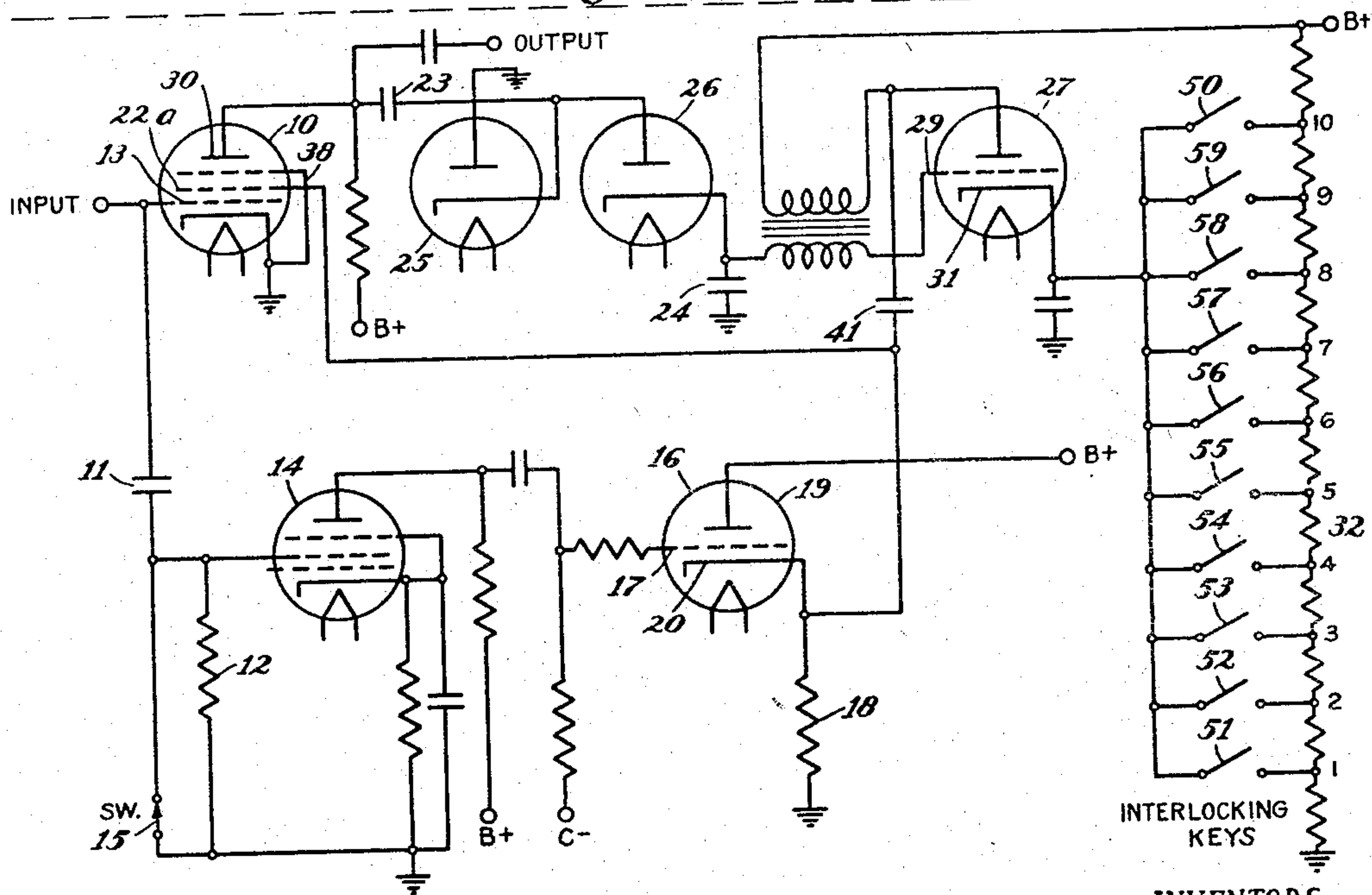
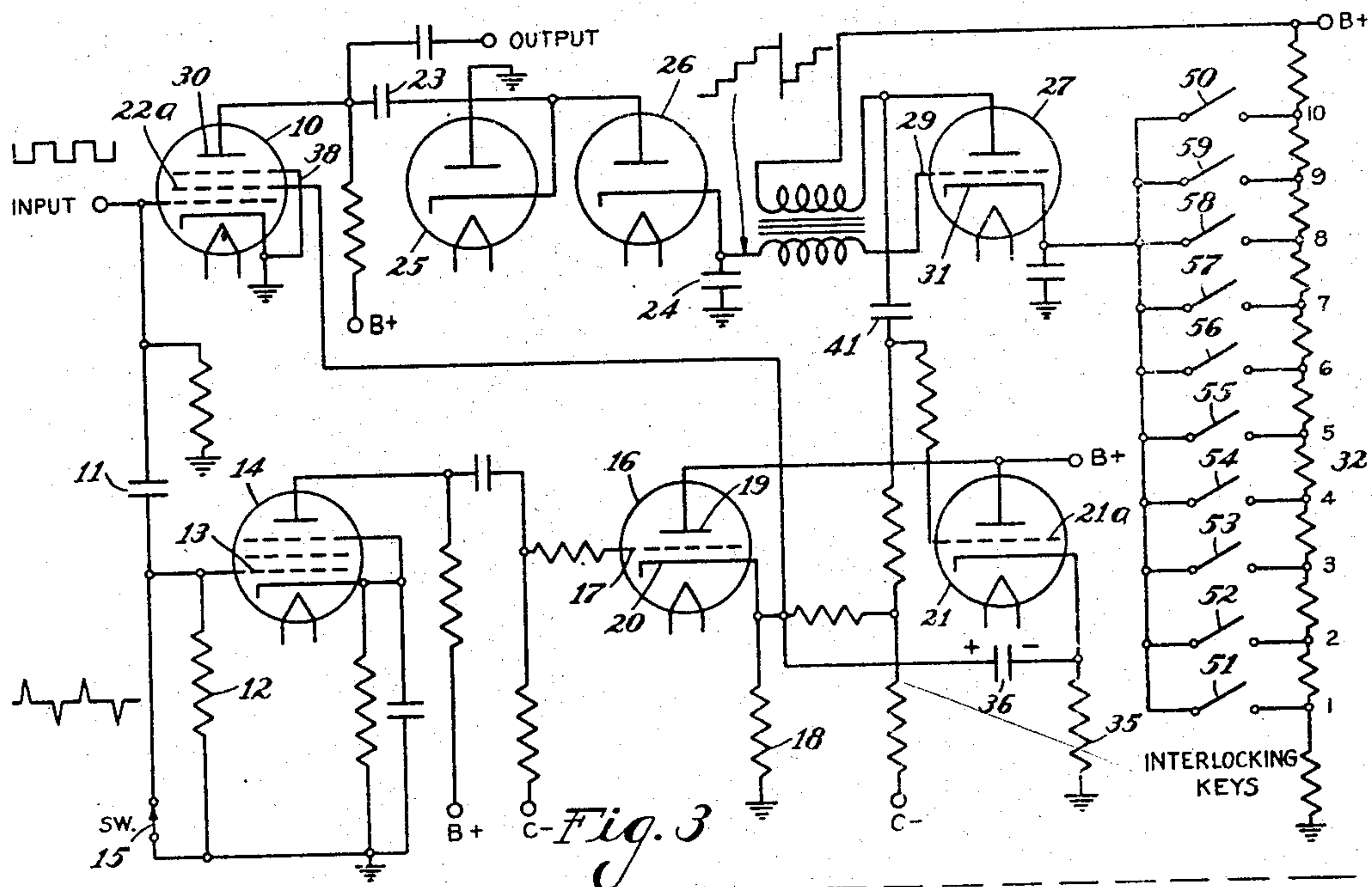


Fig. 4

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METHOD AND APPARATUS FOR
GENERATING IMPULSES

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7 Claims. (Cl. 177—380)

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This invention relates to a method of generating impulses and impulse generating arrangements for use in connection with automatic telephone systems and the like.

In automatic telephone systems, it is commonly the practice to employ a so-called dial impulse sender to generate code impulses corresponding to the several digits of the wanted party's line. In its commonest form, this dial impulse sender includes a pair of contact springs connected in series with the signaling circuit, these contact springs being periodically opened under the action of an interrupter arranged to be operated a desired number of times determined by the subscriber's manipulation of a finger hold dial. Such an impulse dial sender includes a mechanical governor, intended to control the regularity of operation of the interrupter so that the mentioned contact springs, are periodically actuated with a uniform interval between impulses. It will be understood that if a dial impulse sender deviates materially from a predetermined interval, faulty operation of the switching equipment will take place. For example, if the mentioned contacts are interrupted too frequently, as in the case of a so-called "fast dial," the switching equipment controlled thereby will have insufficient time in which to operate in accordance with the impulses, and consequently an incorrect operation of the switching means will take place. On the other hand, if the contacts are interrupted too infrequently, as in the case of a so-called "slow dial," slow-releasing relays associated with said switching means will fail to be held operated during the long period between pulses and consequently the switching means will be released. Therefore, it is important in the original testing, as well as in the repairing of such dial impulse senders, to have a so-called standard impulse generating device or impulse simulator against which the mentioned dial impulse senders can be compared for accuracy of operation.

In addition, in the testing of a telephone system, it is frequently desirable to employ an impulse sender wherein the periodicity of the pulses can be varied at will, and wherein the ratio of the time of pulse to no pulse can be controlled as desired.

In accordance with the main feature of the present invention, there is provided, for satisfying the mentioned requirements, a method of generating pulses, in which method the ratio of pulse to no pulse and the speed or frequency of pulsing as well as the number of pulses and the amplitude thereof can be controlled exactly.

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Another feature of the invention relates to the use of thermionic means for generating pulses of exact predetermined wave form and periodicity.

Other features and advantages of the invention will appear from the detailed description and claims when taken with the drawings in which:

Fig. 1 is a block diagram representing the equipment which can be utilized in practicing the invention.

Fig. 2 illustrates the nature of the generated impulses as observed in the cathode ray oscilloscope, as enlarged in Fig. 2a;

Fig. 3 is a diagrammatic showing of a pulse number counter or metering circuit suitable for use in the arrangement diagrammatically illustrated in Fig. 1; and

Fig. 4 is a diagrammatic showing of a pulse number counter or metering circuit similar to the arrangement of Fig. 3 but somewhat simplified.

In accordance with the present invention, there is provided a generator 5 which is adjustable to develop a given frequency in a predetermined range, such, for example, as a range from 600 cycles to 2300 cycles. This generator may be a standard beat frequency oscillator, the output of which is provided with a network including a capacitor and a resistor, for the purpose of differentiating the waves in order to provide sharp peaks for calibrating. The output of the generator is coupled to and supplies pulses to a ten-to-one pulse counter 6. This pulse counter may be of any well-known form, such, for example, as that shown on page 57 of the RCA Review for July 1940. This pulse counter derives square wave pulses of $\frac{1}{10}$ the frequency of those developed by the generator 5 and supplies these pulses to a second ten-to-one pulse counter 7 of like construction, to which it is coupled. The second counter 7 thus develops triggering pulses of one one-hundredth the frequency of those delivered by the oscillation generator 5, and is coupled to a square wave generator 8 of the trigger type which develops square waves of a frequency determined by the triggering pulses. This square wave generator, which has provisions for changing, at will, the width of its square wave pulses, may be of the arrangement shown on page 176 of the text book entitled "Ultra-High-Frequency Techniques," by Brainerd, Koehler, Reich and Woodruff, tenth printing.

The square wave, so generated by the generator 8, is delivered to a pulse number counter

9 (to be described in connection with Fig. 3) which counter meters the number of pulses that are supplied to power amplifier 40. It will be appreciated that when the generator 5, the counters 6 and 7, the square wave generator 8, as well as the pulse counter 9 and the amplifier are operating, the output of the amplifier will consist of a specified number of square wave pulses of a frequency variable from 6 to 23 pulses per second and having a variable width (timing) and amplitude.

The present arrangement also includes means for visually indicating the duration, amplitude and character of the impulses delivered by the power amplifier. This last-named means comprises a mixer 42 of the vacuum tube type in which signals from the generator 5, the counter 6 and the square wave generator 8 are mixed and the mixed signals from this mixer are delivered to a cathode ray oscilloscope 43 which may be similar in arrangement to that shown on page 225 of the text book "Ultra-High-Frequency-Techniques," referred to above. The mixed signals delivered by the mixer to the oscilloscope will cause the screen of this device to visually indicate the character of the output pulse which will appear as illustrated in Fig. 2. This visual indication will include the output frequency pulses or the square waves A corresponding to the dial impulses being simulated, upon which there will be superimposed impulses C from the generator 5 and calibrating impulses B from the first counter 6. By counting the number of calibrating pulses appearing on the output pulse, the percentage of pulse to no pulse can be determined quickly and easily. The normal sweep will allow the tens and the approximate units to be determined. By expanding this sweep, as shown in Fig. 2a, it will be possible to determine the number of units and the fraction of the units to be estimated.

The pulse number counter generally designated 9 in Fig. 1, may embody the specific circuit arrangement shown in Fig. 3. In this arrangement the square wave from the generator 8 is supplied to the input circuit of a vacuum tube, such as a pentode 10 which does not pass the square wave until it is conditioned to do so in a manner to be described. When thus conditioned, vacuum tube 10 acts as an amplifier and allows the resultant of the square waves to be communicated to the power amplifier 40 and counter circuit.

Vacuum tube 10 is under the control of means including a counter network and a blocking oscillator cooperating with manually selected digit keys (to be described) which means discontinues the passage of square wave pulses through vacuum tube 10 when a number of square pulses, corresponding to the selected digit key, have been communicated. The square wave supplied to the pentode 10 is differentiated by the low time constant combination of a condenser 11 and resistor 12 and is fed to the grid 13 of the vacuum tube 14 during such time as the manual switch 15 is momentarily opened. The vacuum tube 14 is biased to cut off so that positive polarity pulses only can pass therethrough and be amplified.

A triode 16 of the gas or thyratron type, is resistance-coupled to the output of vacuum tube 14. Triode 16 conducts whenever a pulse greater in amplitude than the normal negative bias is present at its grid 17. When the triode 16 conducts, the voltage across the resistor 18 is approximately equal to the difference between the

plate voltage on plate 19 and the voltage drop across the triode 16. This sudden high voltage at the cathode 20 of the gas triode is used for two purposes. The first is to raise the voltage at the grid 21a of a second gas type triode 21 to a value at which this triode will conduct when a positive pulse of sufficient amplitude is applied to grid 21a. The circuit in this condition will be referred to as being "primed." The other use of the high cathode voltage of triode 16 is to raise the voltage on the screen grid 22a of vacuum tube 10 to a value where the tube 10 will act as an amplifier and allow the original square wave to be supplied to the counter network and the power amplifier 40.

The counter network consists essentially of two condensers 23 and 24, as well as two diodes 25 and 26, and a blocking oscillator 27, condenser 23 being appreciably lower in capacitance than condenser 24. The positive voltage present at the anode 30 of pentode 10, due to the normal non-conducting condition of this tube will have charged the two condensers 23 and 24 through the diodes to voltages inversely proportional to their capacitances. When the voltage on screen 22a of pentode 10 is increased by the gas triode 16, pentode 10 conducts during the positive portion of the square wave, and this will cause the anode 30 to approach zero potential. Condenser 23 will discharge through the diode 25 but condenser 24 will hold its initial charge. The negative portion of the input wave will "cut off" the grid of pentode 10, causing the voltage on anode 30 to return to that of the anode supply connected thereto. This again charges the two condensers 23 and 24, thereby accumulating an additional charge on condenser 24 every time the cycle is repeated.

From the foregoing, it should be understood that each cycle of the input wave will produce an additional charge on the condenser 24, during the period that the screen of pentode 10 is positive, due to the action of the gas triode 16.

The grid 29 of the blocking oscillator tube 27 is connected to the condenser 24 so that when the voltage resulting from the charge being accumulated on condenser 24 exceeds the positive bias present on the cathode 31, the tube 27 will conduct, thereby producing a strong pulse in its anode circuit. The grid 29 of the oscillator 27 conducts at this point in the cycle, discharging condenser 24 and restoring the counter to its initial condition. The number of pulses required to "fire" the blocking oscillator can be controlled by the bias on the cathode 31 by means of the multi-unit resistor or bleeder 32 and the selectively operated interlocking keys 51 to 59 and 50. This construction of the interlocking keys insures that only one key can be closed at any given time. It will be noted that these keys allow a selection of positive voltage to be applied to the cathode 31 of the oscillator 27 by connecting to various points along the multi-unit resistor or bleeder. Consequently, by operating any given one of the switch contacts from 50 to 51 a corresponding number of pulses from one to ten can be delivered.

The pulse generated in the anode circuit of the blocking oscillator 27 is fed to the grid 21a of the second gas triode 21, which has been previously "primed." This triode conducts and raises the cathode voltage across resistor 35 to the potential B minus the drop in tube 21, which raises the voltage at the negative terminal of condenser 36. The positive terminal of the condenser 36 is now substantially twice B voltage,

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which is enough to cut off triode 16 and restore the cathode to a low voltage. This causes the screen 22a of the first amplifier tube 10 to drop in potential, thereby causing this tube to cut off and shut off the square wave from the output of the counter. The circuit is now restored to its original state since condenser 24 is discharged and tube 16 is non-conducting, although tube 21 is still conducting. The next pulse from tube 16 "primes" tube 21 as before but also causes it to be cut off as a result of the operation of the condenser 36. Condenser 36 acts in the same manner as described above where triode 21 cuts off triode 16.

The pulse number counter of Fig. 3 may be somewhat simplified as shown in Fig. 4 wherein corresponding parts in both diagrams are designated by the same numerals. In the arrangement of Fig. 4, the condenser 41 is connected to the cathode 20 of the gas triode 16 in order to shut off triode 16 directly, instead of connecting condenser 41 to input of the second gas triode 21 for the purpose of developing the shut off voltage for triode 16.

The circuits of the present disclosure should be taken not in a limiting sense but merely as illustrative of the invention since there can be various modifications in these circuits, within the scope of appended claims without departing from the present invention.

What we claim is:

1. Apparatus for simulating dial impulses and the like which comprises means for generating square waves, means for differentiating said square waves into pulses of positive and negative polarity, means for utilizing the differentiated pulses of one polarity to cause the communication of square wave pulses to a utilization point, means for selectively establishing one of several possible conditions, each different condition being indicative of a different fixed number of pulses desired in a given group, means for accumulating a component corresponding to each square wave communicated until the total of said components bears a predetermined relation to said selected condition, and means for terminating the communication of said square waves in response to the fulfillment of said predetermined relation whereby said group comprises a desired number of impulses.

2. Apparatus for simulating dial impulses and the like which comprises means for electronically generating square waves, means for differentiating said square waves into pulses of positive and negative polarity, means for utilizing the positive pulses to cause the electronic communication of square wave pulses to a utilization point, means for selectively establishing one of several possible conditions, each different condition being indicative of a different fixed number of pulses desired in a given group, means for accumulating a component corresponding to each square wave communicated until the total of said components bears a predetermined relation to said selected condition, and means for electronically terminating the communication of said square waves in response to the fulfillment of said predetermined relation whereby said group comprises a desired number of impulses.

3. Apparatus for producing and visually observing the nature of recurring impulses of pre-

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determined character which comprises means for generating primary pulses at a frequency substantially greater than that of the desired impulses, means for deriving therefrom a submultiple number of secondary pulses, means for utilizing said derived pulses to trigger a source of impulses of predetermined form and amplitude, means for setting up a condition indicative of a desired number of impulses in a group, means for terminating the communication of said impulses to said utilization point in response to the fulfillment of said condition, and means for simultaneously developing a visible indication of the nature of said primary pulses and of said secondary pulses as well as of said communicated impulses.

4. In an impulse generating system, a continuously operating pulse generator, a wave generator triggered by pulses from said pulse generator to deliver impulses, and an impulse number counter coupled to said wave generator and selectively operated to deliver a predetermined number of impulses.

5. In an impulse generating system, a generator of primary pulses greater in number for a given unit of time than the number of impulses eventually desired, a pulse counter for developing from said primary pulses a sub-multiple number of secondary pulses for the given unit of time, a square wave generator coupled to said counter and triggered thereby to develop square wave impulses, and an impulse counter coupled to said wave generator and selectively operated to deliver a predetermined number of said impulses.

6. In an impulse generating system, a generator of primary pulses greater in number per given unit of time than the number of impulses eventually desired, a primary pulse counter for developing from said primary pulses a sub-multiple number of secondary pulses per the given unit of time, a secondary pulse counter for developing from said secondary pulses a further sub-multiple number of pulses per the given unit of time, a square wave generator coupled to said secondary pulse counter and triggered by pulses therefrom to develop impulses, and an impulse number counter coupled to said wave generator and selectively operated to deliver a predetermined number of said impulses.

7. In an impulse generating system, a generator of pulses greater in number per given unit of time than the number of impulses eventually desired, a primary pulse counter for developing from said primary pulses a sub-multiple number of secondary pulses per the given unit of time, a secondary pulse counter for developing from said secondary pulses a further sub-multiple number of pulses per the given unit of time, a square wave generator coupled to said secondary counter and triggered by pulses therefrom to develop square wave impulses, an impulse number counter coupled to said wave generator and selectively operated to deliver a predetermined number of impulses, a mixer unit for superimposing primary and secondary pulses on said square wave impulses, and an oscilloscope coupled to said mixer unit and controlled thereby to display the resultant of said primary and secondary pulses as well as said square wave impulses.

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