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CONTROLLABLE PULSE GENERATOR

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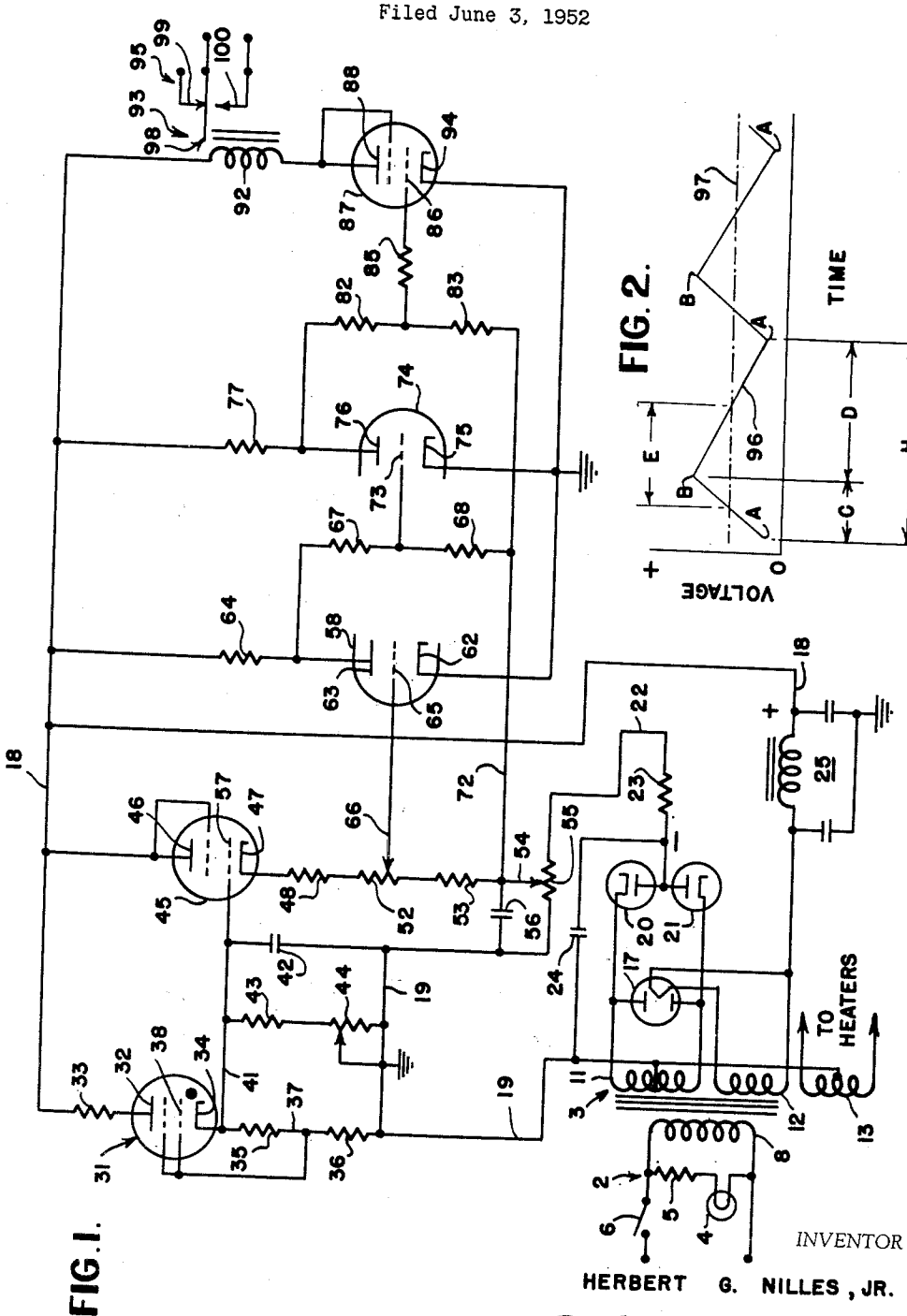

FIG. 1.

FIG. 2.

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CONTROLLABLE PULSE GENERATOR

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1 Claim. (Cl. 307—132)

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The present invention relates generally to a controllable pulse generator, and more particularly to a pulse generator wherein the repetition rate and the pulse duration of its output are independently controllable by separate control elements.

It is an object of the invention to provide a non-sinusoidal wave generator wherein the frequency and pulse duration of the wave may be independently controlled.

It is a further object of the invention to provide a pulse generator controlled by relay means and having independent frequency and pulse duration control.

It is another object of the invention to provide thyratron tube means in combination with appropriate amplifier and switching means so that a wave of variable frequency and pulse duration may be obtained.

Other objects and advantages of the present invention will be readily appreciated as the same become better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which:

Fig. 1 is a circuit diagram of a preferred modification of the present invention; and

Fig. 2 is a chart explaining the operation of the present invention.

According to the invention there is provided a triangular wave generator comprising a thyratron tube connected as a cathode-follower across a source of direct current voltage, the cathode resistance producing a sufficiently high voltage drop to reduce the voltage across the thyratron tube below the minimum ionization voltage. A condenser paralleling the cathode resistor prevents an instantaneous increase in the voltage drop across the cathode resistor during the interval of time required to charge the condenser. When the tube is rendered non-conducting by the voltage drop produced across its cathode resistor, the condenser discharges through the cathode resistor until sufficient potential difference exists across the tube to again cause conduction therethrough. The voltage appearing across the condenser is used to energize a direct current amplifier which controls a relay which operates at a predetermined current through its operating winding. The portion of each cycle during which the relay is actuated is dependent upon the gain of the direct current amplifier and it may be varied.

The repetition rate of the thyratron tube is controlled by varying the value of the resistance

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in its cathode circuit. This has no effect on the charging time of the condenser, but it does vary the discharge time and therefore the total length of the cycle of operation. A rheostat paralleling a fixed resistance is provided as a cathode resistor.

Referring now to Fig. 1, there is shown an input 2 to rectifier unit 3 which supplies the needed voltages for the pulse generator from a conventional source of power, such as 115 volts, 60 cycles. Glow tube 4, in series with limiting resistor 5 indicates that switch 6 has been closed.

Rectifier unit 3 comprises a transformer having a primary coil 8 and a plurality of secondary coils 11, 12 and 13. The primary coil 8 is energized from input 2.

The secondary coil 11 supplies energy to two sets of full wave rectifiers oppositely connected. One set comprises a double diode tube 17 that provides a positive potential on conductor 18 as compared to ground potential on grounded conductor 19 to which the midpoint of coil 11 is connected. The other set comprises a pair of diodes 20 and 21 connected to provide a negative potential on conductor 22 through a resistor 23, the negative potential being with reference to the ground potential on conductor 18. Voltage smoothing means of any suitable kind may be provided, as for example the condenser 24 and filter 25.

The secondary coil 13 supplies heating energy to the cathode heaters of the various tubes shown in a well known manner, the actual connections being omitted in the interests of brevity and clarity.

In order to generate pulses a thyratron tube 31 is provided having an anode 32 connected through a current limiting resistor 33 to the positive conductor 18, and having a cathode 34 connected through the series connected cathode resistors 35 and 36 to the grounded conductor 19. Their joining conductor 37 is connected to the control grid 38 of the thyratron tube 31. The other sides of the resistors 35 and 36 are connected respectively, to a central conductor 41 and to an extension of conductor 19 at ground potential.

The resistance 33 has a resistance of a few hundred ohms to limit the current conducted by the tube 31, but the cathode resistances 35 and 36 have a very large total resistance so that conduction of the tube will produce such a large voltage drop across the resistances as to cause the tube to de-onize when the grid 38 is made negative. The condenser 42 is connected in par-

allel with the resistances 35 and 36 to prevent an instantaneous voltage change thereacross, so that the tube 31 remains conductive during the charging interval of the condenser. When the condenser 42 has become charged, the grid 38 of the tube 31 is made negative with respect to the cathode 34 by the voltage drop across the resistance 35, and the voltage impressed on the tube is reduced to the value at which conduction stops.

The negative potential impressed on the grid 38 is maintained until the condenser 42 discharges sufficiently to allow the thyratron tube 31 to ionize again to repeat the cycle, and the discharge time of the condenser is controlled by the resistance in its discharge path. The resistance in the discharge path in controlled by means of the series connected resistance 43 and the variable resistance 44 connected in parallel with the condenser, so that the discharge time may be varied over wide limits. The charging time of the condenser is short with respect to the discharge time thereof, so that the repetition rate of the thyratron is effectively controlled by varying the setting of the variable resistance 44.

The voltage appearing across the condenser 42 is used to control conduction of the tube 45 which has an anode 46 connected to the lead 18, and a cathode 47 connected through series connected resistor elements 48, 52 and 53 to the movable tap 54 of the potentiometer 55. The potentiometer 55 is connected between the grounded conductor 19 and negative conductor 22 so as to provide an adjustable negative voltage for a purpose later to be described. The condenser 56 is connected between the movable tap 54 and the grounded conductor 19 to prevent appreciable voltage changes from appearing thereacross during the time interval of one cycle. The control grid 57 is connected to the control conductor 41.

The tube 45 is normally conducting, since the voltage on the grid 57 is always above ground potential and its cathode is connected to a point below ground potential. When the charge on the condenser 42 increases, the current through the resistances 48, 52 and 53 produce a voltage drop thereacross which raises the potential of cathode 47 with respect to ground. This increase in potential controls the operation of the switching circuit consisting of three direct-connected stages operating a double-throw relay.

The tube 58 comprises a cathode 62 connected to ground, an anode 63 connected to conductor 18 through the resistance 64, and a control grid 65 connected to the movable tap 66 on the resistor element 52. A voltage divider comprising resistances 67 and 68 is connected between the anode 63 and the conductor 72 which is connected to the movable tap 54 on the potentiometer 55. The junction of resistances 67 and 68 is connected to the grid 73 of tube 74.

The tube 74 comprises a cathode 75 connected to ground and an anode 76 connected through the resistance 77 to conductor 18. A voltage divider comprising resistances 82 and 83 is connected between the anode 76 and conductor 72. The junction of resistances 82 and 83 is connected through resistance 85 to the grid 86 of tube 87. The anode 88 of tube 87 is connected through the control winding 92 of the relay 93 to the conductor 18, while the cathode 94 is connected to ground.

When the condenser 42 charges, the voltage rise at the movable tap 66 of the potentiometer 52 causes the tube 58 to conduct more heavily than before and therefore causes the voltage at the anode 63 of tube 58 to fall in proportion to the voltage rise. This voltage drop is transmitted to tube 74 which conducts less current so as to cause a voltage increase at its anode 76, and this increase is transmitted to the grid 86 of tube 87 to cause tube 87 to conduct more heavily and thus actuate the contacts 95 of relay 93. Armature 98 swings between contactors 99 and 100.

Adjustment of the movable tap 54 on the potentiometer 55 regulates the bias on tubes 76 and 87 and so regulates the current conducted by the tube 87 through the operating winding 92 of relay 93 when the condenser 42 is discharged. The current through the relay is adjusted to a value considerably below the value at which the relay is actuated, since the tube 87 will conduct heavily when condenser 42 is charged. Resistor 85 is provided to prevent the flow of appreciable grid current in the tube 87.

The current conducted by tube 87, when the condenser 42 is charged, corresponds to the voltage impressed on the grid 65 of tube 58, which voltage is adjustable by varying the setting of the movable tap 66 on potentiometer 52. The magnitude of the charge on condenser 42 is substantially uniform between pulses, so that the point at which the relay 93 closes and opens may be regulated by adjustment of potentiometer 55.

The operation of the circuit may be more readily understood by reference to Fig. 2 in which the curve 96 represents the charge on condenser 42 plotted with respect to time. The points A represent the voltage at which the thyratron tube 31 ionizes to conduct current. The points B represent the voltage at which the tube 31 becomes non-conducting. During the time interval represented by C, the condenser is charging; it is discharging during the time interval represented by D. The actuating voltage of the relay 93 is indicated by the line 97. Adjustment of the movable tap 66 has the effect of shifting the curve 96 in a vertical direction so as to vary the time interval E during which the relay is actuated. The cyclic interval H is varied by varying the discharge time D. This is done by varying the setting of the variable resistance 44.

It is also to be noted that the output wave shape at contacts 95 is rectangular since armature 98 swings between contactors 99 and 100 on a make or break basis. Assuming that there is a potential difference between armature 98 and contactors 99 and 100, an initial surge of current results when contact is made. There is then a level period of current flow, followed by an abrupt cut off when contact is broken.

It is apparent that novel circuit means have been provided to control the output of a controllable pulse generator. One control means acts to vary the frequency or repetition rate of the wave; another control acts to vary the pulse duration of the signal applied to the output device. By appropriate choice of circuit constants, the pulse duration may be varied between 5% and 95% in terms of make to break ratio.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claim.

What is claimed and desired to be protected by Letters Patent of the United States is:

A control circuit including a saw tooth generator, an amplifier and a relay requiring a predetermined actuating current, said saw tooth gen-

erator comprising a thyratron tube having an anode, a cathode and a control grid, a source of anode potential connected to said anode, a first and a second resistor serially connected between said cathode and ground, means connecting said control grid to the juncture of said first and second resistors, a capacitor connected between said cathode and ground, a variable resistor connected between said cathode and ground, said variable resistor serving to vary the discharge time of said capacitor, said amplifier comprising at least one tube having an anode, a cathode and a control grid, potentiometer means connecting said capacitor to the cathode-grid circuit of said tube whereby to vary the amplitude of the voltage impressed thereon, and said relay connected in the anode-cathode circuit of said amplifier, whereby said variable resistor varies the cyclic

rate of said saw tooth generator and said potentiometer means the duration of the actuating of said relay in each cycle.

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