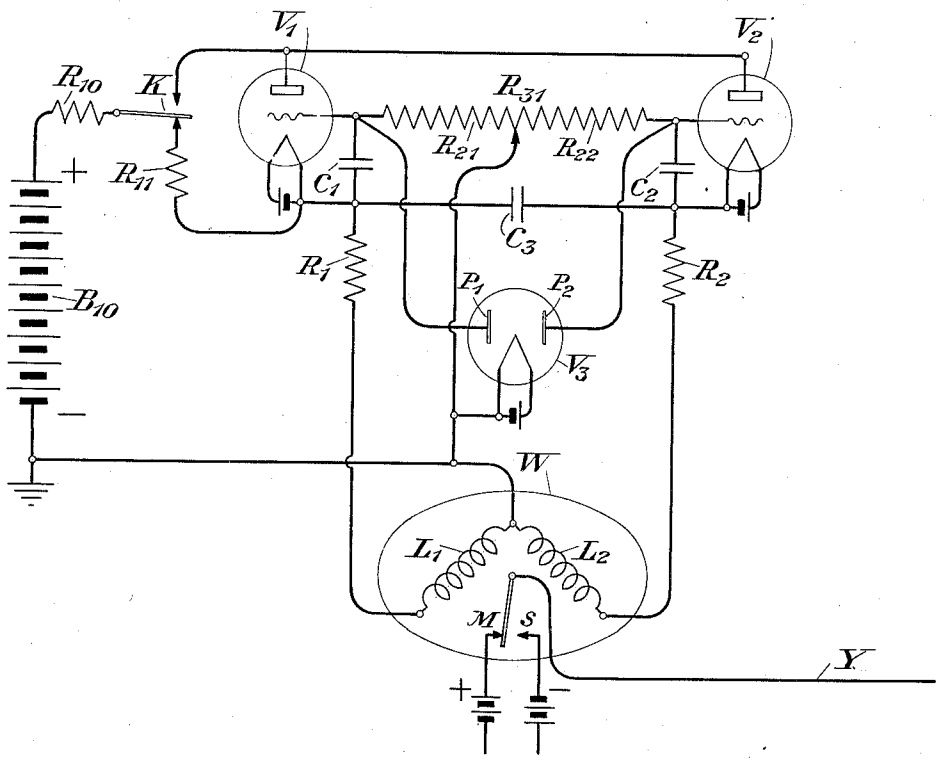
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OSCILLATION GENERATOR

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OSCILLATION GENERATOR

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This invention relates to gas-filled tube circuits, as well as to circuits or systems for producing pulses of current and for generating oscillations. More particularly, this invention relates to circuits and systems for producing pulses of current and electrical oscillations of very low frequencies. This invention also relates to arrangements for producing pulses of current of any desired periodicity and for biasing the pulses by any desired amount.

According to this invention a gas-filled tube circuit is set up to produce pulses of current of opposite polarity at some predetermined periodicity. The circuit is also arranged to vary the length of one of the pulses, such as the positive pulse, with respect to the negative pulse of each cycle by any desired amount without appreciably varying the periodicity of the pulses.

This invention, as well as its object and features, will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of this invention merely for the purpose of illustration.

Referring to the drawing, the reference characters V_1 and V_2 designate two gas-filled tubes of well known construction. These tubes may be, for example, of the 885-type. Each tube includes plate, grid and filament or cathode electrodes, the grid electrode of each tube being used for the purpose of controlling the initiation of ionization of the gas within the tube and the consequent discharge of current between the plate and filament electrodes of the tube, and the grid of the tube usually loses control of the flow of current after gaseous ionization has occurred within the envelope.

Two equal condensers designated C_1 and C_2 are connected between the grid and filament electrodes of the tubes V_1 and V_2, respectively. The charge on these two condensers will be used to apply a unidirectional voltage between the grid and filament electrodes of the associated tube, and hence the condenser will determine the point at which the gas within the associated tube becomes ionized, as will be seen more clearly hereinafter. The grids of the two tubes V_1 and V_2 are interconnected by a resistor R_{31}, which is, according to this invention, a very large resistor, for example, a resistor of about a half megohm. This resistor is divided into two parts designated R_{21} and R_{22}, the division being made by a tap which is movable across the resistor R_{31}.

A resistor R_1 is connected in series between the terminal common to the condenser C_1 and the filament of tube V_1 and one of the windings L_1 of the relay W. The relay W may be the sending relay of a telegraph system. Similarly, an equal resistor R_2 is connected between the junction of condenser C_2 and the filament of tube V_2 and the winding L_2 of the relay W. The terminal common to the windings L_1 and L_2 of relay W is connected to the negative terminal of a battery B_{10}, which may be grounded, if so desired. The positive terminal of the battery B_{10} is connected in series with a current-limiting resistor R_{10}, as well as with the armature of a key K of any well known type, this key being used to control the starting and stopping of the production of pulses or oscillations with the circuit arrangement illustrated in the drawing.

The lower contact of the key K is connected to the filament of the tube V_1 through another current-limiting resistor R_{11}. The upper contact of the key K is connected to the plate electrodes of both tubes V_1 and V_2. A condenser C_3 is connected between the filaments of the tubes V_1 and V_2 as illustrated. The circuit also includes a full-wave rectifying tube V_3, which may be, for example, of the 80-type which is familiar to those skilled in the art. This tube includes two plate electrodes designated P_1 and P_2, which are connected to the upper terminals of the condensers C_1 and C_2, respectively, and a common filament or cathode, which is connected to the terminal common to the windings L_1 and L_2 of the relay W. The relay W may be used to control the flow of current over a line Y, which is connected to the fixed terminal of the armature of the relay. The armature of the relay W may move between two contacts connected to batteries of opposite polarity, as illustrated in the drawing.

In order to initiate the operation of the circuit of the drawing, the key K will be moved to its lower contact. Current then flows from the battery B_{10} over a circuit including the resistor R_{10}, the armature and lower contact of the key K, the resistor R_{11}, the resistor R_1 and the winding L_1 of the relay W, which is connected to the lower or negative terminal of the battery B_{10}. The resistor R_1, although smaller than the resistor R_{31}, is large enough, however, to produce a substantial voltage across its terminals, and this voltage is applied to the condenser C_1 to charge the condenser C_1. The charging circuit for the condenser C_1 includes, in addition to the resistor R_1, the plate P_1 and the filament of the tube V_3 and the winding L_1. The resistor R_1 has an impedance which is substantially greater than

that of the winding L_1. The resistor R_1 may have an impedance, for example, of about 5,000 ohms. The condenser C_1 will thus be charged in such a way that the lower terminal will be positively poled with respect to its upper terminal. The charge on the condenser C_1 will also be in a direction such as to render the grid of the tube V_1 highly negative with respect to the filament, and thereby prevent any flow of current between the plate and cathode electrodes of the tube V_1.

The circuit for charging condenser C_1 above described, is of sufficiently low impedance so that the charge of condenser C_1 will be accomplished very rapidly. The flow of current through the winding L_1 of this circuit will cause the armature of the relay W to close one of its contacts such as that designated M. A positive pulse will then be impressed upon the line Y. However, no current will flow through the winding L_2 of the relay W, nor through the resistor R_2 in series therewith, and hence the condenser C_2 will be uncharged. Thus the tube V_2 will be ready to conduct a pulse of current when a suitable potential is impressed between its plate and cathode electrodes. At the same time the condenser C_3 will be charged by the voltage generated across the resistor R_1, the charge on condenser C_3 being poled in such a direction as to render the left-hand terminal of the condenser positive with respect to its right-hand terminal.

The armature of the key K may then be removed from its lower contact and moved toward its upper contact. At the instant that the lower contact is opened, the condenser C_1 will begin to discharge through a circuit which includes the resistor R_1, the winding L_1 of the relay W and the resistor R_{21} (which is the left-hand portion of resistor R_{31}). The discharge of current will occur at a slow rate because of the relatively large resistance of the element R_{21}.

Immediately after the armature of key K closes the upper contact, the plate and filament electrodes of the tube V_2 will be connected to the battery B_{10}, and the gas enclosed by its envelope will become ionized. The circuit for ionizing the gas within tube V_2 includes the battery B_{10}, the resistor R_{10}, the armature and upper contact of the key K, the plate and filament electrodes of tube V_2, the resistor R_2 and the coil L_2 of the relay W. While the gas within tube V_2 remains ionized, a voltage will be generated across the resistor R_2, which will be used to charge the condenser C_2. The charging circuit of the condenser C_2 will include, in addition to the resistor R_2, the plate P_2 and the filament of the tube V_3 and the winding L_2 of the relay W. The charge on condenser C_2 will be in such a direction as to render the lower terminal at a positive potential with respect to the upper terminal. But the negative potential thus applied to the grid of the tube V_2 will be unable to extinguish the arc previously formed within the tube V_2.

The flow of current through the winding L_2 of the relay W during ionization of tube V_2 will cause the armature of the relay W to close its spacing contact S, and hence a negative pulse of current will be impressed upon the line Y. The voltage generated across resistor R_2 will also reverse the charge on condenser C_3, so that the condenser C_3 will then have a positive potential applied to its right-hand terminal and a negative potential to its left-hand terminal.

The tube V_2 will remain in an ionized condition for the time being, and the charge on the condenser C_1 will continually leak off through the discharge circuit of the condenser C_1 already described. When the charge on condenser C_1 has dropped below a predetermined value, the tube V_1 will then be in a condition to become ionized by the application of the voltage by battery B_{10} to its plate and filament electrodes. This battery potential will be sufficient to ionize the gas of tube V_1, the ionizing circuit including, in addition to battery B_{10}, the resistor R_{10}, the armature and upper contact of key K, the plate and cathode electrodes of tube V_1, the resistor R_1 and the coil L_1 of the relay W.

For a very brief interval both tubes V_1 and V_2 will be in an ionized condition. The condenser C_1 will be recharged by the voltage generated across resistor R_1, the charging circuit for condenser C_1 being the same as already described hereinabove. The lower terminal of the condenser C_1 will have a positive potential applied thereto and its upper terminal a negative potential.

The voltage across resistor R_1 will also tend to recharge the condenser C_3 in such a direction as to apply a positive potential to its left-hand terminal and a negative potential to its right-hand terminal. But before the condenser C_3 will reach the latter state, it will be necessary for the condenser C_3 to discharge the voltage previously impressed thereupon. The discharge of condenser C_3 will then be effected through a circuit including the resistor R_2 and the coil L_2 of the relay W. The flow of current through resistor R_2 during discharge of condenser C_3 will be in such a direction as to increase the voltage across the terminals of resistor R_2 beyond the value previously reached. The voltage across resistor R_2 will, in fact, oppose that impressed by battery B_{10} in the circuit including the plate and cathode electrodes of tube V_2, and the opposing voltage will become so great that the gas within tube V_2 will become deionized. The battery B_{10} will then transmit no more current through the path formed by the plate and filament electrodes of tube V_2.

Immediately after the tube V_2 reaches a deionized state, the condenser C_2 will discharge over a circuit including the resistor R_2, the coil L_2 of relay W and the resistor R_{22} (which is the right-hand portion of resistor R_{31}). The discharge of condenser C_2 will, of course, take place at a slow rate in view of the large magnitude of the resistor R_{22}.

As long as tube V_1 remains in an ionized state, the flow of current through the coil L_1 will cause the armature of the relay W to close its marking contact M, and hence a positive pulse of current will be impressed upon a line Y. This cycle of operations will be repeated again and again as long as the armature of the key K remains closed against its upper contact.

The condensers C_1 and C_2 of the circuit illustrated in the drawing may be, for example, of a capacity of 0.2 microfarad, and the condenser C_3 of, for example, 0.1 microfarad. Each of the condensers C_1 and C_2 will discharge through its individual discharging circuit above described according to the equation

$$e = E\epsilon^{\frac{-t}{RC}}$$

where E is the maximum voltage across the condenser, R is the resistance of elements R_{21} or R_{22} (together with any other resistance) in series with the condenser during discharge, C is the capacity of the condenser, t is the time after the

discharge starts, and e is the voltage at the end of the time t. Thus, each tube such as V_1, will be non-conducting for an interval of time which is proportionate both as to the value of the capacity of the associated condenser, such as C_1, and the resistance such as R_{21}, through which the condenser discharges.

After the voltage e across the condenser, such as C_1, has dropped to a low and predetermined value, the tube V_1 connected to the condenser C_1 will become conducting, i. e., the gas of the tube V_1 will reach an ionized state. The time during which the tube remains ionized will be determined by the equation

$$t = RC \log_e \frac{E}{e}$$

One of the tubes such as V_1 will be ionized substantially as long as the other tube V_2 is deionized, and vice versa.

It will be observed that the discharge rate for one of the condensers, such as C_1, is determined by the magnitude of the resistor R_{21}, and the discharge rate for the condenser C_2 by the magnitude of the resistor R_{22}. Thus by moving the tap toward the left the discharge rate for condenser C_1 will be increased, while that for condenser C_2 will be correspondingly decreased. Hence the length of the positive pulse applied to the conductor Y will become biased with respect to the negative pulse, that is to say, the length of the positive pulse applied to line Y will be increased while the size of the negative pulse applied to line Y is correspondingly decreased. The increase in the length of one of the pulses will be substantially equal to the decrease in the length of the other pulse.

A circuit set up as indicated in the drawing having the constants already referred to was made to generate pulses of current having a frequency of about 5.72 cycles per second. The tap on resistor R_{31} was used to control the amount of bias between the positive and negative current pulses within reasonable limits. This change in the bias between the two types of pulses was accomplished without appreciably affecting the frequency of the pulses generated.

The frequency of the pulses generated by the circuit was tested by transmitting polar signals into a 60-speed monitoring teletypewriter of well-known construction. The circuit was adjusted to transmit in turn the signal codes corresponding to the characters "Blank," "T", "O", "M", "V" and "Letters" to the teletypewriter apparatus. The transition between the various characters was very sharp and distinct. The transition between the characters took place on a change of bias of approximately 2 per cent, thereby indicating that the frequency of the pulse producing apparatus and the bias were steady. The bias of the pulses was measured with a bias meter of well-known construction.

It will be apparent that the pulses transmitted over the line Y are in effect alternating currents consisting of a fundamental and numerous harmonics. In order to eliminate harmonics from such an arrangement, a filter of well known type may be connected in the line Y. This filter will suppress undesired frequencies as, for example, those exceeding a predetermined frequency. On the other hand, a transformer may be used to replace the relay W. The primary winding of the transformer may be connected in place of the windings L_1 and L_2 of the relay W, i. e., in series with the resistors R_1 and R_2, the midpoint of the primary winding being connected to the negative terminal of the battery B_{10}. The secondary winding of the transformer may be connected to the line Y either with or without a filter interposed in the interconnecting circuit.

When the resistors R_{21} and R_{22} are of equal magnitudes, the positive and negative portions of each cycle will be substantially equal in duration as well as in amplitude. By increasing the magnitude of one of these resistors by a predetermined amount, and by decreasing the magnitude of the other resistor by a corresponding amount, the bias between the pulses of each cycle can be brought to any predetermined value. By so increasing the bias between the pulses, any predetermined harmonic current can be obtained from the circuit coupled to line Y.

The particular values assigned to the different elements of the circuit illustrated in the drawing have been given merely for the sake of illustration and are not to be construed as limitations upon the invention. It will be apparent that other values may be assigned to these elements within the scope of the invention.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. Apparatus for producing positive and negative pulses of current of a predetermined periodicity and for varying the ratio of the length of each positive pulse to each negative pulse without appreciably affecting the periodicity of said pulses, comprising an impedance, adjustable means for dividing said impedance into two parts corresponding respectively to the relative lengths of the positive and negative pulses, two equal condensers, means for charging said condensers, and means for independently discharging said condensers through said two parts of said impedance respectively, for periods proportional to said lengths of the positive and negative pulses.

2. The combination of means for producing positive and negative pulses of current of predetermined periodicity, said means including an impedance, two equal condensers, means for charging said condensers to a predetermined potential, means for dividing said impedance into two parts, and means for independently discharging said condensers through said two parts respectively for varying the bias between the duration of the positive and negative pulses by a predetermined amount without appreciably affecting the periodicity of said pulses.

3. Apparatus for generating low frequency oscillations, said apparatus including means for varying the duration of the positive portion of each cycle with respect to the negative portion of each cycle substantially without changing the frequency of said oscillations, said means comprising two equal condensers, means for charging said condensers to a predetermined potential, an impedance element which is divisible into two parts to correspond to the relative durations of the two portions of each cycle, and means for independently discharging said condensers through said two parts of said impedance respectively.

4. The combination of two gas discharge devices, two equal resistors connected respectively to said devices so that all current traversing said

devices when the gas contained therein is ionized will also traverse said respective resistors, means for alternately applying potential to said devices through the respective resistors for ionizing the gas contained within said two devices, two equal condensers, two one-way transmission devices connected respectively in series with said two condensers and said two resistors to control the charge of said condensers by the voltages across said resistors, and a third resistor adjustably divided into two parts, said two parts of the third resistor being connected respectively across the two condensers for controlling the discharge time intervals of said condensers.

5. The combination of two gas discharge devices each comprising a plate, a grid and a filament, means for alternately ionizing the gas contained within said two discharge devices, and means for changing the bias between the durations of the discharges of the two devices to a predetermined value, said means including, in addition to said two devices and said ionizing means two equal condensers connected respectively between the grids and filaments of the two devices, and two resistors connected in series with each other between the two grids of said devices, said two resistors being of magnitudes proportional to the time intervals during which the two devices are to be discharged, means connecting said two resistors across said two condensers for controlling the discharge of the respective condensers.

6. In an oscillation generator, the combination of two gas discharge devices each comprising a plate, a grid and a filament, two equal resistors each connected respectively in series with the plate and filament of the associated discharge device, two equal condensers connected between the grids and filaments of the respective discharge devices, means responsive to the voltages built up across said two resistors for charging the two respective condensers in but one direction, a third resistor connected between the grids of the two discharge devices, and means for dividing said third resistor into two parts of predetermined proportions, each part of said third resistor being connected to but one of said condensers for controlling the discharge of said condenser.

7. Pulse producing inverter apparatus comprising two gas discharge tubes each including a plate, a grid and a filament, two equal resistors, two equal condensers connected between the grids and filaments of the two tubes respectively, a third resistor connected between the grids of the two tubes, a third condenser connected between the filaments of the two tubes, said two equal resistors being connected in series between the plates and filaments of the two tubes, respectively, means for charging said two equal condensers unidirectionally by the voltages generated across the two equal resistors respectively, said third resistor being divided into two parts which are respectively connected to said two equal condensers to control the discharge of said two equal condensers.

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