

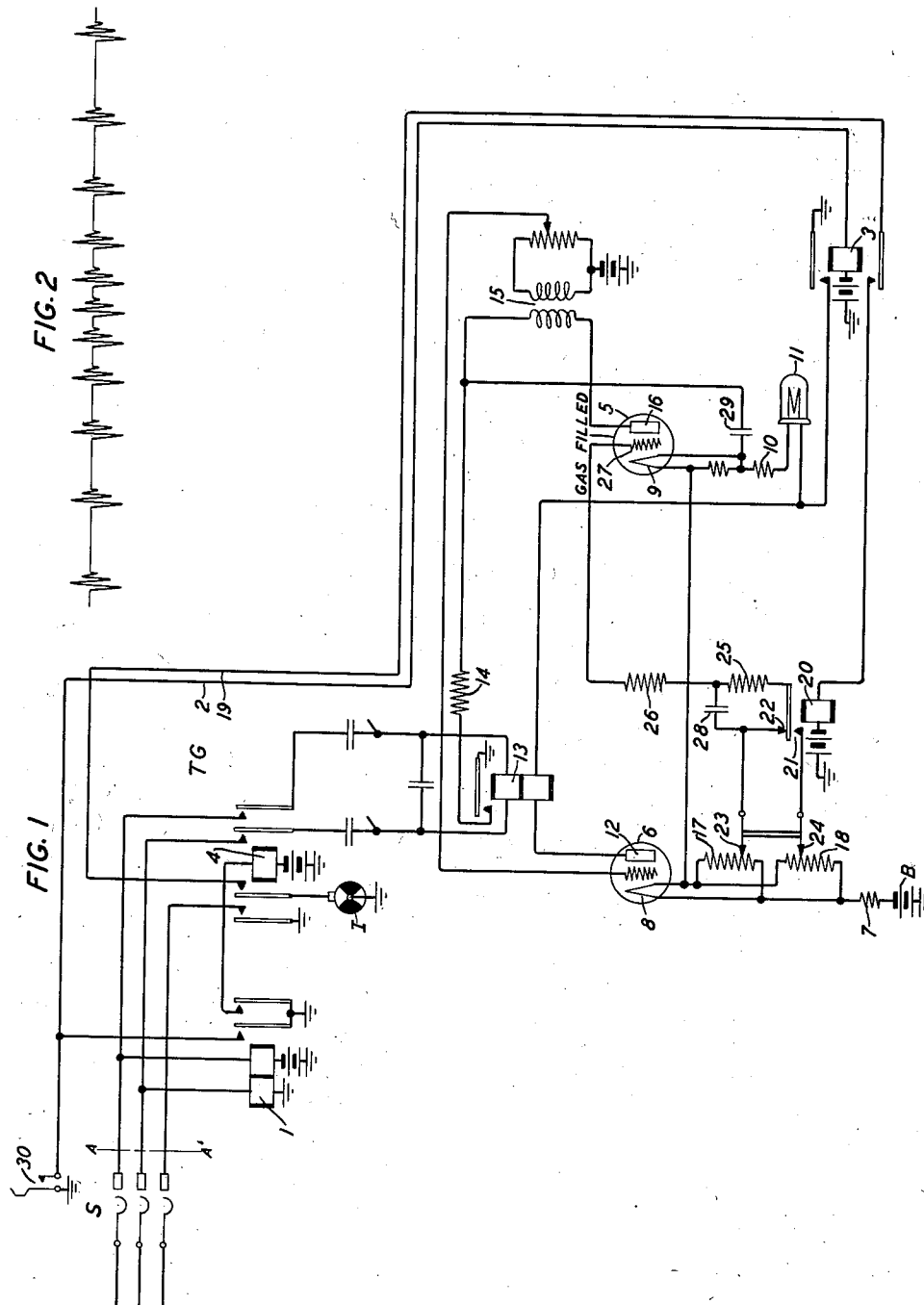
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M. E. KROM

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tone generator

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INVENTOR
M. E. KROM
BY

H. S. Krimm
ATTORNEY

UNITED STATES PATENT OFFICE

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TONE GENERATOR

Myron E. Krom, Madison, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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This invention relates to means for producing and utilizing tone signals in telephone systems and more particularly to means for producing a succession of audible frequency impulses which occur at cyclically varying intervals, that is, impulses which recur at a gradually increasing rate until they reach a predetermined maximum rate and then gradually decrease to a predetermined minimum rate, which cycle of increase and decrease is periodically repeated. Such rapidly recurring impulses, for example, those which start recurring at a rate of 200 per second and gradually increase to 400 per second and then decrease to the 200 rate again, which cycle of increase and decrease is periodically repeated, at a rate of 1 per second, for example, are useful as a so-called "no such number" or "vacant level" tone in automatic telephone systems as an indication to a calling subscriber that an improper switch selection has been made, i. e., he has dialed an improper code.

A feature of the invention resides in applying a periodically varying negative potential to the control electrode of a three-element gas-filled discharge device forming one element of a relaxation oscillator, the energizing potential of which consists of a constant voltage source of direct current connected between the anode and cathode of the device in parallel with an oscillating circuit, whereby when the control electrode potential attains a predetermined value, successive groups of oscillations of uniform frequency and duration are produced in the output circuit of the device, which recurs at an increasing rate while the potential of the control electrode is rising and at a decreasing rate while the control electrode potential is falling.

Another feature of the invention relates to an arrangement associated with the first set of contacts of a vacant selector level or a vacant set of contacts on a connector whereby the extension of a calling line to said contacts causes the connection thereto of a source of characteristic audible frequency, or tone, which source is arranged to supply successive impulses of audible frequency current, which impulses occur at cyclically varying intervals in accordance with the foregoing feature.

The invention will be understood from the following description and accompanying drawing, Fig. 1 of which illustrates an automatic switch adapted to connect a calling line to a set of contacts, thereby initiating the operation and connection to the calling line of a tone generator in accordance with the invention, and Fig. 2

graphically shows the cyclically varying recurrence of the groups of oscillating impulses.

In Fig. 1 of the drawing S, to the left of the broken line A—A', represents an automatic switch, the contacts of which are not connected to a succeeding switch or to a subscriber's line but instead are connected to an arrangement TG, shown to the right whereby when said contacts are seized by the brushes of the switch a characteristic tone is applied to the circuit or line incoming to the switch as an indication to the calling subscriber that an improper code has been transmitted.

For a clearer understanding of the invention let us assume that the calling subscriber has made a mistake and inadvertently transmitted a code of impulses which has advanced the brushes of the switch S to the contacts shown, which contacts are connected to a relay 1, whereby relay 1 operates in a well-known manner over the loop of the calling line. Operation of relay 1 connects ground to conductor 2, thereby operating start relay 3 and also operating relay 4. Operation of relay 3 closes the filament heating circuit of the gas-filled relaxation oscillator tube 5 and amplifier vacuum tube 6, the circuit for which can be traced from battery B, resistance 7, filament 8 of tube 6, filament 9 of gas tube 5, resistance 10 and ballast resistance lamp 11 to ground at the upper contact of relay 3. The output or plate circuit of amplifier 6 is also closed by the operation of relay 3 which can be traced from battery B, resistance 7, filament 8 of tube 6, plate 12 of the tube and lower winding of relay 13 to ground at the contacts of relay 3. As soon as the filament 8 of tube 6 is sufficiently heated relay 13 operates due to plate current flowing therein through tube 6, thereby closing the energizing circuit of gas tube 5 which can be traced from ground, contacts of relay 13, high resistance 14, left-hand winding of repeating coil 15, anode 16 and cathode 9 of gas tube 5 and filament 8 in parallel with resistances 17 and 18 to battery B through resistance 7. Shunting the left-hand winding of coil 15, anode 16 and cathode 9 is a condenser 29 which is charged from battery B in series with high resistance 14. Operation of relay 4 connects ground to the third or sleeve terminal of the switch S to hold the preceding switches in accordance with the usual practice and at its inner contact connects grounded interrupter I over lead 19 and the lower contacts of relay 3 to battery B through relay 20. Relay 20 therefore alternately operates and

releases in step with interrupter I and alternately closes its contacts 21 and 22.

Resistances 17 and 18, which are connected in parallel with filament 8 of tube 6 together with the cooperating sliders 23 and 24 constitute two potentiometers, the sliders of which are so adjusted that slider 23 is more negative, by a predetermined amount, than slider 24.

When relay 20 operates it closes its contact 21 and slider 24 is connected to the control electrode 27 of tube 5 in series with high resistances 25 and 26. It will be noted that slider 23 is connected through condenser 28 to a point between resistances 25 and 26 and due to the fact that slider 24 is positive with respect to slider 23, condenser 28 will start to charge in the circuit from slider 24, contacts 21 of relay 20, resistance 25, condenser 28 and slider 23. As the charge on condenser 28 increases, the potential on control electrode 27 of tube 5, with respect to cathode 9 increases until this potential is sufficiently high to permit tube 5 to ionize and the anode-cathode path thereof to fire, it being assumed that by this time condenser 29 is charged to a sufficiently high potential to cause a discharge between anode 16 and cathode 9 through the left-hand winding of coil 15 when this predetermined control electrode potential is attained.

When condenser 29 discharges across the anode-cathode gap of tube 5 in series with the left winding of coil 15, in the well-known manner of relaxation oscillators, an alternating current impulse is induced in the secondary or right winding of the coil 15, which impulse supplies a certain alternating potential to the grid of tube 6, thereby varying the plate current therein which flows in the lower winding of relay 13. It will be noted that the upper winding of relay 13 is connected over the right-hand front contacts of relay 4 to the tip and ring contacts and the respective brushes of switch S and thence to the calling line.

As soon as condenser 29 is discharged it starts to recharge in series with resistance 14 from battery B and at the same time, due to the fact that condenser 28 has now attained a higher potential charge and hence control electrode 27 is of a higher potential with respect to cathode 9, a smaller potential charge on condenser 29 is required to fire tube 5 and therefore the anode-cathode path thereof breaks down again to discharge condenser 29 through the left winding of coil 15 in a shorter interval of time than before, thereby transmitting to the line a second alternating impulse and the foregoing process continues with the impulses recurring more frequently as condenser 28 charges until relay 20, under control of interrupter I, releases. When this occurs the contact 21 of relay 20 is opened and contact 22 is closed, thereby disconnecting slider 24 from the foregoing circuit and short-circuiting condenser 28 with the high resistance 25, through which resistance condenser 28 slowly discharges. Due to the fact, however, that condenser 28 is charged to a higher potential than the potential of slider 23, the potential of control electrode 27 will not instantly change to the lower potential of the point on resistance 17 to which slider 23 is connected but will decrease slowly in accordance with the discharging rate of condenser 28 through resistance 25 and therefore when relay 20 releases and closes its back contact 22, the rate of recurrence of the oscillating impulses will cease to increase and start to decrease at a rate, dependent on the rate of dis-

charge of condenser 28, until the potential on control electrode 27 of tube 5 is sufficiently negative with respect to cathode 9 to prevent the tube from breaking down at the maximum potential at which condenser 29 is charged by battery B. In practice sliders 23 and 24 are so adjusted with respect to each other that the potential of control electrode 9 of tube 5 is never made sufficiently negative to prevent tube 5 from firing when condenser 29 is fully charged to the potential of battery B.

It will therefore be understood that the impulses produced by tube 5 and amplified by tube 6 will recur at cyclically varying intervals of time as shown in Fig. 2, i. e., successively occur at an increasing rate until a predetermined maximum is reached and then decrease at a corresponding rate for a predetermined interval, after which time the cycle will be repeated.

In large systems where wrong numbers are frequently dialed, it may be desirable to maintain the filament or cathodes of tubes 5 and 6 heated continuously and therefore a key 30 may be provided which when actuated operates relay 3 to close the filament heating circuit as previously described.

What is claimed is:

1. In a tone generator, a gas-filled discharge device having an anode, a cathode and a control electrode, an energizing circuit including a source of direct current and an oscillating circuit including a condenser connected in parallel across said anode and cathode, first and second sources of control potential of different voltage having their positive terminals connected to said cathode, a second condenser, a high resistance, a circuit serially including said condenser and connecting the negative pole of the higher voltage source to said control electrode, and means for alternately and periodically connecting said resistance between said control electrode and the negative poles of said two control potential sources.

2. In a tone generator, a gas-filled discharge device having an anode, a cathode and a control electrode, an energizing circuit including a source of direct current and an oscillating circuit including a condenser connected in parallel across said anode and cathode, first and second sources of control potential of different voltage having their positive terminals connected to said cathode, a second condenser, a high resistance, a circuit serially including said condenser and connecting the negative pole of the higher voltage source to said control electrode, and means for alternately and periodically connecting said resistance between said control electrode and the negative poles of said two control potential sources to alternately and gradually raise and lower the potential of said control electrode with respect to the cathode between such limits that when the control electrode attains a predetermined potential with respect to the cathode, groups of oscillations will occur in the oscillating circuit which groups will successively recur at increasingly frequent intervals while the control potential is increasing and successively recur at decreasingly frequent intervals while the control potential is decreasing until a predetermined low potential is reached.

3. In a tone generator, a gas-filled discharge device having an anode, a cathode and a control electrode, a circuit capable of producing oscillations including said anode and cathode, a source of direct current for supplying energy thereto,

and means for applying a periodical and gradual varying negative bias to said control electrode between such potential values as to cause successively recurring groups of oscillations to occur in said circuit at periodically varying intervals.

4. In a tone generator, a relaxation oscillator comprising a gas-filled discharge device having an anode, a cathode, and a control electrode, a source of direct current and a condenser and means for applying a periodical and gradual varying negative bias to said control electrode between such potential values as to cause said oscillator to produce successive groups of oscillations occurring at periodically varying intervals.

5. A circuit arrangement for generating successive uniform groups of oscillations which recur at periodically varying intervals, a gas discharge device having an anode, a cathode and a control electrode, an oscillating circuit and a direct current source connected in parallel between said anode and cathode, a direct current source of control potential having its positive pole connected to the cathode and its negative pole to the control electrode, and means for gradually varying the potential between said cathode and control electrode in periodically recurring cycles.

6. A circuit arrangement for generating successive uniform groups of oscillations which recur at periodically varying intervals, a gas discharge device having an anode, a cathode and a control electrode, an oscillating circuit and a direct current source connected in parallel between said anode and cathode, a direct current source of control potential having its positive pole connected to the cathode, and the negative pole to the control electrode, and means including an interrupter, a condenser and a high resistance,

for gradually varying the potential between said cathode and said control electrode in periodically recurring cycles.

7. In a telephone system, a calling line, an automatic switch for extending said calling line, a plurality of contacts adapted to be selectively seized by said switch under control of a calling subscriber, called lines terminating in certain of said contacts, a generator of audible frequency impulses recurring at periodically varying intervals and an output circuit therefor, relay means connected to other of said contacts adapted when the corresponding contacts are seized to initiate operation of said generator and connect said output to the calling line, said generator comprising a gas-filled discharge device having an anode, a cathode and a control electrode, an oscillating circuit and a direct current source connected in parallel between said anode and cathode, and means for applying a periodical and gradually varying negative bias to said control electrode with respect to the cathode to control the production of said audible frequency impulses.

8. In a telephone system, a calling line, an automatic switch for extending said calling line, a plurality of contacts adapted to be selectively seized by said switch, certain of which contacts are connected to called lines and certain others of which are vacant as regards their connection to called lines, means for generating successive uniform groups of tone oscillations which recur at periodically varying intervals, and means connected to said vacant contacts responsive to seizure thereof by said switch to initiate operation of said generating means and to connect said tone oscillations to the seized contacts.

MYRON E. KROM.