

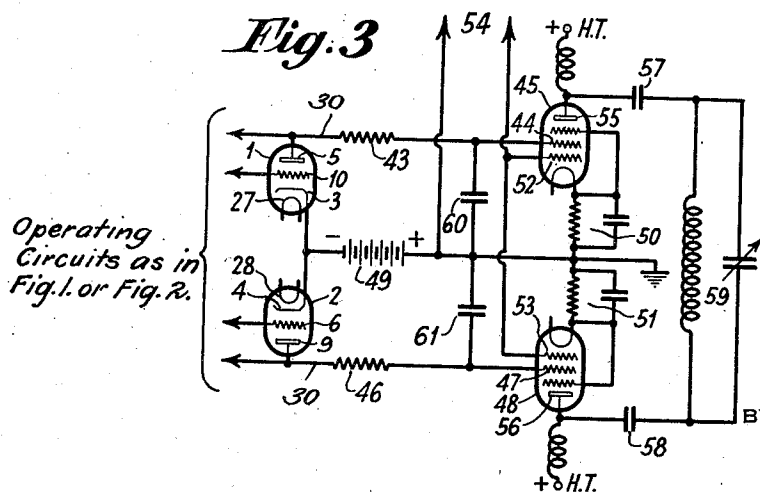
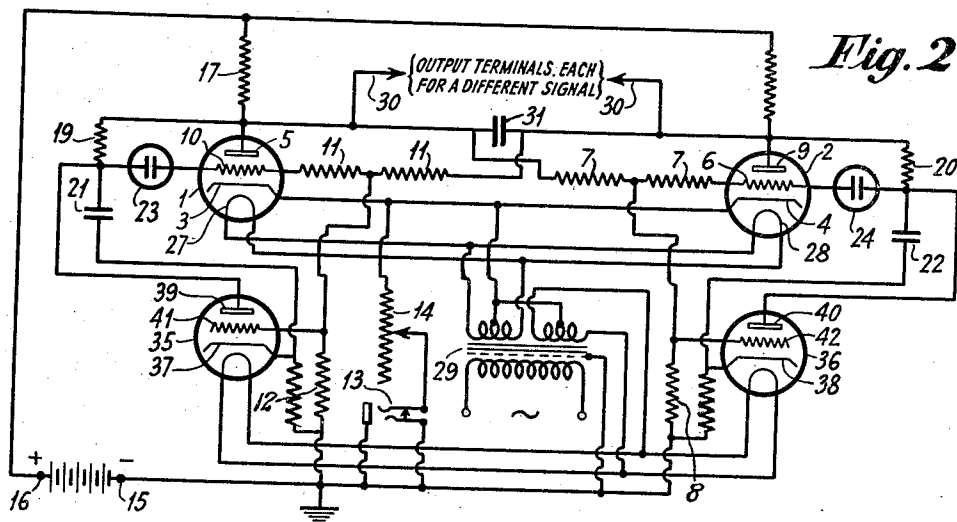
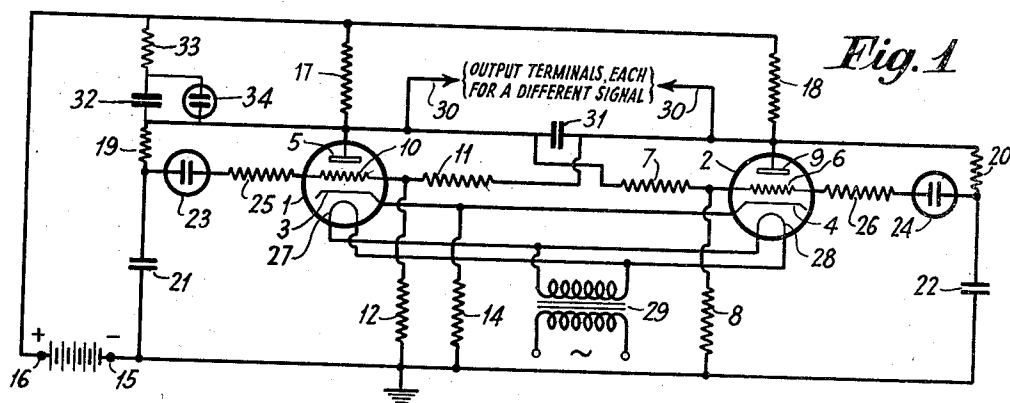
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RADIO SIGNALING SYSTEM

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RADIO SIGNALING SYSTEM

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This invention relates to electric signaling systems suitable for use in radio navigation systems, and has for its object to provide an improved arrangement whereby a predetermined succession of signals may be automatically and repeatedly generated by apparatus not involving the use of mechanically moving parts.

Though not limited exclusively to the uses herein mentioned, the invention is particularly applicable to navigation aiding wireless transmitting systems of the kind wherein interlocking or co-operating signals (such as the Morse letters E and T) are alternately transmitted in directions which overlap so that a receiver situated in the overlapping zone will receive a third signal which, in the case where the interlocking signals are the Morse letters E and T, should be a continuous dash. With the aid of such a transmitting system a mobile receiving station, for example an aircraft equipped with a wireless receiver, may be navigated in a predetermined direction since so long as it is within the area of overlap the characteristic signal made up of the two interlocking or co-operating signals will be received.

Hitherto in transmitting systems of the nature of the interlocking signal system just described, the necessary signals have been usually obtained by means of keys, switches, electromagnetic relays, and similar devices.

One objection to the use for such purposes of keys, switches or relays having mechanically moving parts is that if the keying mechanism has appreciable transit time, this transit time gives rise to intervals between the interlocking signals and accordingly, if such intervals are present, a receiver in the overlap zone will not receive (assuming the case where the interlocking signals are the Morse letters E and T) a continuous dash but in fact will receive a dash which is more or less broken up into a succession of signals. This "breaking up" makes it difficult for the pilot at the receiver to direct his course accurately. If, on the other hand, the signals are too "clear cut", as would be the case if there were employed keys or switches having zero transit time, harmonics of the interlocking signal frequencies are apt to be set up at the beginning and end of each of the interlocking signals (in other words "key clicks" occur) and this may interfere with stations operating on adjacent wave lengths especially if long waves are employed.

As will be seen later the present invention provides an improved automatic signal generat-

ing system whereby a predetermined succession of signals is repeatedly and automatically generated. Such a system involves no mechanically moving parts and avoids the difficulties above mentioned.

According to this invention an automatic signal generating system for generating repeated successions of predetermined signals comprises two electronic or ionic discharge paths each including a control electrode, means for interconnecting said paths so that together they possess two states of equilibrium and time control means actuated by each path whereby when one state of equilibrium has been maintained for a predetermined period of time the said state is disturbed and the second state of equilibrium assumed, the second state of equilibrium being in turn automatically disturbed after the lapse of a second predetermined period of time to re-instate the first state.

The invention is illustrated in the accompanying diagrammatic drawing in which

Fig. 1 shows a multivibrator in combination with gaseous discharge tube means for fixing the time constants;

Fig. 2 shows a modification including the addition of other elements; and

Fig. 3 shows an exemplary circuit in which the invention may be found useful.

Referring to Fig. 1 which shows one way of carrying out this invention, two triode valve discharge paths are employed. For simplicity of description it will be assumed that the arrangement now to be described and illustrated comprises two independent triodes 1, 2, having their cathodes 3, 4, connected together, but it is to be understood that, if desired, the two triode discharge paths may have a common cathode and be constituted by suitably disposed electrodes arranged in a single envelope. In the specified embodiment illustrated the anode 5 of the triode 1 is cross connected to the grid 6 of the triode 2 through a suitable resistance 7 the grid end of which is earthed through a grid resistance 8. Similarly the anode 9 of the triode 2 is cross-connected to the grid 10 of the triode 1 through a suitable resistance 11 the grid end of which is earthed through another grid resistance 12. The two cathodes are connected together and to earth through a self-biasing resistance 14 so that the common cathode point is positive with respect to earth when anode current flows in either valve. A direct current source of anode potential has its negative terminal 15 connected to earth and its pos-

itive terminal 16 connected to the two anodes 5, 9, each anode connection containing a suitable resistance 17 or 18. Each anode is also connected to earth through a circuit including a resistance 19 or 20 in series with a condenser 21 or 22, the condenser in each case being upon the earth side. The junction point of each of said resistances 19 or 20 with the appropriate condenser 21 or 22 is connected to the grid 10 or 6 of the appropriate valve 1 or 2 through a glow discharge device 23 or 24 in series with a resistance 25 or 26. The triodes may be of the indirectly heated cathode type as shown, in which case the heaters 27, 28, may be energized with raw alternating current through a transformer 29 or in any other convenient way.

It will be seen that with this arrangement the anodes and grids are cross-connected and it will be appreciated that any increase in potential of the anode of one valve will increase the grid potential of the other valve, such increase of grid potential in turn causing decrease of, i. e. making more negative, the grid potential of said one grid. Thus the arrangement has two states of equilibrium.

The operation is as follows:—Suppose the arrangement to be in that state of equilibrium in which the anode 5 of the valve 1 is most positive. Then when this state is established the condenser 21 will charge up at a rate determined, inter alia, by its own value, and the value of the series resistance 19 until it accumulates a charge sufficient to "break down" the glow discharge device 23. When this device 23 "breaks down" there is applied to the grid 10 a pulse of sufficient magnitude to disturb the state of equilibrium and cause the whole arrangement to swing over almost instantaneously to its other state of equilibrium. The arrangement will remain in the said other state of equilibrium until the glow discharge device 24 in the grid circuit of the second valve 2 in turn "breaks down" when again the arrangement will swing over to its first state of equilibrium. By suitably choosing the magnitudes of the components each state of equilibrium may be arranged to be maintained for a desired predetermined time; for example, one state of equilibrium may be arranged to be maintained for a period equivalent to a Morse dot and the other for a period equivalent to a Morse dash so that signals corresponding to the Morse letters E and T will be successively and repeatedly generated.

An arrangement as above described may be employed to control an interlocking signal type of navigation aiding transmitting station in any convenient way so that one of the two interlocking signals is sent in one of the two overlapping directions while the arrangement is in one state of equilibrium and the other is sent in the other direction while the said arrangement is in its other state of equilibrium. For example, the potential changes set up between the anode 5 of the first valve 1 and earth may be applied to the screen grid or anode of a valve (not shown) suitably connected in the transmitting station (not shown) to control transmission in one direction, while the potential changes set up between the anode 9 of the second valve 2 and earth may be similarly applied to the screen grid or anode of a valve suitably connected in the transmitting station to control transmission in the second of the two overlapping directions. Thus the anode of one valve in the arrangement above described may be regarded as an output terminal for one signal and the anode of the other valve may be regarded

as the output terminal for the other. The actual output terminals are shown at 30.

It is not necessary in carrying out this invention that the discharge paths be of the hard valve type, for mercury vapor or other gas filled valves may be used. Where, however, valves having a considerable gas filling are employed, that is to say where so-called gas relays are used, it should be remembered that such valves cannot be rendered non-conductive (once they have become conductive) merely by changing the control grid voltage, for, as is well known, once a device of this type passes anode current its anode voltage must be reduced substantially to zero before it can be "switched out".

There is also a critical value of grid bias at which a device of the kind in question will begin to conduct after having been non-conductive, this critical value being almost an inverse rectilinear function of the anode voltage. Accordingly, where gas relays are to be employed in an arrangement as illustrated in Fig. 1 the said arrangement should be modified by including a condenser of suitable size directly interconnecting the anodes of the two relays, i. e. by providing an inter-anode condenser. Such a condenser is shown at 31 in Fig. 1. Thus, assuming the potential of the anode of the relay 1 is high and that of the anode of the relay 2 low, this condenser 31 will be charged with its terminal adjacent the anode of the relay 1 at a high potential and its other terminal at a low potential. If now the grid of the relay 1 is impulsed positively by the "break down" of the discharge device in its circuit and if the instantaneous value of this positive impulse is more than the critical value for the gas relay in question, the relay 1 will become conductive, the voltage on its anode relative to its cathode will fall to a low value (corresponding to the ionization potential of the gas filling) and that terminal of the inter-anode condenser 31 adjacent the anode of relay 2 will drop below cathode potential causing the second relay 2 to become non-conductive, whereupon the said inter-anode condenser 31 will begin to charge in the opposite direction.

If desired, the resistance 14 may be shunted by a suitable condenser so as to produce a steadying action and, of course, if desired, the said resistance may be replaced by a grid bias battery or the like.

In arrangements wherein gas filled triodes are employed it may occur that, upon initially switching on, both triodes conduct, neither condenser receiving a sufficient charge to break down its discharge device and impulse the other grid; this state of affairs corresponds to a third or intermediate state of equilibrium. To overcome this a condenser 32 may be arranged to charge through a resistance 33 from the potential difference across one anode resistance (preferably the one corresponding to the shorter signal) the condenser 32 being connected on the anode side and having associated therewith an auxiliary neon or other discharge device 34 arranged so that when discharge takes place in the auxiliary device 34 the positive terminal of the said condenser 32 is instantly connected to a point of zero or low potential so that the potential of the anode 5 is depressed below zero and the discharge in the gas filled triode 1 extinguished. The time constant of the resistance capacity combination 32, 33, is made so long that when the whole arrangement is in normal operation (i. e. after starting) the condenser 32 never acquires a sufficient charge to cause the auxiliary discharge

device 34 to break down. This "self-starting" arrangement 32, 33, 34 is a refinement which, though available for use, is not essential. In practice with an arrangement as shown in Fig. 1 and utilizing gas filled relays it has been found that, although both gas filled relays conduct if the anodes are switched on before the cathodes reach operating temperature (the worst case) the anode currents are not equal and one timing condenser (21 or 22) does receive a sufficient charge to break down the associated device 23 or 24. Frequently this first discharge is insufficient to extinguish the other relay and two or three discharges may take place before the whole arrangement takes up normal operation. From the practical view point, this "false action" when first starting up is of negligible importance.

In some cases it may be desired to provide for possible inequalities or manufacturing inaccuracies in the valves or other components employed. This may be provided for in various ways; e. g. in a circuit as shown in Fig. 1 the various resistances may be made variable, or alternatively, instead of connecting the screen grids of the valves in the transmitter to be controlled to the anodes of the valves or relays 1, 2 (as hereinbefore described) the said screen grids may be connected to tapping points, which may be adjustable, on the anode resistances 17 and 18.

Fig. 2 shows a somewhat improved arrangement which provides for a more complete discharging of the timing condensers 21, 22 than is obtained with the circuit of Fig. 1. The circuit arrangement of Fig. 2 includes a pair of electron discharge tubes 1 and 2, gaseous discharge tubes 23 and 24 connected to the grids of the respective tubes in the same manner as shown in Fig. 1, timing circuits 19—21 and 20—22 the same as shown in Fig. 1 and resistive cross-connections 11 and 7 between the anode of one tube and the control grid of the other tube. The principal difference between Figs. 1 and 2 is that in the latter figure each timing condenser 21 or 22 is associated with a high vacuum valve 35 or 36 having its cathode 37 or 38 connected to the low voltage side of the appropriate condenser 21 or 22 and its anode 39 or 40 connected to the high voltage side of the said condenser. The grids 41, 42 are connected to points intermediate the resistors 11 and 7 respectively and also to biasing resistors 12 and 8 respectively, the latter being grounded. This arrangement is such that while relay 1 has its grid negative and its timing condenser 21 charging, valve 35—which is across condenser 21—has its grid biased beyond cut-off for the highest anode voltage the said valve 35 can receive, which voltage is, of course, determined by the breakdown voltage of the device 23. Since, in these circumstances, valve 35 is non-conductive, it does not interfere with the charging of condenser 21. When, however, device 23 breaks down and relay 1 becomes conductive the grid bias on valve 35 is automatically reduced so that it becomes conductive and thus gives a more complete discharge of condenser 21. A similar action takes place as regards the valve 36. There are certain other minor differences between Figs. 1 and 2, as will be obvious from the drawing. 13 is a jack for test purposes.

If in any case it be desired to lock an arrangement as hereinbefore described in one of its positions of equilibrium (e. g. for test purposes) this may conveniently be done by disconnecting either relay anode and its timing condenser and switches (not shown) may be provided for this purpose.

If, in Fig. 2, the triodes 35, 36 be removed the arrangement starts slowly from cold but speeds up during the first few reversals until a limiting speed is attained and the timing may not be perfectly regular. In this condition the variations in characteristics between individual devices 23, 24, (these variations may be appreciable) will have more effect on the circuit than is the case where the valves 35, 36, are employed. In place of using valves 35, 36 to assist discharge electromagnetic or other relays may be employed as will be apparent to those skilled in the art.

Fig. 3 shows one form of circuit suitable for use under the control of arrangements as hereinbefore described. The entire circuit arrangement as shown, except for the tubes 1 and 2, may be considered as a work circuit to be inserted between the terminals 30 of Fig. 1. In other words, the resistor 43 has one of its terminals direct-connected to the anode 5 of the tube 1 through the conductor 30 on the left side of Fig. 1, while resistor 46 has a corresponding connection through the right hand conductor 30 to the anode 9 of the tube 2. The anode 5 of relay 1 is connected through resistance 43 to the middle grid 44 of a pentode 45 and a similar connection is made through a resistance 46 from the anode 9 to the middle grid 47 of a second pentode 48. The cathodes of the pentodes are connected to one another and to the positive terminal of a suitable potential source 49 (e. g. of 80–100 volts) through automatic biasing resistance-capacity combinations 50, 51. The outer or suppressor grids of the pentodes are connected to the cathodes as in the usual way and the high frequency input is applied to the control grids 52, 53 in parallel from terminals 54 as shown.

Anode potential is applied to the anodes 55, 56 as indicated and each anode is connected through a condenser 57 or 58 to one or other end of a tuned circuit 59. Condensers 60, 61, are connected between the screen grids 44, 47 and earth as shown.

When relay 1 is non-conductive anode 5 is at high potential and screen grid 44 at substantially the same potential, screen grid 47 being at this instant at low potential. Accordingly, for these conditions, tuned circuit 59 is effectively operated by condenser 57. When the potentials of anodes 5 and 9 reverse, the tuned circuit will be effectively operated by condenser 58. Since the grids 52, 53 are connected to the same point the result of causing the tuned circuit 59 to be excited alternately at opposite ends is to cause the high frequency transmitted to be reversed in phase.

The purpose of the source 49 is to ensure that the screen grid of that pentode which is for the moment idle, is brought approximately to earth potential. The resistance condenser combination 43, 60 and 46, 61 determine the rapidity with which the screen grids 44, 47 can assume changed potentials (under the control of the anodes 5, 9) and by suitably adjusting their values "key clicks" can be substantially avoided.

The invention is of general application to all cases where automatic signal control is desired e. g. it may be used to control automatic traffic light or signal apparatus.

I claim:

1. An automatic signal generating system for generating repeated successions of predetermined signals comprising two electron discharge tubes each including at least three electrodes, means

including cross-connections between an input electrode of each tube and an output electrode of the other tube respectively for enabling said tubes to assume different degrees of conductivity sequentially, and time control means including gas filled discharge tubes each gas filled tube being connected in series between the control electrode of one of the first said tubes and a resistive connection to the anode of the same one of the first said tubes whereby when one state of conductivity has been maintained for a predetermined period of time the said state is disturbed and the second state of conductivity assumed, the second state of conductivity being in turn automatically disturbed after the lapse of a second predetermined period of time to re-instate the first state.

2. An automatic signal generating system for generating repeated successions of predetermined signals comprising two electron discharge tubes having interconnected cathodes, each tube including a control electrode and an anode, a conductive impedance connected between the anode of each tube and the control electrode of the other, a pair of circuits each including a resistance in series with a timing condenser connected across between the anode and cathode of the respective tubes, a circuit including a gaseous discharge device connected between each said control electrode and the high potential side of one of said timing condensers respectively, and means

for causing the two first said tubes to alternately assume different states of conductivity each of which is disturbed after having been maintained for a predetermined time, by a flow of space current in a respective one of said gaseous discharge tubes, and means for taking off generated signals from the anode circuits of the first said discharge tubes.

3. A vibrating system comprising a pair of electron discharge tubes, each tube containing a cathode, an anode, and at least one grid, a resistive connection between the anode of each tube and the grid of the other tube, two circuits each including a gaseous discharge tube and a resistor, each said circuit interconnecting an anode and a grid common to a respective one of said tubes, two capacitive circuits each coupling the cathodes of said tubes to respective points on the said circuits intermediate the gaseous discharge tube and the resistor, and means for causing said discharge tubes to alternately assume different degrees of conductivity, the periodicity of alternations being determined by the time constants of said resistors and said capacitors.

4. A system in accordance with claim 3 and having two auxiliary electron discharge tubes the discharge path in each of which is in shunt with a given capacitor respectively in said two capacitive circuits.

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