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CONTROL OF DISCHARGE TUBES FOR ELECTRIC MOTOR

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Fig. 1

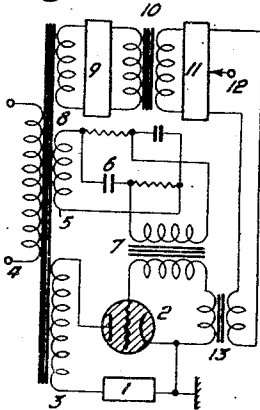


Fig. 2

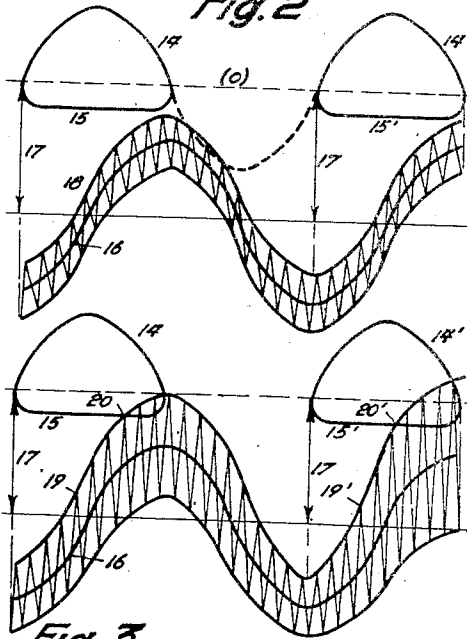
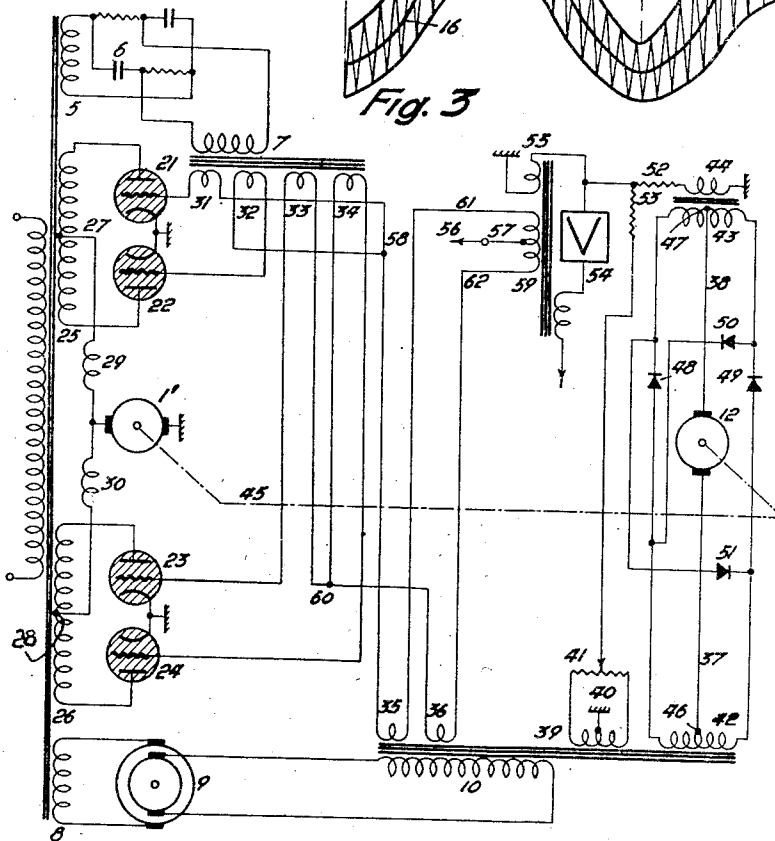


Fig. 3



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CONTROL OF DISCHARGE TUBES FOR ELECTRIC MOTOR

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3 Claims. (Cl. 318—326)

The present invention relates to improvements in or relating to the control of tubes with discharge in gas and vapor, and, more particularly in those of said tubes which comprise a priming or lighting electrode, such as a control grid, for example, in order that their periods of conductivity proper may be adjusted through a signal applied onto said electrode when an alternating feeding voltage is applied between their cathode and their plate.

Accordingly, it also relates to improvements in or relating to the adjustment and (or) the regulation of the feeding with an alternating voltage of the charge circuits such as windings of electric motors, more particularly but not limitatively, series-connected to the feeding in the cathode-plate circuit of said tubes in which case the priming or lighting signal for the tubes is generally subjected to one or more variable magnitudes previously converted into electric voltages; said signal is then figurative, for example, of the spacing between a reference value and a measured value on a servitude magnitude.

The invention has for its object to provide these improvements so that they insure both a higher precision of the lighting control and a greater facility in the flexibility of elaborating the control signal, as well as enabling the possible use of simple circuits which arrangements are well known in remote communication technics.

Said improvements are essentially characterized in that the lighting control signal of a gas or vapor discharge tube which receives a low frequency alternating voltage between its cathode and its plate is constituted through the superposition in the circuit of its lighting electrode in the first place of an alternating voltage of the same low frequency, in quadrature with the feeding voltage, and in the second place of a carrier oscillation of high frequency (with respect to the frequency of the feeding voltage) oscillation which has previously been modulated in amplitude through the servitude signal, so that the lighting signal proper, is constituted, in fact, through the modulation envelope of said carrier oscillation, the average level of which fluctuates according to the low frequency voltage to which said modulated carrier oscillation is superposed, the level around which said low frequency voltage develops in quadrature with the feeding voltage being maintained sufficiently low, and, moreover, constant, in order that said voltage, when operating alone, cannot control a priming or lighting of the tube in the absence of the modulated carrier oscillation.

Preferably, moreover, the low frequency voltage in quadrature with the feeding voltage is directly derived through phase shifting from the feeding voltage itself, and the high frequency oscillation is itself generated under the control of the feeding voltage.

This control method as well as the devices which are used for carrying out the same into practice will be hereafter described, more in details with reference to the accompanying drawings in which are diagrammatically shown:

In Fig. 1, the general arrangement of a lighting control

circuit for a gas or vapor discharge tube in accordance with the present invention;

In Fig. 2, graphs which facilitate the disclosure of the operation of the circuit arrangement of Fig. 1;

In Fig. 3, an illustrative arrangement for applying the invention to the revertible rotation control of a series motor.

Referring to Fig. 1, the feeding of a charge circuit 1 through a gas discharge tube, for example of the type known under the commercial designation "Thyratron," 2, is performed through connecting in series in the plate circuit of the tube, the secondary winding 3 of the feeding transformer 4 (the mains, for example) and the charge circuit 1 grounded as is also the cathode of tube 2.

Accordingly, if the control electrode, a grid in this case, of said tube 2, was permanently under such a potential that the tube be unlocked, any half cycle such as 14, 14' . . . , Fig. 2, would cause the lighting of the tube and, accordingly, the feeding through these half cycles of circuit 1 during the entire duration of the half cycles; this would result in that the grid potential would remain disposed at every moment in the location of the curve where the characteristic or location of the critical priming voltages 15, 15' is passed beyond, that is to say between this curve and axis O, whereas the plate voltage would vary according to half cycle 15, 15'

Through another secondary winding of the same feeding transformer connecting a phase shifting network 6 and an auxiliary liaison transformer, a voltage of the same frequency as the low feeding frequency is applied onto the control grid of the tube; said voltage in quadrature is indicated at 16, 16' . . . on Fig. 2 and its average level is adjusted to such a value 17 that it cannot by itself unlock tube 2. This is indicated on the graph by the fact that this voltage 16 does not intersect the characteristic of the critical grid voltages 15.

Through a third winding 8 of transformer 4 a circuit or generating device of a non-modulated carrier oscillation 9 is connected. This delivers through transformer 10 a stable high frequency oscillation with respect to the feeding voltage frequency; if the network is, for example, at 50 cycles per second the oscillator or frequency converter 9 will be able to supply a thousand cycles per second oscillation.

The advantage of establishing the voltage in quadrature and the carrier oscillation from the feeding voltage itself is quite clear; any phase shifting and any frequency variation of the network will be reproduced by these auxiliary voltages and accordingly a better accuracy or control fidelity obtained.

The carrier oscillation delivered across the terminals of the secondary winding of transformer 10 is applied onto a modulator 11 which receives through input 12, the modulation control or servitude signal. This modulator may consist with advantage, though not limitatively, of a modulator of any usual type used in a carrier wave telephone and, more particularly, of a dry rectifier modulator as hereafter described with reference to the example shown in Fig. 3.

The output of the modulator connects to a transformer 13 the secondary winding of which is introduced in series with the secondary winding of transformer 7 into the circuit comprising the grounded cathode and control grid of tube 2. Said grid then receives a signal of the form shown in the upper graph of Fig. 2, no modulation of the carrier oscillation appearing, that is to say, as a non-modulated carrier oscillation 12 the average level of which varies accordingly to the sinusoidal voltage 16; the level value of the carrier when no modulation appears is adjusted in order that the modulation envelope will not intersect the critical priming voltage characteristics of the discharge tubes. When a modulation signal is

applied at 12, the level of the modulated carrier oscillation varies, on the contrary, according to the lower graph, Fig. 2, so that the modulation envelope 19, 19' . . . intersects the priming characteristic in constant places 20, 20' . . . and the variation of this envelope level effectively operates in order to cause relative lighting advances or delays in the positive half cycles of the plate voltage 14, 14' . . . For this function envelope 19 may be considered, in practice, as a permanent signal owing to the high relative value of the carrier frequency with respect to the cycle of the sinusoidal voltage; an auxiliary damping circuit—with time constant—may, moreover, be connected, if necessary, to the control grid of tube 2 in order to give a greater continuity of the voltage envelope 18 according to a usual arrangement in the remote communication technics.

Of course, for the feeding of a charge such as 1 through both half cycles of a sinusoidal voltage the arrangement of Fig. 1 must be doubled through arranging a second discharge tube having also charge 1 in its plate circuit, but in series with a winding of transformer 4 connected with an inverse phase to that of winding 3 and receiving on its grid through, a second secondary winding of transformer 13, the servitude signal in series with a second secondary winding of transformer 7 connected in an inverse phase with respect to that of the represented winding. Such an arrangement appears, moreover, in Fig. 3 which is relative, however, to the more complex case in which the charge is constituted by a motor 1' with excitation in series and reversible rotation, whence the necessity to provide two control ways, that is two pairs of discharge tubes.

In Fig. 3 motor 1' is provided with both exciter windings 29 and 30. A pair of discharge tubes 21—22 is provided in order to control the passage of the power supply from the network, delivered by the secondary winding 25 of transformer 4, through winding 29 and motor 1', grounded, from middle point 27 of this secondary winding 25, the ends of which are connected to the respective plates of tubes 21 and 22. Likewise, a pair of discharge tubes 23—24 is provided in order to control the passage of the power supply delivered by transformer 4 through its secondary winding 26 through winding 30 and motor 1', grounded from middle point of said secondary 26, shown at 28, and the ends of secondary winding 26 are connected to the respective plates of tubes 23 and 24. One or the other pair of tubes must be automatically put into operation according to the rotation direction of the motor; in either one pair, one of the tubes must control the passage of the half cycles of one polarity and the other tube the passage of the reverse polarity half cycles.

The automatic selection of the half cycle polarities is direct through the provision of the four secondary windings 31—32 and 33—34 for transformer 7 which according to the diagram of Fig. 1 supplies the control grids in quadrature on the plate voltage; secondary winding 31 connects to the grid of tube 21, secondary winding 32 connects to the grid of tube 22, but in reversed polarity through simple inversion of the leads; likewise, secondary winding 33 connects to the grid of tube 23 and secondary winding 34 connects to the grid of tube 24 in reversed polarity through inversion of the leads.

The high frequency carrier oscillation is generated, in the diagrammatic example through a rotating frequency converter 9, and connected to the high frequency outlet terminals of this generator is a transformer 10 provided with four secondary windings 35—36—39—42 the operation of which will be explained progressively.

Secondary winding 42 connects to a modulator of the ring type with dry rectifiers for which the primary winding 43 of a transformer 44 is used as an output circuit; the rectifiers are indicated at 45—49 in series, and at 50—51 in bridge; the middle points 46 and 47 of the windings of transformers 42 and 43 respectively, are connected through leads 37 and 38 to the terminals of a

tachometer dynamo 12 driven by motor 1' as indicated through the mechanical link 45 (with or without reduction or multiplication); thus, the carrier oscillation is modulated through the signal measuring the rotation speed of motor 1', the intensity of which is proportional to said speed and the direction of which, with respect to the points of connection of modulator 42 and 43, depends directly upon the rotation direction of motor 1', so that the modulated oscillation is delivered at the output of transformer 44 with a phase relative to the input phase (in any secondary winding of transformer 10) which is direct for one rotation direction of the motor—that is phase shift zero—and reverse for the other rotation direction of the motor—that is a phase shifting of 180°.

This measuring signal is compared with a reference signal (in magnitude and direction) at the output of transformer 44, in a resistor comparator or divider 52—53. Resistor 53 receives a voltage of the non-modulated carrier frequency, extracted from potentiometer 41 across the terminals of secondary winding 39. The middle point of this winding is grounded at 40 in order to enable the posting of the desired rotation speed for one or the other rotation direction, through simple displacement of the slide of potentiometer 41.

The spacing signal, so obtained, is amplified at 54; this amplifier is of the counter-reaction type as indicated through the secondary counter-reaction winding 55 of its output transformer 59; it is established, furthermore—through plate or cathode characteristic—in order to assume a limitation of the output level of the spacing signal, in the secondary winding 59, to a value lower than double the level of the non-modulated carrier oscillation such as it appears in the secondary windings 35 and 36 of transformer 10, in order to avoid an untimely control of the pair of discharge tubes allocated for the rotation control in the direction opposed to that determined through the posting at 41.

Indeed, the automatic determination of the pair of discharge tubes 21—22 or 23—24 which is to be operated is performed through comparing the phase of the spacing signal with the phase of the reference oscillation in the following circuits: from middle point 57 of secondary winding 59 through lead 61 of one of its ends, through winding 55, to point 58 whence said circuit divides in order to connect secondary windings 31 and 32 of transformer 7, towards the control grid of tubes 21 and 22 respectively; from middle point 57 of secondary winding 59 through lead 62 of the other end of secondary winding 59, through winding 36 to point 60 whence said circuit divides toward windings 33 and 34 of transformer 7 towards the respective grids of tubes 23 and 24.

According to its phase, the spacing signal will be added to or subtracted from—and conversely—the reference high frequency oscillation in one of windings 35 and 36 and that control way will be rendered efficacious in which the addition in phase of the spacing signal and of the reference oscillation is performed by means of the tubes of the pair controlled through said way, said tubes being unlocked following the timing of the half cycles of the feeding voltage because of the automatic switching over through the reversed application of the voltage in quadrature onto their control grids. The other control way, through opposition of the reference and spacing voltages, remains inefficient at least as long as the spacing voltage has not reached, in modulus, such a level that an oscillation appears on this way, oscillation liable of unlocking the tubes of the other pair. Such a level, of course, cannot exist in the phase performing this unlocking unless the spacing signal can exceed a value at least double of that of the non-modulated carrier signal, whence the prerequisite limitation, in practice, in the spacing signal amplifier.

On the other hand, a bias 56 is introduced at 57 at the middle point of secondary winding 59 in order to stabilize level 17, Fig. 2; this introduction location is

convenient, being common to the four discharge tubes but, of course, this level could stabilize through individual bias of the control grids.

Several detail modification may, moreover, be made in the described arrangements, more particularly in the example shown diagrammatically in Fig. 3, without departing from the scope and spirit of the invention; certain modifications have been indicated in the course of the foregoing specification and others may be considered directly such as, for example, the use of a generator and (or) a modulator of another type, the generalization of the diagram to a polyphase power supply and other applications, and we desire that it be understood that no limitations upon the invention are intended other than may be imposed by the appended claims.

What we claim is:

1. A device for controlling the firing of gas discharge tubes and the like, comprising in combination with a gas discharge tube having a cathode, an input electrode and an output electrode, an input circuit connected with said input electrode, a cathode-anode circuit, a phase-shifting network, a supply voltage transformer having three secondary windings one of which is connected in series with a load in the cathode-anode circuit of the discharge tube, another one of which is connected to said phase-shifting network, an additional transformer having primary and secondary windings, the output of said network being connected to the primary winding of said additional transformer and the secondary winding of said additional transformer being connected to the input electrode of the discharge tube, a third transformer having primary and secondary windings, the secondary winding of said third transformer being interposed between the input electrode and the secondary winding of said additional transformer, a modulator, a connection between the primary winding of said third transformer and the output of said modulator, said modulator being supplied with a control signal input and a carrier-oscillation input from a frequency changer controlled by the third secondary winding of the supply voltage transformer.

2. A device according to claim 1, in which the load is a series electric motor, the rotating speed of which is controlled by the discharge tube, said motor driving a tachometric dynamo which generates the control signal to be applied to the control-signal input of the modulator, the output circuit of which comprises a mixing circuit to which is applied the adjustable contactor of a potentiometer connected to the frequency changer, while

the difference signal of the mixing circuit is applied to said output transformer, the secondary of which is connected to the input electrode circuit of the discharge tube in series with the secondary winding of the transformer connected with the phase-shifting network.

3. A device according to claim 1 in which the load is a series electric motor, the rotating speed of which is controlled by the discharge tube, said motor driving a tachometric dynamo which generates the control signal to be applied to the control-signal input of the modulator, the output circuit of which comprises a mixing circuit to which is applied the adjustable contactor of a potentiometer connected to the frequency changer, while the difference signal of the mixing circuit is applied to said output transformer, the secondary of which is connected to the input electrode circuit of the discharge tube in series with the secondary winding of the transformer connected with the phase-shifting network, said motor being reversible and having two excitation windings, one for each direction of rotation, two pairs of earthed-cathode discharge tubes being provided for controlling the energization of the two excitation windings respectively, comprising an output transformer connected to said frequency changer, said output transformer having a plurality of secondaries, one of which is connected to the carrier-oscillation input of the modulator, while another is connected to the potentiometer and has an earthed medium tap, said secondary winding of the mixing circuit output transformer also having an earthed medium tap, the input electrodes of the tubes of said pair of tubes forming a common control channel for determining the operativeness or inoperativeness of that particular pair of tubes, each control channel comprising in series one half of the secondary winding of the mixing circuit output transformer, another secondary winding of the frequency changer output transformer and two secondary windings of the phase-shifting network output transformer connected in parallel and the electrically opposed terminals of which are connected to the respective input electrodes of the two tubes of that pair.

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