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GLOW DISCHARGE TUBE CIRCUIT

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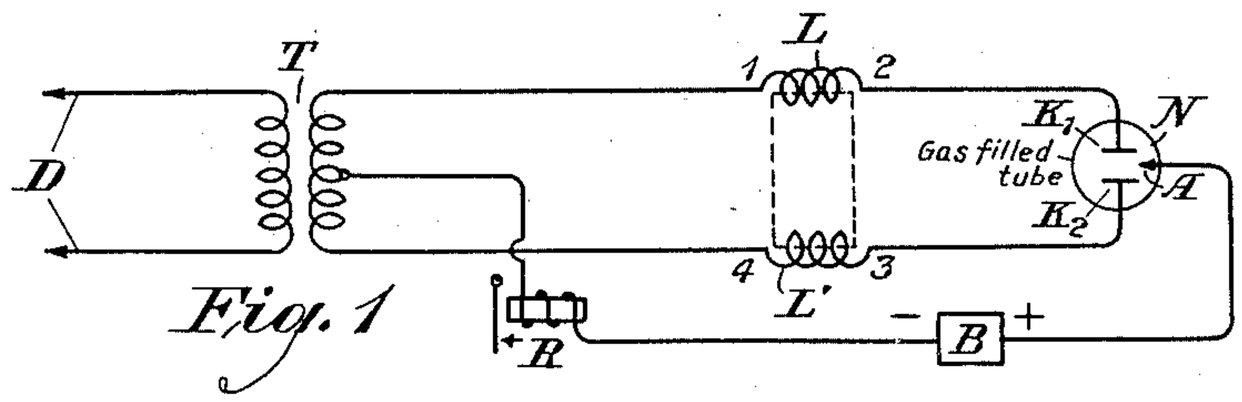

Fig. 1

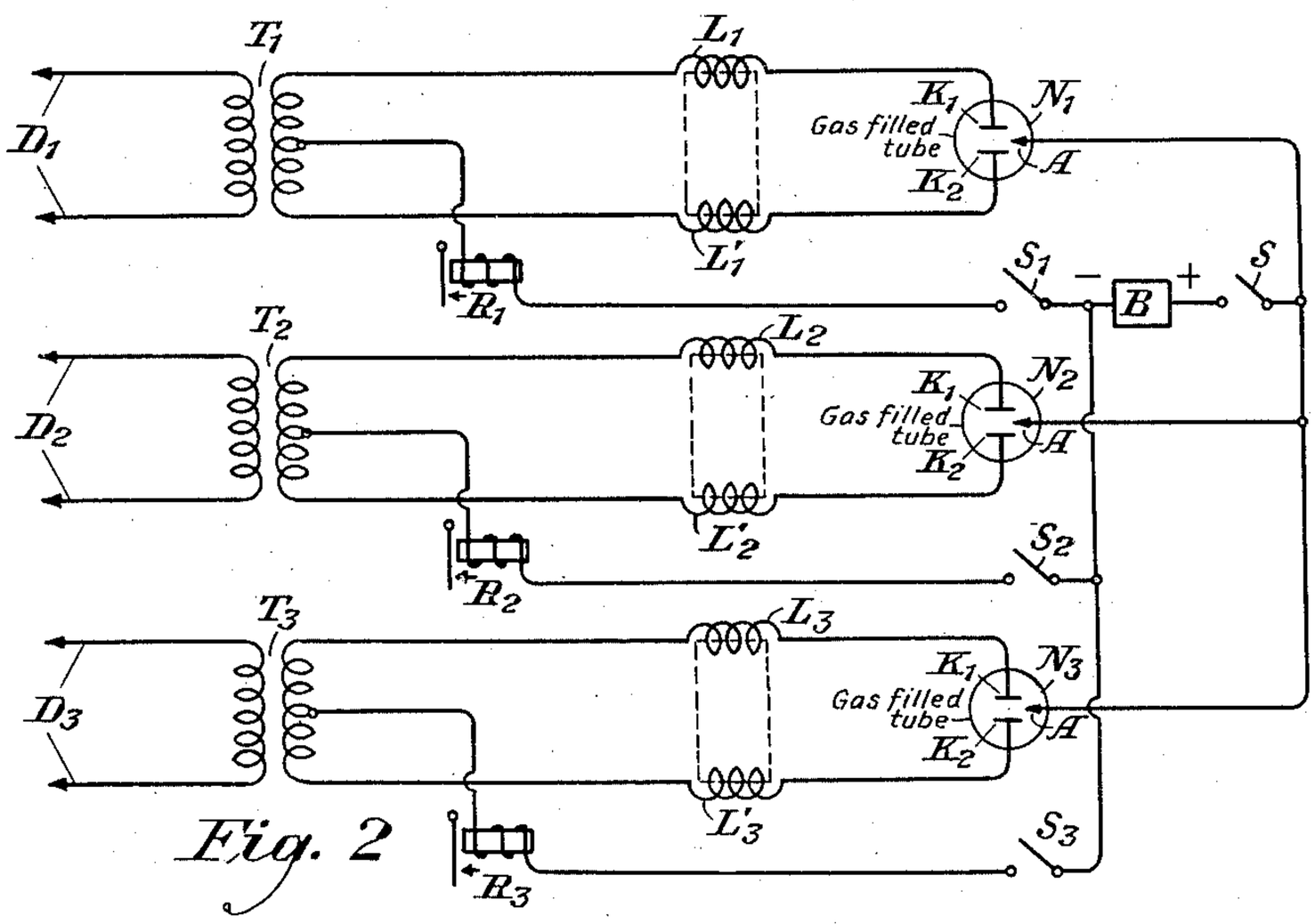

Fig. 2

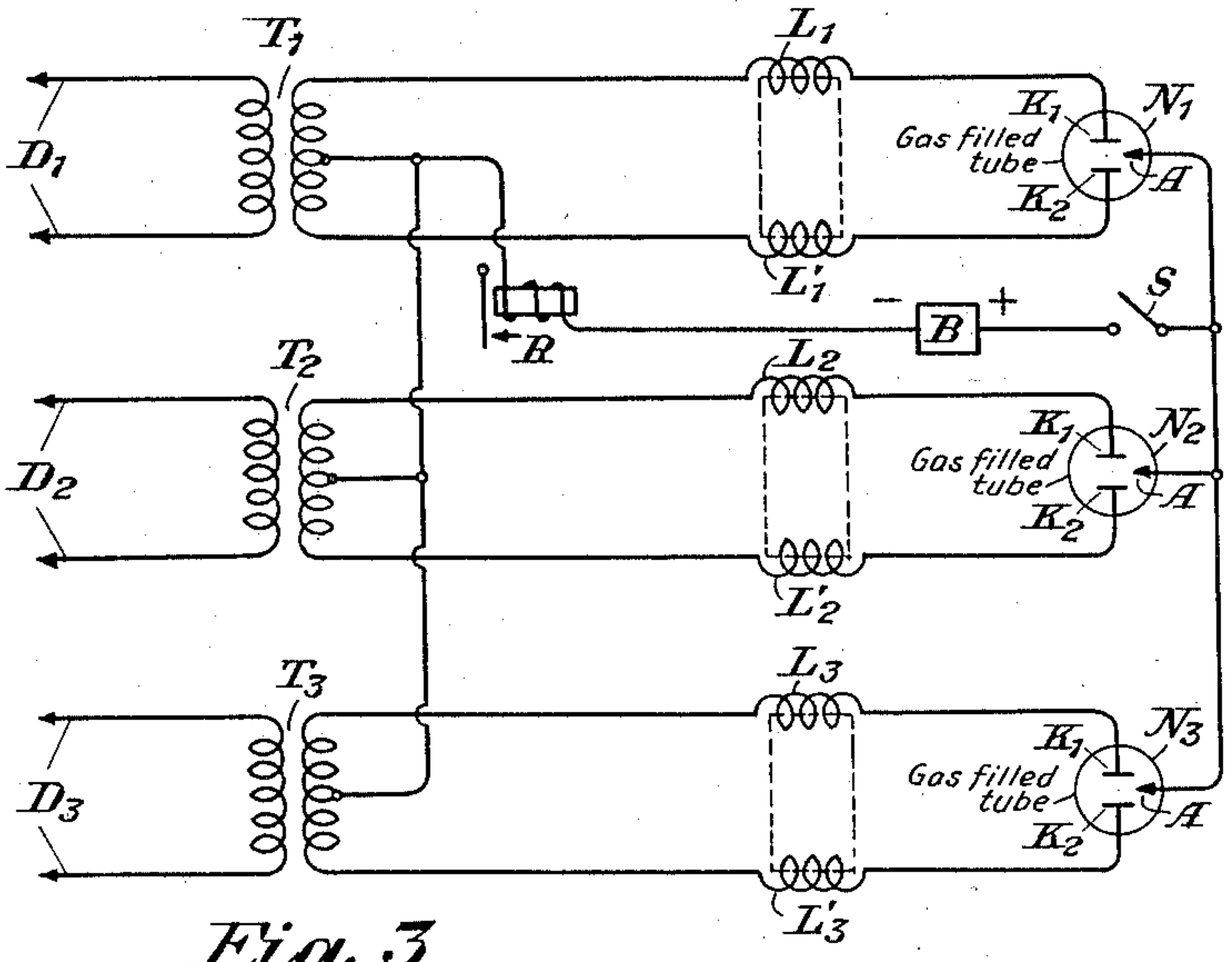

Fig. 3

INVENTOR
L. K. Swart
BY
ATTORNEY

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GLOW DISCHARGE TUBE CIRCUIT

Leland K. Swart, Mountain Lakes, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

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10 Claims. (Cl. 250—27)

This invention relates to electrical transmission systems. More particularly, the invention relates to transmission systems employing cold cathode gas filled discharge tubes which are capable of operating for both halves of an alternating current cycle.

A cold cathode gas filled tube of the neon type having two electrodes can be operated when the voltage impressed across the electrodes equals or exceeds the breakdown voltage between these electrodes. The voltage required to break down the gap between the electrodes can be reduced by the interposition of a biasing potential such as a battery in series with the electrodes. This biasing potential actually reduces the voltage required to cause a discharge between the active electrodes of the tube by an amount which was equal to the magnitude of the biasing potential. But the reduced potential required to energize the tube has to be poled in a certain direction, i. e., a direction in series aiding relation with the biasing potential, however, before there is an actual breaking down of the gap between the electrodes of the gas filled tube. It, of course, requires a considerably higher voltage to produce a discharge between the electrodes of such a tube if impressed with a voltage in the opposite direction.

One of the objects of this invention is to provide a system including a cold cathode gas filled tube which will be capable of operation when impressed with low voltages which flow in either direction. In other words, an object of the invention is to provide an arrangement including a cold cathode gas filled tube which will be capable of operation from either half of a cycle of alternating current.

Another of the objects of this invention is to provide a cold cathode gas filled tube having two cathodes and an anode so arranged that the potential required to produce a discharge between either of the cathodes and the anode will be a certain predetermined value.

Another of the objects of this invention is to include in a transmission system a cold cathode gas filled tube having two cathodes and an anode, and in addition a source of direct current potential which will be used not only to bias both of the cathodes with respect to the anode but also to produce the current required to energize a translating circuit.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing, in which Figure 1 represents one embodiment of the invention which includes one cold cathode gas filed tube; Fig. 2 shows three translating circuits each associated with a cold cathode gas filled tube and a biasing potential common to all of the tubes; and Fig. 3 shows three translating circuits and three corresponding cold cathode gas filled tubes all of which are biased by a common source of direct current potential which also operates a single relay or translating circuit.

Referring to Fig. 1 of the drawing, the reference character D represents a circuit which may transmit direct currents of either polarity or, more usually, alternating currents of any frequency. The circuit D is connected to the primary winding of a transformer T. The secondary winding of the transformer T is connected to the cathodes K_1 and K_2 of a cold cathode gas filled tube designated N, the upper terminal of the secondary winding of the transformer being connected to the cathode K_1 through a choke coil L and the lower terminal of the secondary winding being connected to the cathode K_2 through a choke coil L'.

The choke coils L and L' may be two equal portions of a single winding or they may be separate windings having the same number of turns, and furthermore, it is preferable that they be wound upon a common core of iron. These windings are so poled that if a voltage were impressed in series with them, their inductive reactances would be a maximum. If, however, the potential impressed in series with each of these windings tends to produce a current flow through the coil L in the direction 2, 1 and another potential is impressed in series with the winding L' which tends to produce a current flow in the direction 3, 4, the inductive reactances of the two coils will be equal in magnitude although opposite in effect, and therefore the effective impedance of the two coils will be merely that corresponding to their resistance.

The tube N includes, in addition to the cathodes K_1 and K_2, an anode A. Moreover, the tube is filled with a gaseous medium such as neon, argon, helium or krypton or any combination of these rare gases with other gases such, for example, as hydrogen or mercury vapor. These electrodes are so spaced within the envelope of the tube N that the voltage required to break down the gap between the cathode K_1 and the anode A will be substantially the same as the voltage required to break down the gap between the cathode K_2 and the anode A. The voltage required to break down the gap between the cathodes K_1 and K_2 will gen-

erally be different from that required to break down the gap between either of these cathodes and the anode A, as will be apparent from the description hereinafter following.

The anode A is connected to the midpoint of the secondary winding of the transformer T through a circuit which includes a source of direct current potential designated B and the winding of a relay designated R, and this circuit may, of course, include any other translating device or circuit. The source of potential B, which may if desired be an ordinary storage battery, biases both of the cathodes K_1 and K_2 equally with respect to the anode and thereby reduces the additional voltage required to break down the gap between either of these cathodes and the anode.

When a voltage is transmitted from the circuit D through the transformer T and through the choke coils L and L' to the cathodes K_1 and K_2 of the tube N, it will cause ionization of the gas within the tube N between these cathodes. If this impressed voltage is sufficient to break down the gap between the cathode K_1 and the anode A, current will flow from the source B through the winding of the relay R, through the secondary winding of transformer T, windings L and L', through the ionized gas within the tube N from cathodes K_1 and K_2, respectively, to anode A. This current will continue to flow so long as the voltage impressed by source B between the cathode K_1 and the anode A is greater than the voltage required to sustain the glow between these electrodes.

If the circuit D transmits an alternating current of sufficiently high potential, then during one-half of the alternating current cycle the gap between the cathode K_1 and the anode A will be broken down, and during the other half of the cycle the gap between the cathode K_2 and the anode A will be broken down. When either of these gaps is broken down, the impedance between the electrodes forming the gap will be reduced from a substantial and almost infinite value to a very low and almost negligible value. The gas thus ionized causes current to pass through relay R, causing its operation by virtue of the presence of potential B. Because of the presence of the coils L and L', the circuit included between the cathodes K_1 and K_2 will be protected against such voltages impressed by the circuit D as may tend to cause damage to these two elements of the tube N itself. However, the coils L and L' are so poled that their impedance to the flow of current from the source B through the winding of the relay R will be reduced to a limited value, namely, the actual resistance of these coils which may be considered connected in parallel relationship.

The source of potential B which has been described hereinabove as one of direct current may, if desired, be replaced by a source of potential which is of the alternating current type. In that event, the voltage transmitted by the source D, if continuously applied and of a magnitude sufficiently great, will tend to maintain the gaps between either of the cathodes K_1 and K_2 and the anode A continuously discharged. Since the characteristic of alternating current is such that its magnitude becomes zero twice during each complete cycle, then the gap between either of the cathodes K_1 and K_2 and the anode A will be restored to its initial condition at least once during each cycle. It follows, therefore, that if the source B is one producing an alternating current, it will be unnecessary to include a switch or other mechanical device for breaking the circuit between the anode A and the midpoint of the secondary winding of the transformer T in order to restore the tube to its initial and unoperated condition.

The current emanating from source B passes between the anode A of tube N and both cathodes or electrodes K_1 and K_2 in parallel paths. This substantially increases the current carrying capacity of the tube N.

One of the features of the arrangement shown in Fig. 1 resides in the employment of the electrodes K_1 and K_2 both for producing the ionization of the gas within the tube N and for receiving the currents passed between the anode A and these cathodes.

The total voltage of the source B not only biases both cathodes K_1 and K_2 by its voltage with respect to the anode A so as to reduce the voltage required to ionize the gas within tube N, but this same voltage is employed to energize the winding of the operating relay R or any other translating circuit which is controlled by the tube N.

Fig. 2 shows three translating circuits designated D_1, D_2 and D_3 which are connected through transformers T_1, T_2 and T_3 to the cathodes K_1 and K_2 of the cold cathode gas filled tubes N_1, N_2 and N_3, respectively. The secondary winding of the transformer T_1 is connected to the cathodes K_1 and K_2 of the corresponding tube N_1 through choke coils L_1 and L_1', as shown. The choke coils L_2 and L_2' are interposed between the secondary winding of the transformer T_2 and the cathodes K_1 and K_2 of the tube N_2, and the coils L_3 and L_3' are interposed between the secondary winding of the transformer T_3 and the cathodes K_1 and K_2 of the tube N_3, as shown.

The anode A of each of the tubes N_1, N_2 and N_3 is connected to the positive terminal of the source B through a common switch designated S. The negative terminal of the source B is connected to the midpoint of the secondary winding of the transformer T_1 through a switch S_1 and the winding of the relay R_1. The negative terminal of the source B is also connected to the midpoint of the secondary winding of the transformer T_2 through a circuit which includes a switch S_2 and the operating winding of the relay R_2. Furthermore, the negative terminal of the source B is connected to the midpoint of the secondary winding of the transformer T_3 through a circuit which includes a switch S_3 and the operating winding of the relay R_3.

If all of the switches S, S_1, S_2 and S_3 are closed, then the source B will bias the cathodes K_1 and K_2 of each of the tubes N_1, N_2 and N_3 to a common, predetermined potential with respect to the anode A of each of these tubes. If, then, a potential sufficiently greater than this predetermined value is impressed upon any one of the circuits, such as D_1, for example, it will cause a breakdown between the gaps established between the cathodes K_1 and K_2 and the anode A in the tube N_1 and current will flow continuously from the source B through the operating winding of the relay R_1. Current will continue to flow through the operating winding of the relay R_1 even though the voltage impressed upon the circuit D_1 becomes lower than the voltage required to cause ionization of the gas within the tube N_1. However, if the source B is of the alternating current type, any voltage present in the circuit D_1 which is above the voltage required to ionize the gas within the tube N_1 will maintain the gap between the tube N_1

discharged only so long as that voltage remains impressed upon the circuit D_1. Moreover, if the source B_1 is of the direct current type, then the current flowing through the operating winding of the relay R_1 may be interrupted by opening the switch S_1 whenever desired.

If the voltages impressed upon two of the circuits as for example, D_1 and D_2, or, in fact, all of the circuits D_1, D_2 and D_3, are alternating potentials exceeding a certain predetermined value, then the gaps within all of the tubes associated with these circuits will be broken down and remain broken down if the switches S, S_1, S_2 and S_3 are all closed and the source B is of the direct current type. In that event the source B will continuously supply current to the operating windings of all of the relays R_1, R_2 and R_3 even though the voltage impressed upon any one or all of the circuits D_1, D_2 and D_3 becomes reduced below the predetermined value just mentioned. It will be possible to interrupt the circuit of source B which supplies current to all of the operating windings of relays R_1, R_2 and R_3 by opening the switch S. However, if it is desired to interrupt the current flowing to just one of these operating windings, as for example, that flowing to the operating winding of the relay R_1, it will be necessary to open the switch S_1 only.

Fig. 3 shows three circuits D_1, D_2 and D_3 which are connected to the primary windings of transformers T_1, T_2 and T_3. The secondary winding of the transformer T_1 is connected to the cathodes K_1 and K_2 of the tube N_1 through coils L_1 and L_1', and similarly, the coils L_2 and L_2' and the coils L_3 and L_3' interconnect the secondary windings of the transformers T_2 and T_3, respectively, with the cathodes K_1 and K_2 of the tubes N_2 and N_3, respectively, as shown.

The positive terminal of the source B is connected to the anode of each of the tubes N_1, N_2 and N_3 through a switch S which is in common to these circuits. The negative terminal of the source B is connected to the midpoints of the secondary windings of the transformers T_1, T_2 and T_3 through the operating winding of the relay R, which is in common with these three circuits.

When the voltage impressed upon any one of the circuits D_1, D_2 and D_3 is sufficient to break down the gap between either of the cathodes of any one of the tubes and its associated anode, current will flow from the source B through the operating winding of the relay R. This current will flow continuously and without interruption if the source B is of the direct current type and if the switch S remains closed. It will be possible, then, to interrupt the circuit of the relay R merely by opening the switch S. It will be understood, however, that the switch S may be dispensed with if the source of potential B is of the alternating current type.

It will be understood that the transformer T of Fig. 1 and the transformers T_1, T_2 and T_3 of Figs. 2 and 3 may each be replaced by an autotransformer or by a resistance, some or all of which may be connected to the circuit D or to the respective circuits D_1, D_2 and D_3, some or all of said resistances being also connected to the cathodes K_1 and K_2 of the corresponding tubes shown in the drawing through the associated choke coils.

It will be further understood that the currents transmitted over circuit D of Fig. 1 and over the circuits D_1, D_2 and D_3 of Figs. 2 and 3 need not necessarily be alternating currents. If resistances replace the respective transformers T, T_1, T_2 and T_3, for example, then the tubes N, N_1, N_2 and N_3 will become operated even when direct currents of either polarity are supplied by circuits D, D_1, D_2 and D_3, respectively.

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 forms without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The combination of a source of alternating current, a gas filled tube having two cathodes and an anode, a transformer the primary winding of which is connected to the source of alternating current, the secondary winding of said transformer being connected to the cathodes of said gas filled tube, a source of potential connected between the anode of the gas filled tube and the midpoint of the secondary winding of the transformer, and a translating circuit responsive to the flow of current from said source of potential.

2. The combination of a gas filled tube having two cathodes and an anode, a source of potential, a coil connected between the cathodes of said tube, and a translating circuit, said source of potential being connected between the anode of said tube and the midpoint of said coil through said translating circuit.

3. The combination of a gas filled tube having two cathodes and an anode, an alternating current circuit, a translating circuit, a source of potential, said alternating current circuit being connected to the cathodes of the tube so that a discharge may occur between one of the cathodes and the anode and the other of the cathodes and the anode during alternate half cycles, and means whereby said source of potential will equally bias both cathodes with respect to the anode, said source of potential also supplying current for operating said translating circuit.

4. The combination of an alternating current circuit, a translating circuit which is to be operated when the voltage in the alternating current circuit exceeds a predetermined value, a gas filled tube having two cathodes and an anode, means for interconnecting the cathodes of said tube and for coupling said cathodes to the alternating current circuit, and a source of potential interconnected between the anode of said tube and said means through the translating circuit.

5. In combination, an alternating current circuit, a transformer the primary winding of which is connected to the alternating current circuit, a gas filled tube having two cathodes and an anode, two choke coils, one of which interconnects the upper terminal of the secondary winding of the transformer with one of the cathodes of the tube and the other of which interconnects the lower terminal of the secondary winding of the transformer with the other cathode of the tube, said coils being wound series-aiding about a common core of iron, and a source of potential interconnected between the anode of the tube and the midpoint of the secondary winding of the transformer.

6. The method of operating a translating circuit whenever alternating current flows through an associated circuit having a voltage greater than a predetermined value, with apparatus including a gas filled tube having two cathodes and an anode, and a source of potential which biases

both of the cathodes equally with respect to the anode, which consists in transmitting the currents flowing through the associated circuit to the cathodes of the gas filled tube, breaking the gap between one of the cathodes and the anode during one half of each alternating current cycle, alternately breaking the gap between the other cathode and the anode during the succeeding half of each alternating current cycle, and transmitting current from said source of potential through the translating circuit as long as either of the beforementioned gaps is broken down.

7. The combination of a first circuit through which alternating current flows, a second circuit to be operated when the voltage through the first circuit exceeds a predetermined value, a source of potential for transmitting energy through said second circuit during its operation, a gas filled tube having two cathodes and an anode, means for impressing the currents of the first circuit upon both of the cathodes of the tube, and means responsive to the breaking of the gap between either of the cathodes and the anode for operating the second circuit.

8. The combination of a plurality of circuits each transmitting alternating currents, a plurality of gas filled tubes each corresponding to one of the alternating current circuits, each gas filled tube having two cathodes and an anode, a transformer interconnecting each alternating current circuit with the cathodes of the corresponding gas filled tube, a plurality of relays one corresponding to each alternating current circuit, and a source of potential, one terminal of said source of potential being connected to the anode of each of said tubes, the other terminal of said source of potential being connected to the midpoint of the secondary winding of each transformer through the winding of the associated relay.

9. The combination of a plurality of alternating current circuits, a plurality of gas filled tubes each corresponding to one of the alternating current circuits, each gas filled tube having two cathodes and an anode, a plurality of transformers each interconnecting the cathodes of one of the gas filled tubes with the corresponding alternating current circuit, a source of potential, and a relay, one terminal of said source of potential being connected to the anode of each of said tubes, the other terminal of said source of potential being connected to the midpoint of the secondary winding of each of the transformers through the winding of said relay.

10. The method of operating a first circuit when alternating current having a voltage exceeding a predetermined value flows through a second circuit, with apparatus including a source of potential and a gas filled tube having two discharge gaps, which consists in alternately discharging the gaps of said gas filled tube as long as the voltage in the second circuit exceeds the predetermined value and continuously operating the first circuit by current from said source of potential as long as said gaps are being discharged.

LELAND K. SWART.