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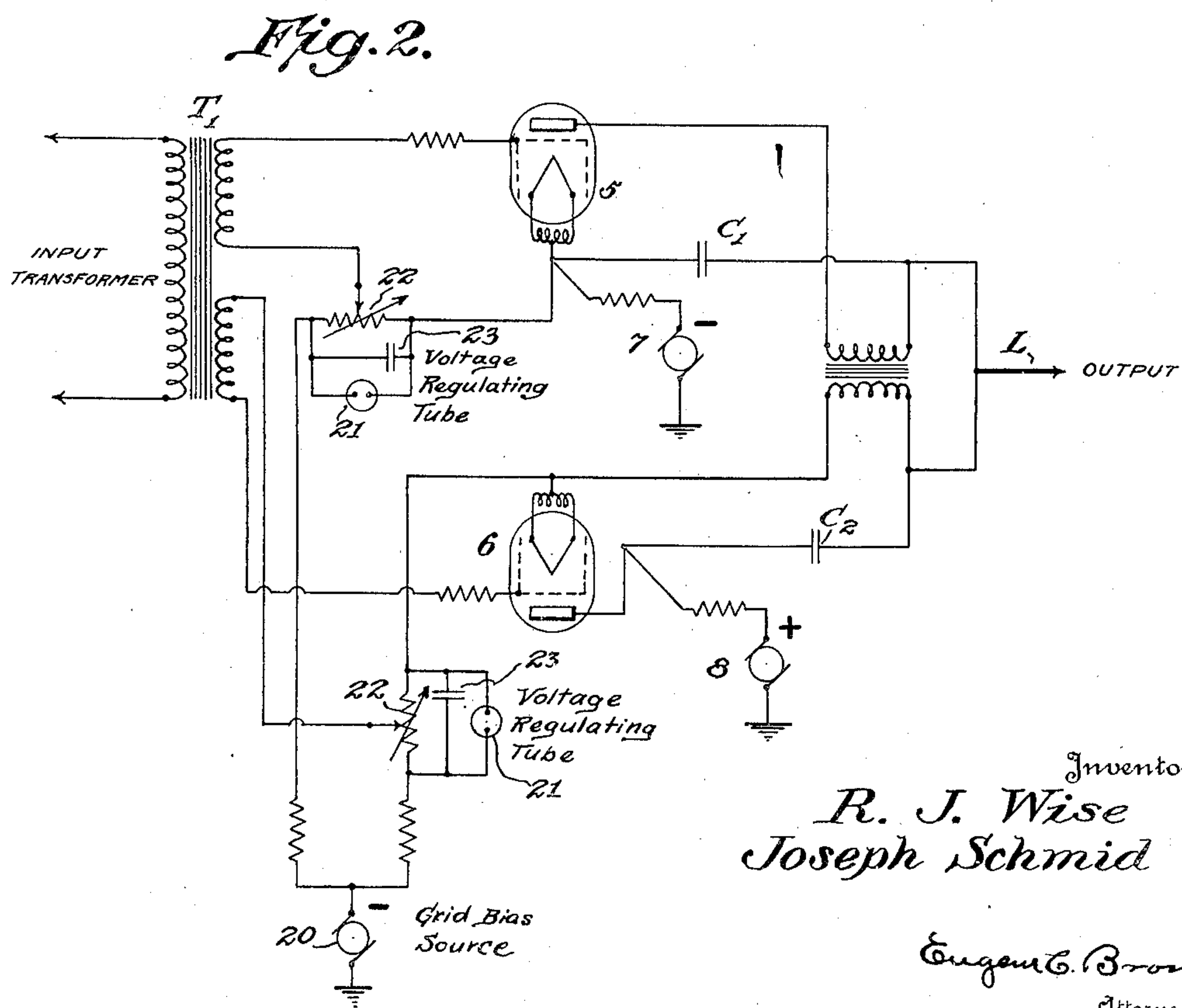
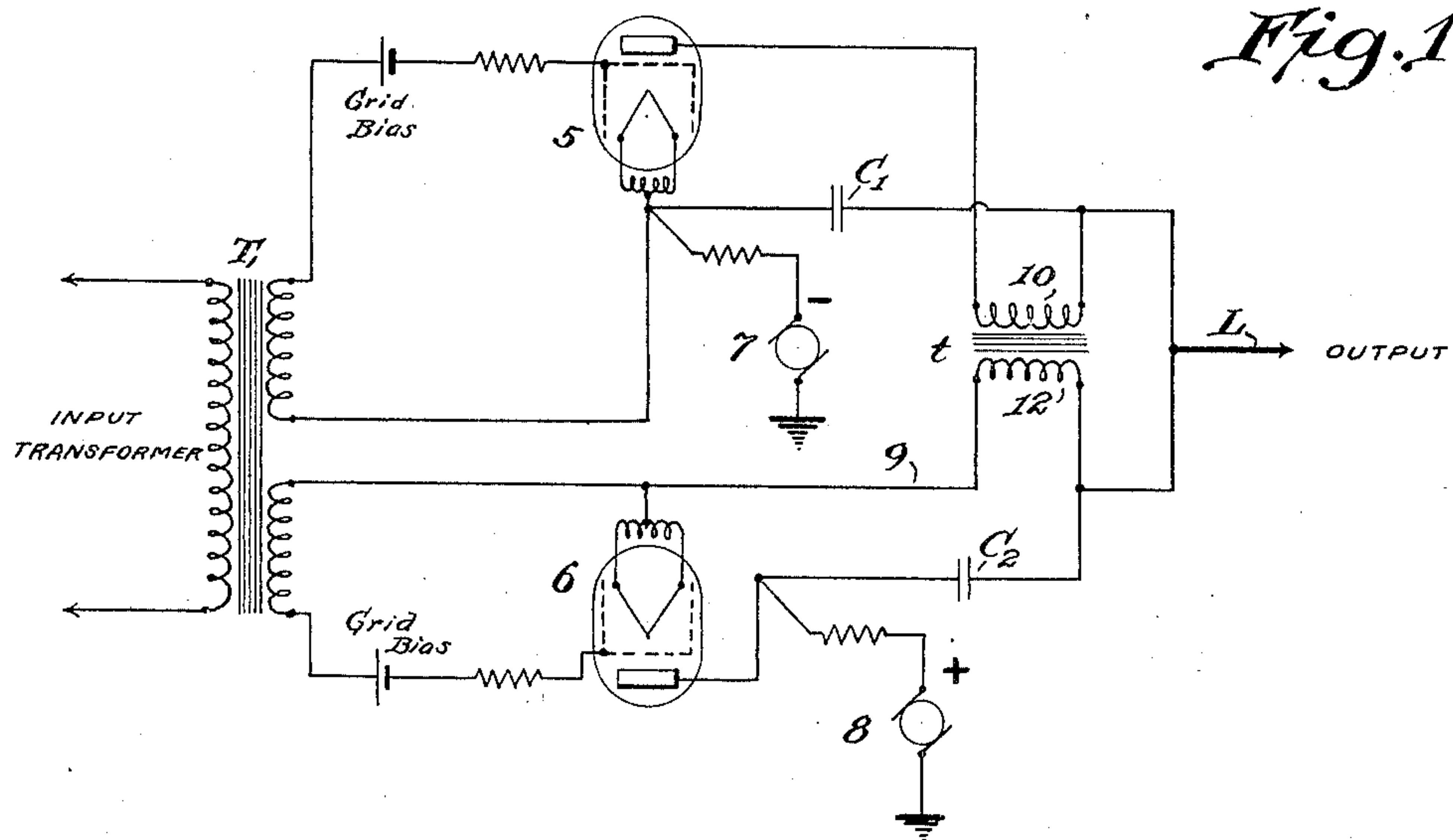
R. J. WISE ET AL

2,016,261

TELEGRAPH SYSTEM

Filed March 9, 1934

5 Sheets-Sheet 1



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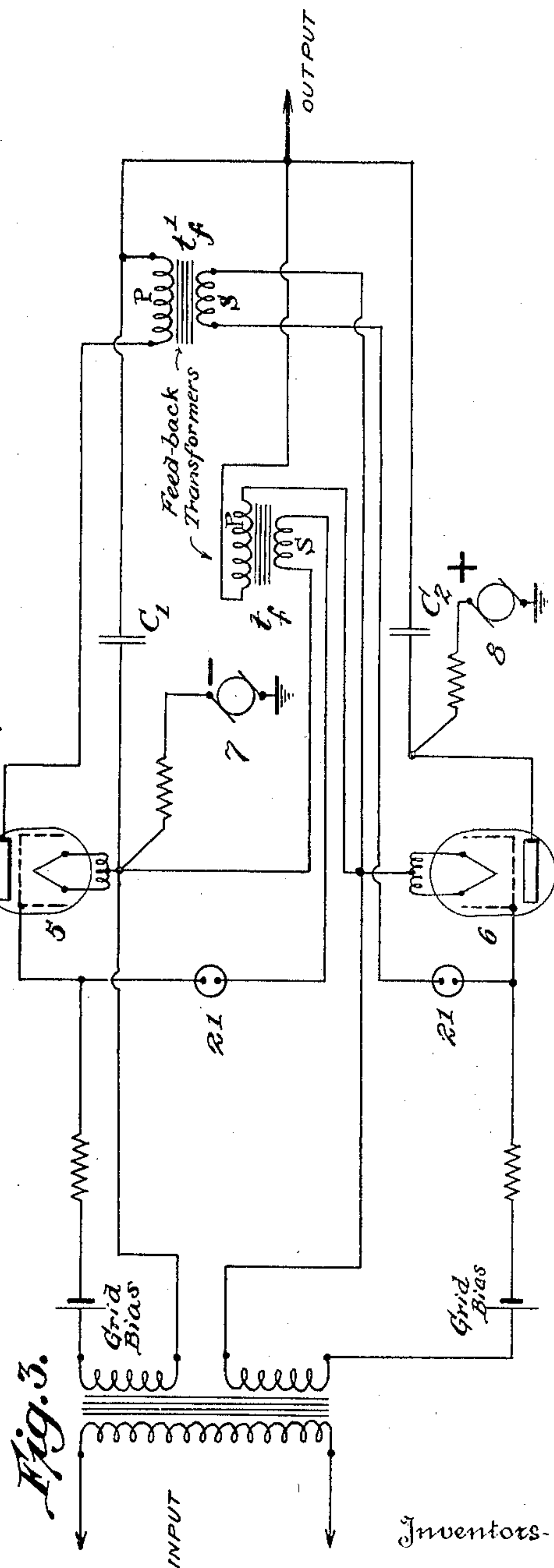
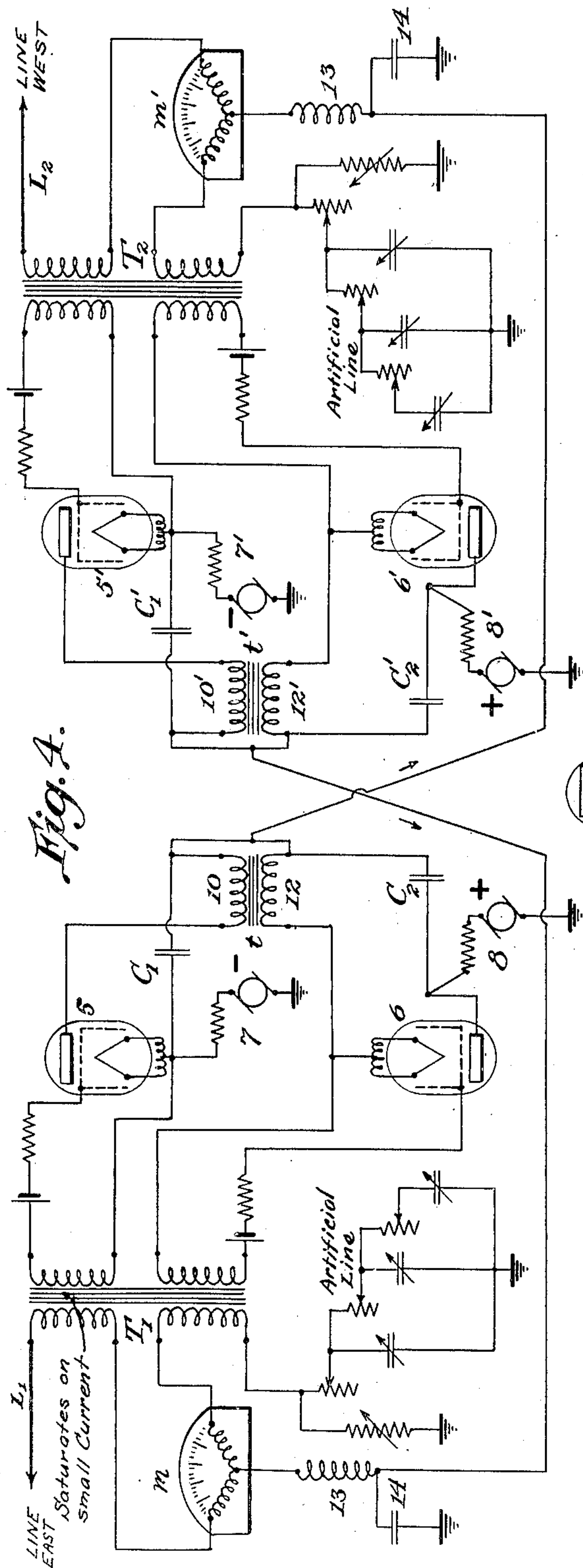
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TELEGRAPH SYSTEM

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5 Sheets-Sheet 2



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Fig. 5.

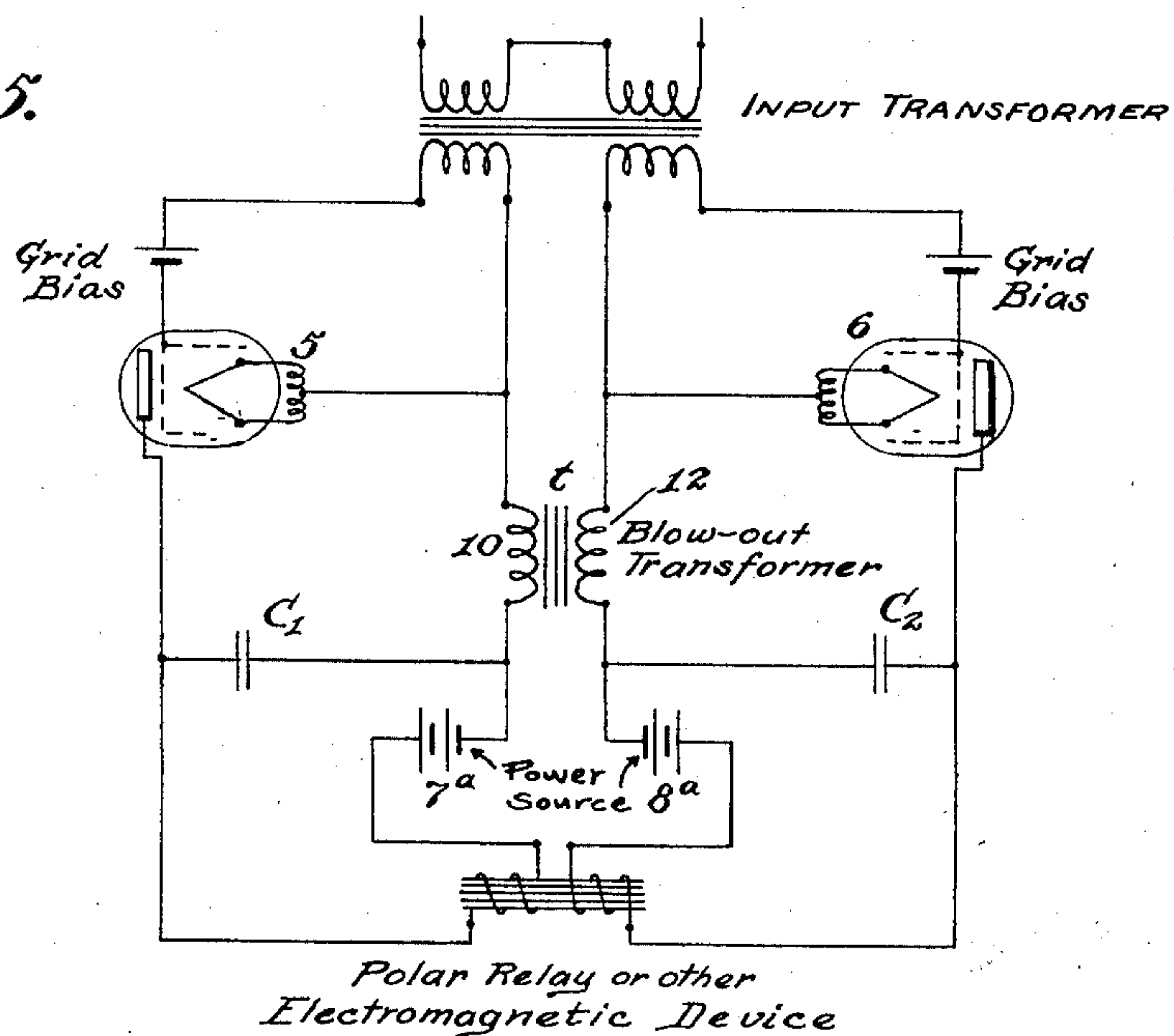
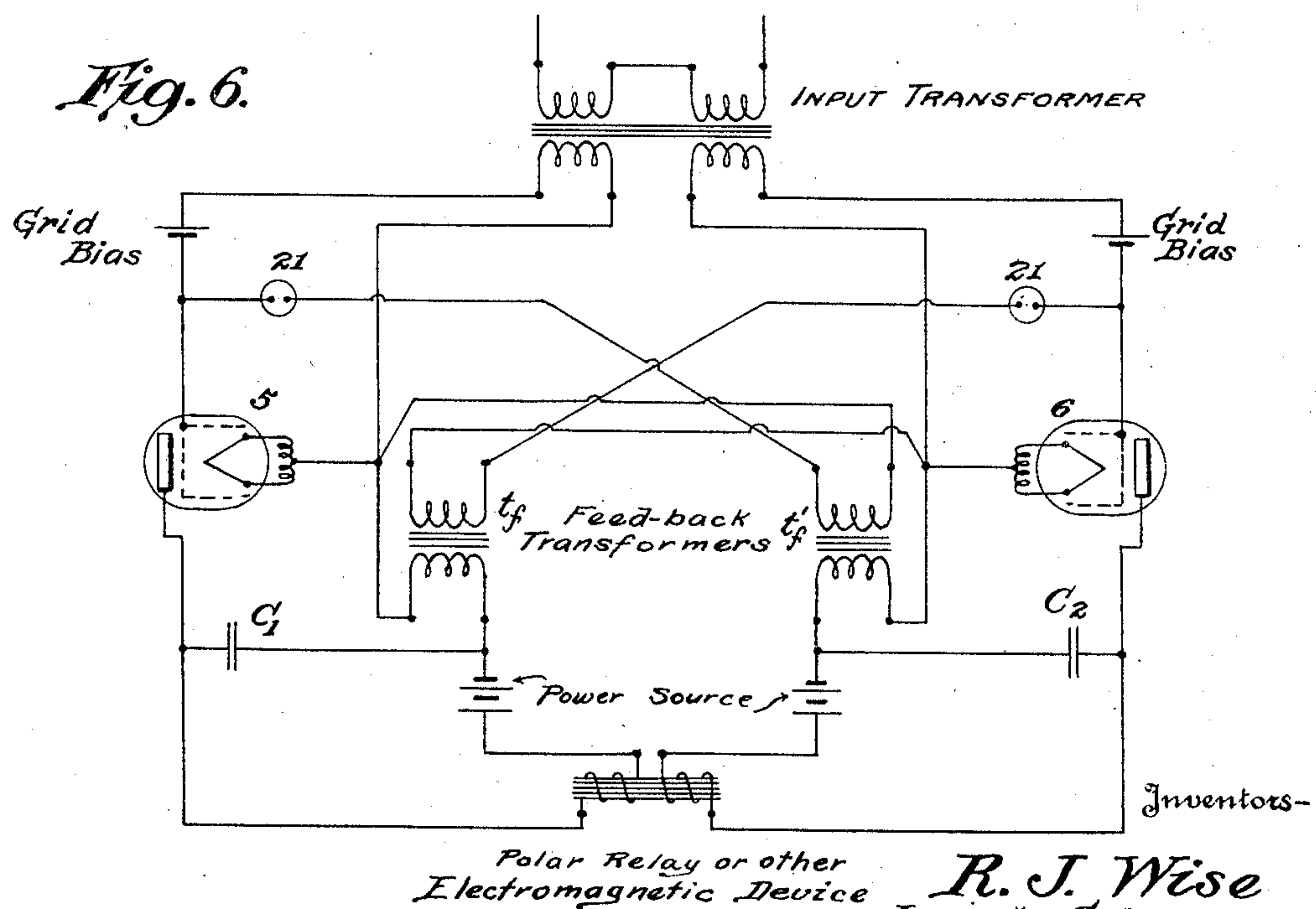


Fig. 6.



*Polar Relay or other
Electromagnetic Device*

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TELEGRAPH SYSTEM

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Fig. 7.

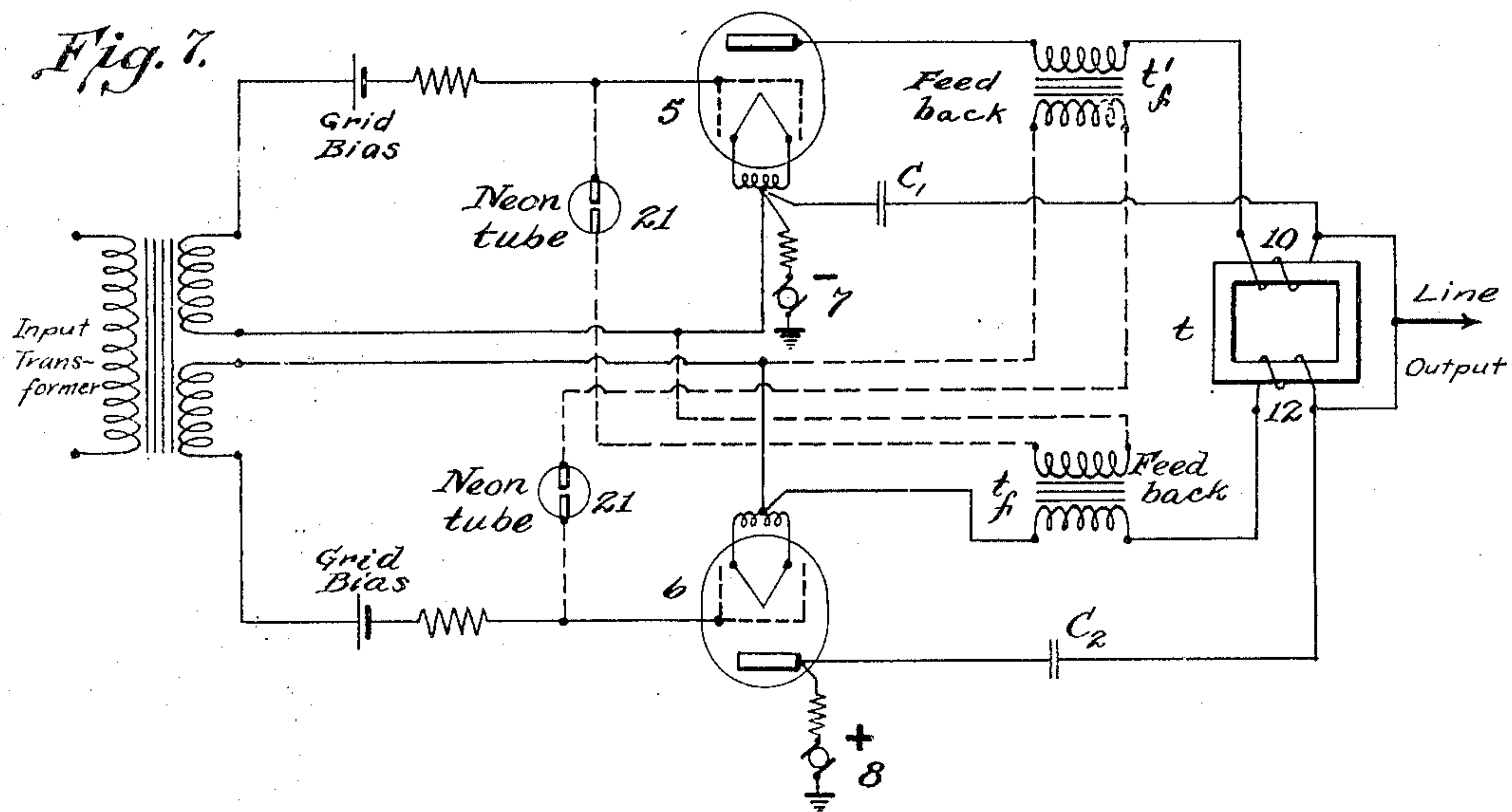


Fig. 8.

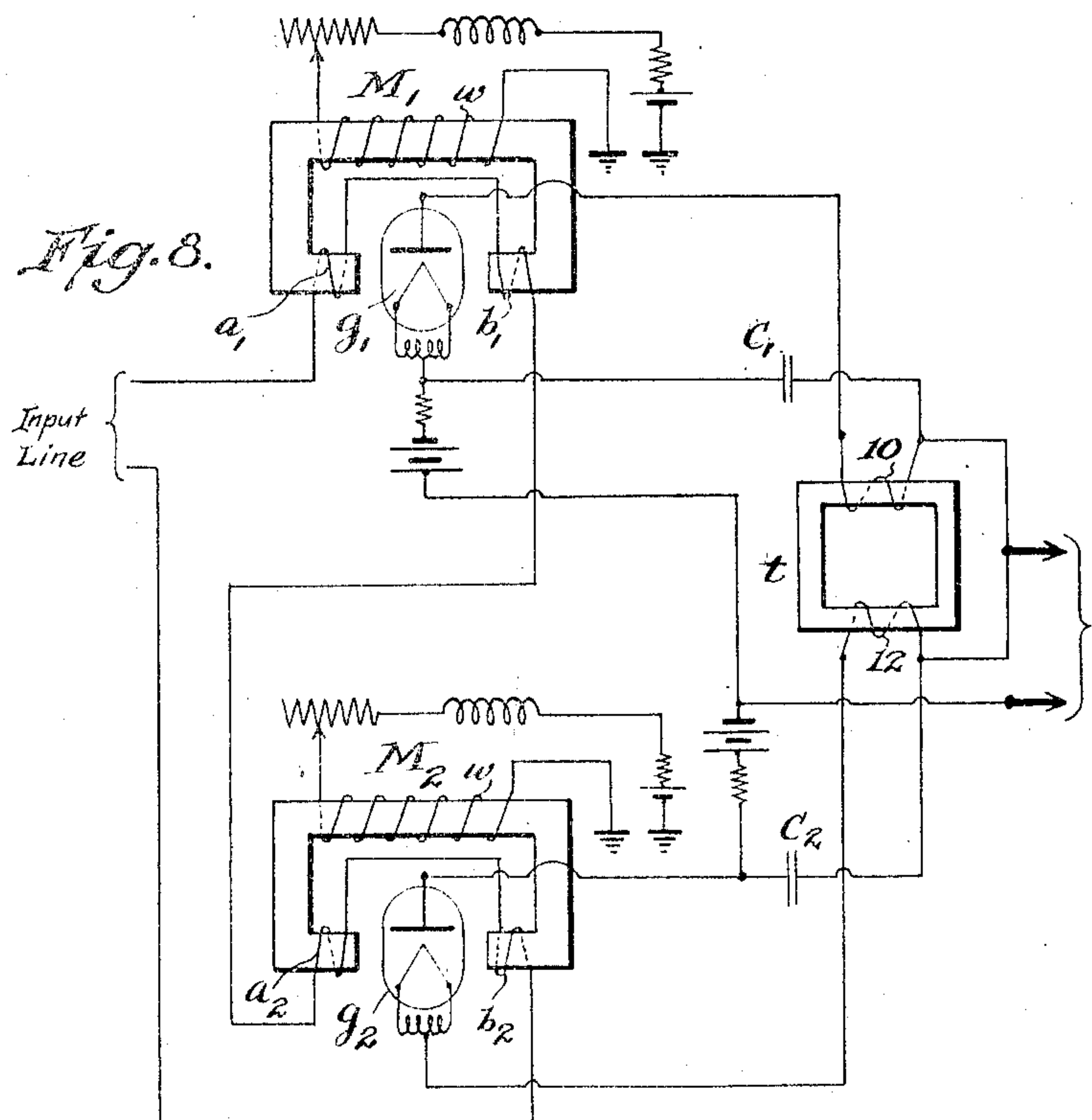
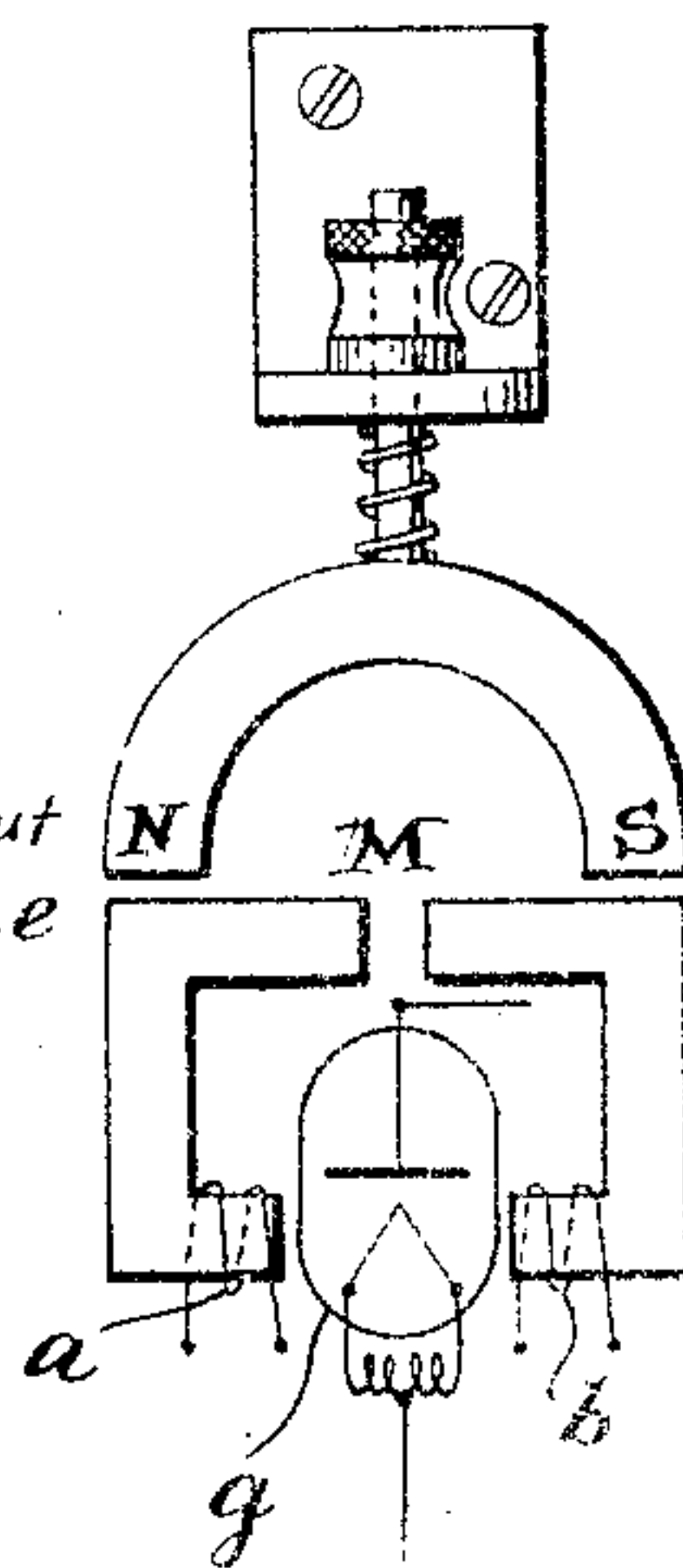


Fig. 9.



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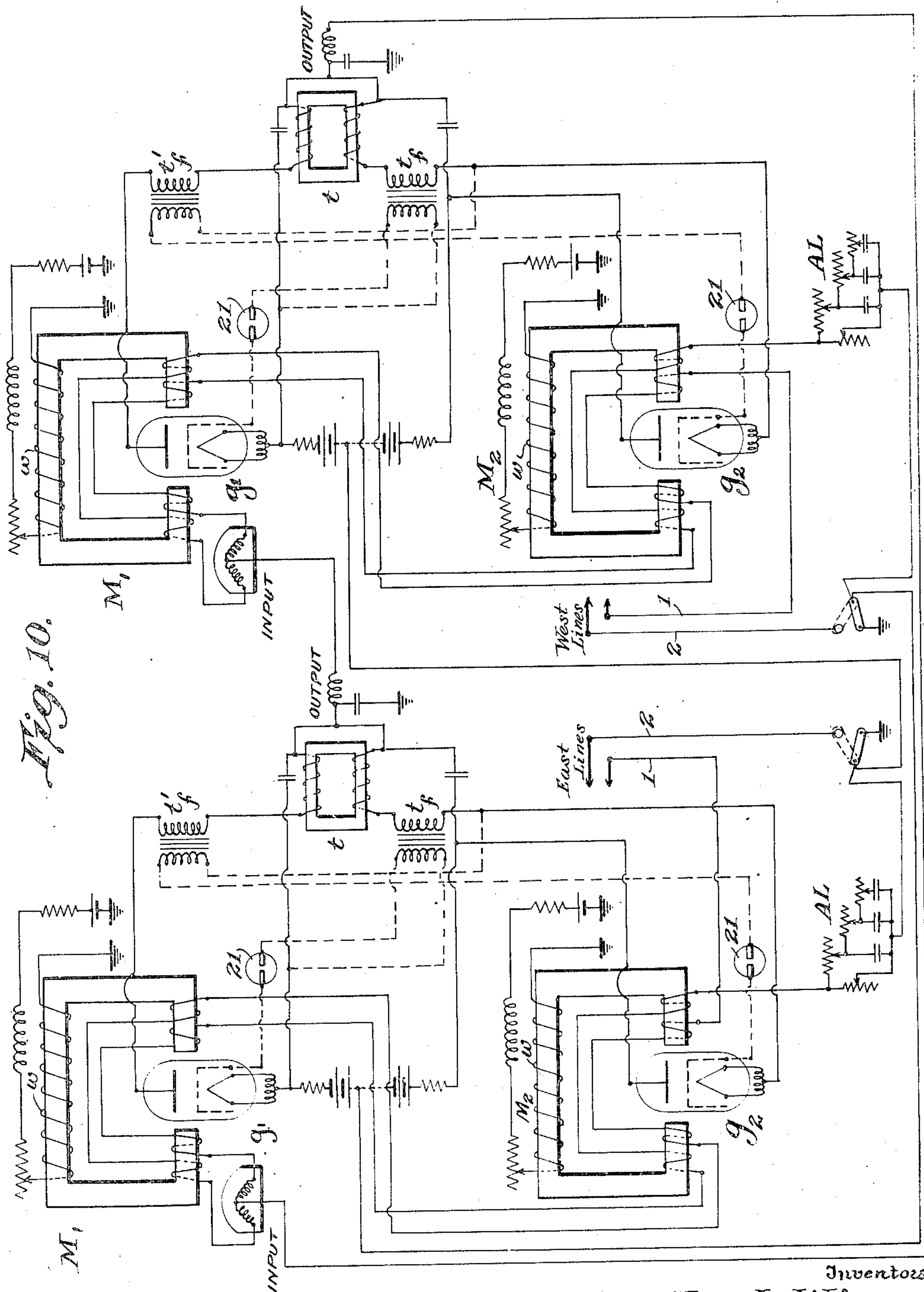
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TELEGRAPH SYSTEM

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,016,261

TELEGRAPH SYSTEM

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Application March 9, 1934, Serial No. 714,856

13 Claims. (Cl. 178—70)

This invention relates to telegraph systems and more particularly to improvements in transmitting, receiving and repeating telegraph signals over circuits employing electrostatically controlled gaseous discharge tubes instead of the usual electromagnetic relays.

One object of our invention is to provide a method of employing such tubes in a pole changer for transmitting signals over ground return circuits, requiring a particular arrangement for alternately extinguishing the tubes.

Another object is to provide an arrangement for repeating signals from one grounded circuit to another grounded circuit.

A further object is to provide a method of providing a grid bias on the tubes without employing the usual grid biasing batteries.

Other objects of our invention will be apparent from the following description in connection with the accompanying drawings in which—

Figure 1 is a diagram illustrating a polechanger arrangement employing gaseous discharge tubes according to our invention for transmitting signals over ground return telegraph circuits;

Figure 2 is a diagram similar to Fig. 1, but showing the grid biasing potential for the tubes supplied from a common central source;

Figure 3 is a diagram showing a polechanger arrangement similar to Fig. 1 but employing a feed-back circuit connection for causing the extinguishment of the tubes;

Figure 4 is a diagram showing a repeater connecting duplex grounded circuits;

Figures 5 and 6 are diagrams showing our feed-back tube extinguishing arrangement applied to electrically separated tubes arranged to operate alternately.

Figure 7 illustrates the manner in which the two arc-extinguishing means, shown separately in Figs. 1 and 3, can be combined;

Figure 8 is a diagram showing a modification of our invention in a pole-changer arrangement whereby the arc through the gaseous path is magnetically controlled;

Figure 9 is a detail view of one form of magnetic control of the gaseous discharge tubes; and

Figure 10 is a diagram of a complete duplex repeater employing the magnetically controlled gaseous discharge tubes.

The advantages attending the use of electrostatically controlled gaseous arc discharge tubes, instead of relays of the electromagnetic type, in telegraph systems have been pointed out by H. H. Haglund in Patents 1,882,817 and 1,914,328.

Our present invention provides arrangements

by which the advantages of grid-controlled arc discharge tubes may be employed in telegraph transmission circuits having ground returns such as duplex circuits. Instead of the inverter arrangement of the tubes employed by Haglund in metallic circuits to cause one tube to extinguish or quench the other tube through a condenser shunted across the plate circuits of the tubes, we have devised a feed-back transformer connection through which the plate circuits are inductively connected and by means of which a highly charged condenser in one circuit discharges a counter voltage in the output circuit of the other tube. The plate or anode of one tube is connected to the positive pole of a grounded source and the cathode of the other tube is connected to the negative pole of a grounded source.

In the polechanger transmitter the signal impulses to be transmitted pass through the primary coil of the input transformer T_1 . The secondary coils are oppositely poled to the grids of the tubes 5 and 6, and consequently when one grid receives a positive impulse the other receives a negative impulse. Thus a change in the incoming signal from marking to spacing will actuate one tube, for example the lower one, while a change from spacing to marking will actuate the other tube. The transformer t and the condensers C_1 and C_2 operate to extinguish one tube when the other tube is actuated.

The operation of the arrangement illustrated in Fig. 1 will be understood by engineers from the above description of the apparatus. Assume at any instant that the lower tube 6 has been started by a positive potential applied to the grid, while the upper tube 5 is then extinguished. Current will flow over a path from generator 8, through anode and cathode of arc discharge tube 6, conductor 9, coil 12 of transformer t , line L, and apparatus at the receiving end to ground.

The condenser C_1 will quickly acquire a high potential, equivalent to the sum of the positive potential being transmitted and the potential of the negatively poled generator 7. When a signal impulse impresses a positive potential upon the grid of tube 5, the plate circuit becomes conductive, thereby permitting the highly charged condenser C_1 to immediately discharge through winding 10 of transformer t . This abrupt current induces a counter voltage through the coil 12 in the output circuit of the tube 6 and thereby extinguishes it. In this manner the tubes are alternately started and extinguished.

Figure 4 illustrates the above described arrangement of Fig. 1, embodied in a two-way re-

peater. The operation will be obvious from previous description. The connection of one repeater portion into the opposite line is through the apex of the line meter m , or m_1 which is grounded through the standard anti-noise set comprising coil 13 and condenser 14.

The use of transformers to connect the lines with the repeater has given rise to serious difficulty due to the fact that the usual transformer allows all fluctuations of current in the primary coil to induce voltages in the secondary coils in proportion to the rate of change of the current. Telegraph lines are subject to rather large extraneous currents caused by induction from neighboring lines which modulate the line signals. When tubes are employed as relays, these extraneous currents are liable to cause false operation of the tubes. We have been able to overcome this difficulty to a large extent by so designing the transformer, employing a high permeability core which saturates at low magnetizing forces, so that the core saturates on a comparatively small value of current, say five milliamperes, when the highest value of the line signal in about fifty milliamperes. Under these conditions the secondary coil then only delivers impulses during the time the impressed signal is changing from five milliamperes limits above and below the zero line. The tubes, therefore, respond only to definite line signals transmitted from the distant end.

Instead of employing individual grid biasing batteries for each tube, as shown in Figs. 1, 3, and 4, we have devised the arrangement of Fig. 2 for supplying the grid biasing potential for the tubes from a common source indicated by the generator 20. The positive pole of the generator is grounded and the negative pole is connected through voltage regulators and resistances to the cathodes of the gaseous arc discharge tubes. The voltage regulating tubes or glow lamps 21, are shunted by high resistance potentiometers 22 in order to provide means for adjusting the potentials impressed upon the grids of the tubes. The glow lamps are also shunted by condensers 23 to further stabilize the voltages across the lamps. The potential of the generator 20 is sufficient to light the voltage regulating lamps 21 at all times by small currents flowing through the cathodes, so that there is a drop of potential across the resistances 22 sufficient to provide the proper negative grid bias.

The condensers C_1 and C_2 in the circuits previously described, cause a rapid growth of current through one coil of the transformer t when a tube is started, irrespective of the load impedance, thereby insuring the generation of a sufficiently high voltage in the other transformer coil to extinguish the opposite tube. The condensers also afford low impedance paths, irrespective of the load, for the extinguishing pulses induced in the plate circuits.

In the arrangements shown in Figs. 1, 2, 3, and 5, the tubes are extinguished by impressing a counter current of sufficient magnitude in the anode plate or output circuit of the tube, sometimes referred to as the plate circuit extinguishing means. Since it is possible to so design gaseous arc discharge tubes that they may be extinguished by impressing a negative potential of sufficient magnitude on the grid of the tube, we have devised a grid circuit extinguishing means comprising a feed-back circuit which is actuated momentarily to impress a high voltage

negative pulse upon the grid of the operating tube upon the starting of the other tube.

We have shown such a feed-back arrangement in Fig. 3. Separate feed-back transformers t_1 and t'_1 are employed for each tube. The primary coils of the transformers are connected in the output circuit of the respective tubes, while their secondary coils are connected to the grids, with an interposed neon lamp or glow tube 21, which maintains the circuit "open", thus keeping the grid circuits disconnected from the feed-back transformers, except during the passage of the high voltage feed-back pulse. At the instant a tube is started the corresponding condenser C_1 or C_2 , which is highly charged as previously described, discharges suddenly through the primary of the associated feed-back transformer thereby inducing a high voltage pulse in the secondary which is properly poled to impress a negative charge upon the grid of the other tube of sufficient value to extinguish it. It will be evident that this grid extinguishing arrangement may be employed instead of the plate circuit extinguishing means when the tubes are properly designed.

In Figs. 5 and 6 we have shown the features of our invention herein described applied to pairs of electrically separate tubes arranged to operate alternately in metallic circuits. In Fig. 5 the tubes are extinguished by impressing a counter current in the plate circuit or output of the tube and in Fig. 6 by impressing a high voltage negative pulse upon the grid of the tube by means of a feed-back transformer.

We have shown in Fig. 7 how the two-arc extinguishing means, shown separately in Figs. 1 and 3, can be used in combination. Two separate feed-back transformers t_1' and t_1 having their secondaries connected as in Fig. 3, deliver a negative pulse to the grid of the tube to be extinguished, when the other tube is started by the incoming signal, in the manner described in connection with Fig. 3. And also, the starting tube causes a counter voltage to be induced, through the transformer t , in the plate circuit of the tube to be extinguished. The extinction of the latter tube is thus brought about by the conjoint action of the negative pulse impressed upon the grid and the counter voltage impressed upon the plate circuit.

It will be observed that the two windings of the transformer t are so connected that the magnetic flux through the core never reverses but merely rises and falls each time a tube operates. Furthermore, the full inductance of the two coils of the transformer t is offered to any currents which tend to flow from one line generator to the other to constitute a short circuit. It would be possible to combine the two feed-back transformers by winding all four windings on the same core, but better results are obtained by using separate transformers as shown.

Instead of rectifier tubes of the grid-controlled type we may employ magnetically controlled gaseous discharge tubes in the manner indicated in the pole-changer arrangement of Fig. 8. The magnetic control is based on the principle that a magnetic field of sufficient density directed between the anode and cathode, perpendicular to the direction of current flow between the two elements, will prevent the initial ionization of the gas within the tube.

Referring to the polechanger arrangement shown in Fig. 8, the magnets M_1 and M_2 provide

controlling fields through the respective gaseous discharge tubes g_1 and g_2 . The winding w carries a current which is adjusted to produce a field just sufficient to prevent the operation of the tube, thereby serving in lieu of a "C" battery on the grid of a three-element tube. This steady field may be obtained by a permanent magnet, as indicated in Fig. 9. Currents flowing through the windings a_1 b_1 operate, according to direction, to increase or decrease the field produced by the winding w .

The tube g_2 is controlled in the same manner, except that the control winding a_2 b_2 is so connected in the line input circuit that its effect on the biasing field of M_2 is opposite to that of winding a_1 b_1 on the biasing field of M_1 . Hence a current in the line circuit will reduce the field through one tube and increase the field through the other tube. The tube through which the field is reduced will start while the other tube will be extinguished by the arc-quenching circuit or circuits. When the incoming signal current reverses, the field is reduced the reverse effect is produced, one tube being extinguished and the other coming on. Thus small current changes in the input circuit can be made to control the polarity of relatively large currents in the output circuit. The arrangement just described provides a simple pole-changer or a one-way telegraph repeater.

Figure 10 is a diagram of a complete duplex repeater embodying the magnetic arc-quenching means shown in Fig. 8 combined with the feedback method disclosed in Fig. 7, the tubes being of the electrostatically controlled gaseous arc-discharge type. The feed-back arc-quenching means, which is shown in dotted lines, may be omitted including the transformers t_1 and t_1' . In this case two-element tubes without grids would be used, as in the arrangement of Fig. 8.

In the following claims we have referred to the circuit through which the condenser discharges to extinguish one tube upon the starting of the other tube, as the arc-quenching circuit.

We claim:—

1. In a telegraph system, a line circuit and means for applying current reversals to said line circuit in accordance with predetermined signals, comprising an electrostatically controlled arc discharge tube for each polarity of current to be applied to said line, oppositely poled generators adapted to be connected alternately to the line upon the operation of the respective tubes, separate arc-quenching circuits associated with each tube, and inductive means energized by the flow of current in the output of each tube to actuate the arc-quenching circuit of the other tube.

2. In a telegraph system, a transmission line, transmitting apparatus adapted to apply currents of opposite polarity to said line, comprising oppositely poled generators, a gaseous ionizable arc-discharge path interposed between each generator and the line, and arc-quenching circuit associated with each path, and means to establish an inductive connection between the current output of each tube with the arc-quenching circuit of the other tube.

3. In a telegraph system as defined in claim 1 wherein said tubes are provided with anode, cathode and grid starting elements, a common biasing means therefor comprising a generator having its negative pole connected to the cathode of each tube in parallel, and a resistance in each of said connections shunted by a voltage regulating device, said resistances being connected to the grids of the tubes.

4. In a telegraph system as defined in claim 1 wherein said tubes are provided with anode, cathode and grid starting elements, a common biasing means therefor comprising a generator having its negative pole connected to the cathode of each tube in parallel, and a resistance in each of said connections shunted by a glow lamp, said resistances being adjustably connected to the grids of the tubes.

5. In a telegraph system, a transmission line, transmitting apparatus adapted to apply currents of opposite polarity to said line, comprising oppositely poled grounded generators, a gaseous ionizable arc-discharge path interposed between each generator and the line, an arc-quenching circuit associated with each path, and means actuated by the initial flow of current in one path to generate a high potential in the arc-quenching circuit of the other path.

6. In a signaling system, a pair of electrostatically controlled arc-discharge tubes having anode, cathode and grid or starting elements, a pair of oppositely poled generators connected respectively to the anode of one tube and to the cathode of the other tube, means for applying potential reversals to said grids, separate arc-quenching circuits connected respectively to each tube, and means actuated by the flow of current from one generator through its associated tube to generate a high potential in the arc-quenching circuit of the other tube.

7. In a signaling system, as defined in claim 6, each arc-quenching path being provided with a normally open spark-gap adapted to be closed by the discharge of said high potential.

8. In a signaling system, a pair of electrostatically controlled arc-discharge tubes having anode, cathode and grid or starting elements, a pair of oppositely poled generators connected respectively to the anode of one tube and to the cathode of the other tube, means for applying potential reversals to said grids, separate arc-quenching circuits embodying condensers connected respectively to each tube, and inductive means actuated by the flow of current in the circuit of one tube to generate a potential in the arc-quenching circuit of the other tube.

9. In a duplex telegraph system, an incoming circuit, an outgoing circuit, a terminal network for balancing said incoming circuit, a transformer having its primary coil connected between the incoming circuit and said network, repeating apparatus comprising a pair of electrostatically controlled arc-discharge tubes having anode, cathode and grid elements, said grid elements being connected to secondary coils of said transformer to receive positive and negative signaling impulses respectively, a pair of oppositely poled grounded generators connected respectively to the anode of one tube and the cathode of the other tube, arc-quenching circuits connected to the respective tubes, and means actuated by the flow of current from one generator through its associated tube to generate a potential in the arc-quenching circuit of the other tube.

10. In a duplex telegraph system, an incoming circuit, an outgoing circuit, a terminal network for balancing said incoming circuit, a transformer having its primary coil connected between the incoming circuit and said network, repeating apparatus comprising a pair of electrostatically controlled arc-discharge tubes having anode, cathode and grid elements, said grid elements being connected to secondary coils of said transformer to receive positive and negative sig-

naling impulses respectively, a pair of oppositely poled grounded generators connected respectively to the anode of one tube and to the cathode of the other tube, arc-quenching circuits
5 embodying condensers connected to the respective tubes, and inductively operated means actuated by the flow of current from one generator through its associated tube to generate a potential in the arc-quenching circuit of the other
10 tube.

11. In a duplex telegraph system as defined in claim 9, said transformer being constructed to saturate magnetically upon the flow of a small value of current compared with the highest value
15 of the line signal, whereby false signals due to extraneous currents are obviated.

12. In a telegraph system having incoming and outgoing lines, apparatus for repeating signal code impulses between said lines, comprising op-
20 positively poled generators, a gaseous ionizable arc-discharge path interposed between each generator and the outgoing line, arc-quenching means as-

sociated with each of said paths, and means actuated by a current impulse transmitted to the outgoing line across one arc-discharge path to generate a potential which causes the quench-
5 ing of the current across the other path.

13. In a telegraph system having incoming and outgoing lines, apparatus for repeating signal code impulses between said lines, comprising oppositely poled generators, a gaseous ionizable arc-discharge path interposed between each generator
10 and the outgoing line, arc-quenching means associated with each of said paths, means activated by the impulses received over the incoming line to condition one path for operation and to prevent the operation of the other path, and
15 means actuated by a current impulse transmitted to the outgoing line across one arc-discharge path to generate a potential which causes the quenching of the current across the other path.

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