

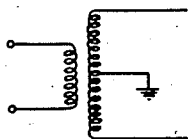
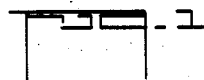
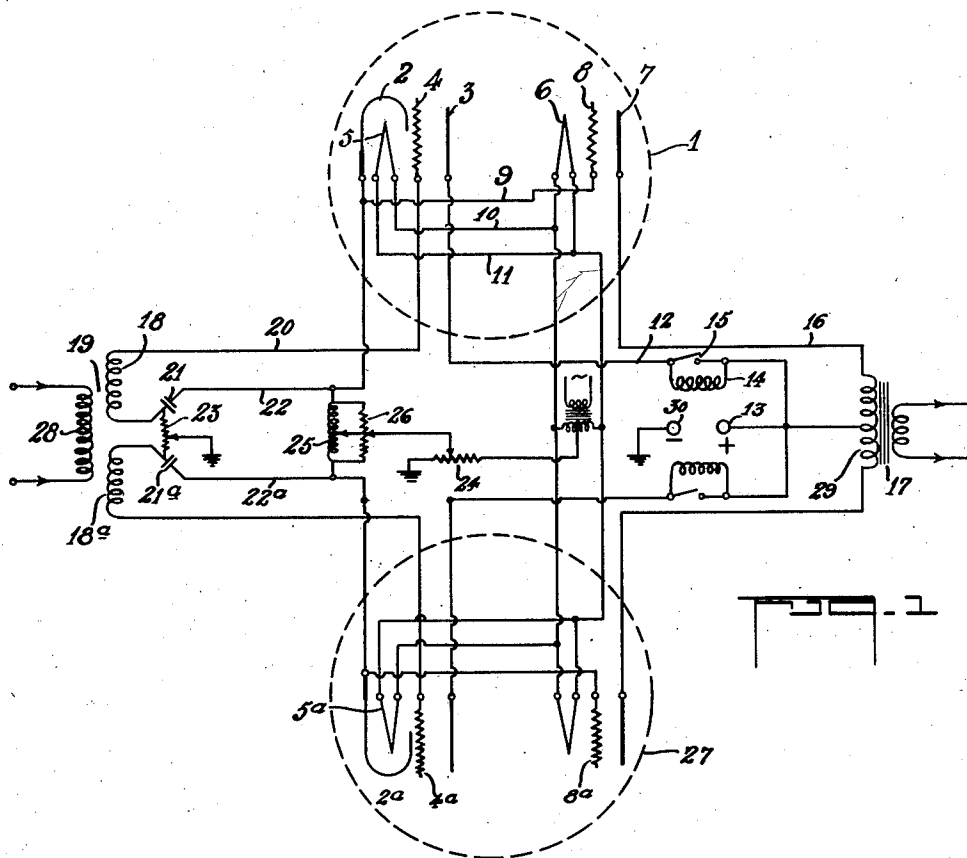
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ELECTRICAL TRANSMISSION SYSTEM

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ELECTRICAL TRANSMISSION SYSTEM

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This invention relates to transmission systems and with particularity to systems employing electric discharge devices as detectors, and/or amplifiers, and/or repeaters.

5 The invention is in the nature of an improvement on the circuits and systems disclosed in application Serial No. 586,301. There are disclosed in said application various systems of connecting sets of electrodes in circuit so as to achieve
 10 undistorted output with a minimum number of electrode sets. In general the system of said application utilizes the positive region of the grid voltage-plate current characteristic, in addition to the negative portion usually employed alone.

15 One of the principal objects of the invention is to provide an organization of circuits and discharge devices employing two pairs of electrode sets, each pair having a direct coupling therebetween and with the pairs connected in push-pull relation to a common input circuit and to a
 20 common output circuit.

A feature of the invention resides in arrangements employing pairs of directly coupled tubes, or electrode sets, in tandem, the pairs being provided with circuits enabling the tubes or electrode sets to act in push-pull arrangement.
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A further feature relates to the novel organization and arrangement of parts and circuits which go to make up a simple and highly efficient system for transmitting electric signals with maximum fidelity.
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Other features and advantages not specifically enumerated will be apparent after a consideration of the following detail descriptions and the appended claims.
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In the drawing,

Fig. 1 discloses an arrangement of electrode sets, or tubes, in push-pull relation according to the invention;

40 Fig. 2 is a schematic showing of a modified manner of coupling the input signal to the electrodes of the system of Fig. 1.

Referring more particularly to Fig. 1, the numeral 1 represents an envelope, preferably evacuated, containing two sets of electrode elements, the first set comprises a cathode 2, an anode 3, and a control grid 4. The cathode 2 may be, although not necessarily, of the indirect heated type, and for this purpose a heating element or filament 5 is provided. The second set of elements in tube 1 comprises an emitting cathode 6, an anode 7, and a control grid 8. Preferably, although not necessarily, the cathode 6 of the second set is of the power type such as ordinarily
 55 provided in so-called output or power tubes. The

filament 5 and the filament 6 may be heated from any desirable source of current, and while the drawing shows these filaments heated by alternating current, it will be understood that the invention is not limited thereto. In accordance with the disclosure of application Serial No. 586,301, referred to above, a cathode 2 is directly connected to the grid 8 by means of a wire 9. Preferably, although not necessarily, this connection may be made within the envelope 1 so as to reduce the number of contact prongs on the exterior of the tube. Similarly the two filaments 5 and 6 may be connected in parallel within the tube by means of the conductors 10 and 11, likewise reducing the number of exterior
 15 terminals required. The anode 3 of the first electrode set is connected by wire 12 to the positive terminal 13 of a source of steady anode potential. In case the system disclosed is to be used for audio amplification this connection to the positive terminal of the anode supply may be a direct connection.
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However, in the event that the first electrode set is to be used as a detector-amplifier combination, the anode potential may be applied through a high frequency choke coil 14, in accordance with standard practice. However, for the purpose of securing simplicity in the drawing, the choke coil 14 is shown as being capable of being shunted by means of a switch 15. It will be understood, of course, that this arrangement is not necessary, and that the choke coil may be entirely omitted and a direct connection made to the anode 3 if the system is to be used for plain amplification. The potential for the anode 7 is applied through conductor 16 and the upper half of the primary winding of the output transformer 17. The set of electrodes 2, 3, 4, may be termed the input section of the tube 1, while the electrodes 6, 7, 8, should be termed the output section. The signal to be amplified is impressed across the grid 4 and the cathode 2 by means of the secondary winding 18 and the input transformer 19. This winding has one end connected to the grid 4 through conductor 20, while the other end of the winding is connected through a condenser 21 and conductor 22 to the cathode 2. The condenser 21 is preferably of sufficient electrostatic capacity to afford a very low impedance to the impressed signal variations. For example, in the case of audio amplification this condenser may have a value of the order of 2 mfd. The direct current path for the input circuit extends from the grid 4, conductor 20, winding 18, upper half of the resistance 23 to ground, thence through
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the left hand section of the resistance 24, upper half of inductive impedance 25, thence directly to the cathode 2.

The impedance 25 is shunted by a resistance 26 for the purpose of controlling the voltage drops across said impedance for various frequencies and/or for controlling the phase angle between the various frequencies, as set forth in the application of J. G. Aceves, Serial No. 533,396. If desired the connections to the resistance 23, 24 and 26 and the impedance 25 may be variable as indicated schematically in the drawing. Impedance 25 is not necessarily one reactor, and it may be two separate inductive reactances connected in series. In certain high frequency applications, it may be desirable to use condensers, in place of resistance 26, shunting impedance 25. With this arrangement, the parallel inductive capacity circuits may be adjusted to resonate, or not. Another tube 27, similar to the tube 1 and having similar sets of electrodes is provided, the electrodes of tube 27 being indicated in the drawing by the same numerals as the corresponding electrodes of tube 1, but with exponents. The various electrodes of tube 27 are connected to the input and output transformers in a similar manner. Thus the signals are impressed across the grid 4^a and the cathode 2^a by means of the lower section 18^a of the secondary winding of the input transformer through condenser 21^a and conductor 22^a to the cathode 2^a. It is believed that the remaining connections to tube 27 will be obvious from the explanation given above in connection with tube 1. At this point, however, it should be noticed that windings 18 and 18^a are in effect the same windings, but split at the center and connected together through the resistance 23. Consequently when a signal is impressed upon the primary winding 28 this signal is further impressed upon the tubes 1 and 27 in a push-pull manner. That is to say, when the current is flowing in one direction through the transformer 28, there will be a positive potential impressed upon the grid 4 for example, and a corresponding negative potential impressed upon the grid 4^a, and vice versa, when the current flows in the opposite direction to the transformer 28.

In accordance with standard push-pull practice the amplified variations pass through the primary winding 29 of the output transformer and induce corresponding variations in the output circuit. By means of the variable resistance 24 any desired bias may be given to the grids 4 and 4^a, with respect to their associated cathodes, and at the same time the bias on the grids 8 and 8^a may be controlled. Because of the direct metallic connection between the cathode 2 and the grid 8 of each of the tubes, the load of the input section of each tube exists between the cathode and the negative terminal 30 of the anode supply, this load also being directly across the grid-cathode circuit of the output section, and the signals are amplified with a minimum distortion. Consequently the output section of each of the tubes 1 and 27 is capable of operating in the positive region of the grid current-plate voltage characteristic, since any current flow, that would normally be demanded by the grid-cathode circuit of the output sections is supplied by a simultaneous increase in current between the anode-cathode of the associated input sections. Therefore, the input section may be looked upon as maintaining a high input impedance and output characteristics that will supply the power demanded by the grid loss of the output section,

that would be normally associated with the results of grid current therein.

As explained in application Serial No. 586,301, the resistance 24 may be so adjusted as to provide the proper grid bias for each of the input sections so that they may function both as amplifiers and detectors. However, in order to keep the radio frequency variations from the output circuit a suitable high frequency by-pass condenser may be connected across the anode 3 and the cathode 2 in accordance with standard practice.

It has been found that in the particular arrangement shown in Fig. 1, the use of a split secondary 18, 18^a on the input transformer connecting to ground through the resistance 23, enables the maximum sensitivity to be achieved. However, if desired, the transformer secondary may be continuous and have its midpoint grounded directly as indicated schematically in Fig. 2. With this latter arrangement, condenser 21, 21^a and connections 22, 22^a as far as condenser 21, 21^a respectively, to the ends of impedance 25, are eliminated.

It will be understood that while Fig. 1 may show input transformer 28, output transformer 29, and impedance 25, with or without a core, it is immaterial to the spirit of the invention, as the particular type of transformers and impedance depend on the particular frequency application.

It will also be understood that the invention is not limited to the arrangement of the input and output sections of each pair in the same envelope. For example, the electrodes 2, 3, and 4 may be arranged in one envelope, and the electrodes 6, 7, and 8 arranged in a separate envelope, the various electrodes then being connected in the manner shown in Fig. 1.

Various changes and modifications may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. An electric wave repeating system comprising divided input and output circuits, a plurality of sets of electrode elements in each divided circuit, each set including a cathode, an anode and a control electrode, the cathode of one set being directly connected to the control electrode of the associated set, one of the cathodes in each set being electrically isolated from its heater filament whereby a single source of current may be used for heating all the cathodes.

2. A system according to claim 1 in which the said sets of electrodes in each divided circuit are arranged in a single envelope.

3. An electric wave repeating system comprising input and output circuits, a pair of electric discharge repeater elements oppositely connected to said input circuit, a pair of electric discharge repeater elements oppositely connected in said output circuit, each of said repeaters including a cathode, an anode and a control electrode, the cathode of one input repeater being directly connected to the control electrode of the associated output repeater, and electrically isolated from its heater filament whereby a single source of current may be employed for energizing all the cathodes.

4. In combination a first cathode and grid, a second cathode and grid, a transformer having a split secondary winding, one section of said winding being connected across the first cathode and grid, the other section being connected across the second cathode and grid, a third cathode and grid, a fourth cathode and grid,

anodes for the first, second, third and fourth cathodes, means directly connecting the first cathode to the third grid and the second cathode to the fourth grid, said first and second cathodes being electrically isolated from their heater filaments whereby a single source of current may be used for energizing all the cathodes.

5 The combination according to claim 4 in which the split secondaries are connected across the associated grid and cathode through condensers.

6 The combination according to claim 4 in which the ends of the split secondaries are connected together through a resistance.

15 7. In a wave repeating system the combination of a transformer having a primary winding and a split secondary winding, a pair of repeater devices each having a cathode and an associated control grid, the outer ends of the split secondary winding being connected respectively to the said grids, the inner ends of the split windings being connected together through a resistance, and connections from a point intermediate the ends of said resistance to each of said cathodes, and another pair of repeater devices each having a cathode, anode and control grid, and short circuit connections from the control grid of the second mentioned repeater devices to the cathode of the first mentioned repeater devices.

20 8. In a wave repeating system according to claim 7 in which a conductor is connected with one end terminating at a point intermediate to the said resistor, and the other end terminating either through resistance or batteries to one or more of the said cathode and/or anodes.

25 9. A system according to claim 7 in which the inner ends of the said secondary windings are connected respectively to said cathodes through condensers.

30 10. A wave repeating system comprising a divided input coil, a repeater connected in circuit with one section of said coil, another repeater connected in circuit with the other section of said coil, each of said repeaters comprising an input section and an output section, each of said sections including a cathode, an anode and a control electrode, means directly connecting the cathode of an input section to the grid of an output section, the cathode of the input section being electrically isolated from its heater filament whereby a single source of current may be employed for energizing all the cathodes.

35 11. In a wave repeating system the combination of a first repeater, a second repeater, each of said repeaters having an input section and an output section, each of said sections including a cathode, an anode and a control electrode, circuit connections whereby the load impedance of each input section exists between the cathode thereof and the negative end of the anode supply, circuit connections whereby the grid cathode of the output section is connected directly across the load impedance of the associated input section, means for impressing signal variations simultaneously on the grids of the two input sections, means for simultaneously taking off the output from the anodes of the two output sections, and means whereby all the cathodes may be energized from a single source of current.

40 12. A wave repeating system comprising a first repeater, a second repeater, each of said repeaters comprising an input section and an output section consisting of a cathode, anode and control grid, and means for impressing waves to be repeated upon both of said repeaters in push-pull

relation, the input and output sections of each repeater being connected so that the load impedance of the input section exists between the cathode and the negative terminal of the anode supply, the cathodes of each input repeater being electrically isolated from their heater filaments whereby a single source of current may be employed for heating all the cathodes.

45 13. A wave repeating system according to claim 12 in which the load impedance of each input section is connected directly across and forms part of the grid-cathode circuit of the associated output section.

14. A wave repeating system comprising a first input coil, an input repeater element having its grid and cathode connected across said coil, a second input coil, a second repeater element having its grid and cathode connected across said second coil, a repeater output element having a grid and cathode connected to said coil, a second repeater output element having a grid and cathode connected to said second coil, means directly connecting the cathode of the first input element to the grid of the first output element, means directly connecting the cathode of the second input element to the grid of the second output element, the cathodes of the input repeater elements being electrically isolated from their heater filaments whereby a single source of current may be employed for heating all the cathodes.

15. In a wave repeating system the combination of a first pair of repeaters, a second pair of repeaters, each pair of repeaters comprising an input and an output section, each of said sections comprising a cathode, an anode and a control electrode, circuit connections whereby the cathode of each input section is directly connected to the control electrode of its associated output section, means for impressing in push-pull relation signal variations simultaneously between the control electrodes of the two input sections and a point substantially at ground potential to the signals to be repeated, and means for simultaneously taking off the output signals from the anodes of the two output sections.

16. In a wave repeating system the combination of a first pair of repeaters, a second pair of repeaters, each pair of repeaters comprising an input and an output section, each of said sections comprising a cathode, an anode and a control electrode, circuit connections whereby the cathode of each input section is directly connected to the control electrode of its associated output section, means for impressing in push-pull relation signal variations simultaneously between the control electrodes of the two input sections and a point substantially at ground potential to the signals to be repeated, said means providing part of a direct current path between the control electrodes of the two input sections and ground, and means for simultaneously taking off the output signals from the anodes of the two output sections.

17. A device in accordance with claim 16, in which the means for impressing the signal variations in push-pull relation on the control electrodes provides part of a direct current path from the control electrodes through resistance or through a source of potential to one or more cathodes and anodes.

18. In a wave repeating system the combination of a first pair of repeaters, a second pair of repeaters, each pair of repeaters comprising an input and an output section, each of said sec-

tions comprising a cathode, an anode and a control electrode, circuit connections whereby the load impedance of each input section exists between the cathode thereof and a negative pole of the anode supply, circuit connections whereby the control electrode and cathode of the output section are connected directly across the load impedance of the associated input section, means for impressing in push-pull relation signal variations simultaneously between the control electrodes of the two input sections and a point substantially at ground potential to the signals to be repeated, and means for simultaneously taking off the output signals from the anodes of the two output sections.

19. In a wave repeating system the combination of a first pair of repeaters, a second pair of repeaters, each pair of repeaters comprising an input and an output section, each of said sections comprising a cathode, an anode and a control electrode, circuit connections whereby the control electrode and cathode of each output section is respectively shunted across the cathode of its associated input section and a point substantially at ground potential to the signals to be repeated, means for impressing in push-pull relation signal variations simultaneously between the control electrodes of the two input sections and a point substantially at ground potential to

the signals to be repeated, and means for simultaneously taking off the output signals from the anodes of the two output sections.

20. In a wave repeating system the combination of a first pair of repeaters, a second pair of repeaters, each pair of repeaters comprising an input and an output section, each of said sections comprising a cathode, an anode and a control electrode, circuit connections whereby the cathode of each input section is directly connected to the control electrode of its associated output section, means for isolating an input signal into two parts whereby one part is impressed across the control electrode and cathode of an input section and the other part simultaneously impressed in opposite phase relation across the control electrode and cathode of the other input section, said means providing part of a direct current path between the control electrodes of the two input sections and ground, and means for simultaneously taking off the output signals from the anodes of the two output sections.

21. A device according to claim 19 in which said means for dividing the input signal provides part of a direct current path from the control electrodes through resistance or through a source of potential to one or more cathodes and anodes.

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