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PRINTING TELEGRAPH SYSTEM

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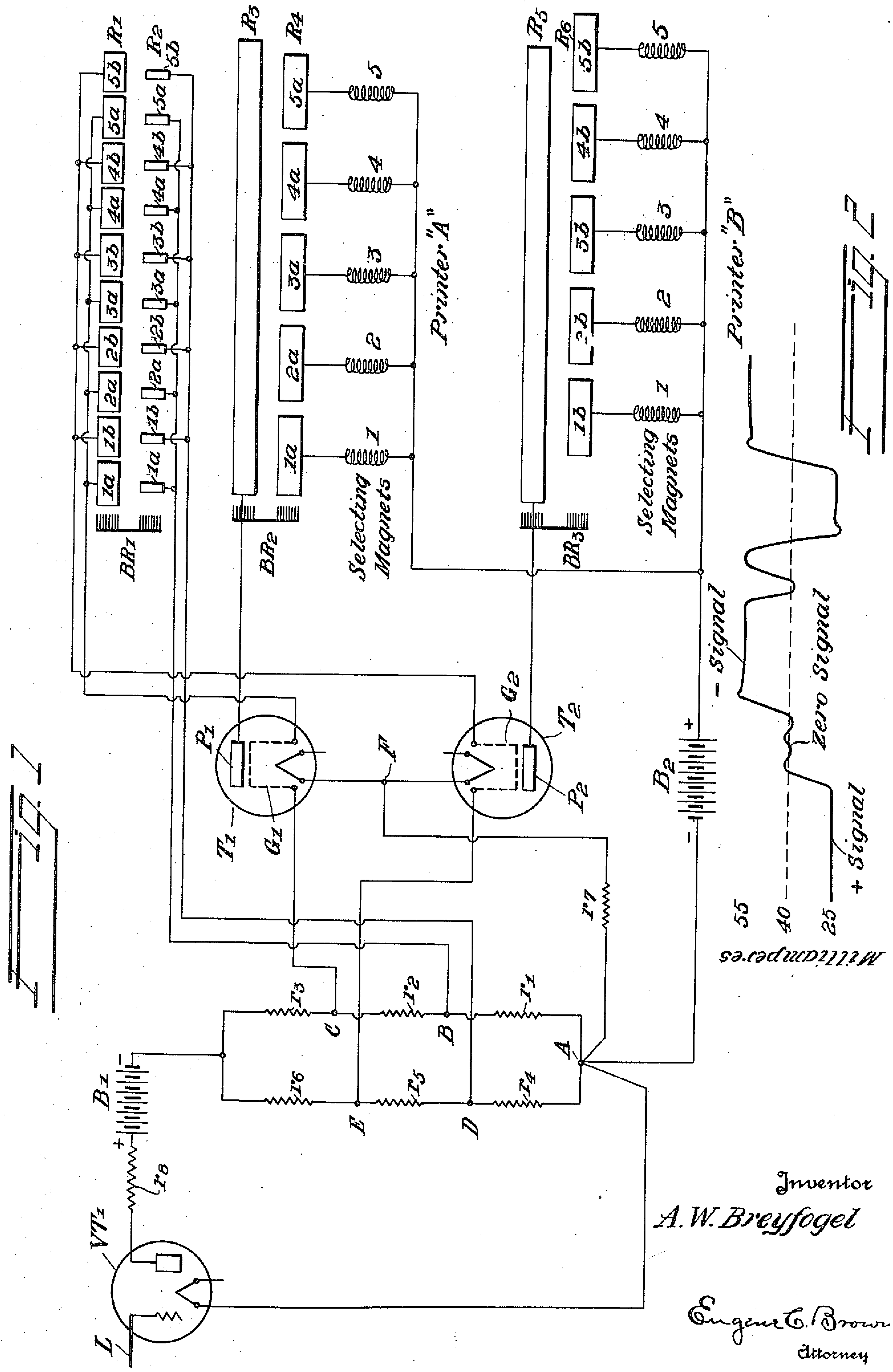

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PRINTING TELEGRAPH SYSTEM

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This invention relates to a printing telegraph system, and in particular to a telegraph system in which thyratron or other grid-controlled, gas-filled thermionic tubes are employed as relays for operating the magnets of telegraph printers in accordance with incoming signals.

An object of my invention is to devise a grid-controlled, gas-filled tube system for telegraph printers in which there are no stabilizing batteries, and in which the necessary operating potentials are supplied directly from potential drops across resistances connected in the plate circuit of the amplifier controlling these grid-controlled, gas-filled tubes.

Another object of my invention is to devise such a relay circuit in which the grid elements of the tubes are maintained at definite potentials with respect to the cathode elements at all times and are never left free or floating.

A further object of my invention is to devise a grid-controlled, gas-filled tube circuit for the operation of one or more telegraph printers in which upon the receipt of successive positive signal impulses the magnets of two printers are operated alternately, and during no signal impulse periods the magnets of only one printer are operated depending upon which printer was last operated by positive impulses, and negative signal impulses are ineffective to operate either printer.

This invention is an improvement upon the relay circuit disclosed in Figure 2 of the copending application of H. H. Haglund, Serial No. 343,109.

My invention is illustrated in the accompanying drawing in which:

Figure 1 is a circuit diagram of the novel relay circuit of this invention; and

Figure 2 is a curve representing current variations in the plate circuit of the amplifier controlling the thyratron relays.

Referring to Figure 1, the general arrangement of the invention comprises a vacuum tube relay VT_1 having its input connected to an incoming line L, and its output circuit controlling the input circuits of two relays T_1 and T_2. Relay T_1 controls the printer magnets of printer "A" through circuits completed by brushes BR_1 associated with pick-up rings R_1 and R_2, and by brushes BR_2 associated with plate rings R_3 and R_4. Relay T_2 controls the magnets of printer "B" through circuits completed by brushes BR_1 associated with pick-up rings R_1 and R_2, and by brushes BR_3 associated with plate rings R_5 and R_6.

The relay circuit may be described in more detail as follows:

In the power or output stage of the vacuum tube amplifier VT_1 is a network of resistances r_1, r_2, r_3, r_4, r_5 and r_6. These resistances are proportioned so that r_1 is equal to r_4, r_2 to r_5, and r_3 to r_6, thus forming a parallel circuit as shown. The point A of this resistance network is connected at point F to the cathodes of the two tubes T_1 and T_2 through a resistance r_7. Point B is connected to the (a) segments of pick-up ring R_2 and point D is connected to the (b) segments of pick-up ring R_2. Point C is connected to the grid G_1 of tube T_1 and to the (a) segments of pick-up ring R_1. Point E is connected to the grid G_2 of tube T_2 and to the (b) segments of pick-up ring R_1. The plate P_1 of tube T_1 is connected to the solid plate ring R_3 and the plate P_2 of tube T_2 is connected to the solid plate ring R_5. The segments of plate rings R_4 and R_6 are connected through the selecting magnets of the "A" and "B" printers to plus battery B_2 as shown. The negative side of the battery is connected to the point A.

In order that the operation of the circuit may be made perfectly clear, it might be well to assume certain resistance and circuit values in some of the circuits. Assume the resistances r_1, r_2, r_4 and r_5 to be 200 ohms each, r_3 and r_6 to be 2000 ohms each and r_7 equal to 7.5 ohms. Let it further be assume that for a given anode potential the thyratron tubes T_1 and T_2 will not start when the voltage on the grid is minus 4.5 volts or more with respect to the cathode but that they will start when the voltage on the grid is minus 4 volts or less with respect to the cathode. This voltage is very well defined for thyratron tubes with a given anode potential.

Let it also be assumed that the current in the power or output stage of the vacuum tube amplifier VT_1, varies between 25 and 55 milliamperes as shown in Fig. 2. When the polarity of the incoming signal is plus, the current is 25 milliamperes; when the signal is zero, the current is 40 milliamperes; and when the signal is minus the current is 55 milliamperes.

Suppose the polarity of the incoming signal is plus and the current in the plate circuit of the vacuum tube amplifier is 25 milliamperes. This current will divide equally between the two branches of the resistance network, 12.5 milliamperes flowing through the resistances r_4, r_5 and r_6. These currents produce a potential drop of 2.5 volts across each of the resistances r_1 and r_2 and r_4 and r_5. The potential at the point A will be plus 2.5 volts with respect to the potential at the points B and D and plus 5 volts with respect to the potential at the points C and E. Also the potential at the grids of the two tubes T_1 and T_2 is minus 5 volts with respect to the point A and the cathodes since the grids of the two tubes T_1 and T_2 are connected respectively to the points C and E. This voltage is sufficiently high to prevent either of the tubes T_1 and T_2 from starting according to the previous suppositions. The pick-up brushes BR_1 now make contact with the $1a$ segments of rings R_1 and R_2, and the plate brushes BR_2 make contact with the $1a$ segments of rings R_3 and R_4. Plus battery is placed on the plate P_1 of tube T_1 through ring R_3, brushes BR_2, segment $1a$ of ring R_4, and No. 1 selecting magnet of the "A" printer. The brushes BR_1 momentarily short-circuit the resistance r_2 thus causing the potential at the grid G_1 of tube T_1 to be reduced from 5 to 3.5 volts and tube T_1 starts. Now 200 milliamperes of current flows from plus battery through No. 1 selecting magnet of the "A" printer, through segment $1a$ of ring R_4, brushes BR_2, ring R_3, through plate P_1 to cathode of tube T_1, through resistance R_7 to minus battery. No. 1 selecting magnet of the "A" printer is operated, and the 200 milliamperes flowing in this circuit produces a voltage drop of 1.5 volts across the resistance r_7. This voltage drop is in the same direction as the voltage drop across the resistance r_1 and raises the voltage at the point B to minus 4 volts with respect to the cathode.

The pick-up brushes BR_1 now pass onto the 1_b segments of rings R_1 and R_2, and the brushes BR_3 pass onto the 1_b segments of ring R_6. The brushes BR_1 short-circuit the resistance r_5 causing the voltage at the grid G_2 of tube T_2 to fall from 6.5 volts to -4 volts and tube T_2 starts. Current will now flow from plus battery through No. 1 selecting magnet of the "B" printer, through segment 1_b of ring R_6, brushes BR_3, ring R_5, through the plate P_1 to cathode of tube T_2, through resistance r_7 to minus battery. No. 1 selecting magnet of the "B" printer will be operated, and 400 milliamperes will flow through the resistance r_7, producing a voltage drop of 3 volts, which adds to the voltage drop across resistance r_4 and raises the voltage at the point D to minus 5.5 volts. But, as tube T_2 has already been started, it cannot be again influenced by the grid until the arc has been stopped by removing the anode potential. Tube T_2 then continues to pass current.

The plate brushes BR_2 now pass off the segment $1a$ of ring R_4, removing the anode potential from the plate P_1 of tube T_1, thus causing the arc to stop and tube T_1 ceases to function. This reduces the current through resistance r_7 to 200 milliamperes and reduces the voltage drop across this resistance r_7 to 1.5 volts. As the brushes BR_1 now pass onto the $2a$ segments of rings R_1 and R_2, and the brushes BR_2 pass onto the $2a$ segments of rings R_3 and R_4, the resistance r_2 is again short-circuited and the voltage at the grid G_1 of tube T_1 is reduced from -6.5 volts to -4 volts and tube T_1 again starts.

This cycle of events will continue so long as the incoming signal is plus and the plate current of the vacuum tube VT_1 is 25 milliamperes, i. e. each tube T_1 and T_2 will start when the pick-up brushes BR_1 come in contact with the corresponding pick-up segments.

Suppose that the voltage of the incoming signal falls to zero as illustrated in Fig. 2 and that the current in the plate circuit of the vacuum tube VT_1 rises to 40 milliamperes. Also suppose that the tube T_2 is operating and the brush BR_3 is still making contact with the plate segment 5_b.

When the pick-up brushes BR_1 move onto the $1a$ segments of rings R_1 and R_2, the resistance r_2 is again short-circuited but the voltage applied to the grid G_1 of tube T_1 is now minus 5.5 volts with respect to the cathode and tube T_1 does not start. When the current in the plate circuit of the tube VT_1 increased to 40 milliamperes, the drop across the resistance r_1 increased from 2.5 to 4 volts and since tube T_2 is still operating, the voltage drop of 1.5 volts across the resistance r_7 is aiding the voltage drop across the resistance r_1 making the voltage on the grid G_1 of tube T_1 minus 5.5 volts with respect to the cathode. The brushes BR_3 now pass off the segment 5_b of ring R_6 removing the anode potential from the plate P_2 of tube T_2, thus causing the arc to stop and tube T_2 ceases to function. The voltage drop across the resistance r_7 now falls to zero. The pick-up brushes BR_1 now move onto the 1_b segments of rings R_1 and R_2 and the plate brushes BR_3 move onto the 1_b segment of ring R_6. The resistance r_5 is short-circuited by the brushes BR_1 thus causing the voltage at the grid G_2 of tube T_2 to fall from minus 8 to minus 4 volts, and tube T_2 again starts.

This cycle of events will continue so long as the potential of the incoming signal remains zero and the plate current of the vacuum tube VT_1 is 40 milliamperes. That is, the relay tube which was last operated by a plus signal will alone continue to operate after the signal voltage has fallen to zero. The other tube will never operate so long as this condition continues.

Now suppose the incoming signal becomes minus and the current in the plate circuit of the vacuum tube VT_1 rises to 55 milliamperes. This increase in current will produce an increased voltage drop across the resistances r_1, r_2, r_4 and r_5. The voltage drop across each of these resistances will be 5.5 volts. Also suppose that the tube T_2 is operating and the brush BR_3 is still making contact with the plate segment 5_b.

When the pick-up brushes BR_1 move onto the $1a$ segments of rings R_1 and R_2, the resistance r_2 is again short-circuited, and the voltage applied to the grid G_1 of tube T_1 becomes minus 7 volts with respect to the cathode, and tube T_1 cannot start. When the current in the plate circuit of the tube VT_1 increases to 55 milliamperes, the voltage drop across resistance r_1 increased from 4 volts to 5.5 volts, and since the tube T_2 is still operating, the voltage drop of 1.5 volts across the resistance r_7 is aiding the voltage drop across the resistance r_1, making the voltage on the grid G_1 of tube T_1 minus 7 volts with respect to the cathode. The brushes BR_3 now pass off the segment 5_b removing the anode potential from the plate P_2 of tube T_2 thus causing the arc to stop, and tube T_2 ceases to function. The voltage drop across the resistance r_7 now falls to zero. The pick-up brushes BR_1 now move onto the 1_b segments of rings R_1 and R_2 and the plate brushes move onto the 1_b segment of ring R_6. The resistance r_5 is short-circuited by the brushes BR_1, this causing the voltage at the grid G_2 of T_2 to fall from minus 11 voltage to minus 5.5 volts. This voltage is above that necessary to permit the tube to start and tube T_2, therefore, does not start.

This cycle of events will continue so long as the incoming signal is minus in polarity and the plate current of the tube VT_1 is 55 milliamperes.

That is, neither relay tube is operated when the incoming signal is minus.

From the foregoing it is seen that when the incoming signal is plus, each tube will start when the pick-up brushes BR_1 pass onto their associated pick-up segments, and when the incoming signal is minus, neither tube will start. Also, when the incoming signal falls to zero, one tube will start every time the pick-up segments associated with it are short-circuited by the pick-up brushes BR_1. Which tube will start depends upon the position of the brushes and whether the incoming signal falls from plus to zero or rises from minus to zero.

From the foregoing description of the operation of the circuit, it will be seen that the grids of the two relay tubes never go plus, and that starting of the tubes is accomplished by reducing the negative bias to such a negative value as will permit starting. This makes the relay tubes more stable for the reason that if the grid goes positive, it draws current and in doing so builds up a charge which changes the grid potential needed to make the tube start.

It will also be noticed that all biasing or stabilizing batteries have been eliminated and that the grids of the relay tubes are kept at their proper potentials by the voltage drops in the signaling circuit itself. Furthermore, the grids of the two relay tubes are never disconnected from the signaling circuit and are never left free to be affected by extraneous pick-up or disturbances.

I claim:

1. In a signaling system, a signaling circuit, a grid-controlled, gas-filled tube having its input circuit connected to said signaling circuit, means for normally maintaining the grid of said tube negative with respect to its cathode, and additional means responsive to positive signal impulses to reduce said negative biasing potential while maintaining its polarity the same.

2. In a signaling system, a signaling circuit, a grid-controlled, gas-filled tube having its input circuit connected to said signaling circuit, means for normally maintaining the grid of said tube negative with respect to its cathode, and additional means responsive to negative signal impulses to increase said negative potential.

3. In a signaling system, a signaling circuit, a grid-controlled, gas-filled tube having its input circuit connected to said signaling circuit, means for normally maintaining the grid of said tube negative with respect to its cathode, and means operable in synchronism with incoming signals for reducing said negative biasing potential during a positive signal period and during no-signal period while maintaining the biasing potential negative.

4. In a signaling system, a signaling circuit, a grid-controlled, gas-filled tube having its input circuit connected to said signaling circuit, means for normally maintaining the grid of said tube negative wth respect to its cathode, and means responsive to signal impulses to decrease said negative biasing potential for positive signals and increase said potential for negative signals while maintaining the polarity unchanged, and means operable in synchronism with said impulses for further reducing said negative biasing potential during positive and no signal periods.

5. In a signaling system, a signaling circuit including a resistance, a grid-controlled, gas-filled tube having its input circuit connected across said resistance, means for establishing a direct current through said resistance to normally maintain the grid of said tube negative with respect to its cathode, and additional means for decreasing said biasing current upon the receipt of positive signals and increasing said biasing current upon receipt of negative signals.

6. In a signaling system, a signaling circuit including a resistance, a grid-controlled, gas-filled tube having its input circuit connected across said resistance, means for establishing a direct current through said resistance to normally maintain the grid of said tube negative with respect to its cathode, means for decreasing said biasing current upon the receipt of positive signals and increasing said biasing current upon receipt of negative signals, and means operable in synchronism with said signals for periodically reducing said negative biasing potential.

7. In a signaling system, a signaling circuit terminated with a vacuum tube amplifier, a source of current and a resistance in the output stage of said amplifier, a grid-controlled, gas-filled tube having its input circuit connected across at least a portion of said resistance whereby the plate current of said amplifier normally maintains the grid of said gas-filled tube negative with respect to its cathode, said vacuum tube amplifier being so connected to said signaling circuit that positive signals produce a decrease in the current through said resistance, and negative signals produce an increase in said current.

8. In a signaling system, a signaling circuit terminated with a vacuum tube amplifier, a source of current and a resistance in the output stage of said amplifier, a grid-controlled, gas-filled tube having its input circuit connected across at least a portion of said resistance whereby the plate current of said amplifier normally maintains the grid of said gas-filled tube negative with respect to its cathode, said vacuum tube amplifier being so connected to said signaling circuit that positive signals produce a decrease in the current through said resistance, and negative signals produce an increase in said current, and means operable in synchronism with incoming signals for periodically short-circuiting a portion of the resistance included in the input circuit of said gas-filled tube.

9. In a signaling system, a signaling circuit terminated with a vacuum tube amplifier having a divided output circuit, a resistance in each branch of said output circuit through which a portion of the plate current flows, a grid-controlled, gas-filled tube associated with each branch of said output circuit and having its input circuit connected across at least a portion of said resistance, whereby the plate current of said amplifier normally maintains the grid of said gas-filled tube negative with respect to its cathode, a pair of telegraph printers, one associated with each gas-filled tube, the plate circuit of each tube being completed through the selecting magnets of its corresponding printer through a pair of plate rings provided with a rotating brush, a pair of pick-up rings having a rotating brush operating in synchronism with the brushes of said plate rings, and circuit connections between the resistance elements in said output circuit and said pick-up rings for alternately short-circuiting a portion of the resistance elements included in the input circuit of said gas-filled tubes in synchronism with incoming signals.

10. In a signaling system, a signaling circuit, a gaseous conduction tube, means for converting signals of different polarities, received over said circuit, into signals of varying magnitude of cur-

rent, means for producing discharges through said tube, selectively in accordance with the magnitude of said current, and current responsive means in the output circuit of said tube.

11. In a signaling system, a source of telegraph signals of varying magnitude of current, a gaseous conduction tube, means for producing discharges through said tube selectively, in accordance with the magnitude of said current and current responsive means in the output circuit of said tube.

12. In a telegraph system, a source of telegraph signals comprising positive, negative and zero selecting conditions, a gaseous conduction tube and means responsive to said selecting conditions for controlling the operation of said tube, whereby discharges will be produced therein in accordance with said signal conditions.

13. In a telegraph system, a source of telegraph signals comprising positive, negative and zero selecting conditions, a gaseous conduction tube and means responsive to said selecting conditions for producing a discharge in said tube when signals of one polarity are received, for preventing a discharge from occurring therein when signals of the other polarity are received, and for starting or preventing the occurrence of a discharge therein when signals of zero polarity are received, depending upon the preceding signal conditions.

14. In a telegraph system, a source of telegraph signals, a gaseous conduction tube having a control electrode, means for applying a potential to said control electrode in accordance with said telegraph signals and means for varying said applied potential during a predetermined portion of each signal impulse, whereby to control the starting of a discharge through said tube, and current control means in the output circuit of said tube.

15. In a telegraph system, a source of telegraph signals, a gaseous conduction tube having a control electrode, means for applying a potential to said control electrode in accordance with said telegraph signals and a distributor operating in synchronism with said signals for varying said applied potential during a predetermined portion of each signal impulse, whereby to control the starting of a discharge through said tube, and current control means in the output circuit of said tube.

16. In a telegraph system, a source of signal impulses, a pair of gaseous conduction tubes having starting electrodes, means for applying predetermined potentials to the starting electrodes of both of said tubes in accordance with every signal impulse received and local means for selectively varying the potential applied to one of said tubes, whereby said selective tube only responds to said signal impulse.

17. In a telegraph system, a source of signal impulses, a pair of gaseous conduction tubes having starting electrodes, means for applying predetermined potentials to the starting electrodes of both of said tubes in accordance with every signal impulse received and local means operating in synchronism with said impulses for varying the potential applied to said tubes alternately, whereby said tubes respond alternately to said signal impulses.

18. In a telegraph system, a source of signal impulses, a pair of gaseous conduction tubes having starting electrodes, means for applying predetermined potentials to the starting electrodes of both of said tubes in accordance with every signal impulse received, local means operating in synchronism with said impulses for varying the potential applied to said tubes alternately, whereby said tubes respond alternately to said signal impulses, and a separate recorder in the output circuit of each of said tubes.

19. In a telegraph system, a source of signals of varying magnitudes, a resistance in circuit with said source of signals, a gaseous conduction tube having a cathode and a control electrode connected across said resistance, whereby the drop in potential thereacross due to said signals, applies a predetermined bias to said control electrode and means for periodically shunting at least a portion of said resistance to alter said bias, whereby to control the starting of said tube.

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