

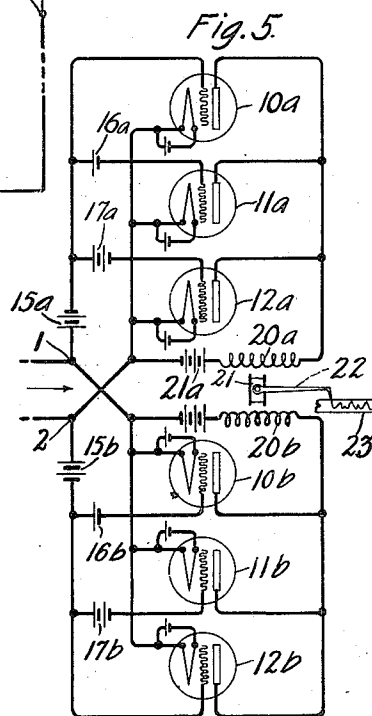
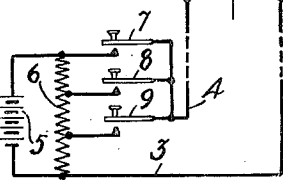
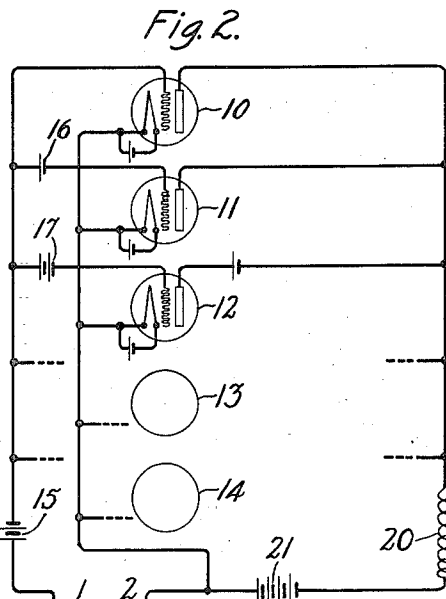
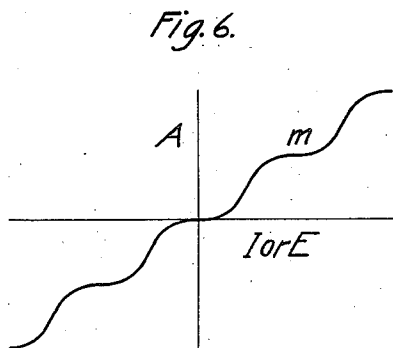
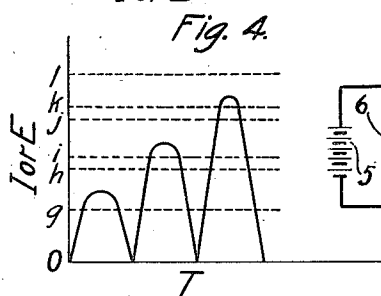
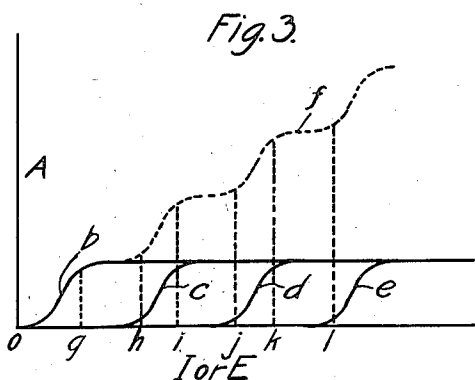
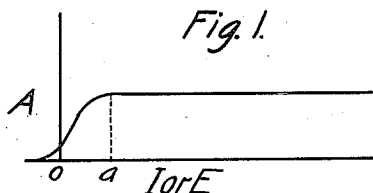
Nov. 11, 1924.

1,514,753

P. I. WOLD

SIGNAL RECEIVING SYSTEM

Filed Nov. 19, 1920



Inventor:
Peter I. Wold.
by Joel C. Palmer Att'y.

UNITED STATES PATENT OFFICE.

PETER I. WOLD, OF SCHENECTADY, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SIGNAL-RECEIVING SYSTEM.

Application filed November 19, 1920. Serial No. 425,094.

To all whom it may concern:

Be it known that I, PETER IRVING WOLD, a citizen of the United States of America, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Signal-Receiving Systems, of which the following is a full, clear, concise, and exact description.

The invention relates to a signal receiving system and more particularly to a system for receiving and for definitely and sharply discriminating between signals in the form of current impulses or waves varying in amplitude.

In numerous telegraph signaling systems, intelligence is conveyed by code impulses differing from each other and arranged in various combinations to represent letters of the alphabet. The impulses necessary to make up any given code may be distinguished from each other electrically in a number of ways and one common way is to employ in the code combination impulses differing in potential. If the line impedance is substantially constant, these impulses also differ to the same degree in current strength. At the receiving station, in order that the impulses may be translated into observable form, or recorded, it is necessary to provide apparatus which will discriminate between impulses varying in current strength. Due to slight variations in the line impedance and in the electrical characteristics of the line, impulses differing in current strength when impressed upon the line at the transmitting end, reach the receiving apparatus somewhat distorted and the actual difference in current strength between succeeding impulses may be insufficient to enable the ordinary receiving apparatus to translate or record them in intelligible signals. In a familiar case where current of one strength represents a dot in the Morse code, of another strength a dash and of still another strength a space, succeeding dash and dot impulses may be received, due to line conditions, as impulses of nearly the same current strength; also succeeding impulses which are sent out of the same current strength from the transmitting station may differ, when received, to a sufficient extent to render them likely to be confused as impulses of different strength at the receiving station.

This is particularly true where the receiving apparatus, as is usual in systems of this character, is arranged to have a response directly proportional to the current strength.

In accordance with a feature of the invention this difficulty is eliminated and discrimination between signaling impulses is made certain by interposing between the usual recording and translating devices at the receiving station an electrical network in the nature of a marginal relay which responds, not in direct proportion to the strength of the received current, but discriminates between small variations in current strength and substantial differences in current strength. The distinction between a device of this sort and the ordinary receiving apparatus may best be illustrated from the characteristic curve of the device plotted between the amplitude of response and the amplitude of the received voltage or current. In the ordinary recording apparatus such as an undulator, this characteristic is substantially a straight line. In the network of the invention, however, the characteristic, as will more clearly appear from the detailed description, is in the form of a stepped curve so that variations in amplitude of current between certain well defined limits is without effect on the amplitude which is recorded or translated.

Therefore, in accordance with a further feature of the invention, a network having a stepped characteristic is provided by utilizing a number of vacuum tubes connected in parallel, each of which is arranged to pass currents between certain definite limits of current strength.

In the drawings, Fig. 1 is the characteristic curve of a vacuum tube of the three electrode type such as is used in the receiving arrangement of the invention. Fig. 2 is a diagrammatic showing of the circuit arrangement involving a number of tubes combined in accordance with the invention with a recording device. Fig. 3 is the characteristic curve of the arrangement shown in Fig. 2. Fig. 4 is a curve showing the character of signal impulses used in the system. Fig. 5 is a modification of the arrangement shown in Fig. 2 and Fig. 6 is the characteristic curve of the arrangement shown in Fig. 5.

If the input circuit of the ordinary three-electrode vacuum tube is connected to a

transmission line and the current is varied in such line and the output circuit is connected to a recording device, the response of the recording device will be substantially
 5 proportional to the variations of line current over a certain definite range which is determined by the relative potentials of the grid and filament of the tube. A typical
 10 curve plotted between the line current or potential and the amplitude of the response of the recorder in an arrangement of this sort is shown in Fig. 1, from which it is apparent that, after the current or potential has reached a value represented by the
 15 abscissa $o-a$, further increase in the current or potential is without effect on the amplitude of the response of the recording device.

Because of this characteristic of the
 20 vacuum tube it functions as a valve or current limiting device and tubes of this sort are commonly referred to as valves. It is well known that by connecting in series with the grid or control electrode of the tube a
 25 source of potential the cut-off point, or the abscissa such as $o-a$ may be adjusted within wide limits of any desired value. In the arrangement shown in Fig. 2, the line terminals are represented at 1 and 2. These may
 30 be connected to a line such as 3-4 leading to the transmitting station at which there is located a source of potential 5 feeding into a resistance 6. Keys 7, 8 and 9 are provided to connect the line conductors 3 and 4 to different
 35 points on the resistance 6 and to impress upon the line currents differing in potential and strength, assuming that the transmission line is of substantially constant impedance.

40 At the receiving station, associated with the line terminals 1 and 2, are a plurality of vacuum tubes 10, 11, 12, 13 and 14. The grids of all of these vacuum tubes are connected to one side of the line, say the terminal 1, in parallel through a source of potential
 45 15 opposing the line potential and the grids of the tubes 11, 12, 13 and 14 individually through additional sources of potential 16, 17, etc., which are increasingly negative for succeeding tubes. The output circuit of the
 50 tubes including the filaments and plates are connected in parallel through the actuating coil 20 of a recording device such as an undulator and the source of potential 21.

55 In the curve of Fig. 3 the abscissa represents line current or potential and the ordinate represents amplitude of response of the recorder, or the current flowing through the coil 20.

60 The source of potential 15 which is the only one which affects the potential of the grid of tube 10 is so chosen with respect to the line potentials that the characteristic of the tube 10 is represented by the full line
 65 curve b . Similarly the source of potential

15 plus the source of potential 16 which is connected in series with the grid of the tube 11 results in a characteristic for the tube 11 such as is shown in the full line
 70 c . Similarly the characteristic of the tube 12 is represented by the full line d and of 13 by the full line e . There will be, of course, as many tubes combined in this manner as are required to discriminate between the
 75 greatest number of different signal impulses imposed by the particular code used. In case the Morse code is used only 3 tubes will be necessary. As the tubes 10, 11, 12, etc., are connected in parallel the combined characteristics of these tubes will be represented
 80 by the dotted line f since the current in the output circuits of each tube will be combined in the coil 20. It is therefore apparent from the curve that variations in the line
 85 current or potential between, say, the points g and h , i and j , k and l , on the curve f will be without any substantial effect on the recorder 20. Therefore, if, as shown in Fig. 4, in which the characteristic signal impulses
 90 for a dot, dash and a space are plotted between current strength or potential and time, the current strength of these impulses are chosen to fall within the points g and h ,
 95 i and j , k and l , which are the same as current strengths represented by similar characters in Fig. 3, it follows that variations in these impulses between the limits, say, g and
 100 h , i and j , and k and l will be without effect and the entire arrangement will sharply discriminate between the signal impulses.

If signaling impulses are employed which vary in polarity as well as in current strength, the arrangement such as shown in Fig. 5 may be used. In this arrangement
 105 there is oppositely connected to the line terminals 1 and 2 an arrangement which amounts to two arrangements which are in all respects equivalent to that shown in Fig. 2. Tubes 10^a , 11^a and 12^a , 10^b , 11^b and 12^b are in
 110 all respects similar to the tubes 10, 11 and 12 of Fig. 2. Similarly the other parts of the circuit in the arrangement of Fig. 5 each correspond to those of Fig. 2 and are designated by the same reference characters with
 115 the subscripts a or b . It is thought that it will be understood without further explanation from a consideration of the explanation given in connection with the arrangement of Fig. 2 that the characteristic of the
 120 arrangement of Fig. 5 is represented by the curve m of Fig. 6.

It is therefore only necessary to point out that in Fig. 5 the recorder represented by the coils 20^a and 20^b and the movable coil and arm 22 will only be affected by variations in the signaling current between the
 125 definite limits as pointed out in connection with Fig. 2, which will result in a tracing on the record tape 23 which is a faithful reproduction of the signaling currents impressed
 130

on the line at the transmitting station, regardless of slight variations in the line impedance.

I claim:—

1. A network for transmitting electric impulses including a series of valves having a common input circuit and a common output circuit, said valves having current admission points occurring at a greater input voltage for each succeeding valve of the series, and having means causing each valve to have a current limiting point occurring at a substantially lower input voltage than that at which the admission point of the next succeeding valve in the series occurs.
2. An electrical network for discriminating against the transmission of voltage impulses of certain amplitudes in favor of the transmission of voltage impulses of higher and lower amplitudes, said network consisting of a plurality of electron valves in parallel and a source of potential in the input circuit of each valve to limit the voltage variations freely transmitted by that valve to those falling within a band of voltage values lying outside of and substantially spaced from the voltage bands within which variations freely transmitted by the others of said valves lie.
3. In combination, a line circuit, a device responsive to electric impulses, a network for discriminating against the transmission of voltage impulses of certain amplitudes in favor of the transmission of voltage impulses of higher and lower amplitudes, said network consisting of a plurality of branch circuits interposed between said line circuit and said responsive device, and means included in each branch to freely transmit only voltage variations falling within a band of voltage values lying outside of and substantially spaced from the voltage bands within which variations freely transmitted by the others of said branch circuits lie.
4. In combination, a line circuit, a device responsive to electric impulses, a network consisting of a plurality of branch circuits interposed between said line circuit and said responsive device, and valves included in each of said branch circuits and adjusted to limit the transmission of impulses through said circuits successively as the line potential increases, the transmission through each circuit being limited when the line potential reaches a value substantially below that at which the circuit through which the transmission is next to be limited is rendered conducting.
5. In a signal receiving system, a signal current path, a current responsive signal

indicating device, and purely electrical means for discriminating against the transmission to said responsive device of currents of certain amplitudes in favor of the transmission to said responsive device of currents of higher and lower amplitudes, said means comprising parallel circuits connected between said current path and said responsive device.

6. A multiple marginal electron relay circuit for discriminating against the transmission of electrical impulses of one magnitude with respect to the transmission of impulses of higher and lower magnitude by purely electrical means involving no mechanically moving parts, said relay circuit comprising a plurality of three electrode electron tubes connected in parallel and having the positions of their grid potential-plate current characteristics so adjusted with respect to each other that the characteristic of the tube combination has a stepped form with inclined portions separated by a substantially horizontal portion indicating equality of response to impulses of substantially different amplitudes.

7. A control system comprising a plurality of stations, a vacuum tube comprising a cathode, an anode and a control electrode at one of said stations, a source of current connected to said anode, a source of potential at said first station, a variable impedance at another of said stations, and a conductive line circuit comprising said variable impedance, said source of potential and said control electrode.

8. A control system comprising a plurality of stations, a vacuum tube comprising a cathode, an anode and a control electrode at one of said stations, a source of current connected to said anode, a source of potential, a variable impedance at another of said stations and a conductive line network comprising said variable impedance, said source of potential and said control electrode.

9. A control system comprising a plurality of stations, a vacuum tube comprising a cathode, an anode and a control electrode at one of said stations, a source of current connected to said anode, a source of potential, a variable impedance at another of said stations and a conductive line network comprising said variable impedance, said source of potential and said control electrode, and means for normally preventing current from flowing over said line.

In witness whereof, I hereunto subscribe my name this 5th day of November A. D., 1920.

PETER I. WOLD.