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R. M. M. OBERMAN ET AL
ARRANGEMENT FOR THE IDENTIFICATION
OF POTENTIAL DIFFERENCES

2,577,147

Filed Aug. 20, 1949

2 SHEETS—SHEET 1

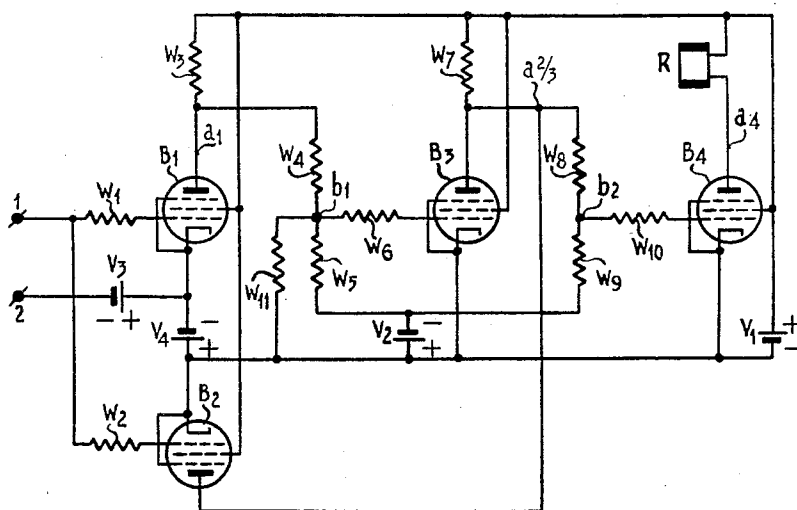
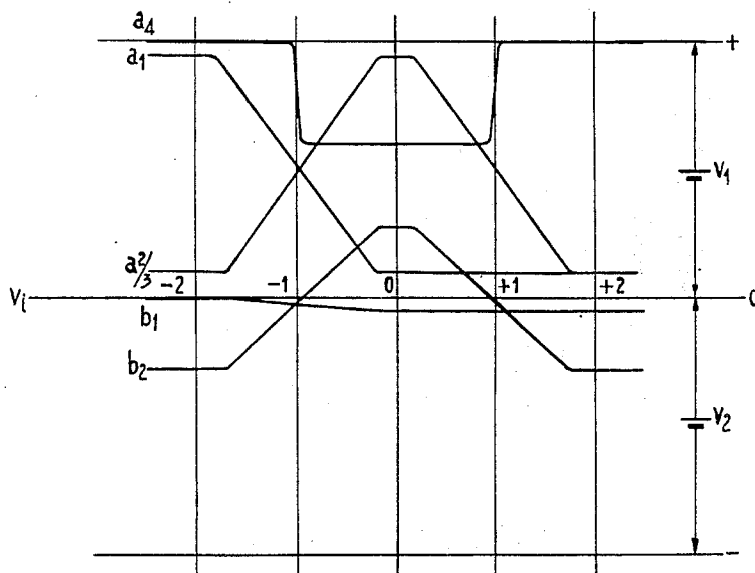


FIG. 1



POTENTIAL DIAGRAM

FIG. 3

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2 SHEETS—SHEET 2

ANODE CURRENT GRAPH

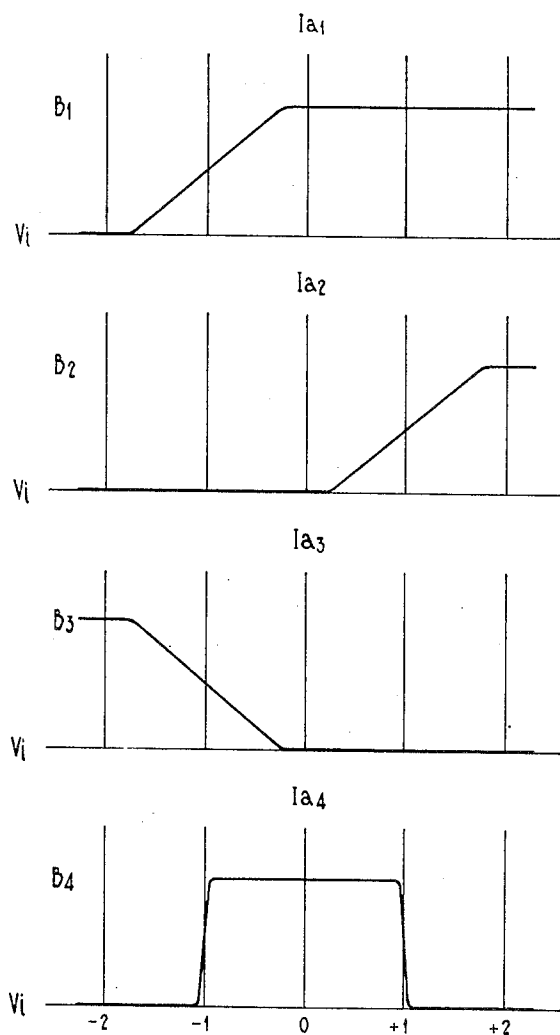


FIG. 2

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UNITED STATES PATENT OFFICE

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ARRANGEMENT FOR THE IDENTIFICATION
OF POTENTIAL DIFFERENCESRoelof M. M. Oberman and Antonie Snijders,
The Hague, NetherlandsApplication August 20, 1949, Serial No. 111,394
In the Netherlands March 23, 1946

10 Claims. (Cl. 250-27)

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The present invention relates to an arrangement for the identification of potential differences by means of two electron tubes, the potential difference to be identified being applied between the control grid and the cathode of each tube.

An arrangement of this kind for A. C. voltages is described in the U. S. Patent No. 1,574,808, where for the identification of the amplitude of an A. C. voltage two electron tubes are used which are connected to the relevant input terminals by the application of various preceding voltages.

It is an object of the present invention to provide an arrangement of this type which is suitable to be operated with direct current.

It is another object of the present invention to provide an arrangement for the identification of potential differences which is reliable in operation and can be easily adjusted to different ranges of operation.

The arrangement according to the present invention comprises in combination a first electron tube having a cathode, a grid and an anode, means for applying the potential difference to be identified between the cathode and the grid of the first electron tube, a second electron tube having a cathode, a grid and an anode, means for applying the potential difference to be identified between the cathode and the grid of the second electron tube, means for shifting the control voltage anode current characteristic of the second tube with respect to that of the first tube, a potentiometer having one of its ends connected to the anode of the first tube, a phase reversing tube including a cathode, a grid and an anode, a tap in the potentiometer connected to the grid of the phase reversing tube, the anode of the phase reversing tube being interconnected to the anode of the second tube, and a device connected to the anode of the phase reversing tube for passing a current when the voltage of the interconnection of the anodes of the phase reversing tube and the second tube is between two predetermined values.

In a preferred embodiment of the invention, an end tube is provided having a cathode, a grid and an anode, a second potentiometer having one of its ends connected to the anode of the phase reversing tube, and a tap in the second potentiometer connected to the grid of the end tube.

The operational range of the arrangement can be adjusted, if desired, by a suitable choice of D. C. voltage sources inserted in the lead from one of the input terminals.

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The novel features which we consider as characteristic for our invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a circuit diagram of an arrangement according to the invention;

Fig. 2 shows the anode current characteristics of the four tubes shown in Fig. 1 as function of the input voltage of the arrangement; and

Fig. 3 shows the voltages of some characteristic points of the arrangement shown in Fig. 1, also as functions of the input voltage of the arrangement.

Referring now to Figure 1, the input terminals 1 and 2 are shown to which the potential differences to be identified are applied which are, for instance, derived from the same direct voltage source. These voltages are chosen, for instance, as multiples of 2 volts. A certain potential can be applied to the terminal 2, while the other terminal 1 is connected to the test wiper of a switch, for instance, in telephone systems, which is moved on over a row of contacts until the identification device according to Figure 1 determines that a contact has been reached with a potential which is almost equal to the one which is applied to terminal 2. The identification device comprises four high vacuum tubes B1 to B4, which are coupled by means of resistances. The resistances W1, W2, W6, and W10 are protecting resistances for the tubes against positive input voltages. The anode of the tube B1 is connected over the resistance W3 to the anode voltage source V1 and over a potentiometer consisting of the resistances W4 and W5 to the negative pole of an auxiliary voltage source V2, which has approximately the same voltage as the anode voltage source V1. The tap point b1 is connected over a resistance W11 to the cathode circuit.

The anode current of the tube B1 as a function of the input voltages is shown in Figure 2. The tube has a grid voltage space of about 2 volts. The anode voltage of this tube is shown in Figure 3 as function of the input voltage (curve a1). The voltage of the point b1 can be adjusted by a suitable choice of the resistances W4, W5, and W11, so that the tube B3 acts only as phase reversing tube without amplification. The point b1 is connected over the protecting resistance W6 to the control grid of the tube B3.

As it appears from the anode current charac-

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teristic of the tube B3 shown in Figure 2, the tube is in conductive position for high negative input voltages, while it becomes non-conductive between -2 volts and 0 volt input voltage in contradistinction to tube B1.

The anode voltage characteristic of the tube B3 is shown in Figure 3 by the curve $a\frac{2}{3}$.

The tube B2 is arranged in a manner analogous to that of the tube B1. The anode current characteristic of this tube is shifted by means of the voltage source V4 so that in the diagram it is 2 volts to the right with respect to that of the tube B1. Therefore, the tube B2 becomes conductive at input voltages between 0 and +2 volts. The downward sloping part of the anode voltage characteristic of the tube B2 in Figure 3 (curve $a\frac{2}{3}$) is also 2 volts to the right of that of the tube B1 (curve $a1$).

The anodes of the tubes B2 and B3 are interconnected so that the collective anode voltage characteristic of these tubes, represented by the curve $a\frac{2}{3}$ in Figure 3, represents the voltage at the point $a\frac{2}{3}$.

From the potentiometer comprising the resistances W8 and W9, which is arranged between the point $a\frac{2}{3}$ and the negative pole of the auxiliary voltage source V2, the control voltage at the grid of the end tube B4 is derived, which is represented in Figure 3 by the curve $b2$.

The anode current characteristic of the end tube B4 is shown in Figure 2. The end tube is non-conductive from a high negative input voltage to -1 volt, then becomes rapidly conductive and remains so almost constantly unto an input voltage of +1 volt, where the tube rapidly returns to the non-conductive condition to remain non-conductive up to the highest admissible positive input voltage.

A relay R, inserted in the anode circuit of the end tube B4, attracts its armature when a potential difference between -1 volt and +1 volt is applied to the input terminals. A contact of the relay R can interrupt the movement of the above mentioned switch.

The operational range of the arrangement can be adjusted by D. C. voltage sources V3 and V4 inserted in the lead from the terminal 2 and the lead connecting the same to the cathode of tube B2. If desired, the voltage sources V3 and V4 can also be derived automatically from the arrangement by means of resistances.

The phase reversing tube can also operate as an amplifying tube when the resistance W11 is omitted and the resistances W4 and W5 are differently dimensioned. In consequence of this, the end tube B4 becomes conductive under the control of the tube B1 almost in jumps or jerks, which may be necessary or desirable for certain applications of the arrangement.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of arrangements for the identification of potential differences, differing from the types described above.

While we have illustrated and described the invention as embodied in arrangements for the identification of potential differences, we do not intend to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of our invention.

Without further analysis, the foregoing will so fully reveal the gist of our invention that others can by applying current knowledge readily adapt it for various applications without omitting fea-

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tures that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention, and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What we claim as new and desire to secure by Letters Patent is:

1. An arrangement for the identification of potential differences comprising in combination a first electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said first electron tube; a second electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said second electron tube; means for shifting the control voltage anode current characteristic of said second tube with respect to that of said first tube; a first potentiometer having one of its ends connected to said anode of said first tube; a phase reversing tube including a cathode, a grid and an anode; a tap in said first potentiometer connected to said grid of said phase reversing tube; said anode of said phase reversing tube being interconnected to said anode of said second tube; an end tube having a cathode, a grid and an anode; a second potentiometer having one of its ends connected to said anode of said phase reversing tube; and a tap in said second potentiometer connected to said grid of said end tube.

2. An arrangement for the identification of potential differences comprising in combination a first electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said first electron tube; a second electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said second electron tube; a direct voltage source for shifting the control voltage anode current characteristic of said second tube with respect to that of said first tube; a first potentiometer having one of its ends connected to said anode of said first tube; a phase reversing tube including a cathode, a grid and an anode; a tap in said first potentiometer connected to said grid of said phase reversing tube; said anode of said phase reversing tube being interconnected to said anode of said second tube; an end tube having a cathode, a grid and an anode; a second potentiometer having one of its ends connected to said anode of said phase reversing tube; and a tap in said second potentiometer connected to said grid of said end tube.

3. An arrangement for the identification of potential differences comprising in combination a first electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said first electron tube; a second electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said second electron tube; means for shifting the control voltage anode current characteristic of said second tube with respect to that of said first tube; a first potentiometer having one of its ends connected to said anode of said first tube; an auxiliary direct voltage source having a terminal connected to the other end of said first potentiometer; a phase reversing tube including a cathode, a grid and an anode; a

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8. An arrangement for the identification of
55 potential differences comprising in combination
a first electron tube having a cathode, a grid and
an anode; means for applying the potential dif-
ference to be identified between said cathode and
said grid of said first electron tube; a second
60 electron tube having a cathode, a grid and an
anode; means for applying the potential dif-
ference to be identified between said cathode and
said grid of said second electron tube; a direct
voltage source for shifting the control voltage
65 anode current characteristic of said second tube
with respect to that of said first tube; a first
potentiometer having one of its ends connected
to said anode of said first tube; an auxiliary di-
rect voltage source having a negative terminal
70 connected to the other end of said first potenti-
ometer; an anode voltage source having a neg-
ative terminal connected to the positive terminal
of said auxiliary direct voltage source; a phase
reversing tube including a cathode, a grid and
75 an anode; a tap in said first potentiometer con-

connected to said grid of said phase reversing tube; said anode of said phase reversing tube being interconnected to said anode of said second tube; an end tube having a cathode, a grid and an anode; a second potentiometer having one of its ends connected to said anode of said phase reversing tube, the other end of said second potentiometer being connected to the negative terminal of said auxiliary direct voltage source; and a tap in said second potentiometer connected to said grid of said end tube.

9. An arrangement for the identification of potential differences comprising in combination a first electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said first electron tube; said means including a direct voltage source connected in series to said cathode of said first electron tube; a second electron tube having a cathode, a grid and an anode; means including a direct voltage source connected in series to said cathode of said second electron tube for applying the potential difference to be identified between said cathode and said grid of said second electron tube; means for shifting the control voltage anode current characteristic of said second tube with respect to that of said first tube; a first potentiometer having one of its ends connected to said anode of said first tube; an auxiliary direct voltage source having a negative terminal connected to the other end of said first potentiometer; an anode voltage source having a negative terminal connected to the positive terminal of said auxiliary direct voltage source; a phase reversing tube including a cathode, a grid and an anode; a tap in said first potentiometer connected to said grid of said phase reversing tube; said anode of said phase reversing tube being interconnected to said anode of said second tube; an end tube having a cathode, a grid and an anode; a second potentiometer having one of its ends connected to said anode of said phase reversing tube; and a tap in said second potentiometer connected to said grid of said end tube.

10. An arrangement for the identification of potential differences comprising in combination

a first electron tube having a cathode, a grid and an anode; means for applying the potential difference to be identified between said cathode and said grid of said first electron tube, said means including a direct voltage source connected in series to said cathode of said first electron tube; a second electron tube having a cathode, a grid and an anode; means including a direct voltage source connected in series to said cathode of said second electron tube for applying the potential difference to be identified between said cathode and said grid of said second electron tube; a direct voltage source for shifting the control voltage anode current characteristic of said second tube with respect to that of said first tube; a first potentiometer having one of its ends connected to said anode of said first tube; an auxiliary direct voltage source having a negative terminal connected to the other end of said first potentiometer; an anode voltage source having a negative terminal connected to the positive terminal of said auxiliary direct voltage source; a phase reversing tube including a cathode, a grid and an anode; a tap in said first potentiometer connected to said grid of said phase reversing tube; said anode of said phase reversing tube being interconnected to said anode of said second tube; an end tube having a cathode, a grid and an anode; a second potentiometer having one of its ends connected to said anode of said phase reversing tube, the other end of said second potentiometer being connected to the negative terminal of said auxiliary direct voltage source; and a tap in said second potentiometer connected to said grid of said end tube.

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