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2,357,922

ELECTRONIC TRANSLATING DEVICE

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Fig. 1

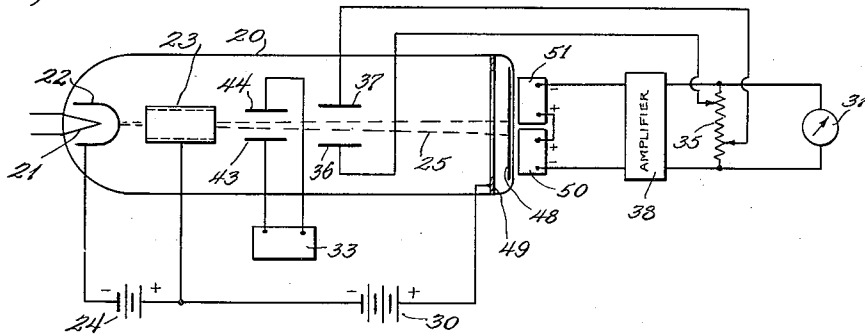


Fig. 1a

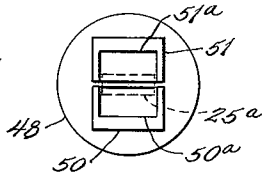


Fig. 1b

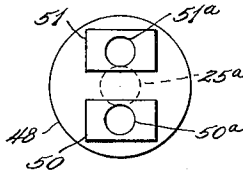


Fig. 2

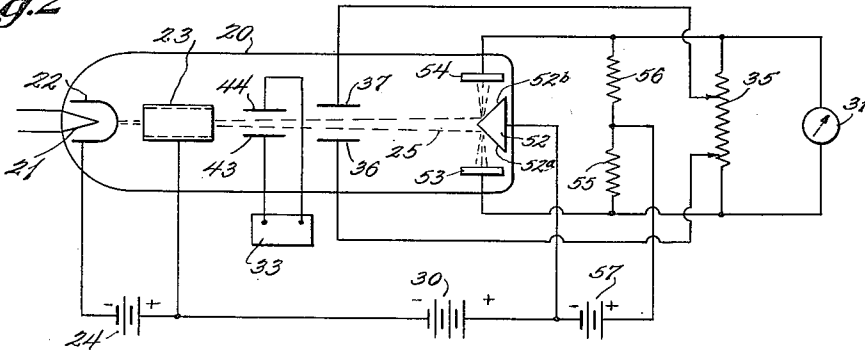
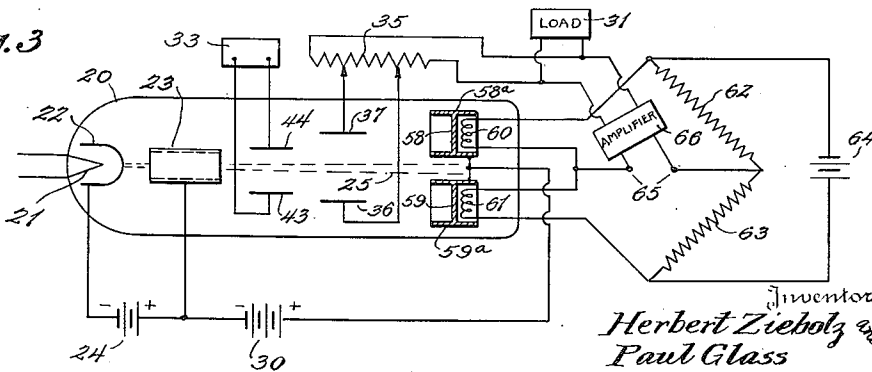


Fig. 3



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UNITED STATES PATENT OFFICE

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ELECTRONIC TRANSLATING DEVICE

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8 Claims. (Cl. 315-12)

The invention relates to an electronic translating device of the cathode-ray tube type for relaying, amplifying, converting, transforming or otherwise translating electrical, magnetic or electromagnetic signals, or signals of any nature which may be converted by known means into electric, magnetic or electromagnetic signals. The invention is useful in translating signals representing physical, chemical or other conditions, such as chemical reactions, heat, sound, light, mechanical motion or displacement which may be converted by such means as thermocouples, microphones, light sensitive cells, mechanical movements or displacements of magnets, charged bodies, electromagnets, coils or cores of electromagnets.

One object of the invention is to provide means for performing these translating functions with a minimum of distortion due to any change in the characteristics of the means or of the electronic device.

Another object of the invention is to provide a translating device for performing these functions without reflecting any variation from the controlled means back into the signal source.

Another object of the invention is to provide means by which mechanical, electrical, magnetic and electromagnetic signals may be converted from one type into another with a minimum of distortion due to changes in the characteristics of the converting means.

Another object of the invention is to provide means by which mechanical, electrical magnetic, electromagnetic signals may be amplified or proportioned with a minimum of influence of changes in the characteristics of the amplifying means.

Another object is to provide an electronic device of this character which can be employed as a direct current amplifier.

The invention disclosed herein is related to the invention disclosed in copending application Ser. No. 417,871, filed November 4, 1941, and the arrangements described in the present application are modifications of the invention disclosed in the earlier application.

In the earlier application Ser. No. 417,871, the electron stream or beam of a cathode-ray tube is deflected by suitable deflecting means to vary the number of electrons intercepted by electron receiving means or an anode, the deflecting means being energized in accordance with signals to be translated. A second deflecting means is provided to act upon the electron stream in opposition to the first deflecting means, and the second deflecting means is energized in accordance

with variations in the number of electrons acting upon the electron receiving means or anode, the arrangement being such that the stream is deflected to establish a state of equilibrium between the two deflecting means.

In all of the arrangements disclosed in the prior application, the variation in the number of electrons received by the receiving means or anode establishes a variable potential in the anode, and this variable potential is utilized to energize the second deflecting means which acts in opposition to the first deflecting means. In the arrangements disclosed herein, the electron beam produces a variable secondary effect at the receiving end of the tube, and the variable secondary effect is utilized to energize the second deflecting means which acts in opposition to the first deflecting means.

Other aims and advantages of the invention will appear in the specification, when considered in connection with the accompanying drawing, wherein:

Fig. 1 is a circuit diagram showing one form of translating device according to the invention, in which the electron receiving means comprises a fluorescent screen which emits light under the impact of electrons;

Figs. 1a and 1b show alternative arrangements of light-sensitive cells which may be employed in Fig. 1;

Fig. 2 is a circuit diagram showing another form of translating device in which the electron receiving means or anode emits secondary electrons; and

Fig. 3 is a circuit diagram illustrating still another form of translating device in which the electron stream of the cathode-ray tube is employed to variably heat two heat-sensitive resistance elements in a Wheatstone bridge circuit.

In the arrangement shown in Fig. 1, there is diagrammatically represented a cathode-ray tube consisting of an insulating envelope 20. The internal construction of the cathode-ray tube may be of any suitable and well known type, but for the purpose of illustration, the tube has a source of electrons represented by a heater or filament 21 for heating an electron emitting cathode 22. The electrons emitted by cathode 22 are accelerated and focused into an electron beam of suitable shape directed along the axis of the tube by means of an accelerating and concentrating electrode 23 mounted in the tube and maintained at a positive potential with respect to the cathode 22 by means of a suitable source of potential, represented by the battery 24. The electron beam

established within the tube is indicated by dotted lines 25.

Suitable electron receiving means, represented by a fluorescent screen 48, is mounted in the end of the tube 20, and this fluorescent screen may be formed as a separate element, or it may be deposited on the glass wall forming the end of the tube in a well known manner. If desired, a ring-shaped electrode 49 may be positioned to surround the screen 48 and be maintained at a positive potential with respect to cathode 22 by means of a suitable source of current represented by the battery 30. This electrode is not essential however and may be omitted.

A pair of light-sensitive cells 50 and 51 are located at the end of the tube 20 and in a position to receive light from the fluorescent screen 48. These cells may be of any known construction, but we prefer to employ cells of the type which develop a potential difference at their terminals under the influence of light. Also, only one cell may be employed, but we prefer to use two cells and to connect these cells in opposition.

The cells may be provided with windows of any desired shape and may be arranged in different spacial relation. In Fig. 1a, there is shown one suitable arrangement in which the two cells are located in contiguous relation behind the screen 48 and are provided with rectangular windows shown at 50a and 51a, while the electron beam has a rectangular cross-section represented by the rectangle 25a and is normally positioned to fall upon the screen 48 on an area which extends over both windows by substantially equal amounts.

In Fig. 1b, the two cells 50 and 51 are spaced apart so that neither window receives light from the area of the screen which is normally affected by the electron beam. Also, this figure shows that the windows as well as the electron beam may be circular in shape.

The two cells 50 and 51 are connected in opposition in an output circuit which includes an output device 31 of any desired nature, such as a meter or a load device. The output circuit is also bridged by a potentiometer 35 which is provided for supplying an adjustable potential to secondary deflecting plates 36 and 37. An amplifying device 38 of any suitable construction may be inserted between the cells and the output circuit as shown, but the amplifier is not essential.

A source of signals to be translated is represented at 33, and these signals are applied to a pair of primary deflecting plates 43 and 44. The plates 36 and 37 are connected so that the potential supplied from 35 tends to deflect the electron beam in a direction opposite to the direction of deflection by plates 43 and 44.

Operation of the arrangement shown in Figs. 1 and 1a is as follows:

Normally, with no signal applied to plates 43 and 44, the electron beam produces an area of fluorescence on the screen 48 represented by the area 25a in Fig. 1a which influences cells 50 and 51 by equal amounts. Under this condition the voltages of the two cells neutralize each other and no current flows in the output circuit. When a signal deflects the beam from its normal position, the voltage produced by one cell decreases and the voltage from the other cell increases, thereby resulting in an unbalance of the two cells, and a resulting current will flow in the load circuit including resistance 35. The potential developed across a portion of resistance 35 and applied to plates 36 and 37 acts in opposition to

plates 43 and 44, and the beam 25 will assume a position of equilibrium where the effects of the two deflecting forces are balanced. Under this condition, the current or voltage supplied to the load device 31 will have a definite relation to the value of the input signal. The proportion or ratio between the input signal and the signal supplied to the load may be adjusted or controlled by adjustment of potentiometer 35. A substantially linear relationship may be obtained between the output signal and the input signal by arranging the circuit constant so that the maximum unbalance between cells 50 and 51 is obtained by a relatively small unbalance between the deflecting forces of the two sets of deflecting plates. For example, the amount of unbalance required between plates 43-44 and plates 36-37 to produce a maximum current or voltage in the load circuit could be of the order of one per-cent difference.

When the cells 50 and 51 are spaced apart as shown in Fig. 1b, the operation is substantially as described above except that normally the two cells do not receive any substantial amount of light from the screen 48.

In the arrangement shown in Fig. 2 the electron beam of the cathode-ray tube produces secondary emission of electrons which is utilized to establish current or energy in the output circuit. In this arrangement an anode 52 is located in the path of the electron beam and is provided with two electron receiving faces 52a and 52b arranged at symmetrical angles to the path of the beam, and the anode is maintained at positive potential with respect to cathode by current sources 24 and 30. A secondary anode 53 is positioned to receive secondary electron emission from anode face 52a, and secondary anode 54 receives secondary electron emission from anode face 52b. Secondary anodes 53 and 54 are maintained at positive potential with respect to the primary anode 52 by a suitable source represented at 57, coupling resistances 55 and 56 being interposed in the energizing circuits. The output circuit or load 31 is connected between secondary anodes 53 and 54, and energy for exciting deflecting plates 36 and 37 is derived from potentiometer 35 connected to the output circuit.

In the operation of Fig. 2, with no signal applied to plates 43 and 44, the electron beam would normally be centered with respect to the anode faces 52a and 52b, so that secondary anodes 53 and 54 would receive substantially equal amounts of secondary electrons from the primary anode 52. Deflection of the beam to either side of its normal position by a signal from source 33 will result in an increase in the secondary electrons supplied to one secondary anode and a corresponding decrease in the electrons supplied to the other secondary anode, thereby establishing a potential difference across the output circuit. This potential difference acts upon plates 36 and 37 to limit the amount of deflection of the beam 25 by plates 43 and 44 and thereby establish equilibrium between the two deflecting means.

It will be understood that only one secondary anode may be employed, and in this case, the output circuit would be connected across the coupling resistance leading to the secondary anode.

In Fig. 3, the secondary effect produced by the electron beam of the cathode ray tube is a heating effect which influences two heat-sensitive resistance elements 60 and 61. In this arrangement, two anode elements 58 and 59 are posi-

tioned in the receiving end of the tube and are maintained at a positive potential with respect to the cathode by sources 24 and 30. The beam 25 is normally concentrated and directed between the anodes 58 and 59, but when the beam is deflected to fall on one of these anodes, the beam heats the anode and the heat from the anode is in turn transmitted to one of the resistance elements 60 or 61 to vary the resistance thereof. For the purpose of confining the heat to the resistance elements and for preventing the loss of secondary energy from the front faces of anodes 58 and 59, we provide metallic tubular shields 58a and 59a surrounding anodes 58 and 59 and extending to the front and rear of these anodes. The heat-sensitive resistance elements 60 and 61 are insulatingly supported in the rear portion of sleeves 58a and 59a behind anodes 58 and 59, and these resistances are connected in a Wheatstone bridge circuit involving external resistances 62 and 63. A source of current 64 is connected to two diagonal points of the bridge, while the output circuit is connected to the other diagonal points of the bridge at terminals 65. An amplifier 66 of suitable construction may be interposed between the load circuit and the Wheatstone bridge if desired. Potential for exciting deflecting plates 36 and 37 is derived from the load circuit as in the previous arrangements.

In the operation of Fig. 3, when no signal is supplied to plates 43 and 44, the beam is directed between anodes 58 and 59, and the normally balanced bridge does not supply any energy to the load circuit. When the beam is deflected to impinge upon either anode, the heat produced by bombardment of the anode is transmitted to the associated resistance, and changes the value of the resistance, to thereby unbalance the bridge and supply energy to the load circuit. The potential supplied to the load circuit is in a direction such that the action of plates 36 and 37 opposes the deflection by plates 43 and 44 and thereby limits the amount of unbalance of the bridge.

In all of the arrangements described herein, an increasing deflection of the beam results in the establishment of increasing energy in the output circuit or load device. In these arrangements the deflection is accomplished by means of deflecting plates, but it will be understood that any other equivalent arrangement may be employed for effecting the primary deflection or for effecting the secondary or balancing deflection. Equivalent arrangements are well known, such as those using a magnetic field instead of an electrostatic field. Several examples of possible arrangements are disclosed in copending application Ser. No. 417,871. The devices disclosed herein are capable of the same uses as the devices disclosed in the earlier application.

In the arrangement shown in Fig. 1, any light-sensitive cell may be used, such as photo-emissive, photo-conductive or photo-voltaic types. Where the cell involves a resistance which is sensitive to light, the cells may be connected in a Wheatstone bridge arrangement like that shown in Fig. 3.

It will be obvious to those skilled in the art that either the input signal or the balancing signal or both signals may be derived from any condition or conditions which can be translated into electromagnetic or electrostatic fields or into movements of such fields. Likewise, the input signal may be set or adjusted or it may be varied and the balancing signal, which may be of a

different magnitude or character, can be maintained proportional to the input signal.

Obviously, the present invention is not restricted to the particular embodiments thereof herein shown and described.

What is claimed is:

1. An electronic translating device comprising, in combination, means for producing an electronic beam, means for receiving electrons from said beam and for generating secondary energy by impact of electrons thereon, input control means including means for variably deflecting said beam over the surface of said electron receiving means in accordance with signal variations, an output circuit including means controlled by the secondary energy generated over a definite area of said electron receiving means for establishing variable energy flow in said output circuit, a second control means acting on said beam, and means for variably energizing said second control means from said output circuit synchronously with said signal variations and in a direction tending to vary the secondary energy in opposition to the variation produced by said input control means.

2. An electronic translating device comprising, in combination, means for producing an electronic beam, means for receiving electrons from said beam and for generating secondary energy by impact of electrons thereon, input control means including means for variably deflecting said beam over the surface of said electron receiving means in accordance with signal variations, an output circuit including means controlled by the secondary energy generated over a definite area of said electron receiving means for establishing variable energy flow in said output circuit, a second deflecting means acting on said beam, and means for variably energizing said second deflecting means from said output circuit synchronously with said signal variations and in a direction tending to deflect said beam in a direction opposite to the direction of deflection by said input control means.

3. An electronic translating device according to claim 2, wherein said electron receiving means comprises a fluorescent screen which emits light under the impact of electrons thereon, and the output circuit includes a light-sensitive cell responsive to the light emitted over a definite area of said screen.

4. An electronic translating device according to claim 2, wherein the electron receiving means comprises a primary anode element which emits secondary electrons by impact of primary electrons thereon, and the output circuit includes a secondary anode element for receiving secondary electrons from said primary anode.

5. An electronic translating device according to claim 2, wherein said electron receiving means comprises an anode element in which heat is generated by impact of electrons from said beam, and the output circuit includes a heat-sensitive resistance element arranged to be influenced by the heat generated in said anode element.

6. An electronic translating device according to claim 2, wherein said electron receiving means comprises a fluorescent screen which emits light under the impact of electrons thereon, and said output circuit includes a pair of light-sensitive cells arranged to receive light from different areas of said screen, said cells being connected in opposing relation in said output circuit, and said electron beam being normally directed along an axis passing between said cells.

7. An electronic translating device according to claim 2, wherein said electron receiving means comprises a primary anode which emits secondary electrons under the impact of primary electrons, and said output circuit includes a pair of secondary anodes arranged to receive secondary electrons from different areas of said primary anode, said secondary anodes being connected to opposite sides of said output circuit, and said beam being normally directed along an axis passing between the areas of said primary anode which influence said secondary anodes.

8. An electronic translating device according

to claim 2, wherein said electron receiving means comprises a pair of anodes in which heat is generated by impact of electrons thereon, and said output circuit comprises a Wheatstone bridge connection having heat-sensitive resistance elements in two arms thereof arranged to be influenced by the heat generated in said anode elements, and said electron beam being normally directed along an axis passing between said anode elements.

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