March 13, 1951 W. A. TOLSON 2,545,123

COMPUTING DEVICE

Original Filed May 20, 1946

Fig. 1

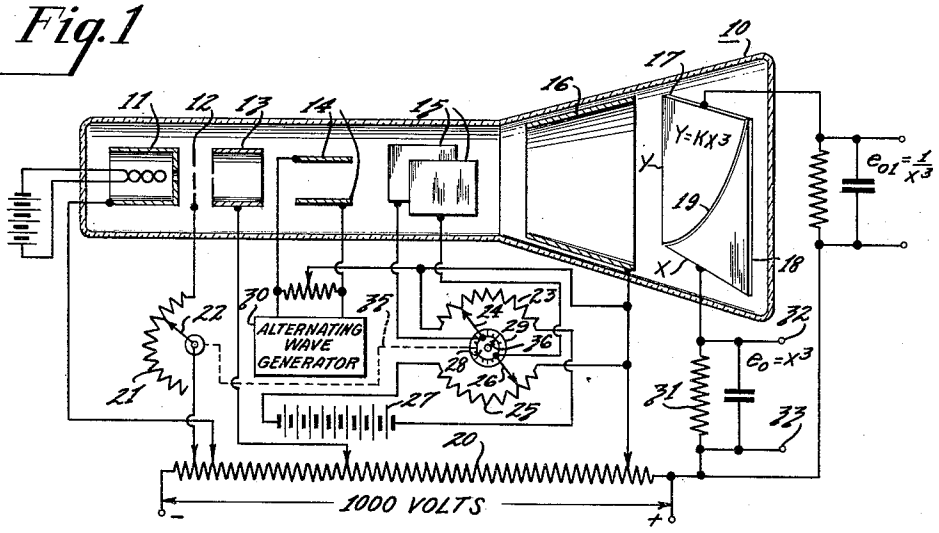


Fig. 2

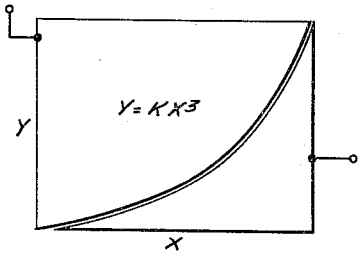


Fig. 3

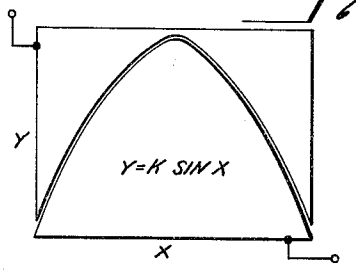
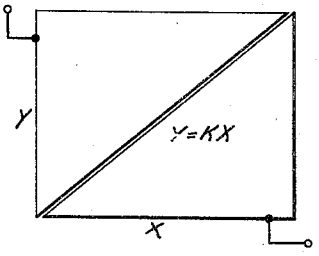


Fig. 4



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UNITED STATES PATENT OFFICE

2,545,123

COMPUTING DEVICE

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Substituted for application Serial No. 673,016, May 20, 1946. This application December 22, 1948, Serial No. 66,674

5 Claims. (Cl. 315—21)

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This invention relates to computing devices of the electronic type, and more particularly to an improved computing device which includes a monoscope type of cathode ray tube having its target or signal plate so formed as to be scanned by the cathode ray to produce output currents or potentials which are representative of different values of a dependent variable, the present application being a substitute for my prior application, Serial No. 673,016, filed May 20, 1946, now abandoned.

It is often desirable to determine the instantaneous value of a quantity which bears a mathematical relation to a second quantity having a value which may be constantly changing. When the rate of change of this independent variable becomes great, the continuous solution of the equation by mechanical means becomes difficult, if not even impossible. The present invention provides a means of solving such an equation at a very rapid rate as long as the range of values of the dependent and independent variables is finite and commensurate.

In the illustrated form of the present invention, a cathode ray device is provided with a target which is divided into two sections. The contour of the boundary line between these two sections is made such that output potentials representative of different values of the dependent variable are produced when the two sections are scanned by the cathode ray along lines corresponding to different values of the independent variable. Thus, the shape of the sections corresponds to the curve of values of the dependent variable for corresponding values of the independent variable.

Selection of the different values of the independent variable may be made by applying suitable, graduated voltage to the horizontal deflectors of the cathode ray device. Vertical scanning of the selected line of the target is effected by applying to the vertical deflectors of the device the output of an alternating wave generator, the wave shape being such that it has a finite slope and such wave being adjusted to an amplitude just sufficient to cause the ray to traverse the entire target. Under these conditions, the unidirectional current flowing in the target or signal plate circuit is a function of the instantaneous value of the dependent variable. Additional functions or modifications of the signal plate function may be introduced by correlated variations of the grid potential of the cathode ray device, thereby producing independent variations in the signal plate current.

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The principal object of the present invention is to provide an improved computer and method of operation whereby potentials representative of the instantaneous values of one variable are rapidly produced in response to the application of potentials which are representative of another variable. Other objects of the invention are the provision of an improved computer of the cathode ray type, and the provision of means whereby an electrical quantity may be continuously varied in value in accordance with the value of a variable.

The invention will be better understood from the following description considered in connection with the accompanying drawings and its scope is indicated by the appended claims.

Referring to the drawings,

Fig. 1 is a wiring diagram of one form of improved computing device according to my present invention, and

Figs. 2, 3 and 4 illustrate different types or forms of signal plates or targets which may be employed in accordance with this invention.

The computer of Fig. 1 includes a cathode ray tube 10 which has a cathode 11, a control grid 12, a first anode 13, a pair of vertical deflectors 14, a pair of horizontal deflectors 15, a second anode 16 and a signal plate or target illustrated as made up of two conductive sections 17 and 18 which are spaced apart or otherwise electrically insulated from one another along a boundary or division line 19. The target 17—18 is illustrated in Figs. 1 and 2 as arranged for the continuous solution of the equation $y=kx^3$.

It may be arranged for the continuous solution of other equations. For example, a target like that of Fig. 3 is required for the continuous solution of the equation $y=k\ xin\ x$. Similarly, a target having a straight-line boundary 19 of appropriate slope, as shown in Fig. 4, may be employed for the continuous solution of the equation $y=kx$, and so on.

Potential for operating the tube 10 is applied from a suitable source (not shown) through a voltage divider 20 to the cathode 11, the grid 12,

the first anode 13, the second anode 16 and the target sections 17 and 18. The voltage of the grid 12 may be applied through a potentiometer 21—22 which can be ganged with a potentiometer 23—24—25—26, as indicated by the broken line 35, where, as in some cases, an additional function or modification of the output function is introduced.

The cathode ray of the tube 10 is normally biased to the lower left hand corner of the target 17—18 by the construction of the tube or otherwise, and is deflected along the horizontal or x axis of the target in measured steps by means of the potentiometer 23—24—25—26 and a unidirectional potential source shown as a battery 27. To this end, the potentiometer 23—24—25—26 may include (1) a rotatable knob 28 which bears an indicating mark 36 and supports the immovable contact members 24 and 26, and (2) a fixed member or scale 29 which is calibrated so that the successive values of the independent variable x are indicated by the mark 36 on the knob 28.

Values of the independent variable x are selected by adjustment of the double potentiometer 23—24—25—26. For any selected position of this potentiometer, the scanning spot may be made to trace a vertical line across the target 17—18 by applying potential to the vertical deflectors 14 from a generator 30 which generates a wave of desired or suitable shape. If it is desired to have the readings of the dependent variable y follow a linear relationship, as with the target of Fig. 4, a triangular wave generator would be used for vertical deflection. It is clear that a wide variety of wave shapes could be used to secure meter scale characteristics best suited to the particular problem being solved. In any case, the wave deflecting potential (1) should be adjusted to an amplitude which is just sufficient to move the beam vertically across the useful portion of the target 17—18 and (2) should have a frequency which is high enough so that the time required for one cycle of deflection is small as compared to the rate at which the ray is moved in the horizontal direction. The height of the curve 19 at the chosen value of the independent variable x represents the value of the dependent variable y for that particular point. Such height is directly proportional to the number of electrons delivered through the cathode ray to the section 18 of the target. Consequently, the direct current delivered from the target section 18 through a resistor 31 is proportional to the value of the dependent variable y at the selected point.

A unidirectional voltage directly proportional to this direct current thus is made available at the terminals 32—33. If the frequency of the alternating wave potential is very high, a small by-pass capacitor across the resistor 31 is sufficient to produce a smooth curve of signal plate current even though the value of x is changing at a fairly rapid rate.

The construction of the target 17—18 results from plotting thereon the curve corresponding to the equation to be solved and mechanically or otherwise suitably separating the two sections of the plate electrically. While the target has been illustrated as divided into two insulated sections having separate direct current return paths, it is apparent that etching or printing of the target may be resorted to for the purpose of providing a target area of the required form.

What the invention provides is an improved computing device and method of operation whereby a dependent variable is continuously evaluated

in response to potentials which are representative of the values of the independent variable.

I claim as my invention:

1. The combination of a cathode ray device including a first pair of deflectors for deflecting said ray along a first axis, a second pair of deflectors for deflecting said ray along a second axis, and a target member having a part of its boundary in the form of a curve defining the relation between first and second variables with respect to said axes, means for indicating potentials representative of different values of said first variable, means for applying said indicated potentials to said first pair of deflectors, and means for applying to said second pair of deflectors an alternating potential of a wave shape having a finite slope and having an amplitude just sufficient to move said ray across said target whereby currents representative of the values of said second variable are made available at said target member.

2. The combination of a cathode ray device including first and second pairs of deflectors for deflecting said ray along first and second axes, a control grid, and a target member having a part of its boundary in the form of a curve defining the relation between first and second variables with respect to said axis, means for indicating potentials representative of values of said first variable, means for applying said indicated potentials to said first pair of deflectors, means for applying to said second pair of deflectors an alternating potential of a wave form having a finite slope, and means ganged with said indicating means for applying to said control grid a potential which is representative of a third variable.

3. The combination of a cathode ray device having first and second pairs of deflectors for moving said ray along first and second axes and having a target consisting of two members spaced from one another along a boundary in the form of a curve defining the relation between first and second variables with respect to said axes, means for indicating potentials representative of the values of said first variable, means for applying said indicated potentials to said first pair of deflectors, and means for applying to said second pair of deflectors a potential whereby said ray is moved to scan said target and make available at one of said members potentials representative of the values of the second of said variables.

4. The combination of a cathode ray device having first and second pairs of deflectors for moving said ray along first and second axes and having a target consisting of two members spaced from one another along a boundary in the form of a curve defining the relation between first and second variables with respect to said axes, means for indicating potentials representative of the values of said first variable, means for applying said indicated potentials to said first pair of deflectors, and a generator of waves having a finite slope coupled to said second pair of deflectors for applying to said second pair of deflectors a potential whereby said ray is continuously moved to scan said target.

5. The combination of a cathode ray device having first and second pairs of deflectors for moving said ray along first and second axes and having a target consisting of two members spaced from one another along a boundary in the form of a curve defining the relation between first and second variables with respect to said

axes, means for indicating potentials representative of the values of said first variables, means for applying said indicated potentials to said first pair of deflectors, a generator of waves having a finite slope coupled to said second pair of deflectors for applying to said second pair of deflectors a potential whereby said ray is continuously moved to scan said target, and means for deriving from one of said target members a direct current which is representative of the values of said second variable.

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