Oct. 23, 1934. D. PRINZ 1,977,999

CATHODE RAY OSCILLOGRAPH

Filed March 16, 1933 2 Sheets-Sheet 1

Fig. 1

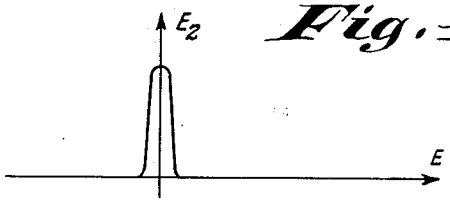


Fig. 2

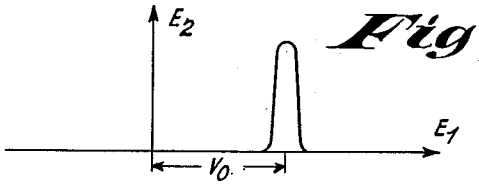


Fig. 3

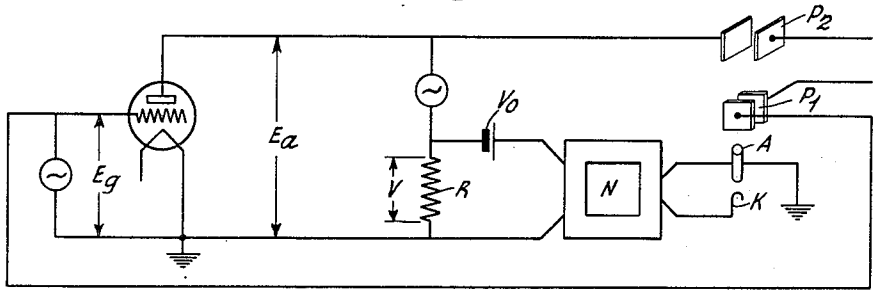
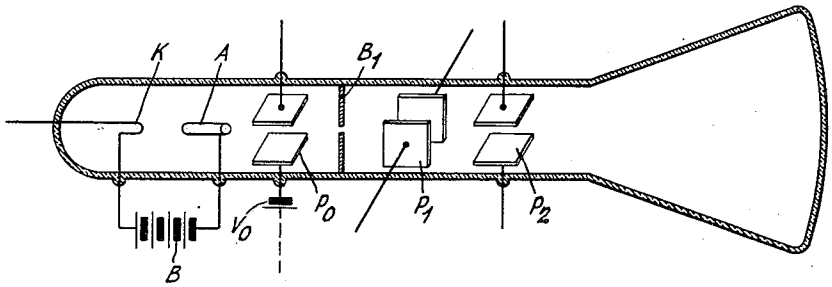


Fig. 4



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Fig. 5

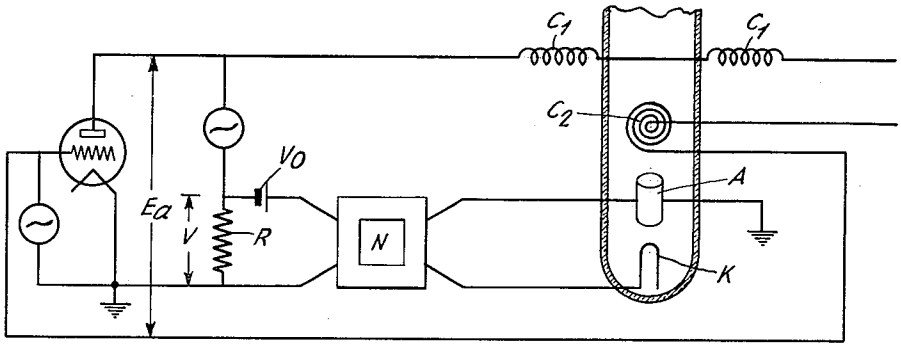


Fig. 6

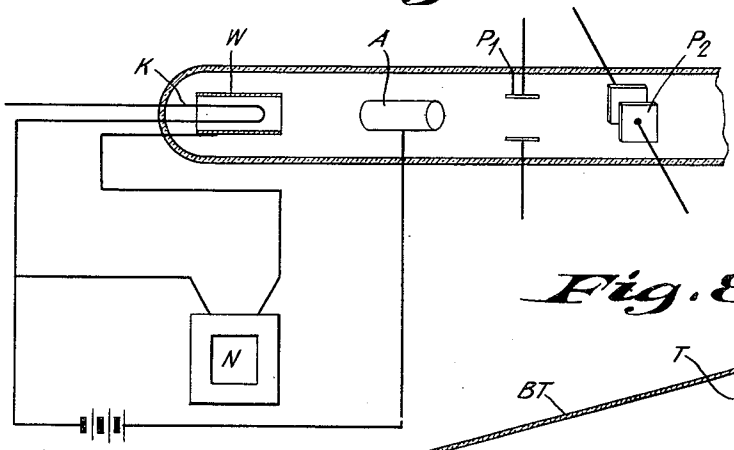


Fig. 8

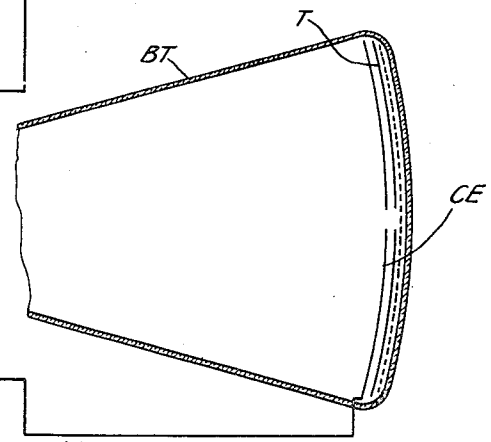
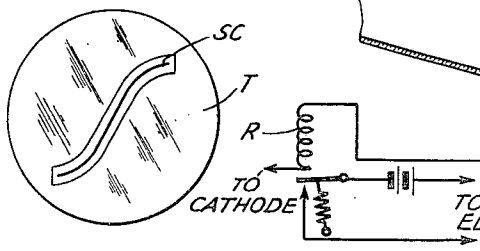


Fig. 7



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UNITED STATES PATENT OFFICE

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CATHODE RAY OSCILLOGRAPH

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Application March 16, 1933, Serial No. 661,098
In Germany March 11, 1932

5 Claims. (Cl. 171—95)

It is known in the prior art that the functional inter-relationship between two physical quantities x and y may be rendered visible or be recorded by causing two electrical voltages or currents proportional to the two variables to act upon a luminous point or spot in such a way that the latter is caused to experience motions in two directions. Such motions of the point are at right angles to each other and are proportional to the values of the variables x and y.

However, this method is practicable only where, owing to the nature of the action, one of the variables, say, y is explicitly given as a function of the respective other variable, i. e., x or, in other words, whenever a change in quantity x entails automatically, as it were, an alteration in the variable y. This is, however, by no means always the case. For instance, in connection with the measurement of the properties of electronic or thermionic tubes the question is of practical interest as to how the grid voltage, in the presence of variable plate voltage, must be altered in order that the plate current may always preserve its value unvaried. In the case of problems of this kind, in which, as will be seen, the functional interrelaitonship is implicitly given by the form $f(x, y)=c$ a method shall hereinafter be disclosed for an automatic representation of the curve-shape.

The invention has recourse to systems of the kind as used in connection with the transmission of still or moving pictures and applies to apparatus used for picture telegraphy, television and the like and, more particularly, to the receiving equipment utilized in such systems. Most suited for this purpose are arrangements in which no mechanically moving or kinetic parts are employed, for instance, arrangements comprising cathode ray or Braun tubes. It is in connection with its application to this latter case of apparatus that the present invention shall be explained in more detail.

For the deflection of the spot of a cathode ray or Braun tube two periodically variable voltages are required in a television receiver outfit; i. e., the spot voltage so-called which causes the shift of the spot within a row from one end thereof to the other, and the line voltage so-called which occasions the shift of the line from one edge of the picture to the other. Both voltages have different frequencies. The relation between these frequencies represents the number of lines into which the resulting electro-optical image is divided.

The accompanying drawings show several forms which the invention may assume. By these drawings

Figs. 1 and 2 show operation curves;

Fig. 3 is a schematic showing of one form of the device;

Fig. 4 is a modification of Fig. 3;

Fig. 5 indicates a device similar to that of Fig. 3 but with magnetic deflection substituted for electrostatic deflection;

Fig. 6 represents a device similar to Fig. 3 with a control effected by a Wehnelt cylinder;

Fig. 7 discloses the use of a pattern or template to mask undesired light; and

Fig. 8 represents a modification of the arrangement of Fig. 7.

The invention moreover has recourse to elements and means which are capable of transmitting current or of producing in an associated system a current or voltage impulse or shock when the potential applied thereto is equal to zero or differs sufficiently little from zero. An element of this kind which in what follows shall be designated as a "no-current relay" may consist, for instance, of an electrical measuring instrument such as a voltmeter or an ammeter, the pointer or needle of which cooperates with a contact which is arranged at the zero point or mark, and which is thus enabled to make another circuit whenever the voltage coming to act upon the instrument happens to be of zero value. No-current relays of the said sort may be made also so that all mechanical masses and inertia are avoided. They are characterized by a "characteristic", i. e., a functional dependence of the voltage output upon the voltage input as illustrated in Fig. 1. The voltage output E_2 will differ from zero only when the voltage input E_1 is of zero value or differs from it sufficiently little. The making of such inertialess no-current relays is fundamentally known in the earlier art, for instance, from the disclosure of German Patent No. 528,902.

Connecting the input terminals of such a no-current relay in series with a voltage $-V_0$, the ensuing system has a characteristic of the kind and form as shown in Fig. 2. The voltage delivered by the same, E_2, will differ from zero when the voltage input E_1 is equal to V_0 or deviates but slightly therefrom.

To represent automatically functions of the form $f(x, y)=c$ the said arrangements are combined in the following manner. There are first produced voltages which are proportional to the variables x and y, and these voltages are fed to the deflecting plates of a Braun tube in the form

of spot and line voltages as above explained. There is moreover generated a voltage that is proportional to the functional value $f(x, y)$. If, for instance, the plate current I_a of an electron tube is concerned (see Fig. 3) which is given as a function $f(E_g, E_a)$ of the grid voltage E_g and a plate voltage E_a, then grid and plate are fed with alternating voltages of suitable frequency; for instance, the grid potential E_g or a voltage proportional thereto, thus constituting the spot voltage, and the plate potential E_a or a voltage proportional thereto to represent the line voltage, are applied to the pair of plates P1 and P2, respectively, of a Braun tube, the plate current I_a being conducted through a resistance R across the terminals of which a proportional voltage drop $RI_a=V$ is occasioned. If now the relationship between E_g and E_a for a definite value of the plate current $I_a=I_{a0}$ is of practical interest, then the voltage $RI_a=V$ is applied to a no-current relay N the input end of which is fed with a biasing voltage $-RI_{a0}=-V_0$. This system will set up a voltage only when the plate current $I_a=f(E_g, E_a)$ attains just the pre-arranged value I_{a0}. The voltage output, if necessary, after sufficient amplification, is connected between plate A and filament K of the cathode ray or Braun tube. What is thus attained is that a luminous spot will appear upon the screen of the Braun tube when the plate current I_a happens to be passing the value I_{a0}.

However, since at this instant voltages are acting across the deflector plates P1 and P2 of the Braun tube which correspond to such values of the variables E_g and E_a, or x and y, respectively, for which the equation $f(E_g, E_a)=I_{a0}$ and $f(x, y)=c$, respectively, is fulfilled, it will be seen that the totality of the dots appearing upon the fluorescent screen, as a matter of fact, will represent the functional relationship between E_g and E_a and x and y, respectively, as furnished by these equations.

Modifying the circuit scheme in such manner that by the no-current relay the plate voltage of the Braun tube is short-circuited, while normally or otherwise it has its full value, then the picture or image of the graph will appear black on white background.

For the case of the Braun tube a special form of inertialess no-current relay fundamentally known in the art will be found particularly suitable. This arrangement also comprises a Braun tube in which, however, the cathode-rays across two deflector plates reach the collecting electrodes through an aperture or the so-called "pinhole" diaphragm. It is only when the voltages acting at the deflecting plates are nearly equal to zero that the current flowing by way of the collecting electrodes differs from zero, as otherwise the electrons will be stopped by the diaphragm.

This design of no-current relay may be combined with the Braun tube serving for the representation of the curve in such a manner that merely one Braun tube is used. This combination is illustrated in Fig. 4. Between cathode K and anode A of the Braun tube is applied a constant voltage derived from the battery B. The electrons issuing from the cathode flow past the auxiliary deflector plate P_0 through the diaphragm B1 and then through the plate pairs P1, P2, which serve the same purpose as in Fig. 3. Applied to these plate pairs, in a way as described, are the voltages which are proportional to the variables x and y. The voltage proportional to the quantity $f(x, y)$ (in the above example I_a) is fed by means of a compensating voltage V_0 to the auxiliary plate P_0. By suitable selection of V_0 conditions may then be made so that electrons will pass through the aperture of the stop or diaphragm and thus impinge and cause a spot upon the fluorescent screen when the variable $f(x, y)$ has the prescribed value c. Hence, the operation of this arrangement is the same as the one depicted in Fig. 3.

Instead of the electrostatic deflection by the agency of plates, as will be understood, recourse could be had also to electromagnetic deflection by the aid of coils which, for instance, may be disposed outside the tube, as shown by Fig. 5.

In lieu of a scheme embodying the no-current or zero-current relay as hereinbefore described, recourse could be had also to a number of other arrangements. For instance, as shown by Fig. 6 the voltage impulse could be caused to act upon a Wehnelt cylinder W which, according to the particular polarity of the voltage would either retard or release the electrons, with the result that either a dark image of the curve is produced on a light background, or inversely a light curve on dark background.

The arrangement as hereinbefore disclosed may not only serve the purpose of rendering functional relaticns of the described sort visible, but also the object of automatically releasing or producing desired observable indications whenever such relation happens to deviate from a pre-arranged or prescribed trend or form. For instance, it would be feasible to sort out and eliminate from a large batch of thermionic tubes those in which the characteristic fails to fall inside certain pre-arranged tolerance limits. For this purpose, all that is necessary is to place in front of the Braun tube a template or pattern T, as shown by Fig. 7 which exposes only a limited strip alongside a standard curve SC. If the curve differs from the prescribed shape to such an extent that portions thereof will be masked by said pattern, the result will be a reduction of the total volume of light. Such a reduction in intensity can be readily registered by the aid of a photoelectric cell and can be used for occasioning or controlling some suitable mechanical operations or indications.

Instead of mounting such a standard pattern or template T on the outside of the Braun tube BT, it could also be disposed interiorly thereof according to Fig. 8 while in the rear of it would be mounted a collector electrode CE. The current flowing in this electrode will fall below the normal value whenever the form of the graph differs from the prescribed value. And such change in the current may be employed directly for the release or control of some suitable response indication under the control of relay R, for example.

Having now described the invention what is claimed and desired to protect by Letters Patent is the following:

1. An arrangement for the automatic indication of functions of the form $f(x, y)=c$ which comprises means to produce a cathode ray spot and for causing the spot to traverse a viewing surface according to a desired pattern, means adapted to render the position of the spot proportional to one of the two variables x and y and the position of the line resulting from a plurality of sequentially produced adjacent spots proportional to the respective other variable, and means for causing the impression of the indication to occur at the instant when the variables x, y assume the value c.

2. The arrangement according to claim 1 comprising in addition a no-current relay whose input is subject to a biasing voltage proportional to the value c, and means for supplying to the no-current relay a voltage proportional to the variables $f(x, y)$.

3. The method of automatically indicating functions of the form $f(x, y)=c$ on a cathode ray tube which comprises rendering the position of the cathode ray spot produced within the tube proportional to one of the two variables x and y, rendering the position of the traced line proportional to the other of the two variables x and y, and producing impressions of the spot at instants when the variables x and y assume the value c.

4. In a device of the character described for indicating functions of the form $f(x, y)=c$, a cathode ray tube for recording, means for causing the cathode ray spot position to be proportionate to one variable and the line position to be proportionate to the second variable, a no-current relay, means for applying to the no-current relay a bias voltage of the value c, a connection between the anode of the cathode ray tube and the output of the no-current relay, and means to apply voltages to the no-current relay proportional to the variables x and y so as to cause impressions of the cathode ray spot to be produced at time periods when voltages representing x and y assume the value c.

5. In a device of the character described for indicating functions of the form $f(x, y)=c$, a cathode ray tube for recording, means for causing the cathode ray spot position to be proportionate to one variable and the line position to be proportionate to the second variable, an axially deflecting plate, a diaphragm mounted within the tube and constituting a no-current relay, means for applying to the deflecting plate a bias voltage of the valve c, and means to apply to the no-current relay voltages proportional to the variables x and y so as to cause impressions of the cathode ray spot to be produced at time periods when the voltages representing x and y assume the value c.

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