

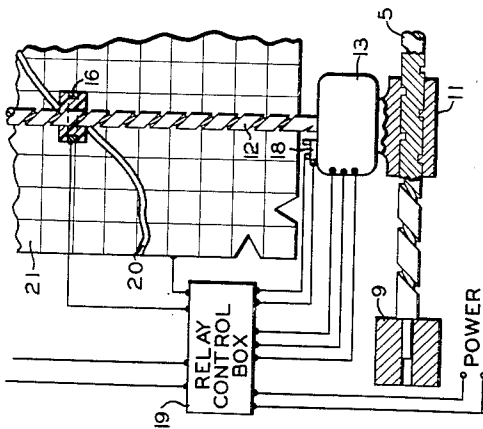
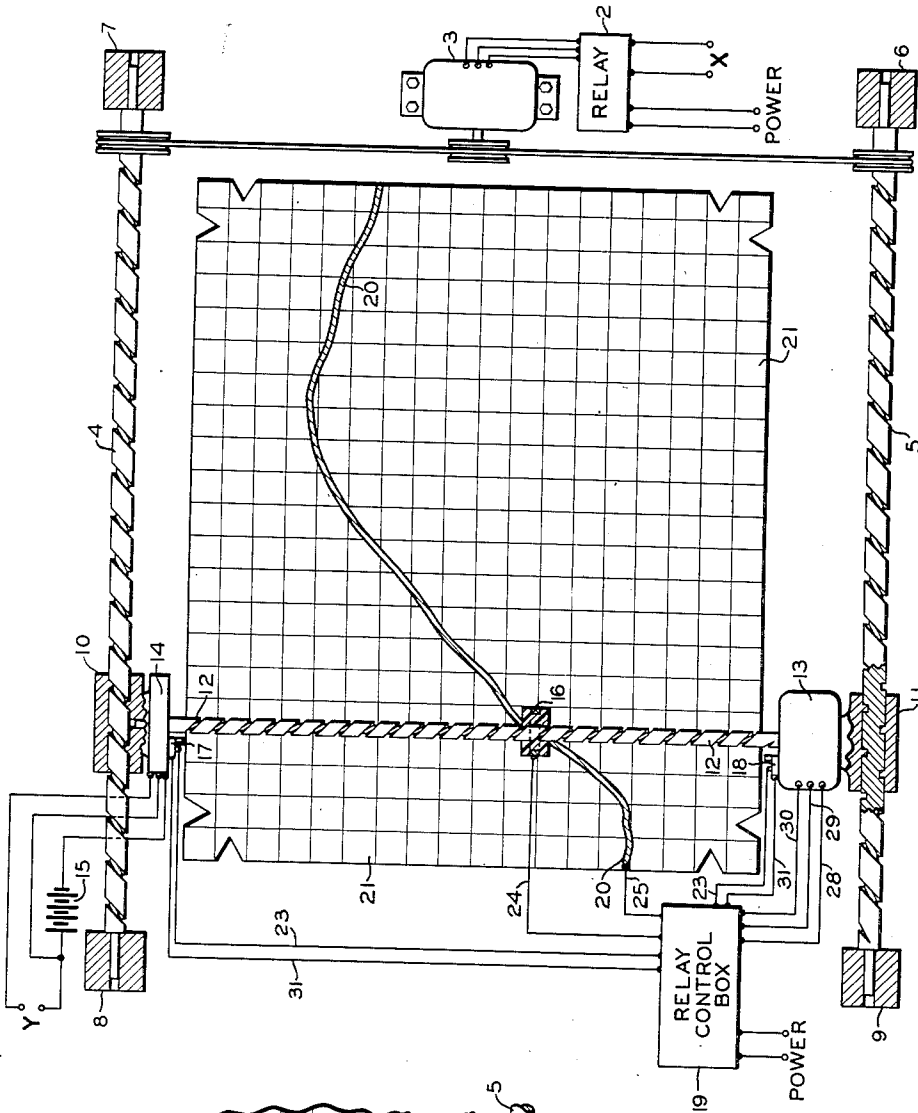
Nov. 11, 1952

P. G. CARPENTER
COMPUTER COMPONENT

2,617,587

Filed Dec. 20, 1949

2 SHEETS—SHEET 1



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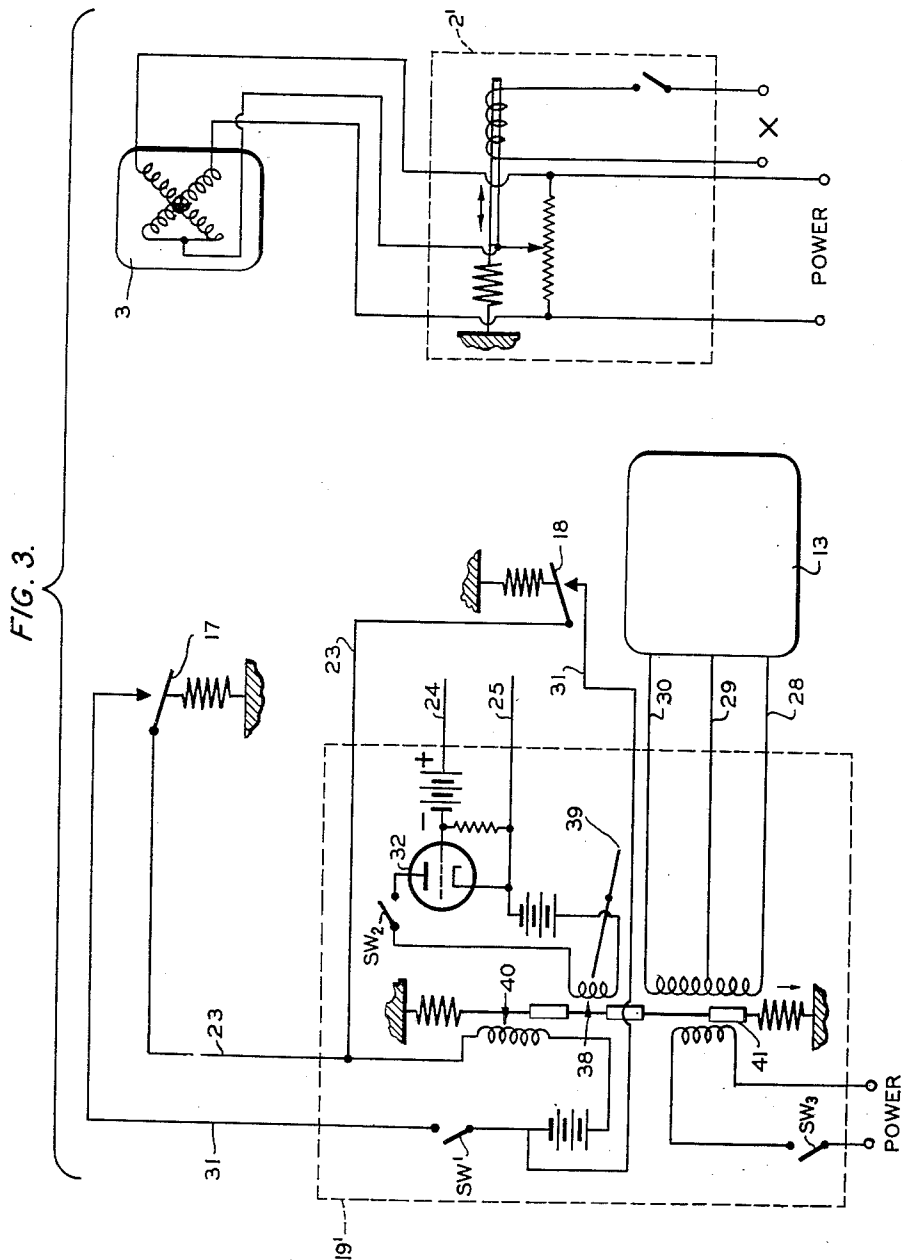
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2 SHEETS—SHEET 2



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UNITED STATES PATENT OFFICE

2,617,587

COMPUTER COMPONENT

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1

This invention relates to a combination of an electrical-mechanical means which is adapted to receive a variable current or voltage and to yield an electrical voltage related to said variable voltage according to a function $y=f(x)$. In other words, the combination of the invention will yield values of "y" for each value of "x," according to a function as expressed above. In one of its aspects the invention provides a method and apparatus for substantially instantaneously obtaining an electrical value of "y" responsive to changes in the electrical value of "x," according to a function as expressed above.

There are instances in which it is possible to determine a functional relationship, between two variables, from experimental data, which relationship can usually be expressed graphically, whereas the analytical expression of the said relationship is of such complexity that mechanization of the expression would be highly, if not totally, impractical. The subject matter of the invention relates to the said instances in which the shape or curve of a function, as expressed, can be empirically determined, thus avoiding time-consuming mathematical determinations or calculations, when such are possible, which are especially involved in irregular curves or functions.

According to this invention there are provided, in combination, means adapted and arranged to yield electrical values of "y" for any electrical value of "x" in a function $y=f(x)$, which comprises a conducting trace or graph of $y=f(x)$; an electrically operated movable contact adapted to contact or follow said trace; electrically operated moving means for said contact; means for relaying electric current from said trace, through said contact, to said electrically operated moving means for said contact to cause said contact to follow said trace responsive to values of "x"; means responsive to values of "x" for moving said contact parallel to the abscissa of said graph; and current varying means which yields the values of "y" in the function $y=f(x)$, adapted to operate correlatedly with movement of said contact along said trace. Instead of a conducting trace, a non-conducting trace upon a conducting plate can be employed, in which event the contact will be adapted to relay current from the plate to the said contact moving means, which will move the contact back on to the trace.

Thus, according to the present invention, there are provided, in combination, electrical and mechanical means in which the values of "y" in the function $y=f(x)$ are plotted, graphed or traced,

2

employing a conducting material. An electrical driving force, responsive to variations in the value of "x," is employed to move parallel to the "x" axis or abscissa on electrically operated movable contact adapted to cause operation, correlated with movements of said contact, of a voltage varying means which yields the value of "y" in the function $y=f(x)$. The electrically operated movable contact is wired or otherwise adapted to receive current from the conducting material, of which the said function is traced, and to relay said current to the electrically operated contact moving means in manner such that the movable contact will follow the trace of conducting material, responsive to any change in the value of "x." Thus each value of "x" will result in a definite value of "y," according to the traced function $y=f(x)$.

With the foregoing description available to him, one versed in the art will be able, readily, to construct and operate an apparatus according to the invention. However, in order to more fully describe the invention, in respect of specific embodiments thereof, reference is now made to the drawing in which Figure 1 is a diagrammatic illustration of the invention when a contacting trace of the function is employed; and wherein Figure 2 is a diagrammatic illustration, of a part of Figure 1, showing the modification in which a conducting plate and a non-conducting trace are employed. Figure 3 shows the detail of the circuits which can be employed in the relay control boxes 2 and 19 of Figure 1.

In Figure 1, 2 represents a relay from which is supplied a current of value "x" which may originate from a computing device. Thus the value of "x" can result from some previously computed functional relationship between "x" and other variables of a problem. The relay supplies current to reversible servomotor 3, which drives screws 4 and 5 by means of cables and pulleys, as shown. Screws 4 and 5 are movably mounted in uprights or bearings 6, 7, 8 and 9. Blocks 10 and 11 are mounted upon screws 4 and 5 and are arranged in combination therewith so that they will move along said screws in the same direction and at the same speed. Thus changes in the value of "x" will cause blocks 10 and 11 to be moved to the right or left, depending upon the direction of change in the value of "x". Blocks 10 and 11 carry a reversibly rotatable screw 12, operated by reversible motor 13, which is mounted on block 11. A potentiometer 14, supplied by a current source 15 and operated by the motion of screw 12, is mounted upon block

3

10. A movable contact 16 is mounted upon screw 12 and will ride between the ends of said screw responsive to operation of motor 13 on block 11. Reversing switches 17 and 18, which may be micro-switches, are mounted on blocks 10 and 11, respectively, to prevent any overrun of contact 16. These switches are suitably connected, as diagrammed, through relay control box 19 to motor 13 on block 11. Trace 20 is provided, as shown, and in this embodiment is made of a conducting material. Contact 16 receives current from trace 20 which passes to relay control box 19 to control motor 13, as diagrammed, and operates said motor as follows. When a certain value of "x" causes motor 3 to move blocks 10 and 11, causing the contact 16 to leave the trace 20, reversing current will be supplied to motor 13 operating screw 12 until the contact 16 is returned upon the trace 20. Each time contact 16 reaches trace 20, motor 13 is reversed thus moving contact 16 away from trace 20. Also, when contact 16 moves away from trace 20, the former electrical circuit is opened causing motor 13 to reverse and urge contact 16 back towards trace 20. By this arrangement the contact 16 will follow very close to trace 20 at all times, and the small amount of "hunting" which may result from this arrangement will be within the permissible error limits of the computer. As stated, screw 12 operates a potentiometer 14, and it is now obvious that depending upon the operation of screw 12, which in turn is correlated with values of "x," values of "y" in the function $y=f(x)$ will be obtained at "y."

In Figure 2, as already indicated, plate 21, on which trace 20 is mounted, is made of conducting material and trace 20 is made of non-conducting material and the wiring is as diagrammed. Thus, when contact 16 moves off trace 20 on to plate 21, motor 13 will be energized, causing the contact 16 to follow the trace 20 until said contact comes to rest on the non-conducting trace.

Reference is made to the drawing in Figure 3 wherein the circuits of relay control boxes 19 and 2 are shown. The circuit contained in relay box 2 labeled 2' is taken from Figure 22, page 55, of the book entitled, "Principles and Methods of Telemetering," by Perry A. Borden and Gustave M. Thynell, Reinhold Publishing Co., New York, N. Y. (1948). In the relay box 2', an adjustable spring biased solenoid is provided to move the tap of a potentiometer in accordance with the values of "x" supplied from an external source. In response to changes in the value of "x," the tap on the potentiometer is moved, thus causing motor 3 to rotate either forward or backward, resulting in motor 13 and related equipment being moved back and forth across the graph on plate 21. With the tap of the potentiometer in its center position, motor 13 should be positioned half way between 6 and 9.

Relay box 19, labeled 19', contains circuits which cause or permit contact 16 to follow trace 20 on plate 21. Reversible motor 13 is connected into relay box 19' by means of conductors 28, 29, and 30. Power is supplied from an external source via two leads through the primary coil of a transformer, the core 41 of which is movable, to the leads 28, 29 and 30. The position of the movable core of the transformer determines the direction of rotation of motor 13. As shown in the drawing, core 41 is energizing circuit 28, 29 of reversible motor 13 and said circuit is taken to operate motor 13 in a direction to move upwardly

4

contact 16. Core 41, the cores of relay 38 and of relay 40 are positioned as shown and held in position by a downward bias of the lower spring of the core assembly. Manual lever 39 which is mechanically linked to the coil of relay 38 is shown to have been moved downwardly, thus positioning the coil of relay 38 above its core. At this moment, the contact 16 (see Figure 1) is on the trace 20 having moved downward thereonto. The circuit for the control of motor 13 is the same as that described in Figure 29, page 65 of "Principles and Methods of Telemetering," by Perry A. Borden and Gustave M. Thynell mentioned above. This circuit has not been modified but it is to be understood that the amplifier and motor control, shown on said page 65, are contained with or in motor 13. In using the circuit, now being described, I am not interested in transmitting small movements but only in the reversible features of the motor and core 41 is used at its upper and lower limits to control the direction of rotation of motor 13. To further carry out this invention, leads 24 and 25 which are connected to contact 16 and trace 20 respectively control the operation of electron tube 32 to operate relay 38. When contact 16 touched trace 20, electron tube 32 in the circuit became biased to cut-off interrupting the flow of current through relay 38. When this happened the spring bias on the core of relay 38 moved the core of the relay 38 and core 41 to its opposite position reversing motor 13. Thus the contact 16 will now move upwardly away from the trace 20, relay 38 will again function, and the contact will again be moved towards trace 20. Thus contact 16 will "hunt" trace 20. If the contact 16 is originally below trace 20 (see Figure 1) the bias on the upper spring of the assembly of cores is adjusted to place core 41 opposite circuit 29, 30 of motor 13 and lever 39 is moved upwardly to position the coil of relay 38 below the core of relay 38. The operation will then be similar to that described for the case when the contact 16 moved downwardly onto trace 20. The electronic circuit to which leads 24 and 25 are connected including vacuum tube 32 and relay 38 are taken from Figure 8 of Patent No. 2,354,391, by A. R. McCourt. Instead of allowing the relay to operate a switch as shown in the McCourt patent, the relay 38 of the present invention moves the core 41 of the transformer to control motor 13 as to the direction of its rotation as described.

Switches 17 and 18 are overrun switches which operate through relay 19' to actuate relay 40. Overrun switches 17 and 18 may be actuated should inertia carry contact 16 past trace 20, or should vacuum tube 32 fail to function. Switches 17 and 18 are spring loaded and are of the type which are pushed to close and pushed again to open. Relay 40 is a large relay compared to relay 38 and operates to move core 41 to its center position once either of switches 17 or 18 is closed, overpowering relay 38 and the spring bias. Thus it can be seen that when either switch 17 or 18 becomes closed due to pressure of contact 16, relay 40 is operated to override relay 38, and the spring bias on the core assembly to cause core 41 to be moved to its center position. With core 41 moving to its center position, motor 13 then stops as the core 41 reaches its center position.

This circuit can be employed to carry out the modification of the invention shown in Figure 2 by connecting the lead 24 to contact 16 and lead 25 to plate 20. To use the circuit thus described

5

to carry out the modification of Figure 2, the manual set control 39 will have to be used in the reverse sense of its use in Figure 1.

Equivalent arrangements for causing contact 16 to follow trace 20, whether conducting or non-conducting, can be devised within the skill of the art.

Reasonable variation and modification are possible within the scope of the foregoing disclosure and the appended claims to the invention the essence of which is that means and manner of substantially instantaneously converting electrical values of "x" to corresponding values of "y" in a function $y=f(x)$ have been provided, as herein set forth and described, particularly in respect of the use of the tracing, conducting or non-conducting, of the function $y=f(x)$ the shape of which can be empirically determined, thus avoiding all time-consuming mathematical determinations or calculations which are especially involved in irregular curves or functions.

I claim:

1. An apparatus for obtaining, for different electrical values of "x," corresponding electrical values of "y," in a function $y=f(x)$, comprising in combination a tracing or graph of said function on a plate, the said trace and plate having different electrical conductivity characteristics, an electrically energized reversing relay, a contact adapted to close a circuit which conducts current to said reversing relay, the said contact being adapted to move in contact with said plate and tracing, means responsive to values of "x," to move said contact on said plate relative to said tracing, electrically operated reversible means to

6

which current is conducted under control of said reversing relay to maintain said contact upon said tracing, voltage varying means, and means coacting with movement of said contact to operate said voltage varying means.

2. An apparatus according to claim 1 in which said tracing is made of electrical current-conducting material and wherein said plate is made of non-conducting material.

3. An apparatus according to claim 1 wherein said tracing is made of non-conducting material and said plate is made of electrical current-conducting material.

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