Feb. 19, 1952 N. E. HANDEL 2,586,160

REPRODUCING APPARATUS

Filed Oct. 11, 1945 2 SHEETS—SHEET 1

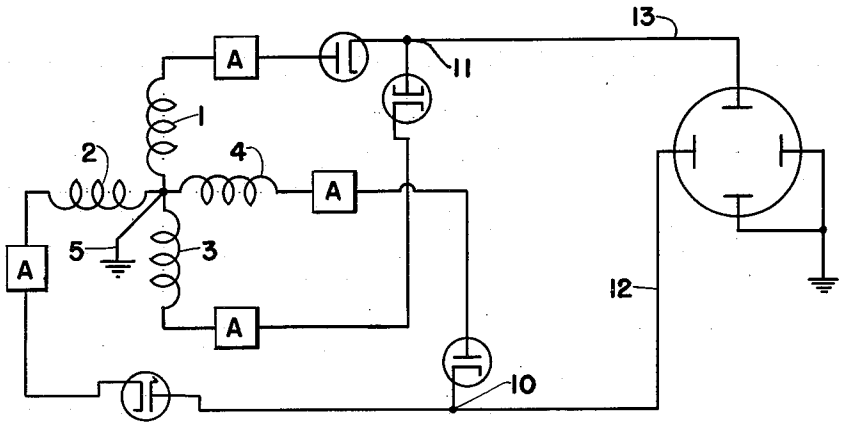


FIG. 1

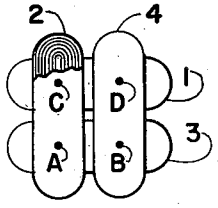


FIG. 2

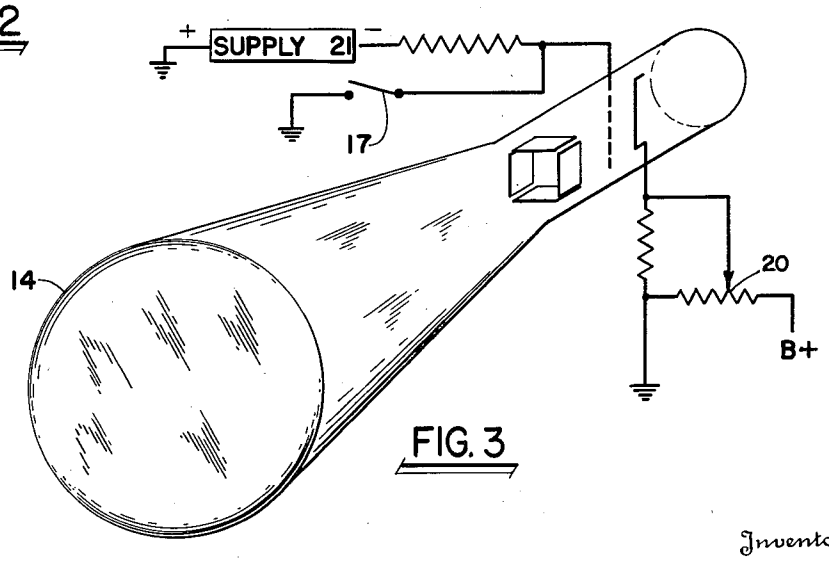


FIG. 3

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REPRODUCING APPARATUS

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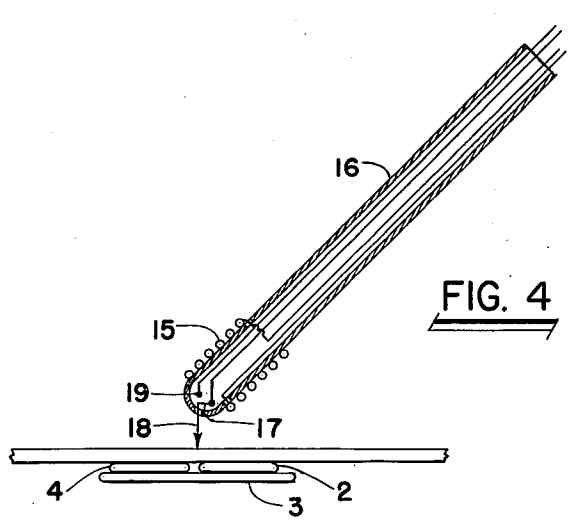


FIG. 4

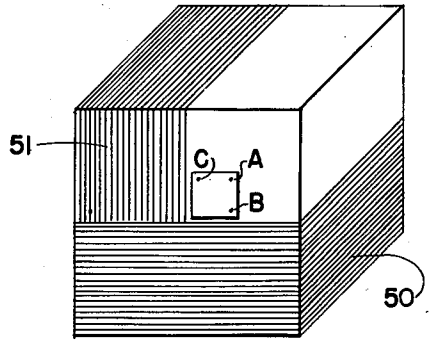


FIG. 5

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2,586,160

REPRODUCING APPARATUS

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Application October 11, 1945, Serial No. 621,832

8 Claims. (Cl. 178—18)

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This invention relates to electrical reproducing apparatus which has for its primary object the provision of means to accomplish a linear transformation from one plane to another of an electrical quantity with a one to one point correspondence and in such a manner as to preserve all angular relationships and ration of linear dimensions.

Another object of the invention is to provide an apparatus in which an electrical quantity is generated which is capable of transformation to a distant point and which is so composed as to preserve angular relationships and linear dimensions set up at the point of generation.

Still another object of the invention is to provide means whereby a motion, such as is involved in writing, can be portrayed on a distant screen of a cathode ray tube or other suitable indicator.

Other objects and advantages of the invention will become apparent from the following specification reference being had to the accompanying drawings in which:

Figure 1 is a diagrammatic representation of a stationary portion of a circuit embodying the present invention;

Figure 2 is a plan view of one form of the inductive apparatus which may be used in carrying out the invention;

Figure 3 is a diagrammatic representation of a cathode ray tube and associated brightening control circuits;

Figure 4 is a central vertical section of a suitable movable inductor for use with the invention; and

Figure 5 is a perspective view of a modified form of the stationary apparatus.

Referring to the drawings, the present invention provides means to generate two D. C. voltages which vary both in amplitude and polarity according to the movement of a stylus-carried inductor in an originating plane which will be more particularly described hereinafter. The D. C. voltages so produced vary in such a manner that their combination has always a unique relationship in a coordinate system. For example, if the face of a cathode ray tube is considered as a reproducing plane and as being divided into rectangular coordinates, the voltages produced by movement of the stylus-carried inductor in the originating plane must be such that for each point in the effective range of movement of the stylus in the originating plane there is only one point on the face of the cathode ray tube to which the beam of the tube will be deflected.

To accomplish the generation of these D. C. voltages the present invention provides four coils, designated 1, 2, 3 and 4 in Fig. 1, with coils 1 and 3 connected in series opposition and coils 2 and 4 likewise connected with the center point of each pair returned to ground as at 5. The output of each coil is connected to a separate amplifier having substantially uniform gain and the outputs of the several amplifiers are rectified. The rectifiers, which may be diodes, are connected oppositely for each end of a coil pair and are combined at 10 and 11 to give difference voltages proportional to the difference voltage existing in the corresponding pairs of pickup coils. Thus, a difference voltage in coil pair 1 and 3 appears at 11 while a difference voltage in coil pair 2 and 4 appears at 10. The D. C. voltages thus produced are connected to deflecting plates 12 and 13 of a suitable long persistence screen cathode ray tube 14 and determine the X and Y deflection of that tube.

As shown in Fig. 2 a preferred form of the invention comprises pickup coils in the shape of flat elliptical members disposed in two layers with coils 1 and 3 underlying coils 2 and 4. The elliptical shape is chosen for the reason that the region of linear operation can be extended since a movement of the stylus to be described from point A to point B in Fig. 2 will produce the same voltage in coil set 2 and 4 as a movement from point C to point D. (Points B and D are equally spaced with respect to the center line of the coils from points A and C.) The pickup coils are disposed under a plate of non-conducting material (not shown) in order to provide a smooth writing surface, the active, linear area being marked on the plate.

A stylus-carried inductor is provided which preferably includes a small exciter coil 15 wound around a holder 16 and generally in the form of a solenoid which is long compared to its diameter in order that the field produced by the upper end may have an inconsiderable influence in the system. The coil 15 is energized from a suitable source of alternating current of any desired frequency although frequencies between 10 kc. and 30 kc. are preferred. Movement of the exciter coil 15 over the plate overlying the coil set shown in Fig. 2 results in voltages being induced in coils 1, 2, 3 and 4 which vary depending on the mechanical position of exciter coil 15. When these voltages are combined and rectified it will be found that the deflection of the beam of the cathode ray tube 14 is such that the position of the beam corresponds with the position of the stylus in the field. Thus a line drawn by the

stylus in the field will be reproduced on the screen of the cathode ray tube and if the line is curved as in writing the beam trace on the face of the tube will be likewise curved. It has been found that messages may be written with the stylus 16 and such messages are legible for a period sufficient to carry the desired intelligence on the screen of tube 14. By increasing or decreasing the brightness, the persistence of the screen may be varied and the message made to last a longer or shorter period at the will of the operator.

Since it is desirable to trace only the intentional motions imparted to the stylus 16 by the operator a brightness control is incorporated which consists of a small spring switch 17 at the base of the holder 16. The switch 17 is comprised of a leaf spring one end of which is fixed to the holder 16 and the other end of which is connected to a stylus point 18. The spring cooperates with stationary contacts 19 which are connected in the grid circuit of the cathode ray tube as indicated in Fig. 3.

As shown in Fig. 3 the cathode ray tube is provided with the conventional brightness control 20 in the cathode circuit and an auxiliary negative bias supply 21 is provided for the control grid of the tube. When the negative supply is connected to the grid the brightening is cut down so that the beam spot is invisible on the tube face. Switch 17 is disposed in parallel with the negative supply and is adapted to short the supply to ground whenever the switch is closed. Thus when the operator presses holder 16 so that the point of stylus 18 bears against the writing surface, as it will in use, switch 17 is closed, the negative supply 21 shorted, and the full brightness of the beam takes place. As previously stated, the degree of brightness is controlled by the conventional brightness control potentiometer 20. However, as soon as the operator releases the holder 16 and stylus 18 from the writing surface, switch 17 opens and the brightness of the cathode ray tube is immediately reduced so that the spot is invisible.

In the apparatus so far described a D. C. voltage is produced which varies both in amplitude and polarity depending on the position of the exciter coil 15 in the field of coils 1, 2, 3 and 4. In the modification shown in Fig. 5 D. C. voltages are produced which are always of the same polarity but which vary in amplitude depending on the position of the stylus in the field. In this modification the coil set is prepared by winding over a cubical form in such a manner that substantially half of the form is covered with wire forming a coil 50 and a second coil 51 is prepared by covering substantially half of the same face of the cube but with its turns at right angles to the turns of coil 50. In the modification the active area is shown as a square outside of each coil 50 and 51. It will be found that if the exciter coil is moved from point A to point B in a line parallel to the turns of coil 51 but perpendicular to the turns of coil 50, there will be produced a substantially linear increase in voltage in coil 50 and no change in the voltage in coil 51. Similarly, motion from point A to point C parallel to the turns of coil 50 and perpendicular to the turns of coil 51 will produce a linear increase in voltage in coil 51 and no change in voltage in coil 50. Obviously, a movement of the exciter coil which has a component in each of the two coordinate directions will change the voltage in each coil.

Since the modified form shown in Fig. 5 provides D. C. voltages which vary in amplitude only it is necessary to bias the deflecting plates of the cathode ray tube so that the center of the system is at one corner of the tube and the D. C. voltage is used to overcome the initial bias. It may be pointed out that such a system lends itself very well to the production of mirror images of the motion of the exciter coil in the field as well as exact correspondence to such motion.

The invention as so far described has been limited to using the D. C. voltages produced by movement of the exciter coil to position the beam spot of a cathode ray tube so that writing, for example, may be reproduced at a distance. It will be apparent that radio or wire transmission is equally feasible. It is only necessary to provide a carrier which is subject to modulation or modification by a variable amplitude voltage. The simplest embodiment of this invention comprises a carrier which is amplitude modulated by two sub-carriers, one representing X axis deflection and one representing Y axis deflection. These sub-carriers are frequently modulated by the X and Y deflection voltages. As the X axis deflection changes, the degree of frequency deviation of its sub-carrier may be changed in a manner well known in the frequency modulation broadcasting art. At the receiving end a discriminator having its center frequency coordinated with the sub-carrier frequency will demodulate the sub-carrier and give a D. C. voltage which varies in amplitude and polarity in exactly the same manner as the D. C. voltage which was originally used to modulate the X axis sub-carrier. The second sub-carrier system corresponding to the Y axis deflection may be similarly demodulated and utilized to operate an indicator. A combination of the outputs of two discriminators can, of course, be used to deflect the beam of a cathode ray tube associated with the receiver.

The brightening control which corresponds to the opening and closing of switch 17 is transmitted, in this system, as a third sub-carrier which is present when brightening is desired and absent when it is not. As previously stated, the techniques required for long distance transmission of these voltages are well known.

While the invention has been described in connection with two preferred modifications, it will be appreciated that various other modifications and changes may be made therein without departing from the scope of the invention as defined in the appended claims. For example, the one to one point correspondence described may be altered to give any desired degree of comparison or expansion in either or both dimensions by properly designing the pickup coils.

What is claimed is:

1. Apparatus for the visual reproduction of a plurality of different angular motions which includes a stationary inductor comprising separate rectangularly related coils disposed on each side of a pair of intersecting coordinate axes, a movable inductor cooperating with said stationary inductor and having imparted thereto the motion to be reproduced, means to supply an exciting voltage to said movable inductor, and means to indicate visually the phase and magnitude of a voltage induced in said stationary inductor by said exciting voltage.

2. Apparatus for the visual reproduction of a plurality of different angular motions within a plane which includes a stationary inductor comprising separate rectangularly related coils disposed on each side of a pair of intersecting co-

ordinate axes, said coils being located below the plane of motion, said coils functioning in pairs with the coils in each pair being connected in series opposition, a movable inductor cooperating with said stationary inductor and having imparted thereto the motion to be reproduced, means to supply an exciting voltage to said movable inductor, and means to indicate visually the phase and magnitude of a voltage induced in said stationary inductor by said exciting voltage.

3. Apparatus for the visual reproduction of a plurality of different angular motions within a plane which includes a stationary inductor comprising separate rectangularly related coils disposed on each side of a pair of intersecting coordinate axes, said coils being located below the plane of motion, the coils associated with each coordinate axis being connected in series opposition, a movable inductor cooperating with said stationary inductor and having imparted thereto the motion to be reproduced, means to supply an exciting voltage to said movable inductor, means to amplify and rectify the voltage induced in each coil of said stationary inductor, and a visual indicator actuated by said rectified voltages, the position of the indicating element of said indicator being dependent on the sign and relative amplitude of said rectified voltages.

4. Apparatus in accordance with claim 3 in which said visual indicator includes a cathode ray tube the beam of which is deflected by said rectified voltage to follow the motion of said movable inductor.

5. Apparatus for the visual reproduction of a plurality of different angular motions within a plane which includes a stationary inductor comprising separate rectangularly related coils disposed on each side of a pair of intersecting coordinate axes, a plurality of coils connected in series opposition being associated with each coordinate axis, the coils associated with one of said axes being disposed above the coils associated with the other of said axes, all of said coils being located below the plane of motion, a movable inductor cooperating with said stationary inductor and having imparted thereto the motion to be reproduced, means to supply an exciting voltage to said movable inductor, means to amplify and rectify the voltage induced in each coil of said stationary inductor, a cathode ray tube, means carried by said movable inductor to control the brightening of said cathode ray tube, and connections whereby the beam of said cathode ray tube is deflected by said rectified voltages.

6. Apparatus for the visual reproduction of a motion which includes a stationary inductor comprising separate rectangularly related coils disposed on each side of a pair of intersecting coordinate axes, a movable inductor cooperating with said stationary inductor and having imparted thereto the motion to be reproduced, means to supply an exciting voltage to said movable inductor, means to amplify and rectify the voltage induced in each coil of said stationary

inductor, a cathode ray tube, means to transmit said rectified voltages to said cathode ray tube whereby the beam of said tube is deflected by said rectified voltages, switch means carried by said movable inductor, and means to utilize an electrical quantity controlled by said switch means to control the brightening of said cathode ray tube.

7. In a reproducing apparatus including a writing surface, a stationary inductor disposed beneath said writing surface, said stationary inductor comprising separate rectangularly related coils disposed on each side of a pair of intersecting coordinate axes, the coils associated with each coordinate axis being a pair connected in series opposition with the pair associated with one axis being disposed above the other pair, a movable inductor cooperating with said stationary inductor and having imparted to it a motion to be reproduced, means to supply an exciting voltage to said movable inductor, means to amplify and rectify the voltage induced in each coil of said stationary inductor, a cathode ray tube, means to transmit said rectified voltages to said cathode ray tube whereby the beam of said tube is deflected by said rectified voltages, switch means carried by said movable inductor adapted to be closed when said movable inductor bears against the above mentioned writing surface, and means to utilize an electrical quantity controlled by said switch to control the brightening of said cathode ray tube.

8. In reproducing apparatus for reproducing a motion including a stationary inductor comprising a first and second coil wound about a portion of a cubical form with one of said coils disposed normal to the other to form intersecting coordinate axes, a movable inductor cooperating with said stationary inductor and having imparted thereto the motion to be reproduced, means to supply an exciting voltage to said movable inductor, means to amplify and rectify the voltage induced in each coil of said stationary inductor, a cathode ray tube, means to transmit said rectified voltages to said cathode ray tube whereby the beam of said tube is deflected by the rectified voltages, switch means carried by said movable inductor, and means to utilize an electrical quantity controlled by said switch means to control the brightening of said cathode ray tube.

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