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POINT PLOTTER FOR GRAPHIC RECORDER

William D. Rempel, Poway, and Marvin L. Underhill,
Ramona, Calif., assignors to Hewlett-Packard Com-
pany, Palo Alto, Calif., a corporation of California
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3 Claims

ABSTRACT OF THE DISCLOSURE

An electromagnetic actuator drives a marking pen for selectively producing point plots on a graphic chart. The operating speed and freedom from undesirable resonances and frictional binding are enhanced by the use of a permanent magnet in place of conventional springs for returning the actuator to its static or normal position.

BACKGROUND AND SUMMARY OF THE INVENTION

Certain known graphic point plotters commonly include solenoid actuators which respond to applied signals for moving a point marker into contact with a graphic chart at selected locations thereon determined by X- and Y-coordinate input data. Apparatus of this type is described in the literature (see, for example, U.S. Pat. 2,976,103 issued on Mar. 21, 1961 to R. N. Flanders et al.). One disadvantage encountered with apparatus of this type is that the springs which are commonly used to supply the restoring force for the movable actuator in combination with the mass of the actuator generally produce undesirable mechanical resonances which limit the speed at which the apparatus can plot points reliably. Also, springs tend to induce misalignment of the moving points, thereby introducing friction and the tendency of the parts to bind up.

Accordingly, the present invention includes a permanent magnet which cooperates with the movable actuator to provide a resilient restoring force therefor without the aid of springs and which also polarizes the movable actuator for providing electromagnetic repulsion force with which to move the actuator in a direction toward a graphic chart.

DESCRIPTION OF THE DRAWING AND PREFERRED EMBODIMENT

The drawing is a pictorial diagram of the plotter of the present invention which is disposed to move about the surface of a graphic chart along coordinate axes. The plotter 9 includes inner and outer body elements 11 and 13, respectively, of nonmagnetic material with a ring-shaped permanent magnet 15 disposed therebetween about midway along the total length of the body. The hollow inner body element 11 attaches at the lower end thereof to the outer element 13 for clamping the assembly to a mount 12 and also serves as a guide for the actuator 17 that is longitudinally slidable within the hollow inner body element 11. The actuator 17 includes at the lower end a marking implement 19 such as a pen tip or a stamp character, or the like and includes at the upper end a slug 21 of soft iron or other magnetic material which is positioned at about the same location along the length of the body as the magnetic ring 15. The slug 21 and the attached actuator 17 and marking implement 19 are thus maintained in an elevated rest position by the slug attaining a position of approximately least flux reluctance within the magnetic ring 15. This magnetic attraction thus provides a resilient

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restoring force that elevates and retains the actuator 17 to its rest position against the force of gravity.

The presence of the slug 21 of magnetic material in the magnetic field of ring magnet 15 magnetically polarizes the slug 21. A coil or winding 23 is disposed about the inner body element 11 below the location of the ring magnet 15 and is arranged to produce a magnetic field in response to signal applied thereto from plotter control 25. The magnetic field thus produced is magnetically linked to the slug 21 and causes it to be attracted in the axial direction toward alignment or centering between the ends of the coil 23. This axial movement carries the actuator 17 and marking implement 19 in a downward direction to produce a mark 27 on a graphic chart 29 at the location thereon contacted by the marking implement 19. Upon termination of the signal applied to the coil 23 from plotter control 25, the magnetic field about coil 23 collapses and the slug is attracted toward alignment or centering position between the ends of the ring magnet 15. This elevates the actuator 17 and marking implement 19 to the rest position out of contact with the chart 29. Conventional X-axis and Y-axis position systems 31, 33 mechanically coupled to the mount 12 for the assembly by conventional support and drive means may reposition the present apparatus at a new location on the graphic chart according to X- and Y-coordinate information. The plotter may be actuated again by signal applied thereto from the plotter 25 to produce a mark on the chart at the new location in the manner described above. Thus, with proper driver signals applied to the coil 23, the apparatus as described above has been operated at rates of the order of 50 strokes per second.

Therefore, the present apparatus provides high-speed plotting of graphic points along coordinate axes without the use of springs to provide restoring force to the marking implement. The absence of springs aids in minimizing the effects of undesirable mechanical resonance commonly associated with high-speed reciprocating motion.

We claim:

1. Plotter apparatus disposed to be supported for movement along coordinate axes above a graphic chart of a graphic recorder, the apparatus comprising:
 - an elongated hollow body of non-magnetic material;
 - an actuator disposed within said hollow body for reciprocating motion therein and including an element attached at an end thereof which protrudes from said body for forming contrasting marks on a graphic chart and including a member of magnetic material attached to said actuator at a location thereon remote from said element;
 - a magnet disposed in said body at a location thereon in substantial alignment with said member in a rest position for retaining said member at said rest position by the magnetic flux force established between said magnet and member;
 - an electromagnetic winding disposed on said body at a location therealong displaced from the location thereon of said magnet in the direction toward the protruding end of said actuator to produce a magnetic field coupled to said member in response to a signal applied to said winding for moving said actuator from said rest position in a direction that increases the protrusion from said body of the end of said actuator having said element attached thereto.
2. The apparatus of claim 1 wherein:
 - said magnet is coaxially disposed about said member; and
 - said winding is coaxially disposed about said member at a location on said body that is displaced from

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the location of said magnet in a direction toward the protruding end of said actuator.

3. Apparatus as in claim 2 comprising:

means coupled to said body for selectively positioning the body along coordinate axes; and

control means connected to said winding for selectively applying signal thereto to move the actuator for producing a contrasting mark at a selected position of said body along coordinate axes.

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References Cited

UNITED STATES PATENTS

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5 JOSEPH W. HARTARY, Primary Examiner

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