United States Patent [19]

Taylor

[11] **3,830,976**

[45] **Aug. 20, 1974**

[54] **PRINTING TELEGRAPH MECHANISM**

[75] Inventor: **Terrence Francis Edward Taylor,** Burgess Hill, England

[73] Assignee: **International Standard Electric Corporation,** New York, N.Y.

[22] Filed: **June 1, 1973**

[21] Appl. No.: **366,220**

[30] **Foreign Application Priority Data**

June 1, 1972 Great Britain 25597/72

[52] **U.S. Cl.** ..... **178/30,** 178/33, 197/1 R, 346/141

[51] **Int. Cl.** **B41j 9/38,** H04l 21/00

[58] **Field of Search** ..... 178/17 R, 27, 30, 33; 346/141; 310/103, 105; 335/229; 197/1 R

[56] **References Cited**

UNITED STATES PATENTS

3,477,365 11/1969 Nyman ..... 346/141 X

Primary Examiner—Thomas A. Robinson

Attorney, Agent, or Firm—A. Donald Stolzy

[57] **ABSTRACT**

The styli of a mosaic printhead are each attached to switchable conductive loops positioned in a gap between a pole piece and a rotatable magnetic member. The rotatable member is rotated continuously and periodically induces currents in closed, conductive short circuited loops thus causing them and their associated styli to move.

10 Claims, 15 Drawing Figures

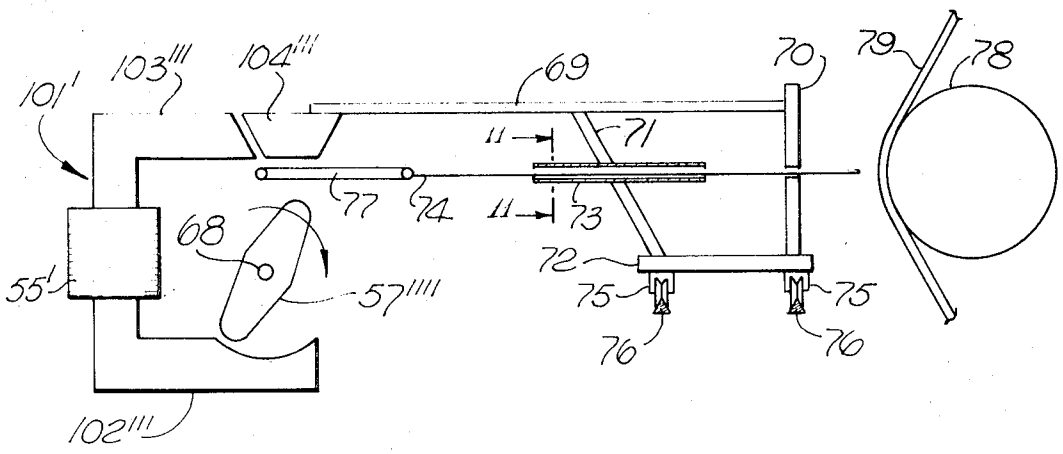
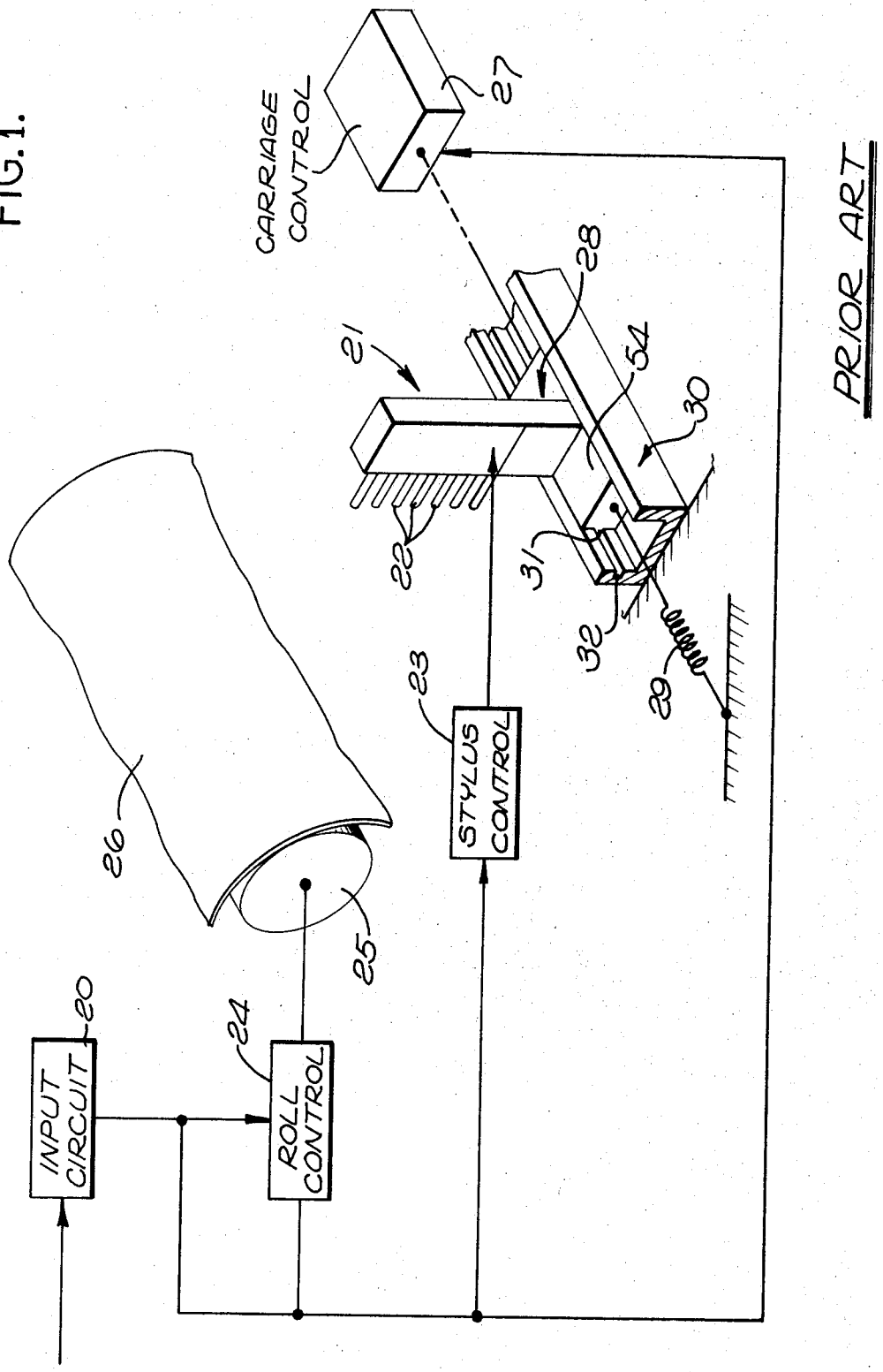


FIG. 1.



PRIOR ART

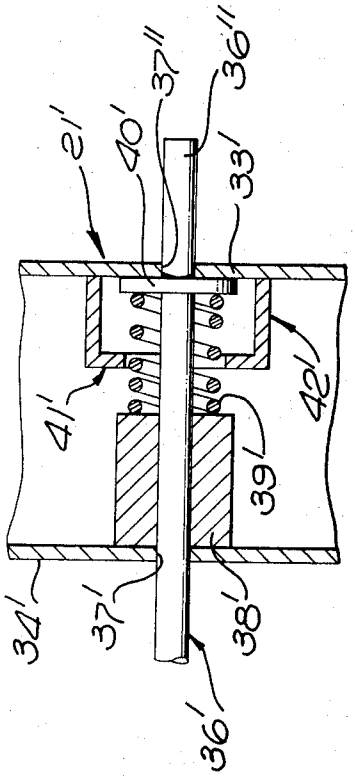


FIG. 4.

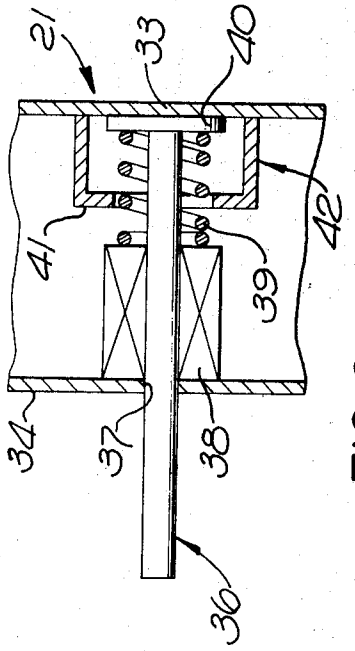


FIG. 2.

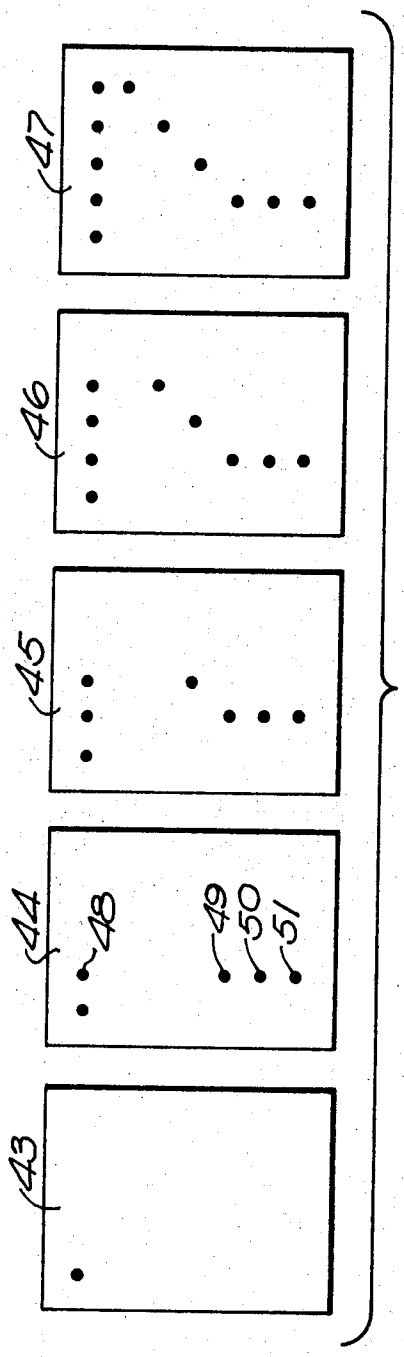


FIG. 3.

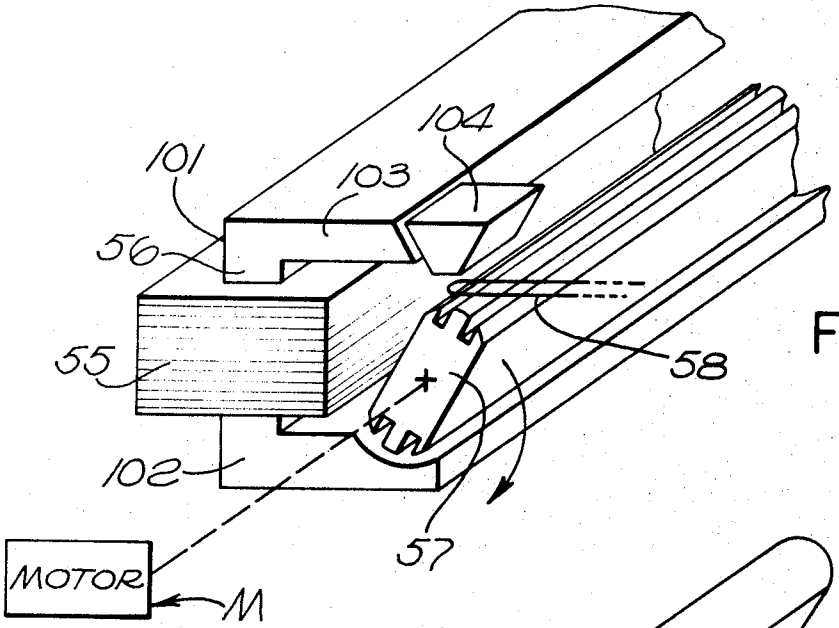


FIG.5.

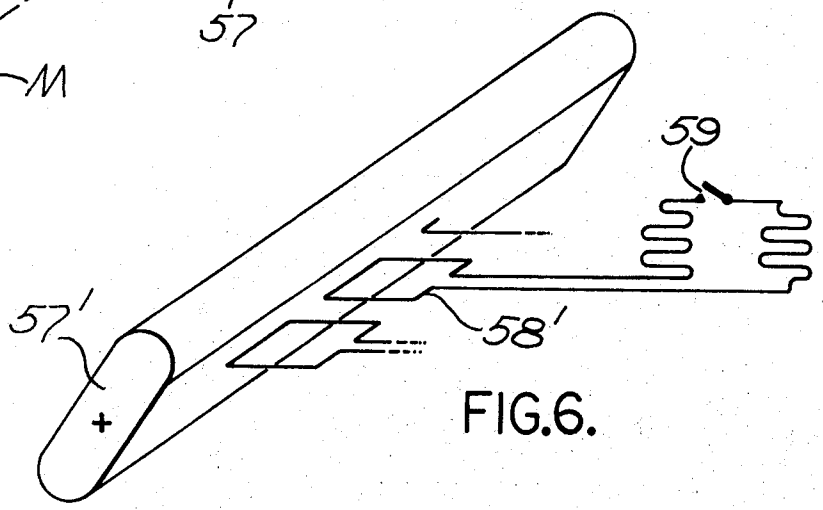


FIG.6.

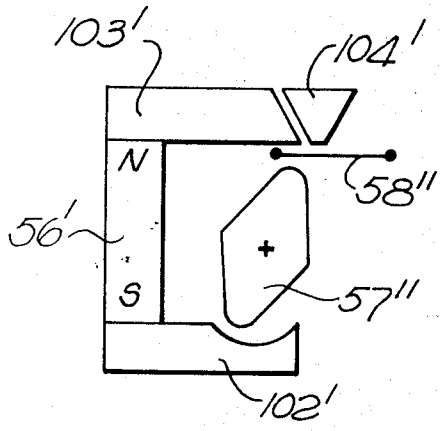


FIG.7.

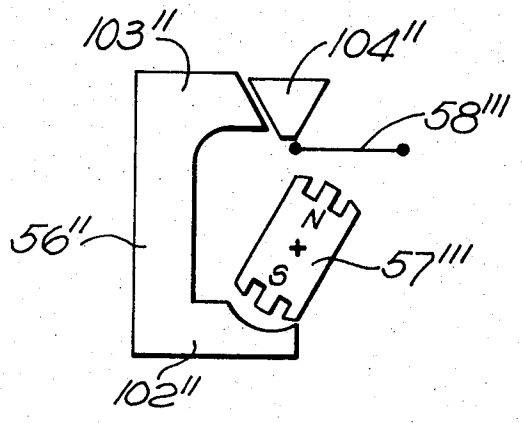


FIG.8.

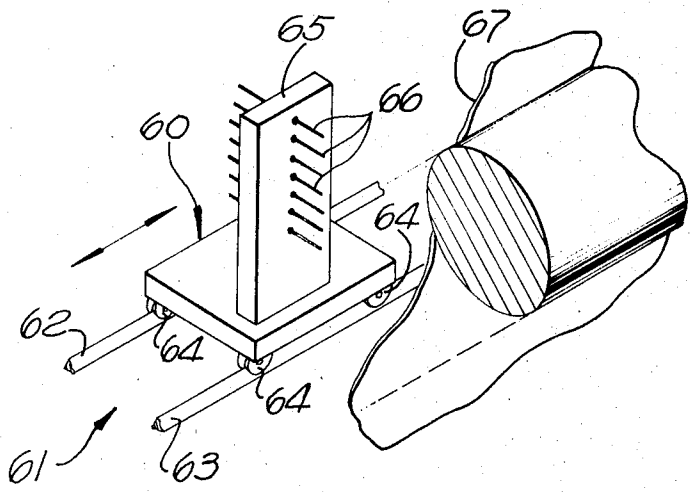


FIG. 9.

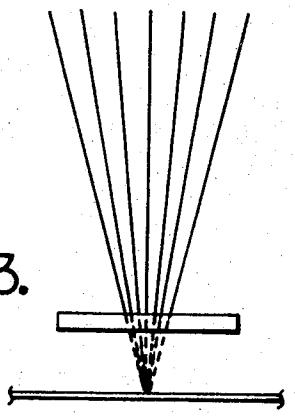


FIG. 13.

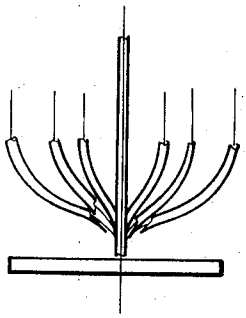


FIG. 14.

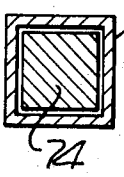


FIG. 11.

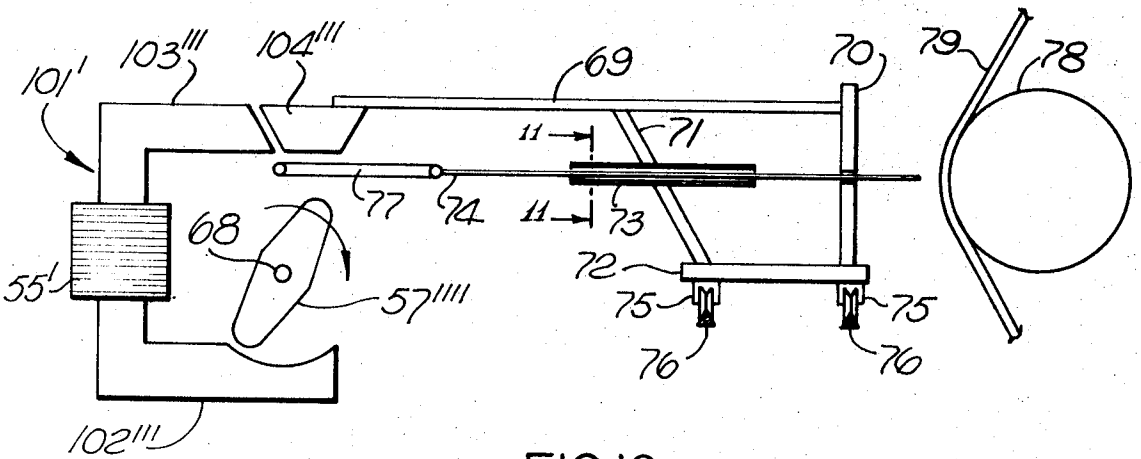


FIG. 10.

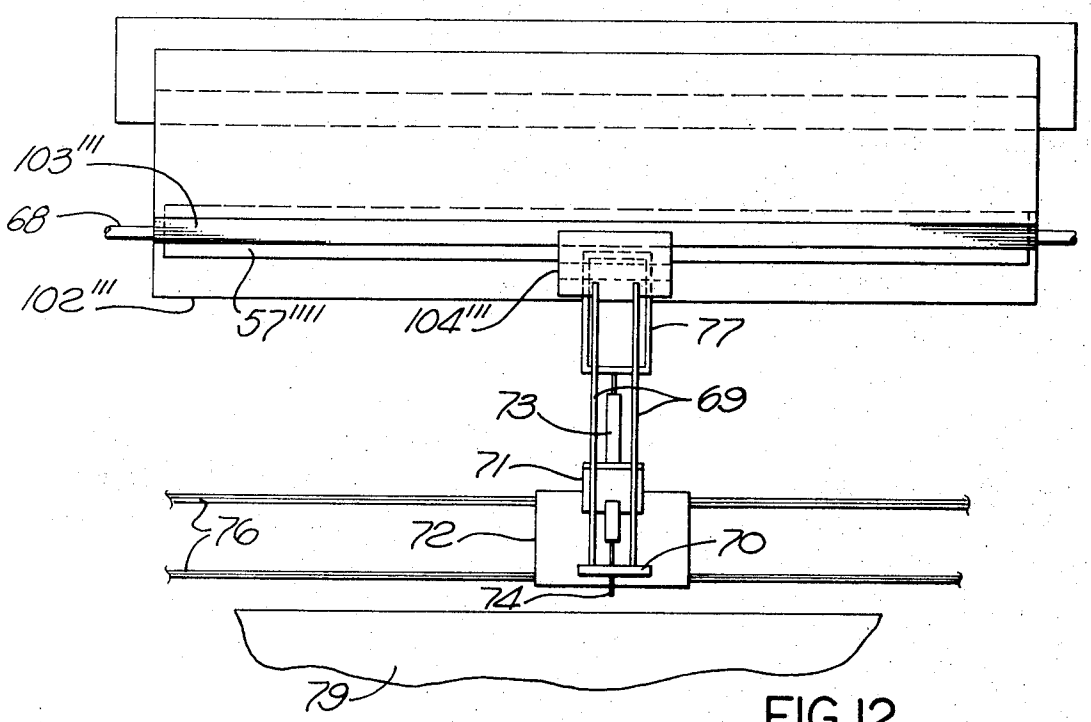
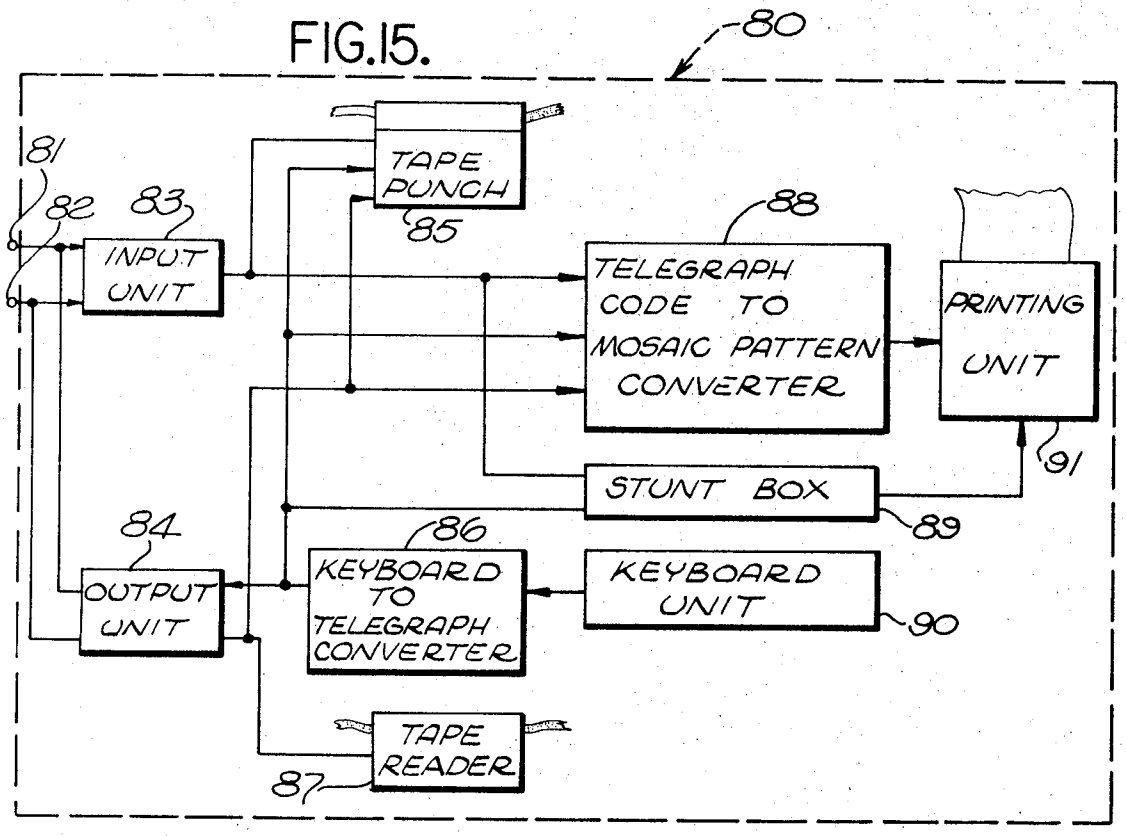

103'''
68
102'''
57''''
104'''
77
73
69
71
76
72
70
74
79

FIG.12.

FIG.15.


80
81
82
83
INPUT UNIT
TAPE PUNCH
85
88
TELEGRAPH CODE TO MOSAIC PATTERN CONVERTER
PRINTING UNIT
91
STUNT BOX
89
84
OUTPUT UNIT
86
KEYBOARD TO TELEGRAPH CONVERTER
KEYBOARD UNIT
90
TAPE READER
87

PRINTING TELEGRAPH MECHANISM

BACKGROUND OF THE INVENTION

This invention relates to the art of serial printing, and more particularly, to a method of printing mosaic characters.

In the past, it has been the practice to print a mosaic character by employing a vertical column of styli equal to the character height and printing no dots or one or more dots by styli actuation at successive different horizontally spaced columns over a character width. Typically a column from 7 to 15 styli may be employed at from 5 to 9 of said horizontal locations. The styli spacing is conventionally, but not necessarily, uniform. So is the location spacing. These two may or may not be equal, as desired.

The styli are typically mounted on a movable carriage on which styli actuators are supported. The actuators and other apparatus on the carriage increase the inertia thereof and decrease its advancing and return acceleration, deceleration and velocity, both maximum and average. This is a disadvantage in the operation of a high speed machine.

SUMMARY OF THE INVENTION

In accordance with the mechanism of the present invention, the above-described and other disadvantages of the prior art are overcome by utilizing a lightweight induced current activated conductive loop to operate a stylus.

The above-described and other advantages of the present invention will be better understood from the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a conventional mosaic printer;

FIG. 2 is a sectional view of a portion of a stylus head, a portion of which may be employed with the present invention;

FIG. 3 is a top plan view of a portion of a recording medium in five states of the development of a mosaic character thereon, the character being the numeral 7;

FIG. 4 is a view similar to FIG. 2, but modified in accordance with the present invention;

FIG. 5 is a perspective view of an electromagnetic arrangement constructed in accordance with the present invention;

FIG. 6 is a perspective view of a rotatable magnetic member, conductive loops and a switch;

FIGS. 7 and 8 are end elevational views of two alternative embodiments of the present invention;

FIG. 9 is a perspective view of apparatus similar to that illustrated in FIG. 1 modified as in FIG. 4;

FIG. 10 is a side elevational view of a portion of the apparatus of the present invention;

FIG. 11 is a transverse sectional view of a stylus portion and support tube portion taken on the line 11—11 shown in FIG. 10;

FIG. 12 is a top plan view of the apparatus shown in FIG. 10;

FIGS. 13 and 14 are alternative embodiments of the present invention; and

FIG. 15 is a block diagram of a telegraphic machine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A conventional prior art mosaic printer is shown in FIG. 1 including an input circuit **20** which receives and stores, for example, a serial binary code which determines which, if any, of a plurality of styli in a column are to be employed to print dots on a recording medium. Input circuit **20** thus controls a stylus head **21** and the individual styli thereof through a stylus control **23.** Input circuit **20** also controls a roll control **24** for a roll **25** which supports a recording medium **26** such as inked paper. Input circuit **20** also controls a carriage control **27** which pulls a carriage **28** in a direction to the right, as viewed in FIG. **1,** against the force of a spring **29** which is fixed at its left end connected to carriage **28** at its right end. Head **21** is fixed to carriage **28.** Carriage **28** has a single guide **30** in which carriage **28** is guided by a tongue **31** that fits in a groove **32** of channel **30.**

As shown in FIG. **2,** stylus head **21** includes a rear wall **33** and a front wall **34.**

In FIG. **2,** a stylus **36** is slidable through a hole **37** in wall **34.** A solenoid winding **38** is fixed to wall **34.** Stylus **36** is thus slidable through winding **38.** A coiled spring **39** rests against the right end of winding **38** and urges stylus **36** in a direction toward wall **38.** Stylus **36** has a flange **40** fixed to the end thereof which is pressed against wall **33** by spring **39.** Movement of stylus **36** in a direction to the left, as viewed in FIG. **2,** is stopped by engagement of flange **40** with a flange **41** on a cylinder **42** fixed to wall **33.**

In the prior art, and in accordance with the present invention, dots may be made on paper **26** by the impact of the end of a stylus thereagainst.

In the prior art, a mosaic character may be formed as shown in FIG. **3** The same portion of a recording medium is illustrated at **43, 44, 45, 46** and **47.** It will be understood when no solenoid corresponding to solenoid **38** in FIG. **2** is energized for any of the styli **22** shown in FIG. **1,** a space will be left on the recording medium. However, this space will not be one character space, but, for example, may be only one-fifth of a character space. When one or more dots in one column are produced, all of these dots may be made simultaneously.

As shown in FIG. **3,** the dot in rectangle **43** is made before the other dots are made. Dots **48, 49, 50** and **51** then may be made simultaneously thereafter. One or more additional dots are added in each column until the numeral seven is portrayed in rectangle **47.**

In accordance with the present invention, the chronological order in which the dots are made may or may not be as described hereinbefore and as shown in FIG. **3.**

A stylus head **21'** is indicated in FIG. **4.** A stylus **36'** is shown in FIG. **4** slidable through a hole **37'** in a wall **34'.** A hollow cylinder **38'** may be slidable on stylus **36'** or fixed to wall **34',** if desired. In either event, stylus **36'** is slidable through cylinder **38'.** A coiled spring **39'** rests against the right end of cylinder **38'** and urges stylus **36'** in a direction toward a wall **33'.** Stylus **36'** has a flange **40'** fixed relative thereto which is pressed against wall **33'** by spring **39'.** Movement of stylus **36'** in a direction to the left, as viewed in FIG. **4,** is stopped by engagement of flange **40'** with a flange **41'** on a cylinder **42'** fixed to wall **33'.**

Note will be taken that the stylus head **21'** in FIG. **4** does not differ a great deal from the stylus head **21** in FIG. **2.** One difference is that, in FIG. **4,** cylinder **38'** replaces solenoid winding **38** in FIG. **2.** Still further, rear wall **33'** has a hole **37''** therethrough through which an extension **36''** slides.

In some cases, all of the structures illustrated between the walls **33'** and **34'** may be omitted with the exception of stylus **36'**. In some cases, flange **40'** may also be omitted. Note will be taken that, as shown, stylus **36'**, flange **40'** and extension **36''** are fixed relative to each other.

Because of the mass of a print wheel which bears all the symbols likely to be required at a given time by a dataprinter, and of the time taken to position a required symbol at the point of printing, the development of mosaic printers has been looked upon favorably. In these printers, symbols to be printed are built up by the selective printing of dots at positions in an array, usually rectangular, of possible positions. A rectangular array of 35 dots, seven rows by five columns enables a readable representation off the roman letters and arabic numerals to be obtained. Instead of using 35 printing styli, or needles, and selecting all those needed for a particular symbol at the same time, mass can be saved by printing the five columns in succession, using only seven needles. In one commercially available printer of this kind, each needle is driven by its own individual solenoid, the mass of which is some 30 grams. In the interest of speed and reduced wear, it is desirable to reduce this mass even further. This is accomplished in accordance with the present invention.

In the drawings, in FIG. **5,** a magnetic yoke **101** is shown. It is of substantially U-shaped cross section which is at least as long as a record web is wide. The record web is that on which the symbols are printed. One limb **102** of the yoke **101** is shaped as a pole piece and another limb **103** cooperates with a short pole piece **104** attached to a printhead carriage. The pole piece **104** causes a local concentration of the magnetic flux produced by the magnetic at the place where it is most useful and so helps to reduce power supply requirements.

A conductive coil **55** encircles a third limb **56** which joins together limbs **102** and **103.** By means of electric current in this coil, the magnetic assembly can be energized. Alternatively, yoke **101** and its limbs **102** and **103** and winding **55** are shorter than the web width, but are replicated across it and are energized in succession, this again reducing the power supply requirements.

A rotatable magnetic member **57** coextensive at least with the width of the record web is mounted to rotate around an axis parallel to its length between the pole pieces, fitting closely in the curved pole piece of limb **102,** but being separated from the pole piece **104** by a distance sufficient to allow a conductive loop **58** to perform a linear movement generally perpendicular to the length of the pole piece and to the record web. The loop, which is rigid, is rigidly connected to a printing needle carried on the printhead carriage, which can be made to traverse the width of the record web in order to print a line of graphical symbols. As many loops **58** as there are printing needles are provided. To each loop **58** there may or may not be connected a switch **59** as shown in FIG. **6** through trailing conductors or slip "rings," for instances. The pole piece **104** is long enough to cover the loops of all the needles which may be actuated at any one instant.

The rotatable member **57** is caused to rotate continuously by a synchronous motor M or a motor synchronous with the incoming message. Motor M may be shut down, on occasion, if desired.

If motor M is synchronous with the incoming data, the column print data should be spaced in some cases to prevent a printout in two columns.

If motor M is a synchronous motor, it should be fast enough to produce one stylus movement for each set of column data. The data for one column should also be spaced in time to prevent a printout in two columns or between columns.

Motor M is energized at least while the yoke **101** is energized. When any switch **59** is closed, cyclic flux variations, when motor M is running and winding **55** is energized, induce a current in the appropriate conductive loop **58** which sets up its own magnetic field. The interaction of the magnetic field produced by the induced current and the field in the gap between pole pieces **104** and rotatable member **57** causes the loop, and the needle rigidly connected thereto, to move towards the record web, the needle thereby printing a dot. This happens as the narrow face of the rotatable member **57** moves to a position at or near conductive loop **58.** Thus, by selective closure of the switches **59,** selected loops **58** and their associated needles are moved.

The switches **59** are controlled either from a keyboard or by signals received from some more or less remote source, and may be any kind of switching device which when closed, or in a conducting condition, offers negligible impedance to the induced currents in an associated loop.

In FIG. **7,** a different yoke arrangement is shown. Here limbs **102'** and **103'** and pole piece **104'** are as in FIG. **5,** but the coil **55** is dispensed with and a permanent magnet forms the limb **56'**.

Yet another arrangement is shown in FIG. **8.** Here limbs **102''**, **103''** and **56''** are as in FIGS. **5** and **6,** as is pole piece **104''**, but rotating member **57'''** is itself a permanent magnet. This arrangement, of course, causes complete flux reversal within the magnetic yoke for each rotation of the member **57'''**.

Pole piece **104** may be coextensive with limb **103** and attached thereto instead of being carried on the printhead, although this does not conserve power as does the travelling pole piece.

In FIG. **9,** a carriage **60** rolls on a track **61** having rails **62** and **63.** Carriage **60** and wheels **64** that roll on track **61.** A support and guide plate **65** is fixed to carriage **61.** Styli **66** are movable through plate **65.** A record web **67** is indicated adjacent styli **66.**

In FIG. **10,** a magnetic yoke **101'** is illustrated with an energizing winding **55'**. Yoke **101'** has a stationary upper limb **103'''** and a stationary lower limb **102'''**. A rotatable magnetic member **57'''** is fixed to and rotatable by and with a drive shaft **68.** A traversing pole piece **104'''** is shown adjacent the limb **103'''**. A pole piece support beam **69** rigidly connects pole piece **104'''** with a support and guide plate **70.** A rear support and brace **71** is fixed to beam **69** and a carriage **72.** Brace **71** also has a support tube **73** fixed thereto through which a stylus **74** is slidable. Carriage **72** has wheels **75** as before, which travel on rails **76.** A conductive loop **77** is fixed to stylus **74.** A platen **78** is pro-

vided on which a web **79** is movable. Platen **78** rolls, but need not have a carriage. It can stay in a fixed axial position.

Plate **70** may or may not be identical to stylus head **21'** of FIG. **4.**

In FIG. **10**, stylus **74** may have a uniform circular cross section throughout its length except for a square portion thereof shown in tube **73.** Tube **73** may or may not be square in cross section throughout its entire length. However, it is square over a portion of its length that stylus **74** is square. Alternatively, no means or some other means may or may not be provided to keep stylus **74** and loop **77** from turning about the axis of stylus **74.** Stylus **74** may or may not be spring biased.

In FIG. **12,** stationary upper limb **103'''** is again shown with drive shaft **68,** rotatable magnetic member **57'''**, stationary lower limb **102'''**, traversing pole piece **104'''**, conductive loop **77,** pole piece support beams **69,** support tube **73,** brace **71,** carriage **72,** rails **76,** plate **70,** stylus **74,** and web **79.** Note will be taken that there are two pole piece beams **69** in both of the FIGS. **10** and **12.**

In FIG. **15,** a telegraphic machine is indicated at **80** having telegraphic lines **81** and **82** connected thereto. Telegraphic machine **80** has input and output units **83** and **84,** respectively. Telegraphic machine **80** also has a tape punch **85,** a keyboard to telegraph code converter **86,** a tape reader **87,** a telegraph code to mosaic pattern coverter **88,** a stunt box **89,** a keyboard unit **90,** and a printing unit **91.**

Telegraphic lines **81** and **82** are connected to input unit **83.** Converter **86** and tape reader **87** are connected to the input of output unit **84.** The output of output unit **84** is connected to telegraphic lines **81** and **82.** The output of tape reader **87** is also connected to converter **88** and tape punch **85.** The output of converter **86** is connected to one input of stunt box **89,** one input to converter **88** and to one input of tape punch **85.**

The output of input unit **83** is connected to still another input of tape punch **85,** to still another input of converter **88** and to still another input of stunt box **89.**

Converter **86** receives an input from keyboard unit **90.** Printing unit **91** receives inputs from outputs of converter **88** and stunt box **89.**

In review, mosaic printheads have been developed by Philips, as well as several others, including that used in the teleprinter manufactured by Extel Corporation of Chicago, Illinois. These printheads build up characters as a pattern of dots in a possible matrix of 7 × 5 dots. Instead of employing 35 styli and energizing all the styli needed for a character at the same time, they have only 7 stylie arranged in a vertical column and form a character by selectively energizing the styli at five postions, one after the other, much in the way described in copending application Ser. No. 295,154, filed Oct. 5, 1972, by T. J. Holland for PRINTING METHOD, now U.S. Pat. No. 3,757,346.

These printheads carry individual motors for each stylus on the printhead, in the case of the Philips head, seven motors being needed. (By "motor," we mean an actuating device for moving the stylus, not necessarily a rotating electrical device. Thus, a solenoid is a motor, and so is a piezoelectric bimorph.) In order to deliver a sufficiently great impact to print these motors must be reasonably powerful. This means that the printhead is carrying a fair amount of mass.

A lightweight printhead is desirable so that it can be traversed across the record web at high speeds, particularly, in "carriage return." It would, therefore, be of advantage if the head carried only the styli and the supports therefor and as little else as possible, ideally as shown herein.

In FIG. **9,** carriage **60** runs on rails and has the support and guide plate **65** through which 7 styli **66** protrude towards a record web **67.**

Some form of motor must move the styli **66** towards the web **67** in order that printing may take place. In accordance with the present invention, the back ends of the styli **66** (the ends remote from the web **67**) have rigid conductive loops **77** attached thereto by motion transmitting means. The motion transmitting means (e.g., connection means between driver means and the styli **66**) may be directed rigid rods, or Bowden cables like bicycle hand brake cables. In accordance with the present invention, loops **77** moving with the printhead are influenced by, not a single motor per stylus, but a common motor, which common motor does not, of itself, traverse the web **67,** but is instead coextensive with the width of the web **67.** All the loops **77** for each stylus **66** are infleunced, when the loop is complete, by the one motor. The motor is, if you like, an electromagnetic "printing bail."

Only one **74** of several styli have been shown in FIG. **10** for clarity. The other styli, if connected to their loops by rigid rods would have to pass through the supports at angles to each other so as to hit the web in a vertical line. See FIG. **13.** If connected by Bowden cable, they could be in line at the support plate. See FIG. **14.**

Some of the dimensions have been greatly exaggerated for clarity. The loops would be much smaller in width so that all could sit side by side under the traversing pole piece.

An alternative to the travelling pole piece would be to have a stationary pole piece coextensive with the stationary upper limb, thus taking some weight off the traversing printhead. Such a stationary pole piece would, of course, be integral with the stationary upper limb, thus eliminating the air gap.

The rotating magnetic member is rotated at a constant speed by some suitable drive means as long as the printer is in use. The grooves shown in FIGS. **5** and **8** cause the flux to swing back and forth across the loops at a greater rate than it would if it depended on the speed of rotation of the rotating magnetic member alone.

The printhead forms part of a printing unit which in turn is part of a telegraphic machine, for example, a teletypewriter or teleprinter. FIG. **15** shows the basic units of such a machine. The input unit accepts telegraph signals from the line and renders them suitable for use within the machine. The telegraph code to mosaic pattern converter does exactly what its name implies producing at its output signals with which to operate the printing unit; such a unit has been described before.

In the event that some question arises concerning the structure or operation of converter **88,** two patents disclosing both are, by this reference hereto, hereby incorporated herein as though fully set forth hereat. These

patents are British Pat. No. 1,240,477 and Swiss Pat. No. 501,971.

The stunt box is a well-known unit which transforms the appropriate telegraph signals into commands to "line feed," "carriage return," "space," et cetra. The keyboard unit generates signals, possibly in its own code, to be applied to the output unit or the printing unit or the tape punch or any combination of the three. The tape reader generates signals to be applied to the same three units in any combination. The keyboard code to telegraph code converter does exacctly what its name implies, assuming that the keyboard does not produce telegraph code directly (otherwise the converter is unnecessary). The output unit renders the signals in the machine suitable for application to the telegraph line. Interconnections between the units have been shown as single lines; however, the intramachine signals may be handled in parallel over multiple connections.

Although the apparatus of the present invention may be used in punched tape or other applications, it most likely will be used more by repeatedly striking paper (web) on a platen with one or more styli simultaneously or consecutively to provide a dot mosaic inked letter, number, character or otherwise. Any means may be employed to provide or not to provide the ink, as desired. An inked ribbon may be used. It is also well known that a character may be produced by striking a conventional "inked" paper which carries its own ink. Paper **79** shown in FIG. **10** may be such "inked" paper, if desired. Many other suitable inking methods and equipments will also be obvious to those skilled in the art.

As stated previously, stylus head **21'** shown in FIG. **4** or any modification thereof may be substituted for plate **70** in FIG. **10.**

The word "carriage" is hereby defined for use hereinbefore and hereinafter and for use in the claims to mean something that carries something else, and may either be movable or be fixed unless its mobility or the lack of it is specifically and expressly stated.

The phrase "carriage means" is hereby defined for use hereinbefore and hereinafter and for use in the claims to mean one or more structures and/or a carriage as that word "carriage" is defined in the immediately preceding paragraph.

The phrase "connecting means" is hereby defined for use herein and for use in the claims to mean either an electrical conductor integral or not with the conductive loop or a switch or otherwise.

What is claim is:

1. A printer comprising:

a base;

a carriage means mounted on said base;

platen means mounted on said base in a manner to support a recording medium adjacent said carriage means;

an elongated axially movable stylus having first and second ends;

a conductive loop fixed relative to said second stylus end;

means to produce relative movement between a recording medium and said first stylus end in a direction approximately normal thereto;

means mounted on said carriage means to guide said axial movement of said stylus;

driver means to produce magnetic flux in a location linking said conductive loop, said driver means causing the amount of said linking flux to change abruptly; and

a selectively operable switch connected in series with said conductive loop to short circuit the same when the switch is closed, said abrupt change in flux leaving said conductive loop axially motionless when said switch is open, said abrupt change in flux causing a force to be applied to said conductive loop when said switch is closed, said force being transmitted to said stylus to move the same axially to cause said first end thereof to strike a recording medium when such is supported in position therefor by said platen means as aforesaid, and to make a detectable recording mark on said recording medium where said stylus first end strikes said record medium, closure of said switch permitting a current to be induced in said conductive loop, which induced current produces its own magnetic field that reacts with that produced by said driver means and causes said force to be applied to said conductive loop.

2. The invention as defined in claim **1,** wherein:

means are provided to prevent said conductive loop from rotating about the axis of said stylus.

3. The invention as defined in claim **2,** wherein:

a spring is provided, said spring being mounted on said carriage means to urge said stylus in a direction away from said platen means.

4. The invention as defined in claim **3,** wherein:

said driver means includes a magnetic circuit having a fixed magnetic yoke including an elongated, noncircular magnetic shaft spaced a short distance therefrom, a maximum flux being established in said magnetic circuit when said shaft is located in one angular position, a minimum flux being established in said magnetic circuit when said shaft is located in another angular position, means to rotate said shaft, means to establish a magnetomotive force in said magnetic circuit, said conductive loop being located between one end of said yoke and said shaft.

5. The invention as defined in claim **2,** wherein:

said driver means includes a magnetic circuit having a fixed magnetic yoke including an elongated, noncircular magnetic shaft spaced a short distance therefrom, a maximum flux being established in said magnetic circuit when said shaft is located in one angular position, a minimum flux being established in said magnetic circuit when said shaft is located in another angular position, means to rotate said shaft, means to establish a magnetomotive force in said magnetic circuit, said conductive loop being located between one end of said yoke and said shaft.

6. The invention as defined in claim **1,** wherein:

spring is provided, said spring being mounted on said carriage means to urge said stylus in a direction away from said platen means.

7. The invention as defined in claim **6,** wherein:

said driver means includes a magnetic circuit having a fixed magnetic yoke including an elongated, noncircular magnetic shaft spaced a short distance therefrom, a maximum flux being established in said magnetic circuit when said shaft is located in one angular position, a minimum flux being estab-

lished in said magnetic circuit when said shaft is located in another angular position, means to rotate said shaft, means to establish a magnetomotive force in said magnetic circuit, said conductive loop being located between one end of said yoke and said shaft.

8. The invention as defined in claim **1,** wherein:

said driver means includes a magnetic circuit having a fixed magnetic yoke including an elongated, non-circular magnetic shaft spaced a short distance therefrom, a maximum flux being established in said magnetic circuit when said shaft is located in one angular position, a minimum flux being established in said magnetic circuit when said shaft is located in another angular position, means to rotate said shaft, means to establish a magnetomotive force in said magnetic circuit, said conductive loop being located between one end of said yoke and said shaft.

9. An electromagnetic actuator comprising:

a base;

a movable conductive loop for connection to a member to be mechanically actuated by movement thereof;

means to guide movement of said conductive loop on said base in the plane of said conductive loop;

connecting means selectively operable to open and to short circuit said conductive loop; and

driver means to produce magnetic flux in a location linking said conductive loop, said driver means causing the amount of said linking flux to change abruptly for inducing a current in said conductive loop.

10. The invention as defined in claim **9,** wherein:

said connecting means includes a selectively operable switch which can be opened or closed, said switch being connected in series with said conductive loop to short circuit the same when the switch is closed, said abrupt change in flux leaving said conductive loop motionless when said switch is open, said abrupt change in flux causing a force to be applied to said conductive loop when said switch is closed, said force being transmitted to said member to move the same, closure of said switch permitting a current to be induced in said conductive loop which induced current produces its own magnetic field that reacts with that produced by said driver means and causes said force to be applied to said conductive loop.

* * * * *