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Kodis

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[54] **WIRE MATRIX PRINT HEAD PARTICULARLY FOR HIGH SPEED PRINTERS**

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[52] **U.S. Cl.** ..... **197/1 R**

[51] **Int. Cl.** **B41j 3/50**

[58] **Field of Search** ..... 197/1; 101/93 C; 178/30

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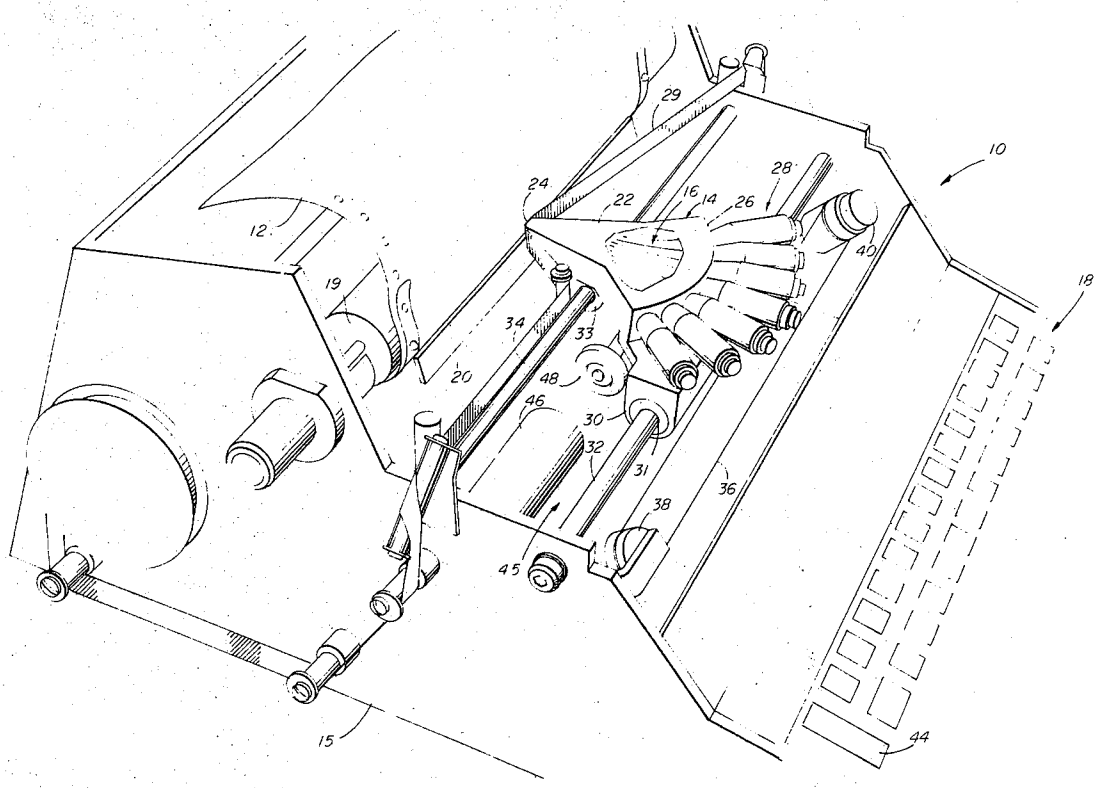
Attorney, Agent, or Firm—Morse, Altman, Oates & Bello

[57] **ABSTRACT**

A high speed printer utilizes a multi-wire print head for printing graphic symbols on a recording stratum by urging selected wire printing elements against a ribbon interposed between the print head and recording stratum. The print head includes a potted body formed with guideways, each guideway adapted to slidably receive one of the wire printing elements. Free flight movement of each wire printing element and distributed frictional contact of each wire within its associated guideway is provided by disposing each guideway in a curved path defined by the elastic curve of the wire printing element received therein.

14 Claims, 8 Drawing Figures



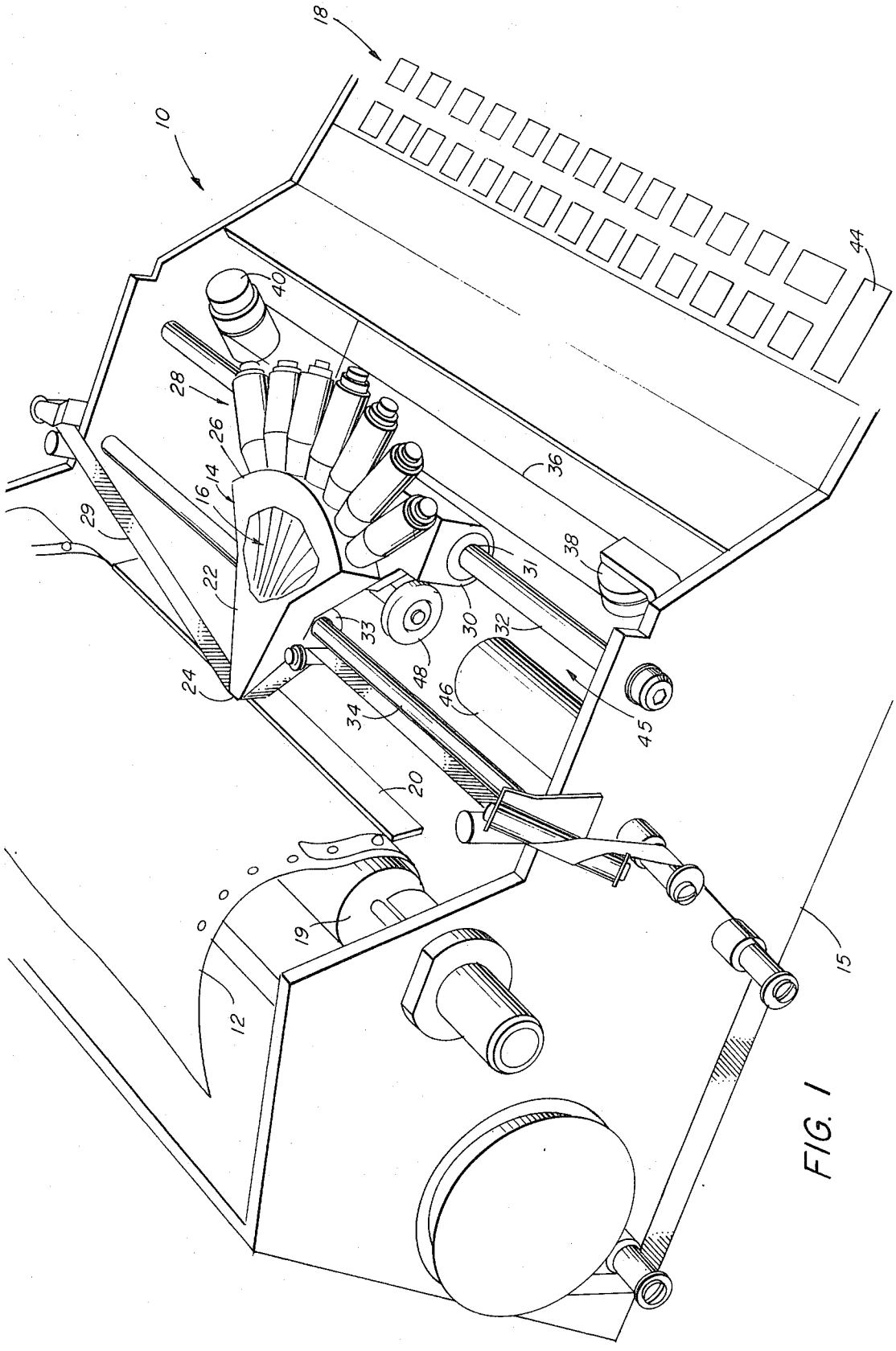

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FIG. 1

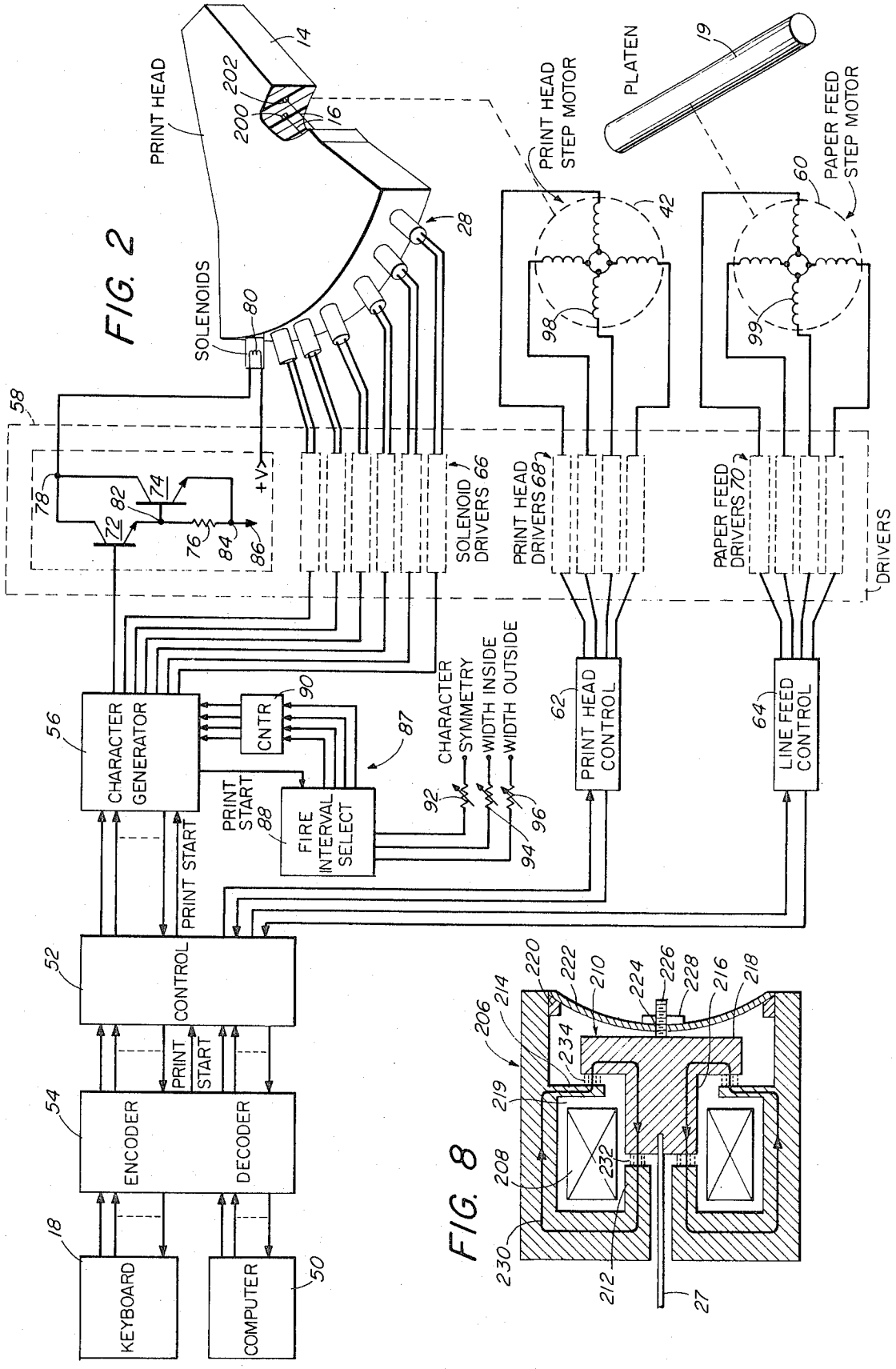

PRINT HEAD
14
202
200
16
28
SOLENOIDS
80
PRINT HEAD STEP MOTOR
42
98
PLATEN
19
PAPER FEED STEP MOTOR
60
99
58
78
72
74
82
76
84
86
+V
SOLENOID DRIVERS 66
PRINT HEAD DRIVERS 68
PAPER FEED DRIVERS 70
DRIVERS
56
CHARACTER GENERATOR
CNTR
90
87
CHARACTER SYMMETRY
WIDTH INSIDE
WIDTH OUTSIDE
92
96
94
PRINT START
88
FIRE INTERVAL SELECT
62
PRINT HEAD CONTROL
64
LINE FEED CONTROL
PRINT START
52
CONTROL
PRINT
START
54
ENCODER
DECODER
18
KEYBOARD
COMPUTER
50

FIG. 2

206
214
220
222
210
224
226
228
216
218
234
219
208
232
230
212
27

FIG. 8

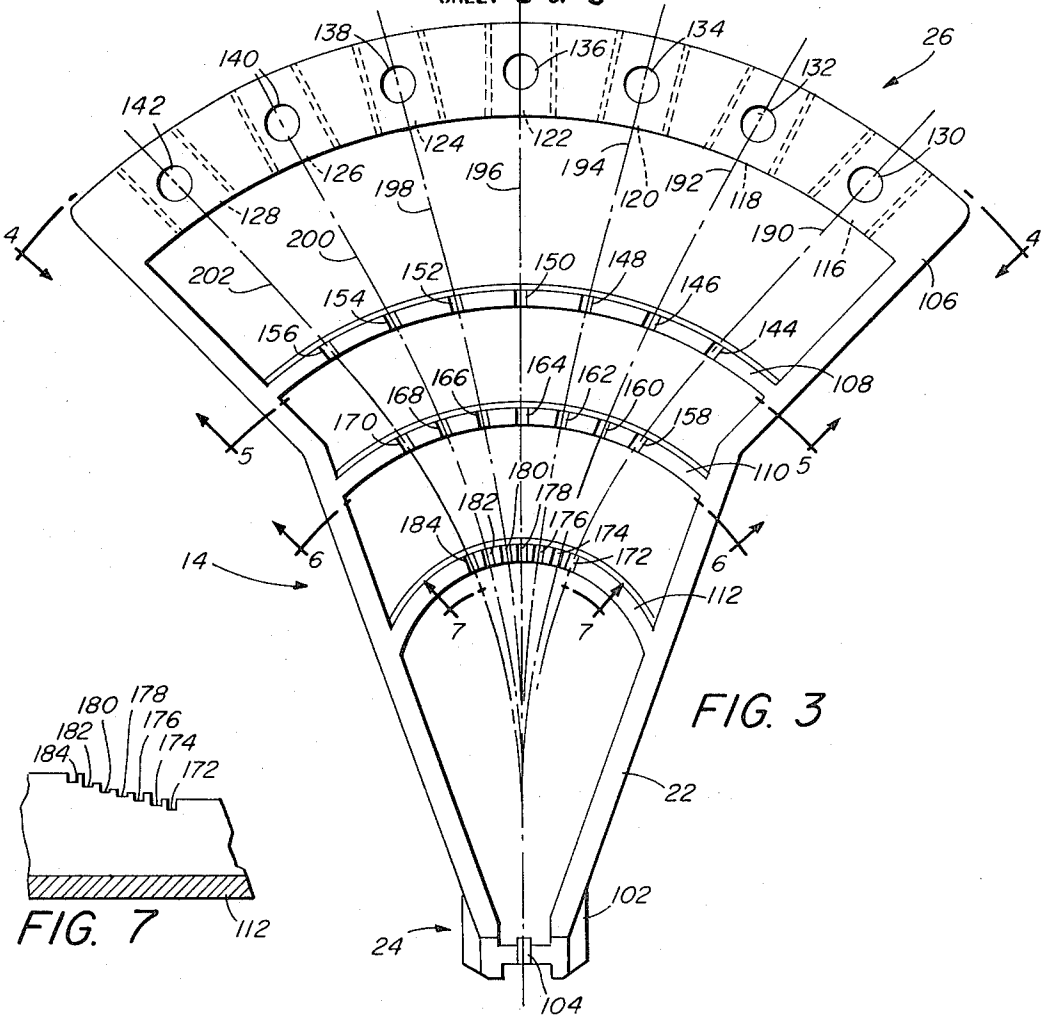


FIG. 3

FIG. 7

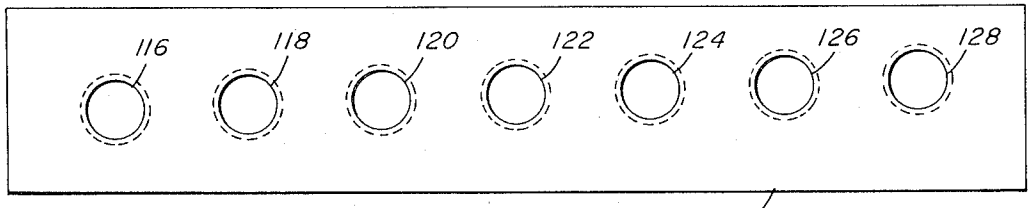


FIG. 4

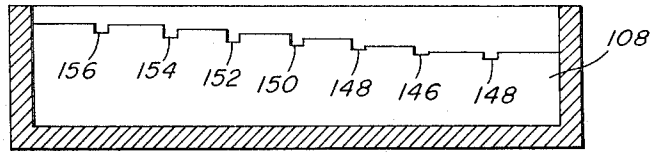
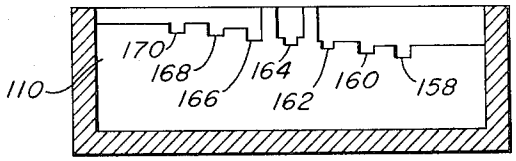


FIG. 5

FIG. 6



WIRE MATRIX PRINT HEAD PARTICULARLY FOR HIGH SPEED PRINTERS

BACKGROUND OF THE INVENTION

1. Field of Invention:

The present invention relates to high speed printing systems and, more particularly, to a wire matrix printing head for such systems.

2. Description of the Prior Art:

In a wire matrix printing system, a plurality of stiff wires slidably mounted to a print head are reciprocated in a predetermined sequence in order to print a graphic symbol on a recording stratum, an ink ribbon being interposed between the print head and recording stratum. Point frictional contact of the wires as they are reciprocated in the print head causes excessive wear at particular points along the length of the wire. In consequence, such wire matrix printing systems have suffered from the disadvantage of limited wire and driver life.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a reliable multi-wire matrix print head for high speed printing systems. The print head comprises a potted body formed with guideways adapted for reception of wire printing elements, one guideway receiving one wire printing element. One end of each wire is operatively connected to a driver having a pair of force gaps, each driver operating to reciprocate one wire within its correlative guideway into engagement and disengagement with a ribbon located between the print head and a recording stratum. Each guideway is disposed in a path having a radius of curvature defined by the elastic curve of the wire received therein in order to provide distributed frictional contact between each guideway and its associated wire. In consequence, there is provided a wire-matrix printing system characterized by extended wire and driver life and high reliability.

The invention accordingly comprises the device and system possessing the construction, combination of elements, and arrangement of parts that are exemplified in the following detailed disclosure, the scope of which will be indicated in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the present invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective of a printing system made in accordance with the present invention;

FIG. 2 is a schematic diagram of the printing system of FIG. 1;

FIG. 3 is a plan view of a wire matrix print head;

FIG. 4 is a section taken along the lines 4—4 of FIG. 3;

FIG. 5 is a section taken along the lines 5—5 of FIG. 3;

FIG. 6 is a section taken along the lines 6—6 of FIG. 3;

FIG. 7 is a section taken along the lines 7—7 of FIG. 3; and

FIG. 8 is a section of a solenoid of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, there is shown a system 10

for printing graphic symbols on a recording stratum 12 by means of a wire matrix printing head 14. Printing system 10 comprises a housing 15, a keyboard 18 and a wire matrix printing head 14. Recording stratum 12, for example an endless roll of paper, is interposed between a platen 19 and a guide plate 20, platen 19 rotatably mounted to housing 15.

Printing head 14 includes a substantially wedge shaped body 22 having a narrowed forward neck portion 24 and an arcuate rearward portion 26. A bank of seven drivers 28 is mounted to arcuate portion 26. A plurality of printing elements 16, for example wires composed of a metal such as tungsten, are mounted to body 22 in a curved path corresponding to the free bending course of each printing element 16. One end of each wire is operatively connected to one driver 28, for example a solenoid. As hereinafter described, one solenoid 28 operates to activate one printing element 16 in such a manner that the free end of each wire extends from neck 24, engages a ribbon 29 and strikes paper 12. Ribbon 29 is threaded between neck 24 and paper 12. As the free end of wire 16 engages ribbon 29 and strikes paper 12, a dot is printed thereon, a given number of printed dots being arranged in a pattern describing a graphic symbol. A series of graphic symbols are presented on paper 12 by laterally moving print head 14 with respect to paper 12. Print head 14 is slidably mounted to housing 15 by means of a carriage 30 which is fastened to body 22.

Carriage 30 is provided with guideways 31 and 33 which are adapted to slidably receive a pair of parallel guides 32 and 34, for example rods, which are connected to housing 15. An endless belt 36, for example a 90 strand stainless steel wire having a polyamide resin jacket, is secured to carriage 30 and is threaded about an idler wheel 38 and a drive wheel 40. Idler wheel 38 is rotatably mounted to housing 15 and drive wheel 40 is coupled to a motor 42, for example a stepping motor. As wheel is rotated by stepping motor 42, belt 36 is driven by wheel 40 and print head 14 is guided along rods 32 and 34.

In the illustrated embodiment, graphic symbols are printed in a line on paper 12 as print head 14 travels from left to right as viewed in FIG. 1. When a carriage return switch 44 in keyboard 18 is depressed, print head 14 is slewed towards the left margin of paper 12. In order to minimize bounce as print head 14 returns to the left margin, there is provided a damping device 45 which includes a dash pot 46 and a piston 48. Dash pot 46 is mounted to housing 15 in registration with piston 48 which is mounted to carriage 30. As print head 14 is slewed to the carriage return position, piston 48 engages dash pot 46.

For a fuller understanding of the operation of printing system 10, reference is now made to the schematic diagram of FIG. 2. Printing system 10 receives input command signals generated from keyboard 18 and a computer 50. The command signals are processed in an encoder/decoder 54 and are fed to a control 52. Coded data signals, for example ASCII coded signals, at an output terminal of control 52 is applied to character generator 56, for example a read-only memory. Solenoid actuating signals as at an output terminal of character generator 56 are applied to a driver 58 for controlling actuation of solenoids 28. Control 52 also generates signals for controlling the position of print head 14 and paper 12. The print head position signals are ap-

plied to driver 58 via a print head control 62 and the paper feed signals are applied to driver 58 via a line feed control 64.

Driver 58 includes a solenoid drivers 66, print head drivers 68 and paper feed drivers 70. In the illustrated embodiment, each solenoid driver 66 includes transistors 72, 74 and a resistor 76. The collectors of transistors 72 and 74 are connected at a junction 78 which is connected to one side of a coil 80 of one of solenoids 28. The other side of coil 80 is connected to a voltage, for example a positive voltage +V. The emitter of transistor 72 and the base of transistor 74 are connected at a junction 82 which is further connected to one side of resistor 76. The other side of resistor 76 and the emitter of transistor 74 are connected at a junction 84 which is further connected to a signal return 86. In operation, a positive signal as at the output of character generator 56 is applied to the base of transistor 72, whereby transistor 72 is driven into the conducting state and the voltage at junction 82 becomes more positive. In consequence, transistor 74 is driven into the conducting state. Current flowing through conducting transistors 72 and 74 operate to energize solenoid 28 associated therewith.

The solenoid actuating signals as at the output of character generator 56 are controlled by a sequencer 87 which includes a fire interval select unit 88 and a counter 90. Fire interval select unit 88 operates to control the time interval at which each solenoid 28 is actuated in order to compensate for the changing velocity of print head motor 42. That is, in order to ensure uniformity in the printed graphic symbols, for example alphanumeric characters, fire interval select unit 88 and counter 90 operates to energize selected solenoids 28 at such a time as to compensate for the changes in velocity of motor 42 from starting to stopping. Fire interval select 88 includes variable delays 92, 94, and 96, for example variable resistors, for governing character symmetry, character width inside, and character width outside by controlling the time constants of fire interval select 88. A print start signal from encoder/decoder 54 is applied to fire interval select 88 which generates signals for enabling counter 90. Coded signals generated by counter 90, for example binary coded signals, are fed to character generator 56 for generation of signals for actuating solenoids 28.

Print head drivers 68, for example driver circuits similar to those described in connection with solenoid drivers 66, receive print head motor signals from control 52 via print head control 62. The signals at the output of print head drivers 68 are applied selectively to windings 98 of motor 42.

Paper feed drivers 70, for example driver circuits similar to those described in connection with solenoid drivers 66, receive command signals from control 52 via line feed control 64. The signals as at the output of paper feed drivers 70 are applied selectively to windings 99 of paper feed motor 60.

The operation of system 10 is such that input signals representing symbols, alphanumeric characters, and instruction codes are applied to control 52, from keyboard 18 and/or computer 50 via encoder/decoder 54. ASCII code signals representing the symbol or alphanumeric character to be printed on paper 12 are fed to character generator 56 from control 52. In addition, print head position signals and paper feed signals generated by control 52 are applied to print head control 62 and line feed control 64.

Fire interval select 88 enables counter 90 which generates binary coded signals for processing in character generator 56. Solenoid actuating signals generated by character generator 52 are applied to solenoid drivers 66 for selectively actuating solenoids 28. As hereinafter described, actuation of selected solenoids 28 produce printed dots on paper 12 by striking ribbon 29 with selected printing elements 16. Print head control 62 operates to energize print head drivers 68 which control the movement and position of print head 14 by selectively driving print head motor 42. Line feed control 64 operates to energize paper feed drivers 70 for controlling advancement of paper 12 by selectively driving paper feed motor 60 which is operatively connected to platen 19.

For a fuller understanding of print head 14, reference is now made to FIGS. 3–7 of the drawings. As best shown in FIG. 3, print head 14 comprises body 22 having narrowed neck portion 24 and arcuate rearward portion 26, a nose 102 mounted to body 22 at neck portion 24. Nose 102 is formed with a slit 104 which is adapted to slidably receive and retain printing elements 16 in a columnar configuration. In the illustrated embodiment, by way of example, body 22 is formed with concentric arcuate ribs 106, 108, 110 and 112 having radii of 2,125, 1.625, 0.9375 and 0.500 inches, respectively.

It will be seen in FIG. 4 that a face 114 of arcuate rearward portion 26 is formed with a plurality of apertures 116, 118, 120, 122, 124, 126 and 128 which are disposed along an oblique path with respect to the horizontal plane of body 22. Each aperture 116, 118, 120, 122, 124, 126 and 128 is adapted for reception of one solenoid 28. Rib 106 is formed with a plurality of holes 130, 132, 134, 136, 138, 140 and 142 which are in registration with and in a plane perpendicular to the longitudinal axis of apertures 116, 118, 120, 122, 124, 126 and 128, respectively. In the preferred embodiment, holes 130, 132, 134, 136, 138, 140 and 142 are tapped holes adapted to receive set screws (not shown) for securing solenoids 28 in their respective apertures 116, 118, 120, 122, 124, 126 and 128.

Referring now to FIGS. 5, 6 and 7 it will be seen that rib 108 is formed with guides 144, 146, 148, 150, 152, 154 and 156 which are disposed along an oblique path with respect to the horizontal plane of body 22. Each guide 144, 146, 148, 150, 152, 154, and 156 is adapted to receive one printing element 16. Rib 110 is formed with guides 158, 160, 162, 164, 166, 168 and 170 which are disposed along an oblique path with respect to the horizontal plane of body 22. Each guide 158, 160, 164 166, 168 and 170 is adapted to receive one printing element 16. Rib 112 is formed with guides 172, 174, 176, 178, 180, 182, 184 which are disposed along an oblique path with respect to the horizontal plane of body 22. Each guide 172, 174, 176, 178, 180, 182 and 184 is adapted to receive one printing element 16.

Referring again to FIG. 3, it will be seen that guides 144, 158 and 172 define a guideway having a path denoted by the dashed line 190; guides 146, 150 and 174 define a guideway having a path denoted by the dashed line 192; guides 148, 162 and 176 define a guideway having a path denoted by the dashed line 194; guides 150, 164 and 178 define a guideway having a path denoted by the dashed line 196; guides 152, 166 and 180

define a guideway having a path denoted by the dashed line **198**; guides **154, 168** and **182** define a guideway having a path denoted by the dashed line **200**; and guides **156, 170** and **184** define a guideway having a path denoted by the dashed line **202.** In accordance with the teaching of the present invention, each path **190, 192, 194, 196, 198, 200** and **202** is disposed in a curved path having a radius of curvature (R) of the elastic curve for each printing element **16.** The radius of curvature (R) for each curved path is given by the expression;

$$R = (EI)/M$$

where:

E = modulus of elasticity
I = moment of inertia
M = bending moment

It is to be noted that, in the preferred embodiment, the path described by each printing element **16** is such that the longitudinal axis of each wire **16** at the marginal end operatively connected to each solenoid **28** is coaxial with the longitudinal axis thereof and the longitudinal axis of each wire **16** at the marginal end slidably received within slit **104** is in registration with the longitudinal axis of body **22.**

In the preferred embodiment, printing head **14** is fabricated by placing a wire having a diameter slightly larger than the diameter of wire **16** in each of paths **190, 192, 194, 196, 198 200** and **202.** A potting compound, for example a plastic consisting of a tetrafluorene polymer and an activator such as molybdenum disulfate, is poured into body **22** about the wires positioned therein. Once the potting compound has cured, the wires are removed leaving a molded structure formed with guideways disposed in a curved path having a radius of curvature of the elastic curve of each wire **16.** Thereafter, one end of each wire **16** is secured to each solenoid **28.** Each wire **16** is threaded in its corresponding guideway and solenoids **28** are mounted to body **22.** The length of each wire **16** is such that the free end thereof is flush with the exterior face of nose **102.**

It is to be understood that, in alternative embodiments, each printing element **16** comprises an outer sleeve and an inner core. The bore diameter of each sleeve and the diameter of each core is such that the core is slidably received within each sleeve. Each sleeve is mounted to the guides formed in ribs **108, 110** and **112** along the curved paths hereinbefore described. In such alternative embodiments, each core and each sleeve are composed of materials having like elastic curves, for example, each sleeve is composed of a metal such as berrylium copper and each core is composed of a metal such as tungsten.

Referring now to FIG. **8,** it will be seen that each solenoid **28** comprises a frame **206,** a coil **208** and an armature **210.** In the illustrated embodiment, by way of example, solenoid **28** is cylindrical and coil **208** is a ring. Frame **206** is substantially L shaped in cross section having inwardly extending arms **212** and **214.** Arm **212** is disposed in a plane substantially parallel to the longitudinal axis of solenoid **28** and arm **24** is disposed in a plane substantially perpendicular to the longitudinal axis of solenoid **28.** In cross section, armature **210** is substantially a T shaped structure having a body **216** and a head **218.** Core **208** is disposed within an enclosure **219** defined by frame **206** and armature **210.** A bracket **220** having a resilient member **222,** for example a spring, affixed thereto is mounted to frame **206.** Spring **222** operates to retain wire **16** in a retracted position. Spring **222** is formed with a hole **224** which is adapted for reception of a stud **226** mounted to head **218.** Stud **226** and hole **224** are dipsosed along the longitudinal axis of solenoid **28.** A locking device **228,** for example a snap ring, retains spring **222** on stud **226.**

The operation of solenoid **28** is such that when coil **208** is energized, there is produced a flux path denoted by reference character **230** and resulting force gaps denoted by reference characters **232** and **234.** In consequence, body **216** is pulled towards arm **212** and head **218** is pulled towards arm **214.** It is to be understood that force gaps **232** and **234** are sufficient to overcome the force provided by spring **222.** As armature **210** is moved towards the left, as viewed in FIG. **8** of the drawings, wire **16** which is mounted thereto, is urged out of nose **102** into engagement with ribbon **29.** When coil **208** is deenergized, the elastic impact of each wire **16** and spring **222** operate to pull armature **210** towards the right, whereby wire **16** is retracted into nose **102.**

It is to be understood that, in alternate embodiments, the number of actuators and printing elements is other than seven, for example, one, four, five, nine, etc.

Since certain changes may be made in the foregoing disclosure without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description and depicted in the accompanying drawings be construed in an illustrative and not in a limiting sense.

What is claimed is:

1. A high speed printing system for printing graphic symbols on a recording stratum, said system comprising:

a. wire matrix print head means including body means generally disposed in a horizontal plane, said body means having a narrowed neck forward position and an arcuate rearward portion, a nose mounted to said body means at said neck portion, said body means formed with a plurality of guideway means;

b. a plurality of wire printing element means, one of each said wire printing element means slidably received in one of each said guideway means and disposed along a path on each guideway means oblique to the horizontal plane of said body means;

c. each said guideway means disposed in said printing head means in a curved path corresponding to the free bending curve of said wire printing element means;

d. a plurality of actuator means mounted to said arcuate rearward portion of said body means along a path oblique to the horizontal plane of said body means, one of each said actuator means operatively connected to a first end of one of each said wire printing element means for reciprocating each said wire printing element means within each said guideway means each guideway means having a successively more oblique path with respect to the horizontal plane from the rear of the body means to its forward position, said nose formed with a vertical guideway for receiving and retaining said wire printing element means in a columnar configuration in registration with a longitudinal axis of said body means, each said actuator means having first

and second states, a second end of selected ones of said wire printing element means projecting out of said nose in engagement with said recording stratum when its corresponding actuator means is in said first state, said second end of each said wire printing element means and recording stratum disengaged when said actuator means are in said second state; and

e. means operatively connected to said actuator means for controlling said first and second states of each said actuator means.

2. The high speed printing system as claimed in claim 1 including:

a. drive means operatively connected to said wire matrix print head means; and

b. control means for generating command signals, said drive means operatively connected to said control means;

c. said drive means responsive to said command signals, said drive means operating to move said wire matrix print head means relative to said recording stratum.

3. The high speed printing system as claimed in claim 1 wherein said curved path described by each said guideway means is such that a marginal area of each said wire printing element means at said first end is coaxial with a longitudinal axis of said actuator means associated therewith and a marginal area of each said wire printing element means at said second end is in registration with the longitudinal axis of said body means.

4. The high speed printing system as claimed in claim 1 wherein said actuator means is a solenoid in cylindrical form having first and second force gaps, said solenoid includes a frame, a coil, and an armature, said frame having a substantially L shaped profile in cross section, said frame formed with first and second inwardly extending arms, said first arm disposed in a plane substantially parallel to a longitudinal axis of said solenoid and said second arm disposed in a plane substantially perpendicular to the longitudinal axis of said solenoid, said armature having a substantially T shaped profile, said armature formed with a body portion and a head portion, said body portion disposed in a plane substantially parallel to the longitudinal axis of said solenoid in juxtaposition to said first arm, said head portion disposed in a plane substantially perpendicular to the longitudinal axis of said solenoid in juxtaposition to said second arm, said first force gap formed between said first arm and said body portion, said second force gap formed between said second arm and said head portion, said first and second arms and said body portion defining an enclosure, said coil disposed within said enclosure.

5. A high speed printing system for printing graphic symbols on a recording stratum comprising:

a. housing means;

b. first means operatively connected to said housing means for generating command signals;

c. control means operatively connected to said first means for generating coded data signals in response to said command signals;

d. wire matrix print head means slidably mounted to said housing means, said wire matrix print head means slidably mounted to said housing means, said wire matrix print head means including body means having a narrowed neck forward portion and an arcuate rearward portion, a nose mounted to said body means at said neck portion, said body means formed with a plurality of guideway means;

e. a plurality of wire printing element means, one of each said wire printing element means slidably received within one of each said guideway means and disposed along a path of each guideway means oblique to the horizontal plane of said body means;

f. each said guideway means disposed in a curved path corresponding to the free binding curve of each said wire printing element means;

g. a plurality of actuator means mounted to said arcuate rearward portion of said body means along a path oblique to a horizontal plane of said body means, each said actuator means operatively connected to one of each said wire printing element means for reciprocating each said wire printing element means within each said guideway means each guideway means having a successively more oblique path with respect to the horizontal plane from the rear of the body means to its forward position, said nose formed with a vertical guideway for receiving and retaining said wire printing element means in a columnar configuration in registration with a longitudinal axis of said body means, selected ones of said wire printing element means projecting out of said print head means in engagement with said recording stratum when its corresponding actuator means is in said first state, said wire printing element means and recording stratum disengaged when said actuator means are in said second state;

h. character generator means operatively connected to said control means and actuator means for generating actuating signals for controlling said first and second states of each said actuator means; and

i. driving means operatively connected to said control and print head means for moving said print head means relative to said recording stratum, said driving means responsive to said command signals.

6. The high speed printing system as claimed in claim 5 including sequence means operatively connected to said character generator means for generating signals for controlling the time interval of said actuating signals.

7. The high speed printing system as claimed in claim 5 including line feed means operatively connected to said recording stratum and control means, said line feed means responsive to said control means, said line feed means operating to move said recording stratum relative to said print head means.

8. The high speed printing system as claimed in claim 7 wherein said first means is keyboard means.

9. A wire matrix print head comprising:

a. a body having rearward arcuate portion and narrowed forward neck portions, a nose formed with a vertical slit mounted to said neck portion at the most forward portion thereof, said body formed with a plurality of guideway;

b. a plurality of wire printing element means, one of each said wire printing element means received within one of each said guideways and disposed along a path on each guideway means oblique to the horizontal plane of said body means, each said wire printing element means having first and second ends;

c. each said guideway disposed in a curved path corresponding to the free bending line of said wire printing element means received therein;

d. a plurality of driver means, each said driver means having first and second states, said driver means mounted to said body at said rearward arcuate portion, said driver means disposed in a path oblique to a horizontal plane of said body means, one of each said driver means operatively connected to said first end of one of each said wire printing element means, said driver means operating to reciprocate its associated wire printing element means within its corresponding guideway, each guideway means having a successively more oblique path with respect to the horizontal plane from the rear of the body means to its forward position, said second ends of wire printing elements means received in said nose slit and retained in a columnar configuration in registration with a longitudinal axis of said body means, said second end of said wire printing element means being substantially flush with said forward most portion of said nose when said driver means is in said first state and said second end of selected ones of said wire printing element means projecting out of said forward most portion of said nose when said driver means associated therewith is in said second state.

10. The wire matrix print head as claimed in claim **9** wherein said curved path described by each said guideway is such that a marginal area of each said wire printing element means at said first end is coaxial with a longitudinal axis of its associated driver means and a marginal area of each said printing element means at said second end is in registration with the longitudinal axis of said body.

11. The wire matrix print head as claimed in claim **10** wherein said driver means is a solenoid in cylindrical form having first and second force gaps, said solenoid includes a frame, a coil, and an armature, said frame having a substantially L shaped profile in cross section, said frame formed with first and second inwardly extending arms, said first arm disposed in a plane substantially perpendicular to the longitudinal axis of said solenoid, said armature having a substantially T shaped profile, said armature formed with a body portion and a head portion, said body portion disposed in a plane substantially parallel to the longitudinal axis of said solenoid in juxtaposition to said first arm, said head portion disposed in a plane substantially perpendicular to the longitudinal axis of said solenoid in juxtaposition to said second arm, said first force gap formed between said first arm and said body portion, said second force gap formed between said second arm and said head portion, said first and second arms and said body portion defining an enclosure, said coil disposed within said enclosure.

12. The wire matrix print head as claimed in claim **10** wherein each said wire printing element means is composed of tungsten.

13. The wire matrix print head as claimed in claim **10** wherein said body is filled with a curable plastic material, each said guideway formed in said plastic material.

14. The wire matrix print head as claimed in claim **13** wherein said plastic material is composed of a tetrafluorene polymer and a molybdinum disulfate activator.

* * * * *