

12

EUROPEAN PATENT SPECIFICATION

45 Date of publication of patent specification: **03.09.86**

51 Int. Cl.⁴: **B 41 J 3/12, B 41 J 25/28**

21 Application number: **82110808.1**

22 Date of filing: **23.11.82**

54 **Compact shuttle printer mechanism.**

30 Priority: **23.12.81 US 333598**
23.12.81 US 333599

43 Date of publication of application:
29.06.83 Bulletin 83/26

45 Publication of the grant of the patent:
03.09.86 Bulletin 86/36

84 Designated Contracting States:
BE CH DE FR GB IT LI NL SE

58 References cited:
US-A-4 306 497

73 Proprietor: **International Business Machines Corporation**
Old Orchard Road
Armonk, N.Y. 10504 (US)

72 Inventor: **Kekas, Dennis Harry**
3425 Horton St.
Raleigh, NC (US)
Inventor: **McCray, Charles Martin**
721 Northbrook Dr.
Raleigh, NC 27609 (US)
Inventor: **Grubbs, William Andrew**
12506 Village Sq. Tr., No. 202
Rockville, MD 20852 (US)

74 Representative: **Bonin, Jean-Jacques**
Compagnie IBM France Département de
Propriété Industrielle
F-06610 La Gaude (FR)

EP 0 082 329 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Description**Field of the invention**

This invention relates to dot matrix printers in general and to print head suspension or carrier systems for such printers in particular, and to drive mechanisms for oscillating the print head carrier or suspension systems therein.

Prior art

A wide variety of dot matrix print mechanisms are known, of course. Those employing a shuttle principle in which print heads are affixed to a movable carrier are commonplace, but those in which the print heads and the carrier move together as a single piece are relatively few. Only U.S. Patent 4,127,334 is presently known to the applicant for this latter type of design.

This patent utilizes a generally E-shaped pair of flexible spring elements to support a rigid frame on which are mounted one or more print heads for reciprocation along a print line. The E-shaped spring elements are known to provide a linear translation when the top and bottom legs of the E-shaped springs are anchored to framework and the center leg is flexed back and forth. Two sets of such E-shaped springs are employed in this known patent, with one set of springs at each end of a general printing region and with the print head framework being affixed to the center legs of the E-shaped springs. This obscures the printing since the line of print produced is in a lower vertical position than the top of the springs. This patent also includes an off-center crank reciprocating driving means operating as an ordinary connecting rod and crank mechanism. This mechanism introduces forces which are not in the desired line of travel and hence introduces unwanted vibrations in a direction perpendicular to the desired printing line. Also, such a mechanism cannot impart a linear velocity to the print head framework and, therefore, makes the control of the printing operation much more complex. In addition, this patent employs command springs built up from several pieces requiring mechanical affixation in an interconnection with the other elements such as the print head mounting framework and requires additional frame elements for mounting and springs themselves. The complex assembly of multiple pieces is subject to requiring periodic adjustment, may involve additional manufacturing and maintenance expense, and may also produce a higher degree of unreliability due to the numerous parts and concomitant potential areas for mechanical failure.

Objects of the invention

In view of the foregoing difficulties with the known prior art, it is an object of this invention to provide an improved reciprocating shuttling printer of reduced cost and complexity.

An additional object of the present invention is to provide improved reciprocable driving means to provide a pure linear velocity in direct axial alignment with the motion of the shuttle framework along the printing line.

Still a further object of this invention is to provide a compact, low cost printer of modular form that can be added in replication to a given terminal or printing application where one or more printing stations may be required for the same machine.

Summary

The dot printer according to the invention comprises an elongated printing element support member, one or more dot printing elements mounted on said support member orthogonally thereto, a platen arranged adjacent to and parallel with said support member, a suspension spring and frame element essentially composed of two identical parallel E-shaped plate spring elements having each a style and three legs, said support member being rigidly mounted between the free ends of the first (upper) pair of legs, the free ends of the second (central) pair of legs being connected to a frame piece which is rigidly affixed to the frame of said printer, said support member and the free ends of the third (lower) pair of legs being connected together through a connector bar, and said styles of both E-shaped element being connected together through braces, and

drive means causing a linear speed reciprocation movement of said printing element support member in a direction parallel to said platen, without orthogonal or off-axis forces.

According to a specific aspect of the invention, the various part of the suspension spring and frame element and the printing element support member are molded as one piece plastic element.

According to another aspect of the invention the drive means comprise a fixed field magnet and a coil suspended in the field of the magnet and moving thereto upon application of electrical current to the coil, and electronic control means connected to said coil to modify the current in said coil in terms of its displacement, and to move this coil with a linear speed between both ends of its displacement.

According to another aspect of the invention the drive means comprise a uniformly rotating motor, a meshed pair of non circular gears, one of which being coupled to the motor, the other one being coupled to the driving shaft of a crank and rod type mechanism, the geometrical configuration of said non circular gears being such that said driving shaft is rotated at an irregular angular velocity which, when transmitted to said crank and rod type mechanism cause, the free end of said rod to move at a substantially linear velocity.

The invention will now be described with regard to preferred embodiments showing the best modes contemplated for utilizing the invention as shown in the accompanying drawings as follows.

Brief description of the drawings

- 5 Figure 1 illustrates a pictorial view of the one-piece molded plastic print head suspension, compound cantilever spring and head mounting frame element.
- Figure 2 illustrates an exploded schematic view of the major components for the printer utilizing the one-piece molded suspension and spring assembly of the present invention as well as the voice coil driver assembly of the present invention and other elements of the preferred embodiment.
- 10 Figure 3 illustrates a schematic cross-sectional view taken toward the edge of the paper in a printer constructed according to the general scheme shown in Figure 2.
- Figure 4 illustrates the emitter output, velocity of the print head and direction of travel for several half cycles of operation.
- Figure 5 illustrates the air moving function of the vanes of the rear of the E-spring assemblies which are integrally molded with the device shown in Figure 1.
- 15 Figure 6 illustrates an electrical flow chart and schematic diagram for the control and feedback of the voice coil linear driver mechanism shown in Figure 2.
- Figure 7 illustrates the detail of the voice coil winding employed in the preferred embodiment.
- 20 Figure 8 is a force and displacement chart for operation of the mechanism shown in Figure 2 over a complete cycle of oscillation from left to right and back.
- Figure 9 is a force and displacement chart for the forces to be generated by the drive means to drive the carrier assembly as shown in Figure 2.
- Figure 10 illustrates an alternative reciprocating drive mechanism utilizing noncircular gears to provide an irregular angular velocity and provide abrupt transitions in direction with a smooth and linear velocity profile intermediate the transitions.
- 25 Figure 11 is a comparison of the velocity output profile developed by a mechanism depicted in Figure 7 as contrasted with normal circular gearing output results.
- Figures 12 and 13 schematically illustrate the nomenclature and measurement conventions adopted for describing the noncircular gear set values in connection with Appendix Table I.
- 30

Detailed specification

The print head suspension framework and mounting system which is depicted in Figure 1 is an integrally molded single piece of plastic. The design was originated to obtain the lowest possible parts cost. It requires, due to the flexing of the E-shaped cantilever spring members, a relatively low tensile modulus in order to keep the spring rate as low as possible since the spring loads will be reflected as loads on the moving voice coil driver system. However, creep modulus of the selected material must be sufficiently high so as to minimize cold flow problems. A number of materials were surveyed and parts were modeled. The most effective material is a polysulfone having a creep modulus of 22,750 kg/cm² at 5°C and 280 kg/cm² load, a tensile modulus of 24780 kg/cm² and a specific gravity of 1.37. Other suitable materials are a polyester and copolymers of engineering structural polymer. In general, the desired materials must have 1.1 to 1.4 specific gravity, 23800 kg/cm² minimum tensile modulus and a creep modulus of 22400 kg/cm² minimum at 50°C and 105 kg/cm² load.

Turning to Figure 1, the one-piece molded print element shuttle suspension and frame member 1 is seen to comprise two relatively E-shaped cantilever spring elements at the ends 2 and 3 respectively.

The molded E-shaped spring members are made such that each member 2 and 3 has first, second and third legs numbered 11, 12 and 13, respectively. Legs 12 are made twice the width of legs 11 and 13 so that the spring rate of the outer leaves 11 and 13 exactly equals that of the center leaf 12. The outer ends forming the bar or stile of the E-shape on each of the spring suspension members 2 and 3 connected together through braces 10a and 10b, the styles and the braces being formed together in a common piece 10. As will be seen later, when the suspension elements of the molded spring assembly are operated in flexure, the end pieces 10 can be utilized to provide a fanning and cooling action for electronic components necessary for the operation of the printer.

Print head carrier frame 7 and aligning member 8 are integrally molded with the spring suspension system. A connector bar 6 connecting the upper framework elements 7 and 8 to the lower framework elements 4 and 5 assures that elements 4, 5, 7 and 8 will move together in reciprocation. Framework element 5 is not visible on the figure because it connects both legs of element 4 and is hidden behind connector bar 6. The oscillatory drive means applies reciprocating forces along the lines EE in Figure 1. This means will be described in greater detail below.

60 Elements 7 and 8 are shown with alignment holes for accepting wire matrix print heads. It is equally advantageous to employ ink jet dot printers, thermo electric printers, and the like. The holes shown in members 7 and 8 are therefore only indicative of the relative position of a plurality of dot forming heads which may be carried by members 7 and 8.

The frame piece 9 is integrally molded with the E-spring elements and is affixed to the center legs 12 of each E-shaped spring end piece 2 and 3, respectively. Frame piece 9 is affixed to rigid framework in the

printing machine mechanism not shown. Thus the center legs 12 are rigidly anchored by the attachment frame members 9 to a mechanical ground.

The element 5 may have attached to it an optical apertured grid strip to serve as a timing emitter of the well known sort normally employed in wire matrix or dot matrix printers to give appropriate timing pulses for use in electronic control system for synchronizing the firing of the dot matrix solenoids or the like to construct the desired characters.

Turning to Figure 2, the overall major component of a preferred embodiment of a dot matrix printer mechanism utilizing the integrally molded spring framework suspension and carrier assembly 1 are shown. A linear voice coil actuator 14 having a movable armature or coil 15 and a driving bulkhead 16 as utilized in the preferred embodiment are also shown together with other elements in the preferred design. A roller member not shown in Figure 2 is affixed to the bottom of the frame member 5 or 4 to interact with the cam member 17 at each end of oscillatory stroke. This action rocks the cam member 17 in a clockwise or counter clockwise direction depending upon the direction of motion of member 4. A oneway clutch 18 torqued by cam 17 provides a unidirectional rotary motion output on shaft 19 for the purpose of incrementing a paper feed roller 20 and driving a ribbon drive spindle 21.

An individual print element 22 is shown positioned coaxially in line with a set of the apertures in the frame member 7 and 8, it being understood that one or more such print heads 22 may be employed and that they may be of any of a variety of types. An emitter aperture grid 23 containing numerous apertures or slots 24 may be affixed to member 4 or 5 for oscillation back and forth with the carrier and suspension. The emitter grid 23 may pass between the typical photo source and sensor mounting block 25. This block contains a light emitting diode and a photo sensor on opposite sides of a slot through which the emitter grid 23 reciprocates in a well known fashion.

A fixed platen 26 is shown positioned adjacent the printing area where the print head 22 will be reciprocated. Paper feed roll 20 can, through a normal friction feeding engagement with a paper supply 2, cause the paper to increment by one dot height. It is necessary to feed the paper supply at the end of each reciprocating stroke of the carrier to begin printing a new dot. This is done by means of cam member 17, one way clutch 18, etc.

Turning to Figure 3, a schematic cross section of the major elements depicted for the assembly in Figure 2 is illustrated. As may be seen, the feed roll 20 is depicted as roll pair 20A and 20B which frictionally grip and drive the paper 27. The cantilever suspension assembly 1 is rigidly affixed by the frame pieces 9 attached to the center leg 12 of each of the E-shaped spring members. The molded framework 7 and 8 are shown together in a mere schematic representation. The print heads 22 would be coplanarly arranged with respect to the printing line on platen 26 as indicated. An overall cover which may incorporate a plastic tearing knife or guide bar 28 is also shown.

Turning to Figure 4, a timing diagram for a preferred embodiment of the printer as schematically illustrated in Figures 2 and 3 is shown.

In Figure 4 line A illustrates a velocity chart versus time. An initial "set up" time between point A and point C during which the one-piece molded carrier and print head assembly is accelerated from 0 to 396 millimeters per second velocity is shown. This time period may be arbitrary, but typically requires approximately 20 milliseconds. From point C to point D on line A, one full cycle of printing consisting of a left to right and a right to left printing stroke is indicated. The elapsed time of 111 milliseconds (H) is arbitrary and of course longer print lines or greater or lower speeds might be employed. The desired printing stroke covers approximately 16.6 millimeters which is sufficient to encompass 10 dot matrix characters of 5 dots of primary width each. As shown by section E in Figure 4, a brief period at the end of each printing stroke left to right or right to left is allowed for paper feeding time, approximately 13.6 milliseconds as shown. The left to right and right to left print strokes are indicated in sections F and G, respectively, and are truncated to show only a few of the 50 emitter pulses on line B which would be desired. Between the times labeled T_1 and T_{50} , these emitter pulses would be produced by the aperture emitter 23 shown in Figure 2. Each emitter pulse has a total duration I which corresponds to a distance of approximately .339 millimeters of lateral travel. Wire firing for wire matrix print heads can be easily timed to the rising or falling edge of such pulses produced by an emitter.

Turning to Figure 5, a plan view of a portion of the integrally molded spring and suspension means 1 is shown. Only the leaves of the E-shaped spring members 11, 12 and 13 and the connecting end pieces 10 are indicated. The rest position is identified as position A in which only the top most leaf 11 of the E-shaped member is visible. On a printing stroke to the right (to position B for element 10) the center leaf 12 becomes exposed as leaves 11 and 13 flex to the left (equivalent to the print head carrier 7, 8 moving toward the right in Figure 1 and 2). In the opposite direction of travel from the rest position A, printing is also accomplished. The left is indicated by the position of element 10 indicated by a letter C. This back and forth motion of the leaves 11, 13 and the common connector members 10 produces a significant air flow shown generally by the arrows in Figure 5 which may be directed or channeled to impinge upon a circuitboard 29 carrying electronic component 30 schematically shown as resistances. As is well known in the printer field, electronic circuit boards 29 typically require small cooling fans or other source of air flow to provide adequate cooling and stable operation of sensitive electronic components. By adding a fan shaped flap 10 as the common connector illustrated in Figures 1 and 2, etc., the integrally molded spring and suspension carrier assembly also serves as a fan to provide this cooling flow of air.

The linear voice coil driving assembly 14, 15 and 16 indicated in Figure 2 can be driven electronically using power drive amplifiers similar to those employed in the audio or high fidelity industry. The specific drive coils are mounted in the armature 15 and are supplied with current by the circuit shown schematically in Figure 6. An additional winding is supplied in the armature 16 to provide a back electromotive force (EMF) pick up signal providing feedback for the control of the precise velocity and position of the armature 16. The circuitry of Figure 6 schematically shows the overall drive and feedback control technique.

Separate windings 31 and 32 are schematically illustrated and will be described further with respect to specific figures depicting them later. A waveform generator 33 generates a rising voltage waveform of the proper shape and duration (to be described below) at its output 34. This is summed with the feedback coming on line 35 which provides a small correction to the output signals which are then applied to a power driving amplifier 36 for eventually driving coil 31. As current is applied to coil 31 by the amplifier 36, the fixed pole piece 14 (not shown in Figure 6) interacts with the electromagnetically generated field of the coil 31 to cause the coil to move inward or outward along the pole piece in element 14 in a manner similar to which a voice coil drives an ordinary audio speaker element. Feedback signals are generated by an EMF generated in coil 32 through a load resistor 37. These signals are sensed at an input buffer amplifier and inverted in inverter 39 where they may be at the output compared or summed with the output from the waveform generator in the summer 40. These provide, if any difference or excess exists, a feedback control on line 35 to the summer 41 for modifying the input of power drive amplifier 36 to more accurately control the velocity and position of the moving coil 31. Overall limits on the voltage excursions can be compared in threshold gate 42 and employed to drive an indicator which will be described in further detail below.

The circuit of Figure 6 may be further described as follows. The feedback coil 32 is physically attached to the mounting core of the power drive coil 31 so that the two coils move together in the presence of the same magnetic field. As the power coil 31 moves, an electro motive force will be generated in the feedback coil 32. Under normal operation, this feedback should be identical in amplitude waveform and frequency to that of the drive coil signal coming from the power drive amplifier 36. Should any aberration of motion occur during the operation of the printer such as by means of a paper jam or intrusion of a foreign object, the signal produced by the feedback coil will be different from that provided to the power amplifier 36. The circuit in Figure 6 processes the feedback signal to detect or correct for these conditions.

The feedback signal is sent to an inverting amplifier 39 through a buffer amplifier 38 to avoid any distortion interaction from the feedback coil 32 modifying the operation of the drive coil 31. From the inverting amplifier 39 the signal is summed with the original driving signal in the summer 40 to yield a correction signal. In normal operation the correction signal will be very small and will be centered about 0. The small signals are fed back into the drive amplifier 36 through summer 41. The resulting motion of the drive coil 31 will be one that better tracks the input waveform. If there is a malfunction such that the motion of the drive coil 31 is impeded and differs significantly from the original driving signal, this will be detected by a threshold gate 42 detecting a level of feedback beyond set limits which may be chosen as desired. This event can be used to shut off power and illuminate a light or LED to notify the user that a regular operating condition has occurred. A reset button or switch can be installed if desired to reset and resume operation.

Details for the drive coil 31 and the feedback coil 32 in the preferred embodiment are as follows. The drive coil consists of 240 turns in two layers of 120 turns each of close wound enamel insulated #31 gauge magnet wire and exhibits a total resistance of approximately 6.6 ohms. The feedback winding for coil 32 is one layer of 40 turns of #36 gauge enamel insulated magnet wire wound on a .76 mm pitch on the outer layer of the inner drive coil but insulated therefrom by a single layer of insulating tape between windings. This latter winding exhibits 3.6 ohm resistance. The return leg of the winding is brought back inside of the turns of the winding coil to hold it securely in place in the same manner that voice coils are wound on bobbins. The coil is shown schematically in Figure 7.

In Figure 7 the moving armature 15 and the driving cross head 16 are attached to a bobbin core 43 which may be of non-magnetic metal, cardboard, plastic or the like. In the preferred embodiment, this bobbin is made of aluminum for strength and is machined to a smooth finish for a close but non-frictional fit into the aperture of the driving pole piece 14.

Figure 8 illustrates the spring loading forces moving right and left including the forces occasioned by the cam paper incrementer mechanism 17 and 18, etc. These forces must be supplied by the driving coil and result in the total force shown in Figure 9 for one complete cycle from right to left and back to the right again. As may be understood, when the spring carrier suspension mechanism is deflected to the right or left of center, energy stored in the spring is released so that for at least a portion of the return stroke, the coil need not supply as much force. However, after crossing the center or 0 force position, additional energy must be supplied to deflect the spring in the opposite direction. When these forces are operated at or near the natural period of vibration for the spring suspension system, some efficiency in operation results.

If the frequency of oscillation of current reversal applied to the driving coil is adjusted to be at or approximately the same as the natural period of vibration of the spring and carrier mass suspension system, very small additional forces are required in order to keep the system in motion. These are chiefly those forces which are extracted by the paper incrementing mechanism near each end of the travel from left to right or right to left. Frictional losses are minimum since there are no bearings, pivots, slides, etc.

Frictional losses due to air motion are the primary source of loss other than the direct mechanical loss due to extraction of force by the paper incrementing mechanism previously described.

Figure 10 illustrates an alternative mechanical gear and reciprocating crank mechanism to replace the voice coil driver. A motor 44 supplies a continuous uniform velocity output through the matched circular gear set 45 to shaft 46 carrying the first of a noncircular gear set 47A and 47B. The constant angular velocity output at shaft A is converted into an irregular angular velocity output by the non-circular gear set 47A and 47B to provide an irregular angular velocity output on shaft B labeled 48. The one to one circular gear set 49 applies this irregular velocity to a matched circular gear set 50 through the shaft. In the circular gear set 50, each gear is supplied with a driving pin 51 connected to or journaled in individual arms of a flexible plastic connecting rod 52 like a conventional crank and rod mechanism. This rod 52 provides a direct linear output with no component of force orthogonal to the direction of travel at its output point 53.

A helical thread mounted on a drum 54 operates with fixed interposer pins attached to an incrementing wheel (not shown) to increment the wheel by one thread pitch length on the helix 54 with each rotation of the shaft. Each full rotation of the shaft 51 provides an increment at the beginning of a rotation (end of the previous rotation) and another increment halfway through a revolution. Thus, the helical thread is configured to present a cam surface which is not sloped for approximately one-half of a revolution and then it is stepped upward by the distance equal to a given dot row height representing the end of one left to right or right to left stroke at the output 53. This will increment the paper by one dot height. Then, with continued rotation of shaft the shaft, further increment will occur at the end of the return stroke. These details of the helical thread path on drum 54 would be obvious to one of ordinary skill in the art and are not described further.

The flexing drive coupling member 52 can be molded of plastic to reduce cost as is done in the preferred embodiment. The non-circular gear set 47A and 47B is utilized to better control the output motion at point 53. The velocity profile obtained differs substantially from that that would be obtained with normal circular gearing. Figure 11 illustrates the difference.

In Figure 11, the upper curves illustrate the tracing obtained of velocity and time given a normal circular gear set with an input drive rotating at 540 RPM which yields approximately nine cycles per second or 111 milliseconds per cycle. The velocity labeled V1 is slightly greater than that at V2 from the effect of the crank pin and angular thrust output being different at one end of the throw from the other as is well known in the mechanical arts.

The lower portion of Figure 11 illustrates the velocity profile versus time that may be obtained with the noncircular gearing shown in Figure 10. Initial high velocity acceleration rates followed by a flat sustained velocity and an abrupt but smooth transition to the opposite direction are shown. The velocity profiles can be designed so that the maximum V1 and V2 velocities are equal and that the velocity is maintained at a very steady rate over the interval of a print line which is most desirable.

The non-circular gear set comprises two identical gear of non-circular form. They are so designed that the sum of radii measured from each gear center to their common mesh point is constant. In the case illustrated, the constant is 30 mm. This can be verified in Appendix Table I by adding the radii R1 and R2 at each degree of rotation measured as R for gear 1 in the Table. A full set of radius values for each gear in one-degree increments for 0 through 360 is listed in the Table. For gear 1, r is zero when the longest diameter is horizontal in the small Figure 12. Since each gear will rotate by an amount that will produce an equal peripheral travel and R1 does not equal R2, it follows as shown in Figure 13, that r_1 does not equal r_2 for most gear positions. The starting position is shown in Figure 12 with gear 1 set with its longest axis horizontal and defined as 0 degree rotation for purposes of this description. Also for purposes of description, gear 1 in Figure 12 is assumed to rotate counter clockwise. Gear 2 will be engaged with a slight amount of pre-rotation in the clockwise direction as shown in Figure 12 and in the first entry in Table I as 1.49198681 degrees of rotation (measured in this case relative to the gear's shortest axis positioned horizontally). The other table entries follow the same format under each degree of rotation for gear 1. The entries are: degree of rotation r_1 , gear designation (gear 1), R1 (tangent radius for gear 1), r_2 degree of rotation for gear 2, and R2 (tangent radius for gear 2). Further details of the non-circular gear set employed in the preferred embodiment are given below in the Appendix, Table I which shows the radius of the gears as a function of angular rotation for one full 360° arc. These gears can be of molded plastic for quiet operation and low cost manufacture. This arrangement has the result of achieving a flat velocity profile across the print line distance. This is of interest in providing high forces for the incrementing function without the limitation of requiring these forces to be extracted from the maximum ends of travel of a voice coil as disclosed above where the force available requires higher currents at these points.

The flexing V-shaped coupling element 52 provides the unique result of counter balancing orthogonal forces. The two counter rotating gears provide orthogonal forces that directly cancel in the V flex coupling 52. Only the resultant straight linear thrust along the axis of symmetry midway between the two shafts of the output gears are produced along the line shown at the output coupling 53.

This mechanical design for the drive mechanism has the additional advantage in that the motor 44 can supply at its output pulley a continuous rotary drive for driving printing ribbon and the like without the necessity of the more complex stepwise camming and incrementing arrangement necessary with the above disclosed voice coil prime driver designs. However, the voice coil design is easily constructed with a minimum of mechanical cost and complexity and provides a basically electronically controlled mechanism.

0 082 329

Either drive may be satisfactorily employed provided that appropriate spacings in the emitter grid are used to adjust the aforementioned velocity profile differences. It will be understood that the non-constant velocity output of the voice coil is not a detriment in such operations since actual wire firing timings for printing the dots are derived from a physical displacement registered by the emitter grid.

5

APPENDIX—TABLE I

	0. θ_1	8.	16.
	1. Gear 1	1.	1.
10	17.96141301 R_1	17.96141301	17.96141301
	1.49198681 θ_2	13.42788129	25.36377578
	12.03858699 R_2	12.03858699	12.03858699
	1.	9.	17.
15	1.	1.	1.
	17.96141301	17.96141301	17.96141301
	2.983973621	14.9198681	26.85576259
	12.03858699	12.03858699	12.03858699
20	2.	10.	18.
	1.	1.	1.
	17.96141301	17.96141301	17.96141301
	4.475960431	16.41185491	28.3477494
	12.03858699	12.03858699	12.03858699
25	3.	11.	19.
	1.	1.	1.
	17.96141301	17.96141301	17.96141301
	5.967947241	17.90384172	29.83973621
30	12.03858699	12.03858699	12.03858699
	4.	12.	20.
	1.	1.	1.
	17.96141301	17.96141301	17.96141301
35	7.459934052	19.39582853	31.33172302
	12.03858699	12.03858699	12.03858699
	5.	13.	21.
	1.	1.	1.
40	17.96141301	17.96141301	17.96141301
	8.951920862	20.88781534	32.82370983
	12.03858699	12.03858699	12.03858699
45	6.	14.	22.
	1.	1.	1.
	17.96141301	17.96141301	17.96141301
	10.44390767	22.37980215	34.31569664
	12.03858699	12.03858699	12.03858699
50	7.	15.	23.
	1.	1.	1.
	17.96141301	17.96141301	17.96141301
	11.93589448	23.87178897	35.80768345
55	12.03858699	12.03858699	12.03858699
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	24. 1.	32. 1.	40. 1.
5	17.96141301 37.29967026 12.03858699	17.85093341 49.17869283 12.14906659	17.24136579 60.48561194 12.75863421
	25. 1.	33. 1.	41. 1.
10	17.96141301 38.79165707 12.03858699	17.80918199 50.63956133 12.19081801	17.09909739 61.81103063 12.90090261
	26. 1.	34. 1.	42. 1.
15	17.96141301 40.28364388 12.03858699	17.75966524 52.09047469 12.24033476	16.92919857 63.10622272 13.07080143
20			
	27. 1.	35. 1.	43. 1.
25	17.95843948 41.77501532 12.04156052	17.70168353 53.52983296 12.29831647	16.72078763 64.36539285 13.27921237
	28. 1.	36. 1.	44. 1.
30	17.9494876 43.26453602 12.0505124	16.63433785 54.95590603 12.36566215	16.45263075 65.57984493 13.54736925
	29. 1.	37. 1.	45. 1.
35	17.93446227 44.75095649 12.06553773	17.55646252 56.36679603 12.44353748	16.06998424 66.73346776 13.93001576
	30. 1.	38. 1.	46. 1.
40	17.91320062 46.23300314 12.08679938	17.46652229 57.76038548 12.53347771	15. 67.73346776 15.
	31. 1.	39. 1.	47. 1.
45	17.88546522 47.70936733 12.11453478	17.36244872 59.13426308 12.63755128	14.4133724 68.65819457 15.5866276
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	48.	56.	64.
	1.	1.	1.
5	14.16097317	13.073753	12.43185749
	69.55225033	76.08600759	81.9545062
	15.83902683	16.926247	17.56814251
	49.	57.	65.
	1.	1.	1.
10	13.96468522	12.97903913	12.36680428
	70.42312099	76.84854029	82.65584273
	16.03531478	17.02096087	17.63319572
	50.	58.	66.
	1.	1.	1.
15	13.79797032	12.88923623	12.30447502
	71.27474086	77.60182263	83.35118661
	16.20202968	17.11076377	17.69552498
20	51.	59.	67.
	1.	1.	1.
	13.65052384	12.80386124	12.24474567
	72.10966203	78.34640032	84.04082729
25	16.34947616	17.19613876	17.75525433
	52.	60.	68.
	1.	1.	1.
30	13.51705096	12.72252336	12.18750757
	72.92972469	79.08276499	84.72503853
	16.48294904	17.27747664	17.81249243
	53.	61.	69.
	1.	1.	1.
35	13.39440198	12.64490138	12.13266505
	73.73634436	79.81136364	85.40408021
	16.60559802	17.35509862	17.86733495
	54.	62.	70.
	1.	1.	1.
40	13.28052285	12.57072777	12.08013344
	74.53065884	80.5326059	86.07819982
	16.71947715	17.42927223	17.91986656
	55.	63.	71.
	1.	1.	1.
45	13.17398623	12.49977709	12.02983756
	75.31361233	81.24686978	86.74763381
	16.82601377	17.50022291	17.97016244
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	72. 1.	80. 1.	88. 1.
5	11.98171033 87.4126087 18.01828967	11.66869145 92.59647382 18.33130855	11.47169612 97.60391364 18.52830388
	73. 1.	81. 1.	89. 1.
10	11.93569176 88.0733421 18.06430824	11.63798904 93.2302818 18.36201096	11.4546893 98.22157325 18.5453107
	74. 1.	82. 1.	90. 1.
15	11.89172804 88.73004353 18.10827196	11.60906212 93.86151998 18.39093788	11.43933211 98.8378944 18.56066789
20			
	75. 1.	83. 1.	91. 1.
25	11.84977073 89.38291521 18.15022927	11.58188883 94.4903515 18.41811117	11.42561526 99.45302192 18.57438474
	76. 1.	84. 1.	92. 1.
30	11.80977619 90.03215275 18.19022381	11.55644937 95.11693635 18.44355063	11.41353062 100.0670993 18.58646938
	77. 1.	85. 1.	93. 1.
35	11.77170501 90.67794574 18.22829499	11.5327258 95.74143164 18.4672742	11.40307112 100.6802689 18.59692888
	78. 1.	86. 1.	94. 1.
40	11.73552151 91.32047826 18.26447849	11.5107019 96.36399188 18.4892981	11.39423074 101.292672 18.60576926
	79. 1.	87. 1.	95. 1.
45	11.70119342 91.95992944 18.29880658	11.49036306 96.98476922 18.50963694	11.38700445 101.9044491 18.61299555
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	96.	104.	112.
	1.	1.	1.
5	11.38138817	11.39423074	11.5107019
	102.51574	107.4052378	112.3440751
	18.61861183	18.60576926	18.4892981
	97.	105.	113.
	1.	1.	1.
10	11.37737876	11.40307112	11.5327258
	103.126684	108.0184074	112.9685704
	18.62262124	18.59692888	18.4672742
	98.	106.	114.
	1.	1.	1.
15	11.37497401	11.41353062	11.55644937
	103.73742	108.6324848	113.5951552
	18.62502599	18.58646938	18.44355063
20	99.	107.	115.
	1.	1.	1.
	11.37417257	11.42561526	11.58188883
	104.3480867	109.2476123	114.2239867
25	18.62582743	18.57438474	18.41811117
	100.	108.	116.
	1.	1.	1.
	11.37497401	11.43933211	11.60906212
30	104.9588227	109.8639335	114.8552249
	18.62502599	18.56066789	18.39093788
	101.	109.	117.
	1.	1.	1.
35	11.37737876	11.4546893	11.63798904
	105.5697667	110.4815931	115.4890329
	18.62262124	18.5453107	18.36201096
	102.	110.	118.
	1.	1.	1.
40	11.38138817	11.47169612	11.66869145
	106.1810576	111.1007375	116.1255773
	18.61861183	18.52830388	18.33130855
45	103.	111.	119.
	1.	1.	1.
	11.38700445	11.49036306	11.70119342
	106.7928347	111.7215148	116.7650285
50	18.61299555	18.50963694	18.29880658
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	120.	128.	136.
	1.	1.	1.
5	11.73552151	12.08013344	12.57072777
	117.407561	122.6814265	128.2741431
	18.26447849	17.91986656	17.42927223
	121.	129.	137.
	1.	1.	1.
10	11.77170501	12.13266505	12.64490138
	118.053354	123.3604682	129.0027417
	18.22829499	17.86733495	17.35509862
	122.	130.	138.
	1.	1.	1.
15	11.80977619	12.18750757	12.72252336
	118.7025915	124.0446794	129.7391064
	18.19022381	17.81249243	17.27747664
20	123.	131.	139.
	1.	1.	1.
	11.84977073	12.24474567	12.80386124
	119.3554632	124.7343201	130.4836841
25	18.15022927	17.75525433	17.19613876
	124.	132.	140.
	1.	1.	1.
30	11.89172804	12.30447502	12.88923623
	120.0121646	125.429664	131.2369664
	18.10827196	17.69552498	17.11076377
	125.	133.	141.
	1.	1.	1.
35	11.93569176	12.36680428	12.97903913
	120.672898	126.1310005	131.9994991
	18.06430824	17.63319572	17.02096087
	126.	134.	142.
	1.	1.	1.
40	11.98171033	12.43185749	13.073753
	121.3378729	126.8386369	132.7718944
	18.01828967	17.56814251	16.926247
	127.	135.	143.
	1.	1.	1.
45	12.02983756	12.49977709	13.17398623
	122.0073069	127.5529008	133.5548479
	17.97016244	17.50022291	16.82601377
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	144.	152.	160.
	1.	1.	1.
5	13.28052285	15.	17.46652229
	134.3491624	141.352039	151.7187107
	16.71947715	15.	12.53347771
	145.	153.	161.
	1.	1.	1.
10	13.39440198	16.06998424	17.55646252
	135.155782	142.5056618	153.1296007
	16.60559802	13.93001576	12.44353748
	146.	154.	162.
	1.	1.	1.
15	13.51705096	16.45263075	17.63433785
	135.9758447	143.7201139	154.5556738
	16.48294904	13.54736925	12.36566215
20	147.	155.	163.
	1.	1.	1.
	13.65052384	16.72078763	17.70168353
	136.8107659	144.979284	155.995032
25	16.34947616	13.27921237	12.29831647
	148.	156.	164.
	1.	1.	1.
	13.79797032	16.92919857	17.75966524
30	137.6623857	146.2744761	157.4459454
	16.20202968	13.07080143	12.24033476
	149.	157.	165.
	1.	1.	1.
35	13.96468522	17.09909739	17.80918199
	138.5332564	147.5998948	158.9068139
	16.03531478	12.90090261	12.19081801
	150.	158.	166.
	1.	1.	1.
40	14.16097317	17.24136579	17.85093341
	139.4273121	148.9512436	160.3761394
	15.83902683	12.75863421	12.14906659
	151.	159.	167.
	1.	1.	1.
45	14.4133724	17.36244872	17.88546522
	140.352039	150.3251212	161.8525036
	15.5866276	12.63755128	12.11453478
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	168. 1.	176. 1.	184. 1.
5	17.91320062 163.3345502 12.08679938	17.96141301 175.2617969 12.03858699	17.96141301 187.1976914 12.03858699
	169. 1.	177. 1.	185. 1.
10	17.93446227 164.8209707 12.06553773	17.96141301 176.7537837 12.03858699	17.96141301 188.6896782 12.03858699
	170. 1.	178. 1.	186. 1.
15	17.9494876 166.3104914 12.0505124	17.96141301 178.2457705 12.03858699	17.96141301 190.181665 12.03858699
20	171. 1.	179. 1.	187. 1.
	17.95843948 167.8018628 12.04156052	17.96141301 179.7377573 12.03858699	17.96141301 191.6736518 12.03858699
25	172. 1.	180. 1.	188. 1.
	17.96141301 169.2938496 12.03858699	17.96141301 181.2297441 12.03858699	17.96141301 193.1656386 12.03858699
30	173. 1.	181. 1.	189. 1.
	17.96141301 170.7858365 12.03858699	17.96141301 182.7217309 12.03858699	17.96141301 194.6576254 12.03858699
35	174. 1.	182. 1.	190. 1.
	17.96141301 172.2778233 12.03858699	17.96141301 184.2137178 12.03858699	17.96141301 196.1496122 12.03858699
40	175. 1.	183. 1.	191. 1.
	17.96141301 173.7698101 12.03858699	17.96141301 185.7057046 12.03858699	17.96141301 197.641599 12.03858699
45			
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	192.	200.	208.
	1.	1.	1.
5	17.96141301	17.96141301	17.96141301
	199.1335859	211.0694803	223.0053748
	12.03858699	12.03858699	12.03858699
	193.	201.	209.
	1.	1.	1.
10	17.96141301	17.96141301	17.96141301
	200.6255727	212.5614671	224.4973616
	12.03858699	12.03858699	12.03858699
	194.	202.	210.
	1.	1.	1.
15	17.96141301	17.96141301	17.96141301
	202.1175595	214.053454	225.9893484
	12.03858699	12.03858699	12.03858699
20	195.	203.	211.
	1.	1.	1.
	17.96141301	17.96141301	17.96141301
	203.6095463	215.5454408	227.4813352
25	12.03858699	12.03858699	12.03858699
	196.	204.	212.
	1.	1.	1.
30	17.96141301	17.96141301	17.96141301
	205.1015331	217.0374276	228.9733221
	12.03858699	12.03858699	12.03858699
	197.	205.	213.
	1.	1.	1.
35	17.96141301	17.96141301	17.96141301
	206.5935199	218.5294144	230.4653089
	12.03858699	12.03858699	12.03858699
	198.	206.	214.
	1.	1.	1.
40	17.96141301	17.96141301	17.96141301
	208.0855067	220.0214012	231.9572957
	12.03858699	12.03858699	12.03858699
45	199.	207.	215.
	1.	1.	1.
	17.96141301	17.96141301	17.96141301
	209.5774935	221.513388	233.4492825
50	12.03858699	12.03858699	12.03858699
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	216. 1.	224. 1.	232. 1.
5	17.96141301 234.9412693 12.03858699	17.91320062 246.8585758 12.08679938	17.46652229 258.3859581 12.53347771
	217. 1.	225. 1.	233. 1.
10	17.96141301 236.4332561 12.03858699	17.88546522 248.33494 12.11453478	17.36244872 259.7598357 12.63755128
	218. 1.	226. 1.	234. 1.
15	17.96141301 237.9252429 12.03858699	17.85093341 249.8042655 12.14906659	17.24136579 261.1111846 12.75863421
	219. 1.	227. 1.	235. 1.
20	17.96141301 239.4172297 12.03858699	17.80918199 251.265134 12.19081801	17.09909739 262.4366033 12.90090261
	220. 1.	228. 1.	236. 1.
25	17.96141301 240.9092165 12.03858699	17.75966524 252.7160473 12.24033476	16.92919857 263.7317954 13.07080143
	221. 1.	229. 1.	237. 1.
30	17.95843948 242.400588 12.04156052	17.70168353 254.1554056 12.29831647	16.72078763 264.9909655 13.27921237
	222. 1.	230. 1.	238. 1.
35	17.9494876 243.8901087 12.0505124	17.63433785 255.5814787 12.36566215	16.45263075 266.2054176 13.54736925
	223. 1.	231. 1.	239. 1.
40	17.93446227 245.3765291 12.06553773	17.55646252 256.9923687 12.44353748	16.06998424 267.3590404 13.93001576
45			
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	240.	248.	256.
	1.	1.	1.
5	15.	12.94340527	12.08022273
	268.3590404	274.9475585	280.608891
	15.	17.05659473	17.91977727
	241.	249.	257.
10	1.	1.	1.
	14.30598452	12.8140918	11.99392308
	269.2705971	275.6931747	281.2749951
	15.69401548	17.1859082	18.00607692
	242.	250.	258.
15	1.	1.	1.
	14.00473934	12.69230769	11.91136614
	270.1461527	276.4265081	281.9334952
20	15.99526066	17.30769231	18.08863386
	243.	251.	259.
	1.	1.	1.
	13.76945629	12.5771403	11.83236452
25	270.9945196	277.1483838	282.5847833
	16.23054371	17.4228597	18.16763548
	244.	252.	260.
	1.	1.	1.
30	13.56897309	12.46788278	11.75675676
	271.8203336	277.8595291	283.2292277
	16.43102691	17.53211722	18.24324324
	245.	253.	261.
	1.	1.	1.
35	13.39119801	12.36397525	11.68440285
	272.6266048	278.5605927	283.8671759
	16.60880199	17.63602475	18.31559715
	246.	254.	262.
40	1.	1.	1.
	13.22992331	12.26496585	11.6151807
	273.4155054	279.2521598	284.498957
	16.77007669	17.73503415	18.3848193
	247.	255.	263.
45	1.	1.	1.
	13.08146	12.1704842	11.51898327
	274.188708	279.934763	285.1248837
50	16.91854	17.8295158	18.45101673
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	264. 1.	272. 1.	280. 1.
5	11.48571635 285.7452542 18.51428365	11.07678794 290.5402815 18.92321206	10.82497548 295.1209662 19.17502452
	265. 1.	273. 1.	281. 1.
10	11.42529668 286.360354 18.57470332	11.03705969 291.1223146 18.96294031	10.80386798 295.683781 19.19613202
	266. 1.	274. 1.	282. 1.
15	11.36765042 286.9704569 18.63234958	10.99973729 291.7012402 19.00026271	10.78501326 296.2450624 19.21498674
20			
	267. 1.	275. 1.	283. 1.
25	11.31271187 287.5758263 18.68728813	10.96479338 292.2772672 19.03520662	10.76840067 296.804995 19.23159933
	268. 1.	276. 1.	284. 1.
30	11.26042247 288.1767162 18.73957753	10.93220339 292.8506005 19.0677966	10.75402101 297.3637622 19.24597899
	269. 1.	277. 1.	285. 1.
35	11.21072989 288.7733721 18.78927011	10.9019453 293.4214412 19.0980547	10.74186646 297.9215456 19.25813354
	270. 1.	278. 1.	286. 1.
40	11.16358723 289.3660321 18.83641277	10.87399937 293.9899865 19.12600063	10.73193052 298.4785256 19.26806948
45			
	271. 1.	279. 1.	287. 1.
50	11.11895249 289.954927 18.88104751	10.84834798 294.556431 19.15165202	10.72420792 299.0348819 19.27579208
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	288. 1.	296. 1.	304. 1.
5	10.71869464 299.5907931 19.28130536	10.75402101 304.0434357 19.24597899	10.93220339 308.5711635 19.0677966
	289. 1.	297. 1.	305. 1.
10	10.71538781 300.1464376 19.28461219	10.76840067 304.6033684 19.23159933	10.96479338 309.1471906 19.03520662
	290. 1.	298. 1.	306. 1.
15	10.71428572 300.7019932 19.28571428	10.78501326 305.1646497 19.21498674	10.99973729 309.7261161 19.00026271
20			
	291. 1.	299. 1.	307. 1.
25	10.71538781 301.2576376 19.28461219	10.80386798 305.7274646 19.19613202	11.03705969 310.3081492 18.96294031
	292. 1.	300. 1.	308. 1.
30	10.71869464 301.8135489 19.28130536	10.82497548 306.2919997 19.17502452	11.07678794 310.8935038 18.92321206
	293. 1.	301. 1.	309. 1.
35	10.72420792 302.3699051 19.27579208	10.84834798 306.8584442 19.15165202	11.11895249 311.4823987 18.88104751
	294. 1.	302. 1.	310. 1.
40	10.73193052 302.9268852 19.26806948	10.87399937 307.4269896 19.12600063	11.16358723 312.0750586 18.83641277
45	295. 1.	303. 1.	311. 1.
	10.74186646 303.4846686 19.25813354	10.9019453 307.9978302 19.0980547	11.21072989 312.6717146 18.78927011
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	312. 1.	320. 1.	328. 1.
5	11.26042247 313.2726044 18.73957753	11.75675676 318.2636475 18.24324324	12.46788278 323.7000469 17.53211722
	313. 1.	321. 1.	329. 1.
10	11.31271187 313.8779738 18.68728813	11.83236452 318.9149356 18.16763548	12.5771403 324.4219227 17.4228597
	314. 1.	322. 1.	330. 1.
15	11.37675042 314.4880767 18.63234958	11.91136614 319.5734356 18.08863386	12.69230769 325.155256 17.30769231
20	315. 1.	323. 1.	331. 1.
	11.42529668 315.1031765 18.57470332	11.99392308 320.2395398 18.00607692	12.8140918 325.9008722 17.1859082
25	316. 1.	324. 1.	332. 1.
	11.48571635 315.7235471 18.51428365	12.08022273 320.9136677 17.91977727	12.94340527 326.6597227 17.05659473
30	317. 1.	325. 1.	333. 1.
	11.54898327 316.3494737 18.45101673	12.1704842 321.5962709 17.8295158	13.08146 327.4329254 16.91854
35	318. 1.	326. 1.	334. 1.
	11.6151807 316.9812548 18.3848193	12.26496585 322.287838 17.73503415	13.22992331 328.221826 16.77007669
40	319. 1.	327. 1.	335. 1.
	11.68440285 317.619203 18.31559715	12.36397525 322.9889016 17.63602475	13.39119801 329.0280971 16.60880199
45			
50			
55			
60			
65			

0 082 329

APPENDIX—TABLE I (contd.)

	336.	344.	352.
	1.	1.	1.
5	13.56897309	16.92919857	17.75966524
	329.8539112	338.4118275	349.5832968
	16.43102691	13.07080143	12.24033476
	337.	345.	353.
	1.	1.	1.
10	13.76945629	17.09909739	17.80918199
	330.7022781	339.7372461	351.0441653
	16.23054371	12.90090261	12.19081801
	338.	346.	354.
	1.	1.	1.
15	14.00473934	17.24136579	17.85093341
	331.5778337	341.088595	352.5134908
	15.99526066	12.75863421	12.14906659
20	339.	347.	355.
	1.	1.	1.
	14.30598452	17.36244872	17.88546522
	332.4893903	342.4624726	353.9898549
25	15.69401548	12.63755128	12.11453478
	340.	348.	356.
	1.	1.	1.
	15.	17.46652229	17.91320062
30	333.4893903	343.8560621	355.4719016
	15.	12.53347771	12.08679938
	341.	349.	357.
	1.	1.	1.
35	16.06998424	17.55646252	17.93446227
	334.6430132	345.2669521	356.9583221
	13.93001576	12.44353748	12.06553773
	342.	350.	358.
	1.	1.	1.
40	16.45263075	17.63433785	17.9494876
	335.8574652	346.6930251	358.4478428
	13.54736925	12.36566215	12.0505124
	343.	351.	359.
	1.	1.	1.
45	16.72078763	17.70168353	17.95843948
	337.1166354	348.1323834	359.9392142
	13.27921237	12.29831647	12.04156052
50			

Claims

1. A dot printer comprising:
 - at least one dot printing element (22);
 - an elongated support member (7) for said printing element,
 - a platen (26) arranged adjacent to and parallel with said support member,
 - a suspension spring and frame element (1) comprising two identical and parallel E-shaped plate spring elements (2, 3) having each a stile (10), a first (upper), a second (central) and a third (lower) legs (11, 12, 13), forming a pair of stiles and three pairs of legs, the ends of said support member (7) being respectively
 - connected to the free ends of one pair of said legs, the free ends of at least one of the remaining pairs of legs being rigidly affixed to the frame of said printer to support the whole suspension element, and
 - drive means (14—16) for reciprocating said support member in a direction parallel to said platen, characterized in that:
 - the ends of said support member (7) are respectively rigidly connected to the free ends of the first
 - (upper) pair of legs (11),

- the free ends of the second (central) pair of legs (12) are connected to a frame piece (9) which is rigidly affixed to the frame of said printer,
said support member (7) and the free ends (4) of the third (lower) pair of legs (13) are linked together through a connector bar (6),
5 said stiles (10) of said E-shaped elements are connected together through braces (10a, 10b),
said drive means are designed to cause a linear speed reciprocation movement of said printing element support member without orthogonal or off-axis forces.
2. Dot printer according to claim 1, characterized in that said E-shape plate spring elements (2, 3), said support member (7), said frame piece (9) and said connector bar (6) constitute a unitary molded flexible
10 plastic element.
3. Dot printer according to claim 1 or 2, characterized in that said drive means are arranged to reciprocate both the first (upper) and the third (lower) pairs of legs (11, 13), thus flexing said first and second pair of legs and moving said support member (7) and said dot printing element (22) back and forth along a print line parallel to said platen (26).
- 15 4. Dot printer according to claim 1, 2 or 3, characterized in that the combined spring rates of said first and third pairs of legs equals that of said second pair of legs.
5. Dot printer according to any one of the preceding claims characterized in that said drive means comprise:
a fixed field magnet (14),
20 a winding coil (15) suspended in the field of said magnet and moving with respect thereto upon application of electrical current to said coil, the external end of said coil being connected to said printing element support member for reciprocation thereof, said coil (15) comprising:
a first winding (31) receiving a driving current from a waveform generator (33) and
a second winding (32) including a circuit containing an inverting amplifier (38, 39) summation means
25 (40, 41) and control means for modifying the driving current applied to said first winding to produce exact tracking between input driving signals to said winding and the resulting physical motion thereof.
6. Dot printer according to any one of the previous claims, characterized in that it further comprises:
paper print media drive means (20) for feeding said paper (27) incrementally past said platen (26),
incremental cam and clutch means (17, 18), and
30 an interposer means so affixed to said suspension spring and frame element as to be reciprocated therewith and to interact with said cam and one way clutch means for providing intermittent rotary output, said intermittent rotary output being connected to said paper media drive and incrementing means (20) to increment said paper at the end of each said reciprocation.
7. Dot printer according to any one of claims 1 to 4, characterized in that said drive means comprise:
35 a uniformly rotating motor (44),
a meshed pair of non-circular gears (47A, 47B), one of which (47A) being coupled to said motor (44), the other one (47B) being coupled to the driving shaft of a crank and rod type mechanism (50, 51, 52), the geometrical configuration of said non-circular gears being such that said driving shaft is rotated at an irregular angular velocity which, when transmitted to said crank and rod type mechanism causes the free
40 end of said rod (52) to move at a substantially linear velocity, said free end being connected to said support member (7) to provide said linear reciprocation movement.
8. Dot printer according to claim 7, characterized in that said driving shaft of said crank and rod mechanism is coupled to the shaft of another identical crank and rod type mechanism arranged symmetrically with respect to the first one, the respective free ends of both rods (52) being connected
45 together and both rods being so mounted that they always form a V, more or less flared according to the angular position of the shafts, but having always the same symmetry axis, which symmetry axis is parallel to the direction of said reciprocating movement.
9. Dot printer according to any one of the preceding claims, characterized in that said stiles (10) of said E-shaped elements are adapted to cause a fanning of air whenever said legs are flexed back and forth by
50 said reciprocation.
10. Dot printer according to any one of claims 2 to 9, characterized in that said unitary molded flexible element is molded integrally of a plastic having a specific gravity of at least 1.06, a tensile modulus of at least 23800 kg/cm² and a creep modulus of at least 22400 kg/cm² at 5°C and 105 kg/cm² load.

55 Patentansprüche

1. Matrixdrucker mit:
mindestens einem Punktdruckelement (22);
einem länglichen Halteglied (7) für das besagte Druckelement,
60 einer am besagten Halteelement anliegenden und parallel zu ihm angeordneten Druckwalze (26),
einer Aufhängungsfeder und einem Rahmenelement (1), mit zwei identischen und parallelen E-förmigen Blattfederelementen (2, 3), von denen jedes eine Stufe (10), ein erstes (oberes), ein zweites (mittleres) und ein drittes (unteres) Bein (11, 12, 13) besitzt, welche ein Paar Stufen und drei Paar Beine bilden, sodass die Enden des besagten Halteglied (7) an den freien Enden eines Paares der
65 besagten Beine angeschlossen sind, und die freien Enden von mindestens einem der verbleibenden

- Beinpaare starr am Rahmen des besagten Druckers befestigt sind, um das ganze Aufhängeelement zu tragen,
 und Antriebsmittel (14—16), um das besagte Halterungsglied in einer Richtung parallel zur besagten Walze zu bewegen,
- 5 dadurch gekennzeichnet, dass:
 die Enden des besagten Halterungsgliedes (7) starr an die freien Enden des ersten (oberen) Beinpaars (11) angeschlossen sind,
 die freien Enden des zweiten (mittleren) Paares (12) an ein Rahmenteil (9) angeschlossen sind, welches starr am Rahmen des besagten Druckers befestigt ist,
- 10 das besagte Halterungsglied (7) und die freien Enden (4) des dritten (unteren) Beinpaars (13) durch eine Verbindungsstange (6) miteinander verbunden sind,
 die besagten Stufen (10) der besagten E-förmigen Elemente durch Streben (10a, 10b) miteinander verbunden sind,
 die besagten Antriebsmittel ausgelegt sind, um eine Bewegung des besagten
- 15 Druckelementhalterungsgliedes in linearer Geschwindigkeit in beiden Richtungen ohne rechtwinklige oder von der Achse wegstrebende Kräfte zu erzeugen.
2. Matrixdrucker gemäss Anspruch 1, dadurch gekennzeichnet, dass die besagten E-förmigen Blattfederelemente (2, 3), das besagte Halterungsglied (7), das besagte Rahmenteil (9) und die besagte Anschlussstange (6) ein einziges gegossenes flexibles Plastikbauteil bilden.
- 20 3. Matrixdrucker gemäss Anspruch 1 oder 2, dadurch gekennzeichnet, dass die besagten Antriebsmittel so angeordnet sind, dass sie sowohl das erste (obere) als auch das dritte (untere) Beinpaar (11, 13) hin- und herzubewegen, und damit das besagte erste und zweite Beinpaar biegen und das besagte obere Glied (7) und das besagte Matrixdruckelement (22) an einer Druckzeile parallel zur besagten Druckwalze (26) vorwärts und rückwärts bewegen.
- 25 4. Matrixdrucker gemäss Anspruch 1, 2 oder 3, dadurch gekennzeichnet, dass die kombinierten Federkräfte des besagten ersten und dritten Beinpaars gleich mit denen des zweiten Beinpaars sind.
5. Matrixdrucker gemäss einem der vorangehenden Ansprüche, dadurch gekennzeichnet, dass das besagte Antriebsmittel enthält:
 einen festen Feldmagneten (14),
- 30 eine Wicklungsspule (15), im Feld des besagten Magneten aufgehängt, und sich bewegend in Abhängigkeit von dem an der besagten Spule anliegenden elektrischen Strom, wobei das äussere Ende der besagten Spule an das besagte Druckelement-Halterglied angeschlossen ist, um dieses hin- und herzubewegen, enthaltend:
 eine erste Wicklung (31), die einen Antriebsstrom aus einem Wechselstromgenerator (33) empfängt,
- 35 und
 eine zweite Spule (32) mit einer Schaltung, die einen Umkehrverstärker (38, 39) mit Summiermitteln (40, 41) und Steuermitteln für die Änderung des Antriebsstromes enthält, der an die besagte erste Wicklung angelegt wird, um eine genaue Entsprechung zwischen den Eingangsantriebssignalen an der besagten Wicklung und den sich daraus ergebenden physikalischen Bewegungen zu erzeugen.
- 40 6. Matrixdrucker gemäss einem der vorangehenden Ansprüche, dadurch gekennzeichnet, dass er ausserdem enthält:
 Antriebsmittel (20) für Druckmedium Papier für den inkrementalen Vorschub des besagten Papiers (27) über die besagte Druckwalze (26),
 inkrementale Nocke und Klammern (17, 18) und
- 45 ein dazwischenliegendes Mittel, so an der besagten Aufhängungsfeder und am Rahmenelement befestigt, dass es zusammen mit diesem hin- und herbewegt wird und mit der besagten Nocke und Einwegklammer in Wechselwirkung tritt, um in Abständen eine Drehbewegung zu liefern, wobei die besagte Drehbewegung an dem besagten Papiermediumantrieb angeschlossen wird, und Mittel (20) zum Inkrementieren des besagten Papiers am Ende einer jeden Hin- und Herbewegung.
- 50 7. Matrixdrucker gemäss einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, dass der besagte Antrieb enthält:
 einen gleichmässig laufenden Motor (44),
 ein ineinander eingreifendes Paar von nicht runden Getriebeelementen (47A, 47B), von denen eines (47A) am besagten Motor (44) angekoppelt ist, während das andere (47B) an der Antriebswelle eines
- 55 Mechanismus vom Typ Kurbelwelle und Stange (50, 51, 52) angekoppelt ist, und die geometrische Konfiguration des besagten nicht-runden Getriebeelementes so ist, dass die besagte Antriebswelle in einer ungleichmässigen Winkelgeschwindigkeit angetrieben wird, die, wenn sie an den besagten Kurbelwellen- und Stangenmechanismus übertragen wird, das freie Ende der besagten Stange (52) in einer wesentlich linearen Geschwindigkeit antreibt, während das besagte freie Ende am besagten Halterungsglied (7)
- 60 angeschlossen ist, um die besagte lineare Hin- und Herbewegung zu erzeugen.
8. Matrixdrucker gemäss Anspruch 7, dadurch gekennzeichnet, dass die besagte Antriebswelle des besagten Kurbelwellen- und Stangenmechanismus an die Welle eines anderen identischen Kurbelwellen- und Stangenmechanismus angeschlossen ist, der symmetrisch zum ersten angeordnet ist und dass die freien Enden der beiden Stangen (52) miteinander verbunden sind und beide Stangen so montiert sind,
- 65 dass sie immer ein V bilden, je nach der Winkelposition der Wellen, mehr oder weniger weit geöffnet,

jedoch immer mit der gleichen Symmetrieachse, die parallel zur Richtung der besagten Hin- und Herbewegung verläuft.

9. Matrixdrucker gemäss einem der vorangehenden Ansprüche, dadurch gekennzeichnet, dass die besagten Stufen (10) den besagten E-förmigen Elementen angepasst sind, um eine Belüftung zu bewirken, immer, wenn die besagten Beine durch die besagte Vor- und Rückwärtsbewegung nach vorn und hinten gebogen werden.

10. Matrixdrucker gemäss einem der Ansprüche 2 bis 9, dadurch gekennzeichnet, dass die besagten einheitlich gegossenen flexiblen Elemente vollständig aus Kunststoff mit einem spezifischen Gewicht von mindestens 1,06 gegossen sind, mit einem Spannungsmodul von mindestens 23800 kg/cm² und einem Kriechmodul von mindestens 22400 kg/cm² bei 5°C und einer Belastung von 105 kg/cm².

Revendications

1. Une imprimante par points comprenant:
 - au moins un élément d'impression par points (22),
 - un élément de support allongé (7) pour ledit élément d'impression,
 - une platine (26) disposée dans une position adjacente et parallèle audit élément de support,
 - un élément à cadre et ressort de suspension (1) comprenant deux éléments flexibles à plaques en forme de E identiques et parallèles (2, 3) présentant chacune un montant (10), une première (supérieure), une deuxième (centrale) et une troisième (inférieure) pates (11, 12, 13), formant une paire de montants et trois paires de pates, les extrémités dudit élément de support (7) étant respectivement raccordées aux extrémités libres d'une paire desdites pates, les extrémités libres d'au moins l'une des paires de pates restant étant fixées au chassis de ladite imprimante pour supporter l'élément de suspension en entier, et des moyens d'entraînement (14—16) pour animer ledit élément de support d'un mouvement de va et vient parallèlement à ladite platine,
 - caractérisée en ce que:
 - les extrémités dudit élément de support (7) sont respectivement fixées aux extrémités libres de la première (supérieure) paire de pates (11),
 - les extrémités libres de la deuxième (centrale) paire de pates (12) sont raccordées à une partie de chassis (9) qui est fixée au chassis de ladite imprimante,
 - ledit élément de support (7) et les extrémités libres (4) de la troisième (inférieure) paire de pates (13) sont reliées par une barre de connexion (6),
 - lesdits montants (10) desdits éléments en forme de E sont reliés par des tirants (10a, 10b),
 - lesdits moyens d'entraînement sont conçus un mouvement de va et vient à vitesse linéaire dudit élément de support d'élément d'impression sans application de forces orthogonales ou désaxées.
2. Imprimante par points selon la revendication 1 caractérisée en ce que lesdits éléments flexibles à plaques en forme de E (2, 3), ledit élément de support (7), ladite partie de chassis (9) et ladite barre de connexion (6) constituent un élément en plastique flexible moulée formant une unité.
3. Imprimante par points selon la revendication 1 ou 2 caractérisée en ce que lesdits moyens d'entraînement sont agencés de façon à animer d'un mouvement de va et vient à la fois les première (supérieure) et troisième (inférieure) paires de pates (11, 13), ce qui provoque ainsi la flexion desdites première et deuxième paires de pates et le déplacement dudit élément de support (7) et dudit élément d'impression par points (22) suivant un mouvement de va et vient le long d'une ligne d'impression parallèle à ladite platine (26).
4. Imprimante par points selon la revendication 1, 2 ou 3 caractérisée en ce que les constantes de ressort combinées desdites première et troisième paires de pates sont égales à celle de ladite deuxième paire de pates.
5. Imprimante par points selon l'une quelconque des revendications précédentes caractérisée en ce que lesdits moyens d'entraînement comprennent:
 - un aimant de champ fixe (14),
 - une bobine à enroulement (15) suspendue dans le champ dudit aimant et se déplaçant par rapport à celui ci lors de l'application de courant électrique à ladite bobine, l'extrémité extérieure de ladite bobine étant connectée audit élément de support d'élément d'impression pour animer celui ci d'un mouvement de va et vient, ladite bobine (15) comprenant:
 - un premier enroulement (31) recevant un courant d'excitation à partir d'un générateur de formes d'ondes (33) et
 - un second enroulement (32) comprenant un circuit contenant un amplificateur inverseur (38, 39), des moyens de sommation (40, 41) et des moyens de commande pour modifier le courant d'excitation appliqué audit premier enroulement pour obtenir une correspondance exacte entre les signaux d'excitation d'entrée audit enroulement et le mouvement physique résultant de ceux ci.
6. Imprimante par points selon l'une quelconque des revendications précédentes caractérisée en ce qu'elle comprend en outre:
 - des moyens de commande des milieux d'impression en papier (20) pour alimenter ledit papier (27) par incréments devant ladite platine (26),

des moyens de commande à came et embrayage (17, 18) et
un moyen de commande fixé audit élément du châssis à ressort de suspension pour être animé d'un mouvement de va et vient avec celui ci et fonctionner en association avec ledit moyen à came et à embrayage monodirectionnel pour délivrer une sortie de rotation intermittente, ladite sortie de rotation
5 intermittente étant appliquée auxdits moyens de commande et d'incrémentation du milieu en papier (20) pour incrémenter ledit papier à la fin de chacun desdits mouvements de va et vient.

7. Imprimante par points selon l'une quelconque des revendications 1 à 4 caractérisée en ce que lesdits moyens de commande comprennent:

- un moteur à rotation uniforme (44),
- 10 un engrenage de deux pignons non circulaires (47A, 47B), dont l'un (47A) est accouplé audit moteur (44), l'autre (47B) étant accouplée à l'arbre d'entraînement d'un mécanisme du type à tiges et manivelles (50, 51, 52), la configuration géométrique desdits pignons non circulaires étant telle que ledit arbre d'entraînement est entraîné en rotation à une vitesse angulaire irrégulière qui, lorsqu'elle est transmise audit mécanisme du type à tiges et manivelles, provoque le déplacement de l'extrémité libre de ladite tige
15 (52) à une vitesse pratiquement linéaire, ladite extrémité libre étant raccordée audit élément de support (7) pour provoquer ledit mouvement de va et vient linéaire.

8. Imprimante par points selon la revendication 7 caractérisée en ce que ledit arbre d'entraînement dudit mécanisme à tiges et manivelles est accouplé à l'arbre d'un autre mécanisme de type identique disposé symétriquement par rapport au premier, les extrémités libres respectives des deux tiges (52) étant reliées
20 et les deux tiges étant montées de façon qu'elles forment toujours un V plus ou moins évasé selon la position angulaire des arbres, mais en conservant toujours le même axe de symétrie, lequel axe de symétrie est parallèle audit mouvement de va et vient.

9. Imprimante par points selon l'une quelconque des revendications précédentes caractérisée en ce que lesdits montants (10) desdits éléments en forme de E sont conçus pour provoquer une ventilation
25 pneumatique chaque fois que les pattes sont fléchies d'avant en arrière et vice versa par ledit mouvement de va et vient.

10. Imprimante par points selon l'une quelconque des revendications 2 à 9, caractérisée en ce que ledit élément flexible moulé en une seule pièce est constitué d'une seule pièce de matière plastique dont le poids spécifique est au moins de 1,06, le module de traction d'au moins 23800 kg/cm² et le module de fluage d'au moins 22400 kg/cm² à 5°C et avec une charge de 105 kg/cm².

35

40

45

50

55

60

65

FIG. 2

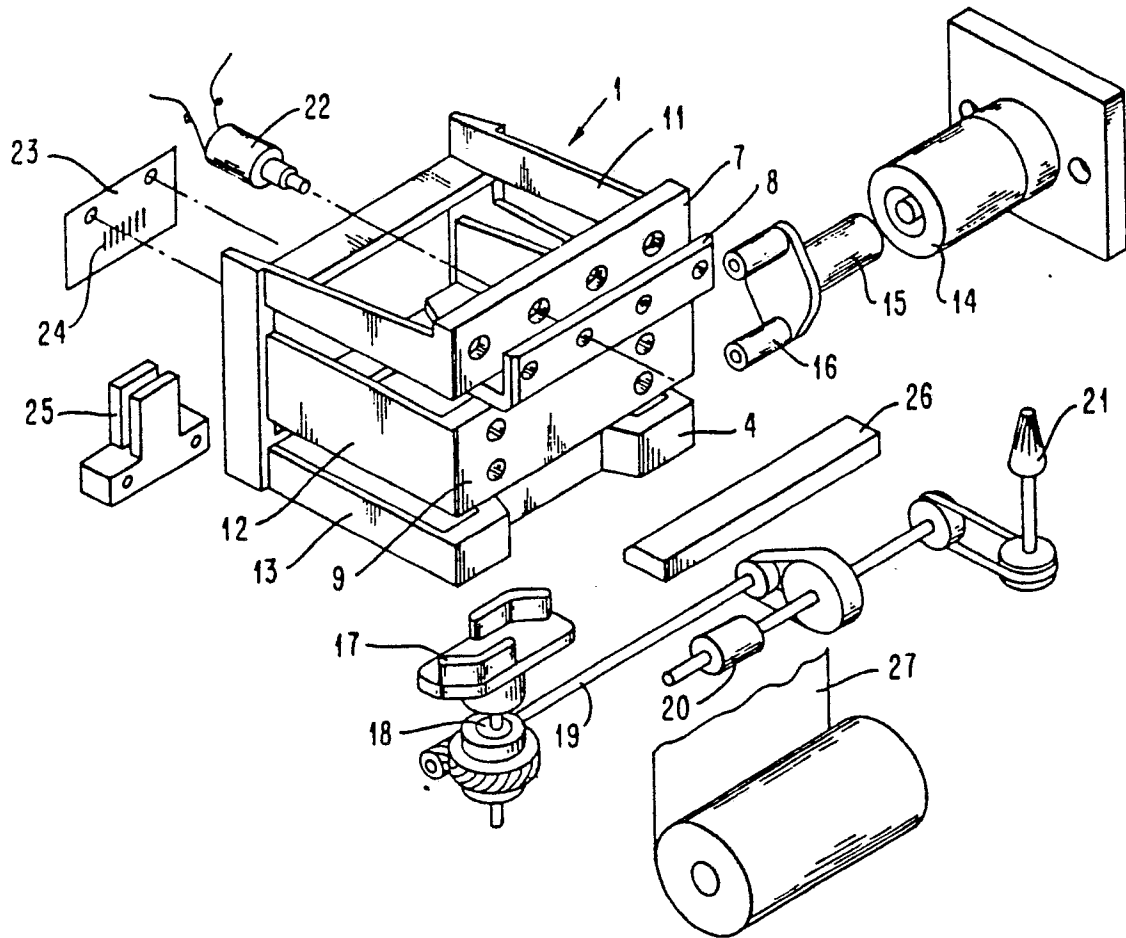
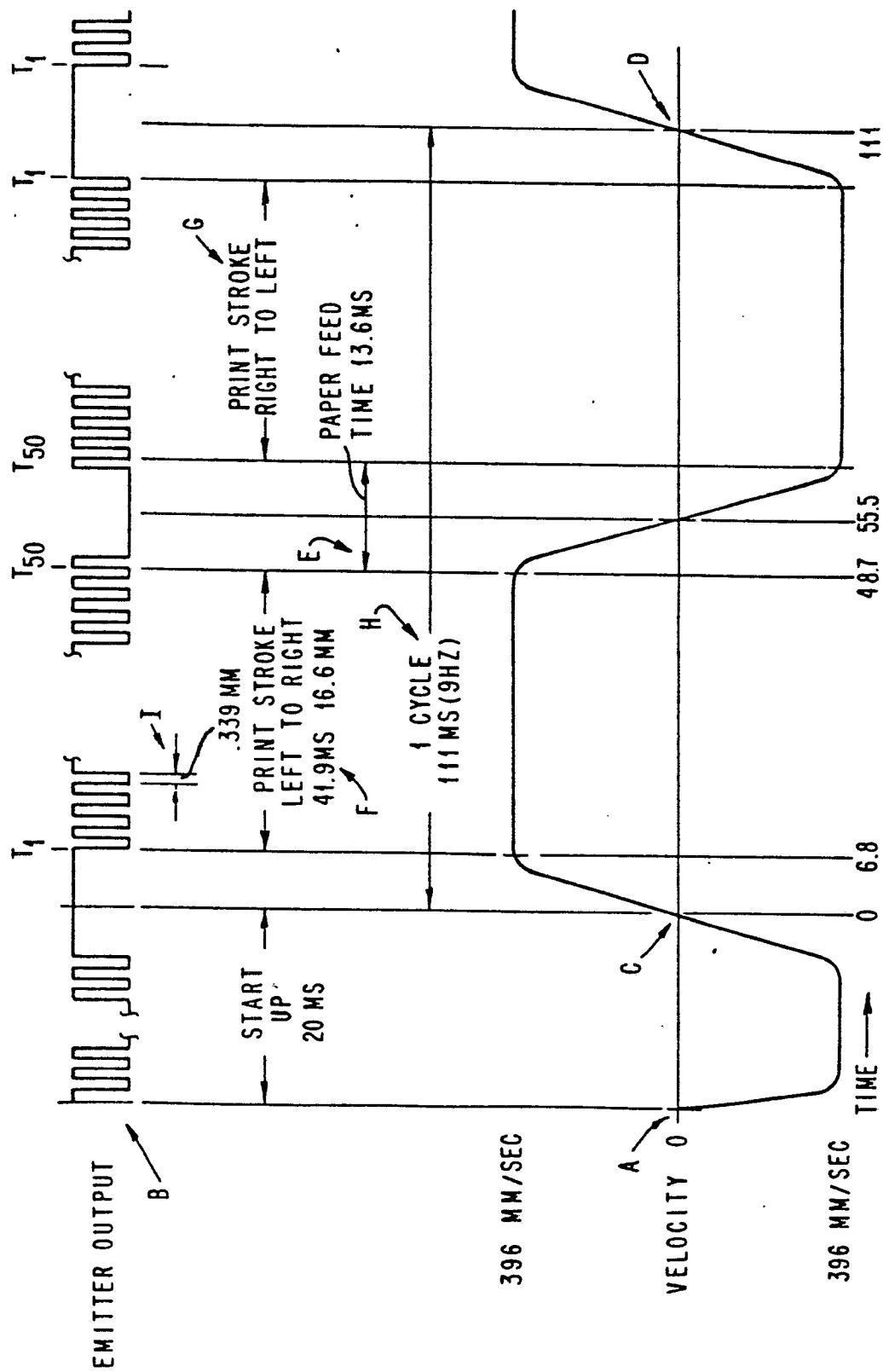
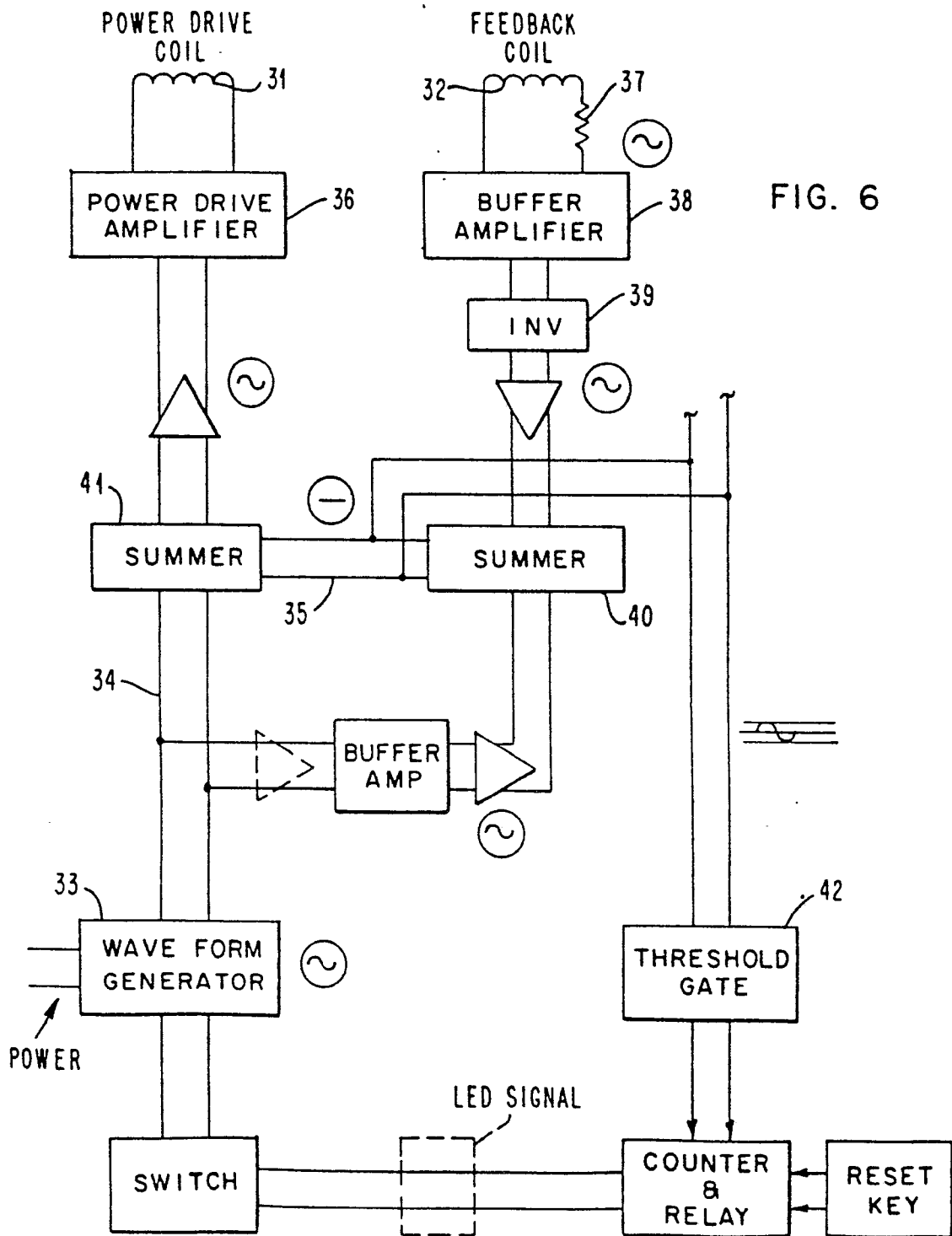
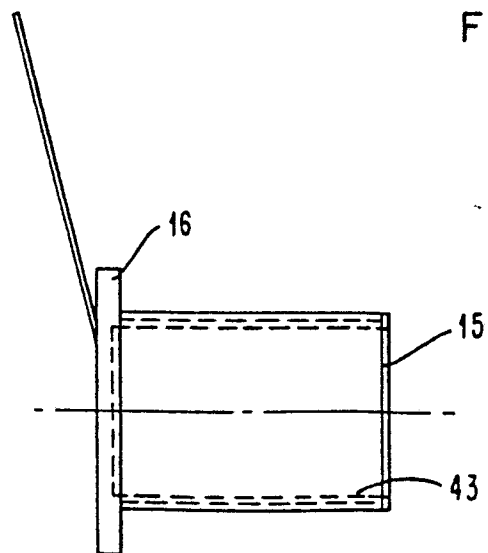
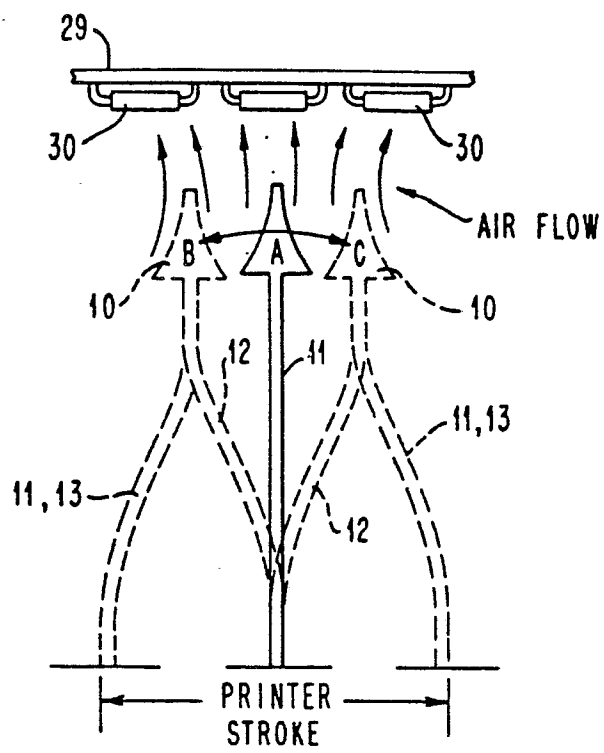


FIG. 4







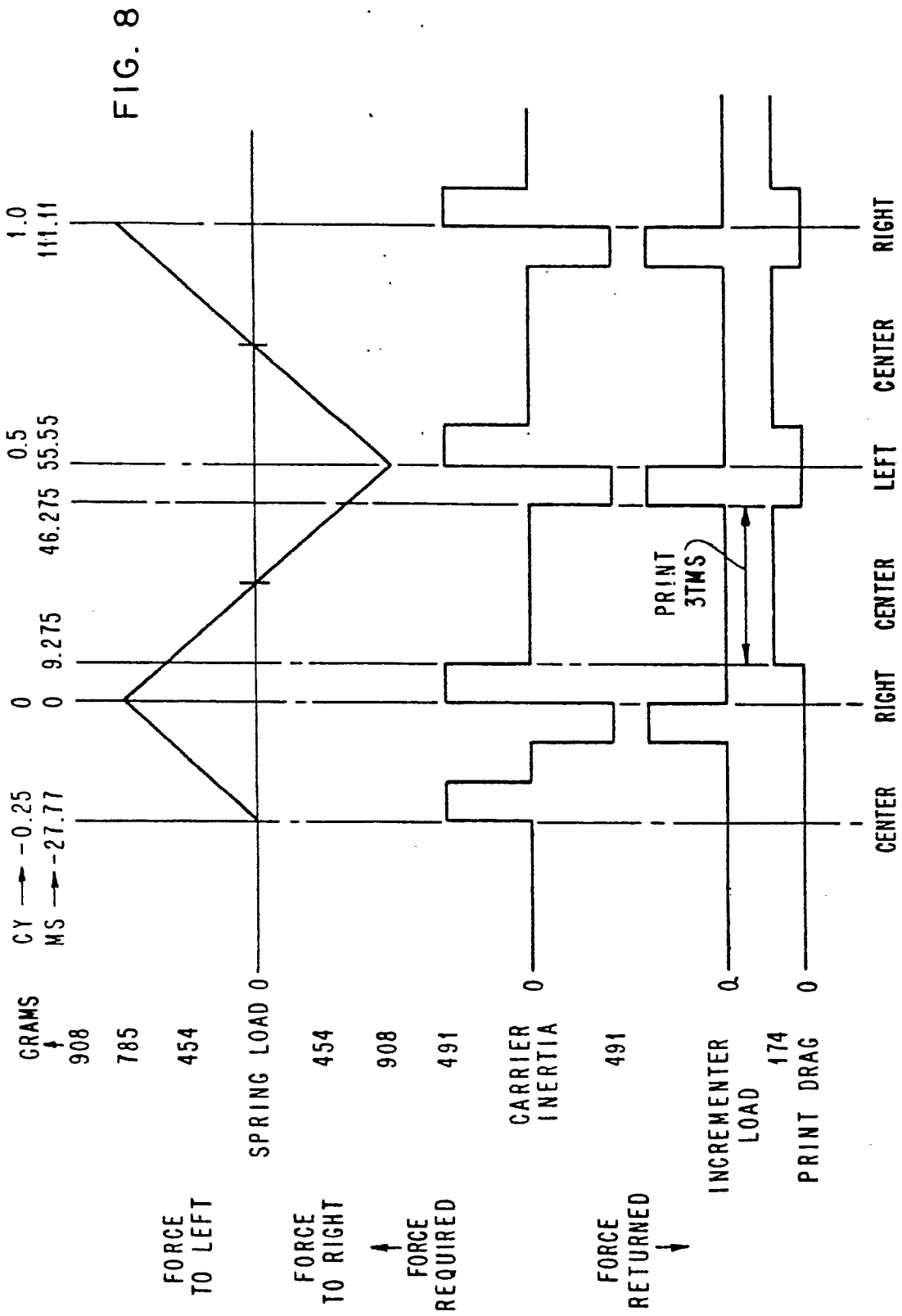


FIG. 9

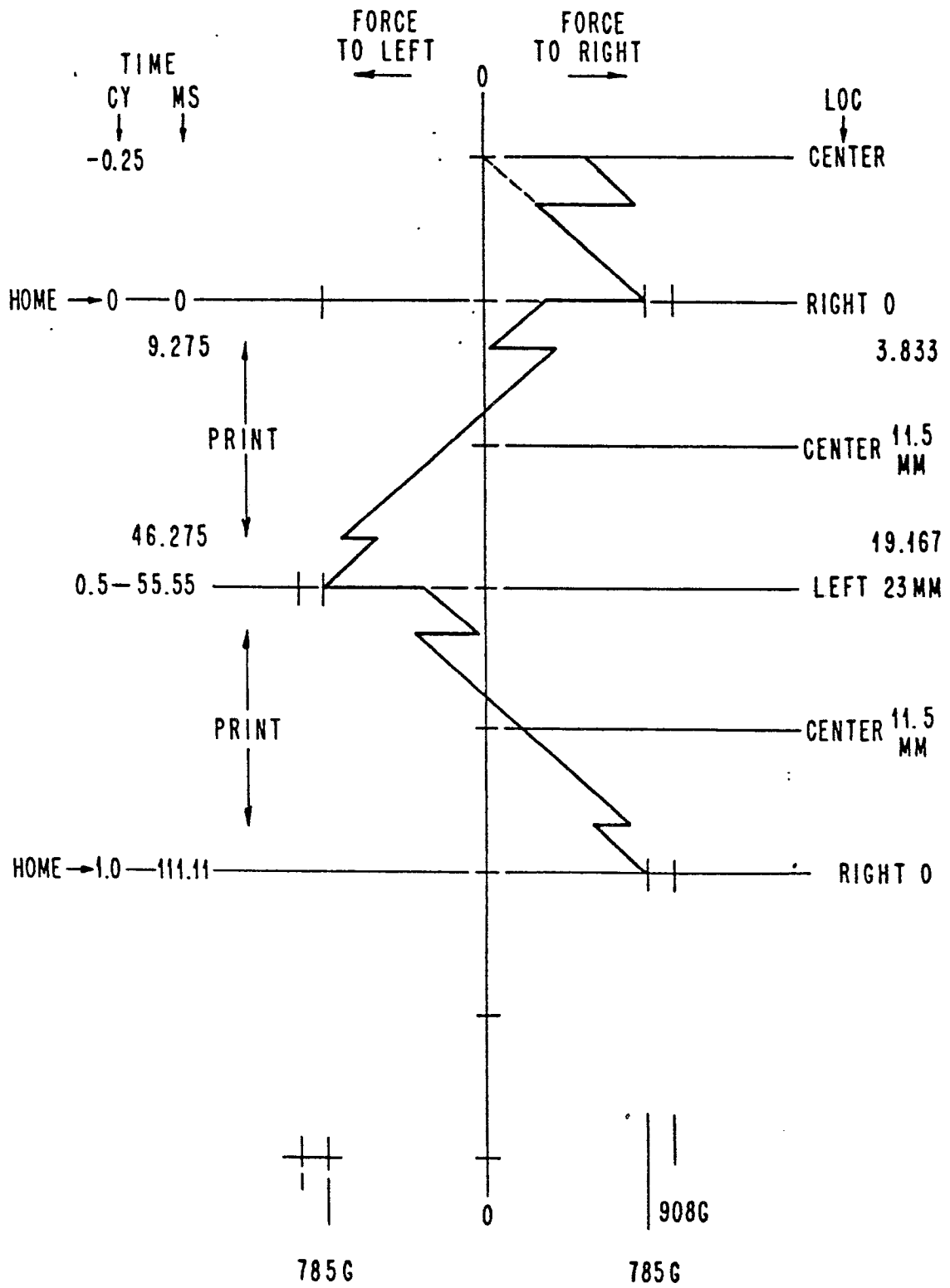


FIG. 10

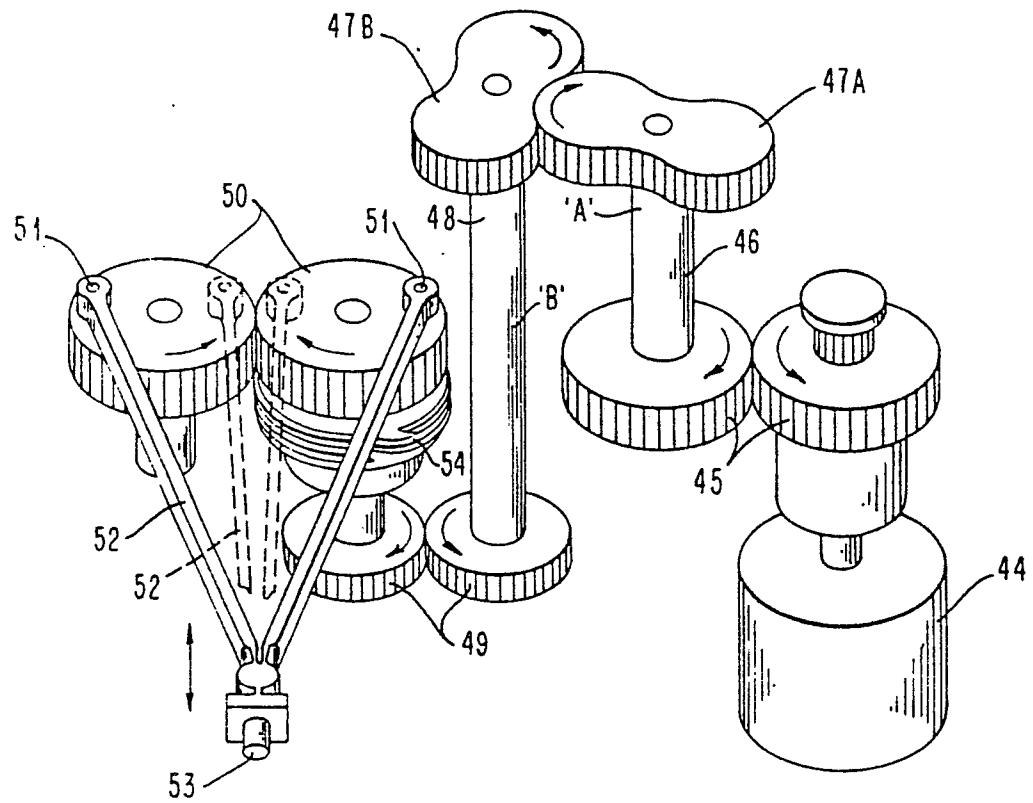


FIG. 12

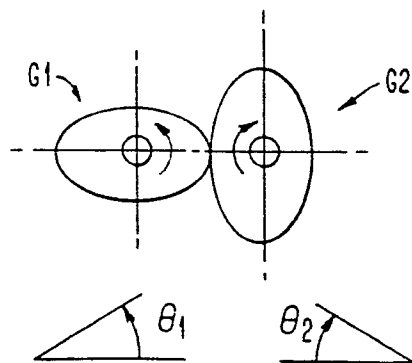


FIG. 13

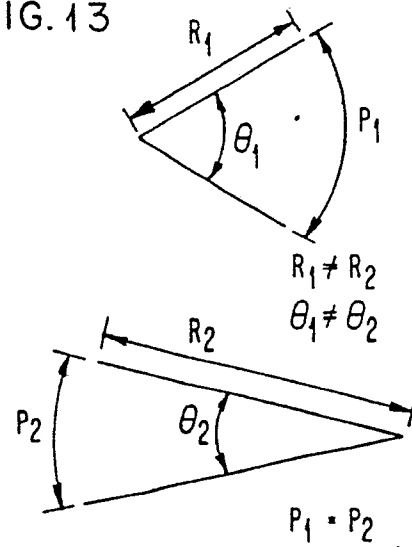


FIG. 11

