United States Patent

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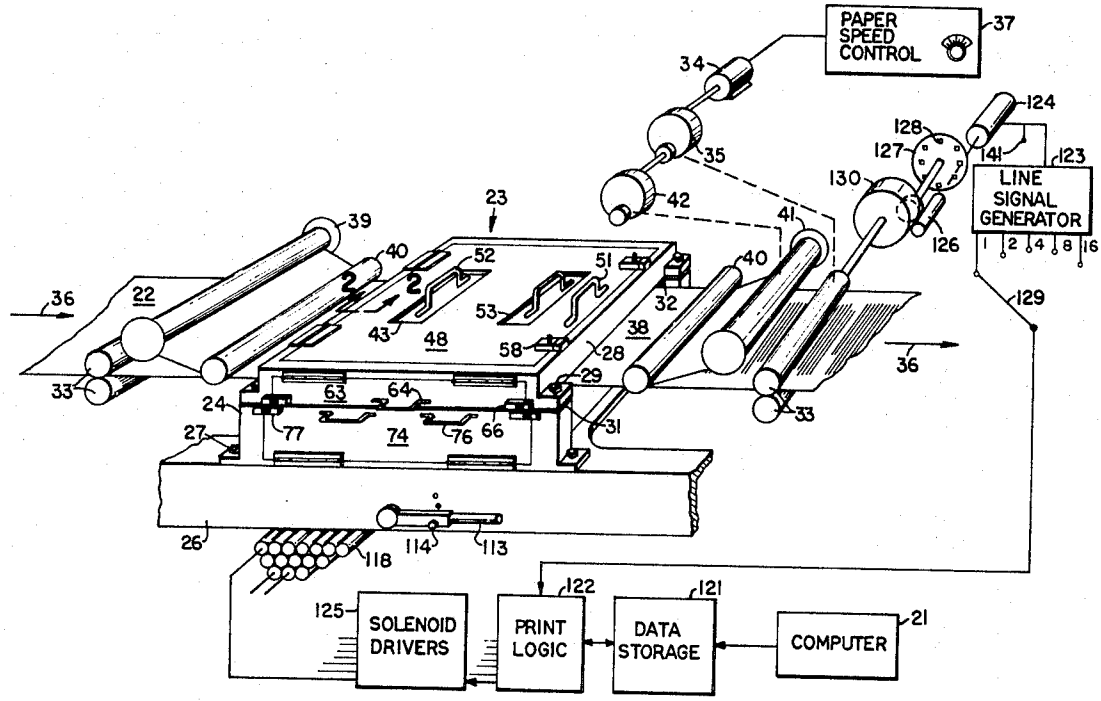
[54] **HIGH-SPEED DATA PRINTOUT**
25 Claims, 15 Drawing Figs.

[52] **U.S. Cl.** ..... **178/25,** 101/401.2, 346/74 ES
[51] **Int. Cl.** **H04l 17/30,** G01d 15/16
[50] **Field of Search** ..... 178/25, 36; 346/74 ES, 74 MP

[56] **References Cited**
UNITED STATES PATENTS
3,348,232 10/1967 King ..... 346/74 ES

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ABSTRACT: Signals identifying alphanumeric characters for a plurality of lines of printing are temporarily stored in a memory while recording paper moves through a printing station having a plurality of rows of character-imprinting elements. Each row is comprised of identical character-imprinting elements and the number of rows is at least equal to the number of distinct characters which may be printed. A control system repetitively examines the memory to detect momentary coincidences between positions on the moving paper and any imprinting elements of any row which correspond to a character to be imprinted at those positions. The control system activates the appropriate imprinting elements as such coincidences occur to effect a very fast multiline form of printout. The rows of imprinting elements are defined on a flat stationary unitized member which may readily be removed and replaced and in which individual rows may be replaced as a unit and the associated actuating elements are also unitized for rapid replacement. Line spacing is adjustable and the system is adaptable to the printing of graphical or pictorial data.



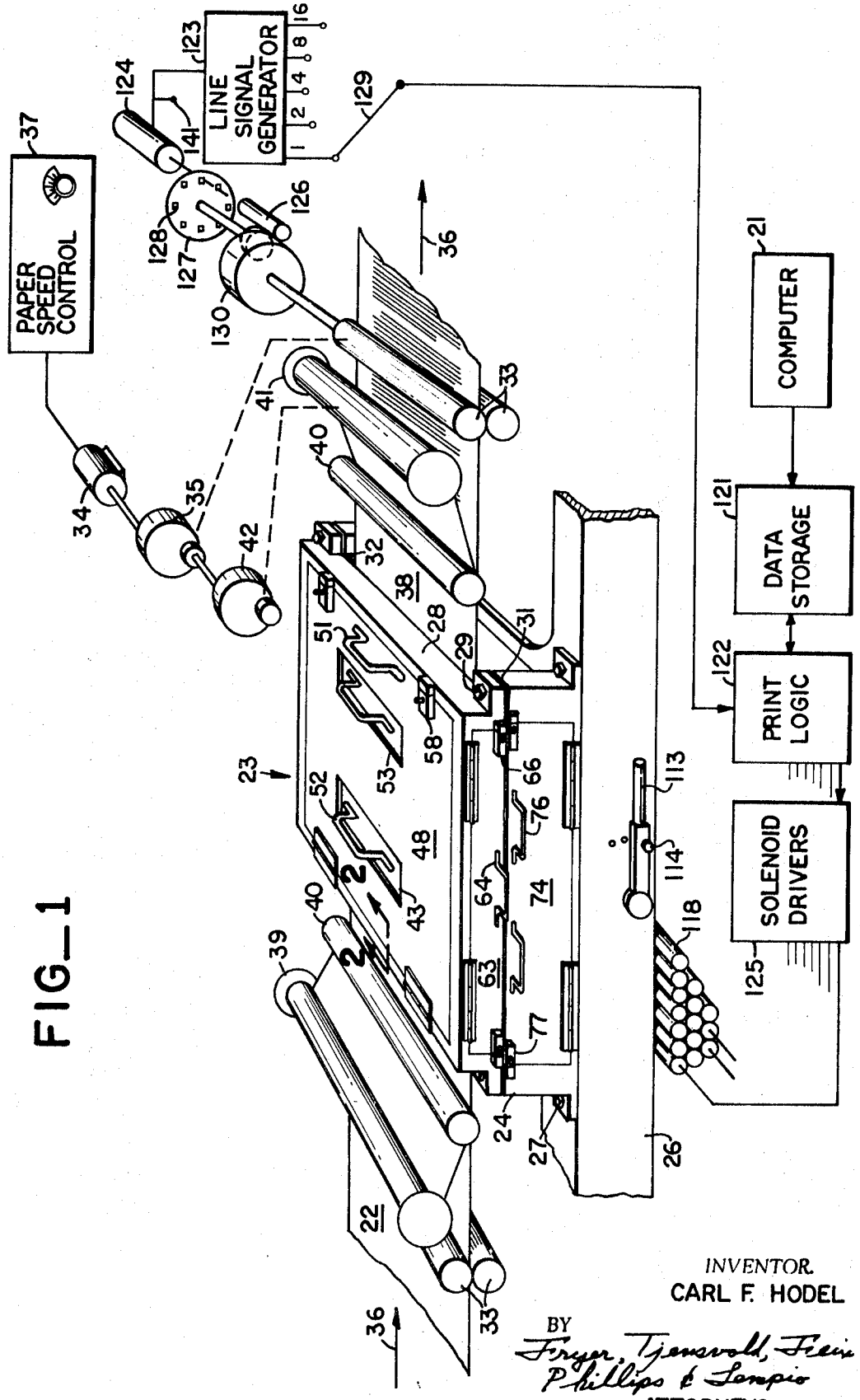


FIG_1

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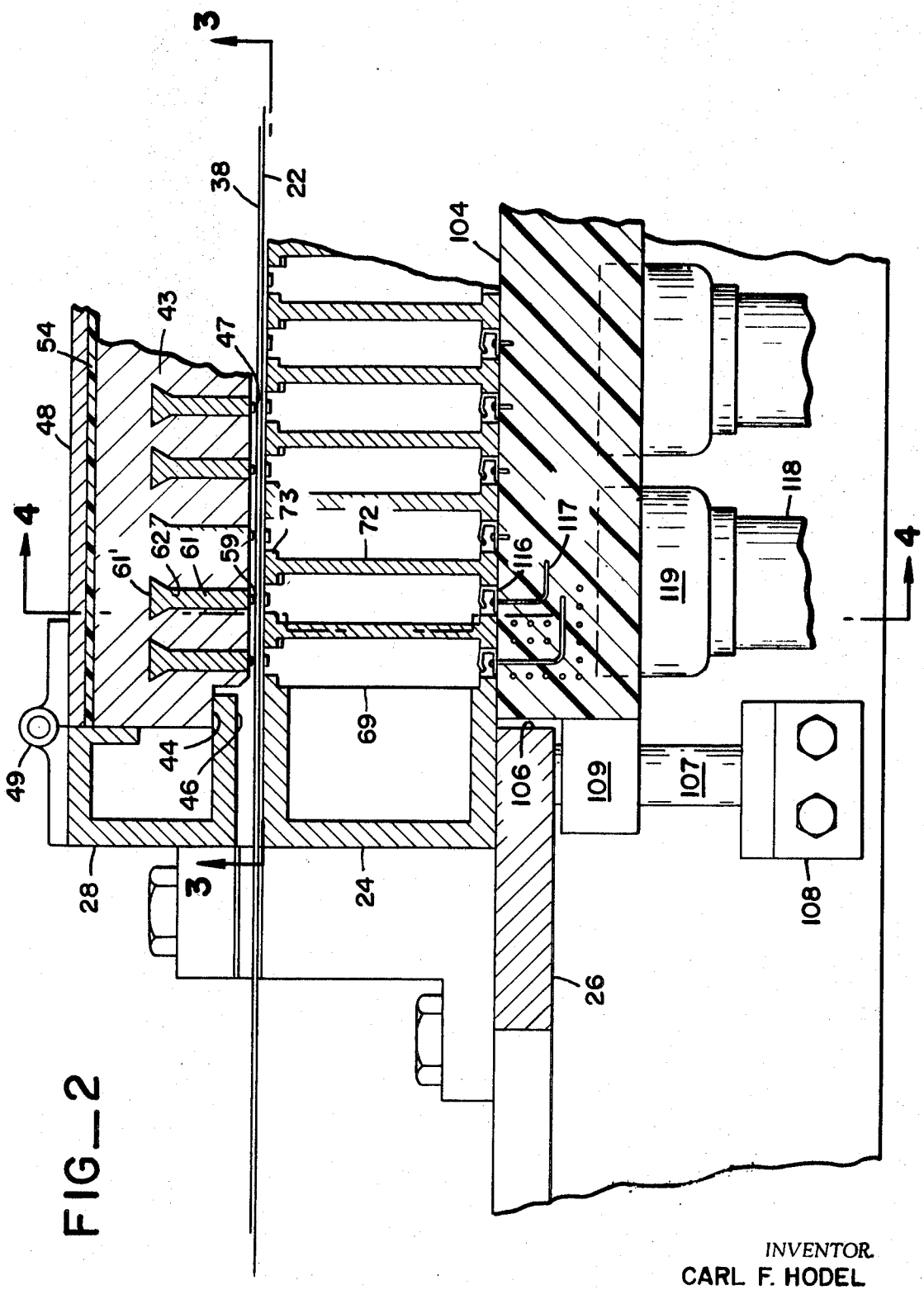


FIG_2

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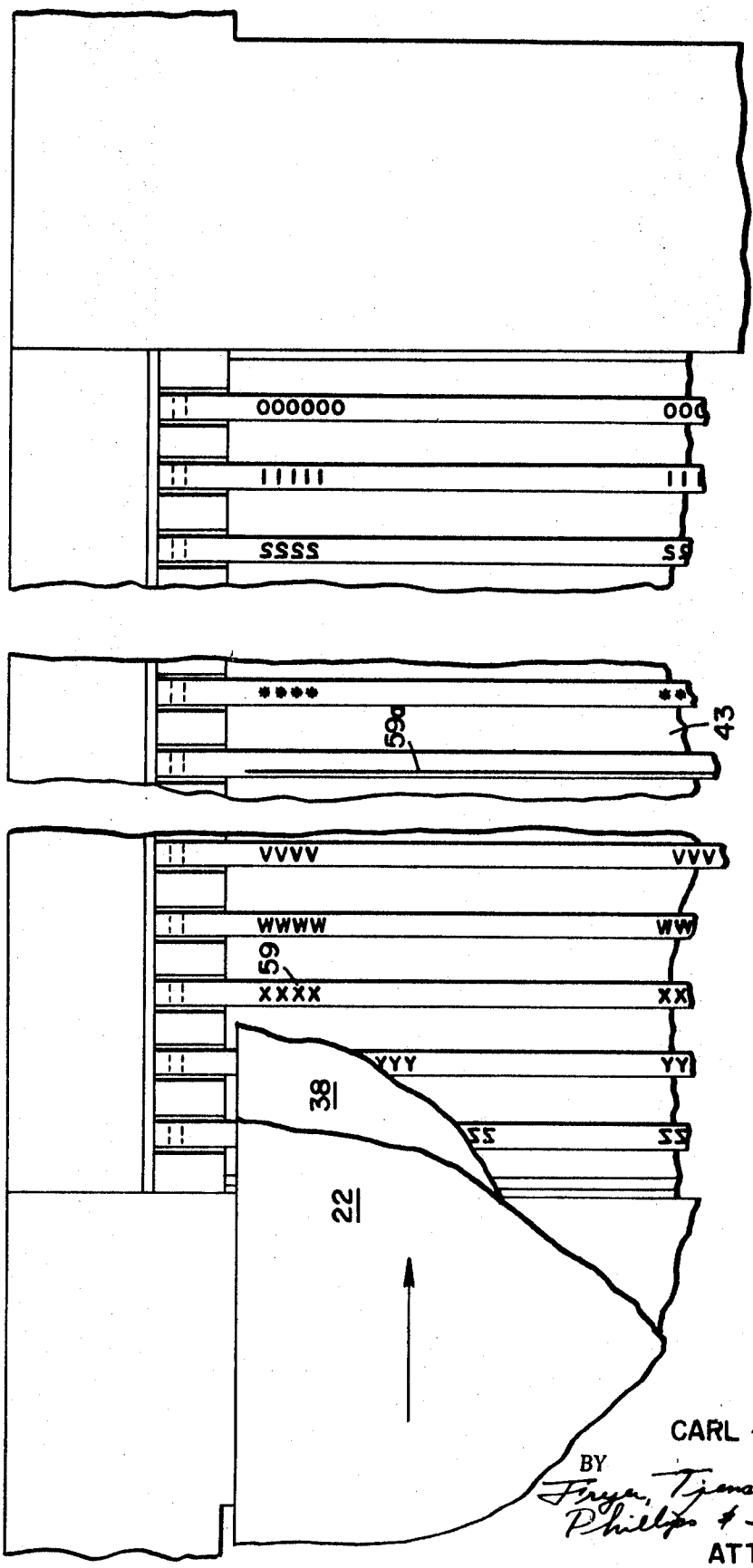


FIG_3

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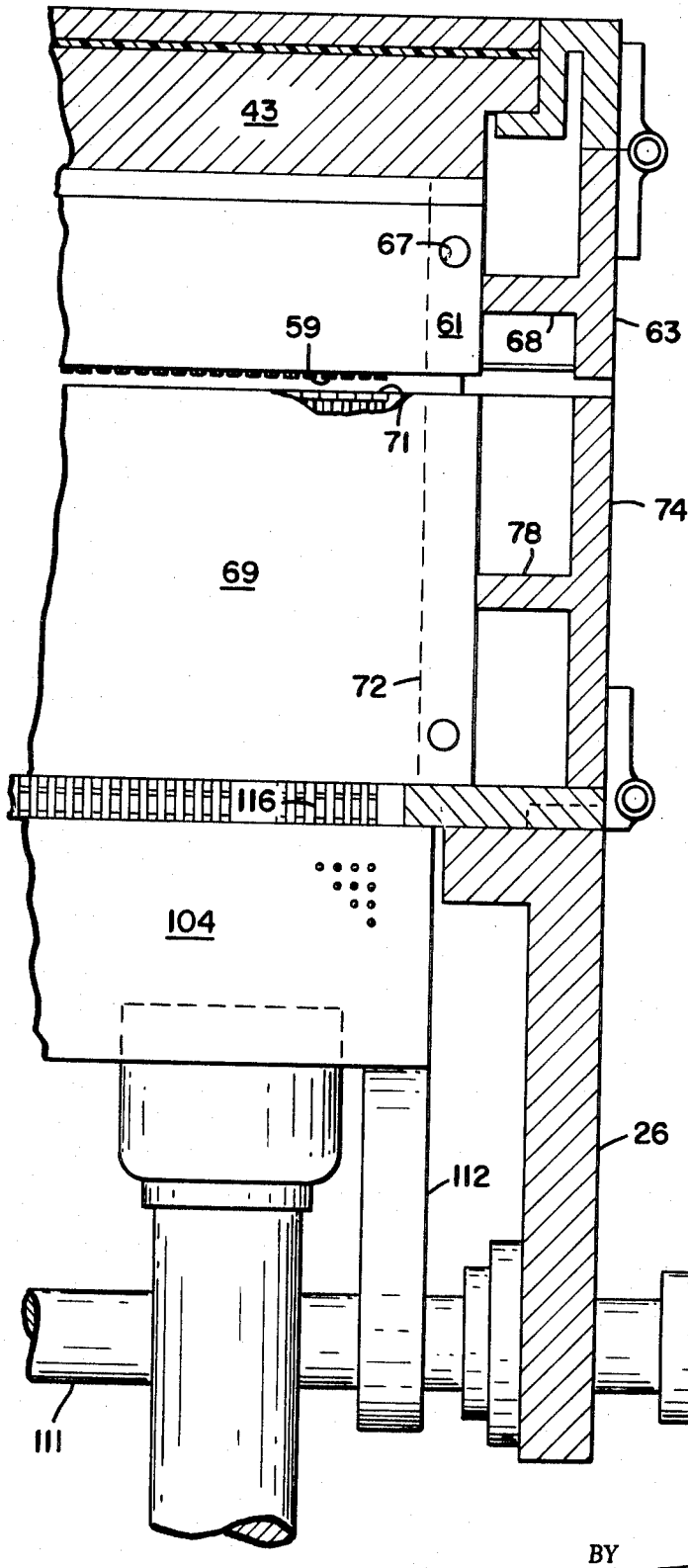


FIG_4

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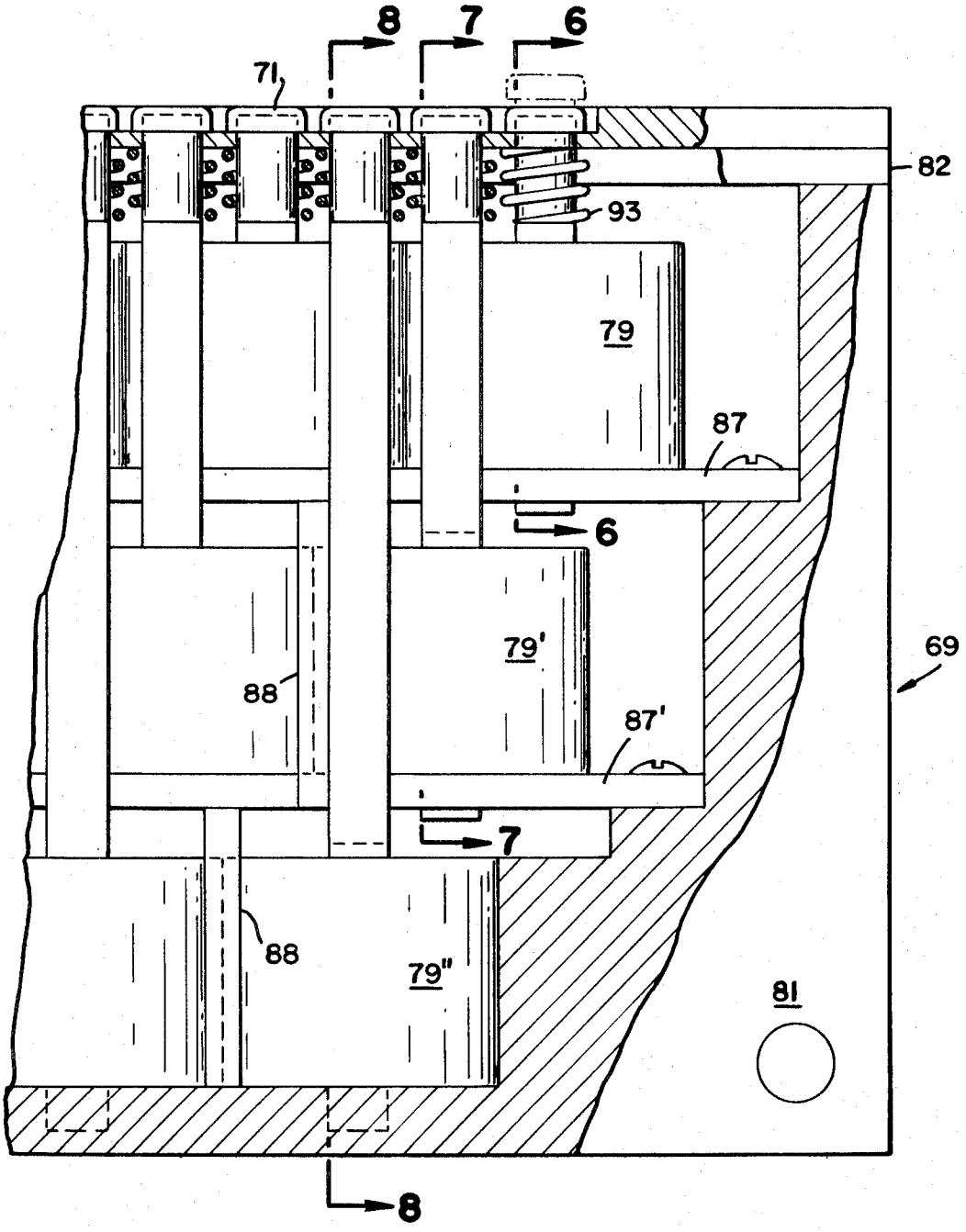


FIG_5

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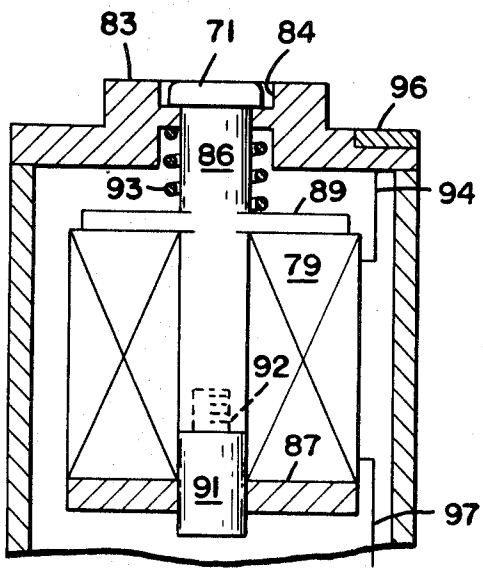


FIG_6

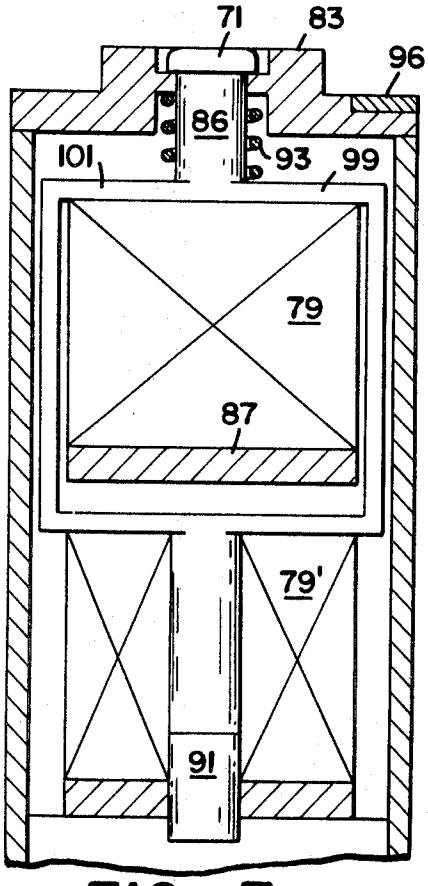


FIG_7

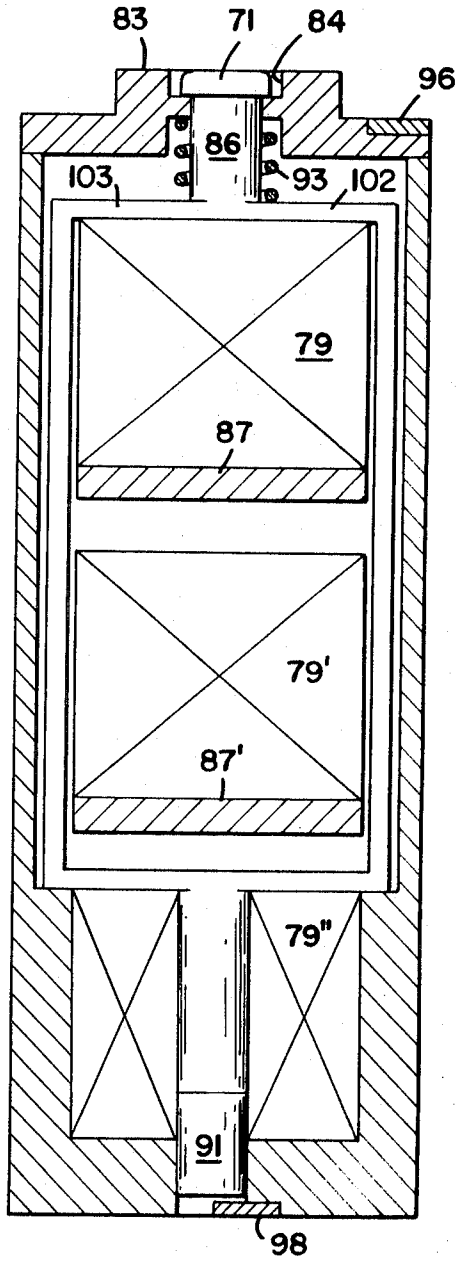


FIG_8

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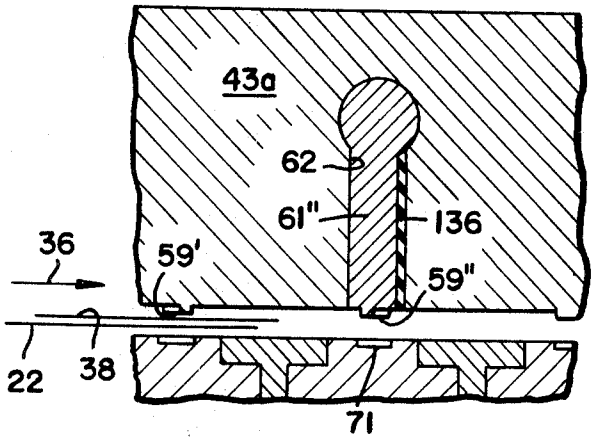


FIG_9

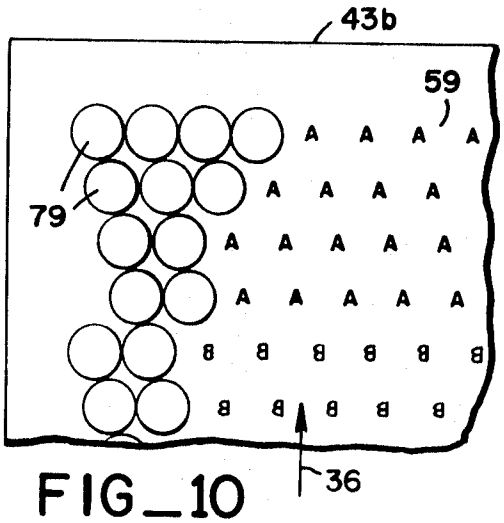


FIG_10

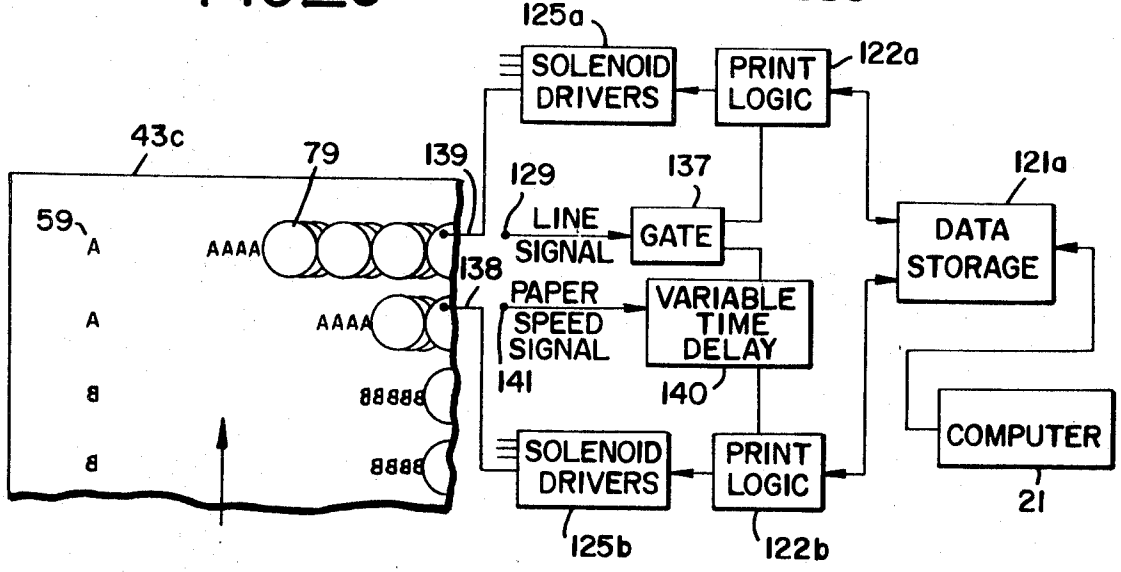


FIG_11

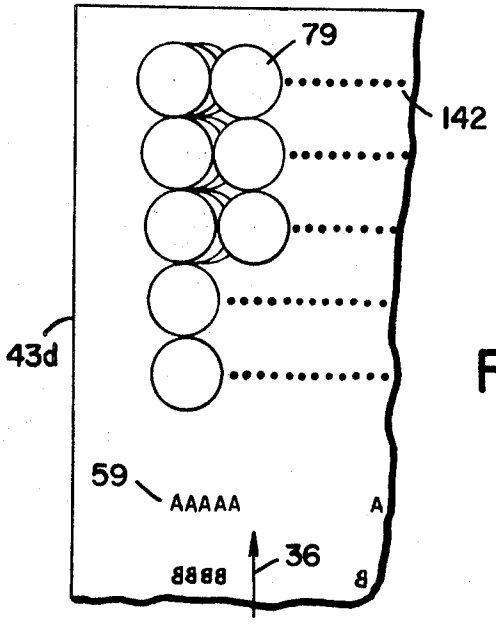


FIG_12

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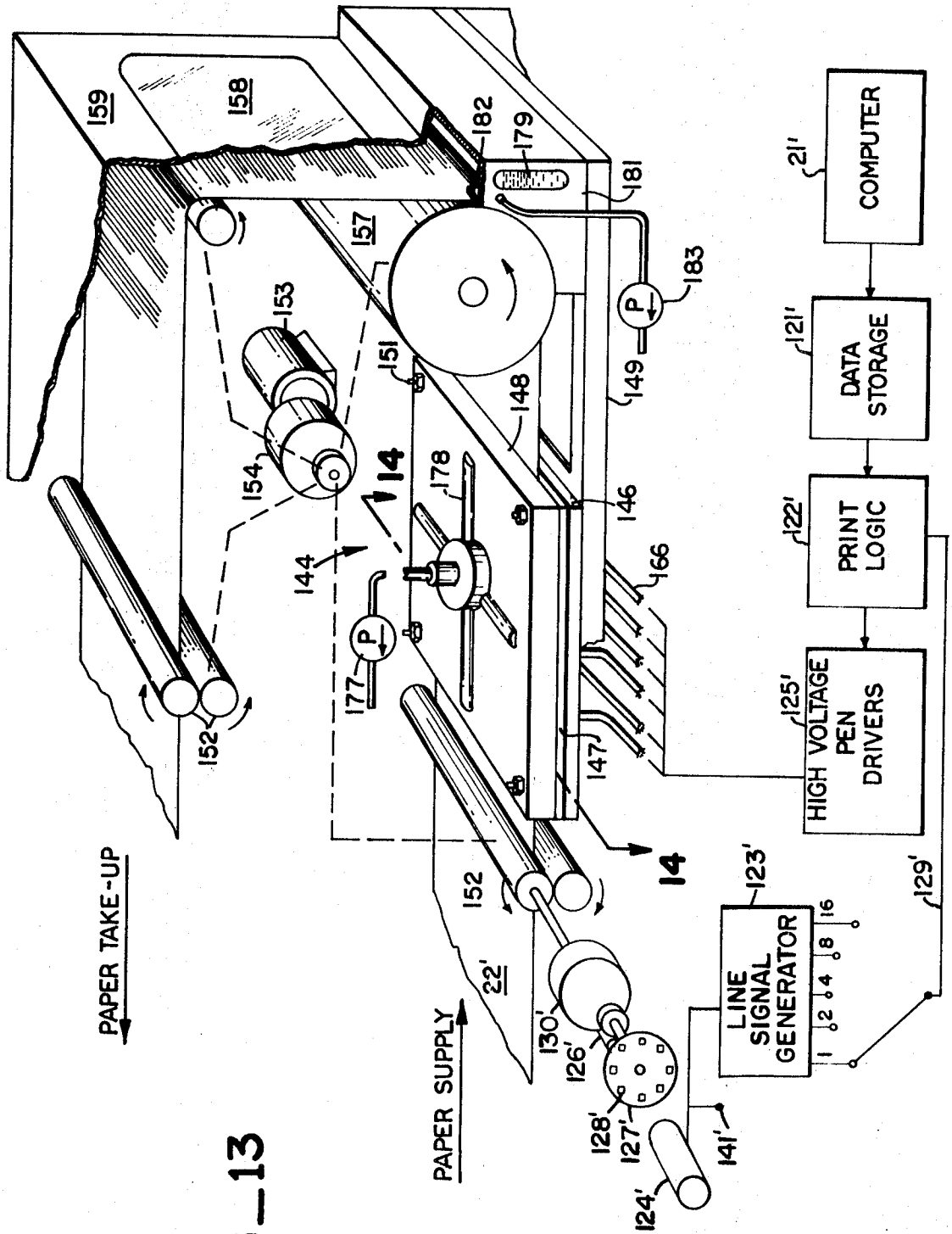


FIG_13

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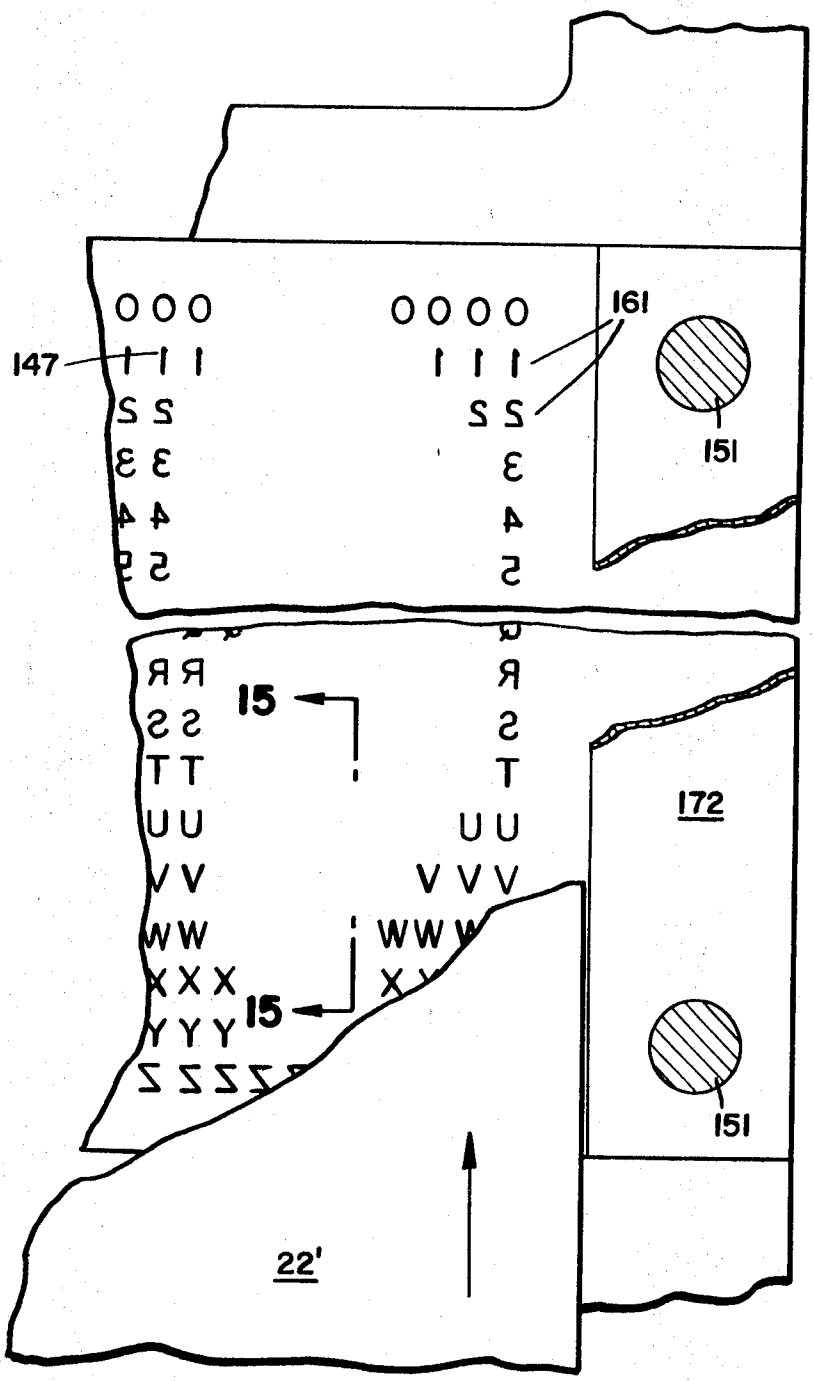


FIG_14

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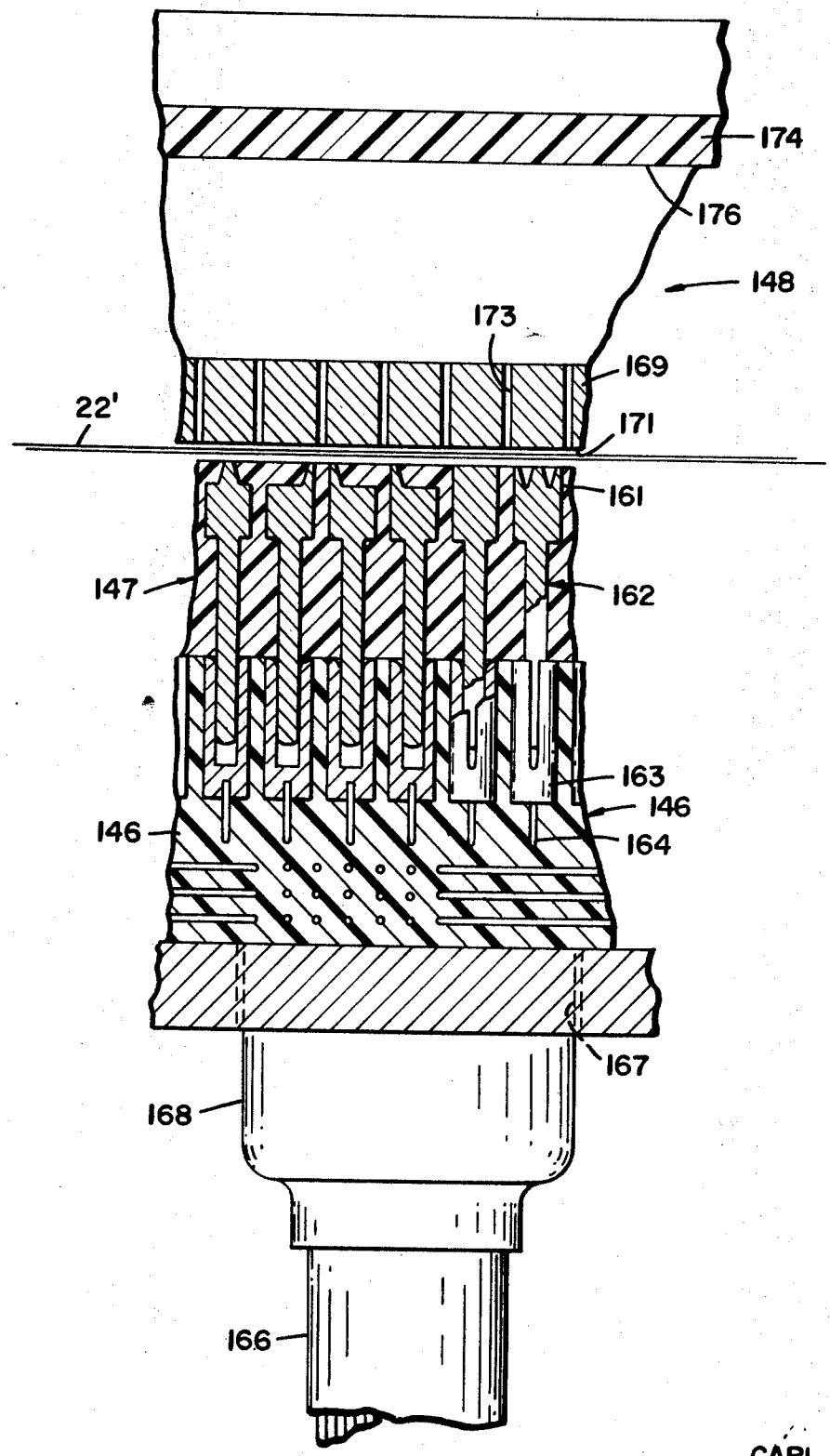


FIG. 15

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HIGH-SPEED DATA PRINTOUT

BACKGROUND OF THE INVENTION

This invention relates to the printing of information from coded input signals and more particularly to apparatus for efficiently realizing very high speeds in the printout of information from electronic data processing systems.

Many conventional printing operations are essentially duplicative in character in that the basic object is to reproduce one or more copies of information which already exist in the alphanumeric form identical to or closely resembling the printed information. These duplicative printing operations are typified by traditional printing at a press to reproduce a written manuscript and by photostating and electrostatic copying or the like. Recent advances in computer technology have given emphasis to a second somewhat distinct category of printing operation in which the information to be printed does not initially exist in anything resembling the printed form but is represented instead by coded signals of the type which may be stored in a memory circuit or device. A printing system of this type must translate the coded signals into the appropriate alphabetical or numerical characters as it prints.

The printout of information which is generated within a digital computer obviously requires translative printing techniques. In addition, such techniques are now being used for printing operations which have traditionally been duplicative in character. For example, many commercial organizations have adopted computer processing as a means for computing, printing and addressing monthly bills. Some libraries, notably those of the technical variety, have ceased storing printed copies of documents and are utilizing magnetic tape or the like to preserve information. This requires translative printout when access to the information is desired. There are many other commercial and scientific operations which require the printout of imprint which is initially in coded signal form and the practice of these operations is increasing at an extremely rapid rate.

In these systems, printout speed has become a critical consideration. Just as the human hand cannot write as fast as the mind can think, commercially available printers cannot operate at a rate comparable to the speed at which most data-processing systems deliver information in the form of electrical pulses or the like. It is widely recognized that the overall efficiency of computer systems is badly limited by the relatively slow speeds of the available printout mechanisms.

While there are several basic types of printout mechanism, each has characteristics which prevent the printing of information in an efficient and reliable manner at the speeds which are theoretically desirable. Unfortunately, those types of printer which operate at the faster speeds are in general those which require complex apparatus, expensive recording paper, or produce characters with relatively poor legibility or permanence.

Electrical typewriter printers, for example, provide good legality and durability and use inexpensive paper however printing speed is extremely poor as each letter of each line must be imprinted in sequence. To provide faster output, many data processing operations use an on-the-fly printer of the kind in which rows of character imprinting elements are provided on a revolving drum. This is still undesirably slow as each line of the recording paper must be kept at periphery linear-printing zone for a time period sufficient to sweep all rows of imprinting characters on the drum past the line on the paper. Somewhat higher speeds are realized with another class of printout device which utilizes a cathode-ray tube or the like to display lines of characters for imprinting upon photographically sensitive paper. Such paper is relatively expensive, the necessary developing components may be complex and there are still limitations to printout speed in the form of electronic complications at the cathode-ray tube, required exposure times at each line and other factors.

To resolve the printing speed limitations of conventional equipment, it has heretofore been proposed to make use of a multiline parallel printing technique in which the printing mechanism works on portions of many successive lines of printing at the same time. In particular, it has been proposed that the paper be moved past a printing station comprised of many rows of character-imprinting elements with each row being composed of like character-imprinting elements and with a number of rows equal to the number of distinct characters which are to be imprinted. Each time that the paper advances one line space, character-imprinting elements which are juxtaposed at that moment with a position on the paper requiring the corresponding character are actuated simultaneously. Any given line of printing is built up gradually as it passes along the series of rows of imprinting elements. This offers the prospect of strikingly greater printing speeds than can be realized by printers which must complete an entire line or a group of whole lines before the paper can be advanced a significant amount.

While the speed advantage of the multiline parallel form of printing is evident, the technique has not heretofore been practiced in the art to any great extent. The difficulty involved can be understood considering the fact that a mechanism of this kind designed to print the standard 120 character lines and having a full set of alphanumeric characters supplemented by punctuation marks and the like requires about 65 rows of character imprinting elements. Thus over 7,000 separate character imprinting components are needed together with a matching number of actuators. In prior proposed constructions, the many character defining elements must each be carried on movable mechanism and, together with their associated actuators, must be physically packed into a constricted spaced dictated by the acceptable character size, character spacing and line spacing. Understandably, the constructions heretofore proposed has been extremely complex from the mechanical standpoint and are vulnerable to excessive downtime and maintenance difficulty. Further, these prior constructions are characterized by inherent operational inflexibilities with respect to such factors as line spacing, character size and interchangeability of type font.

SUMMARY OF THE INVENTION

The present invention provides a simplified, reliable and operationally flexible multiline parallel printing system capable of printout speeds substantially higher than those realized with commonly used conventional techniques.

The invention utilized a memory to store temporarily the input signals representative of characters for a plurality of lines of printing. Recording paper or the like is moved continuously past an array of stationary character defining elements arranged in a plurality of rows and preferably carried on a single unitized replaceable member. The array of imprinting elements is associated with a matching array of actuating means which variously may be electromechanical, electrostatic or other. As the paper moves, a control circuit repetitively inspects the memory to detect momentary coincidences between areas of the paper and imprinting elements corresponding to characters to be printed at such areas. Upon detection of such coincidences, the control system energizes the appropriate actuating elements. Normally, this results in a gradual, seemingly random completion of each line of printing as the line on the paper travels past the successive rows of imprinting elements as portions of a large number of successive lines are being imprinted more or less concurrently.

The present invention differs from prior parallel printers in that the multiplicity of character-defining elements are stationary and are preferably all disposed at a single flat fixed surface along which the paper travels. Any specific imprinting element is energizable independently of the timing of energizing of the imprinting elements of other rows whereby the spacing of lines of printing on the paper is not inherently fixed by the spacing of the rows of imprinting elements but may be varied by adjusting a control.

Because the character-defining elements are fixed, the elements may all be located on a single member which may be removed and replaced as a unit to interchange type face with a minimum of delay or difficulty. Further, in a preferred form, individual rows of character-defining element are also removable as a subunit for quick and convenient replacement. Similarly, the associated actuator elements may readily be removed and replaced in unitized groups to minimize downtime from component malfunction. The invention further provides practical arrangements for the disposition of the large number of actuators which may be solenoid-controlled hammers for example, at the printing mechanism without introducing undesirable constraints to the size or spacing of characters. The invention provides still other features to be hereinafter described which jointly contribute to the efficient and reliable application of the multiline parallel-printing technique to computer printout and related printing operations.

Accordingly, it is an object of this invention to provide for higher printing speeds from coded signal input data than has heretofore been customarily realized.

It is a further object of the invention to provide for greater flexibility in a multiline parallel-printing system with respect to type font, line spacing and size and spacing of characters to be printed.

It is another object of the invention to provide a multiline parallel-printing system in which printing speed is not limited by the operation time of individual character-imprinting means and the actuating means therefor.

It is still another object of the invention to provide for a compact, unitized and simplified construction for a multiline parallel printout apparatus in which the interchanging and replacement of character-defining elements as well as the actuating elements therefor is greatly simplified and facilitated.

The invention, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a partially diagrammatic, perspective view of a first mechanism for printing from coded signals wherein electromechanically actuated elements are utilized to perform the imprinting operation;

FIG. **2** is an elevation section view take along line **2—2** of FIG. **1** illustrating certain of the internal elements of the printing structure thereof;

FIG. **3** is a foreshortened view taken along the plane indicated by line **3—3** of FIG. **2** illustrating the face of a matrix of character-defining elements which is a component of the mechanism of FIG. **1**;

FIG. **4** is an elevation section view along a portion of the plane defined by line **4—4** of FIG. **2** further illustrating the internal construction of the mechanism of FIG. **1**;

FIG. **5** is a broken out view of one end of a row assembly of solenoids and hammers which constitute the imprinting element-actuating means in the mechanism of FIG. **1** and illustrating one structure for accommodating the necessary number of solenoids in a constricted space;

FIG. **6** is a first section view of the assembly of FIG. **5** taken along line **6—6** thereof;

FIG. **7** is a second section view of the assembly of FIG. **5** taken along line **7—7** thereof;

FIG. **8** is a section view taken along line **8—8** of FIG. **5** further illustrating the electrical connector and hammer construction;

FIG. **9** is a fragmentary section view illustrating alternate arrangements for mounting character-defining elements in the printing apparatus of FIGS. **1** to **8**;

FIG. **10** is a diagrammatic view illustrating a modified arrangement of character-defining elements and actuating solenoids for a printer essentially similar to that of FIGS. **1** to **8**;

FIG. **11** is a diagrammatic view of still another modification of the printing mechanism of FIGS. **1** to **8** whereby operation at still higher speeds may be realized;

FIG. **12** is a diagrammatic view of a modification of the printing apparatus of FIGS. **1** to **8** with which graphical and pictorial printing may be performed thereby;

FIG. **13** is a partially diagrammatic perspective view of a second printing mechanism in accordance with the invention wherein imprinting is accomplished by electrostatic means;

FIG. **14** is a foreshortened fragmentary section view taken along the plane columns by line **14—14** of FIG. **13** and illustrating a matrix of character-imprinting elements utilized in the electrostatic printer; and

FIG. **15** is a cross section view of portions of the electrostatic printing mechanism taken along line **15—15** of FIG. **14** and illustrating internal elements of the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is adaptable to usage in a variety of data processing contexts which are related insofar as information to be printed out on a recording medium in alphabetical or numerical form is represented initially by coded signals which are usually binary-coded electrical pulses. Referring now to FIG. **1** of the drawing, a typical source of such signals is a digital computer **21**. The signals which are to be decoded and printed may be generated by the computer **21** itself or may be data derived essentially from external sources and which has been processed and transmitted through the computer. In other instances, the source of signals may not be a computer but may merely be an input component of the type which reads the signals from a magnetic tape or other data storage device. As hereinbefore discussed, it is characteristic of most such signal sources that data is generated or delivered at a rate exceeding that at which it can be printed out by conventional printing mechanisms.

In the embodiment of FIG. **1**, imprinting of the characters on a recording web such as paper **22** or the like is performed by electromechanical means at a printing station **23**. The mechanism includes a flat rectangular actuator housing **24** secured to the top surface of a suitable support frame **26** by bolts **27** and a flat rectangular-type matrix housing **28** secured to housing **24** by bolts **29**. The housings **24** and **28** are separated a small distance by spacer elements **31** therebetween to provide a thin passage **32** through which the paper travels.

The paper **22** is carried through the printing station **23** by a drive system which may be of essentially conventional construction except insofar as high paper speeds are provided for. Accordingly, the paper-driving means is shown schematically in FIG. **1** as a series of paired parallel drive rollers **33** situated at both the input and output ends of the printing station with the paper **22** being passed between each pair of rollers. One or more pairs of the rollers **33** are turned by a suitable electrical motor **34** through the first speed reduction mechanism **35** to travel the paper through the printing station **23** in the direction indicated by arrows **36**. To accommodate to different printing operations and different operating conditions it is desirable that the paper drive motor **34** be of the variable speed type and that it be provided with a speed control **37** which may be adjusted by an operator.

To provide for the imprinting of characters on the paper **22** as will hereinafter be described in more detail, an inked ribbon **38** travels through the printing station passage **32** immediately above the paper and below the type matrix housing **28**. Ribbon **38**, which is about as wide as the paper **22**, extends from a supply reel **39** above the input end of the printing station **23** to a takeup spool **41** at the output end, the ribbon being passed under a guide roller **40** at each end of the printing station. It is advantageous to drive the ribbon **38** by the same means which drives the paper **22** inasmuch as any change of paper speed may thereby be matched by an appropriate change of ribbon speed. However it is unnecessary that the ribbon travel as fast as the paper and accordingly the ribbon may be driven by

coupling the takeup spool **41** to the output of a second speed-reducing mechanism **42** which is driven through the first speed-reducing mechanism **35**.

Considering now an important aspect of the invention which provides for structural simplicity and operational flexibility, the type matrix housing **28** contains a flat rectangular type matrix member **43** which carries all of the multiplicity of character-defining elements required for multiline parallel printing. Type matrix member **43** is readily removable and replaceable as a unit as will hereinafter be described in more detail.

Referring now to FIGS. **2** and **3** in conjunction, the type matrix member **43** has a recess around the lower edges thereof defining a surface **44** which rests upon an inwardly directed shelf **46** of housing **28** whereby the matrix member is supported with the lower surface **47** thereof at the passage **32** through which the paper **22** and ribbon **38** is passed. Matrix member **43** is held within the housing **28** by a flat top door **48** having one end fastened to an end of the housing by suitable hinges **49**. As shown in FIG. **1**, door **48** has a handle **51** opposite from the hinges whereby it may be swung upwardly to provide for removal of the matrix member **43**. To facilitate this operation, additional handles **52** are provided at the top surface of the matrix member **43** and the door **48** has openings **53** to avoid interference therewith. As shown in FIG. **2** in particular, a lining **54** of resilient material such as rubber is preferably disposed on the underside of door **48** to aid in holding the matrix member **43** in position. A latch **58**, shown in FIG. **1**, holds the door closed.

Referring again to FIGS. **2** and **3** in conjunction, matrix member **43** carries parallel rows of character-defining elements **59** which in the present example include a complete set of arabic alphabetical and numerical characters together with the various punctuation marks required for alphanumeric printing. A solid line row **59*a*** may be included to print lines on the paper at any programmed time interval, whereby guide, index or separation lines may be printed concurrently with printing of the alphanumeric characters. In order to print properly, the character-defining elements **59** are in mirror image form as viewed on the underside of matrix member **43**. It should be understood that the invention is applicable to printing other types of character or for printing numerical characters alone and may in fact be utilized to print pictorial or graphical data as will hereinafter be described.

In the present example, each row of character-defining elements **59** is composed of like characters and there is one row for each of the different distinct characters which may be printed. It should be understood that this arrangement is also subject to variations. In general, to use the multiline parallel-printing technique, there must be a number of rows of character-defining elements **59** at least equal to the number of different characters which are to be printed. In the present example, there are 65 such rows to include all alphabetical and numerical characters together with punctuation marks and each row has 120 character-defining elements in conformity with the standard computer printout format. However it is possible and often advantageous to utilize more than the minimum number of rows of character defining elements as will hereinafter be discussed. Further it is not strictly necessary that each row be composed of like characters as the associated control circuitry can be programmed to adapt to other arrangements, provided that each column of character-defining elements on the matrix **43** contains at least one of each of the different distinct characters in at least one of the rows transected by the columns. In other words, at least one of each character must be provided in some one of the rows at each of the 120 columns which extend parallel to the direction of paper travel. Generally, it is advantageous to utilize the present arrangement in which each row is composed of like characters in that the detection and correction of malfunctions is simplified.

As described above, all character-defining elements **59** may be removed and replaced as a unit by replacing the matrix member **43** and this is highly advantageous when it is desired to change the type font or to adapt the mechanism to the printing of entirely different characters. However there are also instances where it is advantageous to be able to replace one or more individual rows of character-defining elements **59**. Certain specialized printing jobs for example may require a small number of unusual characters such as certain Greek letters. In other instances, it may be observed that some particular character is not printing properly due, for example, to a deformation of a particular character defining element **59** at the row corresponding to that character. To greatly facilitate the removal and replacement of one or more character-defining elements **59**, each row thereof is formed along the lower surface of a rectangular bar **61** which extends transversely through the lower portion of the matrix member **53** in a conforming slot **62** therein, the lower end of the bar being substantially at the lower surface of the matrix member so that the associated character-defining elements **59** project slightly therebelow. To retain the bars **61** in position in matrix member **43**, the upper ends of the bars may have an enlarged portion **61'** fitting in a correspondingly enlarged portion of the slots **62**. The bars **61** are removable by being withdrawn sidewardly from the matrix member **43** and for this purpose, as shown in FIG. **1**, one side of the housing **28** is provided with a hinged door **63** which may be lifted to expose the ends of the bars. Door **63** has a handle **64** to facilitate operation and a latch **66** to hold the door in the closed position.

Referring now to FIG. **4**, the ends of the bars **61** adjacent door **63** project a small distance from the side of matrix member **43** and each such projecting portion of each bar has a transverse aperture **67** into which a suitable tool may be inserted to facilitate withdrawal of the bar from the matrix. Door **63** has a projection **68** on the inner side which bears against the adjacent ends of the bars **61** when the door is closed and latched to forestall shifting of the bars.

Referring now to FIGS. **2** and **4** in conjunction, the lower housing **26** supports and positions a plurality of rows **69** of actuators for selectively causing any one of the previously described character-defining elements to imprint its character upon the paper **22**. Each row **69** of actuator elements is a unitized assembly extending parallel to an associated one of the rows of character-defining elements **59** immediately below the paper **22** and ribbon **38**. Each row **69** of actuators has a plurality of flat headed hammers **71** equal in number to the number of character-defining elements **59** in the corresponding row with each hammer being positioned to impress the paper and ribbon against an associated individual one of the character-defining elements. To receive and support the actuator row assemblies **69**, housing **24** in this example has a plurality of transverse vertical partitions **72** adjacent ones being spaced apart to receive one of the actuator row assemblies therebetween. Each such partition **72** has linear projections **73** at the top and bottom which overlap conforming shoulders on the adjacent actuator assemblies.

The above described unitized construction of each row **69** of actuators is a further highly valuable feature of the invention in that malfunctions of an actuator are quickly and easily corrected. In particular, any of the actuator row assemblies **69** is removable as a unit in that it may be withdrawn sidewardly from housing **28**. For this purpose, as shown in FIG. **1**, a hinged door **74** is provided at one side of housing **24**. Door **74** has handles **76** to facilitate operation and a latch **77** holds the door closed under normal conditions. Referring to FIG. **4**, removal and replacement of the actuator row assemblies **69** is further facilitated in that the end of each assembly closest to door **74** projects a small distance theretowards from the ends of housing partitions **72** whereby the actuator assembly may readily be gripped by a suitable tool. Door **74** is provided with a projection **78** along the inner surface which bears against the exposed ends of the actuator assemblies when the door is closed and latched to prevent any longitudinal shifting thereof.

Referring now to FIG. 5, important operational advantages of the invention are realized by making each of the hammers 71 actuatable independently of the actuation of other hammers in other rows thereof. If the hammers 71 of a plurality of rows must be actuated at precisely the same time, then the line spacing of the printing on the paper is necessarily fixed at the spacing of successive rows of character-defining elements. For structural reasons, this spacing is generally larger than the preferred spacing of successive lines of printing. This limitation is avoided by the present invention by utilizing an individual solenoid coil 79 to control each hammer together with means for energizing any coil independently of the timing of energizing of the coils of other rows.

In order to drive the hammer 71, the solenoid 79 must usually have a bulk exceeding the restricted space allotted to each hammer 71 along the row. FIG. 5 illustrates still another important aspect of the invention whereby the necessary number of solenoids 79 are fitted into the unitized assembly 69 while providing for close spacing of the hammers 71 and for desirably small character size and spacing.

Each actuator row assembly 69 has a rectangular casing 81 having a top plate 82 secured thereto. As best shown in FIG. 6, top plate 82 has an upwardly extending boss 83 along the central portion of the upper surface thereof with a slot 84 extending therealong into which the hammers 71 fit in the retracted positions thereof.

Each hammer 71 is carried on the upper end of a driver member 86 which extends downwardly to the associated solenoid coil 79. High-speed operation requires fast-acting solenoids, and under some conditions this could result in a undesirably hard impact of the hammer 71 against the paper 22 and overlying character-defining element 59. To forestall difficulties of this kind, the hammer 71 may be formed of a slightly resilient material such as a fairly stiff rubber. Further, to avoid interference with the passage of paper through the printing station, the hammers 71 are formed with rounded edges facing the input and output ends of the printing station as shown in FIG. 6, and in their retracted positions preferably do not project above the upper surface of the boss 83.

Considering now the preferred disposition of the solenoids 79 within the assembly 69, with reference to FIGS. 5 to 8 in conjunction, the particular solenoids used in this embodiment of the invention have a diameter substantially —equal to the distance spanned by three of the character positions along a row in a column of printing and thus cannot be disposed in a simple side-by-side linear relationship. The desired close spacing of the hammers 71 is achieved by spacing each successive series of three solenoids 79 vertically as well as horizontally. Thus a first solenoid at one end of the assembly 69 is situated below its associated hammer 71 and near the top of the casing 81. The solenoid 79′ for the next hammer 71 is situated below the level of the first solenoid 79 and is spaced horizontally therefrom so that it is directly below its own hammer 71. Similarly the solenoid 79″ for the third hammer 71 of the row is situated below the level of solenoid 79′ and again it is spaced horizontally therefrom. This sequence of vertical and horizontal spacing of the solenoids is then repeated for each successive group of three along the row 69. It will be apparent that this basic form of positioning the solenoids can be utilized where the individual solenoids have other porportions relative to the associated hammers 71. Thus if relatively smaller solenoids are used, the vertical spacing of the solenoids into only two layers may be adequate while if relatively larger solenoids are used each vertically spaced columns may include more than three solenoids before the sequence is repeated along the row.

Referring now to FIGS. 6, 7 and 8 in conjunction with FIG. 5, the uppermost layer of solenoids 79 is supported by a member 87 which extends along the row assembly 69 immediately below the upper most solenoids. Similarly, the intermediate layer of solenoids 79′ is supported by a similar member 87′ spaced below the first support member. The lowermost layer of solenoids 79″ may be mounted directly in the floor of casing 81. To provide adequate support without resorting to massive construction of the support members 87 and 87′, a series of vertical posts 88 extend therebetween at intervals along the length thereof and similar posts extend between the lower support member 87′ and the floor of the casing 81. This is possible in that the disposition of circular solenoids 79 in the described arrangement provides space for such vertical posts on either side of the points of contact of adjacent solenoids.

Referring now to FIGS. 5 and 6 in conjunction, those of the hammer drivers 86 which are associated with one of the top layers of solenoids 79 may extend directly into the associated solenoid. To limit motion of the hammer driver 86 into the solenoid at a position at which the associated hammer 71 is fully retracted against the floor of slot 84, a pair of arms 89 extend sidewardly from the driver and abut against the topmost surface of the solenoid. To provide for the desired upward motion of the driver 86 and hammer 71 when the solenoid is energized, the lowermost portion of driver 86 is an armature element 91 formed of ferromagnetic material which may be fastened to the remainder of the driver by threads 92. With the hammer 71 retracted as described above, the armature element 91 is preferably proportioned so that is upper end extends a small distance into the solenoid 79. Thus when the associated solenoid is energized, armature 91 is drawn upwardly and carried driver 86 and hammer 71 in a similar direction. To insure fast retraction of the hammer 71 after the solenoid 79 is deenergized, a compression spring 93 is disposed around driver 86, in coaxial relationship thereto, between the arm extensions 89 and the lower surface of casing top member 83.

To provide for energizing of each solenoid coil 79, one of the leads 94 therefrom extends upwardly to a metallic contact 96 in the shoulder of the top member 83. As shown in FIG. 2, contact 96 bears against the adjacent partition member 73 of housing 24 which is formed of conducting material and which is grounded. The other solenoid lead 97 extends downwardly to a second contact 98 situated at the bottom surface of casing 81 as shown in FIG. 8 for coupling to energizing means as will hereinafter be described.

Referring now to FIG. 7 in particular, it is not possible to couple the second layer solenoids 79′ to the associated hammers 71 and drivers 86 in the same manner as is done for the top layer solenoids 79 as the top layer solenoids intervene therebetween. This problem is resolved by coupling the armature element 91 of each intermediate layer solenoid 79′ with its hammer driver 86 through a pair of staggered arms 99 and 101 which extend around the intervening layer solenoid 79. Thus, each such arm 99 and 101 extends sidewardly from driver 86 then downwardly, then back under the upper layer solenoid 79 and support member 87 to connect with the armature element 91 of the associated second layer solenoid 79′. In order to provide space for the horizontal portions of the arms 99 and 101 to travel upwardly and downwardly in response to energization of the solenoid 79′, the intermediate layer of solenoids 79′ must be spaced an appropriate distance downward from the lower surface of upper support member 87.

Referring now to FIG. 8, the armature elements 91 associated with the lowermost layer of solenoids 79″ connect with the corresponding hammer drivers 86 through arms 102 and 103 which are staggered in a manner similar to that described with reference to FIG. 7, except that the vertical portions of the arms are of sufficient length to extend past both the upper layer of solenoids 79 and the intermediate layer of solenoids 79′. Again, the lowermost solenoids 79″ must be spaced below the undersurface of lower support member 87′, a distance sufficient to provide for the desired travel of the arms 102 and 103.

Referring now again to FIGS. 2 and 4 in conjunction, the capability of separately energizing any one of the above described solenoids 79 requires that a separate electrical connection be provided to each individual solenoid at the previously described metallic contacts 98 which are distributed

along the underside of the actuator row assembly **69**. Further, in keeping with a important object of the invention, this must be provided for without complicating the removal and replacement of the actuator row assemblies. For this purpose, a unitized contact board **104** is situated below housing **24** and is movable upwardly and downwardly as a unit to open or close a separate connection with all solenoids simultaneously. To receive the contact board **104**, the support frame **26** has a rectangular opening **106** beneath housing **24**. An upright cylindrical guide **107** extends between the horizontal portion of the frame **26** and a support bracket **108** near each corner of the opening **106** and contact board **104** is provided with sleeve projections **109** at each corner which engage the guides **107** and are slidable therealong in the vertical direction.

As shown in FIG. **4**, a shaft **111** extends beneath board **104** and is journaled to opposite sides of the frame **26** to support a pair of asymmetrical cams **112** which bear against the underside of the board. One end of shaft **111** projects through the side portion of frame **26** and a handle **113**, best shown in FIG. **1**, is secured to the projecting end for turning the cams **112** to raise and lower the contact board. Handle **113** may be provided with a latch **114** for fixing the angular position of the handle at any of several desired positions to provide for varying the tension of spring contacts to be hereinafter described.

Referring now again to FIGS. **2** and **4**, a plurality of C-shaped spring contacts **116** are secured to the top surface of contact board **104** in rows which are spaced similarly to the spacing of actuator row assemblies **69**. Each such row includes a separate spring **116** positioned to contact each of the superjacent contact elements **98** along the underside of the actuator row assembly **69**. Thus, as the contact board **104** is raised against the underside of housing **24** as previously described, each spring **116** is compressed slightly to form a reliable connection with a separate one of the actuator solenoids. To connect to the associated control circuitry, each spring **116** has a conductor wire **117** coupled thereto, the wire preferably being imbedded within the board **104** which may be formed of cast plastic. At the underside of contact board **104** each wire **117** couples to one of a plurality of disengageable multiconductor cable **118** through a disengageable connection **119** which may be of the well-known pin variety, for example.

Control circuitry suitable for operating a multiline parallel printout mechanism from a serial form signal input is known to the art, and accordingly, is indicated diagrammatically in FIG. **1**. The coded input signals from computer **21** or other source are delivered to a temporary storage **121** which may be comprised of flip-flop circuits, an array of magnetic cores or any of the other memory devices known to the art. Storage **121** is capable of storing a quantity of signals corresponding to the total number of lines of printing which are within the printing station **23** when the printout mechanism is adjusted to provide the minimum line spacing and is programmed to receive and store the signals for a new line while erasing the signals for a completed line each time that the paper **22** advances through the printing station **23** a distance equal to one line spacing of printing. As the paper **22** moves through the printing station **23**, a print logic circuit **122** receives a signal from a line signal generator **123** each time the paper has advanced one line spacing and upon receiving each such signal the logic circuit examines the data storage **121** to detect momentary coincidences between any of the character defining elements **59** and a position on the paper which requires imprinting of the corresponding character. At each such cycle the logic circuit **122** activates the appropriate ones of an array of solenoid drivers **123** each of which is coupled to a separate one of the actuator solenoids through the previously described cables **118** and associated connections at the contact board **104**. Each such solenoid driver may be a solid-state switch or equivalent device known to the art for supplying an energizing current impulse to the associated solenoid.

The print logic **122** and data storage **121** are shown apart from the computer **21** in FIG. **1** to facilitate an understanding of the control of the mechanism and in some instances these components are physically distinct from the data source such as computer **21**. However, it will be apparent that the functions of the data storage **121** and print logic **122** can be performed by an appropriately programmed computer **21** which is also the source of the data to be printed. This is usually the preferred mode of operation where adequate computer capacity is available.

Unlike prior multiline parallel printing systems, the cycling rate of the logic circuit **122** is not necessarily matched to the rate at which a given line on the paper passes successive rows of imprinting elements. Such a cycling rate provides for only one line spacing of the printing and this is necessarily fixed at the spacing between successive rows of imprinting elements. Because of mechanical consideration, this spacing of the rows of imprinting elements is generally larger than the preferred line spacing of printing. This limitation is avoided in the present invention by cycling the logic circuit **122** a plurality of times during the interval required for a given line on the paper to advance from one row of imprinting elements to the next. In particular, the desired line spacing is selected and then the logic circuit **122** is cycled at a rate which provides for a cycle each time any line on the paper is at any one of the rows of imprinting elements. This not only provides for a closer line spacing of imprinting but also provides for selectively varying the line spacing through appropriate changes in the cycling rate of the logic circuit **122**. It should be observed that there is no mechanical constraint in the above described construction of the printout mechanism which prevents this mode of operation. There is no limitation in the mechanical or electrical system which requires that the character-imprinting elements **59** of more than one row thereof be actuated precisely at the same instant.

As discussed above, the logic circuit **122** cycles each time a line signal is received from a line signal generator **123** which clocks the movement of paper **22** through the printing station **23**. Thus line signal generator **123** must deliver a line signal to logic circuit **122** each time that any line on the paper is at any row of imprinting elements and the repetition rate of these line signals relative to paper speed must be changed if the line spacing is to be changed as discussed above.

To provide for this, the line signal generator **123** may be a pulse frequency divider which receives input pulses from a photoelectric tube **124**. Phototube **124** views a light source **126** through a rotating opaque disc **127** having a series of light transmissive windows **128** equiangularly spaced therearound at a radius which provides for the periodic momentary transmission of light from source **126** to the phototube. Disc **127** is driven by one of the paper drive rollers **33** through a speed-increasing gearbox **130** whereby the frequency of input pulses to the line signal generator **123** is determined by the speed of paper **22** which itself may be freely changed by the paper speed control **37**. In order to provide an output or line signal at any selected one of a series of different repetition rates relative to paper speed, line signal generator **123** may be a counter-divider of known construction which divides the input signal frequency by a factor determined by the selected setting of a multiple position control switch **129**. Thus, at any given paper speed, line signal generator **123** may be adjusted at switch **129** to cycle print logic **122** at a repetition rate needed to effect any one of a series of different line spacings of printing on the paper **22**.

The construction of the printing mechanism may be modified and varied in different ways to meet specialized operating conditions and requirements while utilizing basic features of the invention. FIG. **9**, for example, illustrates two modifications with respect to mounting the character defining elements **59** on the undersurface of the unitized stationary-type matrix **43***a*. For greatest simplicity, the character-defining elements may be formed as an integral part of the undersurface of the type matrix **43***a*, by casting for example, as illustrated at **59'** in FIG. **9**. The character-defining elements **59'** may all be formed in this manner or this construction may be used with one or more of the replaceable bar inserts hereto-

fore described to provide for some variation of the printing obtainable from the matrix. A second row of character-defining elements **59''** is shown in FIG. **9** as carried on a specialized removable bar **61'** which is capable of a limited amount of yieldability in the direction of paper travel as indicated by arrow **36**. This construction may be desirable when printing at extremely high speeds in that at various times a large number of the hammers **71** may be actuated and may be simultaneously compressing the paper **22** and ribbon **38** against the suprajacent stationary character defining elements **59** and the slight flexibility imparted to the latter will avoid impeding the travel of the paper and ribbon to the point where difficulties could occur. The resiliently positioned insert **61'** may be of essentially similar construction to that previously described except that it is of slightly less width in the direction of paper movement than the slot **62'** in the type matrix **43** in which it is received and the additional space thus created is filled with a thin flat backing strip **136** of resilient material such as rubber. Thus the associated character-defining elements **59''** may advance a small amount with the paper **22** if necessary during the actuation of the hammers **71** in the associated row thereof and will be subsequently restored to its initial position after the hammers retract by the resiliency of backing strip **136**. To provide for this motion, the widened upper end of the replaceable bar insert **61''** is of circular cross section in this instance.

Referring now to FIG. **10**, a modification of the invention is illustrated which provides for a simplified single layer disposition of the solenoids **79** which serve as actuators for the character-imprinting elements **59**. This is effected by providing several successive rows of character-defining elements **59**, all of which carry the same character and which are spread apart a distance sufficient to provide for the disposition of the solenoids **79** in a single layer both in the direction of paper travel **36** and at right angles thereto. The individual character-defining elements **59** of each row are offset one column space with respect to the like character-defining elements of the adjacent rows and, in the example illustrated in FIG. **10**, four rows of each distinct kind of character-defining element are provided. This of course requires a type matrix element **43*b*** which is elongated in the direction of paper travel relative to the previously described embodiment but this increase in size may in some cases be justified by the simplification in the mounting of solenoids **79**.

In a printout system of the kind described above, printing speed may ultimately be limited by the recovery time of individual actuators since any particular actuator and its associated imprinting elements may be required to print its character at the same column position in two successive lines of printing and if the second of the two lines on the paper passes the particular actuator before it has recovered and is ready to operate again the desire printout cannot be successfully accomplished. It should be understood that this limitation on printing speed still provides for much higher printout speeds than are realized with the commonly used existing apparatus. Nevertheless it is of course desirable to increase printing speed even more and FIG. **11** illustrates a modification of the invention which removes actuator recovery time as a limiting factor in printing speed.

In the arrangement of FIG. **11**, the type matrix **43*c*** is provided with two rows of identical character-defining elements **59** for each distinct character to be printed with both of the two rows providing the character for all column positions and each having its row assembly of actuator solenoids **79** which may be arranged as hereinbefore described. In this construction, the control circuit is arranged to utilize one row to print a first character of a given type and then to utilize the other row of the same characters to print the next character of the same type which occurs in that column position. The practical effect of this is that the same character can be printed at the same column position in two successive lines of printing without waiting for the solenoid which printed the first character to recover. In other words, the two solenoids **79** capable of printing the same character at the same column position on the paper are used alternately for that purpose. This provides for printing the same character in two lines in succession in a time equal to one-half the recovery item of a specific solenoid. It will be apparent that if still greater printing speeds are called for, additional rows of the same character-defining elements may be provided as necessary.

The arrangement of the control circuitry to alternately make use of two different solenoids capable of imprinting at the same column position on the paper may be achieved in various ways and FIG. **11** illustrates one such arrangement wherein the extra row of solenoids for each distinct character, taken in combination constitute in effect a second duplicate printout system which is used for each alternate cycle of operation. In particular, the solenoids **79** of a first row thereof for each character are coupled to a first set of solenoid drivers **125*a*** controlled by a first logic circuit **122*a*** as previously described and the alternate row of solenoids for the same character has solenoid drivers **125*b*** controlled by the duplicate logic circuit **122*b***. Both logic circuits **122*a*** and **122*b*** may interrogate the same data storage **121*a*** which received the input signals from the computer **21** or other source. To alternately cycle the two systems, a gate **137** directs even line signals from generator **123** to one logic circuit **125*a*** and directs the alternate or odd line signals to logic circuit **125** *b*. Since the extra row of imprinting elements for each character is displaced from the primary row to which the line signals are referenced, it is necessary that the solenoid-energizing signals which are directed to the other row be delayed for the time required for the paper to travel between the two rows. For this purpose a variable time delay circuit **140** is situated between gate **137** and the print logic **122*b*** of the alternate system. Time delay **140** thus functions to defer operation of the solenoids **79** of the extra rows until the line on the paper has moved to the extra row of character-imprinting elements **59**. Since this time is a function of the paper speed, which is itself variable, time delay circuit **140** is controlled by a signal indicative of paper speed which may be derived from an output terminal **141** at phototube **124** as shown in FIG. **1**. It should be understood that the time-delaying function can be performed at any of various other points in the alternate control system comprised of logic **122*b*** and solenoid drivers **125*b***.

The invention may also be adapted to the printout of pictorial or graphical data either by itself or in combination with alphanumeric text. FIG. **12**, for example, illustrates a type matrix member **43*d*** as modified for such printing. The matrix member **43*d*** includes the alphanumeric character defining elements **59** as hereinbefore described and in addition carries a plurality of rows of dot-defining elements **142** each having an actuator solenoid **79** associated therewith in the manner hereinbefore described. The dot-defining elements **142** of each row are offset, in a direction transverse to the paper travel **36**, from the dot elements of the adjacent rows by a distance equal to the total column width divided by the number of rows of dot-defining elements. Five such rows are employed in the present instance with the dots of each row being offset from those of the adjacent rows by one-fifth of the transverse spacing of adjacent dot-defining elements in any one row. Each dot-defining element preferably has a diameter of about one-fifth of the above described spacing between dots in a particular single row. This arrangement of dot-defining elements **140** allows an image to be imprinted on paper, in a parallel fashion, by printing dots to define dark areas as the paper travels along the rows of dot-defining elements. Scanning devices which translate a printed image into serial signals indicative of image density at each incremental area of the image are known to the art and are used for example in wire photosystems. Coded output signals from such a device may be processed to operate the dot matrix **43*d*** essentially as hereinbefore described for alphanumeric printout.

If greater image definition is desired than is afforded by the dot size of the above described construction, the diameter of the dot-defining elements **142** may be reduced and an ap-

propriately larger number of rows of such elements may be provided. Similarly, if faster image printout is required, the sequence of rows of dot-defining elements **142** may be repeated one or more times rather than utilizing the single sequence of five as illustrated in FIG. **12**.

Basic aspects of the invention may be utilized in printout mechanisms which employ fundamentally different means for imprinting characters on the paper. Referring now to FIG. **13**, an embodiment of the invention is shown in which electrostatic printing is employed. The printing station **144** region in this embodiment requires no moving parts whatsoever other than the paper **22'** itself.

The printing station **144** in this instance is comprised of a connector board **146**, an imprinting element matrix **147** situated immediately thereabove and a backing electrode member **148** which is uppermost. Board **146**, matrix **147** and electrode member **148** are each of flat rectangular configuration and are secured to a subjacent frame **149** by upright bolts **151** which extend through the corners of each member. Paper **22'** is of the coated type suitable for electrostatic printing and is moved continuously between matrix **147** and electrode member **148** by a suitable drive system which may, for example, consist of paired rollers **15** driven by a variable speed motor **153** through a speed reduction mechanism **154**. In the embodiment of the invention shown in FIG. **13**, the drive rollers **152** are arranged to carry the paper **22'** horizontally through the printing station and then around a drum **157** of a developing station and then upwardly past a viewing window **158** in a suitable housing **159**. The paper may then be traveled horizontally again back over the printing station **152** to suitable paper takeup means.

Referring now to FIG. **14**, the paper **22'** passes along an array of mirror image character defining elements **161** which in this instance are situated immediately under the paper on the top surface of matrix **147** and which are arranged in rows of like character-defining elements including at least one row of each character which it may be desired to print. Owing to the absence of electromagnetical actuators, the rows of character-defining elements **161** in this instance may be closely spaced and the assembly as a whole may be relatively compact.

Referring now to FIG. **15**, each character-defining element **161** is the enlarged upper end of a pin **162** which constitutes the actuator in this embodiment and which has a lower end that projects from the bottom surface of the matrix **147** to form the male element of a pin connector. Each of the pins **162** including character-defining elements **161** must be electrically insulated from each of the others and this is advantageously provided for by forming the matrix member **147** of a suitable insulative plastic which can simply be cast around the array of character-defining elements to form a solid integral unit therewith.

A separate electrical connection to each of the character-defining elements **161** is provided for by a matching array of female pin connector elements **163** each adapted to engage with a separate one of the projecting lower ends of pins **162**. The highly desirable unitized solid construction is again provided for by casting the connector board **146** of insulative plastic around the array of female connector elements **163** to form an integral structure therewith. Within the lower portion of connector board **146**, an individual lead wire **164** connects each female element **163** with one of a plurality of multiconductor cables **166**, suitable holes **167** being provided in frame **149** to receive the connector element **168** at the end of each cable.

Referring still to FIG. **15**, the backing electrode member **148** has a flat plate **169** disposed parallel to the upper surface of matrix **147** and spaced a small distance therefrom to form a thin passageway **171** for the paper **22'**. As shown in FIG. **14**, this spacing is provided for by a thin spacer element **172** disposed between matrix **147** and plate **169** along each side thereof, the spacers being transpierced by the bolts **151** which secure the entire assembly together. It will be apparent that the spacer elements **172** may be removed and replaced with thinner or thicker elements as desired to adjust the height of the paper passage **171**.

Referring now again to FIG. **15**, effective electrostatic printing requires that the paper **22'** be kept from undergoing slight oscillations in the vertical direction relative to the character-defining elements **161** and backing electrode plate **169** and to assure that uniform paper position is maintained at extreme high speeds, it may be desirable to provide a vacuum means for holding the paper flat against one of the elements. Thus a series of narrow passages **173** may be provided through the backing electrode plate **169**, each being at the interstice between four of the character-defining elements **161** so that the absence of conductive metal at these points will not interfere with electrostatic imprinting by distorting the electrical fields. The backing electrode member **148** includes a top plate **174** spaced above plate **169** to form a plenum region **176** therebetween. Referring now to FIG. **13** in conjunction with FIG. **15**, an air pump **177** has an intake coupled to the plenum region **176** to draw air therefrom and thus to draw air through the passage **173** in electrode plate **169** and thereby maintain the paper **22'** flat against the plate. Pump **177** is preferably coupled to plenum region **176** through manifolding **178** formed on the top plate **174** to assure a reasonably uniform negative air pressure at all regions of the backing electrode member.

Referring now to FIG. **15**, a selected individual character-defining element **161** may be caused to imprint its character upon the paper **22'** by applying a high voltage electrical signal to the element. The paper **22'** is of a type having a coating which will receive and retain an electrical charge having a configuration conforming to the character to be printed. Thus when a voltage pulse, typically of several hundred volts magnitude, is applied to any selected one of the character-defining elements **161**, an electrical field is created between the character-defining element and backing electrode plate **169** and electrical charges are imparted to an area of the adjacent surface of the paper with the charged area having a configuration conforming to the desired character. Referring now again to FIG. **13**, the paper **22'** emerges from the printing station **144** with the appropriately charged areas at the underside of the paper and passes around drum **157** as previously described at which region the charged underside of the paper is exposed to a developing solution **179**. The developing solution is a liquid suspension of visible pigment particles which are electrostatically attracted to the charged areas of the paper and which are retained thereat as the paper emerges from the solution. The printing is thus defined on the surface of paper **22'** in a visible manner and the pigment particles are permanently bonded thereto as the paper dries during its passage upwardly and backwardly from the developer.

The mechanism for exposing the charged paper to the developing solution may be of essentially conventional construction and thus may include a tank **181** having one side conforming to an adjacent portion of drum **157** with an opening **182** thereat whereby the solution within the tank contacts the paper as it is carried around the drum. To avoid leakage, a slight degree of vacuum may be maintained within the tank **181** by a pump **183**.

Control circuitry for the electrostatic system of FIG. **13** may be essentially similar to that hereinbefore described with reference to the electromechanical printout mechanism except insofar as the electrical print impulses which are transmitted to the individual character-imprinting means are of higher voltage. Thus the serial form output signals from a computer **21'** or readout device are transmitted to a temporary data storage **121'** which is repetitively scanned by a print logic circuit **122'** at a rate determined by a cyclical signal from an adjustable line signal generator **123'**. As in the previous instance, print logic **122'** activates the appropriate ones of a plurality of high-voltage drivers **125'**, each of which is connected to a separate one of the character-defining elements **161** through the cables **166**, upon detecting coincidences between a position on the paper and an imprinting element **161** cor-

responding to a character to be printed at such position. The variable line signal generator **123'** may again be controlled by a rotary disc **127'** coupled to one of the drive rollers **152** through speed increasing device **130'** and having a series of light transmissive areas **128'** around the periphery for transmitting pulses of light between a source **126'** and phototube **124'** with a frequency which is a function of the paper speed as determined by the setting of the variable speed drive motor **153**.

Thus many modifications and variations are possible within the scope of the invention, and it is not intended to limit the invention except as defined in the following claims.

1. Apparatus for printing from coded signals that identify specific ones of a plurality of distinct characters to be printed, comprising:

an array of character-defining elements arranged in a plurality of rows and columns, each column containing at least one of each of said distinct characters;

means for moving a recording web along said array of character-defining elements in a direction parallel to said columns thereof,

an array of actuator elements each being associated with a separate one of said character-defining elements for causing the associated character-defining element to impart its character to said recording web, said actuator elements of any row being energizable independently of the timing of energization of the actuator element of other rows,

a data storage receiving and temporarily storing said coded signals, and

control means for repetitively examining said data storage to detect coincidences between the momentary position of an area of said recording web and a character-defining element corresponding to a character which is to be imprinted thereat, said control means energizing the corresponding ones of said actuator elements upon detection of said coincidences, and wherein said control means cyclically repeats said examination of said data storage and energization of appropriate ones of said actuators more than once while a given line of printing on said recording web moves from a given row of said character-defining elements to the adjacent row thereof

2. Apparatus as defined in claim **1** further comprising a line signal generator producing a line signal in response to predetermined increments of movement of said paper past said array of character-defining elements, and wherein said control means is coupled to said line signal generator and controlled thereby to repetitively examine said memory and energize appropriate ones of said actuators in response to said line signals from said generator.

3. Apparatus as defined in claim **2** wherein said line signal generator produces said line signals at intervals which are less than the time required for a given point on said web to travel from one row of said character-defining elements to the next row thereof.

4. Apparatus as defined in claim **2**, wherein said line signal generator has a control for selectively changing the repetition rate of said line signals relative to the time interval required for a point on said web to move from one of said rows of character-defining elements to the next row thereof whereby the spacing of lines of printing on said recording web may be selectively changed.

5. Apparatus as defined in claim **1** having a line signal-producing means coupled to said control means for producing line signals which determine the cycling rate at which said control means examines said data storage and actuates appropriate ones of said actuator elements, said line signal-producing means comprising:

a rotatable element coupled to said means for moving said web whereby said rotatable element rotates in synchronism with the movement of said web and at a rate proportional to the speed of said web,

pulse-generating means having an input controlled by said rotatable element for generating said line signals at a repetition rate determined by the angular speed of said rotatable element, and

means for selectively changing the number of said line signals produced by said pulse-generating means in response to a given increment of rotation of said rotatable element.

6. In an apparatus for printing from coded signals which identify distinct characters to be printed in a plurality of lines of printing on a moving recording web, an array of character-imprinting means and supporting means therefor, said character-imprinting means and supporting means therefor, said character-imprinting means being arranged in rows and columns with said columns being aligned with the direction of movement of said recording web and wherein at least one imprinting means corresponding to each distinct character is present in each column in at least one of the rows transected thereby, said character-imprinting means each being comprised of a stationary character-defining element having a configuration conforming to the corresponding character and having an individually energizable actuator therefor, wherein a plurality of said character-defining elements are formed as integral portions of a single member which carries all character-defining elements for an entire row thereof and is removable from said supporting means independently of other rows of character-defining elements.

7. Apparatus for printing from coded signals which identify distinct characters to be printed in a plurality of lines of printing on a moving recording web comprising an array of character-imprinting means arranged in rows and columns with said columns being aligned with the direction of movement of said recording web and wherein at least one imprinting means corresponding to each distinct character is present in each column in at least one of the rows transected thereby, said character-imprinting means each being comprised of a stationary character-defining element having a configuration conforming to the corresponding character and an individually energizable actuator therefor, wherein a plurality of said actuator elements are secured to a single support member whereby said plurality of actuator elements may be installed and removed as a unit.

8. Apparatus as defined in claim **7** wherein said plurality of actuator elements which are secured to a single support member comprise all the actuators for a row of said character-defining elements.

9. Apparatus for printing from coded signals which identify distinct characters to be printed in a plurality of lines of printing on a moving recording web comprising an array of character-imprinting means arranged in rows and columns with said columns being aligned with the direction of movement of said recording web and wherein at least one imprinting means corresponding to each distinct character is present in each column in at least one of the rows transected thereby, said character-imprinting means each being comprised of a stationary character-defining element having a configuration conforming to the corresponding character and an individually energizable actuator element therefor, said actuator elements being of the electrically energized form said apparatus further having a unitized connector board member disposable against a plurality of said actuator elements and carrying at least one individual electrical contact for coupling to each of said plurality of actuator elements whereby electrical connection to all said plurality said plurality of actuators maybe made simultaneously by disposition of said board against said actuators.

10. Apparatus for printing from coded signals which are indicative of a plurality of distinct characters to be printed comprising:

a type matrix having a flat surface with a plurality of stationary character-defining elements thereon, said character-defining elements being arranged on said surface in a plurality of rows and columns,

drive means for traveling a recording medium along said surface, said recording medium being parallel to said surface and moving in a direction normal to said rows of character-defining elements thereof,

a flat support means carrying a plurality of electrically energizable actuator elements being each associated with a specific one of said character-defining elements to transfer the character defined thereby to said recording medium,

a connector board disposable at said support means in parallel relationship thereto and carrying a plurality of electrical connector means each being positioned to connect with a separate one of said actuator elements when said board is disposed at said support means, and

control circuitry receiving and temporarily storing said coded signals for a plurality of lines for printing, said control means being coupled to said connector board for energizing appropriate ones of said actuator elements therethrough as said recording medium travels past said matrix.

11. Printout mechanism operating from coded input signals which identify specific ones of a plurality of distinct characters to be printed, comprising:

a fixed array of stationary character-defining elements arranged in a plurality of rows and columns with at least one element defining each of said distinct characters being in each of said columns in at least one of the rows transected thereby, each of said character-defining elements having a projecting portion shaped in conformity with the character defined thereby,

drive means for traveling a recording web past said array of character-defining elements along a path at which said recording web is parallel to said array and moves in a direction parallel to the columns of character-defining elements, and

a plurality of actuator elements disposed in a matching array of rows and columns on the opposite side of the path of travel of said recording web from said array of character-defining elements, each of said actuator elements having a flat-headed movable hammer and a separately energizable electrical drive means therefor for impressing said recording web against the projecting portion of the associated character defining element, wherein said electrical drive means of said actuators are comprised of solenoid coils having movable cores of ferromagnetic material coupled to said hammers and wherein a plurality of said solenoid coils are joined together in a unitized group which may be removed from said mechanism independently of others of said solenoids.

12. Printout mechanism as defined in claim **11** wherein said plurality of solenoid coils joined together in a unitized group comprises all solenoid coils associated with a row of said character-defining elements, said solenoid coils being disposed within a housing having transverse guide means therein for receiving said unitized row thereof may be removed by being withdrawn sidewardly from said housing without removing other rows of solenoid coils.

13. Printout mechanism as defined in claim **12** wherein said unitized row of solenoid coils is carried in a casing having a plurality of contacts therealong each electrically connected with a separate one of the solenoid coils of said row, said mechanism further comprising a contact board disposed adjacent said unitized row of solenoid coils and having a plurality of spring contacts positioned therealong to connect with individual ones of said solenoid coil contacts, and mechanism for selectively impressing said contact board against said unitized row of solenoid coils and for retracting said contact board therefrom to facilitate said removal of said unitized row of solenoid coils.

14. Printout mechanism operating from coded input signals which identify specific ones of a plurality of distinct characters to be printed, comprising:

a fixed array of stationary character-defining elements arranged in a plurality of rows and columns with at least one element defining each of said distinct characters beings in each of said columns in at least one of the rows transected thereby, each of said character-defining elements having a projecting portion shaped in conformity with the character defined thereby,

drive means for traveling a recording web past said array of character-defining elements along a path at which said recording web is parallel to said array and moves in a direction parallel to the columns of character-defining elements, and

a plurality of actuator elements disposed in a matching array of rows and columns on the opposite side of the path of travel of said recording web from said array of character-defining elements, each of said actuator elements having a flat-headed movable hammer and a separately energizable electrical drive means therefor for impressing said recording web against the projecting portion of the associated character defining element,

wherein said electrical drive means for said hammers are of greater extent in a direction parallel to said rows than said hammers and wherein a sequence of successive ones of said electrical drive means along said row of actuators are spaced from the associated hammer by progressively greater amounts and wherein said sequence is repeated along said row.

15. Printout mechanism as defined in claim **14** wherein said drive means are comprised of solenoid coils driving a movable armature and each of said hammers is coupled to the associated one of said drive means by a driver member extending therebetween wherein the driver members associated with those of the drive means which are separated from the associated hammer by an intervening one of the other drive means have an angled configuration and extend around said intervening drive means.

16. Printout mechanism operating from coded input signals which identify specific ones of a plurality of distinct characters to be printed, comprising:

a fixed array of stationary character-defining elements arranged in a plurality of rows and columns with at least one element defining each of said distinct characters being in each of said columns in at least one of the rows transected thereby, each of said character-defining elements having a projecting portion shaped in conformity with the character defined thereby,

drive means for traveling a recording web past said array of character-defining elements along a path at which said recording web is parallel to said array and moves in a direction parallel to the columns of character-defining elements, and

a plurality of actuator elements disposed in a matching array of rows and columns on the opposite side of the path of travel of said recording web from said array of character-defining elements, each of said actuator elements having a flat-headed movable hammer and a separately energizable electrical drive means therefor for impressing said recording web against the projecting portion of the associated character-defining element,

wherein said electrical drive means of each of said actuators has a greater extent along said rows than the associated hammer, and wherein said array of character-defining elements has a plurality of rows of like character-defining elements with each successive row thereof being offset from the adjacent rows in a direction transverse to the travel of said recording web and with the character-defining elements of each row being spaced apart by a plurality of column spaces, said electrical drive means of said actuators for each distinct character being correspondingly arranged in a plurality of rows, whereby said electrical drive means of said actuators may be equidistantly spaced from said array of character-defining elements.

17. Printout mechanism operating from coded input signals which identify specific ones of a plurality of distinct characters to be printed, comprising:

a fixed array of stationary character-defining elements arranged in a plurality of rows and columns with a plurality of elements corresponding to each distinct character in each column, each of said character-defining elements having a projecting portion shaped in conformity with the character defined thereby,

drive means for traveling a recording web past said array of character-defining elements along a path at which said recording web is parallel to aid array and moves in a direction parallel to the columns of character-defining elements, and

a plurality of actuator elements disposed in a matching array of rows and columns on the opposite side of the path of travel of said recording web from said array of character-defining elements, each of said actuator elements having a flat-headed movable hammer and a separately energizable electrical drive means therefor for impressing said recording web against the projecting portion of the associated character-defining element, each of the plurality of similar character-defining elements in the same column having a separate one of said actuators associated therewith, and

control means sequentially utilizing different ones of the plurality of similar character-defining elements in the same column to imprint successive ones of the same character in successive lines on said recording web whereby the printing speed of said printout mechanism is not limited by the operation time of a single actuator.

18. Printout mechanism operating from coded input signals which identify specific ones of a plurality of distinct characters to be printed, comprising:

a fixed array of stationary character-defining elements arranged in a plurality of rows and columns with at least one element defining each of said distinct characters being in each of said columns in at least one of the rows transected thereby, each of said character-defining elements having a projecting portion shaped in conformity with the character defined thereby,

drive means for traveling a recording web past said array of character-defining elements along a path at which said recording web is parallel to said array and moves in a direction parallel to the columns of character-defining elements, and

a plurality of actuator elements disposed in a matching array of rows and columns on the opposite side of the path of travel of said recording web from said array of character-defining elements, each of said actuator elements having a movable hammer with a flat head formed of resilient material and a separately energizable electrical drive means therefore for impressing said recording web against the projecting portion of the associated character-defining element.

19. Printout mechanism operating from coded input signals which identify specific ones of a plurality of distinct characters to be printed, comprising:

a fixed array of stationary character-defining elements arranged in a plurality of rows and columns with at least one element defining each of said distinct characters being in each of said columns in at least one of the rows transected thereby, each of said character-defining elements having a projecting portion shaped in conformity with the character defined thereby,

drive means for traveling a recording web past said array of character-defining elements along a path at which said recording web is parallel to said array and moves in a direction parallel to the columns of character-defining elements, and

a plurality of actuator elements disposed in a matching array of rows and columns on the opposite side of the path of travel of said recording web from said array of character-defining elements, each of said actuator elements having a flat-headed movable hammer and a separately energizable electrical drive means therefor for impressing said recording web against the projecting portion of the associated character-defining element, wherein said flat-headed hammers have a rounded edge transverse to the direction of paper movement.

20. A printout device for printing from coded signals that identify specific ones of a plurality of distinct characters to be printed, comprising:

an array of electrostatic imprinting means arranged in a plurality of rows and columns, each such imprinting means having a character-defining portion shaped in conformity with one of said distinct characters and wherein each column includes at least one imprinting means corresponding to each of said distinct characters,

means for moving a recording web along said array of electrostatic imprinting means, in a direction parallel to said columns thereof, said recording web being capable of retaining an electrical charge for at least a limited period,

an array of actuators each being connected to a separate one of said imprinting means for transmitting a pulsed electrical voltage thereto to cause said imprinting means to impart a charge to said recording web wherein the charged area of said web has a configuration conforming to the character defined by said means, said actuators of any row being energizable independently of the timing of energization of the actuators of other rows,

a data storage receiving and temporarily storing said coded signals, and

control means for repetitively examining said data storage to detect coincidences between the momentary position of an area of said recording web and an imprinting means corresponding to a character which is to be imprinted thereat, said control means energizing the corresponding ones of said actuators upon detection of said coincidences, and wherein said control means cyclically repeats said examination of said data storage and energization of appropriate ones of said actuators more than once while a given line of printing on said recording web moves from a given row of said imprinting means to the adjacent row thereof.

21. A printout device as defined in claim 19 wherein said character-defining elements of said imprinting means are fixed with respect to each other and situated at a flat planar surface along which said recording web travels.

22. A printout device as defined in claim 21 further comprising a conductive backing electrode spaced from said character-defining elements of said imprinting means to define a passage for said recording web.

23. A printout device as defined in claim 22 wherein said backing electrode has a plurality of apertures therethrough, and further comprising vacuum means coupled to said apertures for holding said recording web thereagainst.

24. A printout device as defined in claim 19 wherein said array of imprinting means are at least partially imbedded in an insulative matrix member whereby said imprinting means may be removed and replaced as a unit.

25. A printout device as defined in claim 24 wherein said imprinting means extend at least to the surface of said matrix member opposite from said character-defining elements and further comprising a unitized connector board fittable against said surface and removable therefrom and carrying an array of electrical connectors each positioned to connect with a separate one of said imprinting means when said board is implaced against said matrix member.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,609,238 Dated Sept. 28, 1971

Inventor(s) CARL F. HODEL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 36 "imprint" should be --information--.

Column 2, line 22 after "understood" insert --by--.

Column 7, line 66, "columns" should be --sequence--.

Column 8, line 24, "that is" should be --that its--; line 27 "carried" should be --carries; line 48 after "intervening" insert --upper--.

Column 9, line 37 "preferably being" should be --being preferably--.

Column 12, line 4 "item" should be --time--; line 22 "received" should be --receives--.

Column 13, line 24 "15" should be --152--; line 38 "electromagnetical" should be --electromechanical--.

CLAIM 9, col. 16, line 66 "to all said plurality said plurality of actuators" should be --to all of said plurality of actuators--.

CLAIM 12, col. 17, line 57 after "row" insert --of solenoid coils whereby said utilized row--.

CLAIM 16, col. 18, line 70, after "each" insert --such--.

CLAIM 17, col. 19, line 12, "aid" should be --said--.

Signed and sealed this 25th day of April 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents