

[72] Inventor **Tommy N. Tyler**
Littleton, Colo.
 [21] Appl. No. **861,062**
 [22] Filed **Sept. 25, 1969**
 [45] Patented **Jan. 11, 1972**
 [73] Assignee **Honeywell Inc.**
Minneapolis, Minn.

2,844,434	7/1958	Beard	346/74 MP
2,951,121	8/1960	Conrad	346/74 MP X
3,012,232	12/1961	Eckert et al.	346/74 MP X
3,221,315	11/1965	Brown et al.	346/135 X
3,292,171	12/1966	Wilson	346/74 MP X
3,320,523	5/1967	Trimble	324/43
3,443,214	5/1969	Meservey	324/43

Primary Examiner—Edgar S. Burr
 Attorneys—Arthur H. Swanson and Lockwood D. Burton

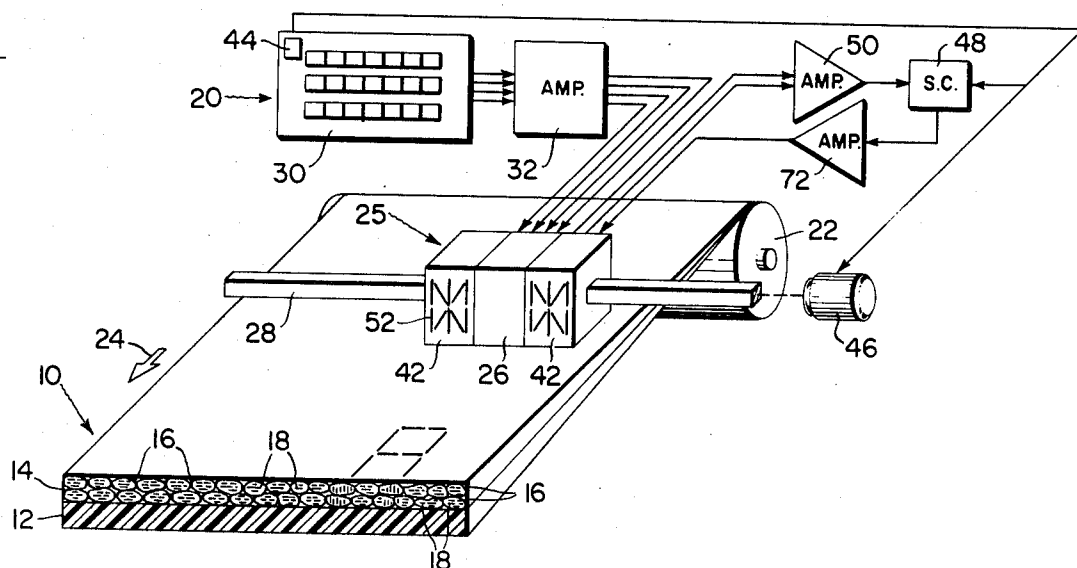
[54] **ALPHANUMERIC PRINTING DEVICE
 EMPLOYING MAGNETICALLY POSITIONABLE
 PARTICLES**
3 Claims, 13 Drawing Figs.

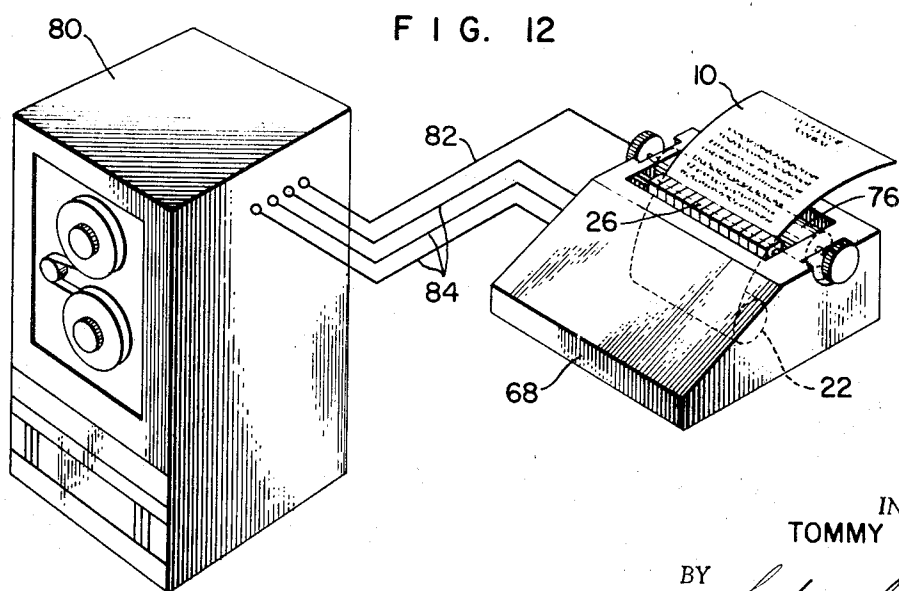
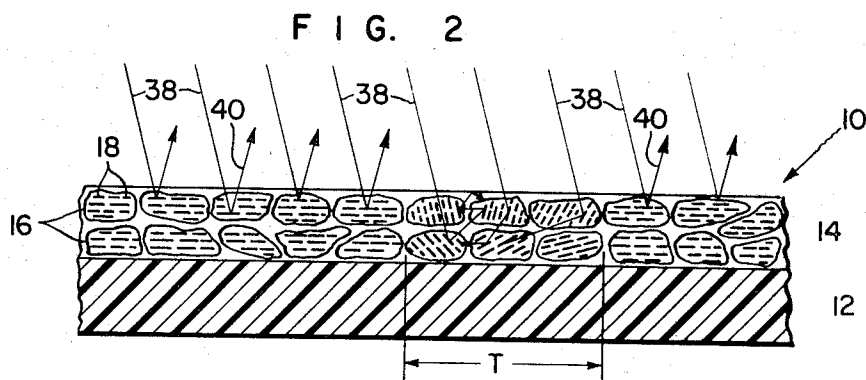
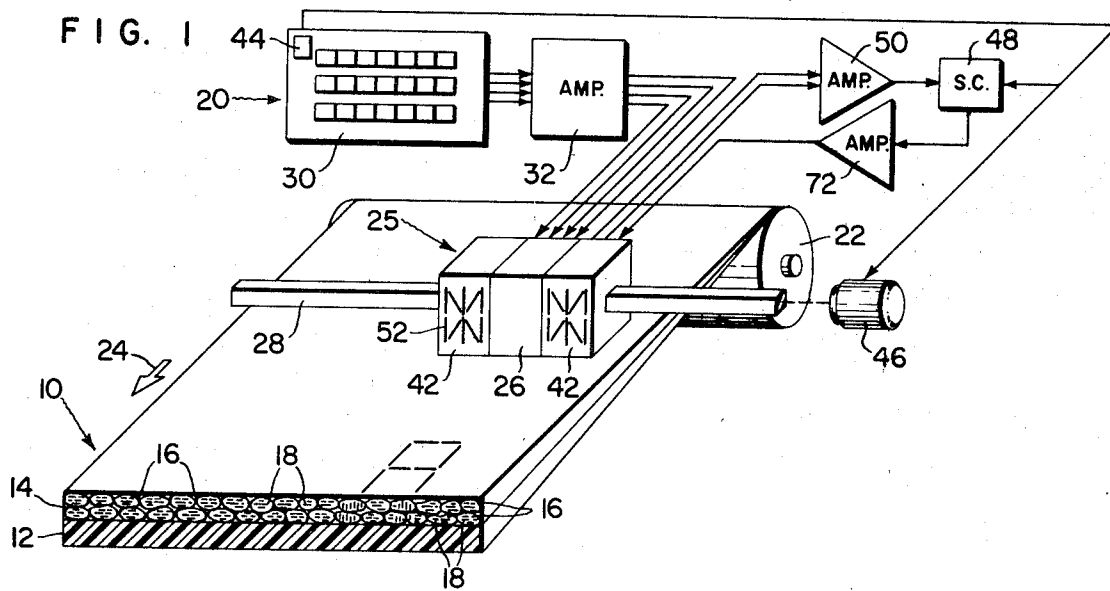
[52] U.S. Cl. **197/1,**
35/66, 101/1, 101/DIG. 13, 324/43, 340/174.1,
346/74 MP, 117/235
 [51] Int. Cl. **G01d 15/12**
 [50] Field of Search **197/1, 181;**
346/74 MP; 178/7.5 D, 7.3 D; 101/DIG. 13, 1

[56] **References Cited**
UNITED STATES PATENTS

Re25,363	4/1963	Tate	117/235 X
2,481,621	9/1949	Rosenthal	178/7.5 D
2,841,461	7/1958	Gleason	346/74 MP

ABSTRACT: A printing device is shown that uses a specially adapted paper upon which alphanumeric characters may be printed without impact and from which erroneously printed characters may be removed. The alphanumeric character to be printed is selected by a keyboard which electrically energizes core elements within a recording head. The core elements generate a force field that reorients preoriented highly reflective flakelike particles within the specially adopted paper. The reorientation causes the reflective flakelike particles to become absorptive for forming a dark contrasting trace upon the paper which represents the selected alphanumeric character. If an error is made, the recording head may be utilized to remove the erroneously selected alphanumeric character by again reorienting the reflective flakes into their previous light-reflective orientation.





INVENTOR.
TOMMY N. TYLER

BY *Lockwood D. Burton*

ATTORNEY.

FIG. 3

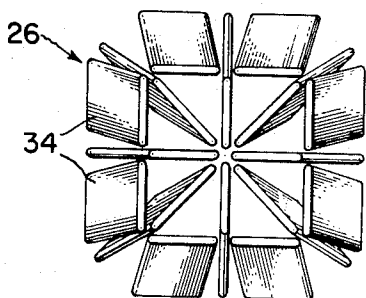


FIG. 4

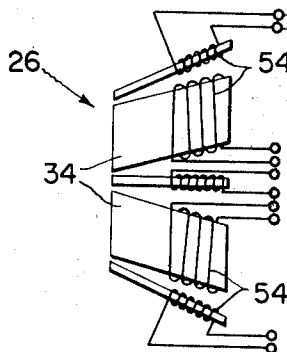


FIG. 5

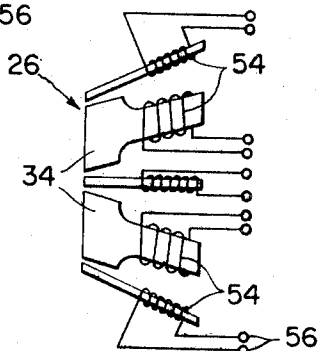


FIG. 6

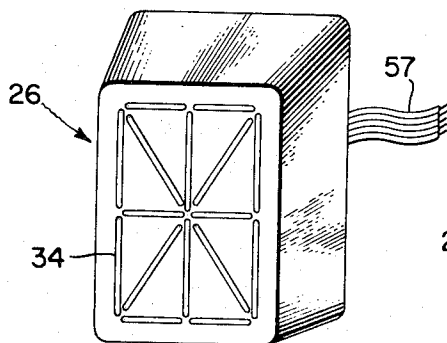


FIG. 7

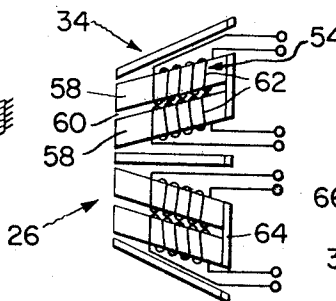


FIG. 8

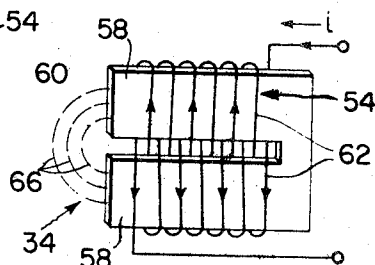


FIG. 9

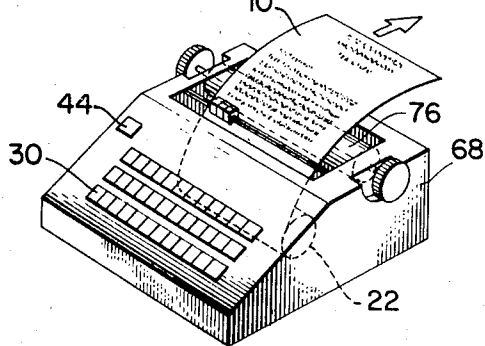


FIG. 10

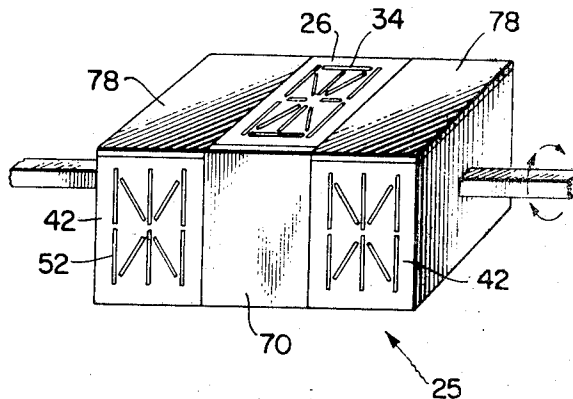
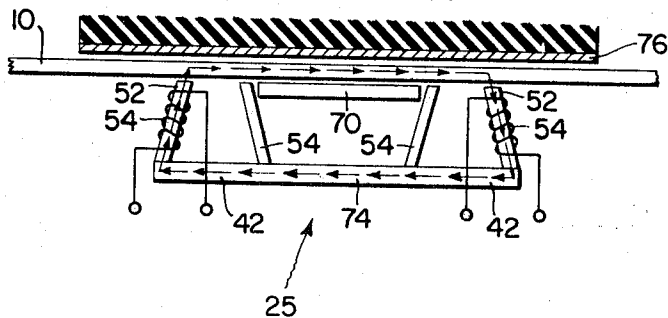


FIG. 11



INVENTOR
TOMMY N. TYLER

BY *Rockwood Martin*

ATTORNEY.

FIG. 13

A B C D E F G H I J K L M

a b c d e f g h i j k l m

N O P Q R S T U V W X

n o p q r s t u v w x

Y Z 1 2 3 4 5 6 7 8 9

y z

INVENTOR.
TOMMY N. TYLER

BY

Lockwood & Newton

ATTORNEY.

ALPHANUMERIC PRINTING DEVICE EMPLOYING MAGNETICALLY POSITIONABLE PARTICLES

The present invention relates to an alphanumeric printing device; and, more particularly, to an alphanumeric printing device which is capable of impactlessly printing preselected alphanumeric characters upon a specially adapted paper and which is capable of erasing these selected alphanumeric characters should an incorrect selection be made.

Alphanumeric printing devices, such as a common typewriter, are well known in the prior art. These typewriters require many moving parts, one for each alphanumeric character, and rely on the impact of the moving parts against a carboned belt to print an alphanumeric character upon a piece of paper. The prior art typewriters have a response time which is limited by the mechanical linkages therein. The time in which a completed document may be printed or typed is also limited by the number of errors made by the operator. More recent typewriters are provided with electromechanical arrangements which reduce the number of moving parts and thereby reduce the mechanical wear and the response time. However, these typewriters are also subject to component failure due to mechanical and electromechanical wear and the operator must continue to correct erroneously selected alphanumeric characters through the use of extra external equipment.

Accordingly, it is an object of the present invention to provide an improved alphanumeric printing device.

It is another object of the present invention to provide an alphanumeric printing device which is quiet, requires few moving parts, and does not rely upon impact to print an alphanumeric character upon a recording paper.

Still another object of the present invention is to provide an alphanumeric printing device which is capable of printing a plurality of preselected alphanumeric characters one line at a time.

A further object of the present invention is to provide an alphanumeric printing device wherein an alphanumeric character may be selected and, should that selection be incorrect, corrected without requiring stenographic accessories but relying wholly upon internal components of the alphanumeric printing device.

Still a further object of the present invention is to provide a simple alphanumeric printing device which requires few moving parts thus reducing mechanical wear and decreasing the response time thereof.

In accomplishing these and other objects, there has been provided a recording paper which is responsive to a force field and a force-field-generating head which generates a selected field pattern depending on the alphanumeric character to be printed upon the recording paper.

Other objects and many of the attendant advantages of the present invention will become apparent to those skilled in the art as a better understanding thereof is obtained from the following description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a perspective view, schematically showing the printing device of the present invention;

FIG. 2 is an enlarged cross-sectional view showing an embodiment of the recording paper utilized within the present invention;

FIG. 3 is a front view, showing a recording head of the present invention and the arrangement of its core elements;

FIG. 4 is a side view of the recording head of FIG. 3;

FIG. 5 is a side view, similar to FIG. 4, showing a second embodiment of the core elements of the recording head;

FIG. 6 is a perspective view, showing another embodiment of the recording head of the present invention;

FIG. 7 is a side view of the recording head of FIG. 6, showing the core elements thereof;

FIG. 8 is an enlarged perspective view showing a single core element useful within the present invention;

FIG. 9 is a perspective view, showing an alphanumeric printing device of the present invention;

FIG. 10 is a perspective view, showing a recording head and erasing head used in the alphanumeric printing device of the present invention;

FIG. 11 is a cross-sectional view, schematically showing the operation of the erasing head;

FIG. 12 is a perspective view showing another embodiment of the alphanumeric printing device; and

FIG. 13 is a tabulation, showing the alphanumeric characters which may be printed by the recording heads shown in FIGS. 3-8.

Referring now to the drawings, FIG. 1 shows the recording paper 10 including a substrate member 12 and field-sensitive web member 14, sensitive to a force field such as a magnetic or an electrostatic field. In the preferred embodiment of the present invention the web member 14 is sensitive to magnetic fields. Further, it will be understood that the present invention may be practiced without the substrate member 12 wherein the field-sensitive web member 14 forms a continuous, self-supporting web. The substrate member 12, when used, may comprise various materials such as plastic or paper. The utilization of the substrate member 12 within the present invention is useful to provide a surface upon which the field-sensitive web 14 may be spread. However, the substrate member is not essential to the present invention and the present invention may be practiced without the use thereof.

The field-sensitive web member 14 is formed from transparent material having tiny fluid-containing chambers 16 in which are suspended highly reflective flakelike particles 18. In the preferred embodiment, the chambers 16 are formed by encapsulating tiny droplets of fluid and particles 18 within individual capsules which are then coated upon the substrate 12. The flakelike particles 18 may be formed from paramagnetic or ferromagnetic materials such as iron, nickel or stainless steel; or from a combination of both magnetic and nonmagnetic materials such as nickel-plated aluminum. One of the important features of the particles 18 is that they are substantially flake-, disk-, plate-, or leaf-shaped and not acicular. The present invention shall refer to the particles as flakelike particles, but it is to be understood that this is a descriptive term and not meant to limit the flat, broad shape of the material. The recording paper utilized within the present invention is further described in a copending patent application by Dale O. Ballinger, Ser. No. 828,993, filed May 29, 1969 and assigned to a common assignee.

In FIG. 1, the recording paper 10 is utilized within an alphanumeric printing device indicated at 20. The recording paper 10 is unrolled from a supply roll 22 in the direction indicated by an arrow 24. The paper 10 is drawn under a trisectioned record/erase head 25, having the central section thereof arranged to mount a recording head 26. The record/erase head 25 is rotatably and slidably mounted upon a suitable carriage 28. Selection of the desired alphanumeric character is accomplished by a signal-generating keyboard 30 which applies a signal through an amplifier 32 to the recording head 26. Depending on the alphanumeric characters selected, predetermined core elements 34, as shown in FIG. 3, are energized for generating a magnetic field pattern. For example in FIG. 1, the proper core elements 34 have been energized to form the letter "A" upon the recording paper 10.

In FIG. 2, the operation of the recording paper 10 is more completely described. The magnetic field generated by the recording head 26 perpendicularly reorients the preoriented, highly reflective flakelike particles 18 within their encapsulating chambers 16. As described in the copending Ballinger application, Ser. No. 828,993, the reflective flakelike particles 18 are preoriented with the plane thereof parallel to the plane of the recording paper 10 for reflecting incident wavelengths of ambient light which strike the surface thereof to form a bright reflective surface thereon. The incident light is indicated at 38, while the reflected light is indicated at 40. In the area of reorientation indicated by "T," the reflective flakelike particles 18 cause the ambient light to be absorbed for forming a dark, contrasting trace upon the bright background surface of the recording paper 10.

The trisected record/erase head 25 includes a pair of erase heads 42 located on each side of the centrally arranged recording head 26. If an operator of the present invention were to select an incorrect alphanumeric character, the error may be corrected by selecting the next correct character and then depressing an error key 44 located on the keyboard 30. This causes the trisected record/erase head 26 to backspace and to rotate 90° for placing the erase heads 42 on each side of the incorrectly selected alphanumeric character. This rotational motion is achieved by a signal applied to a control motor 46 from the signal-generating keyboard 30. This signal also energizes a switching circuit 48 which then senses signals generated by the erase heads 42 as they move into position over the reoriented areas of the recording paper 10 on each side of the incorrectly selected character. The generated signals sensed by the erase heads 42 are created in much the same way a magnetic tape generates a signal within a playback head as the head moves across the magnetic tape. These signals are amplified by amplifier 50 and applied to the switching circuit for establishing which core elements 52 within the erasing heads 42 will be energized to erase the erroneously printed alphanumeric characters. The switching circuit 48 provides a signal to the erasing core elements 52 within the erasing head 42 that align themselves with the correctly printed alphanumeric characters. This signal generates a flux which passes through the recording medium for reorienting the reflective flakelike particles 18 into a plane parallel to the plane of the recording medium. This removes the erroneously selected alphanumeric character. The trisection record/erase head 25 is then returned to its operating position and the correct character is printed upon the recording medium 10. The erasing operation will be explained in further detail hereinbelow with reference to FIGS. 10 and 11.

Referring now to FIGS. 3-8, the structure of the recording head 26 will be described. The preferred embodiment of the recording head consists of 16 core elements 34 including eight arranged on a rectangular periphery about a second set of eight which radiate from the center of the rectangle along the diagonals and through the centers thereof. As shown in FIGS. 4 and 5, each core element 34 is provided with its own coil 54 which is energized by a pair of input terminals 56. An input signal applied from the amplifier 32 to the input terminals 56 creates a flux within each core element 34 which is utilized to reorient the preoriented magnetic flakelike particles 18 contained within the recording paper 10. FIG. 5 illustrates a recording head wherein the core elements 34 have been relieved to receive the coils 54. In FIG. 6, a recording head encapsulated within a suitable potting compound and arranged with a height-to-base ratio of 2:3 is shown. Input signal wires 57 are provided wherein the number required between the input terminals 56 and the core elements 54 may be reduced by utilizing one signal common wire and 16 signal wires.

In order to generate a flux pattern which is substantially perpendicular to the plane of the recording medium 10, it is necessary to provide an air gap 60 for directing the flux into the recording medium, as shown in FIGS. 7 and 8. In FIG. 7, the core elements 34 consists of a pair of generally straight core members 58 which are separated by the airgap 60. The coil 54 includes a pair of coil members 62 wound in opposite directions upon each of the core members 58. In this manner, a current passing through the coil members 62 generates an adding flux in opposite direction within each of the core members 58 which is passed through a back gap spacer 64 and out of the front airgap 60 as illustrated in FIG. 8. In FIG. 8, an alternate winding method for the coil members 62 is shown. Here, the coil 54 is wound in the shape of a figure-eight upon the core members 58 for creating two oppositely wound coil members 62 which generate a flux through the core members 58 forming the core element 34. The flux exits the front surfaces of the core members 58 around the airgap 60 shown by the arrows 66.

A preferred embodiment of the present invention is illustrated in FIG. 9 in the form of a typewriter 68. The recording paper 10 may be inserted as a separate piece of paper, as is

well know, or may be supplied from a supply roll 22, as discussed hereinabove. One advantage of the present invention is that an operator of the typewriter 68 may correct a mistake by simply energizing the error key 44, as briefly described hereinabove. This key causes the recording head 26 to backspace and rotate 90° for placing the incorrectly typed alphanumeric character adjacent a central shield element 70, as shown in FIG. 10. It will be seen that the trisected record/erase head 25 consists of a generally rectangular solid whose central recording head 26, including core elements 34, is disposed on one surface and whose erasing heads 42, including core elements 52, are disposed on a second surface 90° from the recording head.

As the recording paper 10 responds to external magnetic flux for reorienting the highly reflective flakelike particles 18 contained therein, any flux pattern utilized to erase an erroneously recorded alphanumeric character will also create a reorienting effect at the points where the flux enters and exits the recording paper. Thus, the procedure of erasing an erroneously typed alphanumeric character is complicated by the fact that an erasing field will make undesired erasures on the recording paper 10 unless provisions are made to prevent or minimize the problem. The present invention avoids this problem by providing a unique erasing arrangement. After making an error, the operator types the next correct alphanumeric character desired before depressing the error key 44. The record/erase head 25 then backspaces to align the recording head 26 with the erroneously selected alphanumeric character. Once aligned, the record/erase head 25 rotates 90° for placing the erase heads 42 on each side of the switching circuit 48. The core elements 52 within the erase head sense which portions of the recording paper 10 has been preoriented and generate a signal through the amplifier 50 to the switching circuit 48. As the erase heads complete their rotation and lock into position, the switching circuit 48 energizes those core elements 54 located over the previously recorded portions of the recording paper 10 on each side of the error and applies a signal thereto through an amplifier 72, FIG. 1. While only one amplifier 72 is shown, it should be understood that each core element is provided with its own amplifier and only those core elements sensed by the switching circuit 48 are energized to generate the erasing signal. This erasing signal enters the recording paper 10 through the portions thereof which have been previously reoriented to establish the desired characters on each side of the error. Thus, the area through which the erasing flux enters the paper will not be erroneously marked. The flux signal then passes parallel to the recording paper 10 for reorienting the magnetic, reflective flakelike particles 18 contained therein into a plane parallel thereto. As described hereinabove, this creates a light and bright reflective background upon the recording medium. After erasure, the record/erase head 25 is returned to its operating position and the desired alphanumeric character is printed by the core elements 34 of the recording head 26.

Referring now to FIG. 11, the construction of the erasing heads 42 will be described in greater detail. For example, if an operator wished to type the word "injoined" and then erroneously typed "im" in place of "in," the operator continues by typing the "j" and then depress the error key 44. The record/erase head 25 then backspaces two spaces and rotates 90°, sensing the typed letters "imj" as it rotates into its erasing position. The switching circuit 48 then energizes the core elements 52 which correspondent to the vertical core elements utilized to type the letters "i" and "j" on each side of the erroneous "m." It should be noted here that the erase heads 42 are not provided with horizontal core elements 52. The reason for this is that it is desired to generate a flux field between the erase heads and it is therefore unnecessary to utilize the horizontal core elements. After the switching circuit 48 selects the proper core element 52 to be energized, the coils 54 associated therewith are energized for generating a magnetic flux within each core element. All core elements in one erase head 42, for example the left hand are wound to generate a

flux in one direction while all core elements in the second erase head 42 are wound to generate a flux in the second direction. A back flux-conducting bar 74 is provided between each of the erase heads 42. This flux-conducting bar serves to conduct the flux from the core elements of one erasing head to the core elements of the second erasing head 42. The flux enters the recording paper 10 in an area where the desired alphanumeric characters have already been printed. The flux is then conducted through the recording medium in a plane parallel thereto for reorienting the magnetic reflective flakelike particles 18 by the action of the shield element 70.

The shield element 70 is formed from a material having a low permeability and a high reluctance. This diamagnetic material causes the flux to be retained within the recording medium 10 between the shield element 70 and a paper cylinder 76 of the typewriter 68. The paper cylinder 76 is also coated with the diamagnetic material which may be a layer of bismuth formed from vacuum-depositing the metal upon a substrate. It will be noted that the paper cylinder 76 in a prior art typewriter is coated with a layer of a hard rubber. However, one advantage of the present invention is that the printing of the alphanumeric characters is achieved by an impactless arrangement. Therefore, the paper cylinder 76 may be formed from the metal bismuth without creating a mechanical problem. Once the erasing process has been accomplished, the trisection record/erase head 25 is rotated 90° back to its original position. Shield elements 78, similar to shield 70 are provided on each side of the recording head 26 to further limit the flux pattern generated thereby. This serves to protect the previously recorded alphanumeric characters during the operation of the recording head 26.

It will be noted by those skilled in the art that the erasing head just described is limited in its function. For example, if an error were made in the last letter of a word which forms the last word of a sentence, the operator would be unable to place an alphanumeric character opposite the erroneously typed character to provide an entrance for the flux which is necessary to erase the error. In this situation, erasing may be accomplished by providing an erasing head with a wider spacing wherein the operator may place a desired new character at a greater distance from the erroneously typed character to provide an entrance for the erasing flux. A second arrangement for erasing the erroneously typed character is to return the trisection record/erase head to the beginning of the line, rotate it to the erasing position, and allow it to sweep the full line while generating an AC signal within the erase heads 42. This arrangement provides a flux within the recording paper 10 which reorients the reflective flakelike particles in a plane parallel to the plane of the recording medium. The reason for this is that there are apparently very few flux components generated perpendicular to the recording medium as they tend to be made smaller and smaller by the AC signal as the erasing heads move thereacross. This reduces the number of reflective particles 18 oriented perpendicularly to the recording medium for retaining the highly reflective background surface thereof.

In FIG. 12, a further embodiment of the present invention is shown wherein the signal generating keyboard 30 is replaced by a computer 80. Generally speaking, a computer will not create printing errors; and, therefore, the present invention lends itself to full line printing by establishing a head having a plurality of recording heads 26 arranged in a side-by-side relationship, one for each character to be printed upon a line of the recording paper 10. Due to this, the typewriter 68 is provided without a keyboard or an erase key. A plurality of recording heads 26 is arranged opposite the paper cylinder 76 which is controlled by a computer input 82 for rolling the recording paper 10 off the supply roll 22. It will be observed here that the paper cylinder is the only moving component within the typewriter 68. The information stored within the computer 80 is applied over input lines 84 to the typewriter which selectively energizes the core elements 34 within each recording head 26 for placing alphanumeric characters upon the recording paper 10 one line at a time.

Referring now to FIG. 13, a set of alphanumeric characters has been tabulated to illustrate the alphabet and the numbers 1 to 9 which may be formed by the recording head 26 of FIG. 6. It should be noted that all uppercase letters and the numbers may be printed by the recording head 26 as illustrated in FIG. 6. The majority of the lowercase letters may also be reproduced by the recording head 26 shown in FIG. 6. However, the lowercase letters "g, j, m, n, p, q, z, and y" must be typed by shifting the recording head 26 down one-half space prior to energizing selected core elements 34 thereof. Further, in order to type the lowercase letter "k" it is necessary to shift the recording head 26 one-half space beyond its normal spacing sequence. Finally, in order to type the lowercase letter "x," it is necessary to first energize one lower diagonal core element 34 of the recording head 26, space the recording head one-half space, and then energize the second lower diagonal core.

The alphanumeric characters tabulated in FIG. 12 are representative of one of several possibilities, and it will be understood by those skilled in the art that other combinations are possible within the teachings of the present invention. Further, it will be obvious to those skilled in the art that the erasing procedures set out hereinabove is but an illustration of one of many possibilities and it is not intended to limit the scope of the present invention simply to the arrangement discussed hereinabove. It will be seen that the present invention accomplishes the object of providing a recording medium upon which alphanumeric characters may be printed and erased therefrom without requiring separate stenographic equipment. Further, it will also be seen that this erasing procedure set out herein may be accomplished through a simple operation which will maintain the neat formal appearance of the characters being printed upon the recording paper.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An alphanumeric printer comprising:

a supply of force-field-responsive paper;

said force-field-responsive paper including reflective, force-field-responsive, and flakelike particles preorientated in parallel with a plane of said paper for forming a uniform background thereon with respect to incident light; said flakelike particles being magnetic particles;

force-field-generating means for generating a magnetic force field in the shape of a predetermined alphanumeric character in juxtaposition with said force-field-responsive paper;

keyboard input means connected to said force-field-generating means for selecting said predetermined alphanumeric character;

said reflective flakelike particles preorientated on said magnetic force field responsive paper being arranged to reorient in response to said generated magnetic force field for forming a contrasting trace upon said uniform surface of said paper by altering the response of the surface of said paper with respect to the incident light thereon, said contrasting trace taking the form of said selected alphanumeric character; and

erasing means for generating a magnetic force field capable of orientating said reorientated reflective flakelike particles back to the first-mentioned preorientated position in the event an error is made in selecting said predetermined alphanumeric character;

said erasing means comprising:

switching circuit means;

means within said keyboard input means for energizing said switching circuit means;

erasing head means for generating sensing signals in response to previously recorded alphanumeric characters;

means connecting said erasing head means to said switching circuit means for receiving said generated sensing signal within said switching circuit means; and

means connecting said switching circuit means to said erasing head means for applying an erasing signal thereto in accordance with said received sensing signals.

2. An alphanumeric printer as claimed in claim 1, additionally comprising:

said erasing head means including a pair of erasing heads having a common paper-facing surface arranged on each side of said magnetic-field-generating means;

core elements arranged within said erasing heads and exposed on the paper facing surface thereof;

said pair of erasing heads sensing a correctly printed alphanumeric character on each side of an incorrectly printed character and generating said sensing signals accordingly; and

said switching circuit means applying said erasing signal to said core elements deposited adjacent said correctly printed alphanumeric character for creating a flux pattern through said magnetic-field-responsive paper and erasing said incorrectly printed character therebetween.

3. An alphanumeric printer as claimed in claim 2, addi-

tionally comprising,

said magnetic-field-generating means including a recording head having a paper-facing surface thereon;

said paper-facing surface of said recording head and said paper-facing surface of said erasing heads angularly disposed to each other;

flux-conducting means joining the core elements of said erasing heads opposite the paper-facing surface thereof;

said erasing heads having coil means wound upon the core elements thereof to generate a flux in one direction within the first erasing head of said pair and to generate said flux in the other direction within the second erasing head of said pair for passing said flux through said first erasing head, said magnetic-field-responsive paper, said second erasing head, and the through said flux-conducting means thereby orienting said magnetic flake-like particles within said magnetic-field-responsive paper parallel to the plane thereof and erasing any alphanumeric character printed therebetween.

* * * * *

25

30

35

40

45

50

55

60

65

70

75