United States Patent

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[23] **Continuation-in-part of Ser. No. 692,928, Dec. 22, 1967, abandoned.**
[45] Patented **July 20, 1971**

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[54] **KEYBOARD INPUT DISPLAY DEVICE**
4 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** ..... **197/1 R,** 101/1, 101/DIG. 13
[51] **Int. Cl.** **B41j 3/00**
[50] **Field of Search** 101/DIG. 13; 197/DIG. 4

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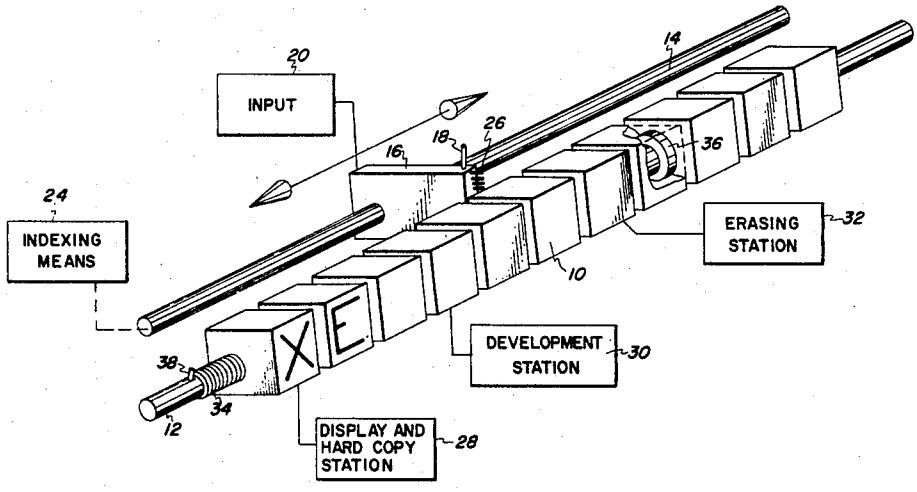
ABSTRACT: A plurality of multifaceted single character display elements, each of which is independently rotatable to printing, development, display-hard copy, and erasure stations in response to a keyboard input, is disclosed. The use of single character display elements together with resilient spacing means between each element makes possible line justification prior to making a hard copy.



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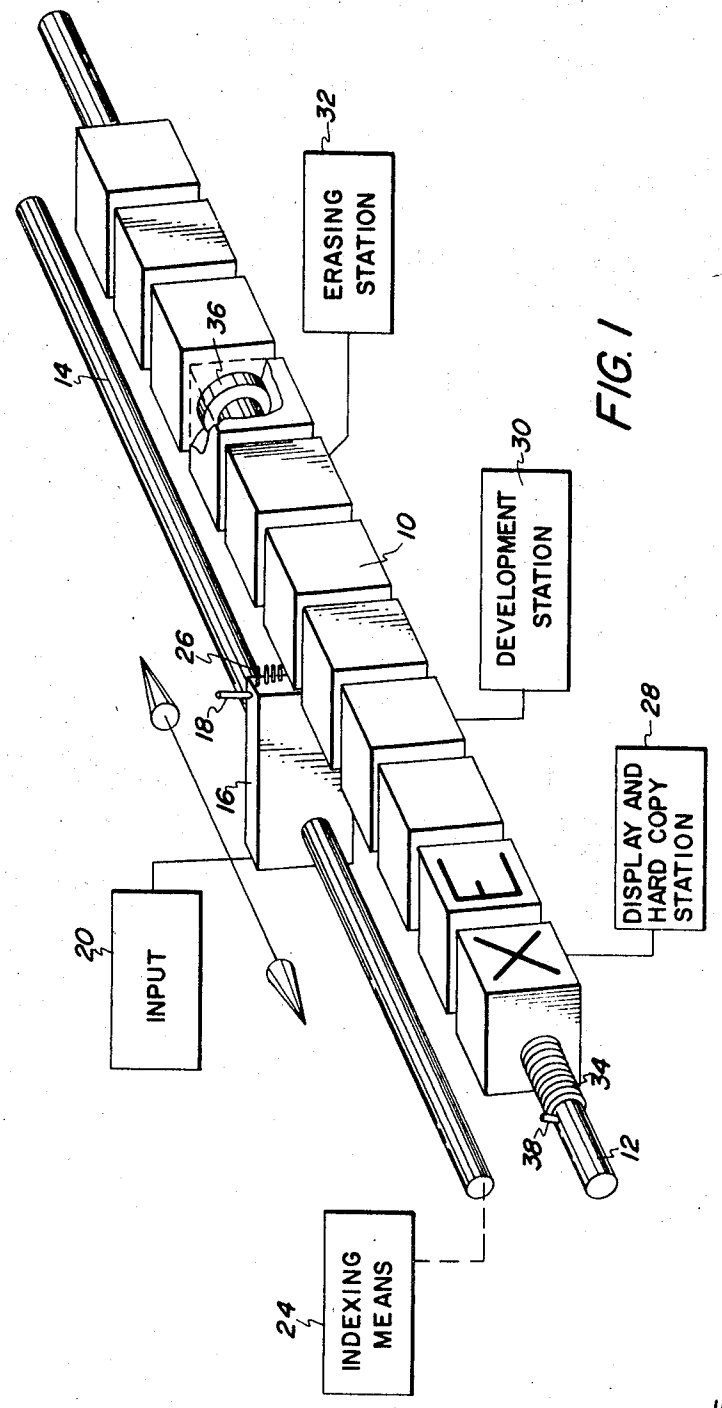

FIG. 1

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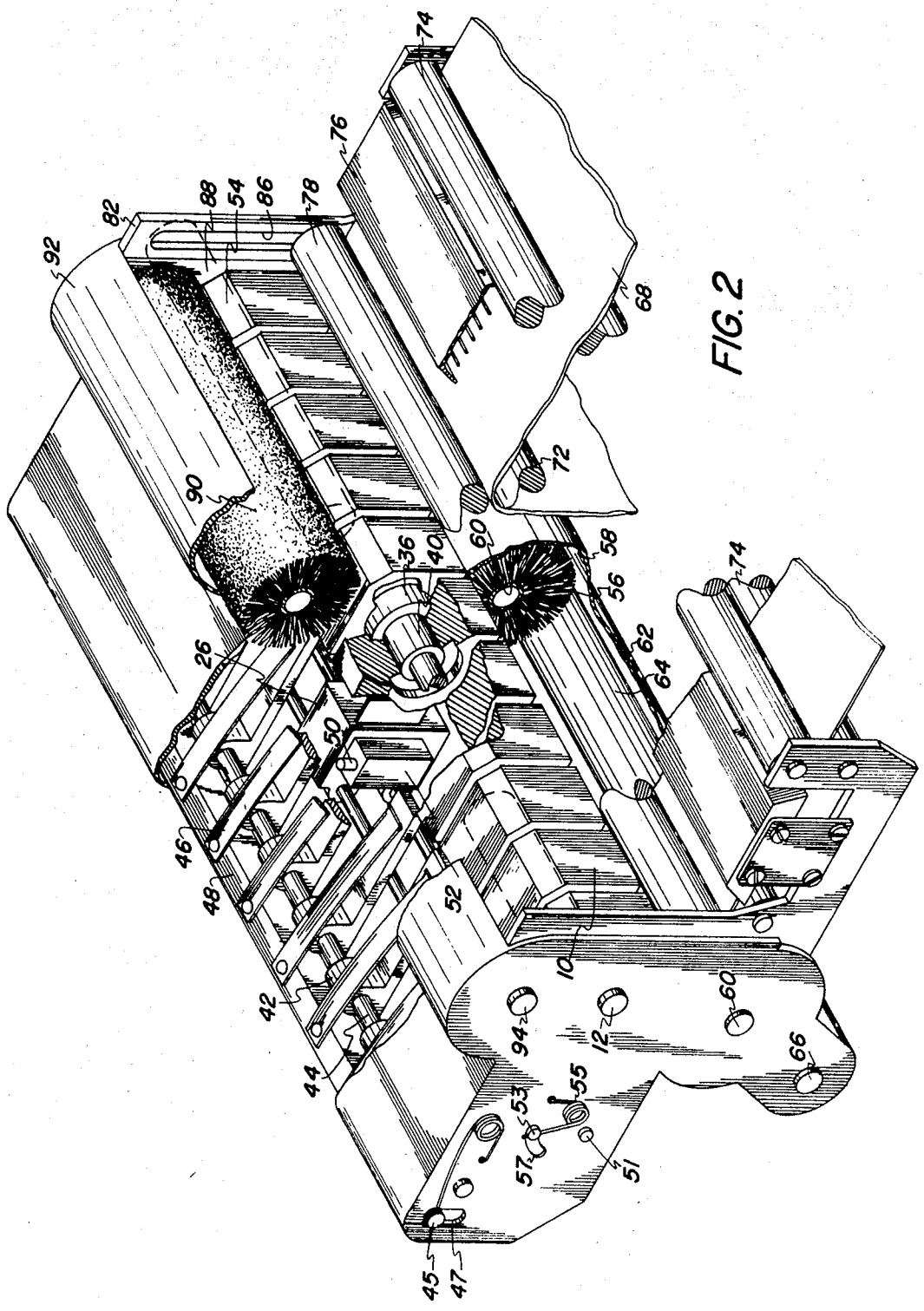
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FIG. 2

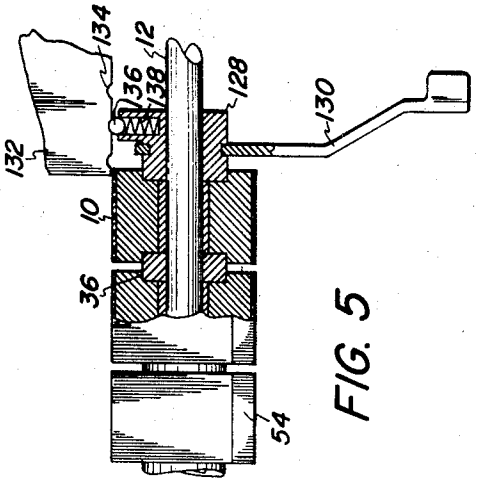

FIG. 5

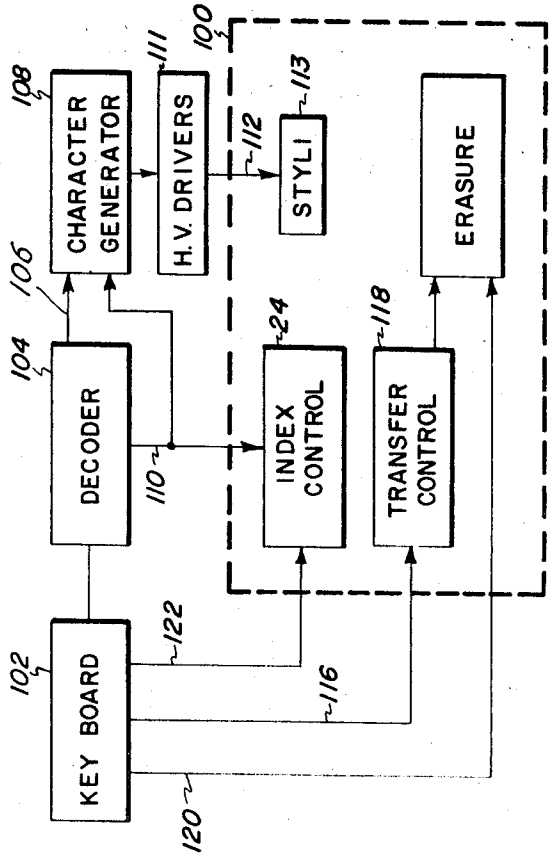

FIG. 4

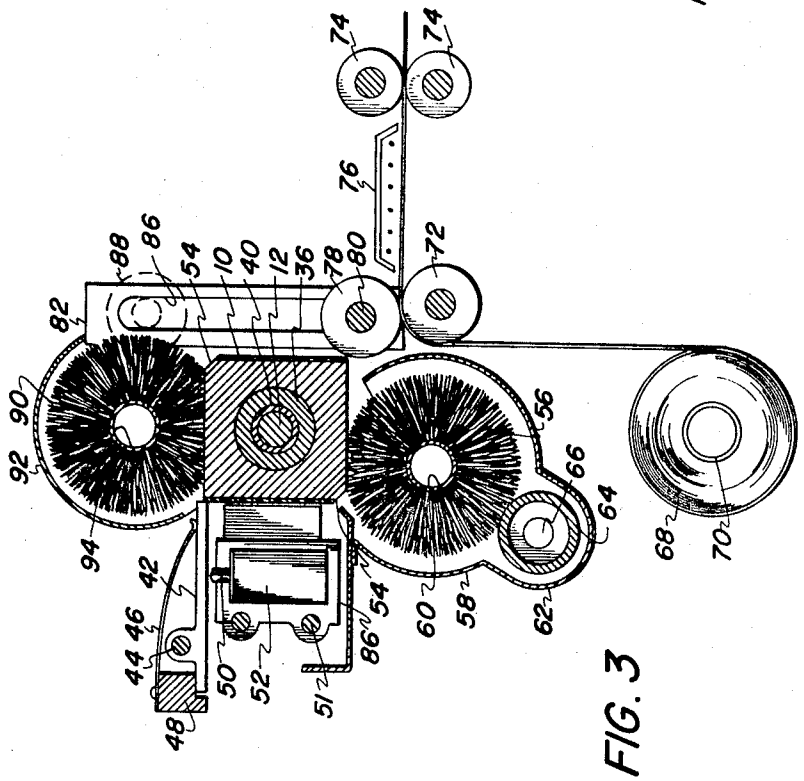

FIG. 3

KEYBOARD INPUT DISPLAY DEVICE

CROSS-REFERENCE TO OTHER APPLICATIONS

This application is a continuation-in-part of application Ser. No. 692,928, filed Dec. 22, 1967, the printing to The printing same assignee as the present application, and now abandoned.

BACKGROUND OF THE INVENTION

In general, the present invention relates to display devices and more specifically to a system for the display of alphanumeric information.

The present invention may find use as a date output display device, an electrostatic typewriter, or as a composing device for short run printing operations.

The prior art in this area has involved the use of optical projection devices which require large local external memories and switching matrices. In addition to being overly complex for the job to be done, these devices have been costly. Cathode-ray tube systems do a generally adequate job, but at a high cost. A great deal of difficulty has been experienced in obtaining a hard copy output from the prior art systems which has justified lines without extremely complex computer control of the output. In addition, the ability to view the output as it is produced and to correct any errors before the creation of a hard copy output has been extremely limited.

Accordingly, it is an object of the present invention to provide a new, simple, and highly effective output display device and method which overcomes the deficiencies of the prior art as described above.

It is a further object of the present invention to provide a display device in which the last character formed may be viewed immediately after its formation for error correction.

Another object of the present invention is to provide a display device in which it is possible to justify a line before transferring it to a hard copy.

Other objects in a fuller understanding of the invention may be had by referring to the following description in claims when read in conjunction with the accompanying drawing.

SUMMARY OF THE INVENTION

The present invention overcomes the deficiencies of the prior art and achieves the objectives by providing a plurality of multifaceted single character display elements together with resilient spacing means between each element to make possible line justification prior to the making of a hard copy. The rotation of each element independently to the printing, development, display-hard copy, and erasure station coupled with a backspacing capability makes possible substantially instant viewing of a character after its formation and error correction, when desired.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to facilitate the understanding of this invention, reference will now be made to the appended drawings of two embodiments of the present invention. The drawings should not be construed as limiting the invention but as exemplary only. In the drawing:

FIG. 1 is a perspective view of one embodiment of the present invention with certain parts illustrated in block form;

FIG. 2 is a perspective view of another embodiment of the present invention with some parts broken away and showing parts which may be used with the embodiment illustrated in FIG. 1;

FIG. 3 is a cross-sectional view of the embodiment illustrated in FIG. 2;

FIG. 4 is a block diagram of an electronic control circuit which may be used both embodiments of the present invention; and,

FIG. 5 is a sectional view of the line justification apparatus of the present invention.

DESCRIPTION OF THE EMBODIMENTS OF THE PRESENT INVENTION

One embodiment of the present invention is shown in FIG. 1 in which a plurality of multifaceted single character display elements are shown as cubes **10**.

While, for simplicity, cubes **10** will be referred to throughout as the preferred embodiment of the multifaceted single character display element, it is clear that other polygonal elements having **5**, **6**, or **8** sides, etc. may be employed to permit any desired arrangement of separate corona charging, imaging, toning, display, transfer, storage, hard copy, and erasure stations.

The cubes **10** are individually free to rotate around cylindrical shaft means **12** and thus may present any one of their four sides to the front display and hard copy station **28** for viewing, projection and/or the formation of a hard copy. Each of the cubes **10** is faced on the four sides in planes parallel to the central shaft **12** with a dielectric layer on which a character pattern may be generated, toned, and erased, as desired.

Alternatively, the faces of cubes **10** may be coated with a photoconductor which may be charged and locally discharged in image configuration by optical character masking means as well known in the art. In any case, the basic cube may be of a conductive material.

An electrographic printing head **26** indicated by the plurality of electrographic recording styli constitutes the preferred embodiment of the printing means. The printing head **26** is common to all of the cubes **10** and traverses along cylindrical shaft **14** to print out the input message on the plurality of cubes **10** under the control of a suitable keyboard indexing means **24** or the like. This will be described in more detail hereinafter. The indexing means **24** normally causes the printing head **26** to progress one step at a time but spacing and backspacing keys are available to produce these operations.

The electrographic styli of printing head **26** may be in a seven pin linear array for a printout utilizing five or more indexing steps per cube, or may be a 35 pin matrix.

In the alternative, the electrographic printing head may be a rotatable wheel or cylinder with fully formed characters thereon. It is, also, possible to employ various ink deposition devices, a golf ball printing head, or a chain printer which transfers an image from a ribbon.

As will be seen in connection with the description of FIG. 4, the input means **20** is preferably a keyboard input device for low speed operation, however, it may also be a data link from a computer or the like. The information to be printed will normally be derived from the output of the keyboard one character at a time and in general is assumed to be presented to the printing head **26** one character at a time although the binary bits within a character may be in either parallel or series form.

Attached to the printing head **26** is a cursor **18** to aid in showing the operator the entry position. Such a cursor **18** is particularly useful in backspacing and error correction operations.

Printing head actuator means **16** is mounted to travel with the printing head. Means may be provided, as set forth hereinbelow with reference to FIGS. **2** and **3**, to rotate each cube through a toning position at development station **30** to a viewing position at the display and hard copy station **28** immediately after the imaging operation.

Stop means **38** together with resilient means **34** and interelement resilient means **36** make format control possible by enabling individual character elements to be separated to completely fill any desired line length. The resilient means **34** and **36** may be springs or other resilient elements. In the alternative, air wedges or similar means may be employed to control spacing. This is described in more detail in connection with FIG. **5**.

The development station **30** comprises means to render visible for display the latent image, if any, produced by the printing means **26**. It consists of means well known in the xero-

graphic and electrographic arts for the development of latent electrostatic images and any of the typical well-known techniques such as a fur brush, magnetic brush, cascade, or powder cloud development may be employed. A suitable arrangement is seen in greater detail in FIGS. 2 and 3.

At the display and hard copy station 28 the toned image may be transferred to paper or to an offset roll for later transfer to a hard copy medium. In addition to direct viewing, the image may be projected and if necessary inverted or reversed by an optical system in conformity with the transfer operation being employed and the configuration of the image on the cubes 10.

The erasing station 32 comprises an erasing device for removing or neutralizing the electrostatic charge pattern on the surface of a cube 10 for error correction or to otherwise prepare the surface for reimaging. In addition to an element suitable for erasing a single cube 10 the erasing station may comprise a means sufficient to erase an entire line at a time prior to rotation of the cubes 10 to the printing position for reimaging.

The transfer and erasure stations are shown in greater detail in FIGS. 2 and 3 which will be described hereinafter.

In operation, input data from a keyboard input unit 20 or the like is fed to a printing head 26 which deposits an electrostatic pattern of charge or otherwise marks the face of cube 10 which is in the printing position in a single character configuration. Means may be provided, as described hereinbelow with reference to FIGS. 2 and 3, to rotate the cube 10 just printed to the development station position 30 as the printing head 26 is indexed to the next cube 10 on which it is desired to print. The most recent character is in each case displayed for error checking and correction, if desired. Correction is made possible by the provision for backspacing and erasure of individual characters.

Data enters at the normal left edge and writing progresses to the right as viewed at the display station with each one of the faces of the cube being made visible to an observer in turn. The provision of separate cubes 10 each displaying a single character and separated by resilient means 36 makes possible line justification for any desired length of line in excess of the physical dimensions of the cube array employed. Following the completion of these operations the cubes 10 may be rotated to the erasing station 32 where they are prepared to receive new data when rotated again to the printing station.

Reference will now be made to FIGS. 2 and 3 which illustrate another form which the present invention may take and also illustrate the developing, hard copy transfer, and erasure stations compatible with the embodiment previously described in connection with FIG. 1. As shown there are a plurality of cubes 10 fixed for rotation with shaft 12 by way of a frictional coupling collar 40 unless the cubes are restrained from rotation. During the recording and display mode they are restrained from rotation by means of a plurality of detent arms 42 which act to engage the upper left-hand corner of the cube 10 prohibiting it from turning with shaft 12. These detent arms 42 may be mounted pivotally on a shaft 44 and spring loaded by way of a leaf spring 46 which maintains the detent arms in a restraining position unless activated as will be described hereinafter. A support member 48 also serves as a stop surface for the detent arm and as a support also for the leaf spring 46. From this description it will be appreciated that when the detent arm 42 is rotated in a counterclockwise direction as used in FIG. 3 about shaft 44 cube 10 will be able to rotate in a counterclockwise direction with shaft 12.

The manner in which the detent arm may be actuated is by means of an armature element 50 which is moved by the action of a solenoid 52 mounted on the printing head 26. Several methods may be used to actually energize the solenoid. It may be done manually from the keyboard by the depression of a suitable key which simply sends a pulse to the solenoid. Alternatively, it may be automatically actuated by suitable control circuitry which is to be initiated at the completion of the recording of a character on a particular cube 10. The width of the detent arm in the direction of the recording is large enough to permit a wide latitude of actuation timing of solenoid 52.

As shown in FIGS. 2 and 3, each cube 10 has had two opposite edges 54 beveled so as to avoid interference with the detent arm 42 in its restraining position. This permits each cube when its associated detent arm is raised to rotate 180°. As noted in connection with the embodiment of FIG. 1, there are associated with the array of cubes 10 a development station, a display-hard copy station, and an erasure station. These will now be described in greater detail.

As shown best in FIG. 3, a fibrous applicator 56 in the form of an elongated cylinder is mounted in a housing 58 to be driven into rotation by motive power from a source not shown but applied to its support shaft 60. A sump is formed at 62 in the housing 58 to accommodate a quantity of electroscopic marking particles which are conveyed to the applicator 56 by a suitable donor roller 64 associated with a drive shaft 66 to which suitable rotative power may be supplied. The applicator 56 may be made, for example, form either natural fur or synthetic fibers having that particular triboelectric relationship to be used as an electroscopic developing means. The housing 58 assists in keeping the electroscopic marking particles within the developing station. As shown in FIG. 3 the cube 10 interferes with the periphery of the applicator 56 and if this cube 10 was to rotate 180° in a counterclockwise direction, it can be seen that the facet opposite the printing head 26 would be brought into developing contact with the applicator as it revolves in housing 58. In this manner, the latent electrostatic images placed on that facet of the cube 10 will be rendered visible by the transfer of such marking particles from the applicator 56 to the surface thereof.

As the cube 10 rotates its 180° the developed image will end up at the display station which also represents the hard copy station. FIG. 3 as well as FIG. 2 illustrates a supply roll 68 of recording medium supported on a pulley 70 which forms a web around an idler roller 72 and through two pinch rollers 74. Between idler roller 72 and pinch roller 74 there is positioned adjacent the path of the web a suitable fusing station 76 which may comprise a plurality of resistance heating wires of suitable design for fusing electroscopic marking particles into the fibers of the recording web.

As shown in FIGS. 2 and 3 there is a transfer roller 78 mounted for rotation on a fixed shaft 80. This transfer roller is shown in its transfer position so as to pinch the recording medium between the transfer roller 78 and the idler roller 72, prior to the webs entry to the fusing area. Two slotted brackets 82 are positioned at both sides of the array of cubes 10 and provide a guiding effect by way of the slots 86 for the transfer roller 78. The broken lines illustrate the alternate position of the transfer roller 72 and have been given the reference numeral 88. In this position the surface of the transfer roller is in contact with another fibrous cylindrical member 90 which constitutes the erasure means suitably housed in a housing 92. This erasure means is supported for rotation about a shaft 94 which is driven from a suitable source of motive power not illustrated.

The transfer roller is free to rotate about its shaft 80 and will rotate freely under the influence of the rotating erasure brush 90. In this manner, the entire periphery of the transfer roller is cleaned by the erasure brush 90. The transfer cycle preparatory to creating a hard copy of the displayed information may be initiated by depressing a special key on the keyboard to be described. This may cause a suitable transfer bias voltage to be applied to the transfer roller which in turn is caused to begin its movement down through the viewing station guided by the slots 86 in the brackets 82. The transfer roller being free to rotate about its axis is moved in slight interference with the image area of the cubes and thus as it rolls down the cube's face without slipping most of the developed image will transfer from the cube to the transfer roller. This is a result of a combination of mechanical surface forces and the attraction of the biased voltage on the transfer roller itself. At the end of the

traversal of the transfer roller, it comes into contact with the recording medium supported by the idler roller **72**. Appropriate limit switches may be incorporated as is well known in the art to react to the end of traversal of the transfer roller to energize the pinched rollers **74** drawing the recording medium over the idler roller **72**. This movement in the recording medium also causes the transfer roller to roll in contact with it. This same limit switch may also serve the purpose of reversing the bias voltage on the transfer roller causing the transferred image to transfer from the roller to the recording medium. The relation between the transfer roller's circumference and the distance the roller travels is selected so that each line transfers to the web in proper registration relative to the previous line. After transfer, but before the next line is composed, the transfer rollers return to the erase position as shown by the broken lines to await the next transfer. At this point, a limit switch may again be used to control the potential on the roller.

After the hard copy transfer cycle is completed it is necessary to erase the residual images remaining on the face of cubes **10**. This is accomplished simultaneously with the erasure of any residual image on the transfer roller **78** by the effect of the erasure brush **90** rotating on its shaft **94**.

By the suitable depression of the proper key of the keyboard, the detent arms may be uniformly actuated to permit the cubes to rotate another 180° back to their original position. During this rotation, the erasure brush **90** is in operation and sweeps the surface clean of any residual marking particles as well as neutralizing the charge triboelectrically that remained on the recording surface of the cube **10**.

Additionally, the erasure brush **90** may include conductive fibers which are grounded to act as a discharge path for any residual charges on the cubes **10**.

It is noted that suitable mechanical means may be provided for actuating all the detent arms **42** at the same time which may be actuated from the keyboard.

This can be accomplished simply by energizing an appropriate lever to momentarily depress shaft **45** in slot **47** as shown in FIG. **2**. Shaft **45** is integral with stop member **48** for detent arms **42**. As can be seen in FIG. **3**, such a depression will pivot all the detent arms about their support shaft **44** releasing all the cubes for rotation at one time. In the alternative, each cube may be erased individually as information is recorded on another recording surface opposite the originally recorded surface. In this way each cube may be erased during the time that the new recorded information is developed and presented to the display station.

After the transfer of the developed image from the transfer roller **78** to the recording medium **68**, the pinch rollers **74** will eventually pull the transferred image now on the recording medium under the fuser **76** to make the image permanent on the insulating medium.

Having described the mechanical structure of the recorder and display device of FIGS. **1** and **2** of the present invention, one possible way of controlling this system will be described with reference to the block schematic of FIG. **4**. What has been described as the recorder or printer is represented basically by the suitably labeled block **100**. The input to the printer originates, for example, from a conventional keyboard **102** which may generate an appropriate binary code uniquely identifying the alphanumeric symbol corresponding to the actuated key of this keyboard.

This binary code, such as used in the American Standard Code for Information Interchange, is provided to the input of a conventional decoder circuit **104** which decodes the binary code to generate a character pulse on one of a series of parallel outputs indicative of the alphanumeric symbol selected at the keyboard **102**. Output conductor **106** is intended to represent a number of outputs each of which would correspond to a separate alphanumeric character in the particular alphabet incorporated in the keyboard **102**.

These outputs collectively provide one input to a character generator **108** which may take various conventional forms. As an example only, generator **108** may consist of a diode matrix having a number of character select input wires which corresponds to the outputs of the decoder circuit **104**. These wires are selectively coupled to readout wires via diodes which are forward biased when their respective character select wire is energized. Another form which the character generator may take is a magnetic core matrix, having five columns and seven rows, wherein a particular character select wire associated with one of the outputs **106** intertwines an appropriate pattern of magnetic cores corresponding to the alphanumerical symbol to be recorded. The character generator as well as the other parts of the block diagram of FIG. **4** are not intended to from a particular part of the present invention per se and therefore are shown schematically only since will known conventional circuits may be used to provide their functions.

Output **110** from the decoder **104** simply provides a signal indicative of the fact that a binary code has been decoded in the decoder **104**. In this manner, for each character entered at the keyboard **102** which effects a decoding process in the decoder **104**, an output signal will be generated on conductor **110**. This effectively provides a control pulse to the character generator which may initiate, for example, in the case of a magnetic core matrix, a distributor circuit which would sequentially readout each column of the core matrix at a rate correlated to the speed of the styli movement. As each column is sampled by the distributor circuit, a group of parallel outputs would be energized depending on the cores set by the character select wire. The signals on these parallel outputs would be supplied to a suitable driver stage **111** which would provide parallel recording signals to the styli array **113** via output **112**.

The manner in which the signals are supplied to the recording styli as well as to solenoid **52** may be by way of a flexible cable containing the necessary leads.

Additionally, the signals present on output **110** of the decoder **104** are supplied to an index control **24** which may include a one revolution clutch or a stepping motor. The pulses at output **110** would then either engage the clutch or activate the stepping motor for a period of time necessary to move the stylus array distance sufficient to record one character on the face of one of the cubes **10**.

As will be appreciated, the printing head **26** in FIGS. **1** and **2** may be reciprocated through the recording zone by several conventional techniques. One such technique would use a stepping motor coupled to the shaft of a pulley about which is entrained a drive cord having two ends, each coupled to one side of the printing head **26**. A spring return system can be used to retrace the head back to its initial point. Such drive arrangements are well known in the arts. For example, the system disclosed in U.S. Pat. No. 3,300,017, which issued Jan. 24, 1967, in the name of Z. Yazejian et al. would accomplish the proper printing head control.

Furthermore, during such retrace it may be desirable to move the conductive recording styli from contact with the cubes **10** when electrography is the recording technique used. This also has many conventional implementations, one being simply to pivot the printing head **26** about a point prior to the retrace movement. In FIG. **2**, such a point may be the axis of guide shaft **51**. Suitable cam arrangements can be made to move the other guide shaft **53** against the bias of spring **55** and along slot **57** to accomplish this.

Additional keys on the keyboard **102** may control other stations of the present invention. For example, one key, a transfer key, may energize output **116** to supply signals to the transfer control **118** which will activate a clutch or motor to begin the hard copy transfer operation already described. This same key can also energize the erasure brush **90** at the option of the designer or the erasure station may be allocated a separate key, or both. Therefore, output **120** may independently control the erasure station.

While being controlled by the decoding operations, the index control may also be independently controlled by the keyboard for spacing or backspacing via output **122**.

As was noted hereinabove, keys may be provided on keyboard **102** for independently actuating solenoid **52** for cube rotation and for depressing shaft **45** to rotate all the cubes simultaneously.

The correction operation in case a wrong character is recorded may be accomplished in the manner to be described. The print head **26** can be backspaced one character by depressing the appropriate key on the keyboard **102**. The print head is then positioned for recording on the facet of the cube which is opposite the facet bearing the developed image of the wrong character. The correct character is entered via the keyboard and recorded on the clean facet rotating the cube to erase the facet bearing the wrong character and displaying the correct one.

FIG. **5** illustrates how one end of shaft **12** in the embodiments of FIGS. **1** and **2** may look for manual justification of the recorded and displayed lines. While a manual system will be described herein, an automatic version could easily be constructed.

As noted hereinabove, each cube **10** has a recess on each side through which shaft **12** passes. Between the cubes and fitting in these recesses is a resilient space **36**. As shown in FIG. **1**, the left end of shaft **12** is fitted with a fixed stop **38**. The right end of this shaft **12** as shown in FIG. **5** has a sliding stop or collar **128** fitted thereto with a lever **130** attached to the collar. By means of this lever **130**, the operator can selectively slide the collar on the shaft **12**. A detent block **132** mounted on the frame (not shown) supporting shaft **12** for rotation has a series of depressions **134** in one surface thereof. These depressions cooperate with a ball **136** biased against the detent block **132** by spring **138** located inside the collar **128**. Thus the collar can be moved to one of the depressions **134** and will be held there by the spring biased ball **136**.

During the compose or record mode, the collar is in its leftmost position as the operator views the cubes, forcing the cubes into their compressed position. After a line is recorded, justification is accomplished by moving the lever **130** to the right until the last character recorded is in line with the right margin. Because of the resilient spacers **36**, all characters recorded will spread proportionately to fill the space between the left and right margins.

While the invention has been described with reference to its preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the invention without departing from its essential teachings.

We claim:

1. A keyboard input display device for producing on a recording medium the characters generated by said keyboard comprising:

a. a plurality of multifaceted polygonal single character display elements axially mounted to rotate about a central shaft means, the face of said elements being capable of retaining an electrostatic charge pattern,

b. printing means for producing a pattern of electrostatic charge representative of a single character on one face of each of said display elements,

c. indexing means for positioning said printing means with respect to each of said display elements thereby enabling a completed line of characters to be generated,

d. actuator means for rotating each of said display elements to development and transfer stations, the electrostatic charge pattern being developed on the face of said display elements at said development station and the developed charge pattern being transferred to said recording medium at said transfer station, and

e. means for providing line justification of a completed line of characters on said display elements prior to developing said charge pattern.

2. The device as set forth in claim **1** further including means for erasing the faces of individual display elements whereby said display elements are prepared for receiving additional electrostatic charge patterns.

3. The device as defined in claim **1** wherein said display elements are rotated to said development and transfer stations a line at a time.

4. The device as defined in claim **1** wherein said display elements are rotated to said development and transfer stations individually a character at a time.