United States Patent

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[33] **Great Britain**
[31] **27,907/68**

[54] **ELECTROGRAPHIC DISPLAY APPARATUS**
11 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **340/172.5**
[51] **Int. Cl.** **G06f 3/14**
[50] **Field of Search** 340/172.5, 324; 235/157; 346/74

[56] **References Cited**

UNITED STATES PATENTS

3,166,636	1/1965	Rutland et al.	340/172.5 X
3,364,473	1/1968	Reitz et al.	340/172.5
3,368,106	2/1968	Berthold	346/74 X
3,432,844	3/1969	Winston	340/172.5 X

OTHER REFERENCES

Brookman et al., Magneto-Luminescent Device, IBM Technical Disclosure Bulletin, Vol. 3, No. 2, July 1960, p. 71

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ABSTRACT: Display apparatus particularly applicable to editing coded information stored in punched or magnetic tapes. Tape information is divided into character codes and function codes by an input unit, said function codes including italic and bold font functions. The character codes are applied to a code translation system which permits same to be sequentially displayed in a manner determined by the function codes. This display may be corrected and redisplayed and the process repeated for a third display, with the final corrected resulting display if coded information being provided as an output in tape or other form.

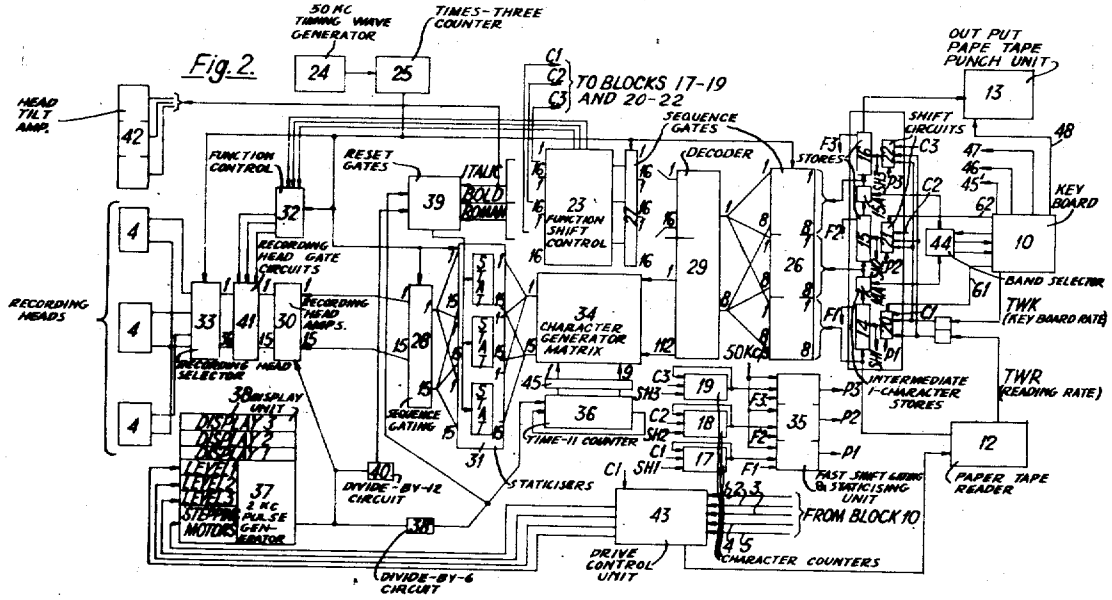
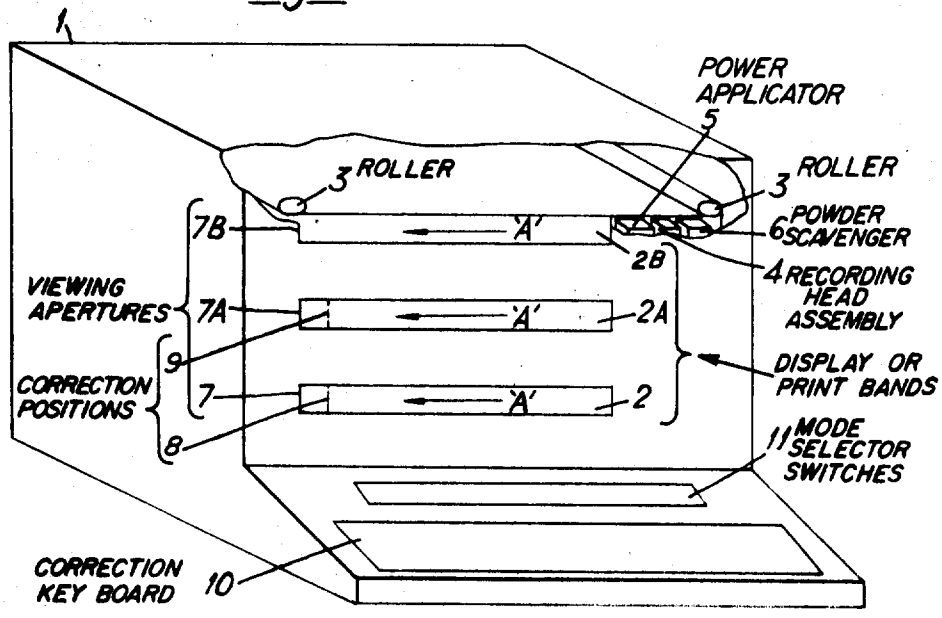


Fig. 1.



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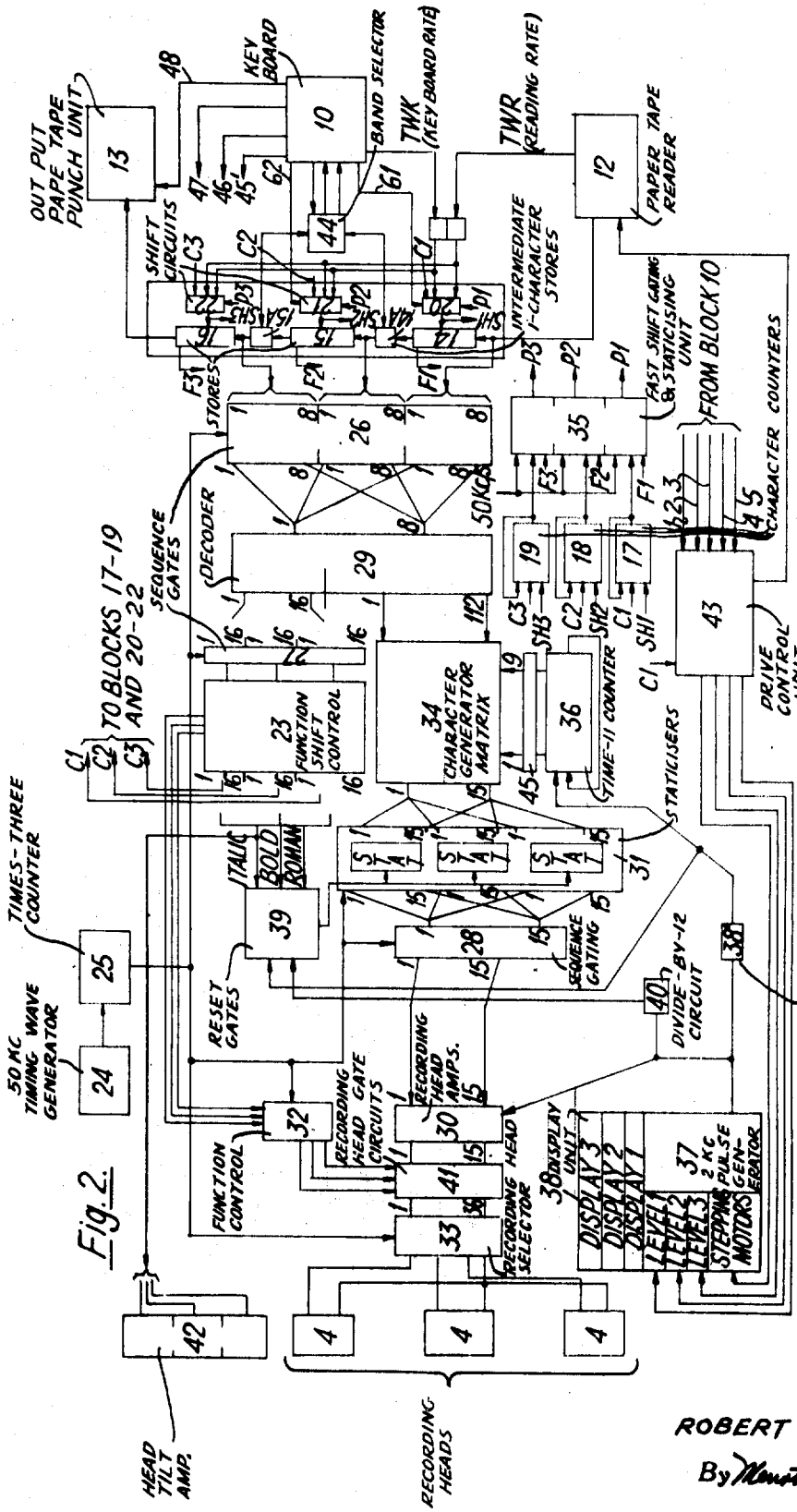

Fig. 2.

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Fig. 3.

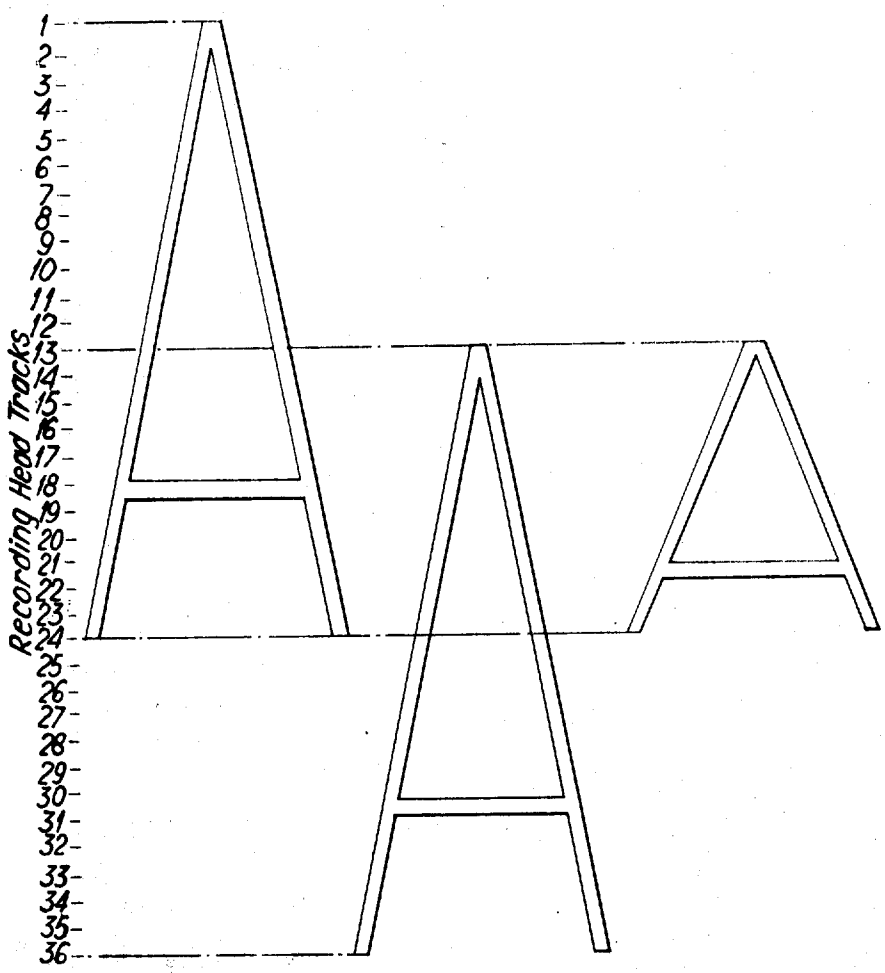

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Fig. 4.

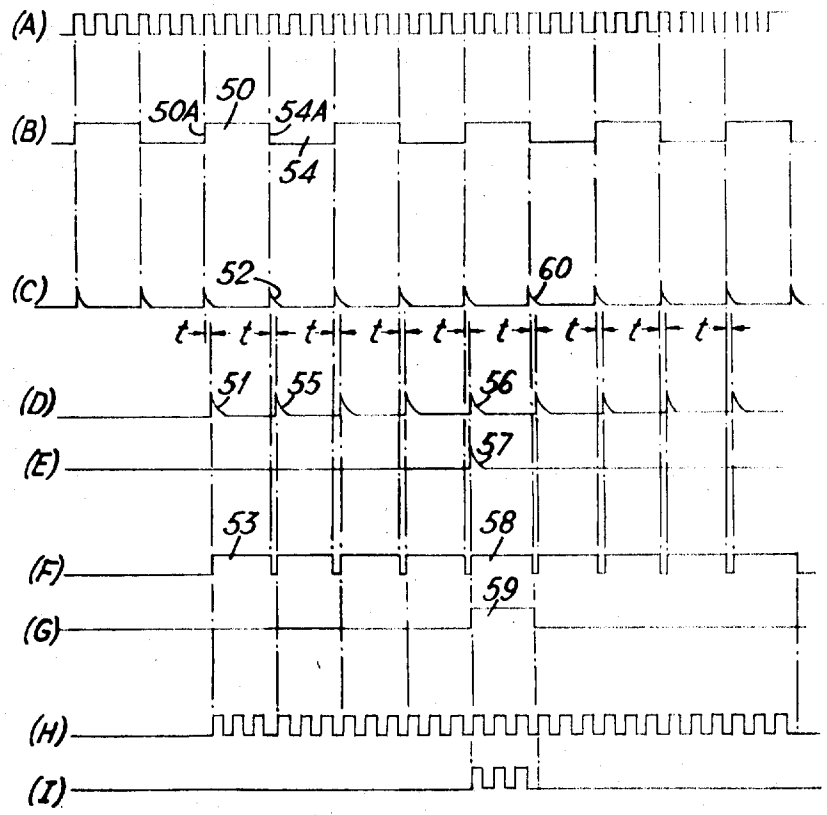

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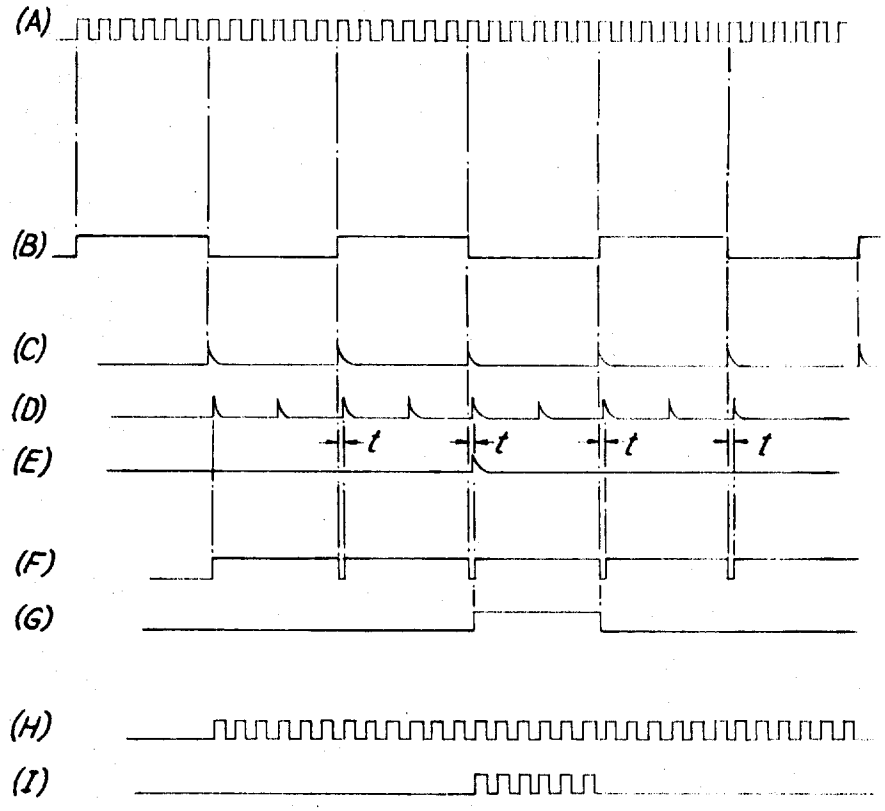
Fig. 5.



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ELECTROGRAPHIC DISPLAY APPARATUS

BACKGROUND OF THE INVENTION

The invention relates to electrographic display apparatus for editing coded information.

Electrographic display apparatus is defined as apparatus of the kind wherein the recording surface of a print drum or band is selectively magnetized or electrostatically charged to form a pattern, or latent image thereon representative of information contained in a signal applied to the apparatus, and wherein the print drum or band is passed through or relative to a powder applicator containing a powder that is attracted to the electromagnetically or electrostatically formed latent image to develop same and to form a powder image which may be viewed at a display position.

The electrographic display apparatus according to the invention has a particular application to the editing of coded information stored in punched tapes used for controlling for example an automatic typesetting device as used in the printing industry. The apparatus may also be adapted for editing other storage media, for instance magnetic tape, which may for some application be used instead of or as an alternative to punched tape.

SUMMARY OF THE INVENTION

The invention provides an electrographic display apparatus of the kind as hereinbefore defined for editing coded information including an input unit for assembling the coded information applied to said apparatus into function and character codes, a code translation system for causing characters representative of said character codes to be sequentially displayed in a manner determined by said function codes on N (greater than or equal to two) display record surfaces, means for connecting the coded information displayed on at least one of said N-display record surfaces, means for providing at the output of said apparatus coded information representative of the characters as displayed on the N^{th} display record surface.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features according to the invention will be better understood from the following description with reference to the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates a cutaway perspective view of an electrographic display apparatus according to the invention,

FIG. 2 diagrammatically illustrates in the form of a block diagram the electrographic display apparatus shown in the drawing according to FIG. 1.

FIG. 3 illustrates the channels of a recording head which forms part of the electrographic display apparatus according to the invention, that are utilized in the formation of various characters,

FIG. 4 illustrates typical waveforms that are generated by the electrographic display apparatus shown in the drawing according to FIG. 2 in order that either a 'Roman' or an 'Italic' character may be displayed, and

FIG. 5 illustrates typical waveforms that are generated by the electrographic display apparatus shown in the drawing according to FIG. 2 in order that a 'Bold' character may be displayed.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a cutaway perspective view of an electrographic display apparatus of the kind as hereinbefore defined is diagrammatically illustrated therein which is adapted for editing a punched tape and which comprises three display units contained within a single housing member 1. The display or print bands 2, 2A and 2B of each of three display units, which are viewed through the apertures 7, 7A and 7B in the housing member 1 and which are in the form of closed loops of tape, are each guided by a series of rollers 3 and

moved in the direction of the arrows 'A' i.e. from right to left by means not shown in the drawings and therefore the characters which are formed on the recording surface of the print bands by the recording head assembly 4 and the powder applicator 5 appear at the right hand side of the display and disappear from view at the left hand side thereof. Before the print band is positioned opposite the recording head assembly 4 during its movement in the direction of the arrow 'A," the previous powdered images are erased and scavenged by a scavenging unit 6.

Each of the three display units are self contained and provided with a powder tray (not shown in the drawings) which is situated underneath the print band in order that residual powder which drops from the band can be collected thereby preventing this powder from contaminating the mechanical parts of the apparatus.

The display units formed by the print bands 2, 2A and 2B will hereinafter be respectively referred to as the first, second and third displays. The first display which is arranged to display the incoming uncorrected data as obtained from the punched tape is provided with a correction facility which may be performed at a position 8, the second display which is arranged to display the corrected data as displayed at the first display is also provided with a correction facility which may be performed at a position 9 and the third display is arranged to display the corrected data as displayed at the second display thereby providing a final check before the corrected punched tape is produced at the output of the apparatus.

Thus in operation the information contained in the punched tape is displayed on print band 2, if no corrections are made, the text progresses to print band 2A and then to print band 2B. Information on the print band 2B after passing a predetermined datum point which is situated towards the left-hand side of the displayed portion of this print band is punched out of a new paper tape. A keyboard 10 provides the means, before a correct punched tape is produced, for initiating a correction at either of the positions 8 and 9 in a manner as will be outlined in subsequent paragraphs and a series of selector switches 11 are adapted as will also be outlined in subsequent paragraphs to effect different modes of operation of the apparatus according to the invention.

Each of the characters will be formed from a series of dots. The same number of characters can be displayed to the left of the correction points as are lost to view between the recording head and the right-hand side of the display window. By way of example it will be assumed that the apparatus is capable of displaying 12 words, say 72 characters, before the correction points and the same number after, that each character is formed from a 9×15 dot matrix, i.e. 9 dots wide × 15 dots high with capitals (upper case) being based on a 9×12 dot matrix, that the equivalent of two dots will be used as spacing between characters, and that each dot of the character matrix will be generated as six pulses to the recording head assembly for 'Roman' and 'Italic' characters and 12 pulses to the recording head assembly for 'Bold' characters.

In order to conform with the above example, a 36-track recording head assembly will be utilized at each one of the three display positions and the head assembly will included a "tilting" mechanism to enable 'Italic' characters to be obtained.

The electrographic display apparatus shown in the drawing according to FIG. 1 is diagrammatically illustrated in the form of a block diagram in the drawing according to FIG. 2. The input to the apparatus is derived from a punched paper tape which is applied to a high speed paper tape reader 12 capable of reading the tape at a rate of approximately 250 characters per second in order to achieve the display quoted in a preceding paragraph when the print band at each of the three displays is running at a maximum speed of say 20 characters per second and to enable functional codes to be shifted rapidly so as not to appear on the display. The output of the apparatus which is a new punched paper tape is provided by a paper tape punch unit 13.

The paper tape applied to the input of the reader **12** has punched into it not only character codes but also functional codes which ensure that characters take the correct form i.e. Italic, Roman or Bold et cetera. It is to be assumed that the functional codes which precede the character codes are in the form of shift codes, thus once a function has been set up it will be cancelled by a subsequent function. The apparatus shown in the drawing according to FIG. **2** is adapted by way of example to allow for the appearance of a maximum of six functional codes before a character code and it is to be assumed that an 8-hole tape is to be employed i.e. 8-bit codes for characters and functions.

No error detection or correction is provided at the reader **12** or punch **13** since the paper tape being read is being continually corrected using the displays and the error rate of a conventional punch is generally of the order of one in 1,000,000 characters punched. This would mean, in practical terms, with 1000 feet lengths of paper tape approximately one error in every 10 reels of tape punched out. However, if a better error rate is required it would be necessary to provide a reading station at the output of the punch **13** which may be provided for example, by using check contacts on the punch **13** i.e. contacts which detect when any one of the punch pins has moved.

Three stores **14**, **15** and **16**, for example ferrite core or waffle iron stores, are provided and the input to each of these stores is displayed at the first, second and third displays. In order for each of these stores to be able to handle the number of characters, quoted in a preceding paragraph, that are required to be displayed at each of the display levels, it is to be assumed that each store is arranged to be capable of storing 108-bit codes and that approximately 25 percent of the store capacity is taken up by functional codes which do not appear on the display.

In order to ensure that the same number of characters are displayed up to the correction point as are held in each store, bearing in mind that some of the stored codes will be functional codes which will not be displayed, it is necessary to count the number of characters to be displayed as they enter the store by means of the character counters **17**, **18** and **19**. When the count reaches the maximum which can be displayed up to the correction point, the characters are fast shifted through the store so that the first character occupies the last position in the store, ready for correction in an intermediate one character store i.e. stores **14A** and **15A**. The three counters **17**, **18** and **19** and associated shift circuitry which are provided, are arranged one for each level. Store **14**, accepts code from the reader **12** at for example four rates i.e. three slow rates for characters and a fast rate for functional codes. This arrangement avoids gaps occurring between the characters on the display due to functional codes. The three slow rates can be considered by way of example as being 20 characters per second, five characters per second and a one shot as defined by keyboard operation.

The shift circuits **20**, **21** and **22** which are respectively associated with the stores **14**, **15** and **16** can be driven at the reading rate TWR of the reader **12** or at the keyboard rate TWK or as will be explained later in more detail at a fast shift rate from the functional shift control **23**, in which case each store can shift independently of the others. Thus the apparatus is arranged such that if a character code appears at the input to any one of the stores **14** through **16** it is shifted through the store at the TWR or TWK rate but if a functional code appears at the input to any one of the stores **14** through **16** it is detected and shifted rapidly before the display band has moved to the next character position.

A significant saving is achieved in the amount of equipment that is used by utilizing common circuitry for each of the three displays and causing this circuitry to be scanned at a high speed, relative to the normal machine speed.

The scanning action is achieved by providing a 50 kc./s timing wave generator **24** which is used to drive a times three counter **25** i.e. one for each display, the three outputs of the counter **25** which each consist of a 50/3 kc./s timing wave are applied to the appropriate levels of sequence gates **26**, **27** and **28** respectively located at the inputs to a decoder **29**, the functional shift control **23**, recording head amplifiers **30** and to staticizers **31**, a function control **32**, and a recording head selector **33**. The apparatus is arranged such that there is no possibility of the scanned circuits getting out of synchronism.

As the 8-bit codes appear at the input of each of the stores **14**, **15** and **16** they are applied to the appropriate eight inputs of the sequence gates **26** and the output of the shift circuits **20**, **21** and **22** are respectively applied to the stores **14**, **15** and **16** and to the counters **17**, **18** and **19** via the wires marked SH1 to SH3. The scanning process, during each complete cycle thereof, causes the 8-bit code associated with each of the stores to be sequentially applied to the decoder **29** and if the 8-bit code represents a character then it is decoded into a discrete signal and applied via one of **112** character wires to a character generator matrix **34** for example, a ferrite core matrix. If the 8-bit code is a functional code then it is decoded into a discrete signal and applied on one of **16** wires to the appropriate input of the functional shift control **23** via the sequence gates **27** which are also scanned in the same sequence as the sequence gates **26**. The three outputs C1 to C3 of the functional shift control are respectively connected to the inputs C1 to C3 respectively of the counters **17** through **19** and to the inputs C1 to C3 respectively of the shift circuits **20** to **22**. Therefore during each complete cycle of the scanning process the three outputs of the three levels of the functional shift control **23** are sequentially applied to their respective counter and shift circuit.

Functional codes appearing at the input to the stores are scanned, decoded and then staticized in the appropriate level of the functional shift control **23**. Immediately after the function is staticized a fast shift pulse is generated which is applied to either the reader or the appropriate shift circuit so that it rapidly shifts the functional code through the store thereby ensuring that no space occurs between characters on the display. Patched resets are provided at the functional shift control **23** which are arranged such that once a function has been staticized, the occurrence of any other selected function will cause the previously staticized function to be reset.

Patching is accomplished for example on a printed circuit board having solder pins mounted on it, so that soldered straps may be used to achieve the required patching.

The fast shift pulse when applied to the appropriate character counter inhibits the signal applied thereto from a shift circuit, which normally steps the counter on by one count, thereby ensuring that the functional code is not counted.

When the number of characters that are to be displayed, i.e. 72 characters in the example quoted, have been counted at a character counter, an output signal is generated thereat which is applied to the input of the counter thereby resetting it, and to the appropriate level of a three level fast shift gating and staticizing unit **35** which is also scanned in the same sequence as the sequence gates **26** etc. by means of the signals derived from the counter **25**. The three outputs P1 to P3 of the three levels of the unit **35** are respectively applied to the shift circuits **20** to **22**. Thus when a signal is generated at the output of the unit **35** it is applied to the appropriate shift circuit to fast shift the characters through the store so that the first of the characters occupies the last position in the store, ready for correction, if necessary, in an intermediate one character store **14A**, or **15A**. In order to terminate this fast shift mode of operation a signal is generated at each of the stores **14** through **16** when the first of the characters occupies the last position in the store i.e. generated respectively on the wires F1 to F3, which is applied to the appropriate level of the unit **35**, this signal is arranged to inhibit the appropriate level of the unit **35** by causing the output signal therefrom to be removed.

Character codes appearing at the input to the stores are scanned, decoded and then applied via one of **112** character wires to the character generator matrix **34**. Each of the **112**

character wires is threaded through the cores in the 9×15 ferrite core matrix which correspond to the dots of a character to be generated and displayed. Hence the character shape is generated by switching the required cores with a current waveform on the character wire.

As shown in FIG. 2, 15 wires are brought out from the 9×15 matrix **34** which are each threaded through the nine cores of a separate one of the **15** rows of the matrix. The nine wires which are threaded through the **15** cores of a separate one of the nine columns of the matrix are driven via a unit **45** by a times 11 counter **36** which is stepped by timing pulses derived from a TWD generator **37** situated at the display unit **38**. The TWD generator **37** generates 66 pulses per character plus space at a frequency of 2 kc./s as shown in the drawings according to FIGS. **4**(A) and **5**(A) and it is to be assumed that both the leading and trailing edges of each of these pulses will be utilized for switching functions. A divide by six circuit **38'** is interposed between the generator **37** and the counter **36** which causes the series of pulses shown in the drawing according to FIG. **4**(B) to be applied at the input to the counter **36** i.e. the number of leading and trailing edges of the pulses shown in the drawing according to FIGS. **4**(A) and **5**(A) are divided by six in a manner such that each of the pulses shown in the drawing according to FIG. **4**(B) embraces three of the pulses shown in the drawing according to FIG. **4**(A).

Each generated dot on a display, as will be explained in more detail in a subsequent paragraph, is built up by the application of six pulses to one of the recording heads **4** for Roman and Italic characters and 12 pulses to one of the recording heads **4** for bold characters, and each Roman and Italic character has a maximum of nine dots in a horizontal direction, the space between characters being equivalent therefore to two dots. The two extra count positions in the counter **36** allow for the spacing between characters. A feedback signal, which is generated at the end of the count cycle, is applied to the input of the counter **36** in order to reset it ready for the next count cycle.

Thus in operation the series of pulses shown in the drawing according to FIG. **4**(B) which are sequentially applied to the counter **36** and which each have a period of 3 milliseconds are applied to the unit **45** which is arranged to provide at each position of the counter interrogation pulses for application to the matrix **34** via each one of the nine column wires thereof. Thus a period of 3 milliseconds is available for the character code and associated functional codes appearing at the input of each of the stores **14** through **16** to be sequentially applied to the matrix **34**, interrogated therein, and the possible 15 bits of information fed out to the respective level of the staticizers **31** wherein the information is stored i.e. a period of 1 millisecond is available for each level.

Since the cores of the matrix **34** are set to a particular character shape by the character pulse on each one of the **112** character wires, the output pulses from the unit **45** must be of opposite polarity to the character pulse so that the column cores are reset and an output is provided for application to the staticizers **31**. In order for the contents of each of the stores **14** through **16** to be sequentially applied via the matrix **34** to its corresponding level in the staticizers **31** it is necessary for the pulses shown in the drawing according to FIG. **4**(B) to be each divided into three separate pulses before they are applied to the matrix **34** and this is effected by the unit **45**. This is necessary since during each of the stepping periods i.e. 3 milliseconds, of the counter **36** it is necessary to interrogate each one of the nine columns of the matrix **34** three times i.e. once during each 1 millisecond period.

Alternatively, if it is assumed that the character pulse and the interrogation pulse are half-write pulses and the matrix gives an output from any one of its cores when both half-write pulses exist at that core then the unit **45** would not be requited since the 15 cores of each column of the matrix **34** would be sequentially energized by the counter **36** with one half-write pulse of 3 milliseconds duration and during this period the 15 cores of each column would be sequentially energized by the character half-write pulses obtained from the stores **14** through **16** thus the contents of each of these stores will be sequentially applied to its corresponding level in the staticizers **31**.

It will of course be necessary in both of the above cases to completely reset the matrix **34** at the end of the interrogation cycle of each column before the next column of the matrix **34** is processed.

During the 1 millisecond period which is available for each display level, the input to each of the three levels of the staticizers **31** is scanned 50/3 times although it should be noted that it is the first scan which sets the appropriate levels of the staticizer. The rate at which the staticizers **31** are reset is fixed by reset gates **39** which are capable of being operated at a rate of either TWD/6 or TWD/12. The TWD/6 drive input to the gates **39** which is obtained from the divide by six circuit **38'** and which is illustrated in the drawing according to FIG. **4**(B) is utilized when it is required to display an Italic or Roman character and the TWD/12 drive input to the gates **39** which is obtained from a divide by 12 circuit **40** and which is illustrated in the drawing according to FIG. **5**(B) is utilized when it is required to display a bold character. The functional codes which are applied to the reset gates **39** determine therefore the rate at which the reset gates **39** will operate. The dot width reset pulses which are applied to the staticizers **31** are shown in the drawings according to FIGS. **4**(C) and **5**(C), the pulses shown in FIG. **4**(C) are applied to the staticizers **31** when it is required to display Roman or Italic characters and the pulse shown in FIG. **5**(C) are applied to the staticizers **31** when it is required to display bold characters.

The function control **32** which derives its input from the functional shift control **23** and which is scanned in a manner as previously outlined is connected via three output wires to recording head gating circuits **41**. These three output wires are utilized to instruct the circuits **41** to channel the information from the character generator matrix **34** to the appropriate input channels of a recording head, for example, the **36** tracks of each of the recording heads **4** may be utilized in a manner as shown in the drawing according to FIG. **3** to provide a normal capital letter with tracks **13** to **24** inclusive, a raised capital letter with tracks **1** to **24** and a dropped capital letter with tracks **13** to **36** thus in this instance the three output wires from the function control **32** would be utilized to instruct the circuits **41** that either a normal, raised or dropped capital is required.

Thus the possible 15 bits of information as obtained from each level of the staticizers **31** is sequentially applied to the recording head amplifiers **30** via the sequence gates **28** where they are amplified to a level sufficient to drive the recording head tracks and also modulated with the 2 kc./s, 66 pulses per character TWD signal, in a manner as will be described in a subsequent paragraph, before being passed to the appropriate recording head **4** via the circuits **41** and the recording head selector **33**.

When it is required to display an Italic character, the output of the functional shift control is applied to the appropriate level of a three level head tilt amplifier **42** which is arranged to tilt the recording heads **4** by a required amount to effect the provision of an Italic display. TWD/6 way of example, typical waveforms are shown in the drawings according to FIGS. **4**(A) to (I) and **5**(A) to (I) which are respectively utilized for obtaining the display of a Roman or Italic and bold capital letter 'T' appearing at the first character position of the store **14**.

Referring to the drawings according to FIGS. **4**(A) to (I), the waveforms according to FIGS. **4**(A) (A) to (C) have already been discussed and it will be seen that each one of the reset pulses according to FIG. **4**(C) has a time relationship with either a leading or trailing edge of the TWD/6 pulses according to FIG. **4**(B). The reset pulses may for example be obtained from the TWD/6 pulses by differentiation of the TWD/6 pulses followed by rectification of the differentiated waveform.

As previously stated, capitals (upper case) are based on a 9×12 dot matrix therefore the capital letter 'T' will be based on the 9×12 dot matrix, i.e. the crossmember of the 'T' will be formed by the first row of nine cores and the upright member of the 'T' will be formed by the top 12 cores of the fifth column of the matrix therefore the waveform shown in the drawing according to FIG. 4(D) represents the series of nine pulses which is representative of the crossmember of the 'T' and which will be obtained from the first row of cores when each column of the matrix **34** has been interrogated and the waveform shown in the drawing according to FIG. 4(E) represents the pulse which is representative of part of the upright member of the 'T' and which will be obtained from the other eleven rows of cores when the fifth column of the matrix **34** has been interrogated.

It will be noted that there is a time delay '*t*' between the output pulses from the matrix **34** and the reset pulses which are applied to the staticizers **31** which is obtained by causing this time delay at the counter **36** and which is equal in time to the TW rate. The reason for this time delay will become evident from the subsequent description.

Considering the interrogation of each column of the matrix **34** during the 1 millisecond period the letter 'T' is formed therein, the TWD/6 pulse **50** (FIG. 4(B)) will give rise at the output of the unit **45** to three interrogation pulses, the first one of which will coincide with the leading edge **50A** thereof and effect the interrogation of the first part (column) of the letter 'T' therefore the first pulse **51** of the series of pulses according to FIG. 4(D) will be provided and the output of the matrix **34** since only one core i.e. the first core of the first row of the matrix, of the first column thereof will have been set by the character pulse. This output pulse will set the first of the 15 positions of the first of the three levels of the staticizer **31** and this position of the first level will then be reset by the pulse **52** (FIG. 4(C)) applied thereto via the reset gates **39** thereby providing an output pulse from the staticizer **31** which is represented by the pulse **53** shown in the drawing according to FIG. 4(F) and which is applied to the head amplifiers **30** via the sequence gates **28**. It can thus be seen that the time delay '*t*' is necessary in order to effect the setting and resetting of the staticizers **31** before the next piece of information is processed.

The pulse **53** is therefore applied to the head amplifiers **30** which is also delayed in time with respect to the reset pulses by an amount '*t*' thereby synchronizing it with the counter **36**, wherein it is amplified to a level sufficient to drive the recording head tracks and also modulated with the 2 kc./s, 66 pulses per character plus space TWD signal to provide the waveform shown in the drawing according to FIG. 4(H). Thus the pulse **53** as shown in FIG. 4(H) embraces three TWD pulses and since the leading or trailing edges of these pulses are utilized for switching functions a series of six pulses is applied to a recording head **4** to generate a dot on the first display.

On completion of this process a period of 1 millisecond will have lapsed and during the next 2 milliseconds a character from the stores **15** and **16** will have been applied to the matrix **34** and processed in the same manner.

After the 3 millisecond period, the letter 'T' will again be written into the matrix **34** from the store **14** and the counter **36** will have been stepped along by an amount such that the pulse **54** (FIG. 4(B)) will give rise and the output of the unit **45** to three interrogation pulses, the first one of which will coincide with the leading edge **54A** thereof and effect the interrogation of the second column of the matrix **34** therefore the second pulse **55** of the series of pulses according to FIG. 4(D) will be provided on the first row wire at the output of the matrix **34** and utilized in a manner similar to the pulse **51** to cause another dot to be generated on the first display to form part of the crossmember of the 'T.' This process in order to form the letter 'T' on the first display is repeated for each of the columns of the matrix **34** every 3 milliseconds. When the fifth column of the matrix **34** is being interrogated the fifth pulse **56** of the series of pulses according to FIG. 4(D) will be provided on the first row wire at the output of the matrix **34** and a pulse **57** (FIG. 4(E)) will be provided on each of the next 11 row wires at the output of the matrix **34**, therefore 12 pulses are simultaneously applied to the first 12 positions of the first of the three levels of the staticizer **31** in order to set them, each of the 12 positions being reset by the pulse **60** (FIG. 4(C)) to give rise at the output of the first level of the staticizers **31** to a pulse **58** (FIG. 4(F)) for the first of the 12 positions thereof and a pulse **59** (FIG. 4(G)) for each or the other 11 positions. In this instance therefore 12 pulses will be applied to the head amplifiers **30** and modulated to give at the output thereof for application to a recording head **4** the waveform shown in the drawing according to FIG. 4(I) for each of the pulses **59** and part of the waveform shown in the drawing according to FIG. 4(H) for the pulse **58**.

Referring to the drawings according to FIGS. 5(A) to (I), waveforms for the generation of bold characters at the display are shown which are produced and utilized by the apparatus in the same manner as the waveforms for Roman and Italic characters except the TWD pulses (FIG. 5(A)) are divided by 12 instead of six to give the pulses shown in the drawing according to FIG. 5(B) and the staticizers **31** are reset by the reset pulses of FIG. 5(C) for every other one of the pulses (FIGS. 5(D) and (E)) generated at the output of the matrix **34** thus the output pulses (FIGS. 5(F) and (G)) from the staticizers **31** when modulated by the TWD pulses at the amplifiers **30** embrace as shown in the drawings according to FIGS. 5(H) and (I) six TWD pulses thus a series of 12 pulses is applied to a recording head **4** to generate a dot on the display.

As shown in the drawing according to FIG. 2 stepping motors are utilized at each level of the display unit **38** which are arranged to step the band, which forms part of each display, a predetermined distance at each step under controlled acceleration and deceleration rates and strobe pulses will be generated within the display unit **38** in order to facilitate the recording of characters to be effected during the acceleration and deceleration periods.

This speed of the stepping motors is controlled by a drive control unit **43** which may for example be arranged as previously stated to operate the stepping motors such that the characters are displayed at either a fast rate of say, 20 characters per second, a slow rate of say, five characters per second or a one shot mode of operation (single character feed).

As shown in FIG. 2, the drive control unit is controlled from the keyboard **10** and the five inputs to the unit by way of example give the following instructions:

Input **1**—selects a rate of 20 characters per second.
Input **2**—selects a rate of five characters per second.
Input **3**—step display **1**.
Input **4**—step display **2**.
Input **5**—step display **3**.

The output of the drive control unit **43** is also connected to the reader **12** since it is necessary to operate the reader **12** at the same speed and in synchronism with the speed at which the display bands are being moved by the stepping motors at the display unit **38**.

The single shot mode of operation is achieved by the generation of single drive pulses, generated as character keys on the keyboard **10** are depressed.

As previously stated the first and second displays of the apparatus according to FIG. 1 are each provided with a correction facility and if an error is seen on say the first display it may be corrected when the error is positioned at the correction point **8** on the band **2** either by modifying or deleting the characters that are in error one at a time as they appear at the correction point **8** or by inserting characters that have been omitted in front of the character which is positioned at the correction point **8**. These actions could of course be carried out independently at the two correction points **8** and **9**.

When a character is at the correction point on the display band, its code occupies the last store position of the appropriate level therefore if a character is to be modified when it reaches the correction point its code store location is readily obtainable.

When a character requires modification, the keyboard **10** in conjunction with a band selector **44** (FIG. 2) is used to select the appropriate display i.e. either the first of second display, when the character reaches the correction point therefore assuming that the character requiring modification is situated at the correction point **8** then the first display will have been selected and the character code will occupy the last store position of the store **14**.

When the display has been selected, the character in the intermediate store **14A** is shifted out into the following store i.e. store **15**, and a new character which is to take the place of the character at the correction point **8** is selected at the keyboard **10** and shifted via the selector **44** into the intermediate store **14A**. Almost immediately after this action the contents of the store **14** are shifted, the character in error being deleted.

If a character appears at say correction point **8** which is obviously preceded by a functional code which is in error then since the functional code is held in the intermediate store **14A** a new functional code can be keyed in from the keyboard **10**, but the apparatus is such that no shift will occur until an actual character code is keyed in, or a new character is read on the reader **12**.

Deletion of characters may be accomplished by stepping the characters into an intermediate store and then resetting all levels of this store to zero from the keyboard **10** by applying a signal to the stores respectively, via the wires **45'**, **46** and **47'**, with no shift into the next store. Characters may be added at say the correction point **8** by inhibiting the shift of the store **14** while adding characters to the intermediate store **14A** and stepping them into the following store i.e. the store **15**. The stores **14** and **15** are inhibited by applying a signal thereto from the keyboard **10** respectively on the wires **61** and **62**. The output punch **13** may also be controlled from the keyboard **10** via a signal on the wire **48**.

If errors occur simultaneously at the two correction points **8** and **9** and the errors are such that the characters have to be modified or additional characters have to be added, the characters at the correction point **9** of the second display must be dealt with first, and while doing this the print band associated with the first display must be stopped. Having dealt with errors on the second display the characters in error on the first display may be corrected.

When characters are to be deleted and simultaneous errors occur on the first and second displays then the characters on the band associated with the second display must be deleted without stopping the band associated with the first display i.e. band **2**, and the error in band **2** is corrected when it appears at the second correction point **9**. At any convenient point in the text preferably when no errors are displayed the apparatus may be reverted to normal operation using the first correction point as before.

If for some reason an error is not detected until it has reached the band associated with the third display then, provided the error is to the right of the punch out position and a note has been made of the last character punched out, it will be necessary to reset all the stores, pull the tape in the reader **12** back a few inches and recycle the tape through the reader **12**. Correction of the previously missed error can then be effected, and the punch out operation can be continued when the previously noted, last character punched out, was immediately to the left of the punch out position.

A "rub out" key is provided at the keyboard **10** which may be used if an incorrect character were actually punched out. This would only be necessary in exceptional cases when it was clearly obvious which characters were in error. In order to effect this action it is necessary for the tape to be back-stepped in the punch and the characters in error overpunched with the "rub out" symbol.

The "rub out" symbol is usually an all hole character and would not be recognized by for example the typesetting equipment. After rub out the corrected characters would be punched out.

It should be noted that the apparatus according to the invention is not limited to the use of three display levels, any number of display levels may be utilized depending on the complexity of the coded information being edited and the number of errors that are likely to occur. It will of course be appreciated that the minimum number of display levels is two since it is necessary to have at least one display level for effecting the correction of the errors in the coded information and another display level for checking this correction and effecting the provision of a corrected punched tape at the output of the apparatus.

I claim:

1. An electrographic display apparatus for editing coded information including an input unit for assembling the coded information applied to said apparatus into function and character codes, a code translation system coupled to said input unit for causing characters representative of said character codes to be sequentially displayed in a manner determined by said function codes on N (greater than or equal to two) display record surfaces, means for correcting the coded information displayed on at least one of said N display record surfaces, and means responsive to said correcting means for providing at the output of said apparatus coded information representative of the characters as displayed on the N^{th} display record surface, said code translation system including N line stores which are each associated with a separate one of said N display record surfaces and capable of storing a plurality of said codes, the output of said input unit being applied to one of said N line stores, the codes stored therein being passed therethrough and through each one of the other of said N line stores in turn, the code appearing at the input of each of said N line stores being sequentially applied to decoding means which generate on application of each code a discrete signal on either one of Y (number of characters the apparatus can generate) output wires thereof which is representative of a particular character and which is applied to a code translation matrix to form that particular character therein or one of Z (number of functions the apparatus can perform) output wires thereof which is representative of one particular function and which is applied to the appropriate level of an N-level function control unit, an interrogation unit for applying interrogation pulses to said code translation matrix in order to sense sequentially during each interrogation period the characters formed therein which appear at the inputs of each of said N line stores, said interrogation pulses resetting at least part of said code translation matrix to its original state and causing to be sequentially generated at the output of the matrix signals corresponding to the form of at least part of the N characters formed therein, and N-level character form controlling means, the input of each level of which is sequentially connected to the output of said code translation matrix and to the output of a separate level of said N-level function control unit, the output signals of said N-level character form controlling means which determine the form in which said N characters are to be displayed being sequentially applied via amplifying and modulating means to a selection matrix which in synchronism with the interrogation unit and said N-level function control unit sequentially directs the output signals to the appropriate input channels of a recording head which is associated with that one of the N display record surfaces on which a character represented by said output signals is to be displayed.

2. An electrographic display apparatus as claimed in claim **1** wherein said N-level function control unit includes N shift control circuits the output of each one of which is connected to a separate one of said N line stores and to its input via one level of an N-level character coincidence counter control unit while the input to said one shift control circuit is connected to one level of an N-level shift control unit and to said input unit, the input to each level of said N-level shift control unit being sequentially connected to the Z output wires of said decoding means, and a dot width reset unit, the input of which is sequentially connected to the output of each level of said N-level shift control unit while its output is sequentially connected to the input of each level of said N-level character form

controlling means, and wherein the output of each level of said Nslevel shift control unit is connected to the input of a separate level of said N-level character coincidence counter control unit.

3. An electrographic display apparatus as claimed in claim 2 wherein when it is required to display Italic characters of said N-level function control unit also includes an N-level recording head tilt control unit, the inputs of which are each connected to one level of said N-level shift control unit while its outputs are each connected to a recording head associated with one of said N display record surfaces.

4. An electrographic display apparatus as claimed in claim 2 wherein when it is required to display the characters either above or below a predetermined datum said N-level function control unit also includes a recording head gating unit interposed between said selection matrix and said amplifying and modulating means and recording head function control means, the output of which is connected to said recording head gating units while the input thereof is sequentially connected to the outputs of said N-level shift control unit.

5. An electrographic display apparatus as claimed in claim 1 wherein drive control means are provided for said N display record surfaces which are synchronized with said input unit for controlling the rate at which the characters representative of said character codes are to be displayed.

6. An electrographic display apparatus as claimed in claim 2 wherein said means for correcting the coded information displayed on at lease one of said N display record surfaces are provided by an intermediate line store interposed between any two of said N line stores, that one of said N line stores which proceeds said intermediate line store being associated with that one of said N display record surfaces on which the characters requiring correction are displayed, and another input unit the output of which is connected to said intermediate line store and to the shift control circuit associated with that one of said N line stores which proceeds said intermediate line store via one position of a two position switch, the other position of said two position switch being connected to said input unit.

7. An electrographic display apparatus as claimed in claim 6 wherein when it is required to correct the coded information displayed on more than one of said N display record surfaces the intermediate line stores associated with these display record surfaces are connected to said another input unit via a selector switch.

8. An electrographic display apparatus as claimed in claim 6 wherein said another input unit includes means for resetting any one or combination of said N line stores, means for inhibiting said N shift control circuits, and means for correcting the coded information produced at the output of said apparatus.

9. An electrographic display apparatus as claimed in claim 6 wherein said another input unit includes means for operation in order to produce the desired function and character codes at the output thereof.

10. An electrographic display apparatus as claimed in claim 2 wherein said N-level character coincidence counter control unit includes at each level thereof a times Y counter the output of each of said counters being sequentially connected to the input of the appropriate one of the N shift control circuits via an N-level gate and staticizer unit, the inputs of which are also each connected to an output of a separate one of said N line stores.

11. An electrographic display apparatus as claimed in claim 1 wherein said means for providing at the output of said apparatus coded information representative of the characters as displayed on the N^{th} display record surface are provided by a punch unit which provides at the output thereof a tape having holes punched therein which are representative of the coded information, the output of that one of said N line stores associated with the N^{th} display record surface being connected to the input of said punch unit.