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Boyce et al.

[11] **3,905,463**

[45] **Sept. 16, 1975**

[54] **CONTROL ELEMENT FOR ELECTRICAL READING OR RECORDING DEVICE**

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[73] Assignee: **The Bunker Ramo Corporation**, Oak Brook, Ill.

[22] Filed: **Feb. 12, 1973**

[21] Appl. No.: **331,838**

[52] **U.S. Cl.** ..... **197/1 R**; 197/84 B

[51] **Int. Cl.**..... **B41j 3/05**

[58] **Field of Search**..... 197/1 R, 18, 19, 20, 84 B, 197/84 R, 176; 101/93 C

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Assistant Examiner—R. T. Rader
Attorney, Agent, or Firm—D. R. Bair; F. M. Arbuckle

[57] **ABSTRACT**

This invention relates to an element for controlling the reading or recording of information with an electrically controlled device. The element includes a track having a normal pattern of sync markings spaced from each other by a predetermined distance and at least one area having a sync pattern differing from the normal pattern. The area having a different sync pattern may not have a marking appear within a predetermined distance of a given marking or may have a distance different from said predetermined distance between selected ones of the markings. All of the sync markings on the track are scanned during the reading or recording of each line of information characters and are utilized for generating sync pulses which control the reading or recording of a stroke of an information character. The variable spacing of the sync markings on the sync track may be utilized to vary the size of the characters recorded, to justify characters of different size, to protect selected areas of the media being recorded on, to encode the information, or for other control purposes.

8 Claims, 12 Drawing Figures

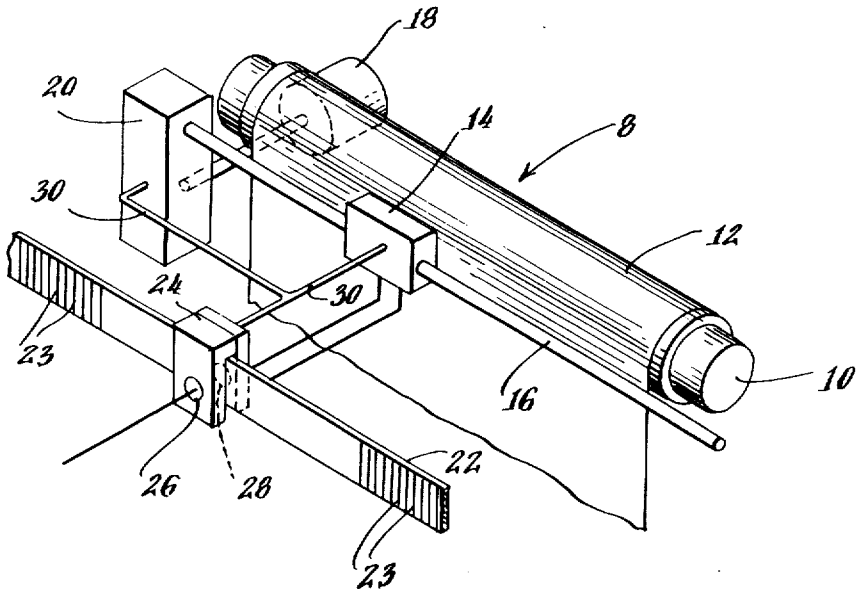
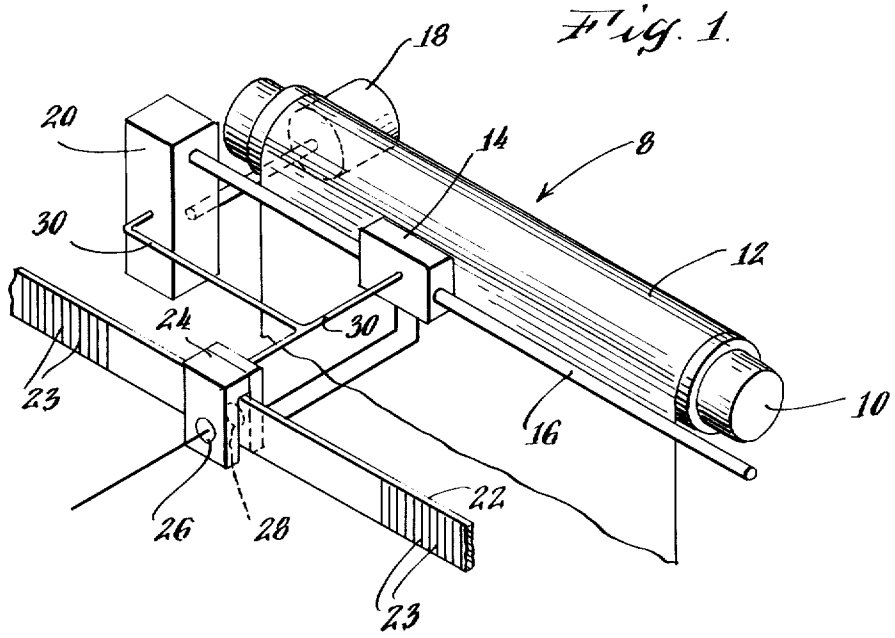


Fig. 1.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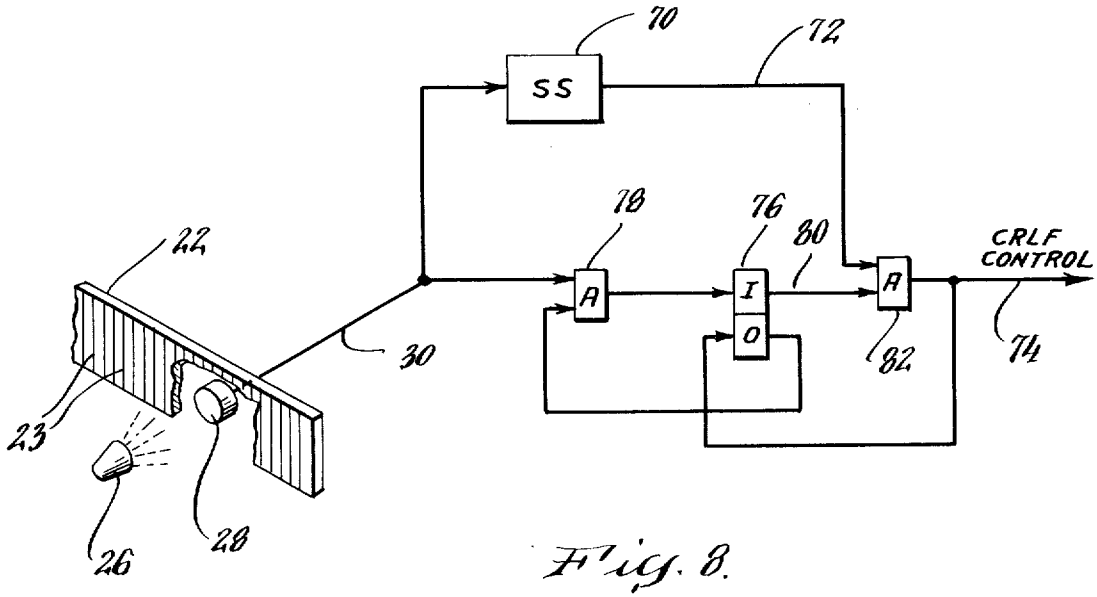
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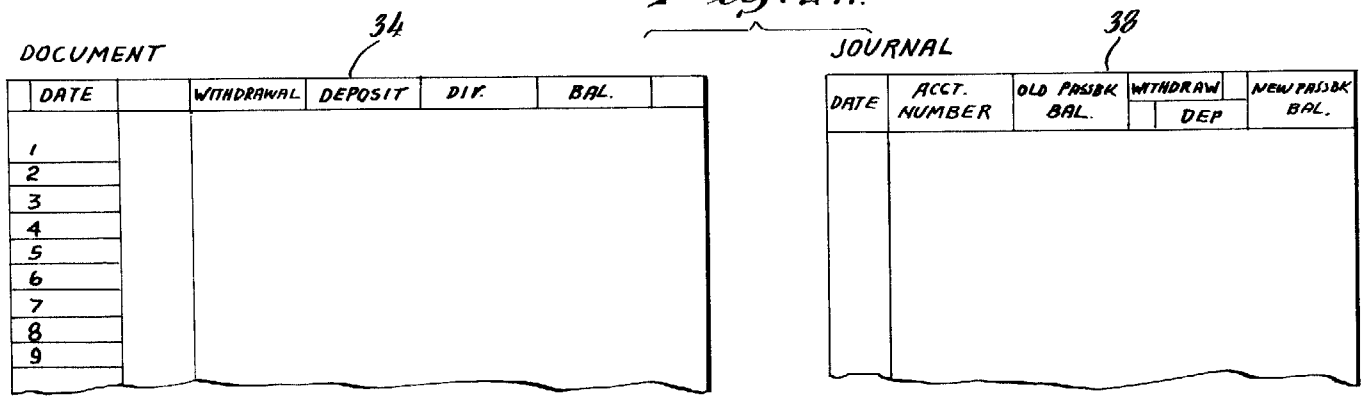
Fig. 8.

Fig. 2A.



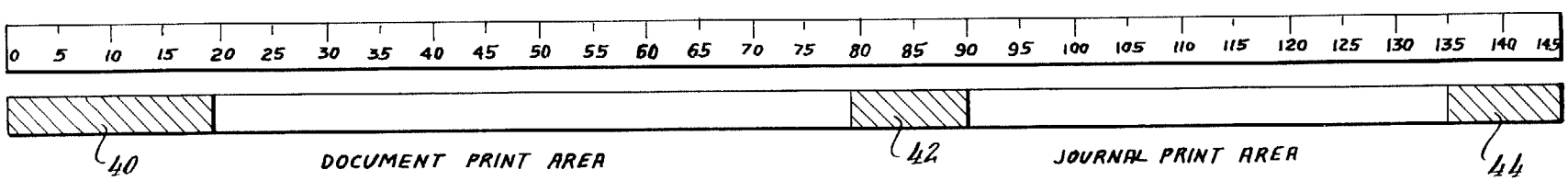


Fig. 2B.

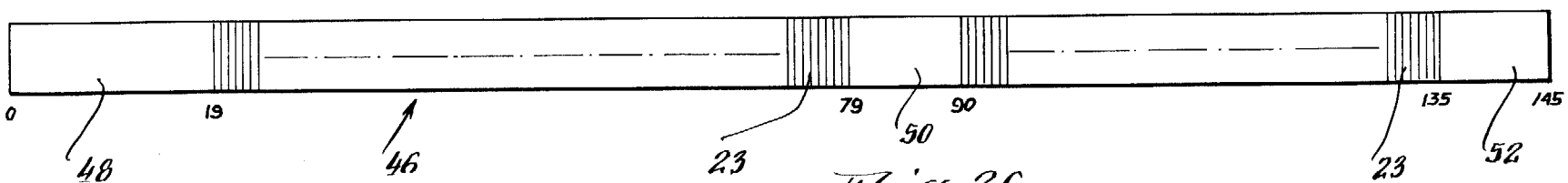


Fig. 2C.

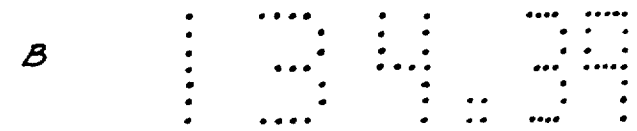
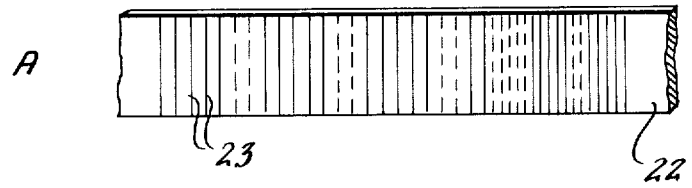


Fig. 3.



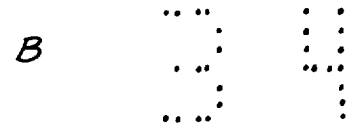
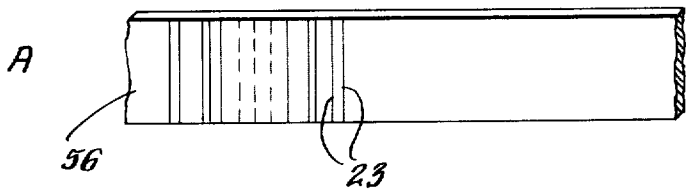


Fig. 4.



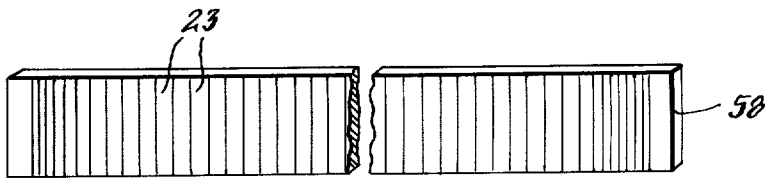


Fig. 5.

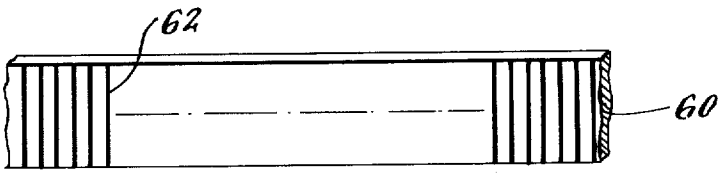


Fig. 6.

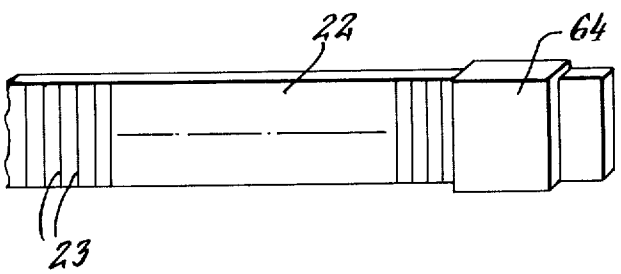


Fig. 7.

CONTROL ELEMENT FOR ELECTRICAL READING OR RECORDING DEVICE

This invention relates to an element for controlling the reading or recording of information with an electrically controlled device, and more particularly, to an element of this type utilizing a special sync track having variably spaced markings formed thereon.

BACKGROUND OF THE INVENTION

All printers, magnetic recorders, and other electronically controlled devices for recording information, and all optical readers, magnetic detectors, and other electrically controlled devices for reading recorded information have one thing in common; the reading or recording is accomplished by either moving a read-record element relative to a stationary medium or by moving the medium relative to a stationary read-record element. While the speed at which the element and the medium move relative to each other may vary, it is normally required that information always be recorded at the same spot on the medium and that it be read from the same spots. In order to assure this synchronization, a sync track is generally provided which is associated with the medium, reading or recording of a bit of information on the medium being permitted only when the element and the medium are aligned so that a mark on the sync track is being read.

An example of a printer utilizing a sync track of the type described above is found in U.S. Pat. No. **3,690,431** entitled "Print Head Assembly Containing Solenoids" issued Sept. **12, 1972** to Robert Howard and assigned to Centronics Data Computer Corp. With this printer, characters are represented by selectively impregnating dots in a 5×7 character matrix. The paper which is being printed on is held stationary in a carriage which has a sync track associated with it, printing being accomplished by a moving wire print head, which head has the wires for printing a single seven bit stroke or column of the character each time it is energized. A light source and/or detector photocell are positioned on opposite sides of the optical sync track and move with the print head. An output is obtained from the detector when it is adjacent a sync mark on the track and is applied to enable the print head. Thus, printing occurs at the same spots and with the same spacing between print strokes regardless of the speed at which the print head moves.

However, the system described above does have limitations in certain special situations. First since a 5×7 matrix is utilized for generating all characters, a period takes up the same space as a letter such as a *w*. The printer thus does not have the ability to justify for character size even when it is known that a punctuation mark or some other one or two stroke character will always appear in a particular character position. One place where this can be a particular problem is when printing numbers, where a period is being utilized as a decimal point. Here, an extra space before or after the period of the decimal point is aesthetically undesirable.

Another limitation of the existing sync system is that all printed characters are of the same size. There are special situations where it may be desired to print characters of different size on the same line such as, for example, to distinguish between dollars and cents on a line of text or to emphasize or call attention to special items. Also, the same print head may be utilized to

print on different mediums such as, for example, a bank pass book and a journal during a single line of printing. Because of differences in the size of the medium or the use to which it is to be put, it may be desired for the print to be larger on one of these mediums and smaller on the other. Another possible situation where it might be desired to print characters of two different sizes during a single line of printing would be where two writing heads were provided, one providing a visual printing and the other, for example, recording information magnetically on a selected area of the medium. Particularly in the latter situation where information is being recorded magnetically or in some other way which is not visible to the human eye, it might be desirable to provide random spacing of the write strokes so that only a device having the same random spacing on its sync track may be utilized to read the material. A relatively simple, substantially tampered-proof system is thus provided for recording for example an account balance to permit off-line banking. Such a coding arrangement could also be utilized in other similar applications.

In order to provide the various capabilities indicated above, a requirement exists for permitting variable spacing between the read or record strokes for different characters on a line, or even between the strokes of a given character of the line. Existing synchronization systems do not provide such a capability. While certain prior art synchronization systems have provided several sync tracks for permitting printing of different size characters, only one of these sync tracks is utilized for printing a given line and all characters on the given line are of the same size. A synchronization system for premitting the printing of the characters of different size on a single line is thus required.

In addition to providing variable sized characters on a single line, a flexible sync system might also be utilized for solving other problems. For example, with a printer of the type described above, the print head is normally accelerating at the beginning of the line and decelerating at the end of the line. The head is thus moving somewhat slower at the beginning and end of the line than on the remainder of the line. With the head continuously moving, there is a slight offset between the instant that a print command is received (i.e. a sync mark is detected) and the time the print solenoids in the print head are actually energized to cause a print operation to be performed. This offset is greater when the head is moving faster than it is when the head is moving slower. By suitable adjustment within the sync system, this offset differential could be eliminated.

The offset problem is even more serious when the printer is being utilized in a manner such that it prints from left to right during one line and from right to left during the succeeding line. Such a mode of operation is desirable in very high speed printers since it eliminates the delay time otherwise required for print head flyback. It is apparent that with this mode of operation, if the same sync marks are utilized, there will be a slight offset to the right of the sync marks during a left-to-right print line and a slight offset to the left of the sync mark during a right-to-left print line. The combined effects of these offsets could result in a noticeable misalignment of the two lines. Again, a requirement exists for providing a means within the sync system to compensate for these offsets.

Further, where the document to be printed on does not completely fill the carriage, it is important, in order

to prevent damage to the carriage, that printing only occur in the areas where the document is positioned. Also, on a given document, there may be areas which contain information, either visible or invisible, which is to be protected against overwriting. Again, it would be desirable if the sync system could be provided with a capability for performing this function. Finally, the sync system might also be utilized for controlling the performance of certain logic functions, in particular such functions as tabbing or carriage return line feed.

SUMMARY OF INVENTION

In accordance with the above this invention provides a control element for use in an electrically controlled device for reading or recording lines of information characters, each of which characters are formed from a selected plurality of strokes. The control element includes a track having a normal pattern of sync markings spaced from each other by a predetermined distance and at least one area having a sync pattern differing from the normal pattern. The area having a different sync pattern may not have a new marking appear within the predetermined distance of a given marking or may have a distance different from said predetermined distance between selected ones of the markings. The element also includes a means operative during the reading or recording of each line of information characters for detecting all the sync markings of both the normal pattern and the pattern in the at least one area, the detecting means including a means responsive to each detected marking for generating a sync pulse. Finally, the control element includes a means responsive to each of the sync pulses for controlling the reading or recording of a single stroke of an information character.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view of a printer of the type in which the control element of this invention might be utilized.

FIG. 2A is an illustration of the type of documents on which printing might be performed utilizing the teachings of this invention as they might be mounted in a printer of the type shown in FIG. 1.

FIG. 2B is a character number chart and a chart of the relative position of the documents on the printer carriage.

FIG. 2C is a perspective view of a sync track suitable for use with a document arrangement as shown in FIG. 2A.

FIG. 3A is a perspective view of a sync track for an illustrative embodiment of the invention.

FIG. 3B is an illustration of illustrative characters obtained utilizing the sync track of FIG. 3A.

FIG. 4A is a perspective view of a sync track for another illustrative embodiment of the invention.

FIG. 4B is a diagram illustrating a few illustrative characters recorded utilizing the sync track of FIG. 4A.

FIGS. 5, 6 and 7 are perspective views of sync tracks utilized for three additional alternative embodiments of the invention.

FIG. 8 is a semi-block schematic diagram of a control circuit suitable for use with the embodiment of the invention shown in FIG. 7.

DETAILED DESCRIPTION

Referring now to FIG. 1, a printer 8 of the type shown in the beforementioned Howard patent is illustrated. This printer consists of a carriage or platen 10 on which is mounted a document 12 to be printed on. Samples of documents suitable for use as a documnt 12 will be described later. A print head, for example a wire print head of the type shown in the beforementioned Howard patent, is mounted to be moved across document 12 by a drive belt 16. Belt 16 is driven by a motor 18 under control of a print and carriage control mechanism 20. Except as specifically indicated later in the application, the nature and function of mechanism 20 are the same as for existing printers and do not form part of the present invention. This mechanism will therefore not be described further.

An optical sync track 22 is attached to the printer in a position parallel to carriage 10. Track 22 is normally opaque but has spaced transparent areas, each of which serves as a sync mark 23. A housing 24 containing a light source 26 and a photocell 28 is mounted for movement with print head 14. Housing 24 is U-shaped so that the light source and photocell are on opposite sides of track 22. Thus, detector 28 is energized to generate a sync pulse on line 30 each time housing 20 comes adjacent to a sync marking on track 22. The signal on line 30 is applied to print head 14 to enable the head to print a single stroke of a character. Whether printing actually occurs when a signal appears on line 30 and the number of wires which are energized to print are determined by other inputs to the print head which do not form part of the present invention. For reasons which will be described in greater detail later, sync pulse line 30 may also be connected as an input to print and carriage control mechanism 20.

FIG. 2A illustrates in some detail documents of the type which may be printed on printer 8 where the printer is being utilized as part of a bank teller terminal. For this embodiment of the invention, an entry is made both in a bank passbook 34 and a journal tape 38 during a single print line, the information printed in the book and journal tape representing the same transaction. For this example, it is assumed that there are 145 possible character positions for the carriage. The bank passbook 34 is positioned starting at character position 20 (FIG. 2B) so that there is a nonprintable margin in the area 40 to the left of the passbook. Positions 20 through 79 contain the bank passbook with a ten character space 42 being provided between the passbook and the journal. Positions 90 through 125 contain the journal tape, leaving a 20 character nonprintable right margin area 44. One each of the documents, there are a number of fields or columns with the nature of the information to be printed in each of these fields or columns being fixed. Thus, the first column of the passbook contains the date which could be a fixed two or three alphabetic characters for the month, two numeric characters for the day, a comma, and two numeric characters for the year. The next column is for withdrawals and would contain positions for four to five numeric characters for the dollars, a position for a period, and two numeric positions for the cents. The information to be printed in the remaining columns of the pass-

book and in the various columns of the journal tape are similarly fixed in format.

With the arrangement shown in FIGS. 2A and 2B, it is apparent that printing is not to occur in the areas 40, 42 and 44 which do not contain documents. Since print head 14 is not enabled unless a sync signal appears on line 30, protection against printing in these areas may be obtained by utilizing the sync track 46 shown in FIG. 2C in place of the standard sync track 22. It is noted that with this sync track, there are areas 48, 50 and 52 which do not contain sync markings, the areas 48, 50 and 52 corresponding to the nonprintable areas 40, 42 and 44 respectively. The absence of sync markings in the areas 48, 50 and 52 assures against the inadvertent energizing of print head 14 when it is adjacent to areas where printing might cause damage to the carriage 10, the print head, or both. The same technique could be utilized to protect against printing in a preprinted or otherwise to be protected field on a document. For example, the left-most field of the passbook is shown as containing preprinted line numbers. Sync pulses could be omitted in the area of the sync track 46 corresponding to this field, protecting against the overwriting of these line numbers.

The predetermined format of the documents to be printed on with the embodiment of the invention shown in FIG. 2 permits other specialized functions to be performed. For example, the print density for all characters on both the passbook and the journal would normally be the same, for example 12 characters per inch. However, as shown in FIG. 3B, it might be desired to distinguish between dollars and cents in, for example, the withdrawal, deposit, dividend, and/or balance columns of the passbook document by utilizing a smaller character for the cents than is used for the dollars. Thus, for example, the print density for the cents character might be 24 to the inch rather than 12 to the inch. As shown in FIGS. 3A and 3B, this is accomplished by spacing the sync markings for the character positions in which the cents are to be printed more closely together than are the sync markings for the other columns.

Also, while five strokes are provided for each character, only two of these strokes are required for printing the period between the dollars and cents. This results in there normally being an excessively large, and not aesthetically pleasing, space between the period and the beginning of the cents indication. Particularly where there is a space problem on the document, this problem may be solved, as shown in FIGS. 3A and 3B, by providing normal spacing for the sync markings for the first two strokes of the character which is to be a period, and spacing the remaining three strokes of this character, and possibly the two strokes for the inter-character spacing, very closely together. This same technique could be utilized in other situations where justification of predetermined characters is desired. It is noted that in FIG. 3A the sync marks for the inter-character spacings and the three unused sync marks for the period have been shown dotted. As discussed previously, these sync marks may, if desired, be omitted to assure that data is not inadvertently printed in these positions.

FIG. 4 illustrates another situation in which variable spacing between the sync markings might be utilized. Assume, for example, that in additon to printing the passbook balance in a visual form, the balance is also printed either magnetically with a suitable head, or in some other nonvisual form, and that the balance in nonvisual form is read by a suitable device and utilized to permit, for example, off-line banking. To prevent tampering with this non-visual material, it may be recorded with random spacing between the strokes of the characters, a sync track 56 such as that shown in FIG. 4A being utilized for this purpose. The appearance of the resulting characters is shown in FIG. 4B. A similar technique could be utilized for the secure recording of magnetic dots or lines or for recording information in any other form.

As indicated previously, there is a slight disparity in off-set when a print head is moving slowly during acceleration and deceleration then when the print head is moving at normal speed. FIG. 5 shows a sync track 58 which may be utilized to compensate for this disparity in off-set. As seen in this figure, the sync markings 23 at the beginning and end of the track are spaced somewhat closer together (the difference in spacing being exaggerated for purposes of illustration) than the spacing at the center of the track.

FIG. 6 illustrates a sync track 60 which may be utilized to compensate for the off-set problem which arises when a print head prints both when moving from left to right and from right to left. The sync markings 62 on this track are slightly wider than normal (two closely spaced sync markings may also be utilized). If a snyc pulse is generated on line 30 when the leading edge of a sync mark 62 is detected, and the width of the mark 62 is roughly equal to twice the normal print off-set, then printing will always occur at the same position on the line, aligned with roughly the middle of the sync mark, regardless of the direction in which the print head is moving.

FIGS. 7 and 8 illustrate another application to which the teachings of this invention may be applied. In FIG. 7, a standard sync track 22 is shown with a slideable shutter 64 position on its right end. In applications where a variable right margin is to be provided, shutter 64 is moved to a position on sync track 22 corresponding to the desired right margin on the document. When housing 24 reaches this point on the sync track, sync pulses no longer appear on line 30. Referring to FIG. 8, it is seen that mechanism 20 contains, among other circuitry, a single-shot 70 which is set by a sync pulse on line 30 and reset to generate an output on line 72 if it does not receive another sync pulse on line 30 within a predetermined period of time equal to, for example, three or four sync pulse intervals. Assume initially that a carriage return line feed signal appears on line 74, causing flip flop 76 to be reset to its ZERO state. When print head 14 starts moving again and detector 28 detects the first sync marking 23 on track 22, a signal appears on line 30 setting single-shot 70 and also applying an input signal to AND gate 78. Since flip flop 76 is in its ZERO state at this time, AND gate 78 is fully conditioned to generate an output which sets flip flop 76 to its ONE state. Flip flop 76 being in its ONE state results in an output on its one-side output line 80 which signal is applied as one input to AND gate 82. So long as successive sync markings are being detected on track 22, single-shot 70 remains set and there is no output on line 72. However, when housing 24 reaches shutter 64, sync pulses are no longer detected and single shot 72 times out, resulting in a signal on line 72 which fully conditions AND gate 82 to generate a

carriage return line feed control signal on line 74. The signal on line 74 resets flip flop 76 to its ZERO state, inhibiting the generation of additional carriage return line feed control signals until the printing of a new line has commenced.

It is apparent that a circuit such as that shown in FIG. 8 could also be utilized for other control functions such as for tabbing or the like. It is also apparent that the applications indicated above for using different sized characters are by way of illustration only, and that sync tracks having variably spaced sync markings might be utilized with any electrically controlled recording or reading device in addition to the printer described for the preferred embodiment. Further, while the tracks for the preferred embodiment have been optical sync tracks which are optically read, it is apparent that the teachings of this invention could be applied with magnetic or other sync tracks. Thus, while the invention has been particularly shown and described above with reference to preferred embodiments, it will be apparent to those skilled in the art that the foregoing and other changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In an electrically controlled recording device for recording a line of characters on a recording medium,

a recording head movable along a line relative to said medium and operable in response to enabling synchronization signals applied thereto for producing selected strokes along said lines so that each character on the line is formed from a plurality of said strokes,

a synchronization track having spaced synchronization marks located in a fixed position relative to said recording medium, and

detecting means for detecting said synchronization marks during relative movement of said head and said medium for producing a synchronization signal in response to each detected mark, each synchronization signal being controllingly coupled to said recording head for enabling said head to produce a stroke at a location along said line corresponding to the location of said head when the synchronization signal is produced,

said synchronization marks being spaced on said track so that the strokes produced by said recording head for a character at a first location along said line will be spaced differently from those produced by said recording head for a character at a second location along said line.

2. The invention in accordance with claim 1, wherein synchronization marks are provided on said track only at locations at which it is desired that a stroke be produced by said recording head.

3. The invention in accordance with claim 1, wherein the recording head produces visual strokes on said medium, and wherein the synchronization marks corresponding to the character at said second location are spaced closer together than the synchronization marks corresponding to the character at said first location so as to thereby cause said recording means to produce characters having different recording densities.

4. The invention in accordance with claim 1, wherein the recording head is adapted to produce non-visual strokes, and wherein the synchronization marks provided on said track corresponding to at least one character are located so that the recording head will produce different spacings between the strokes of the character, thereby providing for recording of a character in coded form.

5. The invention in accordance with claim 1, wherein said recording head moves more slowly during acceleration and deceleration than when moving at normal speed, and wherein the synchronization marks provided at the beginning and end of said track are spaced closer together than those at the center of the track in order to compensate for the slower speed of the recording head during acceleration and deceleration.

6. In a high speed electrically controlled recording device for recording a line of characters on a recording medium,

a recording head movable in either direction along a line relative to said medium and operable in response to enabling synchronization signals applied thereto during continuous movement of the head in either direction for producing selected strokes along said line so that each character on the line is formed from a predetermined plurality of said strokes,

a synchronization track having spaced synchronization marks located in a fixed position relative to said recording medium and,

detecting means for detecting said synchronization marks during relative movement of said head and said medium and for producing a synchronization signal in response to each detected mark, each synchronization signal being applied to said recording head for producing a stroke at a location along said line corresponding to the location of said head when the synchronization signal is produced,

said detecting means being responsive to the leading edge of each synchronization mark during relative movement of said head in either direction, and said synchronization marks having a width chosen in conjunction with the speed of relative movement of said head so that each stroke will be recorded at its proper position along a line regardless of the direction of movement of the recording head.

7. In an electrically controlled recording device for recording a line of characters on a recording medium,

a recording head movable along a line relative to said medium and operable in response to enabling synchronizing signals applied thereto for producing selected strokes along said line so that each character on the line is formed from a predetermined plurality of said strokes,

a synchronization track having spaced synchronization marks located in a fixed position relative to said recording medium and,

detecting means coupled to said recording head for detecting said synchronization marks during relative movement of said head and said medium and for producing a synchronization signal in response to each detected mark, each synchronization signal being applied to said recording head for producing a stroke at a location along said line corresponding to the location of said head when the synchronization signal is produced,

a shutter relatively movable with respect to said track for preventing a selected plurality of said synchronization marks from being detected by said detecting means, and

electrical circuit means to which said synchronization signals are applied for producing an output signal when a Synchronization signal is not received within a predetermined period of time from a previously received synchronization signal.

8. The invention in accordance with claim 7, wherein said predetermined period of time is at least three synchronization signal intervals.

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