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PAPER CARRIAGE SHIFTING MEANS IN HIGH SPEED LINE PRINTERS

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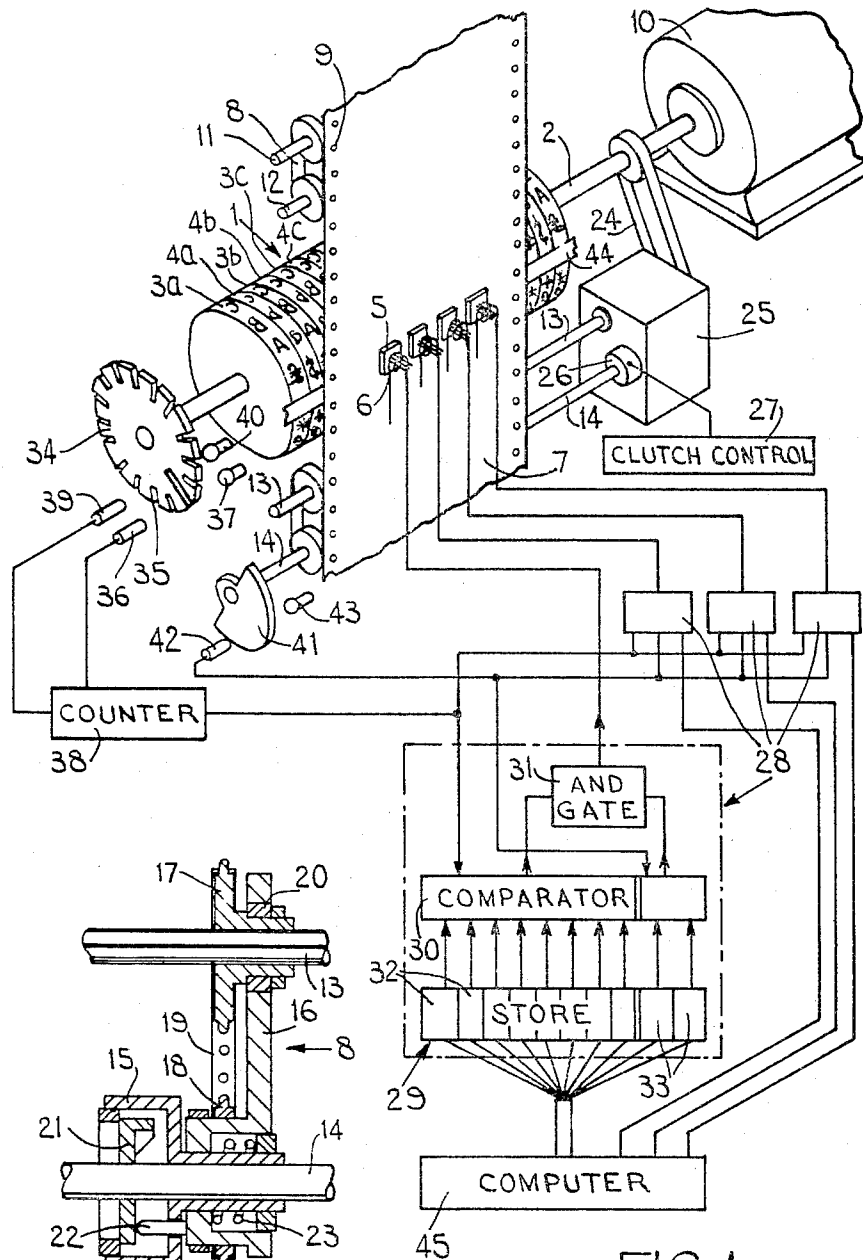


FIG. 2.

FIG. 1.

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## PAPER CARRIAGE SHIFTING MEANS IN HIGH SPEED LINE PRINTERS

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### ABSTRACT OF THE DISCLOSURE

A line printer in which relative movement between a paper web and a print barrel, in a direction parallel to the axis of the barrel, is used to increase the repertoire of characters. Adjacent bands of characters include different character groups, e.g. upper and lower case letters, so that a shift of one column pitch enables a character of either group to be printed in any particular columnar position. The character repertoire can be doubled without increasing the diameter of the print barrel or the operating speed of the print hammers.

### Background of the invention

This invention relates to printing apparatus.

Printing apparatus of the kind usually referred to as "on-the-fly" printers are well known. A typical on-the-fly printer has a type barrel, which carries 120 circumferential bands of characters, and which rotates past a line of 120 print hammers at a speed of 1000 revolutions per minute. A line of type may be printed on a paper or other recording medium between the barrel and the hammers during each revolution of the barrel. A particular character is printed in any columnar position on the medium by energising the print hammer for that column at the moment when the desired character is passing the printing position.

The number of characters in each band is usually within the range 48 to 64. The normal character set forming a band consists of the numerals 0-9, the upper case letters A-Z and symbols such as £, \$, &, etc. The print barrel may be made so that it can be changed by the machine operator if a different set of characters is required for a particular job. However, there is an increasing demand for the printing of character sets of 96 to 128 characters, i.e. twice the size of these which have been generally available.

The incorporation of an enlarged character set requires a corresponding increase in the circumference of the print barrel. The barrel is then of such a size that the operator may find difficulty in changing it. Furthermore, the peripheral speed of the barrel is doubled if the rotational speed is maintained in order to print the same number of lines per minute. Consequently, the operating time for a print hammer would have to be halved.

The present invention provides a printing apparatus which prints optionally a line of characters selected from a first character set or from a second character set.

### Summary of the invention

According to the present invention, printing apparatus includes a cylindrical printing member; a plurality of circumferential bands of type characters on said printing member, each band including at least some characters which are different from the characters which are included in the bands immediately adjacent thereto; means to rotate said printing member about its longi-

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tudinal axis; means to feed a recording medium past said printing member in a direction perpendicular to said axis; a line of print hammers mounted parallel to said axis and selectively operable in co-operation with said printing member to print lines of characters on said recording member; and means to produce relative movement between said recording medium and said printing member in a direction parallel to said axis to select which characters may be printed in a particular columnar position in a line of characters.

### Brief description of the drawings

FIGURE 1 shows a diagrammatic view of the printing apparatus, and

FIGURE 2 shows a sectional view of a tractor mechanism forming part of the apparatus.

### Description of the preferred embodiments

Referring now to FIGURE 1 of the drawing, the printing apparatus includes a cylindrical printing member or print barrel 1 which is mounted on a shaft 2 so that the barrel 1 can be rotated about its longitudinal axis. The barrel 1 carries a number of bands of characters 3 and 4, alternately, each band 3 containing a first set of characters and each band 4 containing a second set of characters. A plurality of hammers 5, each having an operating mechanism 6, is arranged in a line parallel with the axis of the barrel 1. Although for the sake of clarity only four hammers 5 are shown in FIGURE 1, there is, in practice, one hammer for each individual band 3 and 4.

A record medium, which consists of a web of paper 7 on which columns of characters are to be printed, is fed line-by-line between the barrel 1 and the hammers 5 by means of four tractors 8. The tractors 8 have pins which engage in perforations 9 near the edges of the web 7, two of the tractors 8 being arranged to engage the left hand edge and the other two (not visible in FIGURE 1) being arranged to engage the right hand edge of the web 7. An inking ribbon 44 is fed between the web 7 and the barrel 1.

The shaft 2 is rotated by an electric motor 10 so that the characters on each band 3 and 4 are brought successively into a printing position in which they are facing and aligned with the hammers 5. Correctly-timed operation of the hammer mechanisms 6 causes the web 7 and the ribbon 44 to be pressed momentarily together between the operated hammers 5 and the desired characters on the bands 3 and 4, thereby causing printing of the characters on the web 7.

The two upper tractors 8 are carried by shafts 11 and 12 and the two lower tractors 8 by shafts 13 and 14. The tractors 8 may be adjusted laterally in pairs to accommodate different widths of web 7 by sliding the tractor mechanisms 8 along the shafts 11-14.

The tractors 8 are also all movable laterally in synchronism to displace the web 7 in a direction parallel to the axis of the barrel 1 so that each print column lies opposite a band 3 and opposite a band 4 in alternate revolutions of the barrel 1. Each hammer 5 is therefore associated with each adjacent column on the web 7. Referring also to FIGURE 2 of the drawing, which figure shows a section through one of the lower tractors 8, each tractor 8 includes a slide member 15 which is mounted on the shaft 14 (shaft 12 for the upper tractors), and a casing 16 which is slidable on the member 15 and which holds a pair of pin wheels 17 and 18 carrying a tractor band 19. The wheel 18 rotates on a boss formed on the casing 16 and the wheel 17 rotates in a bearing 20, both wheels 17 and 18 being retained in a fixed lateral position relative to the casing 16. The wheel 17 is rotated by

the shaft 13 which is splined so that the wheel 17 may slide along it.

Displacement of the casing 16, and hence the wheels 17 and 18, is effected by a cam 21 which is rotated by the shaft 14. The cam 21 engages with a pin 22 attached to the casing 16 and displaces the casing 16 along the slide member 15 against the action of a spring 23. The profile of the cam 21 is such that the casing 16 is displaced by a distance equal to the width of each character band 3 and 4 for substantially half a revolution of the cam 21 and is returned to its initial position for substantially the other half revolution. The shafts 13 and 14 are driven by the motor 10 through a belt 24 and a gearbox 25 arranged to rotate the shaft 13 intermittently to give the required line-by-line movement of the web 7 and to rotate the shaft 14 to displace and return the pin wheels 17 and 18 for alternate revolutions of the barrel 1. The shafts 11 and 12 are coupled to the shafts 13 and 14 respectively, by means not shown, so that the upper tractors 8 operate in synchronism with the lower tractors. An electromagnetic clutch 26, operated by a clutch control 27 is provided so that drive to the shafts 12 and 14 may be engaged or disengaged.

The hammers 5 are operated at the correct times in the revolutions of the barrel 1 to print the desired characters. To accomplish the timing of the hammers 5 a plurality of identical hammer control circuits 28, one for each hammer mechanism 6, is provided. Each control circuit 28, one of which is shown in detail, includes a store 29, a comparator 30 and an AND gate 31. The store 29 has a number of stages 32 for storing information representing from which line of characters on the barrel 1 a character is to be printed, and further stages 33 to store an indication of which of the two columns associated with the particular hammer is to contain the character. The information is entered into the stores 29 by a computer 45.

A slotted disc 34, carried by the shaft 2, rotates in synchronism with the barrel 1. The disc 34 has a plurality of slots 35 corresponding to the character positions round the bands 3 and 4. As each line of characters reaches the printing position a photo cell 36, energised by a light source 37 which passes light through the corresponding slot 35, generates a signal which is passed to a counter 38. One of the slots 35 is longer than the others and co-operates with a further photo cell 39 and light source 40 to generate a resetting signal for the counter 38 once in each revolution of the barrel 1. The count in the counter 38 at any instant therefore represents which particular line for characters is at the printing position. The comparator 30 compares the count in the counter 38, with the information in the store 29 and, if these correspond, passes a signal to one input of the AND gate 31.

The shaft 14 carries a semi-circular plate 41 which co-operates with a photo cell 42 and a light source 43 to provide an indication of the position of the cam 21 at any instant, and hence an indication of the lateral position of the web 7.

The comparator 30 also compares the indication from the photo cell 42 with the entries in elements 33 of the store 29 and feeds a signal to the other input of the AND gate 31 if there is correspondence. Hence if the particular character line which is at the printing position and the column which is opposite a print hammer 5 are both in accordance with the stored information, the hammer mechanism 6 for that hammer 5 is operated and the character printed.

The above-mentioned displacement of the tractors 8 in pairs to accommodate different widths of web 7, may be effected by cables 46 (FIGURE 2) attached to the members 15, or, alternatively by mean of lead-screws (not shown).

In one embodiment of the invention bands 3 include the usual set of type characters, that is, numerals 0-9, upper case letters A-Z and some symbols. The bands 4 include another set of type characters, such as the lower case letters a-z and a further group of symbols. Thus a pair of

adjacent bands can include up to 128 different type characters.

It is convenient for purposes of description to designate the set of type characters on the bands 3 as set I, and the set of type characters on the bands 4 as set II and to designate the print column positions as *a*, *b*, *c*, *d*, etc. and the bands as 3*a*, 4*a*, 3*b*, 4*b*, etc. numbering from the left hand side as seen in FIGURE 1. During the first revolution of the print barrel in a cycle, the columns *a*, *b*, *c*, *d*, etc. are aligned with the bands 3*a*, 4*a*, 3*b*, 4*b*, etc. respectively. The web 7 is then shifted to the right by one column position, so that print column positions *a*, *b*, *c*, *d*, etc. are aligned with bands 4*a*, 3*b*, 4*b*, 3*c*, etc., during the second revolution of a cycle.

It will be assumed, as an example, that the character 21*Xa* are to be printed in the column positions *a*, *b*, *c*, *d* of a line. The characters in the positions *a*, *b* and *c* belong to set I, and the character in position *d* belongs to set II. The print column positions *a* and *c* are aligned with bands including the characters of set I during the first revolution of the print barrel 1 in the cycle. At the same time, the print column positions *b* and *d* are aligned with bands including the characters of set II. Hence, the web 7 is so positioned during the first revolution that the required characters may be printed in the print column positions *a*, *c* and *d*. Accordingly, the hammers 5 for these positions are operated at the appropriate times during the first revolution to print 21*Xa*. The character in print column position *b* cannot be printed during this revolution because it is a character of set I and this print column position is aligned with a band including characters of set II.

The web 7 is now shifted to the right, so that print column position *b* is aligned with band 3*b*, which includes the characters of set I. Hence, the hammer 5 for bands 3*b* is operated at the appropriate time in the second revolution to print the character 1 in print column position *b*. Thus, the required group of characters is printed in one cycle of two revolutions of the barrel 1. The characters from one set only can be printed in the last print column position, since this position has been moved beyond the last band during the second revolution of a print cycle. Hence, the number of print column positions in which characters of both sets may be printed is one less than the number of bands.

It has been assumed in the foregoing description that the lateral shift of the web 7 occurs between revolutions, that is, in the time between the passage past the printing position of the last character of one revolution and the first character of the next revolution. The time between characters may be too short to allow full movement of the web 7 if the printer is operating at a speed of several hundred lines per minute. The printer operates normally in an asynchronous manner, that is a print cycle may be started at any time. If it is assumed that the characters in a band follow the normal sequence A, B, C, D, E, F, etc. a print cycle might start when the character C is about to pass the printing position. The first revolution of the barrel for that cycle would be completed when the character B next passes the printing position. The movement of the web 7, whether for lateral or line spacing, could then take place whilst the characters C, D and E, say, were passing the printing position. The second revolution for that print cycle would then be started as the character F is about to pass the printing position.

Character sets in excess of 128 characters may be required in certain circumstances, such as a printer which will print at will both Roman and Cyrillic alphabets. Such extended sets may be provided by using different character sets on a group of, say, four adjacent bands, the print barrel carrying a number of groups of four bands. Each print cycle consists of four revolutions, with a lateral shift of the paper occurring at the end of each revolution. The cams 21, the plate 41, the comparators 30 and the stores 29 would then be constructed to provide the required number of steps of web displacement.

The increase in the number of characters is obtained at the expense of a reduction of the line printing speed for a given rotational speed of the barrel 1, since each printing cycle takes two or more revolutions of the barrel 1. This reduction in printing speed is acceptable if the extended character set is being used most of the time. However, it becomes less acceptable as the proportion of printing which uses the standard character set increases. This disadvantage may be overcome by providing optional selection of the number of revolutions which comprise a print cycle, together with a rearrangement of the type characters within the bands. One way in which the printer may be modified is to replace some of the characters of set II with some of the characters of set I. For example, one set of characters which has been proposed as a standard consists of 96 different characters. This requirement may be met if set I includes the usual 64 characters, but set II includes, say, the letters A-Z plus six other characters of set I as well as the additional 32 characters which are required to make up the total of 96 different characters.

The modified printing apparatus is operated with two revolutions per print cycle for printing the 96 character set, in a manner similar to that already described in relation to printing the 128 character set. The letters A-Z occur in each band 3 and 4, so that they are available for printing in each print column position without any lateral shift of the web 7. Consequently, text consisting only of these letters may be printed in the conventional manner with only one revolution of the barrel 1 per print cycle and no lateral web shift. Any other sub-set of the characters of set I may be duplicated in set II, so that, for example, numeric printing, with the appropriate symbols, may be carried out using one revolution per print cycle.

In a further modification of the invention, each band 3 and 4 includes all the characters of set I, together with a sub-set of the characters of set II. For example, in the case of a 96 character set, each band has eighty characters. The 96 character set is made up of 64 characters of set I and 32 characters of set II. The bands 3 include all the characters of set I and 16 of the characters of set II. The bands 4 include all the characters of set I and the remaining 16 characters of set II.

The printing apparatus may be used in the conventional manner, with one print cycle for each revolution of the barrel 1, to print characters from set I, since these characters are included in all the bands 3 and 4. The feeding of the web 7 for line spacing is carried out during the passage of the characters of set II past the printing position. The characters of set II in the bands are aligned along the print barrel.

The print cycle for printing the 96 characters repertoire consists of two revolutions of the barrel 1. The characters of set I will be available for printing in all print column positions during both revolutions. This allows movement of the web 7 to be effected during part of the time when the characters of set I are passing the printing position, so that no additional time is required for movement of the web 7. One possible timing of web movement and printing is as follows:

#### *1st revolution*

Characters 1-38 of set I pass the printing position—line spacing movement of the web 7.

Characters 39-64 of set I pass the printing position—print any of these characters.

Characters 1-16 of set II pass the printing position—print any of these characters.

#### *2nd revolution*

Characters 1-38 of set I pass the printing position—print any of these characters.

Characters 39-64 of set I pass the printing position—lateral shift of the web 7.

Characters 17-32 of set II pass the printing position—print any of these characters.

It will be clear that other timing arrangements are possible which utilise parts of the passage of the characters of set I past the printing position for effecting movement of the web 7.

The modifications of the invention requires selective operation of the cams 21 which provide lateral shifting of the web 7, the web 7 being shifted only if the full character repertoire is being used. The clutch 26 is then selectively operated by the control 27, so that lateral shift occurs during a particular revolution of the barrel 1 only if the clutch 26 is engaged during that revolution. Alternatively, the cams 21 may be replaced by one or more solenoids, the armatures of which are coupled to the tractors 8. The armatures of two or more solenoids may be coupled together through binary additive linkages in known manner to provide several positions of lateral shift, if this is necessary.

The invention has been described in relation to a printing apparatus in which the web 7 is shifted laterally with respect to the barrel 1. It will be appreciated that the same effect is achieved if the barrel 1 is moved axially with respect to the web 7. Hence, the invention requires only that there should be provision for relative movement between the web 7 or other recording medium, and the barrel 1 in a direction parallel to the longitudinal axis of the barrel 1.

The invention is not limited to the apparatus described above, and many variations of the apparatus are possible without departing from the scope of the invention. For example, different print barrel and tractor driving means may be provided. Furthermore, different arrangements for timing the operation of the print hammers may be used.

We claim:

1. A printing apparatus including a print member with a plurality of bands of type characters corresponding to columns of a recording medium,
  - a printing hammer associated with each band and confronting said band at a printing position, odd bands containing one group of type characters, even bands cyclically interlaced between said odd bands and containing type characters, some of which are different from the type characters on said odd bands,
  - means to store a line of characters required to be printed,
  - means for indicating the characters on said odd and even bands at said printing position,
  - means for comparing said stored characters with said indications of actual characters in said printing position and providing a signal indicating an equivalence therebetween,
  - means responsive to said equivalence indication for selectively operating said hammers at the time in which the required characters of said even and odd bands are in said printing position,
  - means for producing a relative movement between said printing member and said recording medium by one columnar position only when the full repertoire of characters on both bands is to be employed, said indicating, comparing and selectively operable hammer means operating again to print only the remainder of said stored characters.
2. A printing apparatus including a print member with a plurality of bands of type characters corresponding to columns of a recording medium,
  - a printing hammer element associated with each band and confronting said band at a printing position,
  - odd bands containing one group of characters,
  - even bands interlaced with said odd bands and containing type characters, some of which are different from the type characters of said odd bands,
  - means to store a line of characters to be printed,
  - means for indicating which characters on said odd and even bands are confronting said printing position,
  - means for comparing said stored characters with said

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indications of actual characters in said printing position and providing a signal indicating an equivalence therebetween,  
 means responsive to said equivalence indicating signal for selectively operating said hammers at the time in which the required characters of said even and odd bands are in said printing position,  
 means for producing a relative movement between said printing member and said recording medium by one columnar position only when the full repertoire of characters on both bands is to be employed, said indicating comparing and selectively operable hammer means operating again to print only the remainder of said characters,  
 said means to store a line of characters including a first storage section associated with each printing hammer element effective to store an indication of the required position of said printing member relative to said hammer to print the stored character, and including a second storage section effective to store an indication of the required relative lateral position of said recording medium and said printing member for printing said desired character in a particular columnar position,  
 said comparing means including a first section associated with each printing hammer element and operable to indicate an equivalence between said actual position of said printing member and said indication of said required position of said printing member, a second comparator section associated with each printing hammer element operable to indicate equivalence between said actual relative lateral position of said printing member and said recording medium with respect to a stored indication of said actual relative position, and means including an AND gate associated with each printing hammer element connected to both said comparator sections for energizing each printing hammer upon first and second comparator sections simultaneously producing said equivalence indications.  
 3. An apparatus as claimed in claim 2 wherein said shifting means include a clutch and clutch control means for selectively shifting said printing member laterally

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by one columnar position only when the full repertoire of characters is to be used, with lateral shifting only occurring during engagement of said clutch.

4. A method of printing type characters on a recording medium including the steps of,  
 presenting a plurality of interlaced odd and even bands, some of the characters of said odd bands being different from characters on said even bands, to a printing position whereby each individual band is confronted with a printing hammer element,  
 storing a line of characters required to be printed, indicating characters on said odd and even bands at the printing position,  
 comparing said stored characters with indications of actual characters in said printing position and providing an output signal indicating an equivalence therebetween,  
 operating said printing hammers in response to said equivalence indicating output signal at the time in which said required characters of said even and odd bands are in said printing position,  
 shifting said recording medium by one columnar position only when the full repertoire of characters on both bands is to be employed and repeating said indicating, comparing and printing operations recited above only with respect to the remainder of characters required to be printed.

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