Oct. 4, 1960 J. WOODHEAD 2,954,860

PRINTING APPARATUS

Filed Sept. 23, 1958 3 Sheets-Sheet 1

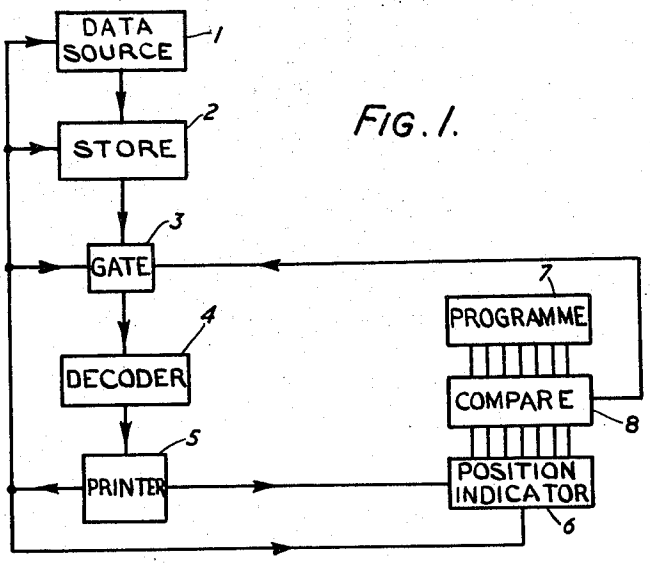

FIG. 1.

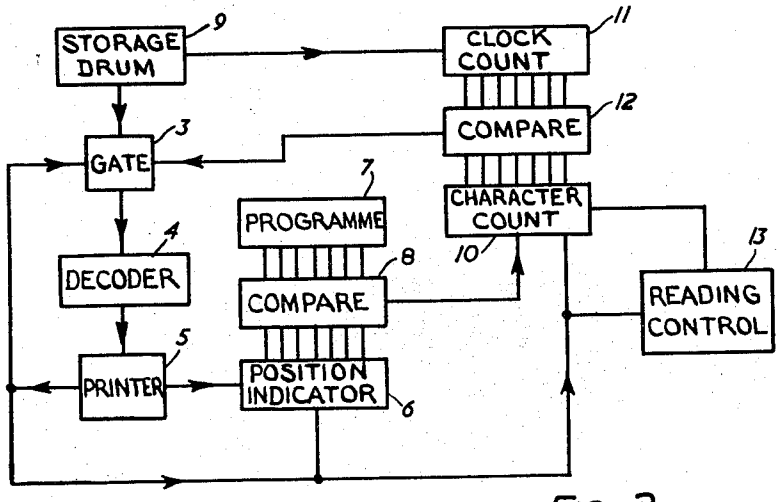

FIG. 2.

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PRINTING APPARATUS

Filed Sept. 23, 1958 3 Sheets-Sheet 2

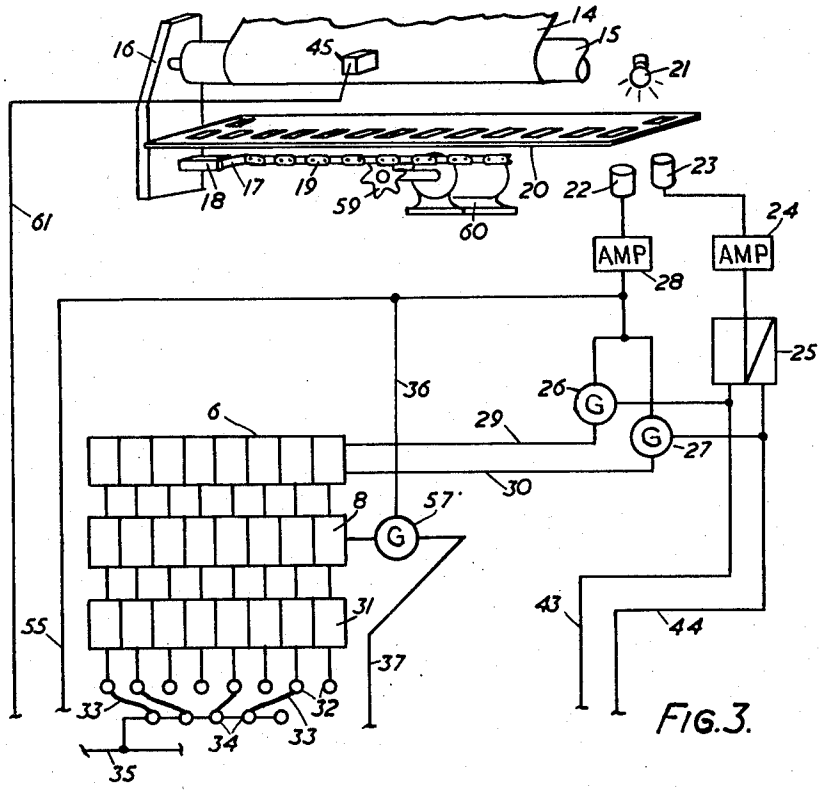

FIG. 3.

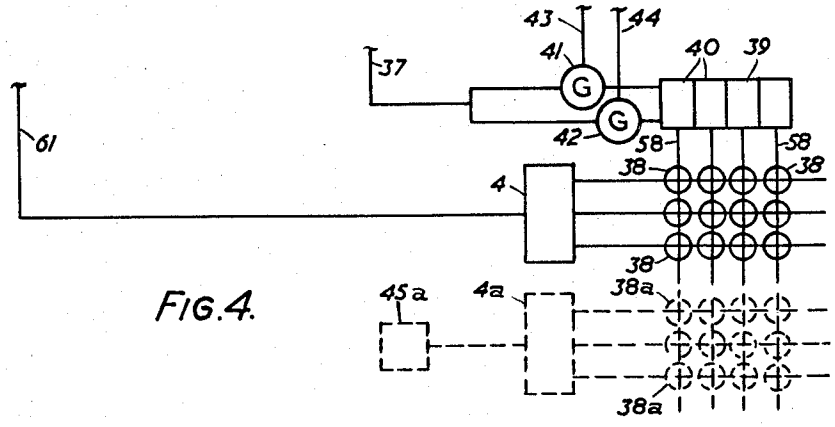

FIG. 4.

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PRINTING APPARATUS

Filed Sept. 23, 1958 3 Sheets-Sheet 3

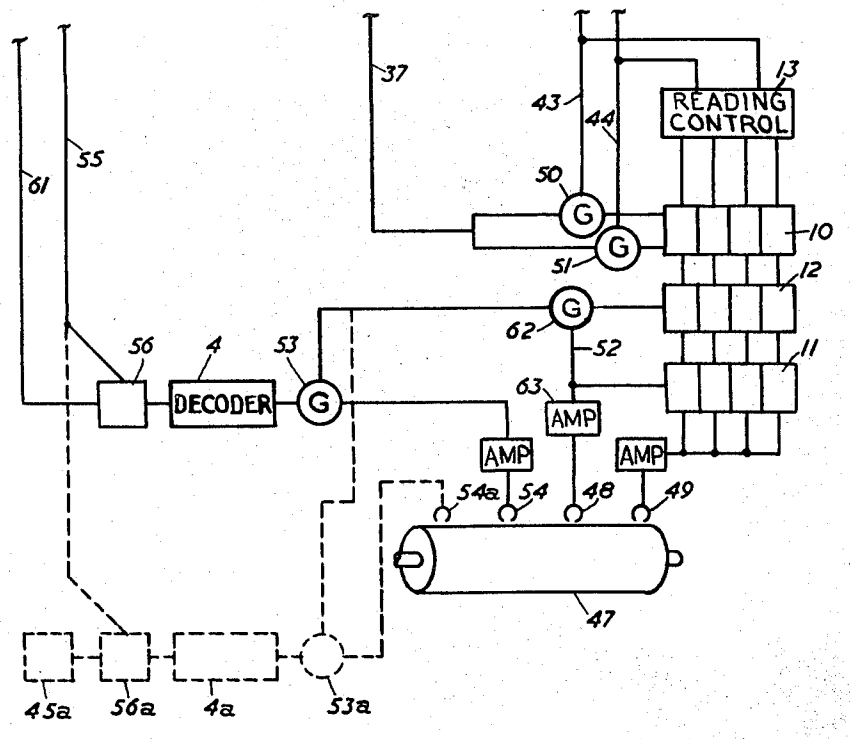

FIG. 5.

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United States Patent Office

2,954,860

Patented Oct. 4, 1960

2,954,860

PRINTING APPARATUS

James Woodhead, Letchworth, England, assignor to International Computers and Tabulators Limited, London, England

Filed Sept. 23, 1958, Ser. No. 762,764

Claims priority, application Great Britain Sept. 25, 1957

28 Claims. (Cl. 197—19)

This invention relates to improvements in printing apparatus in which characters are printed in succession in lines on a document or other record.

Printing apparatus is known in which a succession of characters is printed in a line on a document or card by the selection of appropriate type faces as the document is traversed step-by-step past a printing position. Such apparatus may employ a so-called wire-printing head, in which a number of printing elements or wires are grouped to form a rectangle and each character is formed by the selection of various ones of the wires to form a pattern conforming to the outline of the required character. At the end of a line of characters the printing operation is halted while the document is moved back to its starting position and spaced longitudinally to permit the printing of a new line.

It is an object of the present invention to provide an improved printing apparatus in which lines of characters may be printed on a document or other record, the positions of the characters in a line being determined by relative movement between the document and a printing element or elements in alternate directions, printing taking place during the movement in either direction.

It is a further object of the invention to provide means controlled by the position of the document or other record relative to the printing element or elements to select characters from a storage means to be printed in specific locations in a line.

According to one aspect of the invention apparatus for printing characters in a plurality of character positions on a record includes means for producing relative motion between the record and a printing element adapted to print a plurality of different characters to bring selected ones of said character positions opposite the printing element in sequence, means for indicating that position which is opposite the printing element, a storage device adapted to store the characters to be printed, each character being stored in an identifiable storage location, programme means settable to indicate the storage location associated with each of said selected positions, and means for comparing the indications of the position indicating means and the programme means and adapted to read out the stored character from the appropriate location.

According to another aspect of the invention two or more printing elements may be provided, different ones of the selected character positions being brought opposite each element. The printing elements may be arranged in line and adapted to print a succession of characters in a single line on the record or each element may be adapted to print a succession of characters in a separate line on the record.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram showing an arrangement for printing information derived from a data source,

Figure 2 is a schematic diagram showing a modified arrangement for printing information derived from a magnetic storage drum,

Figure 3 is a schematic drawing showing the control arrangements associated with a printing device,

Figure 4 shows schematically apparatus for reading characters from a static storage device under control of the printing device shown in Figure 3, and

Figure 5 shows schematically an alternative arrangement for reading the characters from a magnetic storage drum.

The device for printing characters on a document may include a platen arranged to carry the document and adapted to be spaced round to bring successive lines into position to receive a line of printed characters. The platen may then be supported in a carriage of conventional form adapted to be moved transversely past a single printing position alternately in opposite directions, line spacing taking place at the end of a transverse movement. A mechanism for moving a carriage at a substantially uniform speed in both directions is described in detail in United States application Serial No. 756,014, filed August 19, 1958, and assigned to the same assignee as the present application.

A printing element may be mounted in a fixed position adjacent to the carriage, and printing impulses may then be applied to the element while the carriage is moving to cause a line of characters to be printed on the document. The spacing of the characters is then controlled jointly by the frequency of the printing impulses and the speed of movement of the carriage. A printing element comprising a head having a number of printing wires selectively operable to print characters on a document supported in the carriage, is described in detail in British Patent No. 796,685.

Alternatively the printing element may include a member, such as a type-wheel or type-bar, bearing type characters, any one of which may be selectively moved to a printing position. A printing impulse may be applied to the printing element to cause the selected character to be printed on the document.

Thus the printing and document holding device is arranged to support the document and move it in a forward direction, that is from right to left, past a single character printing element to receive a line of characters printed in order from left to right. At the conclusion of the forward movement the document is advanced by one line space and is then moved in the reverse direction. During this reversal of motion a further line of characters is printed. At the end of the reverse movement the document is again line-spaced and the entire sequence of events is repeated. However, during a reversal of movement of the document characters are printed from right to left, so that a line of characters must therefore be stored and read out to the printing element in reverse order.

Since the lateral spacing of the characters in a line is conditioned by relative movement between the document and the printing element, it will be apparent that the moving carriage may alternatively be adapted to carry the printing element, the platen being supported in a stationary framework. This is an advantage in the case of a high speed printer wherein it is desirable to reduce the weight of the moving parts. Moreover, because the platen does not move laterally, difficulties inherent in feeding documents or a paper web into a continuously moving platen are eliminated.

It will be apparent that since relative motion between the platen and the printing head is continuous it is possible to control the printing of a line of characters so that printing takes place on the stroke of movement following the completion of the entry of one line into the store.

Thus, it is then necessary to control the line spacing device in a similar way so that line spacing takes place according to a predetermined programme as the lines are printed. For example, an indication that a complete line of characters has been stored may cause a line spacing operation at the end of a carriage movement to be followed by a read-out cycle. Alternatively, the line spacing device may be operated only at the conclusion of a line of printing.

Figure 1 shows a simplified schematic diagram of apparatus in which a line of characters is printed during a single carriage movement. Information representing the characters to be printed in one line is derived from a data source **1** and is applied to a storage device **2**. The information may be presented to the storage device either in parallel, i.e. all characters relating to one line are simultaneously delivered to the storage device; or in series, in which case the information is entered character-by-character into appropriate locations in the store. Information may be stored in coded form and is passed by a gating device **3** to a decoder **4** where it is translated into suitable form for operating the printing device **5**. The print device may be continuously running and it is therefore necessary to arrange means for reading out the contents of store in synchronism with the position of the carriage of the printer.

For this purpose a position indicating device **6** is operated in response to the carriage movement. The device **6** in one form is a commutator similar to that shown in the above mentioned United States application, previously referred to, having an individual contact segment for each position in which a character is to be printed in the line. The contact segments are connected, in succession, by contact brushes to a common line as the carriage moves past the printing head. The commutator may therefore be arranged to scan the locations in the store so that characters in appropriate locations are read out to the printing head in synchronism with the motion of the carriage.

Alternatively, the position indicating device **6** may be a counter arranged to register a value representative of the position of the carriage relative to the printing head. In this case a device for generating an impulse as each printing position passes the printing head may be provided. Such a device may, for example, consist of a contact pair operated by a cam surface on the carriage, or photo-electric pulse generating means may be used, e.g. an illuminated scale containing alternate opaque and transparent areas, scanned by a photo-electric cell. This latter device has the advantage that it imposes no additional load on the carriage mechanism, and it is not itself mechanically operated. It is thus particularly suitable for printers operating at high speeds.

Impulses generated by the device are then added in the counter when the carriage is moving forward and subtracted as the carriage reverses its direction. Limiting switch arrangements operated at each end of a carriage movement may be used to control whether the entry to the counter is additive or subtractive.

In a simple embodiment the limiting switch circuit may also be used to initiate the read-out of a complete line from the store **2**, reading-out always commencing as the carriage begins a new stroke. Similarly the data source **1** may be placed under control of the limit switches, so that data is entered into the store only at the end of a printing stroke, the gate **3** being closed while entry of new data takes place.

During a printing operation it is frequently desirable that characters should be printed in predetermined positions in a line. For example, in the preparation of tabular lists it is required that data should be presented in vertical columns and therefore characters in each line are allocated to columnar positions. However, for economy in the provision of storage locations it is undesirable that storage locations should be provided for those positions in which no character is to be printed. Hence, the layout of each line of printing may be predetermined, for example, by means of a plugboard, in a programme device **7** so that a character is read out from the store **2** only when the location in which it is to be printed is passing the printing head.

The programme control may be effected by providing a comparing unit **8** between the position indicator **6** and the programme device **7**, and using the comparing device to control the gate **3** to allow information to be read out from the store **2** only when the position occupied by the carriage coincides with one of the positions in which a character may be printed. The comparing unit may be of the kind which allows the passage of a control signal upon coincidence between the two input paths, e.g. when the position number registered by the position indicator coincides with a similarly numbered position plugged on the programme device. The control signal is then applied to open the gate **3**.

The arrangement of the printing apparatus and the associated programme device are shown schematically in greater detail in Figure 3. The document **14** upon which characters are to be printed is carried by a platen **15** past a stationary printing element **45**. The platen is in turn mounted in conventional manner in a carriage of which one frame member **16** is shown. Reciprocatory motion is imparted to the carriage by means of a driving arrangement including a link **17** supported by an arm **18** projecting from the frame member **16**. The link **17** is secured to one end of a roller chain **19** which is engaged with a sprocket wheel **59** driven by a suitable motor **60**. The other end of the chain is similarly secured to a second carriage frame member, so that rotation of the sprocket **59** drives the carriage in one direction to the limit of its travel. The point of engagement of the chain with the sprocket is transferred at this time by the continued rotation of the sprocket to a point diametrically opposite that shown, and the carriage is then returned in the reverse direction.

A graticule **20** is supported by the carriage and is illuminated by means of a light source **21**. Two photo-electric cells **22** and **23** are provided to scan the graticule.

The cell **22** scans a strip of the graticule in which alternate transparent and opaque areas are recorded. As these areas are scanned the cell **22** provides a series of output pulses. The areas are so proportioned that each pulse corresponds to a position in which a character may be printed on the document. The part of the graticule scanned by the photo-electric cell **23** contains two transparent areas only and these are arranged to allow light from the source **21** to reach the cell **23** when the carriage is at the limit of its travel in either direction.

Resultant impulses generated by the cell **23** are amplified by a conventional amplifier **24** and applied to a bistable electronic trigger **25**. Thus, the trigger **25** forms a limit switch for the carriage and is changed from one stable state to the opposite state, whenever the carriage reverses its direction of movement. Outputs from the trigger **25** are connected to control gates **26** and **27** which are of conventional form, the gate **26** being opened to allow the passage of pulses when the carriage is moving in one direction and the gate **27** being opened when the carriage is moving in the reverse direction.

Pulses generated by the photo-electric cell **22** are amplified by amplifier **28** and are applied through the gate **26** or the gate **27** to one of two entry lines **29** or **30** to the position indicating device **6**. This device consists of a number of electronic valves arranged to form a ring counter, each valve forming one stage of the counter and being conditioned to conduct in turn in response to the succession of pulses from the amplifier **28**. Pulses delivered over the line **29** are arranged to condition the stages successively in predetermined order, and pulses delivered over the line **30** are arranged to condition the stages successively in the reverse order. As each stage

conducts, the preceding stage becomes non-conductive. Thus the particular stage which is conducting at any time provides an indication of the character position currently brought into position opposite the printing element.

Each stage in the position indicating device **6** is connected so that it is rendered conductive by an impulse derived from one of the lines **29** or **30** and, in this state, conditions the following stage to be rendered conductive by the following impulse. At the same time, the previous stage is restored to its original non-conductive state. It will be appreciated that since the order in which the stages are rendered conductive is reversed during alternate movement of the carriage two control paths are provided between adjacent stages and additional gates are provided in each of these paths. These gates are controlled by the trigger **25** so that the order in which the stages are rendered conductive corresponds to the direction of motion of the carriage.

The programme device **7** shown in Figure 1, consists of a similar number of stages **31** (Figure 3) which are, however, not interconnected. Each stage therefore represents a position in which a character may be printed and is provided with a plug socket **32**. The sockets of those stages in which characters are required to be printed are connected by means of pluggable connectors **33** and sockets **34** to a common line **35**. The potential of the line **35** is such that the stages connected thereto are rendered conductive.

The comparing unit **8** consists of a number of comparing stages, one connected between each stage of the position indicating device and the corresponding stage **31** of the programme device. A comparing stage consists of a single valve, e.g. a triode, whose control grid is connected in parallel to cathode loads of the two stages with which it is associated. Thus if both stages are conducting, both the cathodes are at a high potential and the potential on the control grid of the comparing valve is correspondingly raised. However, if one or both the stages are non-conducting, at least one of the cathodes is at a low potential and the potential on the control grid is maintained at a low value. Raising of the potential of the comparing valve control grid causes the valve to conduct. The cathodes of all the comparing valves share a common cathode load resistor, so that whenever one of the comparing valves is conducting the potential of the common cathode connection is raised. This is connected to control a gate valve **57** of conventional form so that whenever the set stage of the position indicating device corresponds to one of the set stages of the programme device the gate is opened.

Pulses from the amplifier **28** are applied to the gate **57** over a line **36** and a pulse is therefore passed by the gate to a line **37** whenever the carriage is in a position in which a character that is required to be printed is brought opposite the printing element **45**.

The pulses passed over the line **37** are used to control the reading of characters from the storage device. Figure 4 shows an arrangement for reading the characters from a storage device consisting of a matrix of bistable magnetic storage cores **38** arranged in rows and columns. Characters may be entered into the storage device in coded form by the use of conventional half-current techniques to set selected cores in a column to represent a character. Thus each column of cores may be defined as a location in which a single character may be stored, a unique combination of set cores representing each character which is required to be stored. For the sake of clarity each column is shown as having only three cores, but it will be appreciated that in order to allow one of a large number of characters to be stored it is necessary, in practice, to provide a greater number of cores in each column. Since the reading-in of characters forms no part of the present invention only the arrangement for reading characters out of the storage device is shown in schematic form.

Associated with the storage device is a reading distributor **39** generally similar to the position indicating device **6**, and consisting of a number of stages **40**. The stages are rendered conductive in turn by the application of pulses on the line **37**. The order in which the stages conduct is reversed during alternate movements of the carriage so that the order in which characters are read out corresponds to the order in which the positions on the document are brought opposite the printing element. This reversal is controlled by gates, such as **41** and **42**, which are connected by lines **43** and **44** respectively to the trigger **25** (Figure 3) in a similar manner to the control of reversal of the position indicating device **6**.

A read-out winding **58** is associated with each column of cores and is coupled to all the cores in the column so that the application of current to the winding has the effect of resetting any cores in the column which have been set. Each read-out winding **58** is connected to a trigger stage **40** by an amplifying stage so that the resetting current is applied to a read-out winding when the associated trigger stage is set. Hence, the trigger and amplifier form a gating device to allow each column of cores to be read-out in turn under the control of the pulses on the line **37**, and it will be seen that the programme device thus controls, by means of the comparing device, the selection of the storage locations to be read out.

Each row of cores is linked to an output winding. The output windings are connected to a conventional decoding device **4**. As a core is reset due to the application of current to a read-out winding an impulse is induced in the associated output winding. Thus, as each column of cores is read out, impulses representative of the code combination of the stored character are passed to the decoder **4**. From the decoder appropriate control signals are passed over line **61** to select the corresponding character to be printed by the printing element **45**.

It will be appreciated that more than one printing element may be controlled in a similar manner by the same distributor **39**, the read-out windings being extended as shown by dotted lines to link with columns of cores **38***a* in a second storage matrix. A further decoder **4***a* is then used to control another printing element **45***a*. Thus, two or more characters may be printed simultaneously under control of a single programme device.

It will be appreciated that the foregoing arrangement permits only those characters to be stored which are required to be printed in one movement of the carriage, and that therefore the printing device is idle during the time when data is being entered into the store. Read-out from the store may take place, however, whether the carriage is travelling forwards or in reverse.

The efficiency of the apparatus may be increased by the use of a storage device or devices, each comprising two storage sections, data being entered into one section while previously stored information is read out of the other. Thus, provided that data is entered at least as fast as the printing head can read-out, the printer operates continuously. The data entry and read-out paths contain change-over devices to ensure their connection to the appropriate storage sections, and these change-over devices or divertors are conditioned in response to the limit switch of the carriage. Interlocks are also provided to inhibit read-out from a section which has not received a complete line of information and also to inhibit data entry into a section which is already full.

While the storage device has been described as comprising magnetic storage cores, it will be appreciated that other bistable storage elements may alternatively be used; for example, characters may be read from an array of electronic trigger stages or neon storage tubes in a similar way.

The foregoing storage devices are static in the sense that data may be entered into the storage elements, which

are then scanned in response to the movement of the carriage in order to read the data out. However, a storage device in which the character-storing locations are continuously scanned may be used. In this case the required storage location must be selected to be read out as it is scanned under control of the programme device. An example of a storage device in which the locations are continuously scanned is a magnetic storage drum, and Figure 2 shows a modification to the apparatus to enable data to be read-out directly from a storage drum without the intervention of an output or buffer store. Similar parts are referenced with the same numbers. The storage device **9** is in this case a conventional magnetic storage drum containing a plurality of storage tracks in which items of data are recorded and read-out by suitable magnetic heads. A particular item is selected to be read out by a switching operation which selects the head appropriate to the track in which the item is recorded. A clock track is also provided on the drum and sensed by another head which generates a pulse corresponding to each storage location in which a data item may be recorded on the storage tracks. A further track also provides an indication of the beginning of a revolution of the drum so that a particular storage location may be identified by a number derived by counting the clock pulses generated between the beginning of the drum revolution and the scanning of the location by the appropriate head.

The speed of rotation of the drum is such that successive items recorded on a track are sensed considerably faster than they can be recorded by the printing head. The output of the comparing unit **8** is therefore taken to a synchronising network in order that only one item is presented to the decoder **4** for each operation of the printer.

The synchronising network consists of a character counter **10**, a clock pulse counter **11** and a comparing device **12**.

At the beginning of a read-out cycle the character counter **10** is set to a total corresponding to the location from which the first character is to be read. If a complete track is to be read-out this counter will be set to zero. It is more usual, however, to require only part of the contents of a track to be recorded. The particular part is determined in response to the recording programme. Thus, a reading control unit **13** is provided to indicate the location of the first item to be printed, and this unit is arranged to preset the character counter **10** to the number of this first location.

The clock pulse counter **11** is reset to zero each time a revolution-start pulse is sensed, and then counts the clock pulses generated as the drum **9** rotates. These clock pulses are generated just before the locations to which they refer are sensed.

The comparing device **12** operates in a similar manner to the comparing device **8**, so that when the counters **10** and **11** coincide, i.e. as the required location is about to be sensed, a signal is transmitted to the gating device **3** to allow the selected location to be read out to the decoder **4** and the printer **5** then prints the required character. The position indicator **6** is then advanced in response to the movement of the carriage, and a signal generated by the coincidence of the indicated position of the carriage and the programme device **7**, denoting that the next character is required to be read out and printed, is passed by the comparing device **8** to step the character counter **10**. The location corresponding to this new setting of the counter **10** is then read out by the operation of the gating device **3** when the clock counter **11** coincides with the counter **10** as described above.

Figure 5 shows in greater detail the arrangement of the synchronising network in association with a magnetic storage drum **47**. The clock track is sensed by a reading head **48** and the revolution marker signal is read by a head **49**.

Pulses from the head **48** are amplified by means of an amplifier **63** and are passed to the clock pulse counter **11**, which may consist of a number of stages similar to the position indicating unit **6**. In this case the character counter **10** is also similar to the unit **6**. As many stages are provided as there are storage locations to be scanned during a complete traverse of the printer carriage.

However, since only a part of the track in which characters are stored may be required to be read out, it may be preferred to assign each storage location a number in order to facilitate the identification of the first location to be read. In this case the character counter **10** and the clock pulse counter **11** may more conveniently be binary counters. Each counter consists of a number of trigger stages but these are interconnected to form a reversible binary counter.

Pulses derived from the comparing unit **8** (Figure 3) controlled, as described, by the programme device are applied over line **37** to the counter **10**. Since printing may take place while the carriage is moving in either direction, the counter is arranged so that pulses are entered either additively or subtractively under control of gates **50** and **51** respectively which are controlled by lines **43** and **44** from the trigger **25** (Figure 3). The counter **10** (Figure 5) is a conventional binary counter arranged to allow additive or subtractive entry of the pulses by the provision of alternative interconnections between the stages, all the interconnections being controlled by gates which are in turn controlled by the lines **43** and **44** in a similar manner to the gates **50** and **51**.

The comparing device **12**, in this case, is of known construction having a pair of triodes associated with corresponding trigger stages in the counters **10** and **11**. The control grid of each triode is connected to unlike anodes of the trigger stages, that is the control grid connected to a set anode of one stage is also connected to the unset anode of the corresponding stage. Thus when the two triggers connected to one pair of triodes are switched to opposite states, the grid electrode of one of the triodes is connected to anodes which are both at high potential and this triode is then rendered conductive. When, however, both counters are registering identical values, none of the triodes is conducting.

The cathodes of all the triodes share a common cathode load and the common cathode potential therefore falls only when the counters are identical. This condition is used to open a gate **62**, consisting of an inverter followed by a gating valve, in the conventional manner and a clock pulse applied over line **52** to the gate **62** is allowed to pass to condition a further gate **53**.

The character recorded in the selected location is then read by a head **54**, amplified, and passed by the gate **53** to the decoder **4**.

It will be appreciated that, as in the case of the static storage device previously described, additional storage locations may be read-out simultaneously by means of further gates, such as **53***a*, which are arranged to control the outputs of additional heads, such as **54***a*, to further decoders such as **4***a*. These additional control arrangements are shown by means of dotted lines. The additional reading heads may be arranged to scan other tracks on the drum or a number of heads may be arranged to scan the same track.

In the case where only a part of the track of the drum is required to be printed, the counter **10** is preset at the beginning of a reading operation to a value corresponding to the location of the first character required. Since the carriage may be travelling in either direction, this first location may be that of the character at either end of a line. Thus the reading control unit **13** is arranged to hold the values representing the locations occupied by both these characters. At the limit of travel of the carriage the appropriate value is selected by means of a connection from line **43** or **44** (Figures 3 and 5), which is used to operate gates within the control unit, to forcibly set the counter **10** to the required value.

It will be apparent that when both the storage drum and the printing device are continuously running, the speed of the drum must be such that it completes a revolution during the time when the printer carriage is passing one character position. It is possible to arrange that the drum and the printing device are in synchronism in this way by driving both from a common driving shaft, the drive to the printing device being suitably geared down in relation to the drum.

However, if the drum and the printing device are separately and asynchronously driven, and the printing head is adapted to operate upon the application of printing pulses, the application of a read-out signal through the gate 53 and the decoder 4 directly to the printing head may give rise to incorrect spacing between succeeding printed characters. To avoid this result the output from the decoder 4 to the printer 5 is further controlled by a switching device 56.

The printing element having a number of printing wires, referred to earlier, includes an electromagnet for each of these wires, the operation of a selected group of magnets causing the required character to be printed. The switching device 56 contains a trigger stage for each electromagnet and those trigger stages corresponding to the magnets to be selected are switched to the "set" state by the output from the decoder 4. Each trigger stage is associated with a gas-filled relay valve and a "set" trigger stage conditions the relay valve with which it is associated.

A synchronizing pulse is derived from the photo-electric cell 22 (Figure 3) as each character position is moved opposite the printing element 45 and is applied over line 55 (Figures 3 and 5) to trigger those relay valves which have been conditioned. The printing element electromagnets are in the anode circuits of the relay valves and are thus operated to print the selected character under control of the carriage position indication provided by the photo-electric cell.

A similar switching device, such as 56*a*, is provided for each additional printing element 45*a* as shown by dotted lines.

As in the case of the additional printing elements described with reference to Figure 4, these elements are used to reduce the overall printing time. For example, a number of printing heads may be spaced across the width of the platen to reduce the distance moved by the carriage in printing a line of characters. Hence, if four heads are provided, each may be used to print one-fourth of the total number of characters in a line, and the movement of the carriage will be equal to the distance between adjacent heads, i.e. one quarter of a line length. In this case the storage device may be divided into four parts, one part being provided for each of the heads. Alternatively, the heads may be mounted one below the other and four lines of characters printed at the same time. This requires that the storage device shall have four times the capacity of that required for one head, and also requires four decoding devices, but again, since four lines are printed in one carriage movement, the overall printing time is correspondingly reduced. The line spacing mechanism is adjusted to move the document a distance equivalent to four line spaces.

It will be appreciated that the various combinations of platen travel and printing head distribution allow a flexible programme of printing to be followed. For example, in a simple case, a single line of information may be derived from one unit record source, e.g. a record card bearing information, the whole or part of which is to be recorded in a single line on a document. The provision of a storage device between the data source and the printing device allows the order of items of data to be changed, i.e. the items may be read from the source into storage locations which are in a different order from that in which the items appeared in the original record.

Alternatively a single line of characters may be built up from a number of source units. For example, several record cards may be read and data items entered into the store in predetermined order from each card. This feature is useful in printing information, for example, name and address or other indicative data which may occur on separate source records, and may also be used to print information derived, for example, from magnetic or paper tape, where the data is recorded in blocks and where the order in which these blocks are originally recorded differs from the order in which the information is required to be printed. Thus the tape may be read in sequence without the necessity for reversing and re-sensing the tape to read the items in the desired order.

This facility for rearrangement also allows the redistribution of data already recorded on the document. For example, a document may bear pre-recorded information in a form which may be sensed, e.g. a dividend warrant bearing holes or marks representing payee identity and payment to be made, and this information may then be printed in the same or a different order in predetermined positions on the document. In this case the document passes through a sensing station before being fed into the printer carriage, the pre-recorded information being stored and read out in the order required for printing.

Alternatively or additionally, it is also possible to use this re-arrangement facility for the insertion of extra information. For example, certain data may have significance by virtue of its position in predetermined locations in the source record, e.g. data recorded in certain columns of a card represents value in units of currency such as pounds, sterling or dollars. It is then possible to print the appropriate symbols or other descriptive matter by entering the additional matter into the store from another source or by arranging for the permanent storage of such matter.

What I claim is:

1. Apparatus for printing characters in a plurality of character positions on a record, including a printing element capable of printing a plurality of different characters, means for producing relative motion between the record and said printing element to bring selected ones of said character positions opposite the printing element in sequence, means for indicating that position which is opposite the printing element, a storage device adapted to store the characters to be printed, each character being stored in an identifiable storage location, programme means settable to indicate the storage location associated with each of said selected positions, means for comparing the indications of the position indicating means and the programme means, and means controlled by the comparing means to read out the stored character from the appropriate location.

2. Apparatus for printing characters in a plurality of character positions on a record, including at least two printing elements each capable of printing a plurality of different characters, means for producing relative motion between the record and said elements to bring selected ones of said character positions opposite the printing elements in sequence, different ones of the selected character positions being brought opposite each element, means for indicating that position which is opposite a printing element, a storage device adapted to store the characters to be printed, each character being stored in an identifiable storage location, programme means settable to indicate the storage location associated with each of said selected positions, means for comparing the indications of the position indicating means and the programme means, and means controlled by the comparing means to read out the stored character from the appropriate location.

3. Apparatus as claimed in claim 2 in which the printing elements are arranged in line, and adapted to

print a succession of characters in a single line on the record.

4. Apparatus as claimed in claim 2 in which each element is adapted to print a succession of characters in a separate line on the record.

5. Apparatus as claimed in claim 2 in which the storage device is a rotary magnetic storage drum having a separate character reading head associated with each printing element, the heads being selected to read characters recorded on the drum under control of a single programme means.

6. Apparatus as claimed in claim 5, in which each reading head is adapted to scan a separate track on the magnetic drum.

7. Apparatus as claimed in claim 5, in which the reading heads are adapted to scan a single track on the magnetic drum.

8. Apparatus as claimed in claim 5, in which the comparing means includes means adapted to compare a first designation representing the location from which a character is required to be read with a second designation derived from the storage drum representing the location currently being scanned, said comparing means being adapted to select a location to be read out when the designations are identical.

9. Apparatus as claimed in claim 8 in which the designation derived from the drum is read from a separate clock track.

10. Apparatus as claimed in claim 1 in which said comparing means produces an output pulse for each occasion that the indications of the position indicating means and the programme means agree and said read out means comprises scanning means which is coupled to the comparing means to receive said output pulses and responds to successive output pulses to read out the characters from the storage locations in a predetermined order, one for each pulse.

11. Apparatus as claimed in claim 10 in which said relative motion producing means comprises means for causing relative reciprocation of the record and the printing element and said scanning means is switchable between two modes of operation in the first of which it reads out the characters from the storage locations in said predetermined order and in the second of which it reads out the characters in the reverse of said predetermined order and there is further provided control means automatically set in dependence upon the direction of said relative motion and coupled to said scanning means to switch it to said first or second mode of operation respectively depending on whether said relative motion is in one direction or the other.

12. Apparatus as claimed in claim 11 in which said control means comprises a bi-stable element, means for generating an impulse on each occasion that the printing element is brought to either end of the record, and means for applying said impulses to the bi-stable element alternately to set and reset it.

13. Apparatus as claimed in claim 1 in which the storage device comprises a plurality of bi-stable storage elements.

14. Apparatus as claimed in claim 13 in which the bi-stable storage elements are each a bi-stable magnetic core.

15. Apparatus as claimed in claim 1 in which the storage device is a rotary magnetic storage drum.

16. Apparatus as claimed in claim 15 in which the comparing means includes means adapted to compare a first designation representing the location from which a character is required to be read with a second designation derived from the storage drum representing the location currently being scanned, said comparing means being adapted to select a location to be read out when the designations are identical.

17. Apparatus as claimed in claim 16 in which the designation derived from the drum is read from a separate clock track.

18. Apparatus for printing characters in a plurality of character positions on a record, including a printing element capable of printing a plurality of different characters, means for producing relative motion between the record and the printing element to bring said character positions opposite the printing element in sequence, means for indicating that position which is opposite the printing element, a storage device adapted to store the characters to be printed, each character being stored in an identifiable storage location, programme means settable to indicate at which character positions a character is to be printed, means for comparing the indications of the position indicating means and the programme means and for producing an output signal on each occasion that they indicate the same position and means responsive to said output signals to read out the characters stored in selected storage locations to the printing element in a predetermined order, one in response to each output signal.

19. Apparatus for printing characters in a plurality of character positions on a record, including a printing element capable of printing a plurality of different characters, means for producing relative reciprocation of the record and the printing element to bring said character positions opposite the printing element alternately in a predetermined sequence and the reverse thereof, means for indicating that position which is opposite the printing element, a storage device adapted to store the characters to be printed, each character being stored in an identifiable storage location, programme means settable to indicate at which character positions a character is to be printed, means for comparing the indications of the position indicating means and the programme means and for producing an output signal on each occasion that they indicate the same position, means responsive to said output signals to read out the characters stored in selected storage locations to the printing element in a predetermined order, one in response to each output signal, and means for automatically reversing said predetermined order when the character positions are brought opposite the printing element in the reverse of said sequence.

20. Apparatus according to claim 19 in which said position indicating means includes position indexing means for generating a position impulse as each character position is brought opposite the printing element.

21. Apparatus according to claim 20 in which said position indicating means further includes line indexing means for generating an end of line impulse as the printing element reaches either end of the record.

22. Apparatus according to claim 21 in which said position indicating means further includes a reversible counter having as many stages as there are character positions and in which each stage has two conditions of operation but only one stage can be in the first of said conditions at any one time, means for applying said position impulses to the reversible counter to cause stepping of the first condition from one stage to the next, control means for controlling the direction of stepping in said reversible counter and means for applying said end of line impulses to said control means to control the direction of stepping in dependence upon the direction of relative motion of the record and the printing element.

23. Apparatus according to claim 22 in which said programme means includes as many stages as there are character positions, each stage being settable to one of two conditions, the first condition indicating that a character is to be printed at the corresponding position and the second condition that a character is not to be printed at the corresponding position.

24. Apparatus according to claim 23 in which said

comparing means has a stage for every character position, means coupling each comparing means stage to the corresponding stages of the reversible counter and the programme means, and means for generating an output signal on each occasion that both the reversible counter stage and the programme means stage coupled to the same stage of the comparing means are in their first condition.

25. Apparatus according to claim 24 which further includes a normally closed gating circuit, means for applying said position impulses to the gating circuit and means for applying said comparing means output signals to the gating circuit to open it.

26. Apparatus according to claim 18 in which said storage device comprises a matrix of bi-stable storage elements.

27. Apparatus according to claim 26 in which said storage elements are bi-stable magnetic cores.

28. Apparatus for printing characters in a plurality of character positions on a record, including a printing element capable of printing a plurality of different characters, means for producing relative motion between the record and the printing element to bring said character positions opposite the printing element in sequence, means for indicating that position which is opposite the printing element, a rotary magnetic drum storage device having a plurality of information tracks and a clock track and separate reading heads for deriving information representing signals and clock pulses from the respective tracks, character representing signals being stored in successive locations on one of said information tracks, programme means settable to indicate at which character positions a character is to be printed, means for comparing the indications of the position indicating means and the programme means and for producing an output signal on each occasion that they indicate the same position, a first counter coupled to said comparing means to receive said output signals and to count the number received, a second counter coupled to the clock track reading head to count the clock pulses, a further comparing means coupled to said first and second counters and arranged to produce an output signal on each occasion that their conditions are identical, a normally closed gating circuit having a signal input and a signal output, means coupling said signal input to the reading head for the track on which said character representing signals are stored, means coupling the signal output to the printing element and means for applying the further comparing means output signals to open said gating circuit.

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