April 25, 1967 B. J. BARISH 3,316,555

ELECTROSTATIC PAGE PRINTER

Filed April 29, 1963

Fig. 2.

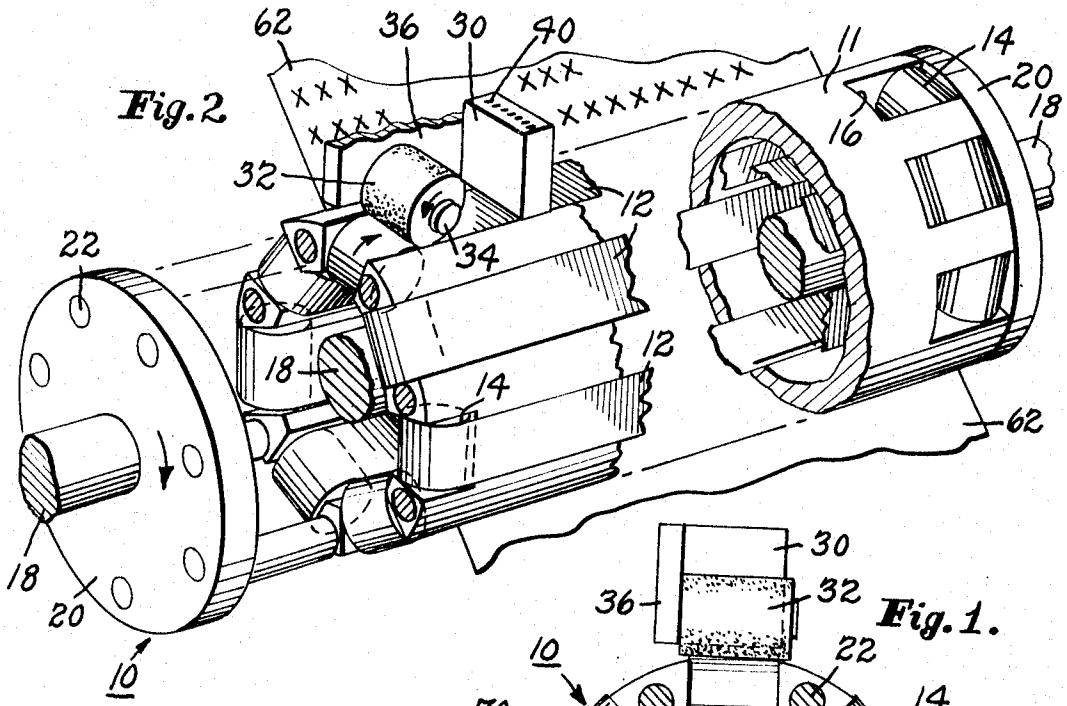


Fig. 1.

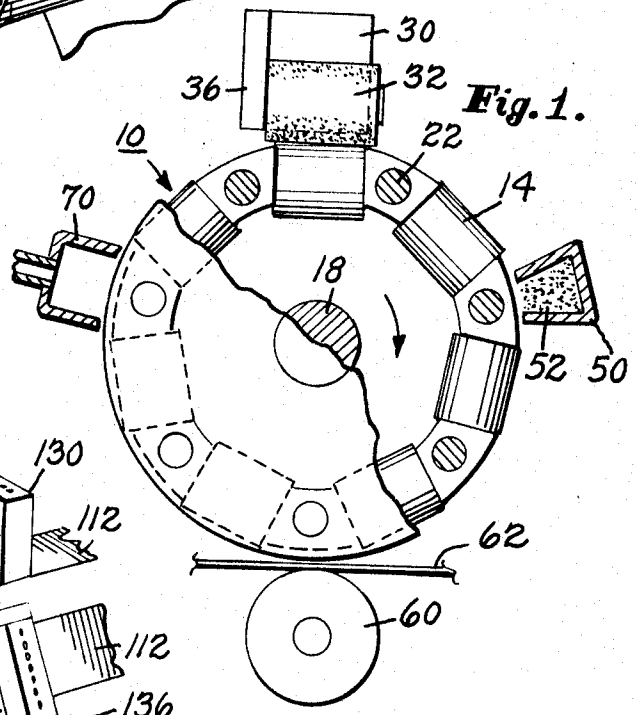
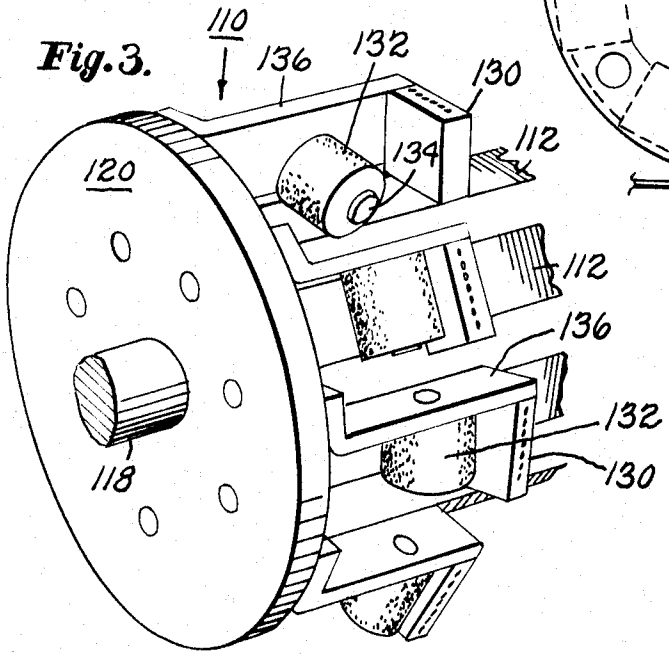


Fig. 3.



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ELECTROSTATIC PAGE PRINTER

Benjamin J. Barish, Detroit, Mich., assignor to Burroughs Corporation, Detroit, Mich., a corporation of Michigan

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This invention relates to recording apparatus and particularly to apparatus which may be used for recording alphanumeric information on a record sheet. The invention is herein described for illustrative purposes as embodied in an electrostatic page printer as this is a particularly suitable application of the invention.

Page printers require the printing of a plurality of lines on a page or sheet. There are many types of mechanical page printers, but these are generally characterized by relatively slow speed or high cost because of the complexity of the mechanism required to overcome the relatively high inertia of mechanical elements. Electrostatic page printers avoid most of these high inertias, since the recording or printing is effected by depositing electrostatic charges on a paper, and, according to the design, it is possible to design the machine so that nothing need be physically moved in the machine except the paper. This is true in one type of electrostatic page printer in which the recording heads are in the form of a matrix of pin electrodes selectively actuatable in accordance with the characters to be printed. However, in this type of printer, there must be a separate printing head for each character position in the printing line. For example, if the printer is designed for printing 72 characters to the line, as in a present form of the printer, the printer would have to include 72 individual printing heads and 72 circuits, etc., to actuate them selectively. While such page printers can operate at very high speeds, they are relatively very costly because of the multiplication of the number of heads and the circuits required for multi-line page printing.

Several arrangements have been proposed for utilizing a single matrix-head in a page printer. See for example Campbell et al. U.S. Patent No. 3,076,393. The advantages in using a single head are of course quite apparent. They drastically reduce the amount of circuitry required to actuate the head, beside reducing the number of heads themselves from, say 72, to but 1. Single matrix-head arrangements are more characteristic of strip printers involving the printing of a single continuous line, rather than page printers involving the printing of a plurality of lines. Strip printers can usually be manufactured at a fraction of the cost of page printers.

Generally speaking, the present invention provides a new and improved printer which is basically a simple strip printer but which is capable of operating as a relatively inexpensive page printer. One form of the invention requires but a single recording head, while another form of the invention includes a plurality of heads in an arrangement which increases substantially the speed of the printer.

A general object of this invention is to provide a new and simplified recording apparatus.

A further object of the present invention is to provide an apparatus which requires only one recording head for printing a multi-line record.

A further object of the invention is to provide an apparatus which may use a plurality of recording heads to increase the speed of the printer.

A further object of the invention is to provide an improved electrostatic page printing apparatus having one or more of the advantages discussed above.

A still further object of the invention is to provide an improved electrostatic printer in which the record sheet ultimately receiving the printed information may be made of inexpensive conventional material, and need not be the relatively expensive type specially treated to have the charge retentive properties usually necessary for use with this type of apparatus.

These and other objects and advantages, which will become apparent as the description proceeds, are obtainable by the present invention which is herein described for illustrative purposes with respect to two forms of electrostatic page printers.

In the drawings:

FIG. 1 is an end view, partly in section, of one form of electrostatic page printer constructed in accordance with the invention;

FIG. 2 is a perspective view, partly broken away, of the recording cylinder frame member of FIG. 1; and

FIG. 3 illustrates a variation of the printer of FIGS. 1 and 2, specially designed for higher speed operation.

The novel electrostatic page printer illustrated in FIGS. 1 and 2 comprises a metal frame member **10** generally cylindrical in shape and rotatable about its longitudinal axis. Cylinder **10** carries a translatably supported record medium which is movable along the cylinder's periphery **11** parallel to the longitudinal axis of the cylinder. This record medium is in the form of a tape **12**, a plurality of which are provided, each being carried in spaced relation to the others on the periphery of cylinder **10**. These tapes **12** are each in the form of an endless loop passing over a pair of end rollers **14** mounted at the ends of the cylinder **10**, and movable over the outer and inner surfaces of the cylinder. Rollers **14** are disposed in notches **16** formed at the ends of the cylinder.

Cylinder **10** is mounted on a shaft **18** which carries a pair of end disks **20** secured to shaft **18** and to the cylindrical surface **11** by a plurality of pins **22**. Rotation or incrementation of shaft **18** thus moves cylinder **10** about its longitudinal axis.

The apparatus further includes a recording head **30** for recording the information on the tapes **12**, and means for driving each tape as the information is being recorded. The latter means comprising a drive roller **32** mounted on a shaft **34**. Recording head **30** and drive roller **32** are coupled together by a bracket **36** fixed to the frame of the machine so as to be relatively stationary with respect to rotatable cylinder **10**.

Recording head **30** comprises a plurality of pin electrodes **40** positioned so as to be slightly spaced from the upper surfaces of the underlying recording tape **12**. Pin electrodes **40** are selectively actuated in accordance with the information to be recorded to produce a pattern of dot-shaped charged areas on the paper surface which collectively form the characters being recorded. The excitation potential of the pin electrodes is in the order of a thousand volts. The underlying surface of cylinder **10**, being made of metal, serves as the back electrode, and may be grounded.

Tapes **12** are either formed or treated so as to have a surface resistivity which makes them adaptable to retain the electrostatic charges deposited by the pin electrode **40** of recording head **30**.

Recording head **30** is of the matrix-type. Its pin electrodes **40** are elements of a matrix which are selectively actuated to form collectively the character to be printed. Various electrode structures and circuits may be used for recording head **30**, such as disclosed in Epstein et al. U.S. Patent No. 3,012,839, for example.

In operation, drive roll **32** is driven by its shaft **34** to drive the tape **12** underlying the roll parallel to the longitudinal axis of cylinder **10**. Recording head **30** electrostatically records a line of information on that tape as the latter is thus driven. When the line of information is completed, drive roller **32** is controlled by its shaft **34** so as to terminate the movement of the tape.

To record the second line, cylinder **10** is rotated one increment until the next tape **12** underlies drive roll **32** and recording head **30**. Drive roll **32** then drives the second tape **12**, moving it parallel to the longitudinal axis of cylinder **10**, while recording head **30** records the characters on that tape. When that line of information is completed, drive roll **32** is again stopped to terminate the movement of the second tape **12**.

Thus, by starting drive roll **32**, recording the information on the tape **12** underlying head **30**, stopping roll **32**, indexing cylinder **10** one increment until the next tape **12** underlies the drive roll **32** and the recording head **30**, and continuing the above operation for each of the tapes **12**, it is seen that lines of information are successively recorded on tapes **12** in a continuous operation.

A developing station **50** is operatively positioned with respect to the periphery of the cylinder **10** in the direction of rotation of the cylinder so as to subject the electrostatic charges on the tape **12** to a cloud of finely divided ink particles **52** which will electrostatically adhere to the charged area, thereby rendering the charged areas visible. A pressure roll **60** is disposed at a point further in the direction of rotation of cylinder **10**, and is effective to produce a transfer of the recordings on the tapes **12** to a record sheet **62**.

There are many ways by which the lines of information carried as inked electrostatic charges on tapes **12** can be transferred to record sheet **62**. For example, this transfer can be effected directly, that is by directly transferring the ink carried on the tape **12** to the paper sheet. Alternatively, this transfer can be effected indirectly. Various known forms of direct transfer utilize electrostatic attraction, heating, and/or pressure for transferring and fixing the powdered ink to record sheet **62**. A form of indirect transfer would be one in which hard, non-friable ink particles are used for the powdered ink, and the transfer is effected through carbon paper. An example of the latter form is described in U.S. patent application Ser. No. 784,300, now Patent No. 3,280,741, filed Dec. 31, 1958.

In the FIG. 1 embodiment, a heat-pressure direct transfer arrangement is illustrated. The powdered ink utilized is a heat-fusible type, and pressure roll **60** is heated so that the ink particles are fused to the record sheet **62** under the heat and pressure of that roll applied against the record sheet **62**, the ink-carrying tape **12**, and the cylinder **10**.

With this arrangement it will be appreciated that inexpensive conventional paper may be used for record sheet **62**, and that it is not required to utilize the expensive specially coated or specially prepared, charge-retentive sheet which is normally required in most other forms of electrostatic printers.

Properly positioned with respect to cylinder **10** at a further location in its rotational cycle is a cleaner unit, schematically illustrated as **70** in FIG. 1, which removes any particles yet remaining on the tapes **12** after they have passed over record sheet **62**. This unit also neutralizes the charges on tape **12**. Unit **70** may include means for electrostatically discharging the tapes and means for applying a vacuum to the tapes to pick up any remaining particles of the powdered ink.

Following is a brief description of the operation: The information to be recorded is received and applied to the pin electrodes **40** of recording head **30**, and drive roll **32** is operated through a shaft **34** to drive the tape **12**, which underlies the recording head **30** at that time, in a direction parallel to the longitudinal axis of cylinder **10**. Head **30** records a line of information on that tape as it is thus driven. When that line of information is completed, drive roll **32** is stopped or disengaged from tape **12** to terminate the movement of the tape, and cylinder **10** is rotated one increment to bring the next record tape **12** in position underlying drive roll **32** and recording head **30**. The second line of information is then recorded on the next tape **12** as it is driven parallel to the longitudinal axis of cylinder **10**. When that line of information is completed, drive roll **32** is disengaged from tape **12** underlying it, cylinder **10** is again rotated one increment to bring the next tape underneath the drive roll **32** and recording head **30**, and the next line of information is recorded on the third tape **12**. This operation continues as one line of information is recorded on successive tapes **12**.

Rotation or indexing of the cylinder **10**, after recording each line, passes the tapes **12** successively past inking unit **50**, the latter applying powdered ink to the charged areas of the tape to render those areas visible. The tapes **12** are then brought into engagement with the record sheet **62** and the pressure roll **60**, which, under heat and pressure, transfers the ink characters to the record sheet **62** as a succession of lines, thus forming a multi-line sheet. Further rotation or incrementation of cylinder **10** brings the tapes successively past the cleaning unit **70** which discharges the electrostatic charges on the tapes and removes any remaining ink particles, putting the tapes into condition for recording further information as they are moved again into operable position with respect to drive roll **32** and recording head **30**.

It is thus seen that the apparatus illustrated in FIGS. 1 and 2 is of very simple construction requiring only one printing head and, therefore, only the one circuit for actuating the one head. Thus, this arrangement has many of the simplicity advantages of a strip printer. Yet it is capable of relatively high speed printing as a page printer since only a tape need be driven and therefore the starting, stopping, and change of speed inertias are very low, comparable to a strip printer. In this particular arrangement illustrated in FIGS. 1 and 2, however, the speed of printing is limited by the requirement to rotate or increment the recording cylinder **10** one position for each new line of recording.

FIG. 3 illustrates another embodiment of the invention which is not subject to this speed limitation. In the FIG. 3 variation, recording cylinder **110** is provided with a plurality of recording heads **130** and a plurality of drive rolls **132**. Each roll is driven by its drive roll shaft **134**. The drive roll **132** and recording head **130** cooperable with the same record tape **112** are connected together by a bracket **136**, similar to the arrangement of FIGS. 1 and 2. However, there is a bracket **136** for each head **130** and record tape **112**, and all the brackets **136** are coupled together so as to rotate with the recording cylinder **110**. This is accomplished by bringing the brackets **136** to one end disk **120** and connecting the brackets to that disk. Since the disk **120** is also coupled to the shaft **118** of cylinder **110**, it is seen that as cylinder **110** rotates, the recording heads **130** will rotate therewith. Thus, a recording head **130** and a drive roll **132** will always be fixed in operable association with the same record tape, as distinguished from the FIGS. 1 and 2 arrangement where there is but one record head drive roll which operates successively on all the record tapes.

Since there is a recording head **130** and drive roll **132** for each tape, it is not necessary to increment the cylinder before recording can be started. It is only necessary that roll **132** for its respective tape be driving its tape parallel to the longitudinal axis of the cylinder before beginning to record the information for that line from its recording head **130**. Thus, the arrangement of FIG. 3 is capable of faster speed of operation.

The remaining parts of the system, namely the inking unit, the pressure roll, and the cleaning unit, may be substantially the same as those described with respect to FIGS. 1 and 2.

For very high speed operation, it may be found advantageous to continuously drive the recording cylinder, rather than to drive it intermittently. Also, the tapes can be moving before they receive the charges from their

heads, it being only critical that they stop when that line of information is completed.

The transfer from the recording cylinder **10** or **110** to the record sheet **62** through pressure roll **60** may be effected by a rolling contact of pressure roll against the record cylinder with the record sheet **62** therebetween, or may be effected by impact, wherein pressure roll **60** is actuated into and out of engagement with record sheet **62** as each tape **12** (or **112**) is in the transfer position. Cylinder **10** may have its peripheral surface **11** very smooth, particularly where printing is effected by rolling contact. However, it may be desirable to flatten the surfaces of the cylinder **10** along the strips underlying the record tapes, particularly where transfer is effected by impact. Both of these arrangements are contemplated by the phrases "cylinder," or "cylindrical member," or equivalent phrases used herein.

While there have been described several forms of the invention as embodied in electrostatic page printers, it will be understood that the invention may be embodied in other forms of recording or similar devices. Further, various features of the described embodiments may be included in other devices without other described features. Other variations, modifications and applications of the invention, or features thereof, coming within the spirit and scope of the invention as defined in the following claims, will be readily apparent to those skilled in the art.

I claim:

1. Recording apparatus comprising: a frame member rotatable about its longitudinal axis; at least one translatably supported recording medium carried by said frame member, each said recording medium being movable along a fixed portion of the periphery of said frame member parallel to the longitudinal axis of said member; means for moving said translatably supported recording medium parallel to the longitudinal axis of said frame member; and means for recording information on said recording medium as it is moved parallel to the longitudinal axis of said frame member.

2. Recording apparatus comprising: a frame member rotatable about its longitudinal axis; at least one recording tape carried by said frame member, each one of said tapes being supported on a fixed portion of the periphery of said frame member and movable parallel to the longitudinal axis of said member; means for moving said recording tape parallel to the longitudinal axis of said frame member; and means for recording information on said tape as it is moved parallel to the longitudinal axis of said frame member.

3. Recording apparatus as defined in claim **2**, wherein said tape is formed as an endless loop, and wherein there is further included a pair of rollers, one carried at each end of said frame member, said tape being supported by said rollers and passing around the inner and outer surfaces of said frame member.

4. Recording apparatus comprising: a cylindrical member rotatable about its longitudinal axis; a plurality of recording tapes carried by said cylindrical member each of said tapes being supported in spaced relation to the others on the periphery of said cylindrical member and movable parallel to the longitudinal axis of said member; means for driving said tapes parallel to the longitudinal axis of said cylindrical member; recording means for recording a line of information on said tapes individually; and means for rotating said cylindrical member to move said tapes in succession to a predetermined position to present said lines of information successively at said predetermined position.

5. Recording apparatus comprising: a cylinder rotatable along the longitudinal axis thereof; at least one strip of recording medium carried by said cylinder, said strip

of recording medium extending along the outer periphery of said cylinder parallel to its longitudinal axis; a matrix-type recording head; means for effecting relative movement between said recording head and said strip of recording medium in a direction parallel to the longitudinal axis of said cylinder to record on the recording medium a line of information; and means for rotating said cylinder to transfer from said recording medium to a record-receiving sheet said line of information.

6. Recording apparatus comprising: a cylinder rotatable along the longitudinal axis thereof; a plurality of strips of recording medium carried by said cylinder, each of said strips a recording medium being spaced from each other and extending along the outer periphery of said cylinder parallel to its longitudinal axis; a matrix-type recording head; means for effecting relative movement between said recording head and each individual strip of recording medium in a direction parallel to the longitudinal axis of said cylinder to record on each strip of recording medium a line of information; and means for rotating said cylinder to transfer from said strips of recording medium to a record-receiving sheet said lines of information.

7. Recording apparatus comprising: a cylindrical member rotatable about its longitudinal axis; a plurality of recording tapes carried by said cylindrical member each of said tapes being supported in spaced relation to the others on the periphery of said cylindrical member and movable parallel to the longitudinal axis of said member; means for driving said tapes parallel to the longitudinal axis of said cylindrical member; at least one electrostatic recording head for electrostatically recording a line of information on said tapes individually; and means for rotating said cylindrical member to move said tapes in succession to a predetermined position to present said lines of information successively at said predetermined position.

8. Recording apparatus as defined in claim **7**, wherein said recording head includes a plurality of pin electrodes selectively actuatable in accordance with the information to be recorded.

9. Recording apparatus as defined in claim **7**, further including means for applying to the tapes powdered ink to render visible the electrostatically recorded information.

10. Recording apparatus as defined in claim **7**, further including means located at said predetermined position for transferring said lines of recorded information to a record sheet.

11. Recording apparatus as defined in claim **7**, wherein there is included only one electrostatic recording head, and further wherein said means for driving said tapes is a drive roll, both said recording head and said drive roll being mounted in position to engage successively each of said recording tapes as said cylindrical member is rotated.

12. Recording apparatus as defined in claim **7**, wherein there is provided a plurality of electrostatic recording heads, one for each of said recording tapes.

13. Recording apparatus as defined in claim **12**, wherein the means for driving the tapes comprises a drive roll for each tape, the drive roll and recording head for each recording tape being fixed to said cylinder to rotate therewith.

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BERNARD KONICK, *Primary Examiner.*

J. BREIMAYER, *Assistant Examiner.*